



FATIMA JINNAH DENTAL COLLEGE HOSPITAL

STUDY GUIDE

First Prof BDS 2026

NAME: _____

BATCH: _____ **ROLL NO:** _____

FATIMA JINNAH DENTAL COLLEGE



Vision

Fatima Jinnah Dental College aspires to advance oral health locally and globally by cultivating compassionate, scholarly, and competent dental professionals who serve communities with purpose, uphold clinical excellence, embrace inclusivity, and improve access to care.

Mission

To educate and empower socially responsible, compassionate, and ethical dental professionals through a globally aligned and inclusive curriculum that emphasizes clinical excellence, scholarly advancement, leadership development, and purposeful community engagement.

Prof. DR. BABUR ASHRAF
B.D.S, FCPS, M.ORTH (RCS)
Principal
Fatima Jinnah Dental College
Karachi-Pakistan



BDS Program Outcomes

Upon successful completion of the 4-year BDS program, the FJDC graduates will be able to:

1. **PO 1 – Clinical Excellence**

Demonstrate clinical excellence by accurately diagnosing and managing dental conditions through the integration of basic and clinical sciences, evidence-based practices, and appropriate use of technology.

2. **PO 2 – Scholarship**

Engage in scholarly inquiry by applying research methodologies to generate evidence, critically appraise literature, and contribute to the advancement of dental knowledge and clinical practice.

3. **PO 3 – Leadership, Communication, and Collaboration**

Exhibit ethical leadership, effective communication, and collaborative decision-making to enhance team-based dental care and contribute positively to professional practice.

4. **PO 4 – Community Advocacy**

Advocate for oral health promotion and disease prevention to enhance individual and community well-being.

5. **PO 5 – Professionalism, Ethics, and Cultural Sensitivity**

Demonstrate ethical practice, accountability, cultural competence, and a commitment to patient-centered care, professional development, and personal integrity.

6. **PO 6 – Technological Adaptability and Lifelong Learning**

Adapt to evolving dental technologies and innovations by embracing a mindset of lifelong learning, digital fluency, and reflective practice to continuously enhance clinical effectiveness and professional growth.

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FATIMA JINNAH DENTAL COLLEGE
Curriculum
Committee
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INTRODUCTION

Study Guide: A guide book is created to facilitate learning, provide direction and point out required critical information to students to maximize the benefit each student can attain from the academic program.

This book will help you in providing:

1. Information on organization and management of the course.
2. A description of the course objectives which will you will be expected to achieve at the end of the course.
3. Information on learning methods that you will experience during the course.
4. Information on Assessment and examination policy, rules and regulations.

Courses:

Several courses of different durations will be taught in the subjects offered in First year as per the PMDC guidelines. The academic year, which includes teaching, assessments, Midterms and pre- Prof Examinations comprises of approximately 40-42 weeks.

The Examining subjects for First year by the University are:

1. Anatomy
2. Physiology
3. Biochemistry
4. Oral Biology

Course No: Each course has a title and a number.

Learning Methods:

- Lecture (LEC)
- Small group discussion (SGD)
- Case Based Learning (CBL)
- Task Base Learning (TBL)
- Practicals (PRAC)
- Demonstrations (DEMO)

Assessments

OSPE will be conducted before the end of sessions

Four CATS (Continuous Assessment Test) for each subject throughout the year will be conducted for regular candidates and the candidates repeating the year.

Midterms will be conducted in the middle of academic year,

Pre –Prof Exams will be conducted at the end of the academic year before the final exams conducted by the University

The annual examinations will be conducted by the University.

Minimum passing marks in all the assessments are 50% of the total marks.

Internal Evaluations:

The University requires internal evaluations which are based on the overall performance throughout the year in OSPE's, CAT's and Midterms.

Total 20% weightage of OSPE and Theory will be sent to the University.

Eligibility for the Annual Examinations:

Minimum of 75% attendance is required as per the University policy and rules.

Attendance in every rotation assessment and CAT's, midterms and Pre- Professional exams is mandatory.

Clearance of all college dues is mandatory.

Rules for repeating the year:

A student who fails to clear 100% subjects of the year after the resit/ supply examinations of that year will be considered a Repeater.

Student repeating will attend all classes of the subject(s) (theory / practicals) he/ she was declared failed in. He/ She will appear in all CAT's of the subject(s) in which he/ she were declared failed in.

The repeater will pay the fees for the subject in which He/ She was declared fail, which will be not less than 25% of the total annual fee per subject to a maximum to 75% of the fee.

If for any reason a student is unable to appear in the annual examination, he or she can avail one chance for that academic year, i.e. to take the Resit/ supply examination. This will be counted as the second attempt.

Assessment Administration Rules and Regulation:

To ensure that the assessments are held according to the standard conditions and that no examinee receives unfair advantage in the assessment, students must adhere to / abide by the rules and regulations of the institution and the university.

The Following examples include misconduct but not necessarily limited to misconduct

1. Copying or attempting to copy answers from another student or allowing answers to

be copied.

2. Making notes of any kind during the assessment.
3. Failure to follow the instructions of the staff present.
4. Acts of disruptive behavior such as raising one's voice, talking to others during the examination.
5. Possession of any unauthorized material such as any photographic equipment or communication device.
6. Memorizing and reproducing examination materials and any unauthorized reproduction by any means.

Students should remember:

1. Students should arrive in the lecture hall/ examination hall 10 minutes before the exam.
2. Students should wear college identification at all times.
3. Admit cards are mandatory to take the exam.

ANATOMY

COURSE DESCRIPTION AND RATIONALE:

Anatomy is the study of the structure, function, development, growth and aging of the living body. It is concerned with these at all levels: whole body, systems, tissues, cells and cell components down to the macromolecular level. It integrates all of these at the structural, functional and dynamic orders. The discipline continues to be fundamental to programmes across biological and Health Sciences spectra, in both teaching and research

The aim of this course is to provide students with a comprehensive overview of the morphology and functional anatomy of the human body. The course incorporates normal structure and function of the human body and provides an insight to the implications of disruption of normal structure and function.

LEARNING OUTCOMES:

The student will be able to:

1. Discuss the structural organisation and functions of each system of the human body.
2. Demonstrate an understanding of a specific embryological event or sequence of events that leads to the development of a particular body region or system.
3. Apply their knowledge of human anatomy to solve questions regarding function and disease.
4. Demonstrate an understanding of structure and a basic understanding of the function, of the central nervous system
5. Demonstrate a clear understanding of the theoretical concepts and practical skills behind different radiological imaging techniques.
6. Work effectively as an individual, in teams and multi-disciplinary settings together with the capacity to undertake lifelong learning.
7. Demonstrate the appropriate written and oral communication skills required

MODE OF INFORMATION (MIT):

- Lecture (LEC)
- Small group discussion (SGD)
- Practicals (PRAC)
- Demonstrations (DEMO)

COURSE NAME: General Anatomy

COURSE CODE: FJ01-ANT-1

LEARNING OBJECTIVES: By the end of the course the students will be able to:

- 1.1 Define anatomy.
- 1.2 Compare the branches of anatomy with regard to their practical implications.
- 1.3 Know the Anatomical Terminologies: Positional, directional terms and Planes

- 1.4 Identify location of the dissected parts/organs of human body with respect to various terms of position, direction and planes of body.
- 1.5 Describe the location and movement of different parts of body with respect to various terms of position and movements.
- 1.6 Comprehend about the basic anatomical concepts of the topic joints
- 1.7 Understand about the basic anatomical concepts of topic bone.
- 1.8 Know about the basic anatomical concepts of topic muscles.
- 1.9 Discuss the organization and components of circulatory system.
- 1.10 Define lymphatic system, lymphatics and lymph nodes
- 1.11 Discuss about basic anatomical concepts of topic nervous system,
- 1.12 Discuss about basic anatomical concepts of the topic Integumentary system

LEARNING STRATEGIES ASSESSMENT:

S:No	TOPIC	MIT	HRS	BCQ	OSPE
1.	Introduction to anatomy	LEC	1	✓	
2.	Anatomical directional terms, position, planes, movements	SGD	3.5	✓	✓
3.	Bones	LEC	2	✓	✓
4.	Bones	SGD	3.5	✓	✓
5.	Joints	LEC	2	✓	✓
6.	Joints	SGD	3.5	✓	✓
7.	Muscles	LEC	2	✓	✓
8.	Circulatory system	LEC	2	✓	✓
9.	Lymphatic System	LEC	2	✓	✓
10.	Nervous system	LEC	1	✓	✓
11.	Nervous system	SGD	3.5	✓	✓
12.	Integumentary system	LEC	2	✓	✓
13.	CT, ligaments and Raphe	LEC	1	✓	✓
TOTAL HOURS			29		

COURSE NAME: General Histology

COURSE CODE: FJ01 – ANT- 2

LEARNING OBJECTIVES: By the end of the course the students will be able to:

- 2.1 Discuss basic concepts concerning the topic
- 2.2 Describe basic concepts concerning the topic Cell
- 2.3 Discuss concepts concerning the topic Epithelium.
- 2.4 Discuss basic concepts concerning the topic Glands.
- 2.5 Discuss basic concepts concerning the topic of Connective Tissues Components and classification.
- 2.6 Discuss basic concepts concerning the topic of microscopic study of muscle, the following:
- 2.7 Discuss basic concepts concerning the topic of microscopic study of circulatory system.
- 2.8 Discuss basic concepts concerning the topic of microscopic study of Immune system,
- 2.9 Discuss basic concepts concerning the topic of microscopic study of skin,
- 2.10 Discuss the about basic histological features of skin and its appendages.

LEARNING STRATEGIES ASSESSMENT:

S:No	TOPIC	MIT	HRS	BCQ's	OSPEs
1	Micro-technique	SGD	3.5	✓	✓
2	Cell & Cell cycle	LEC	2	✓	
	Cell organelles	SGD	3.5	✓	
3	Intercellular junctions	LEC	1	✓	✓
	Epithelium	LEC	2	✓	✓
	Epithelium	PRAC	7	✓	✓
	Classification of glands	LEC	1	✓	✓
4	Connective tissue	LEC	2	✓	✓
	Connective tissue	PRAC	3.5	✓	✓
	Bone	LEC	2	✓	✓
6	Bones	PRAC	3.5	✓	✓
5	Cartilage	LEC	1	✓	✓
	Cartilage	PRAC	3.5	✓	✓
7	Muscles	LEC	1	✓	✓
	Muscles	PRAC	3.5	✓	✓
8	Circulatory system	LEC	2	✓	✓
	Circulatory system	PRAC	3.5	✓	✓
	Nervous system	LEC	2	✓	✓
9	Nervous system	PRAC	3.5	✓	✓
	Lymphoid system and organs	LEC	2	✓	✓
10	Lymphoid system and organs	PRAC	3.5	✓	✓
	Integumentary system	LEC	1	✓	✓

11	Integumentary system	PRAC	3.5	✓	✓
	TOTAL HOURS		55		

COURSE NAME: General Embryology

COURSE CODE: FJ01-ANT-3

LEARNING OBJECTIVES: By the end of the course the students will be able to:

- 3.1 Define embryology and embryological terms.
- 3.2 Discuss the clinical applications of embryology.
- 3.3 Identify parts of male and female reproductive system in relation to reproductive cycle.
- 3.4 Discuss types of cell division and their clinical importance.
- 3.5 Correlate the process of meiosis and gametogenesis.
- 3.6 Discuss the process of fertilization and implantation.
- 3.7 Discuss and explain the events occurring in the development of embryo during second week of development
- 3.8 Discuss the events occurring in the development of embryo during second week of development; formation of Gastrulation, primitive streak and notochord
- 3.9 Discuss the Development of fetus and the Role of teratogen in congenital anomalies.
- 3.10 Discuss the formation of Amnion , Chorion, umbilical cord & Yolk-Sac, Disorders of amniotic fluid, the development and functions of fetal membranes, chorion, amnion and Know the Formation of Placenta
- 3.11 Discuss the types and the Importance of antenatal diagnostic techniques.

LEARNING STRATEGIES ASSESSMENT:

S:No	TOPIC	MIT	HRS	BCQ's	OSPE
1	Introduction to embryology and terminologies	LEC	1	✓	
2	Reproductive system	LEC	2	✓	✓
3	Ovarian and uterine cycles	LEC	2	✓	✓
4	Cell cycle, cell division	LEC	2	✓	✓
	Gametogenesis	LEC	2	✓	✓
5	Fertilization and implantation	LEC	1	✓	✓
6	Development upto 3 rd week	LEC	4	✓	✓

7	Embryonic and fetal periods	LEC	4	✓	✓
8	Fetal membranes and placenta	LEC	2	✓	✓
9	Teratogenesis	LEC	2	✓	✓
10	Antenatal diagnostic techniques	LEC	1	✓	✓
TOTAL HOURS			23		

COURSE NAME: Special Histology

COURSE CODE: FJ01-ANT-4

LEARNING OBJECTIVES: By the end of the course the students will be able to know:

- 4.1 Anatomical Overview of All Endocrine Glands in Body
- 4.2 The Microscopy of Pituitary Gland
- 4.3 Microscopic Anatomy of Thyroid and Parathyroid Gland
- 4.4 Microscopic Anatomy of Pancreas
- 4.5 Microscopic Anatomy of Adrenal Gland
- 4.6 Microscopic anatomy of Oral cavity and its major contents

LEARNING STRATEGIES ASSESSMENT:

S:No	TOPIC	MIT	HRS	BCQ's	OSPE
1	Endocrine microanatomy	LEC	4	✓	
2	Endocrine microanatomy	PRAC	3.5	✓	✓
	Microscopic study of liver	LEC	1	✓	✓
6	Microscopic study of liver	PRAC	3.5	✓	✓
	Microscopic study of major salivary glands	LEC	2	✓	✓
7	Microscopic study of major salivary glands	PRAC	3.5	✓	✓
	Microscopic study oral cavity and tongue	LEC	1	✓	✓
8	Microscopic study oral cavity and tongue	PRAC	3.5	✓	✓

TOTAL HOURS	22	
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COURSE NAME: Special Embryology

COURSE CODE: FJ01-ANT-5

LearningObjectives: By the end of the course the students will be able to:

5.1 Describe development and anomalies of face and pharyngeal apparatus.

5.2 Describe development of nose and Para nasal sinuses

5.3 Discuss development of oral structures.

5.4 Discuss common anomalies of oral structures.

5.5 Discuss development of major salivary gland.

5.6 Discuss the development of endocrine glands:

5.7. Discuss the development of brain and spinal cord

LEARNING STRATEGIES ASSESSMENT

S:No	TOPIC	MIT	HRS	BCQ	OSP E
1	Pharyngeal apparatus with anomalies	LEC	3	✓	✓
2	Development of face with anomalies	LEC	2	✓	✓
3	Development of palate with anomalies	LEC	1	✓	✓
4	Development of thyroid and parathyroid glands with anomalies	LEC	1	✓	✓
5	Development of major salivary glands with anomalies	LEC	1	✓	✓
6	Development of tongue with anomalies	LEC	1	✓	✓
7	Development of brain and spinal cord with anomalies	LEC	2	✓	✓
8	Development of nose and paranasal sinuses	LEC	1	✓	✓
9	Pharyngeal apparatus with anomalies	SGD	3.5	✓	✓
TOTAL HOURS			15.5		

COURSE NAME: Neuroanatomy

COURSE CODE: FJ01-ANT-6

LEARNING OBJECTIVES: By the end of the course the students will be able to:

- 6.1 Describe the features of cranial cavity.
- 6.2 Describe the terminologies of neuroanatomy.
- 6.3 Discuss the clinical importance of blood supply of brain and spinal cords.
- 6.4 Discuss the clinical importance of Meninges of brain and spinal cord and the various spaces.
- 6.5 Describe the location, communication and clinical significance of dural venous sinuses.
- 6.6 Correlate the structure of ventricular system with CSF disorder.
- 6.7 Describe the external features and attachments of cranial nerves with lesions.
- 6.8 Describe the macroscopic features of Cerebellum, Diencephalon and Thalamus
- 6.9 Describe the general distribution of white matter.
- 6.10 Identify the following based on pictures/models:
 - a) Functional cortical areas
 - b) Cranial nerve nuclei and their functional components
 - c) Brain and spinal cords(on radiograph)
 - d) Describe the structural and functional organization of autonomic nervous system.

LEARNING STRATEGIES ASSESSMENT:

S:No	TOPIC	MIT	HRS	BCQ's	OSPEs
1	Cranial fossae	LEC	2	✓	✓
	Cranial fossae	SGD	3.5	✓	✓
2	Meninges and dural venous sinuses with clinical significance	LEC	1	✓	✓
	Meninges and dural venous sinuses with clinical significance	SGD	3.5	✓	✓
3	Blood supply of brain and spinal cord with clinical significance	LEC	2	✓	✓
	Blood supply of brain and spinal cord with clinical significance	SGD	3.5	✓	✓
4	Ventricular system	LEC	2	✓	✓
5	Brainstem and its applied anatomy	LEC	2	✓	✓
	Brainstem and its applied anatomy	SGD	3.5	✓	✓
6	Cerebellum and its applied anatomy	LEC	1	✓	✓
7	Diencephalon and its applied anatomy	LEC	1	✓	✓
8	Cerebrum and its applied anatomy	LEC	3	✓	✓

	Cerebrum and its applied anatomy	SGD	3.5	✓	✓
9	Autonomic Nervous system	LEC	2	✓	✓
10	Cranial nerves I – XII	LEC	5	✓	✓
11	Imaging techniques	LEC	1	✓	✓
TOTAL HOURS			44		

COURSE NAME: Gross Anatomy of Head and Neck Region

COURSE CODE: FJ01-ANT-7

LEARNING OBJECTIVES: By the end of the course the students will be able to:

7.1 Discuss the basic features and their clinical relevance of the structures of skull as seen on five normas.

7.2 Relate the feature of different aspects of skull with their clinical relevance.

7.3 Describe the gross anatomical features of mandible with applied anatomy

7.4 Describe the gross anatomical features of hyoid bone with clinical importance.

7.5 The clinical importance of structures of scalp.

7.6 Discuss the blood supply, nerve supply, lymphatic drainage and clinical conditions associated with muscles of facial expressions.

7.7 Discuss gross anatomy of orbit, eye and its contents along with extraocular muscles with clinical correlation and CN –III, VI, IV.

7.8 Discuss the clinical importance of macroscopic structures of eye and CN –II

7.9 Describe the lacrimal apparatus with parts, nerve supply

7.10 Discuss the division of ear into external, middle and internal ear and content of middle Ear cavity with

functions of external and middle ear as an organ for hearing with clinical conditions and CN-VIII

7.11 Identify and discuss in detail all the structures of temporal and infratemporal region

7.12 Discuss gross anatomy of structures of external nose, nasal cavity and Para nasal sinuses and their clinical application, and CN –I

7.13 Discuss in detail the gross anatomy of oral cavity with their contents

7.14 Identify the gross anatomical features of the tongue, the intrinsic muscles and extrinsic musculature, their movements, blood supply, innervations and lymphatic of tongue and the clinical associated to it. Nerves of the head, i.e., CN –V, VII, XII,

7.15 Discuss macroscopic features of major salivary glands with their functions.

7.16 Identify the cervical vertebrae as land mark and Describe the features and joints formed by cervical vertebrae with differentiation between typical & atypical cervical vertebrae

- 7.17 Identify macroscopic structures of the neck with the boundaries of triangles of neck and all its contents in detail.
- 7.18 Describe in detail the gross anatomy of major salivary glands along with its clinical correlations and the nerves of the neck i.e., CN –IX, X, XI, XII
- 7.19 Discuss gross anatomy and clinical importance of thyroid and parathyroid gland.
- 7.20 Describe the gross anatomy and clinical importance of pharynx.
- 7.21 Discuss the macroscopic and microscopic features of larynx.
- 7.22 Discuss the macroscopic and microscopic features of trachea.
- 7.23 Describe the course of all twelve cranial nerve and effects of its injury.
- 7.24 Identify major arteries and their main branches in neck on models and normal objects.
- 7.25 Discuss lymphatic drainage of head and neck.
- 7.26 Know the Surface Anatomy of major structures in Head and Neck (Facial Artery and Parotid Gland)
- Identify and palpate the Facial artery.
 - Trace the course of facial artery in the face.
 - Identify and palpate the Parotid gland.
 - Identify the landmarks of borders and surfaces of parotid gland.
 - Identify and palpate the carotid artery in the neck
 - Trace the course of internal jugular vein in the neck
- 7.27 Read the X-Rays of head and neck
- Identification of important anatomical landmarks of head and neck structures
 - Counting of cervical vertebrae

LEARNING STRATEGIES ASSESSMENT:

S:No	TOPIC	MIT	HRS	BCQ's	OSPE
1	Osteology of skull with clinical relevance	SGD	14	✓	✓
2	Mandible and its clinical application	LEC	1	✓	✓
3	Hyoid bone	LEC	1	✓	✓
4	Cervical vertebrae & intervertebral joints and movements	LEC	2	✓	✓
5	Scalp and applied anatomy	LEC	1	✓	✓
6	Face and its applied anatomy with CN –V and CN –VII	LEC	4	✓	✓
7	Orbit and Orbital contents	LEC	2	✓	✓
8	Contents of temporal & infratemporal region	LEC	3	✓	✓
9	TMJ, muscles of mastication with its applied anatomy	LEC	3	✓	✓

10	Nose and paranasal sinuses with applied anatomy	LEC	3	✓	✓
11	Contents of oral cavity & description of palate	LEC	1	✓	✓
12	Tongue & CN -XII with applied anatomy	LEC	1	✓	✓
13	Anatomy of parotid, submandibular & sublingual salivary glands	LEC	2	✓	✓
15	Topography of neck & deep cervical fascia	LEC	1	✓	✓
16	Triangles of neck; anterior triangle	LEC	3	✓	✓
17	Triangles of neck; posterior triangle	LEC	1	✓	✓
18	Anatomy of thyroid and parathyroid glands with applied anatomy	LEC	1	✓	✓
19	Anatomy of pharynx with clinical correlation and pharyngeal plexus	LEC	1	✓	✓
20	Anatomy of larynx with clinical correlation	LEC	2	✓	✓
21	Anatomy of trachea and oesophagus	LEC	1	✓	✓
22	Nerves of the neck; cervical plexus, sympathetic cervical chain, ansacervicalis	LEC	2	✓	✓
24	Mandible and muscles of mastication	SGD	3.5	✓	✓
25	Cervical vertebrae & intervertebral joints and movements	SGD	3.5	✓	✓
30	Nose and paranasal sinuses with applied anatomy	SGD	3.5	✓	✓
35	Triangles of neck; anterior triangle	SGD	3.5	✓	✓
36	Triangles of neck; posterior triangle	SGD	3.5	✓	✓
39	Anatomy of larynx with	SGD	3.5	✓	✓

	clinical correlation				
42	X –Rays and surface anatomy of head & neck	LEC	1		✓
43	Bones of upper limb	LEC	1	✓	✓
44	Muscles of arm	LEC	1	✓	✓
45	Muscles of forearm	LEC	1	✓	✓
46	Muscles of hand	LEC	1	✓	✓
47	Bones of lower limb	LEC	1	✓	✓
48	Thigh muscles	LEC	1	✓	✓
	Muscles of leg	LEC	1	✓	✓
	Muscles of foot	LEC	1	✓	✓
TOTAL HOURS			94.5		

GENERAL ANATOMY:

- B.D Chaurasia's Handbook of General Anatomy

GROSS ANATOMY:

Essentials

- Grey's Anatomy for Students
- Clinical Anatomy by regions by R.S.Snell
- Human Anatomy by B.D.Chaurasia; volume 3 (head & neck)

Reference Books

- Netter' Coloured Atlas of Human Anatomy –reference book
- Clinically Oriented Anatomy by KLM –reference book

HISTOLOGY:**Essentials**

- Wheater's functional Histology Coloured Atlas and Text by Wheater's
- Medical Histology by Laiq Hussain

Reference Books

- Di'fioere's Atlas of Histology –reference book
- Junqueira's Basic Histology Text and Atlas by Junqueira –reference book

EMBRYOLOGY:**Essentials**

- Langman's Medical Embryology by T.W.Sadler

Reference Books

- The Developing Human Clinically Oriented Embryology by KLM –reference book

NEUROANATOMY:

- Clinical Neuroanatomy by R.S.Snell

BIOCHEMISTRY

COURSE DESCRIPTION AND RATIONALE:

Biochemistry has been considered as a hybrid of life science as well as chemical science. It is not only essential to understand and appreciate the molecular basis of biological processes but also needed to couple up with the rapidly evolving horizon of molecular level interventions in the diagnostic and therapeutic domain of health sciences. This course introduces basic concepts of biomolecules, their interactions along with regulation which eventually enables students to identify, compare and evaluate biochemical parameters for both health and disease.

LEARNING OUTCOMES: The student will be able to:

Describe the composition, function and regulation of biomolecules

Communicate the composite understanding of biological processes at a molecular level

Identify and interpret biochemical parameters for both health as well as diseased status

Evaluate a case scenario from a biochemical perspective for both diagnostic and therapeutic purposes

Perform certain biochemical procedures to assess different biochemical parameters

Explain the operational aspects of different biochemical equipments and techniques

COURSE NAME: BIOCHEMISTRY OF CELL

COURSE CODE: FJ01-BCH-1

Learning Objectives: At the end of the course, the student should be able to:

- 1.01. Define Biochemistry
- 1.02. Discuss the hierarchy of organization of life
- 1.03. Enlist important biomolecules of human body
- 1.04. Enlist one disease of all the four macro molecules of body
- 1.05. Define metabolism, anabolism and catabolism
- 1.06. Define Cell
- 1.07. Justify that cell membrane surface increases the efficiency of life
- 1.08. Compare Prokaryotic and Eukaryotic cell along with one example each
- 1.09. Compare animal cell and plant cell
- 1.10. Describe the structure and composition of cell membrane
- 1.11. Enlist the lipids taking part in the cell membrane formation
- 1.12. Justify the fluidity of plasma membrane in term of hydrophobic tail
- 1.13. Define Cytoplasm

- 1.14. Enlist the types & functions of cytoskeleton
- 1.15. Describe the structure and function of nucleus
- 1.16. Describe the types and function of organelle of cells
(Endoplasmic reticulum, Golgi apparatus, lysosomes, vacuoles)
- 1.17. Enlist and discuss the bacteria like organelles (Mitochondria/ chloroplast)
- 1.18. Justify that formation of Hydrogen Bond in water
- 1.19. Enlist the properties of water due to hydrogen bonding
- 1.20. Justify that premature infants may develop respiratory distress due to surface tension
- 1.21. Discuss the body fluid compartments
- 1.22. Compare body fluid composition gender wise
- 1.23. Enumerate the ICF and ECF content of a person weighing approximately 70 Kg
- 1.24. Compare the ionic composition of ECF and ICF
- 1.25. Define the strength of solutions in terms of normality, molarity & molality
- 1.26. Define plasma osmolarity
- 1.27. Shows how to prepare isotonic intravenous solution both NS & DW
- 1.28. Define osmosis, osmotic pressure and hydrostatic pressure
- 1.29. Define Isotonic, Hypertonic and Hypotonic solution and discuss their effect on RBC
- 1.30. Justify why crossing across the cell membrane is important for cell membrane
- 1.31. Enlist the modes of transport across cell membrane
- 1.32. Describe osmosis, active and passive transport with one example each
- 1.33. Discuss Active transport in terms of sodium potassium pump
- 1.34. Define Exocytosis and Endocytosis with one example each
- 1.35. Define acid and base
- 1.36. Define pH
- 1.37. Justify the significance of pH in terms of ionic absorption, enzyme activity
- 1.38. Define Buffers
- 1.39. Classify different body buffers on the basis of body fluid compartments
- 1.40. Discuss the most significant ECF buffers
- 1.41. Describe the pH of Plasma and also discuss its range as well
- 1.42. Discuss the acid base imbalance& enlist the type of acidosis and alkalosis with one example each

LEARNING STRATEGIESAND ASSESSMENT:

S:N o	LECTURE TOPIC	MIT	HOURS	BCQ	OSPE
1	Introduction to biochemistry	LEC	1	✓	-
2	Cell-biochemical composition & cell organelles	LEC	1	✓	-
3	Cell membrane	LEC	1	✓	-
4	Water	LEC	1	✓	-

5	Body fluid compartments	LEC	2	✓	-
6	Solutions	PRAC	6	✓	✓
7	pH & buffers	LEC	2	✓	✓
8	Acute respiratory distress syndrome ¹	SGD	1	✓	-
9	Acid base imbalances	SGD	2	✓	✓
Total			17		

COURSE NAME:CARBOHYDRATE CHEMISTRY

COURSE CODE: FJ01-BCH-2

Learning Objectives: At the end of the course, the student should be able to:

- 2.01. Define carbohydrates
- 2.02. Biomedical significance (functions) of carbohydrates
- 2.03. Sources of carbohydrates with clinical implications
- 2.04. Describe energetics of carbohydrates as fuel
- 2.05. Discuss properties of carbohydrates
- 2.06. Classify carbohydrates with examples
- 2.07. Define monosaccharides, disaccharides and polysaccharides
- 2.08. Compare aldo-sugar with keto-sugar and exemplify aldo and keto sugars of 3-7 carbons
- 2.09. Describe the sources and biomedical importance of glucose, fructose and galactose
- 2.10. Describe glycosidic bond of lactose, maltose and sucrose
- 2.11. Justify why sucrose is non reducing sugar
- 2.12. Discuss lactose intolerance
- 2.13. Define homopolysaccharides and heteropolysaccharides with examples
- 2.14. Discuss energy/ food cycle in terms of carbohydrates
- 2.15. Define isomers
- 2.16. Discuss the classification of isomerism
- 2.17. Define chiral or asymmetric carbon and enumerate the numbers of chiral carbon in glucose
- 2.18. Define anomeric carbon in cyclic structure of glucose
- 2.19. Define enantiomers (D & L isomers)/ Anomers (α & β anomers)/ optical isomers (d/+>dextrorotatory& l-/levorotatory)/ epimers with two examples of glucose epimers
- 2.20. Describe invert sugar with an example
- 2.21. Discuss mutarotation with reference to glucose
- 2.22. Define& enlist GAGs or MPSs with their biomedical importance

- 2.23. Describe which GAGs do not contain sulphate/acid group
- 2.24. Define Hunter's & Hurler's syndrome
- 2.25. Knows how carbohydrate is detected schematically in qualitative analysis
- 2.26. Knows the composition of relevant qualitative reagents
- 2.27. Knows the interpretation of qualitative colour tests of carbohydrate scheme

LEARNING STRATEGIES AND ASSESSMENT:

S:N o	LECTURE TOPIC	MIT	HOURS	BCQ	OSPE
1	Introduction of Carbohydrates	LEC	1	✓	-
2	Monosaccharides, disaccharides & oligosaccharides	LEC	2	✓	-
3	Lactose Intolerance	SGD	3	✓	✓
4	Polysaccharides	LEC	1	✓	✓
5	Detection of carbohydrates	PRAC	9	-	✓
Total			16		

COURSE NAME: LIPID CHEMISTRY

COURSE CODE: FJ01-BCH-3

Learning Objectives: At the end of the course, the student should be able to:

- 3.01. Define lipids
- 3.02. Discuss the biomedical importance of lipids
- 3.03. Justify why lipids generate more energy as compare to carbohydrates
- 3.04. Classify lipids
- 3.05. Compare fats & oils and justify why they differ in their physical state
- 3.06. Enlist the biomedical importance of waxes
- 3.07. Differentiate between simple and complex TAGs
- 3.08. Describe the biomedical importance of Lecithin (Surfactant)
- 3.09. Enlist the different types of Lipoproteins
- 3.10. Discuss the concept of good cholesterol vs bad cholesterol
- 3.11. Enlist the essential fatty acids with their number of carbon atoms & double bonds
- 3.12. Describe the usage of terpenes
- 3.13. Describe ceramide, cerebroside and ganglioside
- 3.14. Define fatty acids
- 3.15. Classify fatty acids
- 3.16. Discuss the nutritional and biomedical importance of fatty acids
- 3.17. Knows how lipid is detected schematically in qualitative analysis
- 3.18. Knows the interpretation of qualitative colour tests of lipid scheme

LEARNING STRATEGIES AND ASSESSMENT:

S:N o	LECTURE TOPIC	MIT	HOURS	BCQ	OSPE
1	Introduction to Lipids & Lipid Peroxidation	LEC	1	✓	-
2	Classify Lipids	LEC	1	✓	-
3	Fatty acids & Eicosanoids & Derived Lipids	LEC	1	✓	-
4	Compound Lipids & Cholesterol	LEC	1	✓	✓
5	Atherosclerosis	SGD	3	✓	✓
6	Detection of Lipids	PRAC	6	✓	✓
Total			13		

COURSE NAME: PROTEIN CHEMISTRY

COURSE CODE: FJ01-BCH-4

Learning Objectives: At the end of the course, the student should be able to:

- 4.01. Define amino acids
- 4.02. Discuss optical isomerism of amino acids in terms of chirality
- 4.03. Define Iso-electric pH and Zwitter ion
- 4.04. Classify amino acids on the following basis;
 - a. Standard/Non-Standard
 - b. Essential /Non-Essential/Semi-Essential
 - c. Polarity (Polar/Non-Polar)
 - d. Metabolic fate (Glycogenic/Ketogenic)
 - e. Side Chains (Aliphatic/Aromatic/Acidic/Basic/OH & Sulphur containing)
- 4.05. Enlist the fate of amino acid in the body
- 4.06. Define Proteins
- 4.07. Discuss peptide bond
- 4.08. Classify Proteins on the basis of;
 - a. Shape and Solubility
 - b. Structure
 - c. Function
 - d. Composition

e. Nutritional value

- 4.09. Enlist the function of plasma protein
- 4.10. Describe positive and negative nitrogen balance with example of each
- 4.11. Compare Marasmus and Kwashiorkor
- 4.12. Enlist the four levels of protein structure
- 4.13. Discuss all four level of protein structure with example
- 4.14. Justify sickle cell Anemia results from alteration in Protein Structure
- 4.15. Knows how protein is detected schematically in qualitative analysis
- 4.16. Knows the interpretation of qualitative colour tests of protein scheme

LEARNING STRATEGIES AND ASSESSMENT:

S:N o	LECTURE TOPIC	MIT	HOURS	BCQ	OSPE
1	Amino Acids	LEC	1	✓	-
2	Introduction to Proteins & Protein structure	LEC	1	✓	-
3	Classification of Protein	LEC	1	✓	-
4	Plasma Proteins & Immunoglobulin	LEC	1	✓	✓
5	PEM (Kwashiorkor/ Marasmus)	SGD	3	✓	✓
6	Detection of Protein	PRAC	6	✓	✓
Total			13		

COURSE NAME:ENZYMES

COURSE CODE:FJ01-BCH-5

Learning Objectives: At the end of the course, the student should be able to:

- 5.01. Justify the clinical significance of enzymes in diagnostics, therapeutics and toxicology with one example each
- 5.02. Define Enzymes, Holoenzyme, Apo-enzyme, Coenzyme & Prosthetic group with one example each
- 5.03. Describe the NOMENCLATURE of enzymes
- 5.04. Classify enzymes in SIX major classes with one example each
- 5.05. Describe the mechanism of enzyme catalyst activity
- 5.06. Define active site of enzyme

- 5.07. Discuss the hypothesis of enzyme action with one example each (Lock & Key Induced Fit)
- 5.08. Enlist the factors effecting enzyme activity
- 5.09. Define K_m & V_{max} in terms of enzyme kinetics
- 5.10. Discuss the effect of pH on enzyme activity
- 5.11. Discuss the effect of temperature on enzyme activity
- 5.12. Classify enzyme inhibitors
- 5.13. Compare competitive, non-competitive and un-competitive inhibitors with one example each
- 5.14. Discuss the change in K_m & V_{max} in the above three types of enzyme inhibition
- 5.15. Discuss the diagnostic application of enzymology with clinical examples
- 5.16. Discuss the therapeutic application of enzymes

LEARNING STRATEGIES AND ASSESSMENT:

S:N o	LECTURE TOPIC	MIT	HOURS	BCQ	OSPE
1	Introduction & Mechanism of action of enzymes	LEC	1	✓	-
2	Enzyme Kinetics & factors effecting enzyme action	LEC	1	✓	-
3	Enzyme Inhibitors	LEC	1	✓	-
4	Clinical enzymology	LEC	1	✓	✓
5	Diagnostic enzymology	SGD	2	✓	✓
6	Non-enzymatic cardiac marker	SGD	1	✓	✓
Total			7		

COURSE NAME: NUCLEOPROTEINS

COURSE CODE: FJ01-BCH-6

Learning Objectives: At the end of the course, the student should be able to:

- 6.01. Discuss the Pentose sugars, Nitrogen bases, Nucleosides and Nucleotides in terms of their structure & functions
- 6.02. Discuss the structure of DNA; double stranded, grooves, leading & lagging, bases, types (A/B/Z)
- 6.03. Discuss the Chargaff's rule of base pairing in the double stranded DNA

- 6.04. Discuss the structure of RNA; strand, bases, sugar, types (m RNA/t RNA/r RNA)
- 6.05. Discuss the CENTRAL DOGMA of GENETICS (Transcription & Translation)
- 6.06. Describe the THREE BASES (64) CODONS of 20 amino acids
- 6.07. Define:
 - a. Replication fork
 - b. Okazaki segment
 - c. Leading & Lagging DNA strands
 - d. Blotting Techniques (Southern/Northern/Western)
- 6.08. Define the function of following enzymes in DNA replication:
 - a. DNA polymerase
 - b. DNA ligase
 - c. DNA primase
 - d. Helicase
 - e. Topoisomerase

LEARNING STRATEGIES AND ASSESSMENT:

S:No	LECTURE TOPIC	MIT	HOURS	BCQ	OSPE
1	Nucleotides (RNA & DNA)	LEC	1	✓	-
2	Central Dogma of Molecular Biology	LEC	1	✓	-
3	Blotting techniques	SGD	2	✓	✓
Total			4		

COURSE NAME: HEMOGLOBIN

COURSE CODE: FJ01-BCH-7

Learning Objectives: At the end of the course, the student should be able to:

- 7.01. Discuss the structure of hemoglobin in terms of Pyrrole, Porphyrin, Heme & Globin
- 7.02. Describe the difference between porphyrin and heme
- 7.03. Enlist functions of heme
- 7.04. Describe the site of heme synthesis (organ/cell)
- 7.05. Discuss the steps of heme synthesis especially focusing on 1st step
- 7.06. Describe the regulation of heme synthesis
- 7.07. Enlist the disorders of heme synthesis
- 7.08. Describe Sideroblastic anemia with reference to lead poisoning
- 7.09. Define porphyria
- 7.10. Classify porphyria
- 7.11. Enlist symptomatic triad of porphyria

- 7.12. Enlist different types of hemoglobin
- 7.13. Specify the number of chromosomes and amino acids for both alpha and beta globin chain
- 7.14. Discuss Sickle cell anemia in detail
- 7.15. Discuss thalassemia in detail
- 7.16. Discuss why alpha major thalassemia results in intrauterine death while beta major thalassemia does not
- 7.17. Describe which parts of Hemoglobin are recycled during heme degradation
- 7.18. Enlist steps of heme degradation
- 7.19. Enlist the name of bile pigments
- 7.20. Enlist the steps of bilirubin formation
- 7.21. Describe the transport of bilirubin from macrophage to hepatocyte
- 7.22. Discuss the conjugation of bilirubin in the liver
- 7.23. Enlist the excretory routes of Urobilin / Stercobilin
- 7.24. State the normal concentration of bilirubin
- 7.25. Define jaundice
- 7.26. Classify jaundice with one example each
- 7.27. Discuss on the basis of clinical enzymology how would you differentiate between hepatic and post hepatic jaundice
- 7.28. Justify normal/ physiologic jaundice biochemically
- 7.29. Define kernicterus
- 7.30. Enlist the genetic disorders of bilirubin metabolism and also state which one of them is fatal
- 7.31. Discuss LFTs (Liver Function Tests)
- 7.32. State the normal serum bilirubin level
- 7.33. Discuss serum bilirubin level as a proxy indicator of liver function
- 7.34. Describe the bonding of Fe molecule with heme, globin chain and oxygen
- 7.35. Enlist the two forms of Hemoglobin
- 7.36. Enlist the two states of Hemoglobin
- 7.37. Discuss the exhibition of cooperativity in terms of Hemoglobin
- 7.38. Describe the oxygen binding curve of Myoglobin
- 7.39. Describe the oxygen binding curve of Hemoglobin
- 7.40. Discuss the right and left shift of oxygen binding curve of Hemoglobin
- 7.41. Define Bohr Effect

LEARNING STRATEGIES AND ASSESSMENT:

S:No	LECTURE TOPIC	MIT	HOURS	BCQ	OSPE
1	Heme-Structure	LEC	2	✓	✓
2	Heme-Synthesis & Porphyrins	LEC	2	✓	✓

3	Porphyria	SGD	2	✓	✓
4	Haemoglobinopathies	LEC	2	✓	✓
5	Sickle cell anemia	SGD	2	✓	✓
6	Thalassemia	SGD	2	✓	✓
7	Heme-Degradation & Jaundice	LEC	2	✓	✓
8	Jaundice	SGD	2	✓	✓
9	Liver Function Tests (LFTs)	SGD	2	✓	✓
Total			18		

COURSE NAME: VITAMINS

COURSE CODE: FJ01-BCH-8

Learning Objectives: At the end of the course, the student should be able to:

- 8.01. Enlist the sources, functions of vitamin A, E & K
- 8.02. Describe Night blindness, bleeding tendency
- 8.03. Enlist the sources of vitamin D
- 8.04. Describe the active form of vitamin D
- 8.05. Enlist vitamin D related diseases
- 8.06. Compare Rickets and Osteomalacia
- 8.07. Compare Osteomalacia and Osteoporosis
- 8.08. Enlist the sources of Vitamin C
- 8.09. Enlist the functions of Vitamin C
- 8.10. Discuss the role of Vitamin C in prevention of Scurvy
- 8.11. Discuss Scurvy
- 8.12. Enlist the sources and functions of vitamin B-1, B-2, B-3, B-6, Folic acid & B-12
- 8.13. Describe the following vitamin deficiency clinical abnormalities;
 - a. BeriBeri
 - b. Pellagra
 - c. Neuropathy
 - d. Neural Tube Defect
 - e. Macroblastic Anemia

LEARNING STRATEGIES AND ASSESSMENT:

S:N o	LECTURE TOPIC	MIT	HOURS	BCQ	OSPE
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1	Vitamin A, E & K	LEC	1	✓	-
2	Vitamin D	LEC	1	✓	✓
3	Rickets / Osteomalacia	SGD	2	✓	✓
4	Vitamin C	LEC	1	✓	✓
5	Scurvy	SGD	2	✓	✓
6	Vitamin B 12 & Folic acid	LEC	1	✓	✓
7	Neural Tube Defect	SGD	2	✓	✓
8	Vitamin B 1, B 2, B 3 & B 6	SGD	1	✓	-
9	BeriBeri / Pallegra	SGD	2	✓	-
Total			13		

COURSE NAME: MINERALS

COURSE CODE: FJ01-BCH-9

Learning Objectives: At the end of the course, the student should be able to:

- 9.01. Discuss the uses of Iron (Heme/Iron-Sulfur cluster/Fe containing enzymes)
- 9.02. Enlist the sources of Heme& Non-Heme Iron
- 9.03. Describe the daily requirement & Recommended Dietary Intake of Iron and also discuss why they are different
- 9.04. Discuss the absorption of both Heme as well as Non-Heme Iron
- 9.05. Enlist the names of carrier proteins & oxidoreductases responsible for Iron absorption
- 9.06. Describe the transport of Iron in the serum
- 9.07. Discuss the storage of Iron
- 9.08. Enlist the pivotal organs responsible for Iron metabolism
- 9.09. Enumerate the %age wise distribution of Iron reservoir in the body
- 9.10. Describe the role of Hepcidin in Iron metabolism
- 9.11. Discuss Iron overload(Hemochromatosis/Hemosiderosis)
- 9.12. Compare Iron deficiency anemia & Anemia of Chronic diseases
- 9.13. Enlist three forms of plasma calcium
- 9.14. Enlist biomedical importance of calcium
- 9.15. Describe hydroxyapatite
- 9.16. Enlist the sources of calcium & phosphate
- 9.17. Discuss the plasma regulation of calcium
- 9.18. Enlist the clinical features of hypocalcemia

- 9.19. Enlist the biomedical importance of phosphate
- 9.20. Discuss the functions of Parathyroid Hormone in relation to Calcium and Phosphate ion
- 9.21. Discuss the functions of Calcitonin
- 9.22. Describe chemical composition of bone (Inorganic/Organic)
- 9.23. Discuss the role of Fluoride in prevention of Dental Caries
- 9.24. Enlist the sources of Fluoride
- 9.25. Discuss Fluorosis

LEARNING STRATEGIES AND ASSESSMENT:

S:No	LECTURE TOPIC	MIT	HOURS	BCQ	OSPE
1	Iron	LEC	2	✓	-
2	Iron deficiency anemia & Hemochromatosis & Hemosiderosis	SGD	2	✓	✓
3	Calcium & Phosphorus	LEC	2	✓	-
4	Tetany	SGD	2	✓	-
5	Fluoride & Other Minerals	LEC	2	✓	✓
6	Fluorosis & Dental carries	SGD	2	✓	✓
Total			12		

COURSE NAME: CARBOHYDRATE METABOLISM

COURSE CODE: FJ01-BCH-10

Learning Objectives: At the end of the course, the student should be able to:

- 10.01. Define glycolysis/EM pathway
- 10.02. Compare the types of glycolysis (Aerobic & anaerobic)
- 10.03. Enlist the steps of glycolysis with the relevant enzymes
- 10.04. Calculate the energetics of glycolysis (Both aerobic & anaerobic)
- 10.05. Discuss the regulation of glycolysis (Hormonal/Covalent modification/Allosteric modification)
- 10.06. Discuss the intermediate step of metabolism (Especially mentioning energetics & Co-enzymes)
- 10.07. Enlist the steps of TCA Cycle
- 10.08. Justify TCA as an amphibolic pathway
- 10.09. Discuss the energetic of TCA Cycle
- 10.10. Compare glycogen and starch
- 10.11. State the names of anabolic & catabolic pathways of glycogen metabolism

- 10.12. Describe the biomedical importance of glycogen
- 10.13. State the sites of glycogen metabolism
- 10.14. State the major enzymes of both glycogenesis as well as Glycogenolysis
- 10.15. Discuss the regulation of glycogen metabolism
- 10.16. Enlist the types of GSD along with their deficient enzymes
- 10.17. Justify the name of pathway as HMP shunt pathway & PPP
- 10.18. State the two phases of HMP shunt pathway
- 10.19. State the significance of HMP shunt pathway
- 10.20. Describe the biomedical importance of NADPH & ribose sugar
- 10.21. Describe how many carbon atoms are transferred in transketolase/ transaldolase reaction
- 10.22. State the end product of HMP shunt pathway
- 10.23. Discuss why G6PDH deficiency leads to hemolytic anemia especially when the person being treated with antimalarial medicines
- 10.24. Describe the location of gluconeogenesis (Both organ & cell wise)
- 10.25. Discuss the four steps of gluconeogenesis along with its regulation
- 10.26. Discuss the significance of gluconeogenesis
- 10.27. Describe Cori cycle
- 10.28. Describe Cahill cycle
- 10.29. Define Diabetes Mellitus
- 10.30. Compare Diabetes Mellitus and Diabetes Insipidus
- 10.31. State the difference between Pancreatic, Pituitary and adrenal diabetes
- 10.32. Enlist the types of diabetes mellitus
- 10.33. Compare IDDM with NIDDM
- 10.34. Enlist the presenting sign & symptoms of diabetes
- 10.35. Enlist the biochemical parameters applied in the diagnosis as well as prognosis of diabetes
- 10.36. State the normal levels of FBS, RBS, OGTT and HbA1c (mg/dl or mmol/l)
- 10.37. State the use of OGTT
- 10.38. State the use of HbA1c
- 10.39. Enlist the complications of diabetes mellitus (Microvascular&Macrovascular)

LEARNING STRATEGIESAND ASSESSMENT:

S:No	LECTURE TOPIC	MIT	HOURS	BCQ	OSPE
1	Digestion & Absorption of Carbohydrates	LEC	1	✓	-
2	Lactose Intolerance	SGD	2	✓	-
3	Glycolysis	LEC	2	✓	✓
4	TCA cycle	LEC	1	✓	✓

5	Gluconeogenesis	LEC	1	✓	-
6	Glycogen Metabolism	LEC	1	✓	-
7	Glycogen Storage Disease	SGD	2	✓	-
8	HMP shunt pathway	LEC	1	✓	-
9	Blood glucose regulation & Diabetes Mellitus	LEC	1	✓	✓
10	Diabetes Mellitus	SGD	5	✓	✓
11	Glycemic Parameters (FBS / RBS / OGTT/ HbA1c)	SGD	4	✓	✓
Total			21		

COURSE NAME: LIPID METABOLISM

COURSE CODE: FJ01-BCH-11

Learning Objectives: At the end of the course, the student should be able to:

- 11.01. Enlist the composition of Bile juice
- 11.02. Enlist the names of bile salts and bile pigments
- 11.03. Describe emulsification and micelle formation in terms of lipid digestion
- 11.04. Enlist the names of lipoproteins and describe their density trend
- 11.05. State the names of good and bad cholesterol in terms of lipoprotein
- 11.06. Enlist the biomedical importance of cholesterol in the body (Fate of cholesterol)
- 11.07. Enlist the HMG CoA enzymes and state the rate limiting enzyme of cholesterol synthesis
- 11.08. State the total serum cholesterol level
- 11.09. Justify the name of β oxidation (Why is it called β oxidation?)
- 11.10. Discuss the carnitine shuttle with regards to β oxidation
- 11.11. Enlist the steps of β oxidations
- 11.12. State how many cycles of β oxidation are required to oxidize 16-C Palmitic acid
- 11.13. Enumerate the total as well as net ATP production from β oxidation of Palmitic acid
- 11.14. State one hormonal & one allosteric inhibitors of β oxidation
- 11.15. Justify the use of term De Novo in fatty acid synthesis
- 11.16. State the organs/ intracellular location of fatty acid synthesis
- 11.17. Compare the shuttles used in β oxidation and de novo fatty acid synthesis
- 11.18. State the coenzyme used in reductive fatty acid synthesis with its source
- 11.19. Describe the formation of malonyl CoA in fatty acid synthesis
- 11.20. Discuss Fatty acid synthase complex; enlisting it's seven enzymes
- 11.21. Enumerate the potential ATP consumption in 16-C palmitic acid synthesis

- 11.22. State the hormonal regulation of fatty acid synthesis
- 11.23. State the names of essential fatty acids (ω -3 & ω -6)
- 11.24. Define eicosanoids biochemically
- 11.25. State major classes of eicosanoids with their functions
- 11.26. Describe the two pathways of prostaglandin synthesis
- 11.27. Discuss the mechanism of action of steroids, NSAIDs & leukotriene inhibitors
- 11.28. Enlist the names of ketone bodies
- 11.29. Enlist the HMG CoA enzymes responsible for ketone bodies production
- 11.30. Justify the use of ketone bodies
- 11.31. Enlist one condition each leading to ketoacidosis both with hyper/ hypoglycemia

LEARNING STRATEGIES AND ASSESSMENT:

S:No	LECTURE TOPIC	MIT	HOURS	BCQ	OSPE
1	Digestion & Absorption of Lipids	LEC	1	✓	-
2	Cholesterol Lipid Transport (Lipoproteins)	LEC	1	✓	✓
3	Lipid Profile	SGD	2	✓	✓
4	β Oxidation	LEC	2	✓	✓
5	Ketone Bodies & Prostaglandins	LEC	1	✓	-
6	Prostaglandin inhibitors	SGD	1	✓	-
Total			8		

COURSE NAME: ELECTRON TRANSPORT CHAIN

COURSE CODE: FJ01-BCH-12

Learning Objectives: At the end of the course, the student should be able to:

- 12.01. Justify the names of ETC/Respiratory chain/Oxidative phosphorylation
- 12.02. Describe the source of NADH & FADH
- 12.03. Describe the location of ETC
- 12.04. Describe the complexes of ETC
- 12.05. State which ETC complexes are responsible for proton pumping
- 12.06. State which ETC complexes are responsible for ATP synthesis
- 12.07. Justify why NADH produce 3 ATPs while FADH produce 2 ATPs
- 12.08. State the electron carrier which is not associated with protein
- 12.09. State the mobile components of ETC

12.10. State the inhibitors and un-couplers of ETC

LEARNING STRATEGIES AND ASSESSMENT:

S:No	LECTURE TOPIC	MIT	HOURS	BCQ	OSPE
1	Electron Transport Chain	Lecture	1	✓	✓
2	ETC Inhibitors & Un-couplers	SGD	3	✓	✓
Total			4		

COURSE NAME:PROTEIN METABOLISM

COURSE CODE: FJ01-BCH-13

Learning Objectives: At the end of the course, the student should be able to:

- 13.01. Enlist the fate of amino acid in the body
- 13.02. Discuss the transaminase reactions of amino acids in terms of ALT & AST and coenzyme
- 13.03. Discuss the deaminase reaction of amino acids both oxidative & non-oxidative
- 13.04. State one example of decarboxylation of amino acids
- 13.05. Discuss the role of glutamate in amino group metabolism
- 13.06. Justify the excretion of nitrogen in humans as urea instead of ammonia
- 13.07. State the location of urea cycle (Both organ as well as intracellular)
- 13.08. State how Urea cycle and TCA cycle are synergized
- 13.09. Enlist the amino acids taking part in urea cycle
- 13.10. State the source of both amino groups in the urea molecule
- 13.11. State the rate limiting step of urea cycle
- 13.12. Discuss the steps of urea cycle
- 13.13. State the normal plasma level of blood urea level
- 13.14. Describe uremia and give one reason resulting in the condition
- 13.15. Which inborn error of metabolism in urea cycle is X-linked
- 13.16. Discuss the following inborn error of amino acid metabolism
 - a. Phenylketonuria (PKU)
 - b. Alkaptonuria (AKU)
 - c. Albinism
 - d. Hartnup disease
 - e. Maple syrup urine disease (MSUD)

LEARNING STRATEGIESAND ASSESSMENT:

S:N o	LECTURE TOPIC	MIT	HOURS	BCQ	OSPE
1	Digestion & Absorption of Proteins	LEC	1	✓	-
2	Reactions of Amino Acids & Urea Cycle	LEC	1	✓	✓
3	Phenylalanine, Tyrosine & Tryptophan Metabolism	LEC	1	✓	✓
4	Error amino acid metabolism (PKU / AKU / Albinism / Hartnup's disease / MSUD)	SGD	6	✓	✓
Total			9		

COURSE NAME: NUTRITION

COURSE CODE: FJ01-BCH-14

Learning Objectives: At the end of the course, the student should be able to:

- 14.01. Enlist the nutrients of the body along with their functions
- 14.02. Classify nutrients into major and minor as per the body requirement
- 14.03. Describe the Nutritional Pyramid in terms of food groups
- 14.04. Discuss obesity in terms of BMI also discuss the formula of BMI calculation
- 14.05. Enumerate the BMI of a volunteer through the given SOP
- 14.06. Discuss obesity in terms of BMI
- 14.07. Discuss underweight in terms of BMI
- 14.08. Enlist the diseases of nutritional origin inferring in disease status (Deficiency & excess)

LEARNING STRATEGIESAND ASSESSMENT:

S:N o	LECTURE TOPIC	MIT	HOURS	BCQ	OSPE
1	Introduction of Nutrition (Balanced Diet, Malnutrition & Obesity)	LEC	1	✓	-
2	Body Mass Index (BMI), Obesity	SGD	3	✓	✓

	(Metabolic Syndrome)				
Total			4		

COURSE NAME:ENDOCRINOLOGY

COURSE CODE: FJ01-BCH-15

Learning Objectives: At the end of the course, the student should be able to:

- 15.01. Define hormone
- 15.02. Classify hormones on the basis of composition and solubility
- 15.03. Classify hormone receptors on the basis of location, solubility & mechanism of action
- 15.04. Discuss the G protein receptors
- 15.05. Discuss the G proteins and their types
- 15.06. Discuss the second messenger system & enlist a few hormones using c AMP as second messenger system.
- 15.07. Enlist Anterior & Posterior Pituitary Hormone along with their composition & functions
- 15.08. Discuss Diabetes Insipidus (Neurogenic/ Nephrogenic)/ SIADH/ Gigantism/ Acromegaly/ Dwarfism
- 15.09. Discuss the synthesis of thyroid hormones within the follicular cells
- 15.10. Discuss Cretinism/ Myxedema/ Grave's Disease/ Exophthalmoses
- 15.11. Enlist the Hormones of Adrenal Gland (Cortex & Medulla)
- 15.12. Discuss Cushing Disease/ Cushing syndrome/ Addison's disease

LEARNING STRATEGIESAND ASSESSMENT:

S:N o	LECTURE TOPIC	MIT	HOURS	BCQ	OSPE
1	Introduction of Endocrinology	LEC	1	✓	✓
2	Hypothalamus, Pituitary & Thyroid	LEC	1	✓	✓
3	Adrenal & Pancreatic Hormones	LEC	2	✓	✓
4	Gigantism / Acromegaly/ Dwarfism	SGD	2	✓	✓
5	Diabetes Insipidus (DI) / SIADH	SGD	2	✓	✓
6	Cretinism / Myxedema / Exophthalmos / Goiter	SGD	3	✓	✓
7	Cushing Disease / Cushing Syndrome / Addison's Disease	SGD	2	✓	✓
Total			13		

COURSE NAME: EXPERIMENTAL BIOCHEMISTRY (BIOTECHNIQUES)

COURSE CODE: FJ01-BCH-16

Learning Objectives: At the end of the course, the student should be able to:

- 16.01. Compare different bio-techniques both separating as well as analyzing ones
- 16.02. Identify spectrophotometer as an experimental bio-equipment
- 16.03. Identify different Parts of Spectrophotometer
- 16.04. Describe Beer Lambert's law
- 16.05. State the formula to calculate the concentration of unknown solution using spectrophotometry
- 16.06. Knows the operational aspects of spectrophotometer (Transmittance/ Absorbance)
- 16.07. Describe the uses of Blank & Standard in the operation of Spectrophotometer
- 16.08. Describe the types of spectrophotometer
- 16.09. Discuss the applications of spectrophotometer
- 16.10. Identify glucometer as an experimental bio-equipment
- 16.11. Describe transduction as the underlying principle of glucometer
- 16.12. Shows how the glucometer is operated
- 16.13. Discuss the clinical applications of glucometer
- 16.14. Identify pH meter as an experimental bio-equipment
- 16.15. Shows how the pH meter is operated
- 16.16. Discuss the clinical applications of pH meter
- 16.17. Interpret the clinical implications of different levels of plasma pH
- 16.18. Identify electrophoresis as an experimental bio-equipment
- 16.19. Knows the operational aspects of electrophoresis
- 16.20. Identify different parts of electrophoresis equipment
- 16.21. Justify the reasons of separation of molecules scientifically during electrophoresis
- 16.22. Discuss the types of blotting techniques in electrophoresis along with their uses
- 16.23. Discuss the applications of electrophoresis in terms of thalassemia screening
- 16.24. Identify chromatography (HPLC) as an experimental bio-equipment
- 16.25. Describe the phases of HPLC
- 16.26. Knows the operational aspects of HPLC
- 16.27. Describe different parts of HPLC (Tower/ Pump/ Column/ Monitor)
- 16.28. Justify the reasons of separation of molecules scientifically during HPLC
- 16.29. Describe the types of HPLC
- 16.30. Discuss the applications of HPLC especially in pharmaceutical industry

LEARNING STRATEGIES AND ASSESSMENT:

S:N o	BIOTECHNIQUE TOPIC	MIT	HOURS	BCQ	OSPE
1	Spectrophotometer	DEMO	3	-	✓
2	Glucometer	PRAC	3	-	✓
3	pH meter	PRAC	3	-	✓
4	Electrophoresis	DEMO	3	-	✓
5	Chromatography	DEMO	3	-	✓
Total			15		

COURSE NAME: CLINICAL BIOCHEMISTRY

COURSE CODE: FJ01-BCH-17

Learning Objectives: At the end of the course, the student should be able to:

- 17.01. Enlist the glycemic parameters to diagnose as well as assess diabetes mellitus
- 17.02. State the normal serum level of Fasting Blood Sugar (FBS)
- 17.03. Discuss the diagnostic criteria of Diabetes Mellitus on the basis of FBS
- 17.04. State the normal serum level of Random Blood Sugar (RBS)
- 17.05. Discuss the procedure of oral glucose tolerance test (OGTT)
- 17.06. Interpret the OGTT graph both for normal as well as diabetic individuals
- 17.07. Describe graphically serum glycemic level at different time points
- 17.08. Describe the role of OGTT in the diagnosis and screening of gestational diabetes
- 17.09. State the normal serum level of Glycosylated hemoglobin (HbA1c)
- 17.10. Discuss the role of HbA1c in monitoring long term glycemic compliance
- 17.11. Describe the normal plasma range of total cholesterol, LDL & HDL
- 17.12. State the normal range of LDL/HDL ratio
- 17.13. Discuss the terms of GOOD & BAD cholesterol in terms of atherosclerosis & myocardial infarction
- 17.14. State the normal serum bilirubin level
- 17.15. Discuss serum bilirubin level as a proxy indicator of liver function
- 17.16. Discuss blood ammonia as a detoxification indicator of Liver function
- 17.17. Discuss hepatic enzymes levels and their association with different types of jaundices
- 17.18. Discuss urea, creatinine and electrolytes as assessment parameters of renal function
- 17.19. State normal UCE levels
- 17.20. Classify Uremia (High Blood Urea Levels)
- 17.21. State the plasma protein levels with appropriate level
- 17.22. Describe the role of albumin levels in maintaining the plasma oncotic pressure
- 17.23. Describe the role of globulin levels in preventing recurrent infections

- 17.24. Describe the Albumin/ Globulin ratio (A/G ratio)
- 17.25. Discuss clinical interpretation of hyper and hypo plasma protein levels
- 17.26. Discuss the urine detailed report (Urine DR) (Physical appearance/ color/ constituents/ specific gravity)
- 17.27. State the indication of Urine Culture Test
- 17.28. State the process of urine specimen collection for urine DR (Early morning & Mid Stream)
- 17.29. Discuss the dipstick urine test
- 17.30. Discuss the normal constituents of urine both organic and inorganic
- 17.31. Discuss the abnormal constituents of urine
- 17.32. Discuss the following terms of pathological urine with at least one example each along with the name of the test used to detect them
- Glycosuria
 - Hematuria
 - Proteinuria
 - Hemoglobinuria
 - Ketonuria
- 17.33. Discuss the association of certain key diagnostic enzymes with the following disease status
- Hepatic jaundice
 - Obstructive jaundice
 - Mumps
 - Pancreatitis
 - Myocardial ischemia
- 17.34. Discuss the role of Troponin as non-enzymatic cardiac marker in the diagnosis of MI
- 17.35. Discuss the sensitivity and peak hours timings of different diagnostic enzymes used as a tool in Myocardial Infarction
- 17.36. State normal hemoglobin levels according to the gender
- 17.37. Discuss anemia both qualitative as well as quantitative

LEARNING STRATEGIES AND ASSESSMENT:

S:N o	CLINICAL BIOCHEMISTRY TOPIC	MIT	HOURS	BCQ	OSPE
1	Glycemic Indicators	OBD	3	-	✓
2	Lipid profile	OBD	3	-	✓
3	Liver function test (LFTs)	OBD	3	-	✓
4	Renal function test (RFTs)	OBD	3	-	✓
5	Urine DR	OBD	3	-	✓
6	Diagnostic enzymology	OBD	3	-	✓

7	Anemia (Qualitative / Quantitative)	OBD	3	-	✓
Total			21		

Biochemistry Learning Resources

BOOKS

Essential:

- Δ MN Chaterjea & Rana Shinde. Jaypee Textbook of Biochemistry. 9th edition 2019
- Δ Robber k. Murray, Daryl k. Grinner, Peter A. Mayes, Victor W. Rod well. Harper's Biochemistry 29th edition 2017
- Δ Pamela C. Champe, Richard A. Harvey. Lippincott's Illustrated Review of Biochemistry 6th edition 2017

Recommended:

- Δ John F. Zilva, Peter R. Pannall, Philip D. Maine. Clinical Chemistry in Diagnosis and Treatment, 5th edition 1988
- Δ U. Satyanaryana. Biochemistry, 3rd edition 2008

LOG BOOK

As per the curriculum requirements, a pre-printed log book will be provided in the beginning of the year which needs to be filled in and get checked accordingly as it not only

contains your experimental protocols and SOPs but also comprises of your academic records.

RESEARCH JOURNALS/ PERIODICALS

- Δ JPDA (Journal of Pakistan Dental Association)
- Δ Dental News

TECHNOLOGY BASED LEARNING

- Δ Internet Browsing
- Δ Research as well as academics websites along with relevant portals and blogs
- Δ Simulation CDs & Lectures

ORAL BIOLOGY

COURSE DESCRIPTION AND RATIONALE:

This course introduces the basic concepts of development, anatomy and histological structure of oral tissues along with knowledge of eruption sequence and morphological features of deciduous and permanent dentition.

COURSE OUTCOMES: The student will be able to:

1. Describe basic concepts of oral biology
2. Describe normal development, anatomy and histological structure of teeth, supporting tissues and oral mucosa in different parts of the oral cavity, salivary glands and temporomandibular joint
3. Describe timetable for the development and eruption of deciduous and permanent dentitions.
4. Identify cells, tissues and organs of oral cavity and adjacent structures in histological sections.
5. Predict developmental stage of each tooth in young patients on dental radiographs.
6. Use light microscope.
7. Gain manual competency through practicals (Tooth morphology carving)

MODE OF INFORMATION TRANSFER (MIT):

- Lectures (LEC)
- Small group discussion (SGD)
- Practical (Prac)
- Journal club (JC)
- Workshop (WS)
- Case based discussion (CBD)

COURSE NAME: Structure of Oral Tissues

CODE: FJ01-OB-1

LEARNING OBJECTIVES: By the end of the topic the students will be able to:

1.1: Define Oral Biology

1.2: Describe tooth structure

1.3: Describe

- a) Enamel
- b) Dentin
- c) Pulp
- d) PDL
- e) Cementum
- f) Bone
- g) Oral Mucosa
- h) TMJ

1.4: Describe Hard Tissue Formation

1.5: Discuss Organic Matrix in Hard tissues and role of minerals

1.6: Describe Mineralization

1.7: Discuss Crystal Growth

1.8: Describe role of Alkaline Phosphatase

1.9: Discuss Transport of Mineral Ions to Sites of Mineralization

1.10: Describe Hard Tissue Degradation

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Introduction to Oral Histology	LEC	1		
2	Structures of Tooth	LEC	1	✓	✓
3	Supporting and Surrounding Apparatus	LEC	1	✓	
4	Structure of Oral tissues	SGD	2		
	TOTAL HOURS		5		

COURSE NAME: General Embryology**COURSE CODE:** FJ01-OB-2**LEARNING OBJECTIVES:** By the end of the topic the students will be able to:

2.1: Describe

- a) germ cell formation,
- b) germ cell development
- c) fertilization

2.2: Define

- a) Induction,
- b) Competence
- c) Differentiation

2.3: Describe Formation of Three Layered Embryo and folding of embryo

2.4: Describe Formation of Neural Tube and Fate of the Germ Layers

2.5: Define Neural Crest cells

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Germ cell formation, fertilization	LEC	1		
2	Formation of three layered embryo	LEC	1	✓	✓

3	Fate of germ layers, Neural crest cells	LEC	1	✓	✓
4	Syndromes	LEC	1	✓	
5	General embryology	PRAC	2		
6	Developmental defects	CBD	2		
7	General Embryology	SGD	2		
	TOTAL HOURS		10		

COURSE NAME: Embryology of the Head, Face, and Oral Cavity

COURSE CODE: FJ01-OB-3

LEARNING OBJECTIVES: By the end of the topic the students will be able to:

3.1: Describe Neural Crest Cells and their role in Head Formation

3.2: Describe Branchial (Pharyngeal) Arches and the Primitive Mouth

3.3: Describe Fate of Grooves and Pouches

3.4: Describe arch anatomy

3.5: Describe Formation of the face, palate, tongue, maxilla, mandible and TMJ

3.6: Describe Congenital Defects

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Arches and pouches, Formation, Anatomy and derivatives	LEC	1	✓	✓
2	Development of face	LEC	1	✓	✓
3	Development of palate, tongue	LEC	1	✓	✓
4	Development of mandible, maxilla	LEC	1	✓	✓
5	Development of Skull and TMJ	LEC	1		
6	Congenital defects	LEC	1	✓	✓

7	Embryology of Head and Fcae	PRAC	2		
8	Embryology of Oral Cavity	PRAC	2		
9	Congenital defects	CBD	2		
10	Embryology of Head and Neck	SGD	2		
	TOTAL HOURS		14		

COURSE NAME: Cytoskeleton, Cell Junctions, Fibroblasts, and Extracellular Matrix

COURSE CODE: FJ01-OB-4

LEARNING OBJECTIVES: By the end of the topic, the students will be able to

4.1: Describe

- a) Intercellular junctions
- b) Epithelium
- c) Connective tissue interface
- d) Fibroblast

4.2: Describe

- a) Secretory products
- b) Collagen assembly
- c) Elastin
- d) Proteoglycans

4.3: Define Growth factors and cytokines and understand extra-cellular matrix degradation

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Cell membrane and Cytoskeleton	LEC	1	✓	✓
2	Intercellular junctions, epithelium	LEC	1	✓	
3	Connective tissue interface, Fibroblasts	LEC	1	✓	
4	Cytoskeleton and junctions	PRAC	2		
5	Skin and Oral Mucosa	CBD	2	✓	✓

	defects				
	TOTAL HOURS		7		

COURSE NAME: Development of the Tooth and Its Supporting Tissues

COURSE CODE: FJ01-OB-5

LEARNING OBJECTIVES: By the end of the lecture, students should be able to:

5.1: Define

- a) Primary epithelial band
- b) Dental and vestibular lamina

5.2: Describe the stages of tooth development

- a) Bud stage
- b) Cap stage
- c) Bell stages

5.3: Define

- a) Enamel knot
- b) Enamel cord
- c) Enamel niche

5.4: Describe Nerve, vascular supply, formation of permanent dentition

5.5: Describe hard tissue and root formation

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Primary epithelial bands, Dental and Vestibular Lamina	LEC	1	✓	✓
2	Bud and Cap stages	LEC	1	✓	✓
3	Bell stage, Hard tissue and root formation	LEC	1	✓	✓
4	Root formation	LEC	1	✓	✓
5	Development of tooth and supporting structures	SGD	2		
6	Tooth Development, Bud, Cap stages	PRAC	2		
7	Tooth Development, Bell stage	PRAC	2		

8	Clinical considerations	SGD	2	✓	
9	Tooth Development	CBD	2		
	TOTAL HOURS		14		

COURSE NAME: Bone

COURSE CODE: FJ01-OB-6

LEARNING OBJECTIVES: At the end of the lecture, students will be able to:

6.1: Describe Gross bone histology (compact, spongy, medullary)

6.2: Discuss Bone cells (osteoblasts, osteocyte, osteoclasts)

6.3: Describe Regulation of bone cell formation

6.4: Define Intra membranous and endochondral bone formation

6.5: Describe Sutural bone growth

6.6: Define Bone turnover (Remodeling)

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Bone Histology	LEC	1	✓	✓
2	Bone formation and sutural growth	LEC	1	✓	✓
3	Bone turnover (Remodeling)	LEC	1	✓	
4	Bone Histology	SGD	2		
5	Bone Histology	PRAC	2		
	TOTAL HOURS		7		

COURSE NAME: Enamel: Composition, Formation, and Structure

COURSE CODE: FJ01-OB-7

LEARNING OBJECTIVES: At the end of the lecture, students will be able to:

7.1: Describe Physical characteristics, structure of enamel and amelogenesis

7.2: Describe Electron microscopy of amelogenesis

7.3: Describe Pre-secretory, secretory and maturation stage

7.4: Discuss Ameloblast secretory products

7.5: Describe Mineral pathway and mineralization and Regulation of PH during enamel formation

7.6: Describe Structural organization of enamel and histology

7.7: Describe Enamel Age changes and defects of amelogenesis

7.8: Discuss Clinical Implications, fluoridation and acid etching

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HRS	BCQ	OSPE
1	Enamel Properties	LEC	1	✓	✓
2	Amelogenesis: Presecretory and Secretory stage	LEC	1	✓	✓
3	Amelogenesis: Maturation stage	LEC	1	✓	✓
4	Structural organization	LEC	1	✓	✓
5	Clinical Considerations	LEC	1	✓	
6	Clinical considerations	CBD	2		
7	Enamel	SGD	2		
8	Enamel	PRAC	2		
9	Enamel Histology	PRAC	2		
	Total		13		

COURSE NAME: Dentin Pulp Complex

COURSE CODE: FJ01-OB-8

LEARNING OBJECTIVES: At the end of the lecture, students will be able to

8.1: Describe Basic structure of dentine, type of dentine, pattern of dentin formation

8.2: Define Dentinogenesis

8.3: Describe Odontoblast differentiation, mantle dentin and root dentin

8.4: Describe Secondary and tertiary dentinogenesis and dentin histology

8.5: Describe structure of Pulp, odontoblasts, undifferentiated ectomesenchymal cells

8.6: Discuss Innervation of dentine-pulp complex

8.7: Define Dentin sensitivity and pulp stones

8.8: Describe Age changes of dentin and pulp

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Dentin properties	LEC	1	✓	
2	Dentinogenes	LEC	1	✓	✓
3	Structure andTypes	LEC	1	✓	✓
4	Dentin Histology	LEC	1	✓	✓
5	Age changes, theories of Dentin Sensitivity	LEC	1	✓	✓
6	Pulp	LEC	1	✓	✓
7	Clinical consideratins	CBD	2		
8	Dentin Histology	PRAC	2		
9	Dentin Types	PRAC	2		
10	Pulp	PRAC	2		
	TOTAL HOURS		14		

COURSE:Periodontium

CODE: FJ01-OB-9

LEARNING OBJECTIVES: At the end of the lecture, students will be able to:

9.1: Describe cementum (composition, initiation of formation)

9.2: Describe periodontal cell

9.3: Describe cementogenesis, cementum varieties, CEJ

9.4: Discuss attachment of cementum onto dentine

9.5: Describe Alveolar process and PDL

9.6: Describe PDL and gingival Fiber groups

9.7: Discuss Blood and nerve supply

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Cementum, Cementogenesis	LEC	1	✓	✓
2	Cementum, types	LEC	1	✓	✓
3	Cementum histology	LEC	1	✓	✓
4	Periodontal ligament and gingiva	LEC	1	✓	✓

5	Periodontium, Clinical Considerations	SGD	2	✓	
6	Periodontium	PRAC	2		
	TOTAL HOURS		8		

COURSE NAME: Physiologic Tooth Movement: Eruption and Shedding

COURSE CODE: FJ01-OB-10

LEARNING OBJECTIVES: At the end of the topic, students will be able to:

10.1: Define and describe Pre eruptive, eruptive and post eruptive tooth movement

10.2: Discuss Accommodation for growth and tooth exfoliation

10.3: Describe Odontoclast

10.4: Discuss role of Pressure

10.5: Describe Pattern of shedding and abnormal tooth movement

10.6: Describe orthodontic tooth movement

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Tooth movements	LEC	1	✓	✓
2	Abnormal and orthodontic tooth movement	LEC	1	✓	
3	Abnormal and orthodontic tooth movement	SGD	2		
	TOTAL HOURS		4		

COURSENAME: Salivary Glands

COURSE CODE: FJ01-OB-11

LEARNING OBJECTIVES: By the end of the topic, students will be able to:

11.1: Discuss Functions of saliva

11.2: Describe Anatomy (secretory cells, formation and secretion of saliva) and myoepithelial cells

11.3: Discuss Development of salivary glands

11.4: Describe Ductal modification of saliva and connective tissue

11.5: Discuss Blood and nerve supply

11.6: Describe Histology of major and minor salivary glands

11.7: Discuss Clinical consideration

11.8: Describe Age changes and xerostomia

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Salivary glands types, development	LEC	1	✓	✓
2	Salivary gland function	LEC	1	✓	✓
3	Anatomy, structure of Major and Minor Salivary glands	LEC	1	✓	✓
4	Histology of Major and Minor Salivary glands	LEC	1	✓	✓
5	Age changes	LEC	1	✓	
6	Clinical considerations	LEC	1	✓	
7	Clinical Considerations	SGD	2		
8	Salivary glands types	PRAC	2		
9	Salivary glands Histology	PRAC	2		
10	Salivary glands Histology	SGD	2		
	TOTAL HOURS		14		

COURSE NAME: Oral Mucosa**COURSE CODE:** FJ01-OB-12**LEARNING OBJECTIVES:** By the end of the lecture, students will be able to:

12.1: Define oral mucosa

12.2: Discuss Functions and boundaries of oral mucosa

12.3: Describe Component tissue and glands, epithelial proliferation and maturation

12.4: Describe Ultrastructure of epithelial cell and cellular events in maturation

12.5: Describe Keratinocytes and non-keratinocytes in the oral epithelium

12.6: Describe Junction of epithelium and lamina propria

12.7: Discuss Blood Supply and Nerve Supply

12.8: Describe Masticatory, lining and specialized Mucosa

12.9: Describe Fungiform, filiform, foliate and circumvallate Papillae

12.10: Describe all Junctions in the Oral Mucosa

12.11: Describe Development of the Oral Mucosa and age changes

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Functions, boundaries	LEC	1	✓	✓
2	Components	LEC	1	✓	✓
3	Keratinocytes, Non keartinocytes	LEC	1	✓	✓
4	Histology, Junctions	LEC	1	✓	✓
5	Types, lining, masticatory, specialized	LEC	1	✓	✓
6	Clinical Considerations	LEC	1	✓	
7	Clinical Considerations	SGD	2		
8	Oral Mucosa Histology	PRAC	2		
9	Keratinocytes and non keratinocytes	PRAC	2		
	TOTAL HOURS		12		

COURSE NAME: Temporomandibular Joint

COURSE CODE: FJ01-OB-13

LEARNING OBJECTIVES: By the end of the topic, students will be able to:

13.1: Classify joints (fibrous, cartilaginous joint, synovial joint)

13.2: Describe Types, development, bones and cartilages of joint

13.3: Describe Capsule, Ligaments, disc of joint, muscle contraction, muscles of mastication

13.4: Discuss Blood supply, nerve supply of joint

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	TMJ development and histology	LEC	1	✓	✓
2	TMJ capsule, ligaments and muscles of mastication	LEC	1	✓	
3	TMJ	PRAC	2		
	TOTAL HOURS		4		

COURSE NAME: Facial growth and development

COURSE CODE: FJ01-OB-14

LEARNING OBJECTIVES: At the end of the topic, students will be able to:

14.1: Define and describe Facial Types and profiles

14.2: Discuss Male and Female Faces

14.3: Describe Age Changes

14.4: Define Curves of Occlusion

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Facial types and profiles	LEC	1	✓	
2	Curves of Occlusion	LEC	1	✓	
3	Facial Profiles	SGD	2		
	TOTAL HOURS		4		

COURSE: Repair and Regeneration of Oral Tissues

CODE: FJ01-OB-15

Learning Objectives: At the end of the topic, the students will be able to:

15.1: Discuss Wound Healing in Oral Mucosa and dento gingival junction

15.2: Discuss Repair of Enamel and dentin pulp complex

15.3: Discuss Dental Caries

15.4: Describe Cavity Preparation

15.5: Discuss Repair after tooth extraction and periodontal repair and regeneration

15.6: Discuss concept of Stem Cells

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Wound Healing	LEC	1	✓	✓
2	Repair and regeneration	LEC	1	✓	
3	Repair and Regeneration	SGD	2		
	TOTAL HOURS		4		

COURSE NAME: Introduction to Dental Anatomy

COURSE CODE: FJ01-OB-16

LEARNING OBJECTIVES: At the end of the topic, students will be able to

16.1: Define Dental Anatomy

16.2: Define and discuss Nomenclature

16.3: Discuss Formulae for Mammalian Teeth

16.4: Describe Tooth Numbering Systems

16.5: Define Crown and Root

16.6: Describe Surfaces and Ridges

16.7: Define Morpho Landmarks and angles

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Introduction to oral anatomy	LEC	1	✓	✓
2	Nomenclature	LEC	1	✓	
3	Tooth Numbering System	LEC	1		
4	Crown and Root	LEC	1	✓	
5	Tooth Surfaces and Ridges	LEC	1	✓	✓
6	Oral Landmarks	LEC	1	✓	
7	Identification of morphological landmarks and terminologies on models	SGD	2		✓
8	Oral Landmarks	PRAC	2		
9	Identification of morphological landmarks and terminologies on models	CBD	2		
	TOTAL HOURS		12		

COURSE NAME: Development and Eruption of the Teeth

COURSE CODE: FJ01-OB-17

LEARNING OBJECTIVES: At the end of the topic, students will be able to:

17.1: Discuss Chronology, development and sequence of eruption of Primary Dentition

- 17.2: Describe Prenatal/Perinatal/Postnatal Development
 17.3: Describe Transitional (Mixed) Dentition Period
 17.4: Describe Permanent Dentition
 17.5: Discuss and estimate Dental Age
 17.6: Describe Types of Chronologies
 17.7: Describe stages Of Tooth Formation
 17.8: Discuss Duration of Root and Crown Formation
 17.9: Estimate Time of Enamel Hypoplasia

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Development of Teeth	LEC	1	✓	✓
2	Eruption of Teeth (Primary)	LEC	1	✓	✓
3	Mixed Dentition	LEC	1	✓	✓
4	Eruption of Teeth (Permanent)	LEC	1	✓	✓
5	Crown and Root formation	LEC	1	✓	
8	Chronology	SGD	2		
9	Stages of Tooth Formation	SGD	2		
10	Development and Eruption of Primary Teeth	SGD	2		
11	Development and Eruption of Permanent Teeth	PRAC	2		
12	Development and Eruption of Teeth	PRAC			
	TOTAL HOURS		15		

COURSE NAME: The Primary (Deciduous) Teeth

COURSE CODE: FJ01-OB-18

LEARNING OBJECTIVES: At the end of this topic, students will be able to:

- 18.1: Discuss importance of Primary Teeth
 18.2: Discuss major contrasts between Primary and Permanent Teeth
 18.3: Describe pulp chambers and pulp canals
 18.4: Detailed description of Primary Tooth

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Deciduous dentition	LEC	2	✓	✓
2	Deciduous dentition	SGD	2	✓	✓
3	Contrast between Deciduous and Permanent Dentition	LEC	2	✓	✓
	Total		6		

COURSE NAME: Forensics, Comparative Anatomy, Geometries, and Form and Function**COURSE CODE:** FJ01-OB-19**LEARNING OBJECTIVES:** At the end of the topic, the students will be able to:

19.1: Define Forensic Dentistry

19.2: Discuss Comparative Dental Anatomy

19.3: Describe Facial and Lingual Aspects of All Teeth

19.4: Describe Schematic Outlines, Form and Function of The Permanent Dentition

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Forensic Anatomy	LEC	1	✓	✓
2	Comparative Anatomy	LEC	1	✓	
3	Age Determination	LEC	1	✓	
4	Gender Determination	LEC	1	✓	
5	Forensic Anatomy	SGD	2		
	Total		6		

COURSE NAME: Orofacial Complex: Form and Function**COURSE CODE:** FJ01-OB-20**LEARNING OBJECTIVES:** By the end of the topic, students will be able to:

- 20.1: Define form And Function
 20.2: Describe Articulation of Teeth
 20.3: Describe Interproximal Spaces and embrasures

LEARNING STRATEGIES AND ASSESSMENT:

S.NO	TOPIC	MIT	H R	BCQ	OSPE
1	Orofacial complex: form and function	LEC	1	✓	
2	Articulation of Teeth	LEC	1	✓	
3	Orofacial complex: form and function	SGD	2		
4	Articulation of Teeth	DEM O	2		
	TOTAL HOURS		6		

COURSE NAME: The Permanent Maxillary Incisors

COURSE CODE: FJ01-OB-21

LEARNING OBJECTIVES: At the end of the topic, students will be able to:

- 21.1: Describe Maxillary Central and lateral Incisors (All aspects detailed description)
 21.2: Compare Maxillary central and lateral incisors.

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Maxillary central incisors	LEC	1	✓	✓
2	Maxillary central incisors wax carving on wax blocks	DEMO	2		
3	Maxillary central incisors wax carving on wax blocks	WS	2		

4	Maxillary central incisors	SGD	2		
5	Maxillary Central Incisors	PRAC	2		
6	Maxillary lateral incisors	LEC	1	✓	✓
7	Maxillary lateral incisors wax carving on wax blocks	DEMO	2		
8	Maxillary lateral incisors wax carving on wax blocks	WS	2		
9	Maxillary Lateral incisors	SGD	2		
10	Maxillary Lateral Incisors	PRAC	2		
	TOTAL HOURS		18		

COURSE NAME: The Permanent Mandibular Incisors

COURSE CODE: FJ01-OB-22

LEARNING OBJECTIVES: At the end of the topic, students will be able to:

22.1: Describe Mandibular Central and Lateral Incisors (detailed description all aspects)

22.2: Compare features of Mandibular central and lateral incisors

22.3: Compare features of Maxillary and Mandibular incisors

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HRS	BCQ	OSPE
1	Mandibular central incisors	LEC	1	✓	✓
2	Mandibular central incisors wax carving on wax blocks	DEMO	1		
3	Maxillary central incisors wax carving on wax blocks	WS	1		
4	Maxillary Central Incisors	PRAC	2		

5	Maxillary central incisors	SGD	2		
6	Maxillary lateral incisors	LEC	1	✓	✓
7	Maxillary Lateral incisors wax carving on wax blocks	DEMO	1		
8	Maxillary lateral incisors wax carving on wax blocks	WS	1		
9	Maxillary lateral incisors	PRAC	2		
10	Mandibular lateral incisors	SGD	2		
	TOTAL HOURS		14		

COURSE NAME: The Permanent Maxillary and Mandibular Canines

COURSE CODE: FJ01-OB-23

LEARNING OBJECTIVES: At the end of the topic, students will be able to:

23.1: Describe Maxillary and mandibular Canines (detailed description)

23.2: Compare features of Maxillary and Mandibular canines.

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Maxillary Canines	LEC	1	✓	✓
2	Maxillary canines wax carving on wax blocks	DEMO	2		
3	Maxillary canines wax carving on wax blocks	WS	2		
4	Maxillary canines	SGD	2		
5	Maxillary canines	PRAC	2		
6	Mandibular canines	LEC	1	✓	✓
7	Mandibular canines wax carving on wax blocks	DEMO	1		
8	Mandibular canines wax	WS	2		

	carving on wax blocks				
9	Mandibular canines	SGD	2		
10	Mandibular canines	PRAC	2		
	TOTAL HOURS		17		

COURSE NAME: The Permanent Maxillary and Mandibular Premolars

COURSE CODE: FJ01-O.ANT-24

LEARNING OBJECTIVES: At the end of the topic, students will be able to:

24.1: Describe Maxillary and Mandibular Premolars (All aspects detailed description)

24.2: Compare Maxillary and Mandibular First and Second premolars

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Maxillary Premolars	LEC	1	✓	✓
2	Maxillary Premolars wax carving on wax blocks	DEMO	2		
3	Maxillary Premolars wax carving on wax blocks	WS	2		
4	Maxillary Premolars	SGD	2		
5	Maxillary Premolars	PRAC	2		
6	Mandibular Premolars	LEC	1	✓	✓
7	Mandibular Premolars wax carving on wax blocks	DEMO	2		
8	Mandibular Premolars wax carving on wax blocks	WS	2		
9	Mandibular Premolars	SGD	2		
10	Mandibular Premolars	PRAC	2		
	TOTAL HOURS		18		

COURSE NAME: The Permanent Maxillary and Mandibular Molars

COURSE CODE: FJ01-OB-25

LEARNING OBJECTIVES: At the end of the topic, students will be able to:

25.1: Describe all Permanent Maxillary and Mandibular Molars (Detailed description of all aspects)

25.2: Compare features of first, second and third maxillary and Mandibular molars

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HR	BCQ	OSPE
1	Maxillary Molars	LEC	2	✓	✓
2	Maxillary Molars wax carving on wax blocks	DEMO	2		
3	Maxillary Molars wax carving on wax blocks	WS	2		
4	Maxillary Molars	SGD	2		
5	Maxillary Molars	PRAC	2		
6	Mandibular Molars	LEC	2	✓	✓
7	Mandibular Molars wax carving on wax blocks	DEMO	2		
8	Mandibular Molars wax carving on wax blocks	WS	2		
9	Mandibular Molars	SGD	2		
10	Mandibular Molars	PRAC	2		
	TOTAL HOURS		20		

COURSE NAME:Dento-osseous Structures, Blood Vessels, and Nerves

COURSE CODE: FJ01-OB-26

LEARNING OBJECTIVES: At the end of the topic, students will be able to:

26.1: Describe various structures of The Maxillae and Mandible

26.2: Discuss blood and nerve supply to teeth and other anatomical locations of maxilla and mandible

LEARNING STRATEGIES AND ASSESSMENT:

S:NO	TOPIC	MIT	HRS	BCQ	OSPE
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1	Anatomy of Maxilla	LEC	1	✓	✓
2	Anatomy of Maxilla	SGD	2		
3	Anatomy of Mandible	LEC	1	✓	✓
4	Anatomy of Mandible	SGD	2		
	TOTAL HOURS		6		

COURSE NAME: Occlusion

COURSE CODE: FJ01-OB-27

LEARNING OBJECTIVES: At the end of the topic, students will be able to:

27.1: Define and discuss concepts of Occlusion in Primary Dentition

27.2: Define and discuss concepts of Occlusion in Permanent Dentition

LEARNING STRATEGIES AND ASSESSMENT:

	TOPIC	MIT	HRS	BCQ	OSPE
1	Occlusion in Primary dentition	LEC	1	✓	✓
2	Occlusion in Primary dentition	SGD	1		
3	Occlusion in Permanent dentition	LEC	2	✓	✓
4	Occlusion in Permanent dentition	SGD	2		
	TOTAL HOURS		6		

BOOKS

Oral histology

- **Course book**
Ten cate's Oral Histology: Development Structure and Function (9th edition)
- **Reference book**
A color Atlas and text book of Oral Anatomy, Histology and Embryology (4th edition)
B.K.B Berkovitz, G.R. Holland, B.J. Moxham.

Tooth morphology

- Wheeler's Dental Anatomy, Physiology and Occlusion-Nelson Arch (10th edition)

PHYSIOLOGY

COURSE DESCRIPTION AND COURSE RATIONALE:

The goal of physiology is to explain the physical and chemical factors that are responsible for the origin, development and progression of life. In human physiology, we attempt to explain the specific characteristics and mechanisms of the human body that make it a living being.

COURSE OUTCOMES: At the end of the course the student will be able to:

1. Describe the functional organization of human body and control of internal environment
2. Describe the cell and its organelles with function
3. Describe the membrane physiology and transport through the cell membrane.
4. Describe action potential and membrane potentials and neuromuscular transmission
5. Describe contraction of muscles
6. Describe the physiology of urinary system
7. Describe the physiology of gastrointestinal system
8. Describe the physiology of blood and immune system
9. Describe the physiology of endocrinology
10. Describe the physiology of central nervous system and special senses

MODE OF INFORMATION TRANSFER:

- Lectures(LEC)

- Small group discussions(SGD)
- Workshops with practical hand on(WS)
- Demonstration(DEMO)
- Flip Classroom(FCR)/ Tutorials

COURSE NAME: Functional Organization of Human Body and Control of Internal Environment

COURSE OBJECTIVES: At the end of the course student will be able to:

- 1.1 To study the different parts of microscope
- 1.2 Discuss the principle of homeostasis, Describe negative & positive feedback systems with examples.
- 1.3 To understand how activities of different body systems work together through demonstration
- 1.4 Describe the body fluid compartments
- 1.5 Define the term cell and explain the cells importance as the basic unit of life
- 1.6 Discuss the composition & function of cell membrane & the fluid mosaic model of membrane structure
- 1.7 Describe the structure & functions of different cytoplasmic organelles (Golgi apparatus, endoplasmic reticulum, peroxisomes, lysosomes, ribosomes)
- 1.8 Analyze how mitochondria contribute to ATP production and evaluate its significance in cellular energy metabolism
- 1.9 Discuss cyto skeleton
- 1.10 Describe the structure of nucleus and its function
- 1.11 Discuss different types of membrane transport with examples (Active & passive transport)
- 1.12 Define osmosis & osmotic pressure
- 1.13 Define the term tonicity & distinguish between isotonic, hypotonic and hypertonic solution
- 1.14 To test the osmotic fragility of RBCs

LEARNING STRATEGIES AND ASSESSMENT

S.No	TOPIC	MIT	H R	BCQ	OSCE
1	Introduction to Physiology and body fluid Compartments	LEC	1		
2	Cell membrane	LEC	1	✓	
3	Cell membrane	SGD	1	✓	

4	To test osmotic fragility of RBCs	WS	3		✓
5	Cell organelle	LEC	1	✓	
6	Cell organelle	FCR	2	✓	
7	Mitochondria and ATP	LEC	1	✓	✓
8	To study the parts of a compound microscope	DEMO	2		✓
9	Membrane transport 1	LEC	1	✓	
10	Membrane transport 2	LEC	1	✓	
11	Homeostasis	LEC	1	✓	✓
12	Homeostasis	WS	3	✓	✓
13	Body fluid compartments	SGD	1	✓	✓
TOTAL HOURS			19		

COURSENAME: Nerve and Muscle

COURSECODE: FJ01-PHY-2

COURSE OBJECTIVES: At the end of the course student will be able to

- 2.1 Discuss the distribution of ions across the plasma
- 2.2 Define membrane potential, resting membrane potential, Nernst potential & Nernst equation.
- 2.3 Discuss how the resting potential is created & maintained across the membrane & what is its importance
- 2.4 Explain the basic structure and functioning of different parts of neuron
- 2.5 Define synapse (electrical & chemical synapse)
- 2.6 Discuss graded potential with examples
- 2.7 Define action potential, & discuss graphical representation of Action potential.
- 2.8 Differentiate b/w graded and action potentials
- 2.9 Discuss the properties and propagation of action potential (myelinated & non myelinated nerve fibers)
- 2.10 Describe muscle tissue and its functions
- 2.11 Describe the organizational levels & molecular structure of skeletal muscle
- 2.12 Discuss the parts & steps of impulse transmission through neuromuscular junction (NMJ)
- 2.13 Explain the physiological basis of disorders of NMJ
- 2.14 Discuss how the excitation leads to muscle contraction & relaxation at molecular level in the skeletal muscle.
- 2.15 Discuss the mechanism of skeletal muscle contraction at molecular level
- 2.16 Discuss power stroke (role of ATP)
- 2.17 Define the terms simple muscle twitch, summation, tetanization, fatigue, motor

unit & motor unit recruitment

2.18 Differentiate B/W isotonic and isometric muscle contraction

2.19 Explain the basis of muscle fatigue

2.20 Distinguish between the types of muscle fibers

2.21 Enlist the types of smooth muscles with examples

2.22 Discuss the action potential in smooth muscles, and role of calcium ions in smooth muscles.

2.23 Discuss the structural and functional differences between skeletal, smooth, and cardiac muscles

2.24 Enlist the function of calcium and how its level is maintained in ECF.

2.25 Discuss phosphate metabolism and describe the interaction of Vitamin D, Calcium, Parathyroid hormone and Calcitonin in bone metabolism.

LEARNING STRATEGIES AND ASSESSMENT

S.No	TOPIC	MIT	HR	BCQ	OSPE
1	Membrane Transport	LEC	1	✓	
2	Membrane potential	LEC	1	✓	
3	Membrane potential	FCR	2	✓	✓
4	Structure of neuron and synapse	LEC	1	✓	✓
5	Structure of neuron and synapse	SGD	1	✓	✓
6	Action potential and graded potential	LEC	1	✓	✓
7	Action potential and graded potential	FCR	2	✓	✓
8	Structure of skeletal muscle	LEC	1	✓	✓
9	Structure of skeletal muscle	SGD	1	✓	✓
10	Neuromuscular transmission	LEC	1	✓	✓
11	Neuromuscular transmission	FCR	2	✓	
12	Skeletal muscle contraction and coupling	LEC	1	✓	✓
13	Skeletal muscle contraction and coupling	SGD	1	✓	✓
14	Skeletal muscle mechanics	LEC	1	✓	✓
15	stimuli and onset of fatigue				
16	Energetics of skeletal muscle	LEC	1	✓	✓
17	Energetics of skeletal muscle	SGD	1	✓	✓
18	Smooth muscle and difference between smooth muscle and skeletal muscle	LEC	1	✓	
19	Smooth muscle and difference between smooth muscle and skeletal muscle	SGD	1	✓	
20	Calcium Homeostasis	LEC	1	✓	
21	Calcitonin and PTH	LEC	1	✓	
	Total		24 hrs		

COURSENAME: Blood

COURSECODE: FJ01-PHY-3

COURSE OBJECTIVES: At the end of the course student will be able to:

- 3.1 Describe the components of blood and their functions
- 3.2 Describe the structure and functions of erythrocytes and draw the flow chart showing the steps of erythropoiesis
- 3.2 Learn the humoral, maturation & nutritional factors which can affect the production of erythrocytes
- 3.4 Discuss the formation of hemoglobin
- 3.5 Define anemia, Classify anemia on the basis of morphology & etiology.
- 3.6 Define polycythemia and describe its types
- 3.7 Discuss Rh blood types, hazards of mismatched blood transfusion and define erythroblastosis fetalis.
- 3.8 Define hemostasis and enlist the events of hemostasis
- 3.9 List the contents & functions of platelets
- 3.10 Discuss the mechanism of blood coagulation (extrinsic & intrinsic pathway)
- 3.11 Discuss the factors which prevent clotting in the normal vascular system
- 3.12 Discuss the conditions which cause excessive bleeding in human beings
- 3.13 Learn the types, physical characteristics and functions of White Blood Cells and process of Leucopoiesis
- 3.14 Discuss Inflammation
- 3.15 Define and Classify immunity, Discuss innate and adaptive immunity, its types and functions.
- 3.16 Discuss complement system
- 3.17 Discuss allergy and hypersensitivity reactions
- 3.18 Discuss the structure of antigens & antibody & its mechanism of action.

LEARNING STRATEGIES AND ASSESSMENT

S.No	TOPIC	MIT	HR	BCQ	OSPE
1	Introduction To Blood & Erythrocytes	LEC	1	✓	
2	To study hemocytometer and to assess erythrocyte count	DEMO	2	✓	✓
3	To study the methods of drawing blood sample for hematological investigations	DEMO	2	✓	✓
4	Erythropoiesis and factors affecting erythropoiesis	LEC	1	✓	✓
5	To measure ESR in human subject	DEMO	2	✓	✓

6	Plasma Proteins and Hemoglobin	LEC	1	✓	✓
7	Hemoglobin	SGD	1	✓	✓
8	Estimation of hemoglobin in human by Sahli's hemoglobin o meter	WS	3	✓	✓
9	Anemia and polycythemia	LEC	1	✓	✓
10	Anemia and polycythemia	FCR	2	✓	
11	Blood groups	LEC	1	✓	✓
12	Blood Transfusion	LEC	1	✓	✓
13	To determine blood group in human subject	WS	3	✓	✓
14	Primary hemostasis	LEC	1	✓	✓
15	Primary hemostasis	SGD	1	✓	
16	Secondary hemostasis and Blood Coagulation Pathway	LEC	1	✓	✓
17	Natural Anticoagulants	LEC	1	✓	✓
18	To determine bleeding time and clotting time in human subject	WS	3	✓	✓
19	White blood cells	LEC	1	✓	
20	White blood cells	SGD	1	✓	✓
21	To determine total and differential leucocyte count	DEMO	2	✓	✓
22	Innate and Acquired Immunity, antigen antibody Structure	LEC	1	✓	✓
23	Innate Immunity, antigen antibody structure	FCR	2	✓	
24	Acquired immunity	LEC	1	✓	✓
25	Acquired immunity	SGD	1	✓	✓
26	Reticuloendothelial System	LEC	1	✓	
27	Antibody and Platelets	LEC	1	✓	
	Total Hours		39		

COURSE NAME: Cardiovascular System

COURSECODE: FJ01-PHY-4

COURSE OBJECTIVES: At the end of the course student will be able to:

- 4.1 Describe the physiological properties of cardiac muscle and relate its structure to its function;
- 4.2 Explain why the heart does not fatigue;
- 4.3 Discuss the phases of action potential and relate them to the contractile behavior of the heart (Plateau phase)
- 4.4 Compare the action potential of heart with the action potential of skeletal muscle
- 4.5 Describe the heart's electrical conduction system
- 4.6 Explain why the SA node fires spontaneously and rhythmically & how the SA node excites the myocardium
- 4.7 Draw and label a normal electrocardiogram & Explain 12 ECG leads
- 4.8 Name the intervals, segments & waves of the ECG and explain what myocardial events produce each wave.
- 4.9 Discuss cardiac vector and axis of heart
- 4.10 Understand the following abnormalities in ECG (Tachycardia, Bradycardia, Myocardial Infarction /ischemia Atrial flutter, Atrial fibrillation, Heartblocks)
- 4.11 Describe in detail one complete cycle of heart contraction and relaxation & events of the cardiac cycle to the volume of blood entering and leaving the heart.
- 4.12 Discuss the relationship between electrical activity, ventricular pressure, the opening and closing of heart valves and the heart sounds
- 4.13 Explain what causes the sounds of the heartbeat;
- 4.14 Define cardiac output and explain its importance & how cardiac output is calculated & regulated.
- 4.15 Explain the principle behind the Frank-Starling law of the heart.
- 4.16 Discuss nervous and chemical factors that alter heart rate, stroke volume, and cardiac output;
- 4.17 Discuss the physical characteristics of circulation & interrelationships of pressure, blood flow and resistance
- 4.18 Discuss vascular distensibility and functions of the arterial and venous systems
- 4.19 Define (Systolic blood pressure, Diastolic blood pressure, Mean arterial blood pressure, Pulse pressure)
- 4.20 Describe short term, intermediate, long term regulation of blood pressure
- 4.21 Explain renin Angiotensin Aldosterone system in controlling arterial pressure
- 4.25 Discuss the local control of blood flow in response to tissue needs & mechanisms of blood flow control.
- 4.26 Explain the humoral control of the circulation

- 4.27 Explain the structure of microcirculation and capillary system & how vasomotion influences blood flow
- 4.28 Describe some local, neural, and hormonal influences on vasomotion.
- 4.29 Discuss fluid filtration across capillaries
- 4.30 Discuss the physiological causes of shock

LEARNING STRATEGIES AND ASSESSMENT:

S.No	TOPIC	MIT	HR	BCQ	OSPE
1	Structure of heart and properties of cardiac muscle	LEC	1	✓	
2	Structure of heart and properties of cardiac muscle	SGD	1	✓	✓
3	Cardiac action potential	LEC	1	✓	✓
4	Cardiac action potential	FCR	2	✓	✓
5	Conduction system of heart	LEC	1	✓	✓
6	Conduction system of heart	FCR	2	✓	✓
7	To calculate the heart rate by palpating arterial pulse	WS	3	✓	✓
8	Basic electrocardiography	LEC	1	✓	✓
9	Basic Electrocardiography	SGD	1	✓	✓
10	Basic electrocardiography	WS	3	✓	
11	Cardiac cycle and heart sounds	LEC	1	✓	✓
12	Cardiac cycle and heart sounds	FCR	2	✓	✓
13	To examine heart sounds in human subject	WS	3	✓	✓
14	Cardiac output and factors affecting cardiac output	LEC	1	✓	✓
15	Cardiac output and factors affecting cardiac output	SGD	1	✓	✓
16	Hemodynamics	LEC	1	✓	✓
17	Hemodynamics	SGD	1	✓	✓
18	Blood pressure and its regulation	LEC	1	✓	
19	Blood pressure and its regulation	FCR	2	✓	✓
20	To measure blood pressure in human subject	WS	3	✓	✓
21	Local control of blood flow	LEC	1	✓	
22	Local control of blood flow	SGD	1	✓	

23	Microcirculation and Venous System	LEC	1	✓	
24	Microcirculation and Venous System	SGD	1	✓	
25	Shock	LEC	1	✓	
26	Rapid Control of blood pressure	LEC	1	✓	
27	Long-term control of blood pressure	LEC	1	✓	
28	Interstitium and Lymphatic System	LEC	1	✓	
29	Cardiac Failure	LEC	1	✓	
30	Cardiac Arrhythmias	LEC	1	✓	
	TOTAL HOURS	42			

COURSE NAME: Respiratory System

COURSECODE: FJ01-PHY-5

COURSE OBJECTIVES: At the end of the course student will be able to:

- 5.1 Name the structures & function that make up the respiratory system and list them in correct order
- 5.2 Differentiate between the conducting and respiratory zones of respiratory passages
- 5.3 Name the muscles of respiration and describe their roles in breathing
- 5.4 Explain how pressure gradients account for the flow of air in and out of the lungs ;how the pressure gradient works
- 5.5 Explain Boyle's Law
- 5.6 Discuss the significance of Dead Space
- 5.7 Define composition of inspired air and alveolar air
- 5.8 Discuss the partial pressure of Oxygen and Carbon dioxide in the venous blood, arterial blood, and alveolar air and in tissue cells, the effect of partial pressure for gas exchange, & how partial pressure affects gas transport by the blood
- 5.9 Discuss the respiratory membrane and factors affecting exchange through this membrane
- 5.10 Discuss how oxygen & carbon dioxide is transported in the blood & the role of hemoglobin in the transport of oxygen.
- 5.11 Explain the information which can be obtained from the oxygen hemoglobin dissociation curve graph

- 5.12 Discuss the factors that can influence release or binding of oxygen to hemoglobin, Discuss Bohr's & Haldane effect.
- 5.13 Describe the role of the four main groups of nuclei in the medulla and pons that control breathing
- 5.14 Discuss the factors that can influence rate and depth of breathing
- 5.15 Describe locations of chemoreceptors that monitor blood pH and gas concentrations. & the role of chemoreceptors in the regulation of respiration
- 5.16 Define and give the causes of following disorders (Emphysema, Bronchitis , Asthma, Pneumonia, Pulmonary edema)
- 5.17 Discuss the causes of hypoxia

LEARNING STRATEGIES AND ASSESSMENT:

S.No	TOPIC	MIT	HR	BCQ	OSP E
1	Introduction to Respiratory	LEC	1	✓	
2	Pulmonary ventilation	LEC	1	✓	✓
3	Pulmonary ventilation	SGD	1	✓	✓
4	Pulmonary volumes and capacities	LEC	1	✓	✓
5	To study pulmonary function tests and discuss lung volumes And capacities	FCR	2	✓	✓
6	Diffusion of Gases through Respiratory Membrane	LEC	1	✓	✓
7	Diffusion of Gases through Respiratory Membrane	SGD	1	✓	✓
8	Transport of gases in blood	LEC	1	✓	✓
9	Transport of gases in blood	FCR	2	✓	✓
10	Oxygen hemoglobin dissociation curve	LEC	1	✓	✓
11	Oxygen hemoglobin dissociation curve	FCR	2	✓	✓
12	Regulation of respiration	LEC	1	✓	✓
13	Regulation of respiration	FCR	2	✓	✓
14	Compliance and Respiratory Disorders	LEC	1	✓	
15	Compliance and Respiratory Disorders	SGD	1	✓	
	TOTALHOURS	18		✓	✓

COURSE NAME: Neuroscience

COURSECODE: FJ01-PHY-6

COURSE OUTCOME: At the end of the course student will be able to:

- 6.1 Discuss the basic organization of nervous system
- 6.2 Explain how stimulation of a neuron causes local electric change in its membrane & how are they transmitted from one neuron to another.
- 6.3 Explain how electrical changes generate an action potential in a neuron& how the nerve signal is transmitted down axons
- 6.4 Define & list the properties of synapse
- 6.5 Explain how the stimulation of a postsynaptic cell is stopped
- 6.6 Classify receptors according to location and stimulus type they detect
- 6.7 Discuss receptor potential and transduction of sensory stimuli into nerve impulses
- 6.8 List the different types of sensory pathways (Dorsal column medial lemniscal& Anterolateral pathway)
- 6.9 Discuss the types of pain, pain receptors and dual pathways for transmission of pain signals into CNS
- 6.10 Discuss referred pain and its mechanism
- 6.11 Discuss the analgesia system in the brain and spinal cord & explain the brain opioids system
- 6.12 Discuss the organization of the spinal cord for motor functions & cord reflexes.
- 6.13 Discuss the role of muscle spindles & golgi tendon organs in muscle control
- 6.14 Compare pyramidal and extra pyramidal tracts as to origin, termination and function
- 6.19 Outline the major functions of (Mid brain, Pons, Medulla oblongata)
- 6.20 Discuss the control of motor functions by the brain stem
- 6.21 Explain functional anatomy of cerebellum
- 6.22 Explain the input and output connections of cerebellum
- 6.23 Discuss the different cerebellar disorders
- 6.24 Explain different types of structures that make the basal ganglia & the direct and indirect pathways of basal ganglia.
- 6.25 Explain the functions of basal ganglia and its related disorders
- 6.26 List the components of limbic system along with its functions
- 6.27 Describe the functions of hypothalamus
- 6.28 Discuss the general organization of ANS and how it is activated
- 6.29 Discuss & compare the physiological anatomy & functions of sympathetic nervous system & parasympathetic nervous system
- 6.30 Discuss the functions of adrenal medulla & the value of adrenal medullae to the function of the sympathetic nervous system
- 6.31 Explain the Formation, functions, circulation & absorption of CSF
- 6.32 Describe CSF pressure and its regulation

S.No	TOPIC	MIT	HR	BCQ	OSPE
1	Introduction to Nervous System	LEC	1	✓	
2	Protective Mechanism of Central Nervous System	LEC	1	✓	✓
3	Electrical properties of neuron and synapse	LEC	1	✓	
4	Receptors, Sensory pathways and somatic sensations	LEC	1	✓	
5	Receptors, Sensory pathways and somatic sensations	FCR	2	✓	
6	Motor path ways and cerebral cortex	LEC	1	✓	
7	Pain Pathway	LEC	1	✓	✓
8	Pain Pathway	FCR	2	✓	✓
9	Analgesia system	LEC	1	✓	
10	Analgesia system	FCR	2	✓	
11	To study superficial and deep reflexes on human subject	DEMO	2	✓	✓
12	To examine motor system in human subject	WS		✓	✓
13	Spinal Cord and Brainstem	LEC	1	✓	✓
14	Spinal Cord and Brainstem	SGD	1	✓	✓
15	Cerebellum and Basal ganglia	LEC	1	✓	✓
16	Cerebellum and Basal ganglia	SGD	1	✓	✓
17	To test sensory system in human subject	DEMO	2	✓	✓
18	Muscle spindles and Golgi tendon organ	LEC	1	✓	
19	Limbic system	LEC	1	✓	
20	Limbic system	SGD	1	✓	
21	Autonomic nervous system	LEC	1	✓	
22	Autonomic nervous system	SGD	1	✓	
23	Cerebrospinal fluid	LEC	1	✓	
24	Cerebrospinal fluid	SGD	1	✓	
	Total Hours		31		

COURSENAME: Special Senses and Endocrinology

COURSECODE: FJ01-PHY-7

- 7.1 Draw the eye and describe the physiological functions of each part.
- 7.2 Explain the refractory structures, error of refractions & corrections of errors
- 7.3 Explain accommodation & fluid system of the eye

- 7.4 Discuss the anatomy & function of the structural elements of the retina
- 7.5 Discuss the photochemistry of vision & the formation of image on retina and further processing on visual cortex.
- 7.6 Explain in detail visual pathway along with its lesions.
- 7.7 Explain the physiological anatomy of ear & how sound wave is conducted from tympanic membrane to basilar membrane (role of ossicles)
- 7.8 How sound wave is conducted from tympanic membrane to basilar membrane.
- 7.9 Explain auditory path way in detail and conductive and perceptive deafness
- 7.10 Describe how the vestibular apparatus functions to monitor equilibrium
- 7.11 Discuss the factors and different types of taste sensations and their perception on tongue
- 7.12 Discuss the location and activation of taste buds
- 7.13 Explain Gustatory pathway
- 7.14 Discuss the primary sensations of smell
- 7.15 Discuss the olfactory pathway to brain & location, and activation of the olfactory receptors.
- 7.16 Define the terms anosmia, hyposmia & dysosmia
- 7.17 Discuss & compare endocrine and exocrine glands
- 7.18 List the major endocrine glands and locate them in the body
- 7.19 Classify hormones and explain how a hormone secreted, transported and cleared from the blood
- 7.20 Discuss hormone receptors, activation and mechanism of actions of different hormones
- 7.21 Describe the structural and functional relationships of the hypothalamus-pituitary unit (adenohypophysis & neurohypophysis)
- 7.22 Describe the effects of hypo and hyper secretions of these hormones
- 7.23 Enlist the hormones secreted and discuss the synthesis, secretions & the effects of anterior pituitary & posterior pituitary hormones.
- 7.24 Describe the formation, secretion, function, regulation & disorders of thyroid hormones
- 7.25 What is the mode of action & function of insulin release and its mechanism in target cells
- 7.26 Explain functions of glucagon, somatostatin and pancreatic polypeptide
- 7.27 Name the hormones that regulate the calcium and phosphate homeostasis
- 7.28 Explain functions of parathyroid hormone, vitamin D & calcitonin.
- 7.29 Discuss hypocalcemia & hypercalcemia
- 7.30 Describe the site of formation, function and control of secretion of mineralocorticoids & glucocorticoids
- 7.31 Discuss Cushing syndrome, Cushing disease and Addison's disease

LEARNING STRATEGIES AND ASSESSMENT:

S.No	TOPIC	MIT	HR	BCQ	OSPE
1	Vision	LEC	1	✓	✓
2	Vision	FCR	2	✓	✓

3	To test visual acuity of human subject	DEMO	2	✓	
4	Refractive structure of eye	LEC	1	✓	✓
5	Determination of field of vision /Perimetry	DEMO	2	✓	
6	To test color vision of a subject	DEMO	2	✓	✓
7	Hearing	LEC	1	✓	✓
9	To perform hearing tests in a Subject	DEMO	2	✓	✓
10	Vestibular Apparatus	LEC	1	✓	
11	Vestibular Apparatus	SGD	1	✓	
12	Sense of taste and smell	LEC	1	✓	✓
13	To test sense of taste and smell in human subject	DEMO	2	✓	✓
14	Endocrinology Introduction	LEC	1	✓	
17	Hypothalamic-hypophyseal system	LEC	1	✓	
18	To check temperature of human subject	DEMO	2	✓	✓
19	Cortisol, Adrenal Androgens	LEC	1	✓	
12	Cortisol, Adrenal Androgens	FCR	2	✓	✓
13	Posterior pituitary hormones	LEC	1	✓	✓
14	Posterior pituitary hormones	SGD	1	✓	
15	Thyroid hormones	LEC	1	✓	✓
16	Thyroid hormones	FCR	2	✓	✓
17	To determine body mass index of human subject	DEMO	2	✓	✓
18	Insulin	LEC	1	✓	
TOTALHOURS			33		

COURSE NAME: Digestive and Urinary System

COURSECODE: FJ01-PHY-8

COURSE OUTCOMES: At the end of the course student will be able to:

- 8.1 Discuss the neural control of GIT-Enteric Nervous System.
- 8.2 Contrast the effects of parasympathetic and sympathetic nervous activity in modulating GI activity.
- 8.3 Discuss the hormonal control & types of GIT reflexes
- 8.4 Describe the composition, functions & factors that increase salivary secretion (nervous regulation)
- 8.5 Discuss the chewing reflex, phases of swallowing & swallowing reflex..
- 8.6 What is the function of lower esophageal sphincter?
- 8.7 List the functions of stomach & composition of gastric juice & their functions.
- 8.8 Describe the phases of gastric secretory activity, gastric emptying and its regulation
- 8.9 Describe the types of movement in small intestine.
- 8.10 What structures increase the absorptive surface area of the small intestine?
- 8.11 Distinguish between segmentation and the migrating motor complex of the small intestine.
- 8.12 Discuss the composition, formation and functions of Bile and Bile salts? do these differ in function? How does food in the duodenum inhibit motility and secretion in the stomach?
- 8.13 Describe the glands of small intestine with their secretions and functions.
- 8.14 Name enzymes of the intestinal brush border, and identify the substrate or function of each.
- 8.15 What are the functions of Gall Bladder?
- 8.16 What is the composition, function, phases & factors effecting pancreatic secretion?
- 8.17 Describe the structure, functions & major movements of large intestine
- 8.18 Explain the Defecation reflex & the functions of internal and external anal sphincters.
- 8.19 Discuss Nephron in detail (types & parts)
- 8.20 Discuss the functions of kidney
- 8.21 Define GFR and its value & the forces that promote and oppose glomerular filtration.
- 8.22 Describe the glomerular filtration membrane and elaborate the dynamics of Glomerular filtration.
- 8.23 What is Auto-regulation of GFR? Give its significance.
- 8.24 Discuss the passive and active mechanism of transport for tubular re-absorption
- 8.25 Discuss tubular re-absorption along different parts of the nephron and its regulation
- 8.27 Define tubular load and Tubular transport maximum (T_m).

- 8.28 Discuss the tubular secretion processes in different parts of nephron
- 8.29 Discuss how osmotic gradient is established & countercurrent mechanism
- 8.30 Discuss renal mechanisms for excreting diluted urine, & the role of osmo receptors.
- 8.31 Describe the neural reflex pathway that regulates emptying of bladder
- 8.32 Discuss the effect of following hormones on kidney(ADH, Aldosterone, Angiotensin II, ANP,PTH)

LEARNING STRATEGIES AND ASSESSMENT

S.No	TOPIC	MIT	HR	BCQ	OSPE
1	Digestive system-Introduction	LEC	1	✓	
2	Digestive system-Introduction	SGD	1	✓	
3	GI blood flow	LEC	1	✓	✓
4	GI blood flow	FCR	2	✓	✓
5	Salivation	LEC	1	✓	✓
6	Salivation	FCR	2	✓	✓
7	To test the salivary functions of human subject	WS	3	✓	✓
8	Mastication and swallowing	LEC	1	✓	✓
9	Mastication and swallowing	SGD	1	✓	✓
10	Stomach and its secretions	LEC	1	✓	
11	Stomach and its secretions	FCR	2	✓	✓
12	Small intestine	LEC	1	✓	✓
13	Small intestine	FCR	2	✓	✓
14	Liver	LEC	1	✓	✓
15	Liver	FCR	2	✓	✓
16	Pancreas	LEC	1	✓	✓
17	Pancreas	SGD	1	✓	✓
18	Large intestine and defecation reflex	LEC	1	✓	✓
19	Large intestine and defecation reflex	SGD	1	✓	
14	Kidney Introduction and nephron	LEC	1	✓	✓
15	Kidney Introduction and nephron	SGD	1	✓	✓
16	Glomerular filtration	LEC	1	✓	✓
17	Glomerular filtration	FCR	2	✓	✓
16	Regulation of GFR	LEC	1	✓	
17	Regulation of GFR	SGD	1	✓	
18	Tubular reabsorption	LEC	1	✓	
19	Tubular reabsorption	FCR	2	✓	
12	Counter current mechanism	LEC	1	✓	
13	Counter current mechanism	SGD	1	✓	

14	Renal concentrating and diluting mechanism	LEC	1	✓	
15	Renal concentrating and diluting mechanism	FCR	2	✓	
16	Micturition Reflex	LEC	1	✓	✓
17	Micturition Reflex	SGD	1	✓	✓
TOTALHOURS			43		

RECOMMENDED TEXTBOOK:

1. Guyton & Hall Textbook of Medical Physiology 13th Edition.

REFERENCE BOOKS:

1. Ganong's Review of Medical Physiology 26th Edition.
2. Lauralee Sherwood Human Physiology 9th Edition