Learning Outcomes-Based Curriculum Framework (LOCF)

Scheme and Syllabus of

B. Voc. (Biomedical Sciences)

(Three-Year Bachelor's Degree Programme)

w.e.f. 2022-23

Department of Vocational Studies and Skill Development

School of Life-long Learning

Central University of Haryana
Mahendergarh, Haryana

BACKGROUND

Considering the curricular reforms as instrumental for desired learning outcomes, all the academic departments of Central University of Haryana made a rigorous attempt to revise the curriculum of undergraduate and postgraduate programmes in alignment with National Education Policy-2020 and UGC Quality Mandate for Higher Education Institutions-2021. The process of revising the curriculum could be prompted with the adoption of "Comprehensive Roadmap for Implementation of NEP-2020" in the 32nd meeting of the Academic Council of the University held on April 23, 2021. The roadmap identified the key features of the Policy and elucidated the Action Plan with well-defined responsibilities and indicative timeline for major academic reforms.

The process of revamping the curriculum started with the series of webinars and discussions conducted by the University to orient the teachers about the key features of the Policy, enabling them to revise the curriculum in sync with the Policy. Proper orientation of the faculty about the vision and provisions of NEP-2020 made it easier for them to appreciate and incorporate the vital aspects of the Policy in the revised curriculum focused on 'creating holistic, thoughtful, creative and well-rounded individuals equipped with the key 21st century skills' for the 'development of an enlightened, socially conscious, knowledgeable, and skilled nation'.

With NEP-2020 in background, the revised curricula articulate the spirit of the policy by emphasizing upon— integrated approach to learning; innovative pedagogies and assessment strategies; multidisciplinary and cross-disciplinary education; creative and critical thinking; ethical and Constitutional values through value-based courses; 21st century capabilities across the range of disciplines through life skills, entrepreneurial and professional skills;

community and constructive public engagement; social, moral and environmental awareness; Organic Living and Global Citizenship Education (GCED); holistic, inquiry-based, discovery-based, discussion-based, and analysis-based learning; exposure to Indian knowledge system, cultural traditions and classical literature through relevant courses offering 'Knowledge of India'; fine blend of modern pedagogies with indigenous and traditional ways of learning; flexibility in course choices; student-centric participatory learning; imaginative and flexible curricular structures to enable creative combination of disciplines for study; offering multiple entry and exit points initially in undergraduate programmes; alignment of Vocational courses with the International Standard Classification of Occupations; breaking the silos of disciplines; integration of extra-curricular and curricular aspects; exploring internships with industry and businesses; closer collaborations between industry and higher education institutions for technical, vocational and science programmes; and formative assessment tools to be aligned with the learning outcomes, capabilities, and dispositions as specified for each course.

In case of UG programmes in Engineering and Vocational Studies, it was decided that the departments shall incorporate pertinent NEP recommendations while complying with AICTE, NBA, NSQF, International Standard Classification of Occupations, Sector Skill Council, Industry and other relevant agencies/sources. The University has also developed consensus on adoption of Blended Learning with 40% component of online teaching and 60% face to face classes for each programme.

The revised curricula of B.Voc. Biomedical Sciences program has been devised with concerted efforts of the faculty, Heads of the Departments, Industry experts and members of Life Sciences Sector Skill Development Council (LSSSDC). Curriculum is aligned with National Skill Qualification Framework (NSQF) and has adopted job roles corresponding to NSQF level-4

to NSQF level-7 from the LSSSDC. These job roles are *Machine Operator* (NSQF Level-4), *Quality Control Chemist* (NSQF Level-5), *Licensing Manager* (NSQF Level-6) & *EHS Manager* (NSQF Level-7).

The draft prepared by each department was discussed in series of discussion sessions conducted at Department, School and the University level. The leadership of the University has been a driving force behind the entire exercise of developing the uniform template and structure for the revised curriculum. The Vice Chancellor of the University conducted series of meetings with Heads and Deans to deliberate upon the vital parameters of the revised curriculum to formulate a uniform template. The experts of various Boards of Studies and School Boards contributed to a large extent in giving the final shape to the revised curriculum of each programme.

To ensure the implementation of curricular reforms envisioned in NEP-2020, the University has decided to implement various provisions in a phased manner. Accordingly, the curriculum may be reviewed annually.

PROGRAMME OUTCOMES

After successful completion of the programme, the students shall be able to:

PO1. Scientific knowledge: Apply the knowledge of science and industrial technology to the solution of scientific problems in the industry.

PO2. Problem analysis: Identify, formulate, research literature, and analyze complex scientific problems reaching substantiated conclusions using first principles of biological sciences, and chemical sciences.

PO3. Design/development of solutions: Design solutions for complex problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tools usage: Create, select, and apply appropriate techniques, resources, and modern computing and IT tools including prediction and modeling to complex scientific activities with an understanding of the limitations.

PO6. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the scientific practice.

PO7. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO8. Communication: Communicate effectively on complex activities with the scientific community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO9. Project management: Demonstrate knowledge understanding of the scientific and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO10. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PROGRAMME SPECIFIC OUTCOMES

On completing B.Voc. Biomedical Sciences, the students shall be able to:

PSO-1. Perform manufacturing activities and carry out post manufacturing outcomes.

PSO-2. Conduct quantitative and qualitative analysis to ensure specified quality of the manufactured products.

PSO-3. Manages the work of licensing team in order to ensure that the appropriate licenses are in place for carrying out the life sciences facility operations.

PSO-4. Perform routine analysis in the laboratory while ensuring compliance to god manufacturing processes (GMP) and good laboratory practices (GLP).

PSO-5. Carry out reporting and documentation to meet quality standards.

PSO-6. Coordinate with supervisors and colleagues within and outside the department.

PSO-7. Maintain a healthy, safe and secure working environment in the life science facility.

PSO-8. Use individual judgment to determine if results or processes comply with regulations and approved standards

PSO-9. Make team decisions rather than individual decisions

PSO-10. Listen effectively and orally communicate information accurately

TEACHING LEARNING OUTCOME METHODOLOGIES

Learning based curriculum designed for various courses under B. Voc. (Biomedical Sciences) Programme aim for dissemination of up-to-date knowledge, development of student's capability to use ideas and information, and their ability to test those ideas and evidence. The courses also aim for facilitating the personal development and capacity of students to plan and manage their own learning. Instead of using traditional teaching methods, new teaching methods and pedagogical tools are required to ensure the achievement of desired learning outcomes for each of the courses. In view of the programme outcomes, following teaching methodologies will be used:

- Class room lectures
- Use of up-to-date textbooks, other learning resources
- Use of internet to support and explore the knowledge
- Use of case studies
- Practical exercises for each course to augment the learning
- Work experience through internship and fieldwork
- Projects
- Demonstrations
- Group working
- Simulations (e.g., computer based)
- Problem solving
- Discussion and debate
- Role play
- Quizzes
- Seminar presentations
- Class presentations
- Tutorials
- Examination papers

ASSESSMENT OUTCOME MEASUREMENT METHODS

Methods of measuring student learning are often characterized as summative or formative assessments:

Summative assessments: It includes case study analysis, assessment and evaluation of internship reports, project report evaluation, tests, quizzes, and other graded course activities that are used to measure the performance of learner. These assessments are cumulative and often reveal what students have learned at the end of a unit or the end of a course. Within a course, summative assessment includes the system for calculating individual student grades.

Formative assessment: It includes any means by which students receive input and guiding feedback on their relative performance to help them improve. It can be provided face-to-face in office hours, in written comments on assignments.

An array of direct and indirect methods should be used based upon the above-mentioned methodologies and assessment tools to assess the level of learning outcome(s) under each course with more weightage on 'Formative Assessment' to ensure that the learner improves during the teaching learning process. Direct measures require a learner to present or demonstrate their learning or produce work so that observers can assess how well students' work or responses fit institution-or program-level expectations of outcomes. It includes examinations, field experience, internship, lab reports, case studies, etc. as mentioned under Teaching Learning Outcome Methodologies and Summative Assessment. Through the indirect measures, the observer would be able to infer student abilities, knowledge, and values based on an analysis of reported perceptions about student mastery of outcomes using the indirect measures.

BLENDED LEARNING

B.Voc. Biomedical Sciences is focused to provide quality skill education. Success of skill education requires direct interaction of students with the industrial experts and hands-on-industrial training. Learning at B.Voc. Retail and Logistics Management program in CUH involves regular expert lectures of the industrial experts. With the online classes being the option in NEP-2020, department will be conducting online expert classes from the industry for the skill enhancement of the students.

SCHEME AND SYLLABUS

Bachelor of Vocation (B.Voc.) in

Biomedical Sciences

DEPARTMENT of VOCATIONAL Studies and Skill Development

School of Life-long Learning

Central University of Haryana

Mahendergarh, Haryana

CENTRAL UNIVERSITY OF HARYANA

School of Life-long Learning

Department of Vocational Studies and Skill Development

B. Voc. (BIOMEDICAL SCIENCES)
(Three-Year Degree Programme)
(Semester-wise Course Structure)
(w.e.f. 2022-23)

B. Voc. (BIOMEDICAL SCIENCES)

SEMESTER – I

GENERAL EDUCATION COMPONENT							
Type of Course	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credit**	**Marks**
CC	SLLL BMS 11 01 C 4004	Human Physiology	4	4	0	4	100
CC	SLLL BMS 11 02 C 4004	Physical and Inorganic chemistry	4	4	0	4	100
CC	SLLL BMS 11 03 C 2002	English Communication	2	2	0	2	50
CC	SLLL BMS 11 04 C 0042	Practical	0	0	4	2	50
Total						**12**	**300**
SKILL EDUCATION COMPONENT							
SC	Specific Job Role defined by SSCs as per the guidelines of NSQF.					**18**	
Total Credits						**30**	

SEMESTER – II

GENERAL EDUCATION COMPONENT							
Type of Course	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credit**	**Marks**
CC	SLLL BMS 12 01 C 4004	Biomolecules and Enzymology	4	4	0	4	100
CC	SLLL BMS 12 02 C 4004	Environmental Science	4	4	0	4	100
CC	SLLL BMS 12 03 C 2002	Analytical Chemistry	2	2	0	2	50
CC	SLLL BMS 12 04 C 0042	Practical	0	0	4	2	50
Total						**12**	**300**
SKILL EDUCATION COMPONENT							
SC	Specific Job Role defined by SSCs as per the guidelines of NSQF.					**18**	
Total Credits						**30**	

B. Voc. (BIOMEDICAL SCIENCES)

SEMESTER – III

GENERAL EDUCATION COMPONENT							
Type of Course	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credit**	**Marks**
CC	SLLL BMS 23 01 C 4004	Metabolism of Biomolecules	4	4	0	4	100
CC	SLLL BMS 23 02 C 4004	Organic chemistry	4	4	0	4	100
CC	SLLL BMS 23 03 C 2002	Introduction to Microbiology	2	2	0	2	50
CC	SLLL BMS 23 04 C 0042	Practical	0	0	4	2	50
Total						**12**	**300**
SKILL EDUCATION COMPONENT							
SC	Specific Job Role defined by SSCs as per the guidelines of NSQF.					**18**	
Total Credits						**30**	

SEMESTER – IV

GENERAL EDUCATION COMPONENT							
Type of Course	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credit**	**Marks**
CC	SLLL BMS 24 01 C 4004	Cell Biology	4	4	0	4	100
CC	SLLL BMS 24 02 C 4004	Pharmacology	4	4	0	4	100
CC	SLLL BMS 24 03 C 2002	Medical Microbiology	2	2	0	2	50
CC	SLLL BMS 24 04 C 0042	Practical	0	0	4	2	50
Total						**12**	**300**
SKILL EDUCATION COMPONENT							
SC	Specific Job Role defined by SSCs as per the guidelines of NSQF.					**18**	
Total Credits						**30**	

B. Voc. (BIOMEDICAL SCIENCES)

SEMESTER – V

GENERAL EDUCATION COMPONENT							
Type of Course	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credit**	**Marks**
CC	SLLL BMS 35 01 C 4004	Medical Genetics	4	4	0	4	100
CC	SLLL BMS 35 02 C 4004	Molecular Biology	3	3	0	3	75
CC	SLLL BMS 35 03 C 2002	Medical Biotechnology	3	3	0	3	75
CC	SLLL BMS 35 04 C 0042	Practical	0	0	4	2	50
Total						**12**	**300**
SKILL EDUCATION COMPONENT							
SC	Specific Job Role defined by SSCs as per the guidelines of NSQF.					**18**	
Total Credits						**30**	

SEMESTER – VI

GENERAL EDUCATION COMPONENT							
Type of Course	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credit**	**Marks**
CC	SLLL BMS 36 01 C 4004	Immunology	4	4	0	4	100
CC	SLLL BMS 36 02 C 4004	Natural Product and Heterocyclic Chemistry	4	4	0	4	100
CC	SLLL BMS 36 03 C 2002	Medicinal Chemistry	2	2	0	2	0
CC	SLLL BMS 36 04 C 0042	Practical	0	0	4	2	50
Total						**12**	**300**
SKILL EDUCATION COMPONENT							
SC	Specific Job Role defined by SSCs as per the guidelines of NSQF.					**18**	
Total Credits						**30**	

L: Lectures T: Tutorial P: Practical

CC: Core Course SC: Skill Course

Semester I

Human Physiology

Course code: SLLL BMS 11 01 C 4004

Credits: 4; Total hours: 60

Course Objective: *The objective of the course in human physiology 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 also outlines the factors and biochemical events that disrupt homeostasis leading to various diseases. The course will prepare students for higher education in any field related to molecular medicine.*

Course learning outcomes

Unit 1: The tissue level of organization

After completion of the unit, students will be able to:

- Identify the main tissue types and discuss their roles in the human body
- Identify the four types of tissue membranes and the characteristics of each that make them functional
- Explain the functions of various epithelial tissues and how their forms enable their functions
- Explain the functions of various connective tissues and how their forms enable their functions
- Describe the characteristics of muscle tissue and how these enable function
- Discuss the characteristics of nervous tissue and how these enable information processing and control of muscular and glandular activities

Unit 2: Blood

After completion of the unit, students will be able to:

- Identify the primary functions of blood, its fluid and cellular components, and its physical characteristics
- Identify the most important proteins and other solutes present in blood plasma
- Describe the formation of the formed element components of blood

- Discuss the structure and function of red blood cells and hemoglobin
- Classify and characterize white blood cells
- Describe the structure of platelets and explain the process of hemostasis
- Explain the significance of AB and Rh blood groups in blood transfusions
- Discuss a variety of blood disorders

Unit 3: Bone tissue and skeletal system

After completion of the unit, students will be able to:

- List and describe the functions of bones
- Describe the classes of bones
- Discuss the process of bone formation and development
- Explain how bone repairs itself after a fracture
- Discuss the effect of exercise, nutrition, and hormones on bone tissue
- Describe how an imbalance of calcium can affect bone tissue

Unit 4: Gastrointestinal and Hepatic system

After completion of the unit, students will be able to:

- List and describe the functional anatomy of the organs and accessory organs of the digestive system
- Discuss the processes and control of ingestion, propulsion, mechanical digestion, chemical digestion,
- Absorption, and defecation
- Discuss the roles of the liver, pancreas, and gallbladder in digestion
- Compare and contrast the digestion of the three macronutrients

Unit 5: The nervous system and nervous tissue

After completion of the unit, students will be able to:

- Name the major divisions of the nervous system, both anatomical and functional
- Describe the functional and structural differences between gray matter and white matter structures
- Name the parts of the multipolar neuron in order of polarity
- List the types of glial cells and assign each to the proper division of the nervous system, along with their function(s)

- Distinguish the major functions of the nervous system: sensation, integration, and response
- Describe the components of the membrane that establish the resting membrane potential
- Describe the changes that occur to the membrane that result in the action potential
- Explain the differences between types of graded potentials
- Categorize the major neurotransmitters by chemical type and effect

Unit 6: Renal Physiology

After completion of the unit, students will be able to:

- Describe the composition of urine
- Label structures of the urinary system
- Characterize the roles of each of the parts of the urinary system
- Illustrate the macroscopic and microscopic structures of the kidney
- Trace the flow of blood through the kidney
- Outline how blood is filtered in the kidney nephron
- Provide symptoms of kidney failure
- List some of the solutes filtered, secreted, and reabsorbed in different parts of the nephron
- Describe the role of a portal system in the kidney
- Explain how urine osmolarity is hormonally regulated
- Describe the regulation of major ions by the kidney
- Summarize the role of the kidneys in maintaining acid–base balance

Unit 7: Fluid electrolytes and acid-base balance

After completion of the unit, students will be able to:

- Identify the body's main fluid compartments
- Define plasma osmolality and identify two ways in which plasma osmolality is maintained
- Identify the six ions most important to the function of the body
- Define buffer and discuss the role of buffers in the body
- Explain why bicarbonate must be conserved rather than reabsorbed in the kidney
- Identify the normal range of blood pH and name the conditions where one has a blood pH that is either too high or too low

Unit 8: The Endocrine System

After completion of the unit, students will be able to:

- Identify the contributions of the endocrine system to homeostasis
- Discuss the chemical composition of hormones and the mechanisms of hormone action
- Summarize the site of production, regulation, and effects of the hormones of the pituitary, thyroid, parathyroid, adrenal, and pineal glands
- Discuss the hormonal regulation of the reproductive system
- Explain the role of the pancreatic endocrine cells in the regulation of blood glucose
- Identify the hormones released by the heart, kidneys, and other organs with secondary endocrine functions
- Discuss several common diseases associated with endocrine system dysfunction.

Course Content:

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. Haemostasis. 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: 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 8: 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.

Suggested Textbook:

1. Fox, S.I. (2018) Human Physiology 15th ed., McGraw Hill International Publications, (New York) ISBN 978-1259864629.
2. 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.
3. OpenStax College, Anatomy & Physiology. OpenStax College. 25 April 2013. <http://cnx.org/content/col11496/latest/

Suggested References:

1. Guyton, A.C. and Hall, J.E., (2016) Reed Textbook of Medical Physiology 13th ed.,

Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1455770052

2. Sherwood, L. (2012) Introduction to Human Physiology 8th edition; Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544.

Semester I

Physical and Inorganic Chemistry

Course code: SLLL BMS 11 02 C 4004

Credits: 4; Total hours: 60

Course Objective: *The objective of this course is to offer detailed knowledge about the Thermodynamics, Kinetics, Catalysis, Equilibrium, Buffers, Disperse Systems and Complexation.*

Course Learning Outcomes:

Unit 1: Thermodynamics, Kinetics and Catalysis

After completion of the unit, students will be able to:

- Understand the concepts of thermodynamics
- Apply the laws of thermodynamics
- Describe the basic concepts of kinetics
- Determine the rate of a reaction
- Understand and Apply the Theories of reaction rate and Catalysis.

Unit 2: Equilibrium and Buffers

After completion of the unit, students will be able to:

- Describe the properties of chemical equilibrium
- Explain, using Le Chatelier's Principle, how the equilibrium effected by changes in Temperature, Volume, Pressure and Concentrations.
- State the definition of an Arrhenius acid, a Bronsted-Lowrey acid and a Lewis acid.
- Solve problems using ionization constants, concentrations and pH or pOH for weak acids and weak bases.
- Describe the preparation of a buffer.
- Discuss the common ion effect as it relates to acids and bases in solution.

Unit 3: Disperse System

After completion of the unit, students will be able to:

- Describe classifications of dispersed systems, based on the phases of the components, and based on the size of the dispersed particles.
- Understand the importance of pharmaceutical dispersions.
- Explain the preparation of Emulsions and their stabilisation.

Units 4: Complexation

After completion of the unit, students will be able to:

- Differentiate between different types of complexes
- List the methods of analysis of complexes
- Describe the applications of complexes.

Course Content:

Unit 1: Thermodynamics, Kinetics and Catalysis (15h)

Thermodynamics: First law, second law and third law of thermodynamics, concept of enthalpy and entropy, Hess's law; **Kinetic:** Rate and Rate Equation Order and molecularity, zero, first, Second and pseudo first order reactions, Half-life, Shelf life and the Factors affecting the Rate of Reactions; **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 2: Equilibrium and Buffers (15h)

Chemical equilibrium: Reversible reactions, law of mass action, equilibrium constant, factors influence equilibrium states, relation between Kp and Kc, Van't Hoff reaction isotherm, Van't Hoff Equation; **Ionic Equilibrium:** Acids, bases, pH scale, buffer solutions, indicators, buffer equations and buffer capacity in general; **Buffers in pharmaceutical systems:** Preparation, stability, buffered isotonic solutions, measurements of tonicity, calculations, and methods of adjusting isotonicity

Unit 3: Disperse System **(15h)**

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

Unit 4: Complexation **(15h)**

Metal complexes, organic molecular complexes, occlusion compounds and analysis of complexation, protein binding, hydrophobic interaction, and self-association. Applications of complexes; Chelates and Metalloproteins: Chelate, Metalloporphyrin

Suggested Textbooks:

1. Martin A, Bustamante P, Chun AHC. **Physical Pharmacy**. New Delhi: B.I. Waverly Pvt. Ltd.
2. Puri BR, Sharma LR, Pathania MS. **Principles of Physical Chemistry**. New Delhi: Chand and Co.
3. Martin W, Swarbrick J, Cammarata A. **Physical Pharmacy**. Lea & Febiger, Philadelphia. Latest Edition.

Reference Books:

1. Remington: The Science and Practice of Pharmacy. Mack Publishing Co., U.S.A.
2. Lee., J. D. **A new Concise Inorganic Chemistry**, Pearson Education.
3. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A., Shriver and Atkin's Inorganic Chemistry, Oxford.
4. Castellan, G. W., **Physical Chemistry**, Narosa.

Semester I

English Communication

Course code: SLLL BMS 11 03 C 2002

Credits: 2; Total hours: 30

Course Objective: *Effective communication is an essential skill for success in any sphere of activity, from leadership responsibilities, teamwork, interviews, presentations, and inter-personal relations. This is a skill that needs to be taught in a systematic manner so that students imbibe the fundamentals of communication.*

The ability to think critically is crucial for a good communicator and involves an understanding of the communicative process. Therefore, we need to study every stage of this process systematically in order to be much more effective at communicating successfully – interviews, public speaking, letter writing, report writing, presentations, and inter-persona debates and conversations.

Course learning outcomes

Unit 1:

After completion of the unit, students will be able to

- Understand the importance of effective communication
- Describe the barriers for effective communication
- Apply the rules of effective communication to improve their communication skills.

Unit 2:

After completion of the unit, students will be able to

- Identify the styles of communication
- Describe different elements of communication
- Understand the role of body language in communication
- Describe factors built our perspectives

Unit 3:

After completion of the unit, students will be able to

- Describe and practice the elements of active listening to become active listener.

- Express the concepts through writing.
- Organize the message, lecture and practice brief and conscience writing.

Unit 4:

After completion of the unit, students will

- Have the knowledge of dos and don'ts of an interview
- Be able to deliver effective presentations
- Be able to draft email, C.V.'s and reports for business purposes.
- Develop communication skills for group discussion.

Course Content:

Unit 1: (6h)

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 2: (6h)

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 3: (7h)

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 4: **(11h)**

Interview Skills: Purpose of an interview, Do's and Don'ts 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 Don'ts of group discussion; **Correspondence:** Personal, official and Business, Report writing, drafting an email, Writing of C.V.

Suggested Textbooks:

1. Interview skills and Group discussion, Praveen Joe I.R. Laxmi Publication.
2. Group discussion, job interview skill, Nitin Sharma, Unicorn books pvt Ltd.
3. Adair, John effective communication, London: Pan Macmillan Ltd.
4. Basic communication skills, Sonu Marwah.

Reference Books:

1. Personality development and communication skills, Dr. S.S. Narula, Taxmann publications pvt ltd.
2. Listening skills, Master the art of listening and communication skills, Michele Gilbert.
3. Communication skills, Sanjay kumar, Pushplata, Oxford University Press.
4. Active listening, the forgotten skill, Corbison, Nitor publication.

Semester I

Practical

Course code: SLLL BMS 11 04 C 0042

Credits: 2; Total hours: 60

Course Objective: *The objective of this course is to provide knowledge of basic laboratory preparation and sensitize them towards the necessity of good laboratory practices and Standard Operating Procedures. This course introduces students to the basic human physiology experiments where students learn to prepare slides and counts cells use the microscope. The course also covers the preparation of different volumetric and buffer solutions, evaluating how various factors affect the rate of reaction.*

Course learning outcomes

After completing the course, students will be able to:

- Count the RBC, WBC, different types of leukocytes present in an individual.
- Estimate the amount of hemoglobin in an individual
- Identify type of blood group of an individual
- Measure the blood pressure using sphygmomanometer
- To perform experiments using good laboratory practices
- To report observations and report the experiments
- Learn different ways of expressing concentration of solution
- Convert one form of concentration to another, e.g., Molarity to g/L.
- Prepare different volumetric solutions using a solid or liquid compound.
- Determine the concentration of given solution-using titration.
- Learn to operate pH meter.
- Synthesise a coordination complex.

Course Content:

1. Introduction to Good laboratory practices
2. Introduction to the Microscope
3. Estimation of haemoglobin

4. Determination of bleeding time and clotting time of blood.
5. Determination of total erythrocyte count.
6. Determination of total leukocyte count.
7. To perform differential leukocyte count of blood.
8. Blood Pressure recordings in humans.
9. Determination of blood group
10. Preparation of volumetric solutions and Determination of concentration of an unknown solution by using titration.
11. Preparation of buffer solutions and determination of pH
12. Experiment to study the effect of concentration, Temperature, and surface area on the rate of reaction.
13. Preparation of lyophilic and lyophobic sols.
14. Synthesis of a coordination compound: metal acetyl acetonate

Suggested Textbooks:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (Latest ed.), **Vogel's Textbook of Quantitative Chemical Analysis,** 5th Edn.**,** John Wiley and Sons Inc,.
2. Ahluwalia, V.K.; Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.

Reference Books:

1. Indian Pharmacopoeia (Latest Edition)

Semester II

Biomolecules & Enzymology

Course code: SLLL BMS 12 01 C 4004

Credits: 4; Total hours: 60

Course Objective: *The objective of this course is to offer detailed knowledge about the biomolecules present inside the cell. The course focuses on giving a deeper insight into the fundamentals of structure and function different biomolecules.*

Course Learning Outcome

Unit 1: Carbohydrate

Students will get a grasp on structure and their criterion of classification of carbohydrates. They will be able to understand role of different types of carbohydrates in a cell.

Unit 2: Lipids

Students will learn about structure and function of building blocks of lipids. They will also learn about physio-chemical properties of fatty acids.

Unit 3: Proteins

Students will learn composition and structure of protein. They will also learn different organization level of protein and their functions in the cell. They will also learn how enzyme behave when the optimum conditions are changed.

Units 4: Nucleotides

Students will learn composition and structure of nucleotides. They will also learn about the model and role of DNA and RNA in cell functioning.

Course Content:

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

Definition, classification, structure and functions of carbohydrates; **Monosaccharides-** Glucose, Fructose, Galactose, Mannose, Stereoisomers, 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, 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.

Semester II

Environmental Sciences

Course code: SLLL BMS 12 02 C 4004

Credits: 4; Total hours: 60

Course Objective: *This course introduces students to environment concerns. Students are expected to learn about environment, factors affecting it, environmental ethics and its protection through lectures, presentations, documentaries and field visits.*

Course learning outcomes

CO1: Understand the relationship between humans and their environment, predict the consequences of human actions on the environment, global economy and quality of human life

CO2: Gain in-depth knowledge on natural processes that sustain life.

CO3: Develop critical thinking for environmental protection and conservation of biodiversity, social equity and sustainable development

CO4: Acquire values and attitudes towards understanding complex environmental-socioeconomical challenges, knowledge of pollution and environmental degradation.

CO5: Understand the fundamental concepts of various ecosystems.

CO6: Adopt sustainability as a practice in life, society and industry.

Course Content:

Unit 1: Introduction to Environmental Science (10h)

Multidisciplinary nature of environmental studies; components of environment – atmosphere, hydrosphere, lithosphere and biosphere. Scope and importance; Concept of sustainability and sustainable development; **Ecosystems:** What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chain, food web and ecological succession. Case studies of the following ecosystems: a) Forest ecosystem b) Grassland ecosystem c) Desert ecosystem d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 2: Natural resources, Biodiversity and conservation (20h)

Natural Resources: Renewable and Non-renewable Resources Land Resources and land use change; Land degradation, soil erosion and desertification; Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations; Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state); Heating of earth and circulation of air; air mass formation and precipitation; Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies; **Biodiversity and Conservation:** Levels of biological diversity: genetic, species and ecosystem diversity; Biogeography zones of India; Biodiversity patterns and global biodiversity hot Spots; India as a mega-biodiversity nation; Endangered and endemic species of India; Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity; Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit 3: Environment pollution, policies and practices (18h)

Environmental Pollution: Environmental pollution: types, causes, effects and controls; Air, water, soil, chemical and noise pollution; Nuclear hazards and human health risks; Solid waste management: Control measures of urban and industrial waste; Pollution case studies.

Environmental Policies & Practices: Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture; Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; International agreements; Montreal and Kyoto protocols and conservation on Biological Diversity (CBD). The Chemical Weapons Convention (CWC); Nature reserves, tribal population and rights, and human, wildlife conflicts in Indian context.

Unit 4: Human Communities and the Environment (12h)

Human population and growth: Impacts on environment, human health and welfares; Carbon foot-print, Resettlement and rehabilitation of project affected persons; case studies; Disaster management: floods, earthquakes, cyclones and landslides; Environmental movements: Chipko, Silent valley, Bishnios of Rajasthan; Environmental ethics: Role of Indian and other

religions and cultures in environmental conservation; Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi, Swachh Bharat Abhiyan).

Field work:

- Visit to an area to document environmental assets; river/forest/flora/fauna, etc.
- Visit to a local polluted site Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds and basic principles of identification.
- Study of simple ecosystems-pond, river, ridge, etc.

Suggested Text Books:

1. Basu, M., Xavier, S. (2016). Fundamentals of Environmental Studies, Cambridge University Press, India
2. Bharucha, E. (2013). Textbook of Environmental Studies for Undergraduate Courses. Universities Press.
3. De, A.K., (2006). Environmental Chemistry, 6th Edition, New Age International, New Delhi.
4. Masters, G. M., &Ela, W. P. (1991). Introduction to environmental engineering and science. Englewood Cliffs, NJ: Prentice Hall.
5. Kaushik A. and Kaushik C.P., (2011) Perspectives in Environmental Studies, New age International Publishers, New Delhi, India.

Reference Books:

1. Carson, R. *2002. Silent Spring.* Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R.1993. This *Fissured Land:* An Ecological History of India Univ. of California Press.
3. Gleick, P.H. 1993. Water in *Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
4. Groom, Martha J. Gary K. Meffe, and Carl Ronald carroll. *Principles of Conservation Biology.* Sunderland: Sinauer Associates, 2006.
5. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339: 36-37.
6. McCully, P.1996. *Rivers no more: the environmental effects of dams* (pp. 29-64). Zed Books.

7. McNeil, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
8. Odum, E.P., Odum, h.T. & Andrews, J.1971. *Fundamentals of Ecology.* Philadelphia: Saunders. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
9. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment.* Oxford and IBH Publishing Co. Pvt. Ltd.
10. Raven, P.H., Hassenzahl, D.M. & Berg, L R. 2012. *Environment.* 8th edition. John Wiley & Sons.
11. Rosencranz, A., Divan, S., & Noble, M.L. 2001. *Environmental law and policy in India.* Tripathi 1992.
12. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation.* S. Chand Publishing, New Delhi.
13. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. *Conservation Biology: Voice from the Tropics.* John Wiley & Sons.
14. Thapar, V. 1998. *Land of the Tiger: A Natural History of the Indian Subcontinent.*
15. Wilson, E.O. 2006. *The Creation: An appeal to save life on earth.* New York: Norton.

Semester II

Analytical Chemistry

Course code: SLLL BMS 12 03 C 2002

Credits: 2; Total hours: 30

Course Objective: *The objective of this course is to offer knowledge about the gases, Liquids, and their physiochemical behaviour. This course also provides Knowledge of the spectroscopic technique for the structural identification and characterization of simple organic compounds.*

Course Learning Outcome:

Unit 1: Gases and Liquids

After completion of this unit, students will be able to

- Describe the properties of gases
- Use kinetic theory to explain gas behaviour
- Recognize why gases do not behave as ideal gases
- Understand the surface tension, viscosity and other properties of fluid
- Distinguish between ideal and real solutions
- Explain colligative properties

Unit 2: Spectroscopy

After completion of this unit, students will be able to

- Study and solve problems of Ultraviolet and Visible spectroscopy of organic molecules
- Understand Infrared spectroscopy and its applications to structural problems.
- Learn important terms and theory of Nuclear Magnetic Resonance spectroscopy and Mass spectroscopy
- Solve problems based on UV, IR Spectroscopy to interpret structure.

Course Content:

Unit 1: Gases and Liquids (15h)

Behaviour of Gases: Kinetic theory of gases, deviation from behaviours and explanation. **The Liquid State**: Physical properties (surface tension, viscosity, refractive index, optical rotation, dipole moments and chemical constituents). **Solutions**: Ideal and real solutions, solutions of gases in liquids, colligative properties, partition coefficient, conductance and its measurement, Debye Huckel theory.

Unit 2: Spectroscopy (15h)

Basic Principles of UV Spectroscopy: Application of Woodward-Fieser rule in interpretation of Organic compounds: Application of visible, ultraviolet and infrared spectroscopy in organic molecules. Electromagnetic radiation, electronic transitions, λmax & εmax, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating λmax of conjugated dienes and α, β – unsaturated compounds. **Basic principles of IR Spectroscopy**: Identification of Functional groups of various classes of organic compounds: Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions). Brief introduction to **NMR and Mass Spectrometry**

Suggested Textbooks:

1. B.R.Puri, L.R.Sharma, M.S.Pathania, **Principles of Physical Chemistry,** Vishal Publishing Co., Latest Edition.
2. R.M. Silverstein, G.C. Bassler & T.C. Morrill: **Spectroscopic Identification of Organic Compounds**, John Wiley & Sons.

Reference Books:

1. Castellan, G. W., **Physical Chemistry**, Narosa, Latest Edition.
2. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8th Ed., Oxford University Press
3. Kemp W. **Organic Spectroscopy**: London: ELBS / WH Freeman & Co
4. John R. Dyer, **Applications of absorption spectroscopy of organic compounds**, Prentice Hall India

Semester II

Practical

Course code: SLLL BMS 12 04 C 0042

Credits: 2; Total hours: 60

Course Objective: *The objective of this course is to give hands-on-training to basic biochemistry experiments. Students will be skilled to identify and quantify the carbohydrates, proteins and lipids. Students will learn to examine the effects of physical conditions on enzymes and factors affecting the rate of reaction. This course covers the determination of properties like viscosity, Surface tension and absorbance properties. One important objective of this course to teach students the use of UV-Vis spectrophotometer.*

Course learning outcomes

At the end of this course, Student will be able to

- Learn to determine viscosity and surface tension.
- Determine the partition coefficient of compounds in two immiscible solvents.
- Operate UV- Visible spectrophotometer.
- Verify Beer- Lambert's law.
- Determine the concentration of unknown solution using UV-Visible spectrophotometer.

Course Content:

1. Qualitative tests for Carbohydrates
2. Qualitative tests for Proteins
3. Determination of saponification value of fats and oil.
4. Determination of Iodine number of a fat sample.
5. Titration curve of Glycine.
6. Determination of alkaline phosphatase activity from germinating seeds.
7. To determine temperature optima for alkaline phosphatase
8. To examine effect of pH on activity of alkaline phosphatase
9. To study the effect of substrate concentration on activity of alkaline phosphatase and determination of Km and Vmax of the reaction.
10. Preparation of casein from milk and determination of its isoelectric point.

11. Determination of the relative and absolute viscosity of a liquid dilute solution using an Ostwald's viscometer.
12. Determination of surface tension using stalagmometer.
13. Determination of partition coefficient.
14. Verification of Beer's law using KMnO4 or CuSO4 Solution and determination of concentration of unknown solution
15. Spectroscopic determination of aspirin in tablet

Suggested Textbooks:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (Latest ed.), **Vogel's Textbook of Quantitative Chemical Analysis,** 5th Edn.**,** John Wiley and Sons Inc,.
2. Ahluwalia, V.K.; Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.

Reference Books:

1. Indian Pharmacopoeia (Latest Edition)

Semester III

Metabolism of Biomolecules

Course code: SLLL BMS 23 01 C 4004

Credits: 4; Total hours: 60

Course Objective: *The main objective of the course is to offer detailed and comprehensive knowledge about the synthesis and degradation pathways of amino acids and nucleotides and their importance in the proper functioning of the cells. This course also interrelates the metabolism of these molecules with respect to health diseases in addition to providing overview of inhibitors of metabolism for treating the diseases of metabolic disorders.*

Course Learning Outcome

Unit 1: Carbohydrate metabolism

Students will learn the possible metabolic fates of a glucose molecule inside the cell according to the physiological conditions and resulting metabolic disorders due to defective enzyme involved in the respective pathway. Students will also learn the mechanism behind the synthesis of one ATP molecule.

Unit 2: Lipids metabolism

Students will learn how a molecule of fatty acid is completely metabolized into energy. They will learn to correlate the fatty acid concentration with Diabetes mellitus and starvation. The metabolic disorders related to fatty acid metabolism.

Unit 3: Amino acid metabolism

Students will learn the basic mechanisms involved in the degradation of proteins. They will also learn how a molecule of urea is synthesized inside the cell. The interrelation of pathways in urea synthesis is also learnt. The disorders related to protein metabolism will also be discussed.

Units 4: Nucleic acid metabolism

Students will learn different pathways by which purines and pyrimidines are synthesized by the cell and their regulation too. The regulation of key enzymes of pathways will also be learnt they will also learn how activation –deactivation of specific enzyme of nucleotide metabolism is helpful in treating various diseases

Course Content:

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 CO_2, 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: Nucleic acid metabolism (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.

Reference Books:

1. Devlin, T. M., (2011). *Textbook of Biochemistry with Clinical Correlations.* John Wiley& Sons, Inc. (New York). ISBN: 978-0-4710-28173-4.
2. Nelson, D.L. and Cox, M.M. (2017). *Lehninger: Principles of Biochemistry* (7th ed.). W.H. Freeman & Company (New York), ISBN:13: 9781464126116 / ISBN:10-1464126119.
3. Price, N.C. and Stevens, L.(1996). Fundamentals of Enzymology, Oxford University Press Inc. N.Y.

Semester III

Organic Chemistry

Course code: SLLL BMS 23 02 C 4004

Credits: 4; Total hours: 60

Course Objective: *The objective of this course is to impart knowledge of fundamental concepts of organic chemistry, Stereochemistry, and Different types of organic reactions and their mechanism.*

Course Learning Outcome:

Unit 1: Fundamentals of Organic Chemistry

Students will be able to

- Understand the core concepts of organic chemistry i.e. resonance, hyperconjugation, inductive effect etc. and their application.
- Understand nucleophile and electrophile groups and their properties.
- Recognise various reactive intermediates.
- Identify the suitable ways to generate each type of reactive intermediate
- Explain the concept of aromaticity.

Unit 2: Stereochemistry

Students will be able to

- Identify stereogenic centres in organic molecules
- Distinguish between different types of isomers, including enantiomers and diastereomers
- Draw all stereoisomers for a given structure
- Use (R)- and (S)- descriptors to describe enantiomers and identify if a compound has (R)- or (S)- stereochemistry
- Convert between stereo structures and Fischer projections
- Determine the maximum number of isomers possible in a compound with more than one stereogenic centre

- Identify meso compounds and when to expect them
- Appreciate the role of chirality in nature and in drug design

Unit 3: Organic reactions and their mechanisms (Part-1):

Students will be able to

- Know the various types of organic reactions
- Learn the difference between each type of reaction
- Predict products of each reaction type.
- Understand the concept of organic reaction mechanism
- Apply the concept of different organic reactions for predicting the product of a given reaction.

Units 4: Organic reactions and their mechanisms (Part-2):

Students will be able to

- Learn about generation, stability, and reactivity of free radicals
- Familiarize with the mechanistic aspects of free radical reactions
- Explain pericyclic reactions like Electrocyclic reactions, Cycloaddition reactions and Sigmatropic reactions.
- Evaluate application of Woodward-Hoffmann rules to pericyclic reactions
- Analyse which types of pericyclic mechanism is operative in a reaction.
- Differentiate between photochemical reaction and thermal reaction
- Apply the concept of photochemical reactions to predict the product.

Course Content:

Unit 1: Fundamentals of Organic Chemistry (15h)

Electronic displacements: Inductive effect, Electromeric effect, Resonance, Hyperconjugation. Cleavage of bonds: homolysis and heterolysis. Reaction intermediates: carbocations, carbanions and free radicals. Electrophiles and nucleophiles, Aromaticity: benzenoids and Hückel's rule.

Unit 2: Stereochemistry (15h)

Conformations with respect to ethane, butane and cyclohexane, interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations, concept of chirality (upto two carbon atoms). configuration: geometrical and optical isomerism; enantiomerism, diastereomerism and meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z nomenclature (for upto two C=C systems).

Unit 3: Organic reactions and their mechanisms (Part-1): (15h)

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 4: Organic reactions and their mechanisms (Part-2): (15h)

Free Radical Reactions: Generation, Structure and Stability of Free Radicals, Mechanism and Applications of Free radical reactions, persistent radicals; **Pericyclic Reactions:** Pericyclic reactions and its types, Cycloaddition Reaction, Electrocyclic Reaction, Sigma tropic Rearrangement Reactions; **Photochemical Reactions:** Photophysical Processes, Jablonskii Diagram, Photochemical reactions.

Suggested Textbooks:

1. **A textbook of organic chemistry** – Arun Bahl, B.S. Bahl, Latest Edition.
2. Morrison, R. N. & Boyd, R. N. **Organic Chemistry**, Latest Edn., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Reference Books:

1. F. A. Carey, **Organic Chemistry**, Latest Edition, Tata McGraw Hill.
2. J. Clayden, N. Greeves, S. Warren, **Organic Chemistry**, Latest Ed., Oxford Universitiy Press.
3. F. A. Carey, R. J. Sundberg, **Advanced Organic Chemistry**, Part A: Structure and mechanism, Kluwer Academic Publisher, Latest Edition.

Semester III

Introduction to Microbiology

Course code: SLLL BMS 23 03 C 2002

Credits: 2; Total hours: 30

Course Objective: *The objective of the course is to trace the history of development of the discipline of Microbiology and to emphasize the existence of the immense diversity in the microbial world. The course has been formulated to impart basic and medically relevant information on the microbes and provide knowledge about various microbial infectious agents that cause diseases in humans, the concepts of treatment and the biochemical basis of mechanism of action and drug resistance for various antimicrobial agents.*

Course learning outcomes

Unit 1: History and Scope of Microbiology

Students will develop a good knowledge of the development of the discipline of Microbiology and the contributions made by prominent scientists in this field.

Unit 2: Prokaryotic Cell Structure and Function

Student will gain knowledge on various classes of microorganisms; their structure extracellular and intracellular components and describe characteristics of bacterial cells, cell organelles, cell wall composition and various appendages like capsules, flagella or pili.

Unit 3: Introduction and General Characteristics of Viruses

Student will develop knowledge of the chemical nature of viruses, different types of viruses infecting animals, and bacteria (bacteriophages) outcome and life cycles of viruses involved in causing human diseases like AIDS, Covid and influenza. Students will be able to explain the biology and life cycle of bacteriophages.

Unit 4: Pathogenicity of Microorganisms

Student will be able to explain the concept of symbiosis and parasitism, and the significance pathogenicity in causing human and animal diseases while emphasizing viral and bacterial disease mechanisms.

Course Content:

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

Suggested Textbooks:

1. Prescott, Harley, Wiley, J.M., Sherwood, L.M., Woolverton, C.J. Klien's (2008). Microbiology (7th ed.). Mc Graw Hill International Edition (New York) ISBN: 978- 007-126727
2. Chan, M. J., Krieg E. C. S., Pelczar, N. R. (2004) *Microbiology* (5th ed.). McGraw Hill International. ISBN 13: 9780094623206.
3. Willey, J., Sherwood, L., Woolverton, C. (2017). *Prescott's Microbiology* (10th ed.). McGraw Hill international. ISBN 13: 9781259657573.

Reference Books:

1. Cappuccino J. G., and Sherman N., *Microbiology: A Laboratory manual* (10th ed.). Benajamin/ Cummings. ISBN 13: 9780321840226.
2. Madigan, M. T., Martinko J. M., & Stahl D. A., (2010) *Brock Biology of Microorganisms* (13th ed.). Pearson Education International. ISBN 13: 9780321649638.

Semester III

Practical

Course code: SLLL BMS 23 04 C 0042

Credits: 2; Total hours: 60

Course Objective: *This course aims to impart basic understanding of microbial techniques by hands-on- experience on working with microorganisms and maintenance of microbes under laboratory conditions. It will also provide knowledge about various control methods for the growth of microbes and the characteristic features of different microbes. This course also aims to introduce different quantitative methods to quantify carbohydrates and proteins from unknown source. This course introduces the use of ChemDraw software and Stereomodels. Also, it includes separation of components of organic mixture.*

Course learning outcomes

After completion of this course, a student will be able:

- To visualize and identify various microorganisms
- To culture microorganisms in aseptic conditions
- To prepare and sterilize different types of media
- To maintain different types of cultures
- To carry out research using microorganisms.
- To learn the principles behind and importance of sterilization while working in varied areas of biology in various laboratories.
- Operate ChemDraw Software.
- Draw structures and write equations in ChemDraw. Prediction of NMR of given compounds.
- Explain the stereochemistry of compounds using stereo models.
- Separate the organic compounds from their mixture.
- To perform different biochemical assays to quantify the carbohydrates and proteins in samples.

Course Content:

1. Preparation of LA and LB media
2. Gram's staining
3. Estimation of blood sugar
4. Testing of Liver Function Test (Bilirubin, SGOT, SGPT, Alkaline Phosphatase, Albumin, Globulin, Total Protein)
5. Estimation of urea
6. Estimation of cholesterol
7. Drawing structures, reactions and mechanism using chem-draw software. Prediction of ^{1}H and ^{13}C NMR.
8. Introduction and preparation of stereo models: butane, butane, butyne Cis/Trans alkene, cyclohexane.
9. Separation of mixture of organic compounds.
10. Preparation of solutions based on molarity, normality, percentage, dilutions etc.
11. Preparation of buffers.
12. To quantify the concentration of unknown solution of carbohydrate by Nelson somogyi method
13. To quantify the total protein by lowry method.
14. To perform Bradford assay for protein.

Suggested Textbooks:

1. Ahluwalia, V.K.; Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R.(2012),**Vogel's Textbook of Practical Organic Chemistry**, Pearson.
3. Nelson, D. L. and Michael M. Cox (2008) 5th Edition. *Lehninger principles of biochemistry*. New Jersey, USA: Prentice Hall Publishers. ISBN-13:978-0321707338
4. Berg, J. M., Tymoczko J. L. and Stryer L. (2006) 6th Edition. *Biochemistry*. New York,USA: W. H. Freeman and Co. ISBN-13: 978-0716787242.

Reference Books:

1. Indian Pharmacopoeia (Latest Edition)

2. Sawhney, S.K. and Singh, R. (2005). *Introductory practical biochemistry*. Oxford,UK: Alpha Science International.
3. Devlin, (2011). *Textbook of biochemistry with clinical correlations*. UK: Wiley T &Sons.

Semester IV

Cell Biology

Course code: SLLL BMS 24 01 C 4004

Credits: 4; Total hours: 60

Course Objective: *The course aims to provide advanced knowledge of the function of cellular organelles, the structure and function of cytoskeleton and its role in motility. The course will also provide details of cellular interaction with cells and tissues around and the molecular regulation of cell growth and cell death. The course will outline the molecular details of the origin of cancer and the diagnosis and treatment.*

Course learning outcomes

Unit 1: Introduction to cell Biology

Students will have the knowledge of structure, size, the function of various organelles and types of cells and their function.

Unit 2: Nucleus, Protein Sorting and Transport

Students will have the knowledge of structure of nuclear pore complex, nuclear lamina, transport across nuclear envelope, molecular organization of chromatin. Students will be able to describe the process of posttranslational modification in endoplasmic reticulum, protein sorting and export from Golgi apparatus.

Unit 3: Mitochondria and Peroxisomes

Students will be able to describe organization and functions of parts of mitochondria, its genetic makeup, marker enzymes and export and import of proteins in the mitochondria along with the assembly of peroxisomes.

Unit 4: Plasma Membrane, Extracellular Matrix and Cell Interactions

Students will learn about the different types of molecules which carryout transport of small molecules, Endocytosis, movement across extracellular matrix and bring cell to matrix and cell to cell Interactions.

Unit 5: Cell Signaling

Students will learn about the different types of signaling pathways by focusing on signaling molecules and their receptors and how it leads to activation to signaling cascade leading to the gene expression to carry out a particular function.

Unit 6: Cytoskeleton and Cell Movement

Students will be exposed to cytoskeleton elements and how their association and dissociation leads to movement of a cell and organelles within the cell.

Unit 7: Cell Cycle

Students will be exposed to different phases of cell cycle and it is regulated at the molecular level.

Unit 8: Cell Death and Cell Renewal

Students will have the knowledge of ways a cell undergo death with their detailed mechanism and about the features of stem cells and maintenance of adult tissues.

Course Content:

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.

Reference Books:

1. Cooper, G.M. and Hausman, R.E., (2009). *The Cell: A Molecular Approach*. (7th ed.). ASM Press & Sunderland (Washington DC), Sinauer Associates, MA. ISBN:978-0-87893-30.
2. Karp, G., (2010). *Cell and Molecular Biology: Concepts and Experiments* (8th ed.). John Wiley & Sons. Inc. ISBN: 978-1-118-65322-7.
3. Kleinsmith, L. J., Hardin, H., Wayne G., Becker, M. (2009). *The World of the cell* (7th ed.). ISBN-13: 978-0805393934 / ISBN-10: 0805393935.

Semester IV

Pharmacology

Course code: SLLL BMS 24 02 C 4004

Credits: 4; Total hours: 60

Course Objective: *The objective of teaching pharmacology to undergraduate students is to inculcate in them a rational and scientific basis of therapeutics.*

Course learning outcomes

Unit 1: Introduction to pharmacology

Students will have the knowledge of basic concepts of pharmacology, types of drug nomenclature, prescription drugs, criteria of selection of essential drugs and types of routes of drug administration.

Unit 2: Pharmacokinetics

Students will be able to determine the route(s) of administration, dose, latency of onset, time of peak action, duration of action and frequency of administration of a drug.

Unit 3: Pharmacodynamics

Students will be able to describe the principle and mechanism of drug action in the terms of dose-response relationship, drug potency and therapeutic efficacy.

Unit 4: Pharmacotherapy and clinical pharmacology

Students will be able to explain the various phases and types of clinical trails used in clinical studies.

Unit 5: Autonomic Nervous System and drugs

Students will be able to name cholinergic and anticholinergic drugs while explaining pharmacokinetics, pharmacodynamics and toxic effects of these drugs

Unit 6: Adrenergic System and drugs

Students will be able to name adrenergic and antiadrenergic drugs while explaining pharmacokinetics, pharmacodynamics and toxic effects of these drugs

Unit 7: Antimicrobial and anticancer drugs

Students will be able to describe various classes of antibacterial and anticancer drugs, their mechanism of action along with their pharmacokinetics, pharmacodynamics and toxicological profiles

Unit 8: NSAIDs and diuretic drugs

Students will be able to describe various classes of non-steroidal anti-inflammatory and antidiuretic drugs, their mechanism of action along with their pharmacokinetics, pharmacodynamics and toxicological profiles.

Course Content:

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 trials, Cohort studies and case control studies.

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

Mechanism in autonomic nervous system and cholinergic transmission; **Cholinoreceptors:** Muscranic 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

Semester IV

Medical Microbiology

Course code: SLLL BMS 24 03 C 2002

Credits: 2; Total hours: 30

Course Objective: *The Medical Microbiology course has been formulated to impart basic and medically relevant information on the microbes. The pathogenic microbes and the diseases caused by them are included to broaden the perspective of the subject. This course will also focus on mechanisms of microbial pathogenesis and the host response, and the scientific approaches that are used to investigate these processes. Lastly the course deals with the problem of emerging antimicrobial resistance with reference to known pathogens.*

Course learning outcomes

Unit 1: Human Diseases Caused by Bacteria

Students will learn about pathogenic bacterial species causing the diseases to the humans like bacterial pneumonia, food poisoning, tuberculosis and their mode of acquisition/transmission, clinical symptoms, detection and prevention.

Unit 2: Human Diseases Caused by Viruses and Protozoans

Students will learn about pathogenic viruses (Corona virus, Influenza virus, Dengue, Chikunguia, HIV) and protozoans (Malaria, Leishmania, Amoebiasis) causing the diseases to the humans and their mode of acquisition/transmission, clinical symptoms, detection and prevention.

Unit 3: Chemotherapy and Antiviral Drugs

Students will learn about concepts and mechanism of chemotherapeutic agents and antiviral drugs that inhibit or kill the pathogen while harming the host as little as possible.

Unit 4: Antibacterial Drugs and Drug Resistance

Students will learn about concepts and mechanism of antibiotics that inhibit or kill the pathogen and how drugs resistance is becoming a major challenge to therapeutic treatment.

Course Content

Unit 1: Human Diseases Caused by Bacteria (5h)

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

Unit 2: 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 3: 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, and Range of Effectiveness; **Antiviral Drugs:** General characteristics and mode of action of common antiviral drugs

Unit 4: 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

Reference Books:

1. Jawetz, Melnick & Adelbergs (27th ed.), *Medical Microbiology.* McGraw Hill Education. ISBN-10: 0071790314; ISBN-13: 978-007179031.
2. Kenneth J. Ryan, C., George Ray (2010), *Sherris Medical Microbiology: An introduction to infectious diseases*. McGraw-Hill. ISBN-13: 978-0071604024 ISBN- 10: 0071604022

3. Chan, M. J., Krieg E. C. S., Pelczar, N. R. (2004) *Microbiology* (5th ed.). McGraw Hill International. ISBN 13: 9780094623206.
4. Willey, J., Sherwood, L., Woolverton, C. (2017). *Prescott's Microbiology* (10th ed.). McGraw Hill international. ISBN 13: 9781259657573.

Semester IV

Practical

Course code: SLLL BMS 24 04 C 0042

Credits: 2; Total hours: 60

Course Objective: *The objective of course is to make students learn about the principle and applications of techniques used in cell biology and medical microbiology.*

Course learning outcomes

- students will learn to operate microscope and see different phases of cell division cycle under microscope.
- students will learn about antibiotic resistance in bacteria
- 3 students will learn about basics of tissue culture.

Course Content:

(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 cell
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. Antibiotic Susceptibility Testing by Agar Disk Diffusion Method
8. Study of Antibiotic Resistance in Bacteria
9. Study of Normal Microflora of the Throat and Skin
10. Identification of staphylococcus pathogens
11. Identification of *Mycobacterium tuberculosis*
12. Techniques of Plant /Animal Tissue Culture

13. Calculating viability of bacterial cells after exposure of the bacterial culture to UVrays
14. Differential centrifugation of cell and validation of separated organelles by enzyme markers
15. Demonstration of phagocytosis/apoptosis
16. Determining the Level of Antimicrobial Activity: Dilution Susceptibility Tests, Disk Diffusion Tests, Etest

Reference Books:

1. Indian Pharmacopoeia (Latest Edition)

Semester V

Medical Genetics

Course code: SLLL BMS 35 01 C 4004

Credits: 4; Total hours: 60

Course Objective: *The aim of the course is to provide students with a comprehensive understanding of both classical and modern concepts in genetics with special emphasis on the areas of transmission genetics, molecular and chromosomal aberrations and population genetics in humans. The course will provide detailed knowledge of underlying causes and mechanisms of the genetic disease in humans.*

Course learning outcomes:

Unit 1: Introduction to Medical Genetics

After completion of the unit, students will be able to:

- Describe the scope of medical genetics.
- Describe the application of genetics to medical practices.
- Mention the types and prevalence of genetic disease in humans

Unit 2: Autosomal dominant and recessive disorders

After completion of the unit, students will be able to:

- Define the structure and function of a gene
- Focus on single-gene disorders caused by mutations on the autosomes.
- Discuss the patterns of inheritance of autosomal diseases in families, as well as factors that complicate these patterns.
- Discuss the risks of transmitting single-gene diseases to one's offspring.

Unit 3: Sex-linked and Non-traditional modes of inheritance

After completion of the unit, students will be able to:

- Describe the disease causes mutation located on sex-linked and mitochondrial genome
- Describe the mechanism of X-activation
- Discuss the patterns of inheritance of sex-linked diseases in families, as well as factors that complicate these patterns.

- Discuss genomic imprinting and their clinical consequences

Unit 4: Genetic Variation

After completion of the unit, students will be able to:

- Describe the mendalian form of inheritance in humans
- Describe various types of mutation and their clinical consequences
- Describe methods to detect and measure genetic variation
- Describe causes of genetic variation in the populations

Unit 5: Clinical Cytogenetics

After completion of the unit, students will be able to:

- Detect diseases caused by alterations in the number or structure of chromosomes.
- Describe methods and techniques of cytogenetics
- Describe the anomaly of chromosome number and structure in humans.

Unit 6: Disease-Gene identification

After completion of the unit, students will be able to:

- Describe techniques of identifying mutations by gene mapping, physical mapping and cloning

Unit 7: Biochemical Genetics

After completion of the unit, students will be able to:

- Define type of metabolic process in the human body
- Prevalence of metabolic diseases
- Explain the defects of Carbohydrate metabolism amino acid metabolism and Lipid metabolism.

Unit 8: Cancer genetics, Genetic Testing and Precision medicine

After completion of the unit, students will be able to:

- Describe the hallmarks and causes of cancer
- Describe prenatal diagnosis of genetic disorders and congenital defects.
- Discuss the impact of genomics in the field of medicines

Course Content:

Unit 1: Introduction to Medical Genetics (5h)

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

Unit 2: Autosomal dominant and recessive disorders (8h)

Basic concept of formal genetics: Mendel's contributions, concept of phenotype, Basic pedigree structure; **Autosomal 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 mosacism, reduced penetrance, age dependent penetrance, variable expression, locus heterogeneity, pleiotropy

Unit 3: 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 4: 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 5: Clinical cytogenetics (7h)

Cytogenetic technology and nomenclature: Chromosome banding, Fluoresence 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 6: 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 7: 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 8: 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 congenital defects:** Amniocentesis, Chorionic Villus Sampling; **Impact of genomics:** Pharmacogenetics, Individualized drug therapy, Diagnosing and monitoring common disease

Reference Books:

1. Medical Genetics, 5th Edition, Jorde, Carey, Bamshad
2. Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J. (2017) *An Introduction to Genetic Analysis*, (11th ed.), W.H. Freeman & Company (New York), ISBN: 1464109486
3. Pierce, B.A. (2012) *Genetics - A Conceptual Approach*, (6h ed.), W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-1.
4. Snustad, D.P. and Simmons, M.J. (2012) *Genetics* (6th ed.), John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.

Semester V

Molecular Biology

Course code: SLLL BMS 35 02 C 3003

Credits: 3; Total hours: 45

Course Objective: *The objective of the course is to introduce to the students, the basic concepts of genome, DNA structure, genes, chromatin and chromosomes. It provides comprehensive understanding of DNA replication, transcription and translation processes in a way that students can apply this knowledge in understanding the life processes and develop an interest to pursue high quality research.*

Course Learning Outcome

Unit 1: Introduction to molecular biology

Students will learn about basic concept and will be able differentiate between terms, namely DNA, gene, genome and chromatin. Students will also learn the kinetics of DNA denaturation and renaturation.

Unit 2: DNA Replication

Students will learn how a molecule of DNA is replicated during cell division process. They will also learn about different models of DNA replication. Students will also of understand role of various enzymes involved in the process of DNA replication.

Unit 3: Mechanism of Transcription

Students will learn about the transcription machinery and basic difference between the transcription mechanism in prokaryotic and eukaryotic cell.

Units 4: Transcription Regulation in Prokaryotes

Students will learn gene regulation at transcription level occur in a prokaryotic cell.

Unit 5: RNA Modifications

Students will learn about modification done on mRNA (RNA splicing, RNA editing and shuffling). They will also learn the mechanism of mRNA transport.

Unit 6: Translation (Prokaryotes and Eukaryotes)

Students will learn the basic concept of genetic code. They will also understand the mechanism of how a protein is synthesized from a genetic code inside a cell.

Course Content

Unit 1: Introduction to molecular biology (8h)

Composition and structure of DNA, gene and genome; Introns and exons; Chromatin structure**:** Euchromatin, Heterochromatin, Regulation of Chromatin Structure and Nucleosome Assembly; Denaturation and renaturation kinetics of DNA, Cot curves.

Unit 2. DNA Replication (10h)

General principles of DNA replication**:** 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.

Unit 3: Mechanism of Transcription (7h)

RNA Polymerases, Transcription unit, Mechanism of Transcription in Prokaryotes and Eukaryotes, Promotor sequences and concept of abortive initiation,TBP and other transcription factors, inhibitors of transcriptions(amanitin and rifampicin)

Unit 4: Transcription Regulation in Prokaryotes (5h)

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

Unit 5: RNA Modifications (7h)

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

Unit 6: Translation (Prokaryotes and Eukaryotes) (8h)

Study of genetic code and its exception in some biological systems; 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.

Reference Books:

1. Nelson, D. L. and Cox, M. M (2017) *Lehninger: Principles of Biochemistry* (7thed.) W. H. Freeman & Company (New York), ISBN:13: 9781464126116 / ISBN:10-1464126119.
2. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M. and Losick, R. (2008) Watson: Molecular Biology of the Gene (7th ed.), Cold Spring Harbor Laboratory Press, Cold spring Harbor (New York), ISBN:0-321-50781/ISBN-13:9780321762436

Semester V

Medical Biotechnology

Course code: SLLL BMS 35 03 C 3003

Credits: 3; Total hours: 45

Course Objective: *The objective of the course is to learn basics of theory and practical aspects of recombinant DNA technology and other techniques of DNA manipulation in the microorganisms and mammalian cells which can be used for the development of diagnostic kits and therapeutics interventions in biotech industry.*

Course learning outcomes

Unit 1: Foundations of DNA Technology

After completion of the unit, students will be able to:

- Describe the nature of the biochemical tools used in DNA technology and recognize why microorganisms occupy an important place in the experiments of DNA technology.
- Describe the key discoveries and experiments that formed the basis for modern DNA technology.
- Identify some of the individuals whose work laid the foundations for DNA technology.
- Recognize some important terms and concepts used in DNA technology and broaden your vocabulary of this science

Unit 2: Methods of DNA Technology

After completion of the unit, students will be able to:

- Describe how genes are isolated from cells or synthesized in the laboratory for use in DNA technology.
- List some criteria for selecting vectors to carry foreign genes and host cells to produce the protein encoded by those genes.
- Conceptualize the biochemistry involved in gene expression, understand the problems that can arise in the process, and learn how DNA technologists resolve

those problems.

- Explain the concept of the gene library, describe the process for establishing two types of gene libraries, and discuss how genes are recovered from the library.

Unit 3: Pharmaceutical products of DNA Technology

After completion of the unit, students will be able to:

- Explain how deficiencies of proteins, such as insulin, human growth hormone, and Factor VIII, contribute to ill health and how DNA technology can be used to produce these proteins.
- Appreciate some of the biochemical problems encountered in manufacturing pharmaceutical products by DNA technology and recognize how biochemists circumvent these problems.
- Discuss the synthesis and innovative uses of therapeutic drugs such as tissue plasminogen activator, interferon, and antisense molecules and summarize how they can be used to relieve disease.
- Understand the basis of vaccine activity in the body and conceptualize the role of DNA technology in the production of vaccines.

Unit IV: DNA Analysis and Diagnosis

After completion of the unit, students will be able to:

- Understand the nature of DNA probe and appreciate how it identifies a segment of target DNA.
- Summarize the biochemistry of the polymerase chain reaction and understand how it amplifies a sample of DNA.
- Explain how DNA probes and polymerase chain reaction technology can be used to detect infectious diseases such as AIDS, tuberculosis, and Lyme disease.
- Conceptualize the genetic basis for such diseases as cystic fibrosis, Duchenne's muscular dystrophy, and Huntington's disease and recognize
- How DNA analysis can make the diagnosis of genetic diseases possible.
- Give a synopsis of how certain forms of diabetes, cancer, and hearing and vision loss can be identified through DNA technology.
- Outline several instances in which DNA probes and polymerase chain reaction technology can be useful for monitoring microorganisms in the environment.

Unit V: Gene Therapy

After completion of the unit, students will be able to:

- Explain how "foreign" genes can be delivered to the cells of a patient through the intervention of retroviruses.
- Explain the effects of deficiency of adenosine deaminase and conceptualize how gene therapy can resolve that deficiency.
- Appreciate the mechanism by which gene therapy can be used to treat certain forms of cancer.
- Identify the molecular basis for cystic fibrosis and describe the uses of gene therapy to treat this disease.
- Explain several approaches to treating AIDS patients by using gene therapy.
- Name and explain several instances in which gene therapy will be useful in future years.
- Discuss the levels of review and oversight of gene therapy experiments to ensure the patient's safety and that of the public.

Unit VI: Transgenic Animals

After completion of the unit, students will be able to:

- Understand the nature of a transgenic animal and appreciate some of the technology in its development.
- Summarize the various transgenic animals that have been bred to date and indicate how each is genetically different from its unaltered counterpart.
- Explain some of the problems in adapting the methods used for laboratory animals to research in larger, barnyard animals.
- Describe a number of pharmaceutical products derived from transgenic animals and show how each is useful in medicine.
- Conceptualize how an animal can be made more resistant to infectious disease through transgenic DNA technology.
- Recognize methods by which transgenic animals can help interrupt the spread of disease in nature.
- Identify some of the major researchers who spurred the development of transgenic animals.

Course Content:

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 4: 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 dysptrophy, 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 5: 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 6: 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.

Reference Books:

1. Brown, T.A. (2010) *Gene Cloning and DNA Analysis* (6th ed.), Wiley-Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.
2. 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).
3. 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
4. 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.

Semester V

Practical

Course code: SLLL BMS 35 04 C 0042

Credits: 2; Total hours: 60

Course Objective: *The objective of course is to provide an opportunity to students for hands-on-experience to develop their laboratory skills expected of any molecular biologist working in a research lab.*

Course learning outcomes

Students will acquire knowledge about the principles and applications of latest methods used to extract, analyze, quantify and replicate nucleic acids isolated from different sources.

Course Content:

(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.

13. To hydrolyze DNA and separate nucleotide bases by paper chromatography
14. To plot ultraviolet absorption spectrum of DNA
15. Determination of DNA concentration by A260nm DNA estimation by Diphenylamine (DPA) method
16. Determination of the melting temperature of DNA Isolation of chromosomal DNA from *E coli* cells

Suggested Textbooks

1. Green, M. R. and Sambrook, J. (2012). 4th Edition. *Molecular cloning: A laboratory manual,* New York, USA: Cold Spring Harbor Laboratory Press, ISBN-13:978-1936113422.
2. Cox, M. M. Doudna J. A. and Donnell, M. O. (2012). 1st Edition. *Molecular biology: Principles and practice.* London, UK: W H Freeman & Co Publishers, ISBN-13: 978-0-716-7998-8.
3. Karp, G. (2013). 7th Edition. *Cell and molecular biology: Concepts and experiments.* New Jersey, USA: Wiley Publishers, ISBN-13:978-1118206737

Semester VI

Immunology

Course code: SLLL BMS 36 01 C 4004

Course Credit- 4; Total hours: 60

Course Objective: *This course describes the molecular and cellular basis of the development and function of the immune system. The course will provide the basic framework in immunology that will cover the major topics including innate and adaptive immunity, antibodies and antigens, the molecular events leading to the generation of antibody, humoral and cell mediated adaptive immune response, hypersensitivity, self-tolerance, autoimmunity and vaccines.*

Course Learning Outcome

Unit 1: Introduction to immunology

Students will learn about the important contributions made by scientists in the past which led to modern immunology science. They will get the overview of different types of immunity and will learn that all branches of immunity are interconnected.

Unit 2: Immune Cells and Organs

Students will learn how different immune cells originate, mature and differentiate from single stem cell. They will also learn about the specialized functions of these immune cells in recognizing an antigen and provoking a response against them. Students will also understand the structure and function of various immune organs.

Unit 3: Antigens and antibody

Students will learn the basic difference between antigen, immunogen, hapten and adjuvant. They will learn how different antigen is processed before an immune response is generated against it. They will also come across the structure and functions of different antibodies. Students will learn convectional method of monoclonal antibody production and its clinical uses. They will also learn about major histocompatibility complex.

Units 4: Generation of Immune Response

Students will learn how an antigen is recognized by immune cell and generate humoral or cell mediated immune responses against pathogen.

Unit 5: Complement System

Students will learn about function, activation and regulation of various cytokines and other proteins in immune response

Unit 6: Immunological techniques

Students will learn various immunologic assays that will help them to measure or exploit antibody-antigen interaction in Laboratory.

Unit 7: Vaccines

Students will learn basic concept of immunization. They will also understand designing of different types of vaccines and, type of response they generate.

Unit 8: Immunological Disorders

Students will learn the consequences of dysfunctioning of immune system**.**

Course Content:

Unit 1: Introduction to immunology (4h)

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 (7h)

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 and antibody (12h)

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity), haptens and adjuvant, Epitopes (T & B cell epitopes); T-dependent and T-independent antigens. Antigen

processing and presentation (Cytosolic and Endocytic pathways); Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Hybridoma technology and Monoclonal antibodies; abzymes; Chimeric antibodies; Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules;

Unit 4: Generation of Immune Response (10h)

Generation of Humoral Immune Response (B-cell maturation and differentiation); B-cell acting as antigen presenting cells. BCR and B-cell coreceptor; Cell Mediated Immune Response (Self MHC restriction, T cell activation, T-cell differentiation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance

Unit 5: Complement System (5h)

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

Unit 6: Immunological techniques (10h)

Immunoprecipitation, immunodiffusion, immunoagglutination, immunoelectrophoreis, radioimmuno assay, ELISA

Unit 7: Vaccines (6h)

Concept of active and passive immunization, Designing Vaccines for active Immunization; whole organism Vaccines; purified macromolecules as vaccines; recombinant vector vaccines; DNA vaccines; multivalent subunit vaccines.

Unit 8: Immunological Disorders (6h)

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD.

Suggested Textbooks:

1. Coico, R and Sunshine, G. (2009) *Immunology: A Short Course* (6thed.), John Wiley & sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.

2. Kindt, T. L., Goldsby, R. A. and Osborne, B. A. (2007) *Kuby Immunology* (6th ed.), W. H Freeman and Company (New York), ISBN:13:978-0-7167-8590-3/ ISBN:10:0-7617-8590-0
3. Murphy, K., Mowat, A., and Weaver, C. T. (2012) *Janeway's Immunobiology* (8th ed.),Garland Science (London & New York), ISBN:978-0-8153-4243-4

Semester VI

Natural Product and Heterocyclic Chemistry

Course code: SLLL BMS 36 02 C 4004

Credits: 4; Total hours: 60

Course Objective: *The objective of this course is to offer detailed knowledge about the preparation, properties, and reactions of different organic compounds based on their functional groups. This course also covers the chemistry of Polynuclear and Heteronuclear aromatic compounds and Natural Products.*

Course Learning Outcome

Unit 1: Chemistry of Organic Compounds (Part-1)

After completion of this unit, students will be able to

- Familiarise about different types of organic compounds (Hydrocarbons, Haloalkanes & Haloarenes, Alcohols and Phenols) and their methods of preparation.
- Describe the reactions Shown by the above-mentioned organic compounds.
- Predict the products from reactions of alkenes, alkynes, alkyl halides, alcohols etc.

Unit 2: Chemistry of Organic Compounds (Part-2)

After completion of this unit, students will be able to

- Explain the structure of various organic compounds containing functional groups such as: aldehydes, ketones, carboxylic acid, amines etc.
- Understand the reactions involved in the synthesis of above-mentioned organic compounds.
- Explain reactions shown by these organic compounds and predict the products formed.

Unit 3: Polynuclear and heteronuclear aromatic compounds

After completion of this unit, students will be able to

- Explain the structure, mechanism of reactions of selected polynuclear aromatic compounds.
- Discuss the properties and reactions of important heterocyclic compounds.

- Understand the applications of polynuclear aromatic and heterocyclic compounds in drug synthesis.

Units 4: Chemistry of natural products

After completion of this unit, students will be able to

- Provide an overview of the field of natural product chemistry.
- Identify different types of natural products, their occurrence, structure, biosynthesis and properties.
- Discuss the use of natural products as starting materials for medicines.

Course Content

Unit 1: Chemistry of Organic Compounds (Part-1) (15h)

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

Unit 2: Chemistry of Organic Compounds (Part-2) (15h)

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

Unit 3: Polynuclear and heteronuclear aromatic compounds (15h)

Structure and medicinal uses of **Polynuclear Hydrocarbons:** Naphthalene, Phenanthrene, Anthracene, Diphenylmethane, Triphenylmethane; **Heterocyclic Chemistry:** Synthesis, Properties, Reactions and Medicinal Uses of Heterocyclic Compounds: pyrrole, furan, thiophene, pyridine, pyrazole, imidazole, oxazole, thiazole, quinoline, isoquinoline, phenothiazine and acridine. Identification of Heterocyclic core in Drug molecules

Unit 4: Chemistry of natural products (15h)

Fats and Oils (Phospholipids, Glycolipids and Lipoproteins): Chemistry, hydrolysis, detergents, biosynthesis of fatty acids and steroids, acid value, iodine value and saponification value; 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

Suggested Textbooks:

1. **A textbook of organic chemistry** – Arun Bahl, B.S. Bahl, Latest Edition.
2. Morrison, R. N. & Boyd, R. N. **Organic Chemistry**, Latest Edn., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Acheson RN. **An Introduction to the Chemistry of Heterocyclic Compounds**. Inter-Sciences Publishers, New York. Latest Edition.

Reference Books:

1. J. Clayden, N. Greeves, S. Warren, **Organic Chemistry**, Latest Ed., Oxford Universitiy Press.
2. F. A. Carey, R. J. Sundberg, **Advanced Organic Chemistry**, Part A: Structure and mechanism, Kluwer Academic Publisher, Latest Edition.
3. **Heterocyclic Chemistry**, J.A. Joule and G. F. Smith, van Nostrand, London, Latest Ed.

Semester VI

Medicinal Chemistry

Course code: SLLL BMS 36 03 C 2002

Credits: 2; Total hours: 30

Course Objective: *The objective of this course is to learn the rational physiochemical approach to drug design and drug development and to appreciate the chemistry of drug action. This knowledge is of utmost importance for the understanding of how drugs function at the molecular level. The principles and fundamentals of drug design and drug action once understood; these concepts can be applied to the understanding of many classes of drugs. This basic understanding of the course can be the foundation for the future elucidation of drug action or the rational discovery of new drugs that utilize organic chemical phenomena.*

Course learning outcomes

Unit 1: Principles of drug discovery

After completing this unit, students will be able to:

- Describe drugs discovered without rational drug design
- Explain the approaches of modern rational drug design
- Explicate the principle of target-based drug design
- Rationalize steps involved in drug development
- Clarify preclinical and phases of clinical trials

Unit 2: Lead discovery

After completing this unit, students will be able to:

- Tell the sources and characteristics of lead molecules
- Explain the approaches for screening of compounds for lead discovery
- Describe the drug like properties of compounds
- Describe modern tools to conduct rational drug design.

Unit 3: Lead Modification

After completing this unit, students will be able to:

- Elucidate the structural activity relationship

- Describe the rile of functional group modification
- Identify the pharmacophore and auxophore in a given drug
- Explain structural modifications approaches to increase the potency, therapeutic index, ADME properties, oral bioavailability and membrane permeability of a candidate drug molecule.

Unit 4: Proteins and Nucleic acids as drug targets

After completing this unit, students will be able to:

- Describe the classes interactive drugs
- Explicate the mechanism of action of DNA interacting drugs.
- Explain the binding of drug to a protein, receptor and enzymes
- Describe the principle of design of agonist and antagonists.

Course Content:

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.

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).

Reference Books:

1. Patrick G.I. (2017). 6th Edition. *Introduction to medicinal chemistry*. Oxford, UK: Oxford University Press. ISBN-13: 978-0198749691
2. Silverman, R.B. and Holladay, M.W. (2014). 3rd edition. *The organic chemistry of drug design and drug action*: San Diego, U.S.A: Elsevier, Academic press. ISBN-13: 9780123820303

Semester VI

Practical

Course code: SLLL BMS 36 04 C 0042

Credits: 2; Total hours: 60

Course Objective: *The current course focus on developing basic understanding of antibody-antigen interactions through different lab experiments. This course covers the tests for different organic functional groups, Preparation of drugs, Extraction and Separation Techniques.*

Course learning outcomes

At the end of this course, Student will be able to

- Learn antigen –antibody interactions
- Perform immunoelectrophoresis
- Perform ELISA
- Test the presence of different organic functional groups in an unknown organic sample.
- Prepare and recrystallize Phenytoin.
- Perform extraction of caffeine.
- Separate Colour pigments of Chlorophyll using TLC.

Course Content:

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 examine different immune cell under a microscope
5. To detect ABO blood group type (direct agglutination).
6. To perform Widal test (antibody-antigen interaction/indirect agglutination)
7. To perform immunoelectrophoresis
8. To perform ELISA.
9. Functional group test: Amines, carboxylic acids, aldehydes, ketones, phenols, aromatic, and halogenated hydrocarbons.

10. Preparation of phenytoin and aspirin
11. Extraction of caffeine from Tea leaves and study its absorption properties.
12. Thin-Layer Chromatography of Chlorophyll a and b from Spinach

Suggested Textbooks:

1. Mann, F. G.; Saunders, B. C. (2009), **Practical Organic Chemistry**, Pearson Education
2. Ahluwalia, V.K.; Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.
3. Owen, J. A. Punt, J. Stranford, S. A. Jones, P. P and Kuby, J. (2013). 7th Edition *Kuby Immunology*. New York, USA: W.H. Freeman and Company. ISBN-13: 97f8-1429219198.

Reference Books:

1. Indian Pharmacopoeia (Latest Edition)
2. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (Latest ed.),**Vogel's Textbook of Quantitative Chemical Analysis,** 5th Edn.**,** John Wiley and Sons Inc,.
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R.(2012),**Vogel's Textbook of Practical Organic Chemistry**, Pearson.
4. Hay, F.C. and Westwood, O.M.R. (2002). 4th Edition. *Practical Immunology*. New Jersey,USA: Blackwell Science. ISBN: 9780865429611
5. Delves, P.J. Martin, S.J. Burton, D.R. and Roitt, I. M. (2017). 13th Edition. *Roitt's Essential Immunology*. New Jersey, USA: Wiley-Blackwell Science. ISBN: 13: 978-1118415771

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. 1 LFS/N0622: Regulatory compliance and exchange of information for licensing activities
2. 2 LFS/N0613: Provide analytical support for supply chain management
3. 3 LFS/N0623: Manage, coordinate and interact with people to effectively control licensing operations
4. 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 standards5. LFS/N0234: Supervise effective working of manufacturing process according to EHS standards and identifying and resolving any issues arising during the process
5. LFS/N0101: Maintain a healthy, safe and secure working environment in the life sciences facility.