MBBS SYLLABUS

AND

CURRICULUM

PREFACE

The MBBS students coming out of this prestigious Medical University should be competent in diagnosis and management of common health problems of the individual and the community at primary, secondary, tertiary levels using the clinical skills based on history, physical examination and relevant investigations.

The Graduate Medical Curriculum has been prepared to fulfill the vision of this University and it is oriented towards training students in an unique environment preparing them to undertake the duties and responsibilities of a physician of first contact who is capable of looking after the preventive, promotive, curative and rehabilitative aspects of medicine. The students pursuing Graduate Medical curriculum will have the necessary competencies (knowledge, skills & attitudes) to assume the role of a quality health care provider to the people of India and across the world.

The curriculum is framed involving many experts in relevant medical fields incorporating especially the **specific learning objectives, Teaching methodology, "must know, desirable to know and nice to know"** as put `forth by Medical Council of India and more importantly it includes the vital **Medical Ethics** to practice in patient care, service and research. It also includes the **integrated teaching** using a problem based learning, evidence based approaches starting with clinical or community cases and exploring the relevance of various preclinical disciplines in both understanding and sharp focus on resolving health care problems. Every attempt has been made to de - emphasize compartmentalisation of disciplines so as to achieve both horizontal and vertical integration in different phases with a mission that our Medical Graduates will outshine and match the International standards.

The Introduction of teaching elements, OSCE / OSPE have also been incorporated which are proven to be an important, innovative, reliable and objective modality of assessment for clinical / practical skills in the changing scenario of Medical Sciences.

Record Book / Log Book becomes a reflective record of student's learning and achievements and faculty contribution towards learning. Every student will be motivated to document what he/she has learnt in the respective department / specialty in the log book and make it as a permanent record. The **revised Record Book/Log Book** should be followed by all the affiliated Medical colleges of this University to bring uniformity in teaching and training of students.

Internship is a phase of training wherein the graduate is expected to conduct actual practice under the supervision of a trained doctor. The learning methods and modalities have to be done during the MBBS course itself with larger number of hands on session and **practice on simulators**.

The Introduction of a restructured curriculum and training program with emphasis on early clinical exposure, integration of basic and clinical sciences, clinical competence and skills and new teaching – learning methodologies will lead to a new generation of medical graduates of global standards.

I want to thank the Academic Officer and the team of Academic, Experimental Medicine & Examination wing and the team of experts from their relevant Medical Specialties of various Medical Colleges in the State for their enthusiastic and energetic efforts to bring this revised syllabus & curriculum.

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Comments/feedback are welcome if any and mail it to registrar@tnmgrmu.ac.in

First MBBS

ANATOMY

1.GOAL

The broad goal of the teaching of undergraduate students in Anatomy aims at providing comprehensive knowledge of the gross and microscopic structure and development of the human body to provide a basis for understanding the clinical correlation of organs or structures involved and the anatomical basis for the disease presentations.

2.SPECIFIC LEARNING OBJECTIVES

2A. KNOWLEDGE:

At the end of the course the student shall be able to:

(a) describe the normal disposition, clinically relevant interrelationships, functional and cross sectional anatomy of the various structures in the body;

(b) identify and describe the microscopic structure and correlate elementary ultrastructure of various organs and tissues and correlate the structure with the functions as a prerequisite for understanding the altered state in various disease processes;

(c) describe the basic structure and connections of the central nervous system to analyse the integrative and regulative functions of the organs and systems. The student shall be able to identify the site of gross lesions according to the deficits encountered.

(d) demonstrate knowledge of the basic principles and sequential development of the organs and systems, recognise the clinical stages of development and the effects of common teratogens. The student shall be able to explain the developmental basis of the major variations and abnormalities.

2B. SKILLS:

At the end of the course the student shall be able to;

(a) identify and locate describe all the structures of the body and mark the topography of the living anatomy.
(b) Identify and locate structures in gross Anatomy Sections.
(c) identify describe, depict normal appearance of the organs and tissues under the microscope;
(d) Describe the principles of karyotyping and identify the gross congenital anomalies;

(e) Describe the principles of newer imaging techniques like Ultra sound, MRI, Computerised Tomography Scan, Interpretation of plain and contrast X-rays.
(f) Describe the clinical basis of some common clinical procedures i.e. intra-muscular and intravenous injection, lumbar puncture, kidney biopsy etc.

2C. INTEGRATION:

From the integrated teaching of other basic sciences, student shall be able to describe the regulation and integration of the functions of the organs and systems in the body and interpret the anatomical basis of disease processes.

Horizontal integration can be done in common with basic science departments, and vertical integration can be done with clinical departments. For example, horizontal integration can be the study of liver along with Physiology and Biochemistry; and vertical integration can be the study of anatomical basis of varicose veins along with General Surgery.

A list of topics for Integration is given below.

3. A.TEACHING HOURS - One example of the duration for each of the Teaching-Learning Methods

For example: Embryology Lectures: Duration = 2 hours per week, each class lasting 45 - 60 minutes.

Lectures - hours	Practicals - hours	Group Discussions - hours	Demonstration - hours	Seminars - hours	Integrated Teaching - hours
General Anatomy -9	General Histology-12	Osteology- (Total 26)	Abdomen-15	8	5
General Embryology-10	Upper Limb Dissection-35	Upper Limb-5	Neuroanatomy-23		
General Histology-10	Lower Limb dissection-40	Lower Limb-5	Genetics-2		
Upper Limb-30	Abdomen dissection-60	Thorax-3	Total-43		
Lower Limb-25	Abdomen Histology-14	Abdomen and Pelvis-3			
Abdomen Gross Anatomy-43	Thorax Dissection-30	Head and Neck-10			
Abdomen Embryology-7	Thorax Histology-4				
Abdomen Histology-14	Head and Neck Dissection-86	Radiology 1 each			

		(Total-5)			
Thorax Gross Antomy-15	Head and Neck Histology-8				
Thorax Histology-4	Neuroanatomy Histology-10	Surface Anatomy 1 each (Total 5)			
Thorax Embryology-4					
Head and Neck Gross Anatomy- 50					
Head and Neck Embryology-7					
Head and Neck Histology -8					
Neuroanatomy-20					
Genetics-3					
Total-259 hours	Total -299 hours	Total -36 hours	Total 43 hours	Total 8 hours	Total 5 hours

Grand Total=650 hours

3B.TEACHING METHODOLOGY

Theory (Teaching-Learning methods)

1. Interactive Lecture (include buzz groups, self-assessment questions, quizzes, MCQs. One minute paper)
2. Didactic Lecture- with a problem solving approach, with discussions of relevant clinical problems.
3. Seminar
4. Symposium
5. Role play and discussion on medical ethics topics
6. Self-directed learning

Practicals

1. Dissection
2. Small Group Discussion - Osteology, Surface marking, OSPE-Genetics, Radiology
3. Demonstrations - Histology slides, Embryology models
4. Case Discussion - Nerve Lesions, e.g. Facial Palsy, Radial Nerve Palsy

4.THEORY SYLLABUS & 5.PRACTICAL SYLLABUS

(1) GENERAL ANATOMY SYLLABUS (12 hours)			
Topic and duration of study	**Must Know 60%**	**Desirable to know 30%**	**Nice to know 10%**
Introduction to anatomy			
Anatomical terminology	▪ An understanding of the various subdivisions of anatomy ▪ Anatomical position ▪ Anatomical planes ▪ Terms of direction, relation, comparison, laterality & movement		
Introduction to bones	▪ Composition of bone and bone marrow ▪ Regional classification of skeleton ▪ Structural classification of bone a. Distribution of spongy and compact bone in the body ▪ Classification of bone according to shape ▪ Classification of bone based on ossification ▪ Parts of a long bone ▪ Blood and nerve supply of a long bone ▪ Special features of a sesamoid bone	▪ Laws of ossification, including direction of nutrient foramen and the growing end of the bone ▪ Exceptions to the laws of ossification ▪	
Introduction to joints	▪ Definition ▪ Classification according to a. Structure- with subtypes and examples of fibrous, cartilaginous and synovial joints b. Mobility		Types of sutures (Unnecessary detail)

	c. Axes of movement ▪ Complex and compound joints ▪ Nerve supply of joints- Hilton's law ▪ Blood supply of joints		
Introduction to the muscular system	▪ Structural classification of muscle ▪ Parts of a skeletal muscle Differentiate tendon and aponeurosis ▪ General principles about how attachments of muscles affect the joints they cross ▪ Classification of muscle according to action (agonists, antagonists, synergists, fixators)	▪ Classification of muscle according to direction of muscle fibres and shape	Actions of muscles as compared to systems of levers ▪ Shunt and spurt muscles (Unnecessary detail) ▪ Classification of skeletal muscle according to type of contraction (Will be covered in Physiology)
Introduction to the cardiovascular system	▪ Classification into blood vascular system ▪ Differentiate pulmonary and systemic circulation ▪ Layers of any blood vessel ▪ Types of blood vessels a. General differences between arteries and veins b. Functional difference between elastic, muscular arteries and arterioles c. Function of meta-arterioles, precapillary sphincters, arterio-venous anastomoses d. Microvasculature-types of capillaries and their functional significance ▪ Venous return a. Musculo-venous pumps b. Role of valves ▪ Definition and structure of a portal system ▪ Concept of anastomoses and	▪ Concepts of thrombosis, infarction, aneurysm ▪ Concept of lymphoedema and spread of tumors via lymphatics and venous system	

Lymphatic system	collateral circulation ▪ Significance of end-arteries ▪ ▪ Components and function of the lymphatic system a. Structure of lymph capillaries b. Concept that lymphatics accompany blood vessels c. Concept that lymph ultimately drains into the venous system d. Function of lymph nodes in the lymphatic system		

For the following regions (2) Upper limb and (3) Lower limb, (4) Thorax, (5) Abdomen and (6) Head & Neck- General concept of the parts of the bones to which each muscle is attached, and the relation of the fibres to the axes of the joints they cross in order to understand how a muscle causes a particular movement must be taught. Muscles may be discussed as muscle groups.

Wherever clinical conditions are mentioned only the relevant anatomical basis is required.

(2) UPPER LIMB – SYLLABUS (100 hours)

Topic	Must Know	Desirable to know	Nice to know
Overview	Major segments (e.g. shoulder)		
Bones ▪ Side determination (one feature for each of the opposite directions) ▪ Anatomical position ▪ Identification and description of features of each part ▪ Articulations	Clavicle ▪ Unique features Scapula Humerus Ulna Radius	▪ Muscle attachments	▪
Bones	Articulated hand: ▪ Identify and name the various bones in the articulated hand ▪ Prominent features of carpal bones o Tubercle of scaphoid o Crest of trapezium o Hook of hamate ▪ Parts of metacarpals and phalanges	▪ Scaphoid fractures and avascular necrosis ▪ Peculiarities of pisiform bone in its development, muscle attachment	▪
Pectoral Region	Muscles: ▪ Position, name of bones to which attached, nerve supply and actions of pectoralis major, pectoralis minor and Breast: ▪ Location, extent, deep relations ▪ Type of gland, structure ▪ Age changes ▪ Blood supply ▪ Lymphatic drainage ▪ Applied anatomy:	▪ Attachments of subclavius ▪	Clavipectoral fascia: ▪ Position, extent, structures piercing it

	○ Breast abscess ○ Breast cancer ○ Developmental anomalies		
Axilla	▪ Boundaries, contents ▪ <u>Axillary Artery:</u> ○ Origin, extent, course, parts, relations, branches ▪ <u>Axillary Vein:</u> ○ Formation, extent, course, relations, tributaries ▪ <u>Brachial plexus:</u> ○ formation, branches, relations, area of supply of branches, course and relations of terminal branches ▪ <u>Axillary lymph nodes:</u> ○ Anatomical groups and their areas of drainage	Brachial plexus: - Variations - Prefixed and postfixed plexuses - Injuries – Erb palsy and Klumpke paralysis - Anaesthetic block Enlargement of axillary lymph nodes	
Back **Shoulder Region**	- Concept of layers of muscles of the back with emphasis on trapezius and latissimus dorsi - Injury of spinal accessory nerve, and axillary nerve - deltoid, rotator cuff muscles • Movements of the scapula and muscles involved Testing of serratus anterior • Shoulder joint – description of type, articular surfaces, capsule, synovial membrane, ligaments, relations, movements and muscles involved, blood and nerve supply, Subacromial bursa Injury of axillary nerve during intramuscular injections	Specific attachments of trapezius and latissimus dorsi muscles Arterial anastomosis around the scapula and collateral circulation Dislocation of glenohumeral joint	Triangle of auscultation
Free upper limb	▪ Fascia of upper limb and compartments ▪ Veins of upper limb - Superficial and deep • Lymphatic drainage		

	• Cutaneous nerves of upper limb • Dermatomes of upper limb		
Arm and cubital fossa	▪ Muscle groups of upper arm with emphasis on biceps and triceps ▪ Origin, course, relations, branches (or tributaries), termination of nerves and vessels Cubital fossa – boundaries, roof, floor, contents and relations of contents Venepuncture of cubital veins ▪ Saturday night paralysis	- Nerves liable to be involved in fracture of the humerus and clinical manifestations - Anastomosis around the elbow joint	Deep tendon reflexes of biceps and triceps
Front of Forearm and Palm	▪ Muscle <u>groups</u> of forearm with attachments, nerve supply and actions of: ▪ Flexor muscles in the superficial, intermediate and deep layers of the forearm ▪ Origin, course, relations, branches (or tributaries), termination of nerves and vessels ▪ Position for palpation of radial artery pulsations ▪ Flexor retinaculum and its attachments ▪ Carpal tunnel syndrome • <u>Palm and hand</u> - thenar and hypothenar muscles, lumbricals and interossei - Ulnar and median claw hand - Movements of the thumb and muscles involved - Long flexor tendons, fibrous flexor sheaths, ulnar bursa, radial bursa and digital synovial sheaths - Course and branches of blood vessels and nerves in the hand	- Boundaries and contents of fascial compartments and spaces • Dupuytren contracture of palmar aponeurosis • Applied anatomy of fascial spaces • Tenosynovitis	
Back of forearm	▪ Muscle <u>groups</u> of forearm with attachments, nerve supply and actions of: extensor muscles of forearm	▪	

	▪ Origin, course, relations, branches (or tributaries), termination of nerves and vessels ▪ Wrist drop - Compartments deep to extensor retinaculum and contents of each one		
Dorsum of hand	▪ Extensor expansion - formation and muscles attached	▪ Anatomical "snuff box"	
Joints of upper limb	Description of type, articular surfaces, capsule, synovial membrane, ligaments, relations movements, blood and nerve supply of: ▪ Elbow joint (including muscles involved in movements of the joint) ▪ Proximal and distal radio-ulnar joints (including muscles involved in movements of the joint) ▪ Wrist joint (including muscles involved in movements of the joint) ▪ First carpometacarpal joint (including muscles involved in movements of the joint)	Description of type, articular surfaces, capsule, synovial membrane, ligaments, relations movements, blood and nerve supply of: ▪ Sternoclavicular joint ▪ Acromioclavicular joint Dislocation of radial head	Carrying angle ▪ Intercarpal joints intermatacarpal joints ▪ Carpometacarpal joints,except first carpometacarpal joint ▪ Metacarpophalangeal joint ▪ Interphalangeal joint
Radiology	▪ Anteroposterior and lateral views of bones and joints of upper limb		
Surface anatomy	▪ <u>Bony landmarks:</u> ▪ Jugular notch, sternal angle, acromial angle, ▪ spine of the scapula - vertebral level of the medial end ▪ Inferior angle of the scapula – vertebral level ▪ <u>Surface projection of</u>: ▪ Axillary artery ▪ Axillary nerve ▪ Cephalic and basilic vein ▪ Brachial artery ▪ Radial artery		▪
Embryology	▪ Basic concept of development of upper limb		

(10) GENERAL HISTOLOGY – SYLLABUS (40 hours)

Topic	Must Know	Desirable to know	Nice to know
	Epithelium		
	Connective tissue proper Loose areolar tissue, dense connective tissue –regular, adipose tissue		
	Cartilage		
	Bone		
	Muscle		
	Blood vessels	Microvasculature	
	Lymphoid tissue		
	Nervous tissue		

(8) GENERAL EMBRYOLOGY – SYLLABUS (8 hours)

Topics	Must know	Desirable to know	Nice to know
Introduction	Terms used in embryology Stages of development		
Mitosis and Meiosis and	Primordial germ cells Concept of Chromosomal abnormalities – numerical / structural Gene mutation		
Gametogenesis	Oogenesis Spermatogenesis		

Uterine and ovarian cycles	Uterine and ovarian cycles Ovulation		
Fertilization and Blastocyst	Definition, Phases of fertilization, Results of fertilization, Contraceptive methods- barrier techniques, contraceptive pills, IUD, vasectomy and tubectomy, Infertility Embryonic and adult stem cells	Assisted reproductive technology – IVF, GIFT, ZIFT, ICSI	
Bilaminar germ disc	• Implantation • Abnormal implantation		
Trilaminar germ disc	• Gastrulation		
Embryonic period	Definition, Neurulation – neural pores and the time of closure, Derivatives of each of the 3 germ layers, Somites	External appearance during 2nd month Induction and organogenesis	
Foetal membranes and Placenta	Structure, Placental circulation, Function, Placental barrier		Erythroblastosis fetalis and fetal hydrops
Amnion and umbilical cord	Structure and function	Amniotic fluid- hydramnios and oligohydramnios	Umbilical cord anomalies, Amniotic bands
Birth defects	Types of abnormalities – malformation, disruption, deformation, syndrome, Teratogens		
Prenatal diagnosis	Ultrasonography, Maternal serum screening, Amniocentesis, Chorionic villus sampling		
Twinning	Monozygotic and dizygotic twins, Conjoint twins		

(3) LOWER LIMB – SYLLABUS (80 hours)

Topic	Must Know	Desirable to know	Nice to know
Overview	Regions		

Bones ▪ Side determination (one feature for each of the opposite directions) ▪ Anatomical position ▪ Identification and description of features of each part ▪ Articulations ▪	▪ Hip bone ▪ Femur - ossification of lower end ▪ ▪ Patella ▪ Tibia -Ossification of upper end ▪ ▪ Fibula ▪ ▪ Articulated foot		▪ Neck-shaft angle
Fascia, veins, lymphatics cutaneous nerves of lower limb	▪ Fascia lata ▪ Intermuscular septa ▪ Venous drainage of lower limb ▪ Varicose veins and deep vein thrombosis ▪ Musculovenous pump ▪ Lymphatic drainage of lower limb including areas draining into inguinal lymph nodes ▪ Dermatomes of lower limb ▪ Cutaneous nerves of lower limb	▪ Enlarged inguinal lymph nodes ▪ Flexor, extensor and peroneal retinacula	
Front of thigh	▪ Muscle groups with their attachment, nerve supply and actions ▪ Insertion of psoas major, and quadriceps femoris ▪ Origin, course, relations, branches (or tributaries), termination of nerves and vessels ▪ Boundaries, floor, roof and contents of femoral triangle	▪ Psoas abscess ▪ Femoral hernia ▪ Palpation of femoral artery ▪ Knee jerk	▪
Medial side of thigh	▪ Muscle groups with their attachment, nerve supply and actions ▪ Adductor canal		▪
Gluteal region	▪ Muscle groups with their attachment, nerve supply and actions ▪ Insertion of gluteus maximus, medius and minimus ▪ Relations of piriformis and ischial spine ▪ Origin, course, relations, branches (or tributaries), termination of nerves and vessels - Liability of sciatic nerve to injury during gluteal intramuscular injections	- Trendelenburg sign - Pudendal block	▪
Back of thigh	▪ Muscle groups with their attachment, nerve		▪

	supply and actions ▪ ▪ Position, name of bones to which attached, nerve supply and actions of hamstrings, ▪ Origin, course, relations, branches (or tributaries), termination of nerves and vessels		
Hip joint	• Description of type, articular surfaces, capsule, synovial membrane, ligaments, relations, movements and muscles involved, blood and nerve supply, bursae around the joint, • Fracture neck of femur	Dislocation of hip joint Surgical hip replacement	
Popliteal fossa	▪ Boundaries, roof, floor, contents and relations of contents • • Popliteal pulse ▪ Position, attachments, nerve supply and actions of popliteus		
Front of leg **Anterior compartment,** **Dorsum of foot** **and Lateral Compartments**	▪ Muscle groups with their attachment, nerve supply and actions of muscles in each compartment ▪ Origin, course, relations, branches (or tributaries), termination of nerves and vessels ▪ Injury to common peroneal nerve and foot drop	▪	▪
Knee joint	• Description of type, articular surfaces, capsule, synovial membrane, ligaments, relations, movements and muscles involved, blood and nerve supply, bursae around the joint, ▪ Locking and unlocking of the knee joint	▪ Anastomosis around the knee ▪ Knee joint injuries ▪ Bursitis in knee region ▪ Osteoarthritis	
Back of leg	▪ Muscle groups with their attachment, nerve supply and actions of muscles in superficial and deep muscle groups ▪ Origin, course, relations, branches (or tributaries), termination of nerves and vessels ▪ Relations of ankle joint ▪ "Peripheral heart" ▪ Tendocalcaneus	▪ Ankle jerk	Rupture of calcaneal tendon

Sole of foot	▪ Basic organization ▪ ▪ Factors maintaining and importance of arches of the foot	▪ Flat foot, ▪ Club foot ▪ Plantar fasciitis	▪
Joints of lower limb	• Description of type, articular surfaces, capsule, synovial membrane, ligaments, relations, movements and muscles involved, blood and nerve supply, bursae around the: ▪ Tibiofibular joints ▪ Ankle joint	▪ Subtalar and transverse tarsal joints	
Radiology	• AP and Lateral views of bones and joints of lower limb: • Lateral view of the foot-identification of bones of the foot	▪ Shenton's line	
Surface Anatomy	▪ <u>Bony landmarks:</u> ▪ Vertebral levels of highest point of iliac crest, posterior superior iliac spines, iliac tubercle, pubic tubercle, ischial tuberosity, adductor tubercle, ▪ Tibial tuberosity, head of fibula, ▪ Medial and lateral malleoli, ▪ Condyles of femur and tibia, ▪ ▪ Palpation of pulsations of arteries- femoral, popliteal, posterior tibial and dorsalis pedis ▪ ▪ Mid inguinal point ▪ Midpoint of the inguinal ligament ▪ ▪ Femoral artery, vein and nerve, ▪ Saphenous opening ▪ Dorsalis pedis artery, ▪ Sciatic nerve, tibial and common peroneal nerves, deep peroneal nerve, ▪ great and small saphenous veins		▪ Nelaton's line, ▪ Shoemaker's line ▪ Bryant's triangle ▪
Embryology	▪ Basic concept of development of lower limb		

(5) ABDOMEN & PELVIS – SYLLABUS (135 hours)

Topic	Must Know	Desirable to know	Nice to know
Abdominal wall	<u>Planes</u>		

Anterior abdominal wall Inguinal canal Male external genitalia Posterior abdominal wall Muscles of the back (intrinsic muscles)	Transpyloric, Transtubercular, Subcostal Lateral vertical Linea alba, Linea semilunaris Fascia of anterior abdominal wall Regions and quadrants of abdomen Nerves & blood vessels of abdominal wall <u>Muscles</u> Name of the muscles, direction of fibers, their actions and nerve supply, neurovascular plane Rectus sheath formation, its contents Superficial inguinal ring, Deep inguinal ring <u>Inguinal ligament</u> Attachment & modifications Extent, boundaries, contents Inguinal (Hasselbach's) triangle Inguinal hernia <u>Testis</u> Coverings, internal structure, blood supply, nerve supply, lymphatic drainage, descent of testis, cryptorchidism, ectopic testis <u>Epididymis</u> Parts Muscles – Name, attachments, nerve supply and action Lumbar plexus – root value, formation & branches Position, nerve supply and action	Abdominal incisions Collateral routes for abdominopelvic venous blood Attachments of muscles of anterior abdominal wall <u>Clinical anatomy</u> Varicocoele <u>Penis</u> Parts, components, blood supply and lymphatic drainage Phimosis, Circumcision Lymphatic spread in carcinoma testis and scrotum Cremasteric reflex, Rupture urethra, Ligaments of penis Thoracolumbar fascia <u>Clinical anatomy</u> Psoas abscess	
Peritoneal cavity	<u>Lesser sac</u> Boundaries and recesses, Epiploic foramen <u>Greater sac</u> Boundaries of subdiaphragmatic spaces Definition of ligaments, omentum and mesentery <u>The mesentery</u> Attachment and contents, Rectouterine pouch,	Duodenal recesses Caecal recesses <u>Clinical anatomy</u> Ascitis, Peritonitis	

	Uterovesical pouch Rectovesical pouch	Subphrenic abscess	
Viscera	Name, position, external and internal features, important peritoneal and other relations, blood supply, nerve supply, lymphatic drainage and applied aspects of: Spleen, Abdominal part of oesophagus Stomach, Liver & its vascular segments Gall bladder, Pancreas, Small intestines Caecum, Appendix, Colon, Kidneys, Ureter Suprarenals, Extrahepatic bilary apparatus	<u>Clinical anatomy:</u> Importance of splenic notch during palpation of spleen Accessory spleens <u>Anatomical basis of</u> o Kehr's sign (Referred pain in the left shoulder during splenic infarction) o different types of vagotomy in gastric ulcer o Liver biopsy – site of needle puncture o Referred pain in cholecystitis o obstructive jaundice in biliary tract obstruction o Referred pain around umbilicus in acute appendicitis o Radiating pain of kidney to groin Lymphatic spread in carcinoma stomach – special emphasis on Trosier's sign Clinical importance of Calot's triangle	
Blood vessels & nerves	Veins: Formation, course relations and tributaries of- Portal vein, portosystemic anastomosis o haemetemesis, malena, caput medusae in portal hypertension Inferior vena cava, Renal vein <u>Arteries</u> Origin, course, important relations and branches of abdominal aorta, coeliac artery, superior mesenteric artery, inferior mesenteric artery, common iliac artery, external iliac artery Autonomic nervous system Coeliac ganglion	Concept of superior mesenteric plexus, inferior mesenteric plexus, renal plexus, superior hypogastric plexus, inferior hypogastric plexus Reason for preserving 1st lumbar sympathetic ganglion in lumbar sympathectomy	
Diaphragm	Attachments, openings, nerve supply & action	Abnormal openings and diaphragmatic hernia	

Pelvis	Muscles: Levator ani & coccygeus (pelvic diaphragm), Obturator internus, Piriformis Viscera: Position, features, important peritoneal and other relations, blood supply, nerve supply, lymphatic drainage and Clinical aspects of-Urinary bladder & pelvic part of ureter, Rectum, Anal canal Prostate, age changes Seminal vesicle, Vas deferens, Ejaculatory ducts, Male urethra Uterus & its supports, Fallopian tube Ovary, Vagina, Female urethra Blood vessels: Origin, course, important relations and branches of - Internal iliac artery Nerves: Structures palpable during o Vaginal examination o Rectal examination Internal and external haemorrhoids Anal fistula	Clinical anatomy Anatomical basis of : o suprapubic cystotomy o Urinary obstruction in benign prostatic hypertrophy o Retroverted uterus o Prolapse uterus Neurological lesions of the bladder o Autonomous neurogenic bladder o Atonic bladder o Automatic bladder Lobes involved in benign prostatic hypertrophy & prostatic cancer, Vasectomy Tubal pregnancy, Tubal ligation Sacral plexus Branches Pelvic splanchnic nerve	
Perineum	Extent and Subdivisions of perineum Superficial perineal pouch - boundaries and contents Deep perineal pouch – boundaries and contents Perineal body, Perineal membrane Ischiorectal / ischioanal fossa, Perianal abscess and anal fissure	Clinical anatomy Perineal tear / episiotomy	
Joints	Curvatures of the vertebral column Type, articular ends, ligaments and movements of: Intervertebral joints, Sacroiliac joints, Pubic symphysis Lumbar puncture: Site, direction of the needle, structures pierced during the lumbar puncture	Scoliosis, lordosis, prolapsed disc, spondylolisthesis, spina bifida	
Cross-sectional anatomy	Cross-section at the level of L1 (transpyloric plane)	Cross-sectional anatomy of abdomen and pelvis	
Microanatomy	Gastro-intestinal system: Oesophagus, Fundus of stomach, Pylorus of stomach, Duodenum, Jejunum, Ileum, Large intestine, Appendix, Liver, Gall bladder, Pancreas, Suprarenal gland Urinary system: Kidney, Ureter, Urinary bladder Male Reproductive System: Testis, vas deferens,	Cardio-oesophageal junction	

	Prostate **<u>Female reproductive system:</u>** Ovary, uterus, Uterine tube, cervix, Placenta, umbilical cord	Epididymis, seminal vesicle, Uterus - Proliferative and secretory phases of Corpus luteum	
Embryology	Anterior abdominal wall Diaphragm Development and congenital anomalies of: Foregut & spleen, midgut and hindgut Derivatives of dorsal and ventral mesenteries Urinary system Male reproductive system Female reproductive system	Abdominal aorta **<u>Embryological basis and clinical presentation of congenital anomalies</u>** Achalasia cardia, Congenital hypertrophic pyloric stenosis, Annular pancreas, Errors of rotation of the gut, Errors of fixation, Exomphalos, Gastroschisis, Umbilical hernia, Situs inversus <u>Congenital obstruction:</u> Atresia, Stenosis Meckel's diverticulum, Imperforate anus, Hirchsprung disease (Congenital megacolon), Horseshoe kidney Congenital polycystic kidney, Aberrant renal arteries, Ectopia vesicae, Epispadias Hypospadias, Rectovaginal fistula	Inferior vena cava Portal vein
Osteology	Features of typical and atypical lumbar vertebra, Sacrum <u>Bony pelvis</u>: Anatomical position Define true pelvis and false pelvis Boundaries of pelvic inlet, pelvic cavity, pelvic outlet, Sex determination	Coccyx <u>Bony Pelvis</u> Types <u>Clinical Anatomy</u> Sacralization of lumbar vertebra, Lumbarization of 1st sacral vertebra	
Radiological anatomy	Plain x-ray abdomen <u>Contrast X-rays</u>: Barium swallow, Barium meal, Barium enema, Cholecystography Intravenous pyelography, Hysterosalphingography, Arteriography	Principles of USG, ERCP, CT abdomen, MRI	

Surface anatomy	Regions and planes of abdomen, Stomach Liver, Fundus of gall bladder, Kidneys, Abdominal aorta , Inferior vena cava, Superficial inguinal ring, Deep inguinal ring, McBurney's point	Spleen, Duodenum Pancreas Ileocaecal junction Root of the mesentery	

(4) THORAX – SYLLABUS (60 hours)

Topic	Must Know	Desirable to know	Nice to know
Osteology	**Sternum** **Ribs** ▪ Definition of a true and false rib ▪ Features of a typical rib and 1st rib **Thoracic vertebra** ▪ Features of a typical thoracic vertebra	▪ Features of 2nd, 11th and 12th ribs ▪ Features of the 1st, 11th and 12th thoracic vertebrae	
Thoracic cage	Boundaries of thoracic inlet, cavity and outlet and structures passing through them		
Walls of thorax	**Muscles** Extent, attachments, direction of fibres, nerve supply and actions of external intercostal, internal intercostal, innermost intercostal, **Typical spinal nerve** ▪ Origin, course, relations and branches **Anterior and posterior intercostal arteries, veins and lymphatics** ▪ Origin, course, relations and branches or tributaries	**1st and 2nd intercostal nerves** ▪ Origin, course, relations and branches **Subcostal nerve** ▪ Origin, course, relations and branches	

	Internal thoracic artery ▪ Origin, course, relations and branches		
Pleural cavity	**Pleura** ▪ Parietal pleura and visceral pleura ▪ Suprapleural membrane ▪ Pleural recesses ▪ Blood supply, lymphatic drainage and nerve supply ▪ Applied anatomy · Pleuritis · Pneumothorax · Pleural effusion · Thoracocentesis **Lungs** ▪ External features and relations ▪ Difference between hilum and root ▪ Structures which form the root of lung ▪ Description of a bronchopulmonary segment ▪ Blood supply, lymphatic drainage and nerve supply ▪ Applied anatomy · Lung abscess **Trachea** ▪ Extent, length, relations, blood supply, lymphatic drainage and nerve supply ▪ Applied anatomy · Tracheostomy **Bronchi** ▪ Relations, blood supply, lymphatic	Bronchial asthma Bronchogenic carcinoma · Lobe of azygos vein	

	drainage and nerve supply ▪ Applied anatomy · Bronchitis **Phrenic nerves** ▪ Origin, course, relations and area of supply ▪ Applied anatomy		
Mediastinum	▪ Subdivisions, boundaries and contents of superior, anterior, middle and posterior mediastina		
Middle mediastinum	**Pericardium** ▪ Subdivisions, sinuses in the pericardium, blood supply and nerve supply ▪ Applied anatomy · Pericardial effusion **Heart** ▪ External and internal features ▪ Description of the interior of each chamber ▪ **Conducting system of heart** ▪ Parts, position and arterial supply **Coronary arteries** ▪ Origin, course and branches ▪ Applied anatomy **Venous drainage of heart** Coronary sinus · Formation, course, tributaries and termination · Anterior cardiac veins · Venae cordis minimae **Nerve supply of heart** ▪ Position and components of superficial and deep cardiac plexuses ▪ **Blood vessels**		Fibrous skeleton of heart

Posterior mediastinum	**Oesophagus** ▪ External appearance, relations, blood supply, nerve supply and lymphatic drainage ▪ Applied anatomy · Oesophageal varices **Thoracic sympathetic chain** ▪ Location, extent and relations ▪ Splanchnic nerves **Thoracic duct and right lymphatic duct** ▪ Extent, external appearance, relations and tributaries **Venous drainage of posterior abdominal wall:** **Azygos vein** ▪ Origin, course, relations, tributaries and termination **Hemiazygos vein** ▪ Origin, course, relations, tributaries and termination **Accessory hemiazygos vein** ▪ Origin, course, relations, tributaries and termination **Descending thoracic aorta** ▪ Extent, branches and relations ▪ **Vagus nerve in thorax**		
Joints of thorax	▪ Type, articular surfaces, capsule, ligaments, nerve supply and movements of manubriosternal, sternocostal, costovertebral, costotransverse and xiphisternal joints ▪ Intervertebral joint ▪ Mechanics of respiration ▪ Types of respiration	Costochondral and interchondral joints	
Microscopic anatomy	▪ Trachea ▪ Lung		

Embryology	▪ Development of pleura ▪ Development of respiratory system **<u>Development of heart</u>** ▪ Development of the chambers, interatrial and interventricular septa **<u>Development of vascular system</u>** ▪ Aortic arch arteries ▪ Superior vena cava and inferior vena cava ▪ Coronary sinus ▪ <u>Clinical correlates</u> · Atrial septal defect · Ventricular septal defect · Fallot's tetralogy · Transposition of great vessels · Dextrocardia Patent ductus arteriosus · Coarctation of aorta ▪ **<u>Foetal circulation and changes at birth</u>** · Patent ductus arteriosus ▪ **Development of oesophagus**	Brachiocephalic veins	
Living Anatomy	· Internal thoracic artery · Parietal pleura · Lungs, root of lungs and fissures · Trachea · Heart · Apex beat · Arch of aorta · Oesophagus Surface projection of valves of heart		
Radiology	· Plain X-ray chest – PA view	CT and MRI of Thorax	

(6) HEAD AND NECK – SYLLABUS (135 hours)

Topics	Must know	Desirable to know	Nice to know
Osteology	▪ Anatomical position of skull	▪ Concept of bones which	▪

	▪ Identification and locations of individual skull bones in an articulated skull ▪ Features seen in Normas frontalis, verticalis, occipitalis, lateralis and basalis ▪ Cranial cavity- subdivisions, foraminae and structures passing through them ▪ Details of Mandible and Maxilla, ▪ Features of typical and atypical cervical vertebrae	ossify in membranes and cartilage ▪ Frankfort Plane ▪ Parietal, Occipital, Frontal and Temporal bones ▪ Sphenoid,	
Scalp	▪ Layers of scalp, Extent/ attachment of each layer, Surgical importance of each layer, Blood supply, nerve supply and lymphatic drainage		
Superficial dissection of the face	▪ Muscles of facial expression Muscle groups acting upon the angle of the mouth - Attachments of the orbicularis oculi, orbicularis oris and buccinator muscles only ▪ Sensory innervation of the face	- Names of the superficial muscles in the face, with their actions and nerve supply	
Deep dissection of the face	▪ Facial artery: Origin, course and branches ▪ Facial vein: Formation, course and tributaries ▪ Facial nerve: Branches in the face ▪ Lymphatic drainage of the face ▪ Surgical importance of the deep facial vein ▪ Facial palsy		
Parotid Region	▪ Parts, borders, surfaces, contents, relations and nerve supply of parotid gland ▪ Course of parotid duct	▪ Parotitis (mumps) ▪ Parotid abscess ▪ Plane of dissection and main complication of superficial parotidectomy ▪ Frey's Syndrome	
The side of the neck Posterior Triangle	Boundaries and subdivisions of posterior triangle ▪ Boundaries and contents of the subclavian and occipital triangles ▪ Special emphasis on with nerve supply and actions ▪ Sternocleidomastoid with attachments and relations, Wry neck	▪ Erbs palsy ▪ Klumpke's palsy ▪ Injury to accessory nerve during lymph node biopsies ▪ inferior belly of omohyoid scalenus anterior, scalenus	

	Lymphatic drainage of head and neck	medius, levator scapulae	
Dissection of back	▪ Contents of the vertebral canal	▪ Suboccipital triangle: Boundaries and contents ▪ Position, direction of fibres, relations, nerve supply, actions of: Semispinalis capitis, Splenius capitis	
Cranial Cavity	▪ Cranial fossae: structures related and major foramina and structures passing through ▪ Pituitary gland ▪ Dural venous sinuses	▪ Clinical importance of dural venous sinuses	▪ Pituitary tumours
Orbit	▪ Attachments, nerve supply and actions of muscles of eyeball ▪ Nerves and vessels in the orbit ▪ Ciliary ganglion ▪ Horner's Syndrome	▪ Strabissmus	▪ Testing of extraocular muscles
Anterior Triangle	▪ Boundaries and subdivisions of the anterior triangle ▪ Boundaries and contents of the muscular, carotid, digastric and submental triangles		
Temporal and Infratemporal regions	▪ Extent, boundaries and contents of temporal and infratemporal fossae ▪ Attachments, direction of fibres, nerve supply and actions of muscles of mastication ▪ Temporomandibular joint	▪ Clinical significance of pterygoid venous plexus ▪ Dislocation of temporomandibular joint	
Submandibular region	▪ Parts, borders, surfaces, relations, nerve supply of submandibular gland ▪ Course and relations of submandibular duct ▪ Submandibular ganglion ▪ Position, relations and nerve supply of sublingual gland	▪ Submandibular stones ▪ Bidigital palpability of submandibular swellings	
Deep structures in the neck	▪ Thyroid gland- location, parts, borders, surfaces, relations, blood supply ▪ Parathyroid glands- location, blood supply ▪ Trachea, Tracheostomy- structures encountered ▪ Subclavian artery- Origin, parts, course,	▪ Thyroid swellings- anatomically relevant clinical features ▪ Awareness of liability of injury to external and recurrent laryngeal nerves during thyroidectomy	

	branches ▪ Vagus Nerve in the neck- Course and branches ▪ Accessory Nerve- Course and supply ▪ Cervical Sympathetic chain- Components, branches, area of supply ▪ Deep cervical fascia- parts, extent, attachments, modifications ▪ Deep cervical lymph nodes	▪ Compression of subclavian artery by cervical rib ▪ Fascial spaces of neck ▪ Thymus	
Mouth, Pharynx, Palate	▪ Subdivisions and contents ▪ Names, position, actions and nerve supply of muscles of palate and pharynx ▪ Palatine tonsil- Position, relations, blood supply ▪ Waldeyer's lymphatic ring- Components and their function ▪ Boundaries and clinical significance of pyriform fossa	▪ Tonsillitis and tonsillectomy ▪ Adenoids ▪ Paratonsillar abscess ▪	▪ Killian's dehiscence
Cavity of Nose	▪ Nasal septum ▪ Epistaxis- significance of Little's area ▪ Lateral wall of nasal cavity ▪ Paranasal sinuses concept of referred pain	▪ Maxillary sinus tumours ▪ Sinusitis	
Larynx	▪ Cartilages and ligaments ▪ Names, nerve supply and actions of intrinsic and extrinsic muscles of larynx ▪ Sensory innervation and blood supply of larynx	▪ Laryngitis ▪ Recurrent laryngeal nerve injury	
Tongue	▪ Names, nerve supply and actions of extrinsic and intrinsic muscles of tongue ▪ Nerve supply and lymphatic drainage of tongue	▪ Hypoglossal nerve palsy	
Organs of hearing and equilibrium	▪ Parts, boundaries, contents, relations, blood supply and nerve supply of external ear, middle ear and Auditory tube	Internal ear, Mastoid Antrum, Otitis externa, Otitis media, McEwan's triangle-Approach to mastoid antrum, Myringotomy	
Eyeball	▪ Parts and layers of eyeball	Cataract, Glaucoma, Central retinal artery occlusion, Intraocular muscles- position, nerve supply and actions	
Prevertebral region and Joints of Head and neck	▪ Concept of prevertebral muscles ▪ Atlanto-occipital joint		

	▪ Atlantoaxial joint		
Microanatomy	▪ Pituitary gland ▪ Thyroid and Parathyroid gland ▪ Tongue ▪ Tonsil ▪ Epiglottis	Olfactory epithelium, Eyelid, Lip, Salivary glands, Cornea, Retina, Sclero-corneal junction, Optic Nerve, Crista ampullaris, Macula, Cochlea-organ of Corti, Pineal gland	▪ Adult Tooth
Embryology	▪ Face ▪ Palate ▪ Tongue ▪ Branchial apparatus ▪ Pituitary gland ▪ Thyroid gland ▪ Eye	Facial clefts, First Arch Anomalies, Developmental anomalies of tongue, Branchial cysts and fistulae, Ectopic thymic, parathyroid or thyroid tissue, Thyroglossal cyst, Coloboma iridis	
Surface Anatomy	Vertebral levels of: Hyoid bone, Thyroid cartilage, Cricoid cartilage Surface Projection of Thyroid gland, Parotid gland and duct, Pterion, Common carotid artery, Internal jugular vein, Subclavian vein, External jugular vein, Facial artery	Accessory nerve	
Radiology	Plain X ray skull: AP view, Lateral view ▪ Plain X ray cervical spine lateral view ▪ Plain X ray of paranasal sinuses ▪ Carotid angiogram	CT and MRI of Head and Neck	

(7) THE NERVOUS SYSTEM – SYLLABUS (75 hours)

Topics	Must know	Desirable to know	Nice to know
Subdivisions	Subdivisions of nervous system into Central and peripheral nervous system, somatic and autonomic nervous system		
External features	External features of the brain and spinal cord and its meningeal coverings and blood supply		
Spinal cord	a) External and internal features b) Organization of grey matter into nuclei c) Coverings of spinal cord d) Ascending and descending tracts and their functions	Upper and lower motor neuron lesions	Laminar concept,

	e) Upper and lower motor neurons f) Spinal segment and dermatome g) Blood supply h) Modifications of piamater		
Brainstem	External and interrnal features of		
Cerebellum	Gross features and subdivisions of cerebellum. Deep nuclei, afferent and efferent connections. Cerebellar peduncles	Morphological subdivisions of cerebellum into archi, paleo and neocerebellum, Cerebello-pontine angle tumour, symptoms of cerebellar disease	
Thalamus	Structure, nuclei, connections and functions		
Hypothalamus	Structure, nuclei, connections and functions	Epithalamus,	Circumventricular organs
Cerebrum	Gross features (gyri and sulci) of the cerebral hemisphere – superolateral, Medial and inferior surface, and the subdivisions into lobes, and blood supply. Functional areas and Brodmann's numerals (motor, sensory, visual, auditory, speech, frontal eye field, prefrontal cortex) Horizontal section of cerebrum Midsagittal section of cerebrum		
White fibres of cerebrum Basal nuclei	Association, commissural and projection fibres Components, basic connections and functions)	Anatomical basis of stroke Parkinson's disease, Chorea, Athetosis, Huntingtons disease	
Ventricles of the brain	Features of lateral, third and fourth ventricle. Choroid plexus, Circulation of Cerebro-Spinal Fluid (CSF).	Subarachnoid cisterns, blood- CSF barrier.	
Limbic system			Limbic system – parts and function Connections of limbic system
Reticular formation and ARAS			Reticular formation and ARAS-General arrangement, zones, basic connections and functions

Cranial nerve nuclei Optic and auditory pathways	Cranial nerve nuclei - location Optic and auditory pathways		Functional columns
Blood supply of brain and spinal cord	Blood supply of brain and spinal cord	Clinical importance of blood supply of brain and spinal cord, Lateral medullary syndrome, Medial medullary syndrome, pontine hemorrhage, Weber's syndrome, posterior circulation stroke, Middle cerebral artery stroke.	
Microanatomy	Transverse sections of spinal cord at cervical, thoracic, lumbar and sacral levels Cerebral cortex Cerebellar cortex Nerve endings Transverse sections of Medulla oblongata at levels of motor decussation, sensory decussation and mid-olivary level Transverse section of Pons at upper and lower pons, Transverse section of Midbrain at superior and inferior colluculi	Neuromuscular junction- Motor end plate	Differentiation between motor and sensory cortex Muscle spindle
Embryology	Formation and histogenesis of the developing neural tube Derivatives, curvatures and cavities of Prosencephalon, Mesencephalon and Rhombencephalon Neural crest derivatives Hypophysis cerebri	Developmental anomalies: hydrocephalus, anencephaly, spina bifida, meningocoele, meningomyelocoele,	Development of functional columns

(8) GENERAL EMBRYOLOGY – SYLLABUS (8 hours)

Topics	Must know	Desirable to know	Nice to know
Introduction	Terms used in embryology Stages of development		
Mitosis and Meiosis and	Primordial germ cells Concept of Chromosomal abnormalities –		

	numerical / structural Gene mutation		
Gametogenesis	Oogenesis Spermatogenesis		
Uterine and ovarian cycles	Uterine and ovarian cycles Ovulation		
Fertilization and Blastocyst	Definition, Phases of fertilization, Results of fertilization, Contraceptive methods- barrier techniques, contraceptive pills, IUD, vasectomy and tubectomy, Infertility Embryonic and adult stem cells	Assisted reproductive technology – IVF, GIFT, ZIFT, ICSI	
Bilaminar germ disc	• Implantation • Abnormal implantation		
Trilaminar germ disc	• Gastrulation		
Embryonic period	Definition, Neurulation – neural pores and the time of closure, Derivatives of each of the 3 germ layers, Somites	External appearance during 2nd month Induction and organogenesis	
Foetal membranes and Placenta	Structure, Placental circulation, Function, Placental barrier		Erythroblastosis fetalis and fetal hydrops
Amnion and umbilical cord	Structure and function	Amniotic fluid- hydramnios and oligohydramnios	Umbilical cord anomalies, Amniotic bands
Birth defects	Types of abnormalities – malformation, disruption, deformation, syndrome, Teratogens		
Prenatal diagnosis	Ultrasonography, Maternal serum screening, Amniocentesis, Chorionic villus sampling		
Twinning	Monozygotic and dizygotic twins, Conjoint twins		

(9) GENETICS - SYLLABUS (5 hours)

Topic	Must Know	Desirable to know	Nice to know

Chromosomes	▪ Structure of chromosomes ▪ Classification of chromosomes based on position of centromere		
Karyotyping	▪ Technique of preparing a Karyotype ▪ Types of banding ▪ Clinical applications of karyotyping ▪ Reading of karyotypes for normal male, female, Trisomies, Turner syndrome, Klinefelter syndrome		Fluorescent in situ hybridisation (FISH)
Sex Chromatin	▪ Barr bodies and their clinical significance ▪ Lyon hypothesis		
Patterns of Inheritance and pedigree charts	Mendelian laws of inheritance, Common symbols used in construction of pedigree charts, Understand the characteristics of the types of single gene inheritance, Examples of diseases of each mode of inheritance, Interpret pedigree charts for the various modes of inheritance, Multifactorial inheritance with examples	Clinical features of the examples described: Achondroplasia, Cystic Fibrosis, Vitamin D resistant rickets, Hemophilia, Duchene's muscular dystrophy, Sickle cell anaemia	
Chromosomal Aberrations	Causes of chromosomal aberrations Structural aberrations- types and examples Numerical aberrations- types, examples and clinical features True and pseudohermaphroditism Mosaics and chimeras	Clinical features of other examples of chromosomal aberrations: Prader Willi syndrome, Edward syndrome, Patau syndrome	
Prenatal Diagnosis	▪	Methods of prenatal diagnosis- indications, complications Screening maternal blood for diagnosis of neural tube defects and Down syndrome Ultrasound Fetal echocardiography Amniocentesis Chorionic villus sampling Umbilical blood sampling Genetic counseling and ethical issues in prenatal diagnosis	

6.REFERENCES FOR LEARNING (BOOKS)

Gross Anatomy

1. Cunningham's Manual of Practical Anatomy Volumes 1, 2 and 3 15th edition by GJ Romanes
2. Gray's Anatomy 41st Edition 2016 Standring S
3. Clinical Oriented Anatomy 7th edition by Moore KL, Agur AMR and Dalley AF
4. Essentials of Human Anatomy Vols 1, 2 and 3 by AK Datta
5. A Textbook of Human Anatomy, 2000 by T.S. Ranganathan

Neuroanatomy

1. Clinical Neuroanatomy 7th edition 2009 by Richard S. Snell
2. Essentials of Human Anatomy Neuroanatomy 4th edition 2012 by AK Datta
3. Textbook of Clinical Neuroanatomy 2nd edition Vishram Singh
4. Illustrated Textbook of Neuroanatomy 12th edition by GP Pal

Histology

1. Inderbir Singh's Textbook of Human Histology with Colour Atlas and Practical Guide 7th edition, 2014 by Vasudeva Neelam
2. Wheater's Functional Histology: A Text and Colour Atlas, 6th Edition by Barbara Young, Geraldine O'Dowd, Phillip Woodford
3. Textbook of Histology 2008 by GP Pal

Embryology

1. Langman's Medical Embryology13th edition by T.W. Sadler,
2. Larsen's Human Embryology 5th Edition 2014 by Schoenwolf, Bleyl, Brauer and Francis-West

3. The Developing Human: Clinically Oriented Embryology 9th edition, 2012 by Keith L. Moore
4. Human Embryology 10th edition by IB Singh,
5. Essentials of Human Embryology 6th edition by AK Datta

Genetics

1. Human Genetics 3rd edition 2012 by Gangane SD

7.THEORY EXAMINATION

Total Marks per paper = 50 Marks
3 hours duration and 50 marks each for Paper1 and Paper 2

Paper 1: General Anatomy, General Histology, General Embryology, and Genetics Gross Anatomy of Upper Limb, Lower Limb, Abdomen, Pelvis and Perineum and special histology and special embryology relevant to these regions;

Paper 2: Gross Anatomy of Thorax, Head, Neck, Brain and Spinal Cord and special histology and special embryology relevant to these regions;

Paper 1 and Paper 2:

1 . Essay	1 x 10 Marks	= 10 marks
2. Brief Answers	5 x 4 Marks	= 20 marks
3. Short Answers	10 x 2 Marks	= 20 marks
Total		50 Marks

Histology and Embryology may be included in theory as a part of the essay, short notes and short answers
Marks will be allotted for relevant diagrams which may be part of the essay, short notes and short answers.

8.PRACTICAL EXAMINATION

List of Specimens for Gross Anatomy Practical

Upper Limb
1. Axilla
2. Scapular region
3. Front of arm
4. Back of arm
5. Front of forearm
6. Back of forearm
7. Hand
8. Shoulder joint
9. Elbow joint
10. Wrist joint

Lower Limb
1. Femoral triangle
2. Gluteal region
3. Front of thigh
4. Posterior and adductor compartment of thigh
5. Anterior and lateral compartments of leg
6. Back of leg
7. Sole of foot
8. Dorsum of foot
9. Knee joint
10 Ankle joint

Abdomen, Pelvis and Perineum
1. Anterior abdominal wall
2. Posterior abdominal wall
3. Male external genitalia
4. Inguinal canal
5. Liver and extrahepatic biliary apparatus
6. Stomach
7. Duodenum and pancreas
8. Small intestine and large intestine
9. Blood vessels of abdomen and pelvis
10. Diaphragm
11. Female reproductive system

Thorax
1. Thoracic cage
2. Superior mediastinum
3. Heart- external features
4. Heart- chambers
5. Heart – blood supply
6. Lungs
7. Posterior mediastinum
8. Pericardium

Head and Neck
1. Scalp
2. Face and parotid region
3. Posterior triangle
4. Cranial cavity
5. Orbit
6. Anterior triangle
7. Temporal and infratemporal regions
8. Deep structures of the neck
9. Mouth, pharynx and palate
10. Larynx
11. Nasal cavity
12. Dural venous sinuses

Nervous system
1. External surfaces of the cerebral hemisphere
2. Base of the brain
3. White fibres of the cerebrum
4. Ventricles of the brain
5. Coronal section of the cerebrum
6. Horizontal section of the cerebrum
7. Cerebellum
8. Brain stem

List of Slides for Histology Practical *=Nice to Know

Part 1

General Histology

1. Hyaline cartilage
2. Elastic cartilage
3. White cartilage
4. Bone T.S.
5. Bone L.S.
6. Skeletal muscle
7. Smooth muscle
8. Cardiac muscle
9. Nerve - CS
10. Spinal ganglion
11. Sympethic ganglion
12. Elastic artery
13. Muscular artery
14. Large Veins
15. Medium sized veins
16. Lymph node
17. Skin- Hairy and Non-hairy

Systemic Histology

1. Cardio-oesophageal junction
2. Oesophagus
3. Stomach-Fundus
4. Stomach-Pylous
5. Duodenum
6. Jejunum
7. Ileum
8. Appendix
9. Colon
10. Liver
11. Pancreas
12. Gall Bladder
13. Spleen
14. Kidney
15. Urinary Gladder
16. Suprarenal gland
17. Penis
18. Testis

19. Epididymis
20. Vas deferens
21. Seminal Vesicle
22. Prostate
23. Ovary
24. Uterus
25. Uterine Tubes
26. Vagina
27. Cervix
28. Placenta
29. Umbilical Card
30. Mammary gland

Part 2

1. Tongue-(Papillae * identification Nice to Know)
2. Salivary Gland –serous
3. Salivary Gland –Mucous
4. Salivary Gland –Mixed
5. Tonsil
6. Tooth*
7. Olfactory Epithelium*
8. Cornea
9. Retina
10. Sclero-Corneal Junction*
11. Cochlea*
12. Thyroid & Parathyroid
13. Pituitary Gland
14. Trachea
15. Thymus
16. Lung
17. Spinal Cord – Cervical
18. Spinal Cord – Thoracic
19. Spinal Cord - Lumbar
20. Spinal Cord - Sacral
21. Medulla Oblongata - Pyramidal decussation level
22. Medulla Oblongata -Sensory decussation level

23. Medulla Oblongata -Inferior Olivary Nuclear level
24. Pons – Upper
25. Pons - Lower
26. Midbrain – Superior colliculus
27. Midbrain – Inferior colliculus
28. Pineal Gland
29. Cerebrum
30. Cerebellum

Practical Examination

Anatomy:

Practical examination pattern modified as follows.

Spotters

Gross anatomy	---12 x1= 12 marks
Histology	---12x1= 12 marks

Discussion

Gross anatomy-	--2 x 3 = 6 marks
Histology	--2 x 3 = 6 marks

OSPE- * --2 x 2 = 4 marks

Total 40 marks

SPOTTERS

Gross anatomy-
Upperlimb - 2
Lowerlimb - 2
Abdomen - 2
Pelvis -1
Thorax -2

Head and neck -2
Brain -1

Histology
General – 3
Paper 1 ---5
Paper -2 ---4

Discussion
Gross anatomy
Paper -1 ----1 specimen
Paper –2- ----1 specimen

Histology
General ----1 slide
Systemic ---1 slide.

OSPE* - Two procedural skills stations with a:
(i) Specific Instruction (such as "describe aloud and mark with chalk on the surface of the cadaver the following structure……, and keep the surface of the cadaver ready for the next student") and a
(ii) Checklist with the details of the steps used to practice surface marking and marks allotted such as:
a) Accuracy of the points marked - 0.5 marks
b) Method used to join the points - 0.5 marks
c) Description of the steps followed - 0.5 marks
d) Adequate cleaning of the surface - 0.5 marks

VIVA
Osteology – 5marks
Embryology- 5marks
Radiology- 5 marks
Surface anatomy- 5marks.

This will be implemented from August 2017 examination session onwards.

(For Clinical Anatomy and Genetics charts - the anatomical relevance to common clinical conditions should be asked. The number of charts to be made available should be at least 70:

Paper I	-	30 charts
Paper II	-	30 charts
Genetics	-	10 charts

The clinical anatomy charts should include relevant Gross Anatomy, Embryology and Radiology

List of Surface Markings learnt

Upper limb:

Student must be able to demonstrate

- Relevant bony and soft surface landmarks
- Arteries:
    - Axillary
    - Brachial
    - Radial
    - Ulnar
    - Superficial palmar arch
    - Deep palmar arch
- Nerves:
    - Median
    - Ulnar
    - Radial
    - Axillary
- Others:
    - Flexor retinaculum
    - Extensor retinaculum
- Surface landmarks to palpate the following on the surface:
    - Brachial pulsations
    - Radial pulsations
    - Ulnar pulsations
    - Ulnar nerve
    - Anatomical snuff box/ scaphoid
- Locate the common sites for venipuncture in the upper limb:
    - Median cubital vein
    - Cephalic vein at the wrist
    - Dorsal venous network

Lower limb:

Student must be able to demonstrate

- Relevant bony and soft surface landmarks
- Arteries:
    - Femoral
    - Popliteal
    - Anterior tibial
    - Posterior tibial
    - Dorsalis pedis
- Veins:
    - Great saphenous

- Femoral

- Nerves:
  - Femoral
  - Sciatic
  - Common peroneal
- Others:
  - Inguinal ligament
  - Saphenous opening
  - Bryant's triangle
- Surface landmarks to palpate the following on the surface:
  - Femoral pulse
  - Popliteal pulse
  - Posterior tibial pulse
  - Dorsalis pedis pulse

Thorax:

Student must be able to demonstrate

- Relevant bony and soft surface landmarks
- Superior Mediastinum:
  - Right and left brachiocephalic veins
  - Superior Vena Cava
  - Arch of aorta
  - Trachea
- Events occurring at sternal angle
- Organs:
  - Heart borders and valves
  - Lung borders and fissures
  - Pleura
- Surface landmarks to locate the following on the surface:
  - Apex beat
  - Auscultatory areas for the heart valves

Abdomen:

Students must be able to demonstrate:

- Relevant bony and soft surface landmarks
- Abdominal planes, abdominal regions and organs located in each region
- Surface projection of the following organs:
  - Stomach
  - Liver
  - Spleen
  - Fundus of Gall bladder
  - Base of the appendix

- Morrison's parallelogram for posterior marking of the kidneys

- Blood vessels: Abdominal aorta and Inferior Vena Cava
- Others:
  - Superficial and deep inguinal rings
  - Mc Burney's point
  - Vertebral levels of main events occurring in the abdomen
  - Events occurring at the transpyloric plane
  - Root of mesentery

Head and neck:

Students must be able to demonstrate:

- Relevant bony and soft surface landmarks
- Glands:
  - Parotid gland and duct
  - Submandibular gland
  - Thyroid gland
- Arteries:
  - Facial artery
  - Common, internal and external carotid arteries
  - Internal and external jugular veins
  - Subclavian artery and vein
- Nerves:
  - Spinal accessory nerve
  - Vagus
- Others:
  - Vertebral levels of surface landmarks in the neck
  - Pterion
  - Mastoid antrum
- Surface landmarks to palpate the following on the surface:
  - Frontal air sinus
  - Maxillary air Sinus
  - Carotid pulsation
  - Superficial temporal pulsation
  - Subclavian pulsation

10.<u>FORMATIVE ASSESSMENT</u> - Quarterly (marks need to be submitted three times to the university)

Students should be given feedback on their performance after each of the following **<u>eight units.</u>**

1) General Anatomy and Upper Limb
2) Lower Limb
3) General Histology and General Embryology
4) Thorax
5) Abdomen
6) Head and Neck,
7) Brain and
8) Genetics

11.<u>INTERNAL ASSESSMENT TEST</u> - UNIT WISE

Each student should be shown as having a mark for each of the eight units mentioned above. These marks should be grouped together and sent to the university on three occasions in one academic year. Based on all these marks the total internal assessment will be finally calculated as Theory and Practical marks which will be the average of the 8 Internal Assessment unit tests:

Theory	20 marks
Practical	15 marks
Records 2.5 x 2 =	5 marks
TOTAL	**40marks**

-Gross Anatomy Record and Histology Record
-Record books with pre-drawn sketches should not be used

12.<u>MEDICAL ETHICS</u> -

1) Respect of the cadaver
2) Privacy and confidentiality
3) Cultural sensitivity

4) Consent
5) Autonomy
6) Source of cadavers
7) Eugenics
8) Genetic counselling

13.INTEGRATED TEACHING

1) Vertical Integration- with the help of clinicians and hospital visits wherever possible
2) Horizontal Integration- may be considered for topics such as peptic ulcer, diseases of liver and biliary tract, diseases of the kidney, diseases of the central nervous system, myocardial infarction

Clinical Integration for Upper Limb

Topic	**Clinical Speciality**
Brachial plexus and peripheral nerve injuries	Orthopaedics
Peripheral Pulsations	General surgery/Medicine
Concept of Common fractures and dislocations	Orthopaedics
Concept of growing end of the upper limb bones	Orthopaedics
Surgical approaches for orthopaedic surgery	Orthopaedics
Breast	General surgery

Clinical Integration for Lower Limb

Topic	**Clinical Speciality**
Nerve injuries	Orthopaedics & Medicine or Neurology
Varicose veins	General surgery
Elephantiasis	General surgery
Peripheral pulsations in relation to living anatomy Demonstration of pulses	General surgery
Surgical anatomy of joints of the lower limb	Orthopaedics

Clinical Integration for Abdomen Pelvis and Perineum

Topic	**Clinical Speciality**
Appearance of abdominal viscera in USG, CT and MRI	Radiology
Inguinal region	General Surgery
Contraception in the male and female	Community medicine/OG
Congenital malformations	Paediatric surgery/paediatrics
Portal hypertension	General Surgery/Gastroenterology
Peptic ulcer	General Surgery/Gastroenterology
Assisted reproduction	Obstetrics and Gynecology

Clinical Integration for Thorax

Topic	**Clinical Speciality**
Superior mediastinum –thoracic inlet syndrome, scalenus anterior syndrome	General surgery
Pleural effusion, Pneumothorax, Pleural tapping	Medicine / Respiratory Medicine
Pericardial pain, referred pain from heart	Medicine
Tracheo-oesophageal fistula	Paediatric surgery
Appearance of thorax in CT and MRI	Radiology

Clinical Integration for Head and Neck

Topic	**Clinical Speciality**
Facial nerve palsy	General Medicine
Cataract, Glaucoma, Eyelid infections	Ophthalmology
Surgical anatomy of ENT	ENT

Clinical Integration for Nervous System

Topic	**Clinical Speciality**
Upper and Lower motor neuron	General Medicine
Hemiplegia	General Medicine
Cerebellar lesions	General Medicine
Appearance of the brain in CT and MRI	Radiology

Clinical Integration for Genetics

Topic	**Clinical Speciality**
Prenatal diagnosis	OG

14.RECORDS

Gross Anatomy Record and Histology Record

Records with Pre-drawn sketches should not be used.
List of Gross Anatomy diagrams.

Upper Limb	**Lower Limb**
Typical spinal nerve	Femoral sheath
Lymphatic Drainage of breast	Adductor canal
Brachial Plexus	Cutaneous innervation of the dorsum of foot
Axillary Artery	Superior surface of the tibia
Anastomosis around the scapula	Anastomosis around the knee
Dermatomes of the upper limb	
Anastomosis around the Elbow	
Flexor Retinaculum of Wrist	
Fascial Spaces of Palm	
Extensor Retinaculum of wrist	

Thorax	**Abdomen**
Subdivisions of mediastinum T.S. of thorax at T3 level T.S. of thorax at T4 level Arterial supply of heart Venous drainage of heart Medial surface of lungs Bronchi and bronchopulmonary segments	Regions of abdomen Superficial veins of anterior abdominal wall Lymphatic drainage of skin of abdominal wall Rectus sheath Lesser sac Blood supply, Nerves supply of stomach Lymphatic drainage of stomach Thoracolumbar fascia Anterior & posterior relations of kidney Portosystemic anastomosis Peritoneal reflection in male Peritoneal reflection in female
Head and Neck	**CNS**
Layers of the scalp Vessels & nerves of the scalp Muscles of facial expression Cutaneous innervation of head and neck Posterior triangle Cavernous sinus Superior orbital fissure and common tendinous ring Ciliary ganglion and its connections Carotid triangle - boundaries Carotid arteries and nerves in the neck Structures related to hyoglossus Nasal septum Arteries & nerves of nasal cavity	Internal structure of spinal cord showing position of tracts Interpeduncular fossa and attachment of cranial nerves to the anterior surface of the brain stem Arteries on the base of the brain Floor of fourth ventricle Functional areas of cerebrum Blood supply of cerebrum

List of Histology slides to drawn by I MBBS students

General Histology	
Epithelial Tissue	**Blood vessels**
- Simple squamous epithelium	- Elastic artery
- Simple cuboidal epithelium	- Medium sized artery and vein
- Simple columnar epithelium	- Large vein
- Pseudostratified cil. columnar epithelium	**Glands**
- Stratified squamous epithelium	- Unicellular gland (Goblet cell)
- Transitional epithelium	- Simple tubular gland
Connective Tissue	- Serous gland
- Areolar tissue	- Mucous gland
- Adipose tissue	- Mixed gland
- Tendon L.S	-Sebaceous and sweat gland
Cartilage	-Mammary gland
- Hyaline cartilage	**Lymphoid Tissue**
- Elastic cartilage	- Lymph node
- Fibro cartilage	- Spleen
Bone	- Thymus
- Compact bone L.S.	- Tonsil
- Compact bone C.S.	**Nervous Tissue**
- Spongy bone	- Nerve C.S
- Developing bone	- Nerve L.S (Osmicatted)
Muscle	- Spinal ganglion
-Skeletal muscle L.S.	- Sympathetic ganglion
-Skeletal muscle C.S.	**Integumentary System**

- Smooth muscle	- Hairy skin
- Cardiac muscle	- Nonhairy skin
	- Nail
Special Histology	
Gastrointestinal system	- Cornea
- Oesophagus	- Iridio-corneal junction
- Cardio-oesophageal junction	- Retina
- Stomach - fundus	- Optic nerve
- Stomach - pylorus	- Macula
- Duodenum	- Crista
- Jejunum	- Organ of Corti
- Ileum	- Pituitary gland
- Large intestine	- Pineal gland
- Appendix	- Thyroid gland
- Liver	- Parathyroid gland
- Gall bladder	- Tongue – fungiform and filiform papillae
- Pancreas	- Tongue – circumvallate papilla
Genitourinary system	- Epiglottis
- Kidney	- Olfactory epithelium
- Ureter	**CNS**
- Urinary bladder	**Nerve Endings**
-Adrenal gland	- Motor end plate
-Testis	- Muscle spindle
-Epididymis	- Meissner's corpuscle and Pacinian corpuscle
-Vas deferens	
-Seminal vesicle	-Spinal cord - cervical
-Prostate	-Spinal cord - Thoracic

-Ovary	-Spinal cord - Lumbar
-Fallopian tube	-Spinal cord - Sacral
-Uterus	- Medulla - Motor Decussation
-Cervix	- Medulla - Sensory Decussation
-Placenta	- Medulla - Mid Olivary Level
-Umbilical cord	-Pons – lower pons
Respiratory System	- Pons - upper Pons
-Trachea	- Midbrain – inferior colliculus
- Lung	- Midbrain - Superior Colliculus
Head & Neck	- Cerebrum – Typical Cortex
- Eyelid	- Cerebellum
- Lip	
- Adult tooth	
- Developing tooth –Bell stage	

Record should be followed as recommended by the University.

PHYSIOLOGY

The goal of learning Physiology is to enable an undergraduate student to have a comprehensive knowledge of the normal functions of the organ systems which facilitates an understanding of the physiological basis of health and disease.

HUMAN PHYSIOLOGY

COMPETENCIES:

At the end of the I MBBS Physiology course, the student must:

- Have an understanding of the functioning of the different organ systems of the human body and their interactions towards maintenance of homeostasis or a constant internal environment.
- Be able to apply the knowledge of physiological processes to comprehend mechanisms of disease and basis of treatment.
- Be able to perform some basic laboratory tests and interpret their results
- Be able to perform clinical examination to assess various organ systems.

ii) OBJECTIVES

a) KNOWLEDGE

At the end of the course the student should be able to:

(1) Explain the normal functioning of all the organ systems and their interactions for maintenance of a constant internal environment.

(2) Describe physiological responses and adaptations to changes in internal and external environment.

(3) Describe the physiological principles underlying pathogenesis and treatment of disease.

(4) List normal values and acceptable ranges for relevant physiological parameters

(5) Interpret results of the following laboratory tests:
- (i) serum electrolytes, pH, osmolarity and blood gases
- (ii) pulmonary function tests
- (iii) renal function tests
- (iv) cardiac function tests

(6) Diagnose conditions from symptoms and signs and investigative data provided in case scenarios dealing with common disorders of: hematological, musculoskeletal, alimentary, endocrine, reproductive, renal, cardiovascular, respiratory, and neurological systems.

b) SKILLS

At the end of the course the student should have developed skills in/to:

(1) Basic hematological techniques:

- (i) use and maintenance of a compound microscope
- (ii) collection of blood by the finger prick method using aseptic techniques
- (iii) performance of ESR, total WBC count, Differential count, hemoglobin estimation, PCV, Bleeding and clotting time, blood grouping.
- (iv) Calculation of hematological indices

(2) Distinguish between normal and abnormal data derived from the tests mentioned above.

(3) Perform the following tests and clinical examinations in a normal subject with an understanding of the physiological basis of the examination and the clinical need to do so. The student should be able to:

- (i) Measure blood pressure, record ECG and perform clinical examination of the cardiovascular system.

- (ii) perform tests of ventilatory function using spirometer and peak flow meter and perform clinical examination of the respiratory system

- (iii) do experiments towards understanding the effect of posture and various grades of exercise on cardiorespiratory function.

(iv) perform clinical examination of the abdomen

(v) perform clinical examination of the nervous system including special senses

c) ATTITUDE:

The student must

(i) develop a scientific approach in the practice of clinical medicine

(ii) correlate disease manifestation with derangements of physiological mechanisms and understand rationale of treatment

INTEGRATION

The teaching-learning program should be integrated horizontally and vertically, as much as possible, to enable students to understand the physiological processes in health, derangements in disease and rationale of treatment.

Number of hours:

Lectures + Tutorials:	280
Practicals + OSPE:	160
ECE:	40

	480

TOTAL HOURS ALLOCATED FOR PHYSIOLOGY AS PER MCI NORMS

S.No	*TOPICS*	*LECTURE AND TUTORIALS*	*PRACTICAL AND OSPE*	*ECE*
1	**General physiology and body fluids**	20 Hours	5 Hours	3 Hours
2	**Blood**	30 Hours	40 Hours	6 Hours
3	**Muscle**	15 Hours	5 Hours	3 Hours
4	**Gastrointestinal System**	15 Hours	12 Hours	3 Hours
5	**Endocrine System**	30 Hours	15 Hours	3 Hours
6	**Reproductive System**	20 Hours	5 Hours	2 Hours
7	**Excretory System**	25 Hours	10 Hours	2 Hours
8	**Respiratory System**	25 Hours	20 Hours	4 Hours
9	**Cardiovascular System**	35 Hours	20 Hours	5 Hours
10	**Central Nervous System**	45 Hours	22 Hours	6 Hours
11	**Special senses**	20 Hours	6 Hours	3 Hours
	TOTAL HOURS	**280 Hours**	**160 Hours**	**40 Hours**

The teaching learning methods employed will include

Theory

- **Lectures**
- **Tutorials**
- **Small group discussion**
- **Case based learning**
- **Problem based learning**
- **Integrated teaching module**
- **Early Clinical Exposure**

Practical

- **Demonstration of Hematology Experiments**
- **System wise Clinical Examination**
- **OSPE**
- **OSCE**
- **Case Discussion**
- **Charts and calculation**

THEORY AND PRACTICAL SYLLABUS

GENERAL PHYSIOLOGY AND BODY FLUIDS (Lectures + Tutorials 20 hours; Practicals + OSPE 5 hours; ECE: 3 hours)						
NO	**TOPIC**	**SPECIFIC LEARNING OBJECTIVES**			**TEACHING HOURS**	**CLINICAL INTEGRATION**
		MUST KNOW	**DESIRE TO KNOW**	**NICE TO KNOW**		
1	**Cell Organelles**	• Will be discussed in Biochemistry and Anatomy				
2	**Homeostasis and Feedback System**	• Describe the concept of maintenance of internal environment • Recognize that negative feedback is the most common type of physiological control	• State and describe examples of negative feedback • State and describe instances of positive feedback in human physiology		1 Hour	
3	**Body Fluids**	• List the different body fluid compartments, - state the volume, osmolarity and electrolyte composition of each of the following compartments • Total body water, extracellular, intracellular, plasma, intravascular • Describe the term transcellular fluid • Measurement of volumes of compartments • Describe the Starling's forces that govern fluid exchange across the membranes separating the various compartments • Define Donnan effect and equilibrium • Use the Concept of electro neutrality in the fluid compartments to calculate 'Anion gap' • Define anion gap as the term referring	• Difference between tonicity and osmolarity • Edema and its causes • The dilution principle for measurement of body fluid compartments • Methods of measurement of body fluid compartments	Changes in electrolyte concentration in Vomiting, Diarrhoea, severe dehydration and burns Cause for oedema in Kwashiorkor, Liver failure, glomerulonephritis and filariasis	2 hours	with clinical departments to enable a student to understand the principles of intravenous fluid therapy learn the presentations and management of electrolyte disorders (the causes of fluid and electrolyte disorders may be discussed later in the course) see patients presenting with different types of edema

		to unmeasured anions in plasma.				
4	**Cell Membrane**	• Describe with diagram the fluid mosaic model • State the composition of cell membrane in terms of lipids and proteins and describe how these are organised			1 Hour	
5	**Membrane Transport**	• Classify transport mechanisms as Passive and active with examples and differentiate between them. • List and describe the following passive transport processes with examples: o Simple diffusion of respiratory gases through lipid film o Diffusion of ions through ion channels ▪ Sodium, potassium, calcium and chloride channels ▪ Non-gated channels, voltage-gated, ligand-gated channels and mechano-gated channels o Facilitated diffusion - Glucose transporters (GluTs) o Osmosis • Describe the following active transport processes: o Primary active transport: ▪ sodium-potassium pump, o Secondary active transport: sodium-glucose co-transport (SGLT) and sodium-aminoacid co-transport • Describe the following transport processes by formation of membrane vesicles o Endocytosis	Describe the differences between channel and carrier-mediated transport processes State Fick's law of diffusion • Describe the following active transport processes: o Primary active transport: ▪ calcium pumps - plasma membrane calcium pumps (PMCA) and Sarco/endoplasmic reticulum calcium pumps (SERCA) ▪ Proton pumps - V-type H ATPase, H/K ATPase o Secondary active transport: sodium-hydrogen exchangers, sodium-calcium exchangers, Na/2Cl/K symport	State the mechanism of action of botulinum toxin and the basis of botox injections Channelopathies	3 Hours	Teaching may be integrated with Pharmacology and clinical departments to (i)) enable a student to have a perspective about blockers of the transporters (channels and carrier proteins) used as therapeutic drugs. Examples: Digoxin, Furosemide, thiazide diuretics, amiloride, omeprazole (ii)) understand disorders arising due to mutations of some channels: E.g.: Liddle's syndrome Brugada syndrome Congenital Long QT syndrome

		• Exocytosis				
6	**Membrane Potential**	• Describe the mechanisms involved in genesis of resting membrane potential (RMP) in a prototype cell • Recognise the RMP in a nerve or cardiac cell • Nernst or equilibrium potential 'Equilibrium potential' • Action potentials in neuron, skeletal muscle cell, Sino atrial node and cardiac ventricular cell	• Patch Clamp Technique • Cathode Ray Oscilloscope	• Describe the term 'Depolarizationblock ' in terms of inactivation of voltage –gated sodium channels during sustained partial depolarization and therefore the inability of the tisse to develop new action potential	2 Hours	With Pharmacology and Anaesthesia to understand (i)The use of drugs causing depolarization blockade (ii))Long QT syndrome as an adverse effect of a number of drugs causing blockade of a K channel called HERG channel

Blood (Lectures + Tutorials 30 hours; Practical + OSPE 40 hours; ECE: 6 hours)						
NO	**TOPIC**	**SPECIFIC LEARNING OBJECTIVES**			**TEACHING HOURS**	**CLINICAL INTEGRATION**
		MUST KNOW	**DESIRE TO KNOW**	**NICE TO KNOW**		
1	**Introduction**	• Describe the normal composition of blood • Describe the composition of plasma • State the difference between plasma and serum.	• State the difference between plasma and serum..		1 Hour	
2	**Plasma Proteins (Integration with Biochemistry)**	• State the site of production, normal range and describe the functions of Albumin • Discuss causes for decrease in serum Albumin levels with specific examples of disease conditions • Explain what is plasma oncotic pressure • Discuss the production, various types and role of Globulins (alpha, beta and gamma globulins)	• Causes for decrease in serum Albumin levels with specific examples of disease conditions • Discuss the significance of albumin/globulin ratio • Explain the cause for oedema in Kwashiorkor, Liver failure, glomerulonephritis and filariasis	• Acute Phase Proteins (Special consideration of Fibrinogen as an acute phase protein) • Describe the significance of C- Reactive protein	2 Hours	• With clinical departments to enable a student to examine patients with edema, identify and discuss the mechanism of edema in various disease conditions
3	**Erythrocyte Sedimentation Rate (ESR):**	• Define and state normal values for ESR in men and women • Describe the factors influencing ESR (fibrinogen particularly) • Discuss the significance of ESR in disease states	• Estimate ESR by Wintrobe/Westergren's method of a provided sample of blood and interpret the result		Practical 3 Hours	• See evidences for ESR serving as an index of acute phase reaction
4	**RBC**	• Describe the physical characteristics of red blood cells • List causes and give explanation for physiological variations of the normal	• Explain morphological characteristics of individual stages of		2 Hours	

		RBC count • Explain the functions of RBCs • List the changes in sites of erythropoiesis with age • Illustrate the major changes that take place during the stages of erythropoiesis. • Describe the factors regulating/ affecting erythropoiesis, • Discuss the normal life span and destruction of RBCs	Erythropoiesis • Define Packed Cell Volume (PCV)/Hematocrit and state normal range for men and women • State the physiological variations in PCV		Practical 3 Hours	
5	**Hemoglobin**	• State the components of Hb, the various types of Hb and normal range of Hb in men and women • Briefly discuss the synthesis of haemoglobin • what is reduced hemoglobin. • Define and describe cyanosis • Discuss the types of jaundice • Abnormal Hemoglobin	• Estimate and interpret Hb content by Sahli's Acid Hematin method- Estimation of Hb • Abnormal Hemoglobin • Iron metabolism and iron overload • Discuss the synthesis of hemoglobin • Discuss carbon monoxide poisoning and treatment • Discuss Iron metabolism and iron overload	• Role of phototherapy in treating infants with jaundice due to hemolysis	2 Hours Practical 3 Hours	• With biochemistry to discuss about structure and types of Hb • Describe and detect Cyanosis • Describe sickle cell anemia & • Thalassemia • Identify and describe physiological jaundice of new born • Discuss different types of jaundice.
6	**Anaemia**	• Define anaemia • Classify anaemia based on etiology and morphology • Discuss the principles of treating anemias • Describe major symptoms, signs and effects of anemia	• State the normal reticulocyte count and its significance • Define reticulocyte response • Calculate and interpret red cell indices	• Discuss the principle and indications for Bone Marrow Transplantation	2 Hours	• With medicine departments to see patients with anemia and enable a student to • discuss causes and effects of anemia • Identify signs of

						anemia in a patient • List tests to be ordered to diagnose anemia and interpret the test results.
7	**Polycythemia**	• Define what is Polycythemia • Explain what is Polycythemia rubra vera • Discuss causes for secondary polycythemia • Explain what is relative polycythemia • Discuss the effects of polycythemia	• Classification of Polycythemia and its causes	• Discuss the principles of treating Polycythaemia	1 Hour	• With medicine departments to enable a student to discuss causes and effects of polycythaemia
8	**Platelet**	• Describe the formation, structure, life span & removal of platelets • State the normal platelet count • Describe the functions of platelets. • Discuss the causes and effects of thrombocytopenia	• Details of the various granules in platelets	• Thrombocytopenic Purpura	1 Hour	• With medicine departments to see patients with thrombocytopenia and enable a student to • Discuss causes and effects of thrombo cytopenia

9	**Hemostasis**	• Describe the processes involved in hemostasis such as:
		  • vasoconstriction
		  • Platelet plug formation
		  • Clotting or coagulation pathways
		  • Clot retraction
		• Describe anticlotting and fibrinolytic mechanisms in the body
		• List anticoagulants and their mechanism of action
		• Explain various causes for abnormal hemostasis
		• List the clotting factors and Explain
			• Explain various causes for abnormal hemostasis
			• Perform and interpret simple tests of hemostasis like bleeding time by Duke's method and clotting time by capillary method of Wright on oneself.
			• Explain and Interpret tests such as platelet count, Prothrombin Time, Activated Partial Thromboplastin Time
				• Explain Arachidonic acid metabolism - COX pathway (and lipooxygenase for completion)
				• Explain the role of Prostaglandins (and leukotrienes)
				• Discuss the role of Thrombolysis in therapeutics
				• Explain Disseminated
					2 Hour Theory
					
					3 Hours Practical
						With Medicine Department to see patients with abnormal hemostasis and enable the students to discuss causes and effects of abnormal hemostasis

		the pathways of coagulation • Explain various causes for abnormal hemostasis • Perform and interpret simple tests of hemostasis like bleeding time by Duke's method and clotting time by capillary method of Wright on oneself by collecting blood using finger prick method using aseptic method • Explain Lee and White's method for determining clotting time	and clotting factor assays. • Discuss the use of anti-platelet agents in therapeutics	Intravascular Coagulation • Explain reason for thrombosis and embolism in atherosclerotic vascular disease and venous stasis		
10	**Blood groups & Blood banking**	• Describe the importance of blood groups • Explain the genetic determination of blood groups • Describe the ABO system of blood grouping • State the frequency of different blood groups • Describe the Rh system of blood grouping • Explain the mechanism and consequence of ABO and Rh incompatibility • Explain the condition Erythroblastosis Fetalis, state preventive measure and treatment option for the same.	• Discuss the minor blood group systems. • Perform and interpret blood grouping/typing on oneself by collecting blood using finger prick method under aseptic conditions (or on a provided blood sample) • Explain the process and interpretation of blood cross match	• Bombay Blood Group	1 Hour Theory 3 Hours Practical	• Visit to Blood Bank Storage and Cross matching • With clinical pathology for a visit to the blood bank to observe and discuss procedures done to separate components of blood for clinical use and procedures done in the blood bank for safe blood transfusion. • Teaching may be integrated with clinical pathology to discuss transfusion reaction

11	**WBC**	• State the normal Total and Differential count • Classify types of WBC as granulocytes, agranulocytes • Describe the morphology and functions of neutrophils, eosinophils, basophils, mast cells; Lymphocytes , monocytes. • Perform and interpret total leucocyte on their own blood / provided blood using aseptic precautions • List Conditions in which total leucocyte counts is increased or decreased. • List conditions in which counts of each type of WBC are increased or decreased • Describe the various cells that constitute the monocyte- macrophage system and state their function	• Make a peripheral blood smear on their own blood / provided blood • Perform and interpret the differential leucocyte count using aseptic precautions	• Monocyte-macrophage system and state their function	2 Hours theory 6 Hours Practical	• With medicine - altered total and differential counts • Brief introduction to hematological malignancies • Bone marrow transplantation
12	**Leucopoiesis**	• Outline the process of maturation of white blood cells			1 Hour	
13	**Immunity**	• Classify immunity and state the differences between innate and acquired immunity • Discuss the cells and mechanisms involved in innate • immunity • Name the lymphoid organs in the body and outline the development of T and B cells • Classify acquired immunity and mention the cells involved in acquired immunity • Describe the cells and mechanisms involved in cell mediated immunity • Describe the cells and mechanisms	• Classify immunoglobulins and state their functions • Explain primary and secondary immune response • Illustrate the role of Complement system in immunity	• Name important cytokines. • State their source and functions • Auto Immune Disease Immunodeficiency Syndrome • Organ transplant and • Immunosuppresion	5 Hours	• To integrate with medicine to discuss and observe patients with Immunodeficiency syndromes, • Autoimmune diseases • To integrate with dermatology to discuss and observe patients with • Allergy and

		involved in humoral immunity				Hypersensitivity • To integrate with nephrology to discuss immune response related to • Organ Transplantation and immunosuppressive therapy
14	**Lymph**	• Describe the formation and composition of lymph • Illustrate the lymphatic circulation. • Discuss functions of lymph.	Discuss the pathophysiology of lymphedema		1 Hour	• Integrate with surgery to discuss and observe patients with lymphedema (filariasis, Ca Breast with upper arm edema)

Autonomic nervous system (Lecture 2 Hours)						
No	**Topic**	**SPECIFIC LEARNING OBJECTIVES**			**TEACHING HOURS**	**CLINICAL INTEGRATION**
		MUST KNOW	**DESIRE TO KNOW**	**NICE TO KNOW**		
1	**Organization**	• Sympathetic and parasympathetic divisions • Pre-ganglionic neuron • Post-ganglionic neuron	• B type nerve fibres • Unmyelinated C fibres		2 Hours	
2	**Sympathetic division**	• Thoraco-lumbar outflow • Ganglia close to vertebral column • Post ganglionic neurons longer – travel along vessels to reach viscera • Adrenal medullary cells are neuroendocrine cells				
3	**Parasympathetic division**	• Cranio-sacral outflow • Supply to organs in head - through oculomotor, facial and glossopharyngeal nerves • Supply to thoracic and upper abdominal viscera- through the vagus • Supply to lower abdominal and Pelvic viscera- through S2, S3 and S4 sacral nerves • Ganglia are within or close to the organ of supply • post-ganglionic neurons are short				
4	**Chemical transmission**	• Acetylcholine - all pre-ganglionic neurons, post-ganglionic parasympathetic neurons, sympathetic post-ganglionic neurons that	• Acetylcholine has shorter duration of action due to the degradation by acetylcholinesterase • Nor-epinephrine has a			

		innervate sweat glands, • All other sympathetic post-ganglionic neurons secrete nor-epinephrine	longer duration of action Otto Loewi's experiment			
5	**Acetylcholine**	• Removal by acetylcholinesterase • Receptors • Muscarinic receptors - distribution and difference in action through these receptors • Nicotinic receptors – distribution	• Muscrarinic blocker – atropine • Ganglion blocker - hexamethonium			
6	**Catechol amines**	• Receptors • alpha 1 – vasoconstriction • alpha 2 • beta 1 increases heart rate • beta 2 – bronchodilation • beta 3	• phechromocytoma • Vanillyl mandelic acid • Nor-epinephrine has greater affinity for alpha receptors and epinephrine has greater affinity for beta receptors			
7	**General functions**	• Sympathetics - fight or flight respons	• Walter Cannon • Walter Cannon			
8	**Eye**	• Parasympathetic – Accommodation, miosis • Sympathetic - mydriasis	Parasympathetic – accomodation, miosis Sympathetic - mydriasis			
9	**Heart**	• SA node • Parasympathetic - decreases heart rate – muscarinic receptor • Sympathetic - Increases heart rate - beta 1 receptors • Atria & Ventricle • Parasympathetic - decreases				

		force of contraction • Sympathetic - increases force of contraction - beta 1 & 2 receptors • AV node and Purkinje fibers • Parasympathetic - decreases conduction velocity • Sympathetic - increases conduction velocity - beta 1 & 2 receptors				
10	**Lungs**	• Parasympathetic – bronchoconstriction • Sympathetic -Dilation - beta 2				
11	**Vessels**	• Arterioles • Sympathetic - vasoconstriction - α 1 & 2 • Veins • Sympathetic - constriction - α 1 & 2				
12	**Stomach and Intestine**	Parasympathetic o Increases motility & secretion o Relaxes sphincters □ Sympathetic o Decreases motility & secretion o Contracts sphincters				
13	**Gall Bladder**	• Parasympathetic – contraction • Sympathetic – relaxation				
14	**Urinary Bladder**	• Detrusor • Parasympathetic – contraction • Sympathetic – relaxation				

		• Sphincter • Parasympathetic – relaxation • Sympathetic – contraction				
15	**Male Organ**	• Erection – parasympathetic • Ejaculation – Sympathetic				
16	**Skin**	• Pilomotor - Sympathetic – contraction • Sweat glands • Parasympathetic - generalized dilute secretion				
17	**Liver**	• Sympathetic - glycogenolysis				
18	**Pancreas**	• Exocrine • Parasympathetic increases secretion • Sympathetic –decreases	• Endocrine • Sympathetic - decreases			
19	**Salivary Gland**	• Parasympathetic - profuse watery secretion • Sympathetic - thick viscous secretion rich in enzyme				
20	**Lacrimal Gland**	• Parasympathetic – secretion				
21	**Adipose Tissue**		• Sympathetic - lipolysis			
22	**Drugs**		• Atropine, Neostigmine, physostigmine • Propranalol, Salbutamol • Isoprenalin, dopamine			
23	**Higher Control**	• Hypothalamus, Medulla – RVLM	• Head ganglion - Sherrington			

Muscle (Lectures + Tutorials 15 hours; Practicals + OSPE 5 hours; ECE: 3 hours)						
No	**Topic**	**SPECIFIC LEARNING OBJECTIVES**			**TEACHING HOURS**	**CLINICAL INTEGRATION**
		MUST KNOW	**DESIRE TO KNOW**	**NICE TO KNOW**		
1	**Skeletal Muscle Morphology**	• Describe and draw the structure of sarcomere marking actin filament, myosin filament, I band, A band, H band, Z line and sarcomere • Describe the functions of contractile and regulatory proteins involved in muscle contraction • Draw and describe the structure of the sarco-tubular system	• Describe the functions of other structural proteins like Titin, Desmin etc	• Role of Dystrophin in muscle Dystrophies	2 Hours	• Muscular dystrophy (Neurology/PMR)
2	**Neuromuscular junction**	• Draw and Describe the structure of the neuromuscular junction • Describe the events involved in neuromuscular transmission • Describe the pathophysiology of diseases affecting the neuromuscular junction like myasthenia gravis • Describe the mechanism of action cholinesterase inhibitors • Motor Unit	• Pseudocholinesterase Lambert-Eaton Syndrome • Organophosphorus poisoning • EMG.	• Neuromuscular Blockers	2 Hours	Succinyl choline and depolarization block – (Anaesthesia) Therapeutic use of Botox Myesthenia Gravis – (Neurology) Organophosphorus Poisoning (Medicine)
3	**Muscle Contraction**	• Describe the molecular Basis of muscle contraction, events involved in excitation contraction coupling. • Explain the types of Muscle contraction • Describe the sliding filament theory of muscle contraction	Factors affecting force of contraction; pre-load, after load, beneficial effect. • Describe the physiological basis of the length-tension	• Types of Muscle fibres • Energy sources in muscle • Denervation hypersensitivity • Describe the	2 Hours	Rigor Mortis (Forensic Medicine)

		• Role of ATP and calcium pumps in the mechanism of relaxation of the muscle • Describe the Factors affecting the force of contraction	relationship.	concept of oxygen debt		
4	**Smooth Muscle**	• Structure, distribution, types, molecular mechanism of contraction	• Comparison between smooth, skeletal and cardiac muscle		1 Hour	
5	**Factors modulating smooth muscle contraction And Properties**	• List the various factors that modulate smooth muscle contraction like stretch, sympathetic nerveous system, circulating substances etc. • Describe the special properties of smooth muscle like latch-bridge mechanism and plasticity	•		1 Hour	Cystometrogram (PMR, Urology)

Gastrointestinal System (Lectures + Tutorials 15 hours; Practicals + OSPE 12 hours; ECE: 3 hours)						
NO	**TOPIC**	**SPECIFIC LEARNING OBJECTIVES**			**TEACHING HOURS**	**CLINICAL INTEGRATION**
		MUST KNOW	**DESIRE TO KNOW**	**NICE TO KNOW**		
1	**Salivary Gland**	• Name the Salivary Glands • Functions of saliva. • Describe the regulation of salivary secretion	• Deficient salivation – Xerostomia	• Formation of saliva Composition of saliva	1 Hour	
2	**Enteric nervous system**	• State the location and components of the enteric nervous system. • Explain the functions of the Myenteric plexus and Meissner's plexus • Explain the effect of the autonomic nervous system on the enteric nervous system	• Explain the physiological basis of Congenital Megacolon		1 Hour	
3	**Mouth and oesophagus**	• Explain the process of mastication • Outline the process of Deglutition. • State the importance of lower oesophageal sphincter	• Achalasia Cardia	• Gastro-esophageal reflux disease (GERD)	1 Hour	Reflux esophagitis (Medicine)
4	**Gastric secretion**	• Describe the composition and functions of gastric secretion • Describe the mechanism of gastric acid secretion • State the role of chief cells and parietal cells • Describe the different phases of gastric secretion • Discuss regulation of gastric secretion • Explain the importance of mucus-bicarbonate barrier • Explain the cause of acid peptic disease	• State an example of proton pump inhibitor and histamine receptor blocker • Explain the reason for Pernicious anemia • Physiological basis for the use of proton pump blockers and histamine receptor blockers for peptic ulcers	• Gastric Function Tests • Role of H.Pylori in peptic ulcers	2 Hours	APD Cases shown in Medicne Department
5	**Liver and gall bladder**	• Explain the portal system • Describe the functions of liver	• Explain the pathophysiology of	• Explain the consequences of		Integrated teaching with Anatomy to

	(Horizontal Integration)	• Describe the composition and functions of Bile • Explain Micelle formation and its functions • Explain what is emulsification of fat • Explain the process of Entero-hepatic circulation	• Portal Hypertension • Ascites • Gall Stone • Jaundice	liver Failure	1 Hour	understand the functional Anatomy of Liver With Biochemistry to discuss LFT With Medicine – Liver Failure With Surgery – Jaundice
6	**Gall Bladder**	• State the factors regulating bile secretion • Explain the function of Gall Bladder • Explain how concentration of Bile	• State the composition of gall stones and factors involved in the formation of gall stones	• State what is ERCP and when it is performed • State what is Cholecystectomy and what are the indication of the same	1 Hour	Integrated with Surgery to discuss about Gall Stones
7	**Pancreatic secretion**	• List the Enzymes present in pancreatic juice and explain their functions • Explain the regulation of secretion the role of enterokinase	• Reason for the alkaline pH of pancreatic secretion and its importance	• what is pancreatitis • Explain Steatorrhoea	1 Hour	
8	**Small Intestine**	• Explain the functional anatomy of the small intestine • Discuss the secretions of small intestine and their functions • Describe how small intestinal secretion regulated	• Enterokinase Malabsorption syndrome	• Cholera	1 Hour	
9	**Gastric Motility**	• Explain the process of mixing of food in the stomach • Explain the factors influencing gastric motility and gastric emptying • Describe the mechanism of vomiting	• Explain the Chemoreceptor trigger zone • Discuss the role of Anti-emetics	• Dumping syndrome	1 Hour	
10	**Movements of small intestine**	• Describe peristalsis • Explain the stimuli and factors which influence peristalsis • Describe ‘segmentation contractions’	• State what is basic electrical rhythm of the gastrointestinal tract and it’s role	• Define paralytic ileus	1 Hour	

		and 'mixing contractions' and their functions • Explain what is Migrating Motor Complex				
11	**Large intestine & Movements of Large Intestine**	• Explain the functions of large intestine and formation of faeces • What is segmentation and mixing contractions of large intestine • Explain Defecation Reflex	• State the importance of dietary fibre • Constipation • What is Gastro colic reflex	• Pathophysiology of Hirschprung's Disease	1 Hour	
12	**Digestion and Absorption**	• Digestion and Absorption of carbohydrates • Digestion and Absorption of proteins • Digestion and Absorption of fat	• Glucose Transporters • Fat soluble vitamins • Function of short chain fatty acids	• Lactose Intolerance	1 Hour	
13	**Iron Absorption**	• Absorption of Iron	• Transferrin, Ferritin • Hemosiderin • Hemosiderosis			
14	**GI Hormones**	• Source of Hormones • Functions and regulation of secretion of Gastrin, Cholecystokinin and Secretin			1 Hour	
15	**Water Movement in Intestine**	• Physiological basis of treatment of Diarrhoea	Cholera – Increased chloride and water secretion			

Endocrinology (Lectures + Tutorials 30 hours; Practicals + OSPE 15 hours; ECE: 3 hours)						
NO	**TOPIC**	**SPECIFIC LEARNING OBJECTIVE**			**TEACHING HOURS**	**CLINICAL INTEGRATION**
		MUST KNOW	**DESIRE TO KNOW**	**NICE TO KNOW**		
1	**Introduction to Endocrinology**	• Define Hormone • Classify and list the hormones based on chemical nature • Mechanism of negative and positive feedback regulation of hormone release	• Describe the mechanism of action of hormones including the receptors and second messengers	• Hormone measurement • Radioimmuno Aassay • ELISA	2 Hours	
2	**Hypothalamus**	• Describe the relationship between hypothalamus and pituitary including the Hypothalamohypophyseal tract and the hypothalamohypophyseal portal circulation • List the various releasing and inhibiting hormones released by the hypothalamus			1 Hour	
3	**Pituitary Gland**	• List the various types of secretary cells of Anterior and Posterior Pituitary • List the Hormones secreted by the anterior and posterior pituitary. **Growth hormone:** • List the important actions of growth hormone, its effects on growth and metabolism • Describe the regulation of growth hormone secretion • List important stimuli that increases or decreases the secretion of GH • **Prolactin:** • Describe the actions and regulation of prolactin secretion • List the features of excess Prolactin secretion	• Describe the physiological basis and importanrt features of abnormalities of growth hormone secretion like - Gigantism, acromegaly and pituitary dwarfism • Describe the mechanism of action of Growth hormone (JAK-STAT Pathway) • Explain howInsulin like growth factor (IGF) or Somatomedin mediates the actions of growth hormone	• Plasma Levels, • Plasma Protein Binding, and Metabolism • Prolactinoma	2 Hours	Clinical cases of Hyper and Hypo secretion can be demonstrated Pituitary tumours case with symptoms can be shown

		• **Antidiuretic hormone (ADH)** • Explain the synthesis, release and mechanism, functions and regulation of actions of ADH • Discuss the disorders of ADH secretion - Diabetes Insipidus • **Oxytocin** • Explain the synthesis, release mechanism, functions and regulation of Oxytocin\List the functions of Oxytocin • Role in milk ejection reflex and parturition	• Types of Diabetes Insipidus • Panhypopituitarism • Shehan's Syndrome • Postpartum Pituitary Necrosis	• Syndrome of inappropriate hypersecretion of antidiuretic hormone (SIADH)	1 Hour	Role of Oxytocin in labour and post partum haemorrhage (Obstetrics)
4	**Thyroid Gland (Horizontal and Vertical Integration)**	• Explain the functional Anatomy of Thyroid Gland • List the steps involved in the synthesis of thyroid hormones • Explain the mechanism of release of Thyroid Hormone • Explain the transport actions of thyroid hormone • Describe the regulation of thyroid hormone secretion • List the causes and features of Hypo secretion of thyroid hormones - Myxedema and Cretinism, Goitre and features of Hypothyroidism • List the causes and features Hypersecretion of thyroid hormones – Gigantism and Acromegaly • **Calcitonin** • Secretion and action of Calcitonin	• Explain the physiological basis for Simple Goitre • List the differences between dwarfism and cretinism	• Describe the important thyroid function tests and its clinical use	3 Hours	Cases of Hypo and Hyperthyroidism can be shown

5	**Parathyroid Gland**	• **Parathormone** • Discuss the actions of parathyroid hormone • Describe the causes and features of hyper/hypoparathyroidism • Descibe Calcium Homeostasis • **Vitamin D (Calcitriol)** • Mention the sources, synthesis mechanism of action and • List the features of vitamin D deficiency in children and in adults – Rickets and Osteomalacia • **Calcitonin** • Actions of calcitonin	• List the different types of cells present in the Parathyroid Gland • Describe the secretion of parathyroid hormone • Explain he regulation of secretion of parathyroid hormone • Differences between Tetanus and Tetany	• List the causes of secondary hyperparathyroidism • Recognize its emerging role as an immunomodulator.	2 Hours	Case of Tetany can be shown Cases of Rickets and Osteomalacia can be shown
6	**Adrenal Gland**	• List the hormones secreted by the different layers of Adrenal Cortex • Describe the Functional Anatomy of Adrenal Cortex • Describe the mechanism of action, functions and regulation of action of Mineralocorticoids, Glucocorticoids and sex steroids • Discuss the causes and features of Cushing's Syndrome and Addison's Disease • **Adrenal medulla:** Synthesis and physiological effects of epinephrine and nor-epinephrine on various systems of the body • Factors that regulate the secretion of adrenal medullary hormones	• Disorders produced by the deficiency of enzymes involved in adrenocortical hormone synthesis • Diseases related to Mineralococorticoids • Conn's Syndrome • Aldosterone Escape • Atrial Natriuretic Peptide (ANP)	• Discuss the causes of • Cushing's Syndrome • Adrenal Tumour • Adrenal Hyperplasia, • Secondary Hyperaldosteronism • List the features of Phaeochromocytoma	3 Hours 1 Hour	Indications for steroid therapy, adverse effects 0f steroid therapy and tapering of steroid therapy(Integration with Medicine) Cases of Cushing's Disease and Addison's Disease ca be shown Medical uses of adrenaline and dopamine
7	**Endocrine Pancreas**	• Name the different cells present in the Islets of Langerhans • Physiological stimulus for Insulin secretion • List the target cells of Insulin and the cells that do not require insulin action	• Describe the steps in biosynthesis of Insulin and the origin of the C-peptide (Connecting peptide) • **Diabetes Mellitus:**	• Compare and contrast Type I and Type II Diabetes Mellitus and their complications • Mention the clinical feature of Diabetes Mellitus	2 Hours	Glucose tolerance test and role of HbA1C (Biochemistry) Mechanism of action of insulin

		for glucose uptake • Mention the mechanism of action of Insulin on its receptor • List the important actions of insulin • List the various factors that regulate insulin secretion • Describe the features of hypersecretion of Insulin and Hypoglycemia • **Glucagon** • List the important actions of glucagon	• Discuss the Pathophysiology of Diabetes mellitus • List the hormones that raise blood sugar level	• List the features of hypoglycemia and the counter regulatory hormones • Diabetic Ketoacidosis	1 Hour	and oral hypoglycemic agents (pharmacology) Diabetic ketoacidosis and principles of treatment of Diabetes Mellitus (medicine)
8	**Other Endocrine Glands**	• **Pineal gland** • Mention the role of hypothalamus and melatonin on circadian rhythm • **Thymus** • **Local Hormones**			1 Hour	
9	**Atrial Natriuretic Peptide (ANP)**	• List the important actions of ANP				

Reproductive Physiology (Lectures + Tutorials 20 hours; Practicals + OSPE 5 hours; ECE: 3 hours)						
NO	**TOPIC**	**SPECIFIC LEARNING OBJECTIVE**			**TEACHING HOURS**	CLINICAL INTEGRATION
		MUST KNOW	**DESIRE TO KNOW**	**NICE TO KNOW**		
1	**Sex Determination**	• Differentiate between Genetic sex, Gonadal sex and phenotypic sex. • Describe the role of SRY gene and testis determining factor in development of gonads • Describe the role of testosterone and Mullerian inhibiting substance in the development of male and female internal genitalia	• Discuss the role of dihydrotestosterone in the development of external genitalia	• Describe the cause and features of abnormalities of sex differentiation • (Klinefelter's syndrome • Turner's syndrome • XXX superfemale • Female – Pseudo hermaphroiditisim • Male – Pseudo hermaphroiditisim – androgen resistance)	1 HOUR	

2	**Male Reproductive Physiology**	• Describe the functional anatomy of the male reproductive tract (Testis seminiferous tubules, Sertoli cells, Leydig cells, Blood Testis barrier, Epididymis, Vas deferens, Seminal vesicle, Prostate gland).
		• Describe the blood- testis barrier and its function
		• Discuss factors that regulate Spermatogenesis
		• Describe the structure of spermatozoa
		• Describe the source, mechanism of action and functions of testosterone and dihydrotestosterone
		• State the source and functions of inhibin
			• Outline the steps involved in spermatogenesis
			• State the composition of semen and recognize use of semen analysis as a test to evaluate infertility
			• Discuss about abnormalities of the male reproductive system:
			  • Hypogonadism
			  • Cryptorchidism
				•		

		• Discuss the hypothalamic and pituitary control on testicular function and Feed back control of testicular hormones on hypothalamus and pituitary • Describe the role of prostate, seminal vesicles in reproductive function • Describe the mechanisms that cause erection and ejaculation • State what is capacitation and discuss the changes that occur during capacitation	•	•		
3	**Puberty** **Menopause** **Pituitary Gonadotropins (FSH,LH) and Prolactin**	• Describe the mechanism of action functions and regulation of secretion of pituitary gonadotropins and prolactin • Explain the changes that occur during puberty and describe the mechanism of onset of puberty • Define menopause and describe the physiological changes during menopause	• Discuss causes of precocious and delayed puberty	• Discuss the problems associated with Menopause	1 Hour 1Hour	

4	**Female reproductive system**	• Describe the Functional anatomy of the female reproductive system • Outline the stages of Oogenesis • State differences between oogenesis and spermatogenesis • Describe the development of ovarian follicles **(**Stages of follicle development, ovulation, luteinisation, luteal regression) • Describe the control of follicular development, ovulation and luteinisation (role of FSH, estrogen and LH) • Describe the process of follicle attrition • List the hormones produced by the ovary • Illustrate the synergistic role of thecal and granulosa cells in steroidogenesis • Discuss the mechanism of action and functions of estrogen and progesterone • Describe the feedback regulation of ovarian function • Describe the physiological changes occurring in ovaries, uterus, cervix , vagina and breast during a menstrual cycle • Discuss and illustrate the hormonal changes during the menstrual cycle (changes in FSH, LH, estrogen and progesterone)	• Differences between oogenesis and spermatogenes is • Discuss the physiological basis of use of synthetic estrogens and progestins as oral contraceptives • Describe the mechanism of ovulation • State the tests for ovulation and their physiological basis • Common causes of anovulatory cycles (physiological, PCOD) • Protein hormones produced by the ovary and state their source and functions • Identify common causes of anovulatory cycles (physiological, PCOD)	Define: • Menorrhagia, • Dysmenorrhea, • Amenorrhea, and • Premenstrual syndrome • Discuss role of selective estrogen receptor modulators • List important causes of male and female infertility • Assisted Reproductive Techniques (IVF) • Abnormalities leading to infertility • Assisted Reproductive Technics (IVF) (Gynaecology)	3 Hours	• Investigatio n for male and female infertility •

7	**Physiology of Pregnancy**	• Outline the process of fertilization, implantation and placental formation • Discuss the importance of corpus luteum of pregnancy • Discuss the functions of placenta. • Discuss the secretion and function of hCG from the placenta. • Describe the role of hormonal and mechanical factors influencing labor • Describe the changes that occur in the various organ systems in the mother during pregnancy	• Physiological basis of immunological tests for pregnancy based on hCG • Parturition • Source and functions of relaxin • Describe the fetoplacental unit		1Hour	•
8	**Lactation**	• Describe the Role of estrogen and progesterone in breast development • Describe the mechanism that causes initiation of lactation after delivery • Describe the role of Prolactin and prolactin inhibitory factor (Dopamine) in lactation • Describe the Milk ejection reflex	• Role prolactin inhibitory factor (Dopamine) in lactation • Discuss the effect of lactation on menstrual cycle	• Gynacomastia • Composition of human milk • Prolactinomas • Role of bromocriptine in prevention of lactation	1Hour	•
9.	**Contraception**	• Classify contraceptive methods • Describe the physiological basis of the various methods of contraception	• Details of contraceptives devices, side effects	•	1 Hour	contraceptive devices and procedures (Gynaecology)

Excretory system (Lectures + Tutorials 25 hours; Practicals + OSPE 10 hours; ECE: 3 hours)						
NO	**TOPIC**	**SPECIFIC LEARNING OBJECTIVE**			**TEACHING HOURS**	**CLINICAL INTEGRATION**
		MUST KNOW	**DESIRE TO KNOW**	**NICE TO KNOW**		
1	**Functional Anatomy of Kidney** **Structure of Nephron**	• Describe the gross Anatomy of Kidney • Describe the structure of the cortical and Juxtamedullary nephrons • Describe the salient features of Renal circulation • Describe the structure of the juxtaglomerular apparatus.			1 Hour	Histology of Kidney (Anatomy)
2	**Glomerular filtration and renal blood flow**	• Describe the structure of glomerular capillary membrane and the factors affecting glomerular filtration • Measurement of GFR • **Renal Blood Flow** • Discuss the factors determining and regulating renal blood flow and the mechanisms of autoregulation of renal blood flow • Explain Tubulo-glomerular feed back • **Juxtaglomerular Apparatus** • Explain the structure of Juxtaglomerular Apparatus Discuss the role of Juxtaglomerular Apparatus in Autoregulation of GFR and RBF (TG Feedback) and the regulation of blood pressure via the Renin-AT-Aldosterone axis.	• Concept of Renal Clearance • Inulin Clearance – to measure GFR • PAH clearance to measure RBF • Creatinine Clearance to assess GFR	• Proteinuria/ Albuminuria / Hemoglobinuria	2 Hours	
3	**Proximal Convoluted tubules (PCT)**	• Describe the reabsorption of sodium, chloride and water in the proximal tubule Describe the functioning of the	• The concept of the transport maximum for glucose, renal threshold,			

		important sodium transporters in PCT – sodium-glucose, sodium-aminoacid co-transporters and sodium-hydrogen exchanger in the luminal border, sodium-potassium pump in the basolateral border. • Describe the mechanism of glomerulotubular balance • Discuss the renal handling of glucose, bicarbonate and amino acids in the PCT • Recognize the almost complete reabsorption of glucose, bicarbonate and amino acids in the PCT • Describe the role of Carbonic anhydrase, the sodium-hydrogen exchanger in luminal border, and the bicarbonate transporter in basolateral border in bicarbonate reabsorption in the PCT	types of glycosuria (diabetes mellitus, renal, alimentary) • Describe the action of parathormone on PCT		1 Hour	

4	**Loop of Henle**	• Distinguish between permeability characteristics of the two limbs of loop of Henle.
		• Describe the role of the Na/2Cl/K transporter and the sodium potassium pump in the thick ascending limb (TAL)
		• Describe the function of the Function of LOH in the creation of hyperosmolar medullary interstitium (MI) by the two mechanisms :
		  • Active transport of salt in TAL segment
		  • Counter current multiplication of the active transport
		• Describe the role of the vasa recta in maintaining the hyperosmolarity of the medullary interstitium by counter-current exchange.
			• Mechanism of action of Loop diuretics (Furosemide) as due to blockade of Na/2Cl/K transporter		1 Hour	

5	**Distal Convoluted tubules (DCT)**	• Describe the regulated reabsorption of sodium (aldosterone) via Epithelial sodium channels (ENaC) and Na/Cl symporter in luminal border • Describe the regulated secretion of potassium (aldosterone) via potassium channels in luminal border • Describe the generation of bicarbonate including factors affecting this. • Describe the role of the Phosphate and ammonia as buffers in the formation of urine • Describe the action of Atrial Natriuretic peptide	• Mechanism of diuretic action of thiazide and amiloride • Action of Atrial Natriuretic peptide. • 'Aldosterone escape'.	• Features of hyperaldosteronism and the occurrence of metabolic alkalosis	1 Hour	
6	**Collecting duct (CD)**	• Describe the role of ADH in regulated water absorption • Describe the role of the hyperosmolarity of the medullary interstitium, created by the Loop of Henle in producing a gradient for water absorption. • Describe the role of ADH in urea absorption, abetting the hyperosmolarity of MI. • D**e**scribe the role of aquaporins in water absorption.			1 Hour	
7	**Concentration of Urine**	• **Countercurrent Mechanism** • Countercurrent Multiplier • Countercurrent Exchanger • Role of Urea	• Bartter's Syndrome			
8	**Regulation of osmolarity, Na^+ and K^+ levels**	• Describe the role of osmoreceptors in sensing body fluid osmolarity. • Describe the mechanism of sensing thirst. • Describe the role of ADH, Aldosterone, Angiotensin II and ANP in sodium and water balance.	• List common causes and effects of hypo and hyper natremia • List common causes and effects of hypo and hyperkalemia	• Discuss the importance of the intracellular shifts of potassium • Discuss the use of insulin/glucose infusions to treat	1 Hour	

		• Discuss the effect of aldosterone in the renal handling of K^+ at DCT • Discuss the relationship between K^+ concentrations and the pH of blood.		hyperkalemia		
9	**Regulation of Acid base balance**	• Describe the different buffer systems in the body • Explain the respiratory regulation of acid base balance • Describe the role of the kidney in regulation of acid base balance	• Explain the concept of Anion gap • List common conditions that can lead to primary acid base disorders.	• Identify Primary acid base disturbances i.e. • Respiratory acidosis, • Respiratory alkalosis • Metabolic acidosis, • Metabolic alkalosis from Arterial blood gas and serum electrolyte values	1 Hour	
10	**Micturition**	• Describe the innervation of Bladder and reflex pathway of micturition. •	• Explain the use of a cystometrogram to diagnose urinary problems		1Hour	
11	**Renal Function Tests**	• List the abnormal constituents in urine • Recognize the normal urinary volume • Discuss the significance of the presence of albumin in urine • Discuss the role of serum creatinine in the measurement of renal function	• Concept of Anion gap	• Sigre Anderson Curve	1 Hour	

Respiratory system (Lectures + Tutorials 25 hours; Practicals + OSPE 20 hours; ECE: 6 hours)						
NO	**TOPIC**	**SPECIFIC LEARNING OBJECTIVE**			**TEACHING HOURS**	**CLINICAL INTEGRATION**
		MUST KNOW	**DESIRE TO KNOW**	**NICE TO KNOW**		
1	**Functional Anatomy**	• Functional Anatomy of the respiratory tract • Functions of nose and para-nasal sinuses • Conducting zone and respiratory zone • Pulmonary vasculature • Structure of alveolus & alveolo-capillary membrane	Examination of RS		1 Hour Practical 1 Hour	
2	**Muscles of Respiration**	• Muscles of Inspiration and Expiration • Accessory Muscles of respiration				
3	**Surface Tension Surfactant**	• Surface Tension in air liquid interface • Law of Laplace • Role of surfactant	• Respiratory Distress Syndrome			
4	**Mechanics of respiration** **Pulmonary Ventilation**	• State the normal respiratory rate and define inspiration & expiration • List the muscles of inspiration, expiration & accessory muscles of respiration • Describe the movements of chest wall and the changes in chest wall dimensions produced by respiratory muscles • Recognise the difference between quiet breathing and forceful breathing • Discuss the factors affecting airflow between the atmosphere and alveoli • State the recoil nature of Lungs and			3 Hours	

		chest wall • State the values of intra alveolar pressure, Intra pleural pressure • Discuss the changes in alveolar and intra pleural pressures during respiration • Identify the sites of air way resistance • Indicate changes in airway resistance with inspiration and expiration • Explain the action of autonomic nervous system on bronchial tone • List histamine as a bronchoconstrictor • Recognise that airway resistance is increased in obstructive lung diseases • Define lung compliance and relate it to clinical conditions in which it is altered • State clinical conditions in which work of breathing is increased				

5	**Lung Volumes and Capacities**	• Define the lung volumes and capacities; state the normal values and discuss their physiological variations
		• Explain the recording of the Spirogram with a diagram and recognize the volumes and capacities which cannot be measured by spirometry
		• Record the lung volumes and capacities of a normal subject using a spirometer
		• Discuss the physiological significance of the Residual volume & functional residual capacity
		• Describe the forced expiratory spirogram and describe FEV_1, FVC and the FEV_1/FVC ratio and its variations in obstructive and restrictive lung diseases.
		• Define peak expiratory flow & state its normal value
		• Record peak expiratory flow in a
			• List the common causes Pathology & clinical features of obstructive and restrictive lung diseases.
			  • Asthma
			  • COPD
			  • Emphysema
			  • Chronic bronchitis
			• State the physiological basis of tests to differentiate them.
			• Recognize the flow-volume curves
			• Methods of determining FRC and RV
				• Methods of determining FRC and RV
				• Artificial ventilation
					3 Hours Theory
					
					3 Hours Practical For Spirome -try	

		normal subject • Record FEV_1, FVC and calculate the FEV_1/FVC ratio in a normal subject • Interpret altered values of absolute lung volumes, peak expiratory flow and FEV_1/FVC ratio in restrictive and obstructive lung diseases • Define minute ventilation, anatomical dead space, physiological dead space & alveolar ventilation • Discuss the effect of changes in respiratory rate and tidal volume on alveolar ventilation	• Helium dilution method • Whole body plethysmography • Measurement of dead space			
6	**Alveolar Ventilation**	• Total ventilation = Tidal Volume x Respiratory Rate • Dead Space and Classification • Alveolar Ventilation • Factors affecting alveolar ventilation	• Measurement of Dead Space		1 Hour	
7	**Pulmonary Circulation**	• State the normal rate of pulmonary blood flow & normal range of pulmonary blood pressures • Discuss the special features of pulmonary circulation, pulmonary veins, pulmonary vascular resistance, its response to hypoxia			1 Hour	
8	**Ventilation perfusion Ratio (V/Q Ratio)**	• Explain the regional differences in perfusion, ventilation & V/Q ratio in the lungs • State normal values of V/Q ratio and recognize that physiological dead space is associated with high V/Q and 'physiological shunt' is associated with low V/Q.	• Type I respiratory failure	• State the physiological mechanisms operating to keep the lungs dry • Pulmonary hypertension • Pulmonary embolism • Cor-pulmonale	1 Hour	
9	**Gas Exchange**	• Discuss the factors that affect rate of gas exchange at lung & tissue level, with application to clinical conditions	• Define Type I respiratory failure and state the common causes			

		• State Fick's law of diffusion • Discuss normal composition of atmospheric, tracheal and alveolar air and recognize the conditions which can affect it • Discuss the normal partial pressures of gases in blood entering and leaving lung • Explain oxygen uptake and carbon-dioxide elimination by lungs & tissues and state the normal rates of the same • Define respiratory exchange ratio and state its normal values • State normal time taken for gas equilibration & its application in exercise • State the physiological causes for normal alveolar-arterial oxygen difference • Explain the dependence of carbon dioxide elimination on ventilation • Define physiological shunt	• Explain Type I respiratory failure due to unequal V/Q distribution even when total ventilation and perfusion may be normal • State the Alveolar gas equation and discuss its application • Recognize that arterial PCO_2 is equal to alveolar PCO_2 and that arterial PCO_2 can be used in the alveolar gas equation • State the causes for abnormal Alveolar – arterial oxygen difference • Distinguish between intrapulmonary and extrapulmonary right to left shunts.		1 Hour	
10	**Transport of Oxygen**	• Explain the forms of oxygen transport in blood • Discuss hemoglobin affinity for oxygen • Explain & illustrate oxygen-hemoglobin dissociation curve and discuss the factors affecting it and the physiological advantages of the curve • Explain Bohr effect • Discuss oxygen carrying capacity of blood • Differentiate between oxygen content of blood & % oxygen saturation of hemoglobin • Define hypoxemia and hypoxia; explain the physiological basis of	• State the physiological basis of oxygen therapy as treatment for the different types of hypoxias	• State what pulse oximetry measures	2 Hours	

		types of hypoxia with examples • Define cyanosis and differentiate between conditions in which it occurs and may not occur				
11	**Transport of Carbon dioxide**	• Explain the forms of carbon dioxide transport in blood • Explain the role of chloride shift and Haldane effect			1 Hour	
12	**Regulation of Respiration**	• Express the concept of the sensors, central controller in brain & effectors in the respiratory control system • Describe the location and functions of the respiratory centres in brain; describe the current explanation for the basic rhythm of respiration • Describe the effects of neural inputs on respiration in terms of the voluntary cortical control, motor cortical input, limbic input, peripheral afferent inputs (Hering breuer reflexes, J receptor input, proprioceptor input, and other peripheral inputs) • Express the aim of chemical control of respiration; explain the role of peripheral and central chemoreceptors; explain the feedback control of ventilation to regulate gas exchange & maintain normal levels of arterial blood gases and pH • Discuss and compare the influence of arterial carbon dioxide and oxygen on ventilation in health and in disease • Describe Cheyne-stokes breathing, state its causes, explain the physiological and pathophysiological mechanisms that produce it; state the abnormality in Biot's breathing • Demonstrate the effect of apnoea &	• State the normal values of arterial blood gases (ABG) and interpret altered values • Define hypercapnoea and hypocapnoea • State the causes of asphysxia	• State the causes of respiratory acidosis and alkalosis • Define Type II respiratory failure and mention its causes	3Hours 3 hours practicals for expts on stethogra-phy	

		hyperventilation on respiration; demonstrate the effect of breathing through a tube and the effect of speech & cough on respiration				
13	**Physiological adaptations in special environments (High Altitude, Deep Sea Diving and Gravity)**	• State the physiological effects of zero gravity • State the physiological basis of Caisson's disease & Nitrogen narcosis • State the physiological adaptations occurring at high altitude Physiological effects of zero gravity • Aviation Physiology			1 Hour	
14	**Exercise**	• Describe the effects of exercise on the respiratory system and explain the physiological basis of these effects; explain the physiological need for these changes • Define VO_2 max and oxygen debt			1 Hour	
15	**Pulmonary Function Tests**	• Spirometry • Arterial Blood Gas Analysis • Peak Flow Meter • Pulseoxymetry			1 Hour	
16	**Miscellaneous**	• List the Non-Respiratory functions of lung • State the physiological mechanism of cough, sneeze and gag reflexes			1 Hour	

17	**Clinical examination of respiratory system**	• Demonstrate the methods of Clinical examination of the respiratory system
		• Recognize normal Clinical findings of respiratory system examination
		• State the abnormal findings that may be present in a patient and list the common clinical conditions in which these abnormalities occur and the physiological explanations for these abnormalities if any
			• Pathology & clinical features of
			  • Pleural effusion
			  • Pneumothorax
			  • Pneumonia, consolidation
			  • Fibrosis
			  • Collapse
			  • Bronchiectasis
					3 Hours Practical	

Cardiovascular system (Lectures + Tutorials 35 hours; Practicals + OSPE 20 hours; ECE: 6 hours)						
NO	**TOPIC**	**SPECIFIC LEARNING OBJECTIVE**			**TEACHING HOURS**	**CLINICAL INTEGRATION**
		MUST KNOW	**DESIRE TO KNOW**	**NICE TO KNOW**		
1	**Functional anatomy of heart**	• Describe the functional anatomy of the heart, with respect to its chambers, valves, input and output vessels, AV ring and electrical discontinuity, Conducting system, Coronary supply	Examination of CVS		1 Hour Practical	
2	**Conducting system of Heart SA Node**	• Describe the following: • Contour of SA node action potential with a diagram, depicting the various phases (4, 0 and 3) • Prepotential (phase 4 depolarization) • Currents responsible for generation of SA node action potential: The funny current (I_f), T-type calcium current (ICa_T), L-type calcium current (ICa_L) •	• Intrinsic rate of the SA node and influence of autonomic nervous system, hormones and temperature. • Sinus arrhythmia, sinus bradycardia, sinus tachycardia • Record respiration with a stethograph or respiration belt transducer, as well as ECG or pulse simultaneously, to demonstrate respiratory sinus arrhythmia.			
3	**Atrial Cell**	• Recognize that AP in atrial cell is similar to ventricular cell (fast AP)	•			
4	**Ventricular Cell**	• Describe the contour of the ventricular action potential with the aid of a diagramDescribe the ionic currents responsible for phases 0,1,2,3,4 of the ventricular action potential • State the differences between the SA node action potential (slow AP) and the	• Be able to describe the mechanisms by which calcium is extruded from cytoplasm to terminate systole – the role of the Plasma membrane calcium ATPase and sodium-	• Be able to correlate Starling's law with sarcomere length and actin-myosin interaction • Identify the relationship between		

		ventricular cell action potential (fast AP). • Describe how the action potential leads to an increase in cytosolic calcium concentration • Describe excitation-contraction coupling • State the basic concepts of the sliding filament theory of contraction	calcium exchanger (NCX)	heart failure and sarcomere length		
5	**Cells of conducting pathway**		• State the type of: • AV node AP - similar to SA nodal cell (slow AP) • His Bundle cell: fast AP • Purkinje fibres: fast AP			
6	**Properties of Cardiac Muscle**	• Automaticity • Excitability • Conductivity • Contractility				
7	**Cardiac Cycle**	• Describe with a diagram, the chronological relationship of the following events shown on the same time axis: • ECG • Valvular events • Heart sounds • Pressure curves: Left ventricular pressure, Atrial pressure and aortic pressure • Ventricular Volume curve:	• Concept of Murmurs • Timing of Murmurs • State the timing of murmurs in various valvular and congenital heart defects • Cardiac Catheterization			
8	**Stroke Volume**	• Discuss the determinants of stroke volume	• Recognize echocardiographiy as a method of measuring stroke volume			
9	**ECG**	• Describe the electrocardiogram as a surface recording of electrical changes occurring on the external surface of the heart during the passage of an action	• List the ECG changes in the following conditions: • Myocardial ischemia • Myocardial infarction	• Heart Block • Ischemia • Infarction changes	1Hour Theory	With medicine for reading normal and abnormal ECGs

		potential. • Describe the 12 Leads in which ECG is recorded. • State the rationale of recording from multiple leads. • Identify the lead which is commonly used to monitor patients continuously. • Describe the P, QRS, T and U waves of an ECG in lead II configuration and describe the electrical events responsible for these waves • Describe PR and QT intervals and state what they represent • Describe the significance of ST segment being on the isoelectric line in a normal ECG • Record an ECG in a human subject in all 12 leads • Calculate rate from a normal ECG tracing • Identify if every QRS complex is preceded by a P wave and if every P wave is followed by a QRS complex • State in what conditions the above will not happen	• Hyperkalemia • Ventricular tachycardia • State the causes for PR prolongation • Describe the types of Heart block as represented by ECG changes • Arrhythmias • Vector cardiogram • Calculation of axis • His bundle electrogram		1Hour ECG recordin g to be shown	
10	**Properties of cardiac muscle:** **Automaticity**	• Describe the function of the sinoatrial node as the pace-maker of the heart • Describe the determinants of heart rate and the neural and chemical regulation of heart rate • Describe the ionic currents responsible for rhythm-generation in the SA node	• Understand that there is redundancy in pace-maker function – if the sinus node fails, there are alternate sites of rhythm generation • Arrhythmias		1 Hour	
	Excitability and Refractoriness	• Define refractory period, describe its relation to the duration of the ventricular action potential, and state its physiological significance.	• Describe refractory period in terms of properties of voltage-gated sodium channels • State factors which cause			

			prolongation of action potential duration • Define Long QT syndrome			
	Conductivity	• Describe the normal mode of conduction of the cardiac impulse	• Alternate conducting pathways • Define the causes of arrhythmias in terms of abnormal site of rhythm-generation or re-entry			
	Contractility	• Describe the determinants of force of contraction of the ventricle in terms of o Preload (Starling's law) o Afterload o Inotropic status (contractility) o Frequency (or heart rate), (Bowditch phenomenon or Force-frequency relation) • Discuss the clinically measurable parameters reflecting preload, afterload and force of contraction of the heart • Describe Starling curves or ventricular function curves	• Discuss Ejection fraction (EF) as a measure of cardiac contractility (inotropic status). • State the different modes of and indications for Cardiac catheterization • State how echocardiography may be used as a non-invasive means to assess cardiac function			
11	**Cardiac Output**	• Definition of Stroke Volume, Cardiac Index, EDV, ESV, and EF • Discuss the determinants of cardiac output • Describe the regulation of cardiac output • Discuss high output and low output states	• Methods of Measuring Cardiac Output	• Discuss high output and low output states	2 Hours	
12	**Heart Rate**	• Innervation of Heart – Parasympathetic and Sympathetic • Normal Values • Regulation of Heart Rate • Factors affecting Heart Rate			1 Hour	
13	**Vascular Physiology**	• Describe the function of Aorta and large Arteries as elastic, windkessel vessels • Describe what would happen to pulse	• **Discuss the role of capillaries** as exchange vessels	• State what would happen to pulse volume (as assessed		

		pressure in case of thickening and loss of elasticity of aorta • Describe the role of arterioles as resistance vessels • Describe the term Total Peripheral resistance (TPR) • Discuss the determinants of TPR and the relationship of TPR to blood pressure and cardiac output. • Discuss the role of arteriolar resistance as a determinant of blood flow to a specific organ • Discuss the determinants of arteriolar resistance in terms of Poiseulle's equation • Identify that the arteriolar diameter is the major determinant of arteriolar resistance • Discuss the global and local factors affecting arteriolar diameter and therefore the TPR, blood pressure and blood flow – vasodilator and vasoconstrictor mechanisms • Discuss the physiological role of endothelium-derived relaxing factor (EDRF) or Nitric oxide (NO)	• Describe the Starling's forces determining fluid movement across the capillary membrane • **Describe the function of Veins** as capacitance vessels • **Define the term Venous return** (VR) and discuss its role as preload • Describe the determinants of VR • Discuss the significance of assessing jugular venous pulse • Discuss the interactions between Right atrial pressure, VR and Cardiac output (CO)	by taking the radial pulse) in case of thickened arteries • Discuss the physiological/pathophysiological role of the following vasoactive substances: Histamine, bradykinin, serotonin, thromboxane A2, prostacyclin, Endothelin • Describe Venous return curves • Describe the interaction of Venous return and Cardiac output curves • Discuss the clinical significance of monitoring of CVP	2 Hours	
14	**Blood Pressure**	• Define the following terms: • Mean arterial blood pressure, Systolic pressure, Diastolic pressure, pulse pressure • Describe the determinants of blood pressure • Discuss the short-term (neural and hormonal) and long term (renal) mechanisms regulating blood pressure (with special reference to shock and exercise). • Demonstrate the method of	• Hypertension • Hypotension		1 Hour Theory	

		measurement of blood pressure using a sphygmomanometer. • Describe the principle of measuring blood pressure by sphygmomanometry • Discuss other methods of measuring blood pressureby sphygmomanometer			1 Hour Practical	
15	**Cardiovascular autonomic reflexes**	• Describe the physiological role of the following reflexes, their receptors, specific stimuli, afferent and efferent neural pathways, and the responses. • Baroreceptor reflexes • Chemoreceptor reflexes • Vasovagal syncope • Cushing's reflex • Bainbridge reflex • Bezold Jarisch reflex	• Define Diving reflex		1 Hour	
16	**Effects of exercise on cardiovascular system**	• Discuss the effects of exercise on the cardiovascular system • Demonstrate the effects of mild to moderate and high intensity exercise on the blood pressure and heart rate in a normal subject			1 Hour Theory 1 Hour Practical	
17	**Regional circulations**	• **Features and regulation of the following circulations:** • Coronary • Cerebral • Renal circulation - Auto-regulatory mechanisms (myogenic factors and Tubuloglomerular feedback) • Pulmonary (its pressures, hypoxic vasoconstriction) • Splanchnic • Cutaneous circulation and temperature regulation • Skeletal muscle • Recognize the importance of	• Discuss the term Coronary artery disease Define the following terms: Transient Ischemic attacks (TIA), Stroke, Cerebrovascular accidents (CVA) • List the effects of gravity and acceleration on CVS • Discuss the physiology of **Fetal** circulation before and after birth		3 Hours	

		sympathetic regulation versus local metabolic factors in the regulation of the regional circulations mentioned above.				
18	**Hypertension**	• State the normal ranges for systolic and diastolic blood pressures in the various age groups • Define hypertension	• Discuss the risk factors for essential hypertension and causes of secondary hypertension		1 Hour	
19	**Hypotension (Shock)**	• Define the term 'Shock' or Cardiovascular shock • State the different types of shock • Discuss the pathophysiology of the following types of shock: Hypovolemic, cardiogenic, Distributive (septic, anaphylactic, neurogenic) Obstructive	Describe the term Vasovagal syncope			
20	**Heart Failure**	• Define the term cardiac failure or heart failure. • State the clinical features of left heart failure and right heart failure. • Define the term congestive cardiac failure	• State some causes of heart failure • Discuss the physiological basis of treatment of heart failure		1 Hour	
21	**Myocardial infarction or heart attack**	• Define the following terms: • Angina • Ischemia • Myocardial infarction or heart attack • Discuss the major ECG changes in: • Myocardial ischemia • Myocardial infarction				
22	**Valvular diseases**		• State the causes for stenosis and regurgitation of the valves • State the murmurs associated with the various valvular defects			
23	**Congenital heart diseases**		• State the hemodynamic abnormalities and murmurs in ASD, VSD, PDA			

Central nervous system (Lectures + Tutorials 45 hours; Practicals + OSPE 22 hours; ECE: 6 hours)						
NO	**TOPIC**	**SPECIFIC LEARNING OBJECTIVE**			**TEACHING HOURS**	**CLINICAL INTEGRATION**
		MUST KNOW	**DESIRE TO KNOW**	**NICE TO KNOW**		
1	**Organization of the nervous system**	CNS PNS o Somatic NS o Autonomic NS o Enteric NS			1 Hour	
2	**Neural Tissue**	• State the cell types present in the nervous system • Describe the morphology of different types of neurons and neuroglia • Describe the process of myelination and its significance • Differentiate between white matter and grey matter. • Define the terms 'nuclei' and 'ganglia'.			1Hour	
3	**Nerve Fibres**	• Define the term 'Peripheral nerve'. • State the types of fibres in a mixed peripheral nerve. • Describe Ehrlanger & Gasser's classification of peripheral nerve fibres • Describe nerve injury, degeneration and regeneration of injured fibres	• Numerical classification of sensory fibres • Mechanism of axoplasmic transport • Wallerian degeneration		1 Hour	With medicine or neurology to see cases of peripheral neuropathy With anaesthesia to study mechanisms of local or regional aneasthesia
4	**Electrical properties of the nerve cell membrane**	• Describe the ionic basis of Resting membrane potential of a nerve cell. • Describe the term electrotonic potentials with reference to: • 'receptor or generator potential' in a sensory receptor	• 'excitatory or inhibitory post-synaptic potentials (EPSP and IPSP)' in a post-synaptic neuron • 'end-plate potential' at the neuromuscular	• Strength-duration curve - Rheobase voltage, chronaxie & utilization time • Define the concept of depolarisation	1 Hour	

		• 'excitatory or inhibitory post-synaptic potentials (EPSP and IPSP)' in a post-synaptic neuron • 'end-plate potential' at the neuromuscular junction • Define the term 'Action potential' and describe the currents responsible for the different phases of the action potential in the neuron. • Describe the process of transmission of action potential in unmyelinated and myelinated neurons • Describe the phenomenon of saltatory conduction in a myelinated neuron. • List the factors affecting conduction velocity in a nerve.	junction	block in terms of the properties of voltage-gated sodium channels. • Define the mechanism of action of local anaesthetics.		
5	**Synapses**	Define the terms electrical & chemical synapse Describe the morphological features of a chemical synapse – pre and post synaptic neurons List the morphological types of chemical synapse – axosomatic, axodendritic and axoaxonic Describe the process of synaptic transmission. List the events in the pre-synaptic neuron, culminating in release of neurotransmitter. Describe the events in the post-synaptic neuron – Excitatory and inhibitory post-synaptic potentials, Summation (spatial and temporal) of synaptic inputs at the axon hillock, formation of action potential.	• Define the following properties of synapse: • One-way conduction • Synaptic delay • Convergence and Divergence of synapses • Spatial summation • Temporal summation • Define the term synaptic plasticity • Describe the differences between Pre-synaptic and post-synaptic inhibition. • Define the term Pre-synaptic facilitation	• Define synaptic fatigue • Define the following synaptic phenomena Occlusion & subliminal fringe effects	2 Hours	
6	**Neurotransmitters**	• List the important small molecule neurotransmitters in the CNS and their receptors: • Glutamate and its ionotropic receptors:	• State whether the action of each of the above neurotransmitters on the various receptors is excitatory or inhibitory.	• Glutamate-induced excitotoxicity Organic brain syndromes – Schizophrenia,	1 Hour	

		NMDA, and non-NMDA • GABA • Glycine • Dopamine • Serotonin or 5-HT • Acetylcholine • Noradrenalin	• State the major excitatory neurotransmitter in the CNS • State the inhibitory neurotransmitters of the CNS. • State the mechanism of inhibition. • Denervation hypersensitivity • Criteria for a substance to be called a neurotransmitter	Depression (Psychiatry)		
7	**Introduction to CNS**	• Anatomical parts of CNS • Functional divisions				
8	**Sensations**	• Classify the types of sensations (sensory modalities	• Describe the common attributes of sensory information – modality, location, intensity and duration		1 Hour	
9	**Sensory receptors**	• Differentiate between usage of the term 'Receptors' i.e., sensory receptors versus neurotransmitter or ligand receptors. • List the sensory receptor for each modality of sensation • Touch receptors • Receptors for proprioception • Pain and temperature receptors •	• Define rapidly adapting and slowly adapting receptors • Describe the mechanism of sensory transduction taking a particular receptor as example (e.g., pacinian corpuscle, hair cells of inner ear, rods and cones, muscle spindle etc)		1 Hour	

9	**Ascending sensory pathways** **Pathway for fine touch (Posterior Column)** **Pathway for proprioception** **(Dorsal and Ventral Spinocerebellar Tract)**	**Ascending sensory pathways** • Sensory Cortex – Primary sensory area SI and SII • Sensory Homenculus • Cortical Sensations • Cortical Plasticity **Three neuron pathway of sensory systems** • I order neurons, dorsal root ganglia, Fasciculi gracilis and cuneatus in posterior column and termination in medulla • II order neurons (cross over) : Medial lemniscus from medulla to contralateral thalamus • III order neurons: Thalamocortical neurons • Cortical termination of pathway: Post-central gyrus. • Sensory Cortex-Primary sensory area SI & SII **Important receptors for Proprioception (other than touch and pressure receptors):** • Muscle spindle (muscle length detectors) • Golgi tendon organ • Joint receptors (Pacinian corpuscles) • Fate of proprioceptive input: • Posterior column pathway – same as fine touch • Spinocerebellar tracts – dorsal and ventral; Clarke‟s column • Spinal reflex arcs – stretch and	• Medial to lateral arrangement of fibres in posterior column • Lateral to medial arrangement of fibres in spinothalamic tract	• State the mechanism proposed by V.S.Ramachandran to explain the phantom limb phenomenon.	3 Hours Theory 1Practical session (3 hrs for examination of the sensory system)	

	Pathway for crude touch (Anterior Spinothalamic tract) **Pain and Temperature (Lateral Spinothalamic Tract)** **Sensations from face**	inverse stretch reflex arcs **Receptors for crude touch, pain and temperature : Mechanoreceptors, Nociceptors and Thermoreceptors** **Major pain pathway:** • I order neurons – end in spinal cord; Lissauer's tract; substantia gelatinosa • Fast pain through Aδ fibres and slow pain through C fibres • II order neurons cross over – forming lateral spinothalamic tract • III order neurons – thalamocortical, end in Post-central gyrus. • Pathway for sensations from face				
	Physiology of Pain	Briefly describe receptors for pain. • Describe the pathway for transmission of pain from receptors to the cortex. • Define the following terms: Substantia gelatinosa, Lissauer's tract, fast pain, slow pain. • State the type of peripheral nerve fibres carrying fast pain and slow pain respectively. • Describe the following phenomena: • Referred pain • Peripheral sensitization of pain • Central sensitization of pain – (wind-up) – role of glutamate and NMDA receptors • Dissociated anaesthesia • Phantom limb pain • Describe descending pain control pathways: from Periaqueductal grey, Locus ceruleus and Nucleus Raphae magnus	• Describe the gate control theory of pain • Discuss the principle of using pain balms and Acupuncture for pain relief. • List the endogenous opioids and the types of Opiate receptors. • Describe the role of endogenous opioids in pain transmission	• List a few opiates used to treat pain.	2 Hours	

10	**Motor system**	• Describe the features of organization of the motor system. • Define UMN & LMN	• Arrangement of LMNs in the anterior horn • 'Motor homunculus'			

	Descending Motor Tracts	• List the descending tracts involved in motor control.
		• Describe origin, course, termination and functional role of the Pyramidal tracts. State why the pyramidal tracts are called so.
		• Describe the role of corticobulbar tracts.
		• List the extrapyramidal descending tracts.
		• State the origin, termination and physiological role of the following extrapyramidal tracts:
		  • Rubrospinal
		  • Pontine reticulospinal
		  • Medullary reticulospinal
		  • Lateral vestibulospinal
		• Describe the influence of the extrapyramidal tracts on spinal motor neurons & spinal reflexes
		• Describe the effects of lesion of the pyramidal and extrapyramidal tracts respectively on spinal motor neurons, spinal reflexes & muscle tone
			• Describe the physiological basis and the clinical significance of
			  • Decerebrate posture
			  • Decorticate rigidity
					3 Hours Theory
					
					1 Practical session (3 hrs for examination of the motor system)	

11	**UMN and LMN Lesions**	• Describe the features and Physiological basis of Upper motor neuron & lower motor neuron lesion.
		• Describe the features of:
		  • Hemisection of spinal cord at a given level (e.g. T8, L3 etc)
		  • Brown Sequard syndrome
		  • Complete transaction of spinal cord at a given level.
			• Define the following terms: Hemiplegia, quadriplegia, paraplegia
			• Hemiparesis, quadriparesis & paraparesis
				• Definition of terminology:
				o Transient ischemic attacks
				o Stroke
				o Cerebrovascular accidents
				• Neurogenic bladders
						Clinical cases can be shown

12	**Reflexes**	• Define the term 'reflex'.
		• Describe the components of a reflex arc with a diagram.
		• Classify reflexes:
		  • based on the location of receptors (deep and superficial)
		  • Based on number of synapses in the reflex arc (mono, di or polysynaptic)
		• Describe in detail, the stretch reflex and its physiological significance.
		• List the other terms which are commonly used to refer to the stretch reflex.
		• Identify that the clinically tested deep reflexes (or tendon jerks) are stretch reflexes.
		• Differentiate between alpha and gamma motor neurons.
		• Name the receptor for the stretch reflex and describe its basic structure with a diagram. State the functional role of gamma motor neurons.
		• State the effects of supraspinal influences on the stretch reflex
		• Describe the effects of UMN lesions.
		• Describe the effects of LMN lesions.
		• Describe the inverse stretch reflex arc. State the stimulus and response for the inverse stretch reflex.
		• Describe the functional role of Golgi tendon organ.
		• Describe the physiological basis of "Clasp-knife" rigidity
		• Describe the flexion withdrawal reflex. State its functional role?
		• Describe the afferent, efferent pathways and the centre of integration for the
			• Alpha-gamma co-activation
			• Physiological basis for Jendrassik's maneuver
			• Crossed extensor reflex
			• Importance of using a painless stimulus to elicit plantar response
			• Central excitatory state & irradiation of stimulus in spinal cord
			• Mass reflex & its use in spinal cord injury patients
			
			o Postural reflexes other than stretch reflex and crossed extensor reflex:
			o Brain stem reflexes:
			Righting reflexes (Midbrain**)**
			oLabyrinthine righting
			oNeck righting
			oBody on head righting
			oBody on body righting
			
			• Vestibular or Labyrinthine reflexes (Medulla)
			o Vestibulospinal or tonic labyrinthine reflex (TLR)
			Vestibulocollic reflex
			Vestibuloocular reflex (VOR)
			oVestibular placing reaction
			
			• Tonic neck reflexes (upper cervical cord)
				Tonic neck reflexes (upper cervical cord)
				• Symmetrical tonic neck reflex (STNR)
				• Other Primitive reflexes:
				- Sucking reflex
				- Rooting reflex
				- Grasp reflex - 6 months
				- Plantar – Babinski – 1 year
				Should not remain active beyond 6-12 months of life.
				
				If they do, and they are not integrated, they can interfere with voluntary control of specific movements and result in immature patterns of movement (eg. Cerebral palsy)
				• The primitive reflexes may re-emerge in an adult after brain injury
					2 Hours Theory
					
					1 Practical session (3 hrs for examination of reflexes)
						Pediatrics
						
						Neurology
						
						Medicine
						
						PMR
						
						Study of patients with postural abnormalities as a result of primitive reflexes being expressed.

		following superficial reflexes: Corneal, conjunctival, Abdominal, cremasteric • State the rationale in assessing superficial reflexes, while examining the nervous system. • Describe flexor and extensor plantar reflexes. • Recognize the importance of using a painless stimulus to elicit plantar response • Describe Babinski's sign and state its clinical significance. • List the physiological conditions, where plantar response is extensor. • Demonstrate how to elicit the clinically significant superficial and deep reflexes in normal subject.				
13	**Cerebellum**	• Describe the structure of cerebellum, its somatotopic organization, deep cerebellar nuclei, afferent pathways, internal connections, efferent pathways. • Name the afferent and efferent fibres of cerebellum • Describe the functions of cerebellum.	• Describe the features of cerebellar lesions • Describe cerebellar function tests.	• Cerebellar lesions	3 Hours 1 Hour Practical	Anatomy: Structure, connections and blood supply to cerebellum Medicine Neurology

14	**Basal ganglia**	• Define the term basal ganglia.
		• List the nuclei forming the basal ganglia.
		• List the following:
		  ◦ Input nuclei – which receive afferents from cortex
		  ◦ Output nuclei – which send output to thalamus and spinal cord
		• Describe the internal connections between input and output nuclei – give details of the direct pathway and indirect pathway.
			• Describe the features of Parkinson's disease.
			• Describe the pathophysiological basis of Parkinson's disease.
					2Hours	

		• Describe the origin and termination of the nigro-striatal pathway. State the neurotransmitter in this pathway. • Describe the physiological role and clinical significance of the nigrostriatal pathway.				
15	**Reticular formation**	• Describe the organization of the reticular formation and its physiological role. • Describe the ascending Reticular Activation System	• List the neurotransmitters of various nuclei of RF. • Give an outline of afferent & efferent connections		1 Hour	
16	**Thalamus**	• List the groups of thalamic nuclei • Give an outline of connections of thalamus • List the functions of thalamus.	• List the important features of thalamic syndrome		1 Hour	
17	**Hypothalamus**	• List the major regions and functions of hypothalamus. • Connections of hypothalamus • Describe the functions of the hypothalamus	Hypothalamic Obesity		1 Hour	
18	**Limbic system**	• State the components of Limbic system • Describe the physiological role of the limbic system Recognize the importance of Papez's contributions • Recognize the central role of amygdala.	• New concept of the Limbic System – Emphasis on amygdala. • Kluverbucy Syndrome • Shamrage	• Recognize differences between the new concept of Limbic circuit and Papez's circuit. • Identify nuclei involved in addiction	1 Hour	

19	**Cortex**	• Identify the major somatic and special sensory, motor & association areas in the cortex.
		• Recognize the somatotopy of the motor and somatic sensory areas (homunculi)
		• Recognize the phenomena of hemispheric specialization (dominance), handedness.
			Define the role of corpus callosum – inter-hemispheric transfer of information	• Sperry's Split Brain Experiments
				• Dyslexia
				• Prefrontral Lobotomy
				• Define the following terms:
				  • hemi-neglect syndrome
				  • cortical
					1 Hour	

				blindness • synaesthesia		
20	**EEG**	• State the physiological basis of EEG, types of EEG waves, • Uses of EEG			1 Hour	
21	**Sleep**	• Define the various stages of a sleep cycle. • Distinguish between NREM and REM sleep.	Sleep Disorders • Hypersomnolence • Obstructive sleep apnea • Insomnia	• Theories of sleep – Wakw Cycle	1 Hour	
22	**Language & speech**	• Define the role of Wernicke's & Broca's areas in language & speech • Define aphasia and state the site of lesion in motor and sensory aphasia			1 Hour	
23	**Learning and memory**	• Describe the classification of learning and memory • Describe the following phenomena of implicit or Non-declarative learning: o Non-associative – Habituation Sensitization o Associative – Classical conditioning Operant conditioning • Define Explicit or declarative memory. • Define the term synaptic plasticity • Describe the synaptic phenomenon associated with Short term memory. • Describe the phenomenon leading to long-term memory. • Describe the role of hippocampus in memory formation. • Describe the role of cerebellum in motor learning.	• List Alzheimer's disease and Korsakoff's psychosis as disorders of learning and memory		1 Hour	
24	**CSF**	• Describe the composition, Secretion, Circulation, Drainage and Functions	• Papilledema • Hydrocephalus			

		• Define Blood Brain Barrier • Define Blood CSF barrier			1 Hour	
25	**Cranial Nerves**	•	• Examine the integrity of the cranial nerves I-XII in a normal subject		2 Practical session (6 hrs)	

Special Senses (Lectures + Tutorials 20 hours; Practicals + OSPE 6 hours; ECE: 3 hours)						
NO	**TOPIC**	**SPECIFIC LEARNING OBJECTIVE**			**TEACHING HOURS**	**CLINICAL INTEGRATION**
		MUST KNOW	**DESIRE TO KNOW**	**NICE TO KNOW**		
	EYE					
1	**Functional anatomy**	• List the structures within the eyeball • Name the extraocular muscles and describe their functions • Describe the functions of Iris, Ciliary body, Intra-ocular muscles, Lens, Aqueous humor, Vitreous body and Optic nerve • Describe the formation and drainage of aqueous humour	• State the normal range of intraocular pressure		1 Hour	
2	**Optics of eye**	• List the structures through which light passes before falling on the retina • State the important refracting surfaces of the eye and the extent of contribution of each to image formation. • State that the image formed on the retina is inverted and diminished in size. • Describe the role of crystalline lens in focusing the light rays and describe the changes that happen while focusing a near object – accommodation reflex • List the common refractive errors – Myopia, hypermetropia, presbyopia and astigmatism • Describe the cause for the refractive errors and explain their correction	• Concept of the „reduced eye“ • Accommodative power of lens and near point of vision • "Reduced eye"		1 Hour	Ophthalmology: To observe testing of refraction To observe the use of tonometer To get familiar with case charts of refractive errors To observe examination of fundus using Ophthalmoscope Observe perimetry
3	**Retina**	• List the retinal cells contributing to the visual pathway. (photoreceptors,	• Cone & rod density distribution in retina			

		bipolar cells and ganglion cells) • Describe optic disc, macula lutea and fovea as important structural features in the retina • Classify photoreceptors – Rods and cones • List major structural and functional differences between rods and cones • Demonstrate visual acuity on a subject using Snellen's chart	• Convergence of synapses		1 Hour	Ophthalmology: To observe testing of visual acuity
4	**Photo transduction**	• Visual pigments • "Dark current" – at rest in the photoreceptors • Hyperpolarizing receptor potential in rods & cones in response to light • Transmission of Action potential to the optic nerve.	• Decomposition of rhodopsin - biochemical steps involved Neurotransmitters involved • Wavelengths of light best absorbed by pigments		1 Hour	
5	**Light & Dark adaptation**	• Describe the changes that happen during dark and light adaptation	• Nyctalopia			
6	**Colour vision**	• Name the types of photoreceptors responsible for colour vision • Classify cones based on their spectral sensitivity • List the types of colour blindness • Describe theories of colour vision • Demonstrate the use of Ishihara's chart to check for colour blindness	• Color constancy and Purkinje shift • Theories of color vision		1 Hour	
7	**Optic Pathway**	• Draw and describe the optic pathway from the photoreceptors to the visual cortex • Describe the visual field defects produced by lesions at various levels of the pathway	• List the conditions producing pupillary constriction & pupillary dilatation		1 Hour	
8	**Pupillary Reflexes**	• Describe the pupillary light reflex pathway • Differentiate between direct and consensual pupillary light reflexes	• Describe the accommodation reflex pathway • List the features of	• Conditions producing pupillary constriction & pupillary dilatation	1 Hour	

		• Demonstrate direct and consensual light reflexes on a subject provided	Horner's syndrome Explain Argyll-Robertson pupil			
9	**Eye Movements**	• List the extraocular muscles and describe their actions • Name the cranial nerves innervating the extraocular muscles • List the types of eye movements (saccadic, smooth pursuit, vergences	• Saccadic & smooth pursuit movements • Opto-kinetic reflexes		1 Hour	
	EAR					
1	**Functional anatomy of the ear**	• List different parts of the ear. • Mention functions of outer ear • Describe the role of middle ear in impedance matching • List structures within the inner ear and specify their functions • Describe the importance of attenuation reflex			1 Hour	
2	**Inner Ear Function of cochlea**	• Draw the cross-section of cochlea with all 3 three scalae. • Describe the 'travelling wave theory' of hearing • Describe the function of basilar membrane in frequency discrimination - 'Place principle' of hearing	• Volley effect or Frequency principle of hearing		1 Hour	
3	**Sound**	• Physics of sound • Concept of the Decibel scale	• Noise - as an occupational hazard		1 Hour	
4	**Sensory transduction in cochlea**	• Recognize the importance of endocochlear potential and sensory transduction in the cochlea.				
5	**Processing of auditory signals**	• Describe the auditory pathway	• Describe the mechanisms underlying sound localization and masking effect of sounds	• Describe the concept of tonotopic maps	1 Hour	
6	**Assessment of hearing**	• Define an audiogram • Identify a normal air-conduction and bone-conduction tracing		• Principle of hearing aids	1 Hour	

		• Identify conductive hearing loss and sensory neural hearing loss using audiogram • Describe the principle of Rinne's and Weber's test				
7	**Deafness**	• Types of deafness - Conductive & Neural	• Audiogram • Distinguish between conductive hearing loss and sensory neural hearing loss based on audiogram	• Speech Audiometry	1 Hour	
	VESTIBULAR APPARATUS					
1	**Functional anatomy of vestibular apparatus**	• List the structures which make up vestibular apparatus and their functions			1 Hour	
2	**Mechanism of stimulation vestibular hair cell**	• Describe the mechanism of stimulation of otolith organs - deflection of hair cells using gravitational force/inertial force of otolith membrane • Describe the mechanism of stimulation of semicircular canals - deflection of hair cells using inertial force of endolymph			1 Hour	
3	**Vestibular pathway**	• Describe the connections of vestibular nucleus to the cortex and cerebellum • Describe the projections through vestibulospinal tracts • Describe the functions of Vestibular system - Maintenance of balance, equilibrium and posture	• Connections to cranial nerve nucleii controlling • Eye movements - Vestibulo-ocular reflex • Head & neck movements		1 Hour	
4	**Tests of Vestibular function**		• Identify nystagmus in a patient • Caloric test • Rotation in a Barany chair	• Meniere's disease	1 Hour	
	SMELL					
1	**Microscopic anatomy of**	• Describe the arrangement of olfactory sensory neuron within the olfactory	• List the types of cells within the olfactory bulb	• Pheromones		

	olfactory epithelium and olfactory bulb	epithelium	• Describe the connections of olfactory sensory neurons with cells in the olfactory bulb		1 Hour	
2	**The olfactory pathway**	• Describe the olfactory pathway from the olfactory sensory neurons to the cortex	•	•	1 Hour	
	TASTE					
1	**Receptors for Taste**	• Describe the arrangement of taste cells within taste buds and organization of taste buds within papillae.			1 Hour	
2	**Basic qualities of taste sensation**	• The student must be able to: • List the four basic qualities of taste sensation • Demonstrate how to test for the four basic qualities of taste sensation	• List umami as the fifth taste sensation			
3	**Taste pathway**	• Draw and describe the taste pathway from the anterior two-third and posterior one-third of the tongue to the gustatory cortex				

REFERENCE LEARNING BOOKS

Text Book of Medical Physiology by Guyton and Hall – A South Asian Edition

Ganong's Review of Medical Physiology

Text Book of Physiology by Dir.Prof.A.K.Jain (Volume I & II)

Understanding Medical Physiology – A Text Book for Medical Students by RL Bijlani and S Manjunath Best &

Taylor's Physiological Basis of Medical Practice by O.P.Tandon and Y.Tripathi

Text Book of Human Physiology by Sarada Subramanyam A

Text Book of Practical Physiology by CL Ghai

Manual of Practical Physiology by Dir.Prof.A.K.Jain

THEORY EXAMINATION

Theory Examination - Pattern of Question Paper I and II

1	Essay	1 x 10 marks	= 10 marks
1.	Brief Answers	5 x 4 Marks	= 20 marks`
2.	Short Answers	10 x 2 Marks	= 20 marks

	Total		50 Marks

Physiology Practical Examination Including OSCE, OSPE and Viva

Practical : Total 40 marks

I Haematology : 16 marks (Major -10 marks, Minor 6 marks)

Major experiment

1. Total RBC Count
2. Total Leukocyte count
3. Differential count
4. Absolute Eosinophil count

(Students can be taught to dilute the blood, charge the chamber, focus the counting grid and one sample square can be counted and the steps for calculation to be mentioned correctly. They need not count all squares)

Minor experiment

1.Hemoglobin Estimation
2.Blood Grouping
3.Bleeding Time and Clotting Time
4.ESR or PCV

Suggestion:

(To avoid mouth sucking in doing hematology experiments with RBC and WBC pipettes instead, automated micro pipettes can be used)

II Clinical Examination : 20 marks (CNS-10marks +CVS/RS–5marks+Clinical discussion or chart–5 marks) (One question from CNS Examination for 10 marks and one question from CVS/RS for 5 marks)
(Clinical Discussion includes giving a case scenario pertaining to the First M.B.B.S. level and student should identify the disease with the given data)
Charts will have a picture and two or three questions to be relevant to the picture given

III OSPE (2 Skilled stations): 2x2=4 marks (1 station in Hematology and one in clinical examination)

VIVA : (20 marks)

General Physiology, Blood, Muscle, Digestive system - 6 marks
Endocrinology, Reproduction, excretory system - 4 marks
Cardiovascular system, Respiratory system - 4 marks
Central nervous system and Special senses - 6 marks

INTERNAL ASSESSMENT (40 marks) (Theory 20 & Practical 15 + Record 5)

Theory to asses knowledge	-	Periodic Test in the first week of Oct, Dec, Jan, Mar and May (5 test totally) and Model Exam Paper I & II in June last week.
Practical to asses skill	-	One Practical Exam in Hematology and one in clinical examination. Model Practical in June.
Viva to asses communication	-	Viva marks to be included in internal assessment calculation.

MEDICAL ETHICS

Privacy and confidentiality of Students

Ethical Issues

INTEGRATED TEACHING

2 vertical and 3 horizontal integration to be done in each Academic Year

e.g. Horizontal – Gastric secretion, Liver, Kidney

Vertical – Anemia, Jaundice and Hemiplegia

RECORD

Record should be followed as recommended by this university

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BIOCHEMISTRY

Goals and objectives given below are as per the Medical Council of India Regulations on Graduate Medical Education, 1997.

GOAL

The broad goal of the teaching of undergraduate students in biochemistry is to make them understand the scientific basis of the life processes at the molecular level and to orient them towards the application of the knowledge acquired in solving clinical problems.

SPECIFIC LEARNING OBJECTIVES

a.KNOWLEDGE

At the end of the course, the student should be able to:
(1) describe the molecular and functional organization of a cell and list its subcellular components;
(2) delineate structure, function and inter-relationships of biomolecules and consequences of deviation from normal;
(3) summarize the fundamental aspects of enzymology and clinical application wherein regulation of enzymatic activity is altered;
(4) describe digestion and assimilation of nutrients and consequences of malnutrition;
(5) integrate the various aspects of metabolism and their regulatory pathways;
(6) explain the biochemical basis of inherited disorders with their associated sequelae;
(7) describe mechanisms involved in maintenance of body fluid and pH homeostasis;
(8) outline the molecular mechanisms of gene expression and regulation, the principles of genetic engineering and their application in medicine;
(9) summarize the molecular concepts of body defence and their application in medicine;
(10) outline the biochemical basis of environmental health hazards, biochemical basis of cancer and carcinogenesis;
(11) explain the principles of various conventional and specialized laboratory investigations and instrumentation analysis and interpretation of a given data;
(12) suggest experiments to support theoretical concepts and clinical diagnosis.

b. SKILLS:

At the end of the course, the student should be able to :
(1) make use of conventional techniques/instruments to perform biochemical analysis relevant to clinical screening and diagnosis;
(2) analyze and interpret investigative data;
(3) demonstrate the skills of solving scientific and clinical problems and decision making;

c.INTEGRATION

The knowledge acquired in biochemistry should help the students to integrate molecular events with structure and function of the human body in health and disease.

TEACHING HOURS:

Theory classes: Total: 115 hours

Serial no.	***Topic***	***Number of hours***
1.	Cell	2 hours
2.	Enzymes	5 hours
3	Chemistry and metabolism of carbohydrates	15 hours
4	Chemistry and metabolism of lipids	15 hours
5	Chemistry and metabolism of proteins	15 hours

6	Vitamins	10 hours
7	Nucleotide chemistry and metabolism	6 hours
8.	Integrated metabolism	3 hours
9	Bioenergetics	3 hours
10	Homeostatic mechanisms in the body (pH, water and electrolyte balance)	4 hours
11	Immunology	2 hours
12	Minerals	5 hours
13	Haem metabolism	6 hours
14	Function tests	4 hours
15	Molecular biology	12 hours
16.	Metabolism of xenobiotics	2 hours
17.	Oxidative stress	1 hour
18.	Nutrition	3 hours
19.	Importance of and ethical issues in laboratory medicine	2 hours
	Total	115 hours

TEACHING METHODOLOGY

Lectures, tutorials, small group discussions, integrated teaching modules, use of charts (paper-based clinical scenarios) for case discussions, practical exercises and demonstrations

THEORY SYLLABUS FOR FIRST YEAR M.B.B.S.

Note: The syllabus has been prepared keeping in mind the requirements of a doctor at the end of the MBBS course. It is also to emphasize that the teaching of Biochemistry needs to continue throughout the clinical phase of training of the MBBS students, when they will be in a better position to make correlations between derangements in biochemical processes and disease conditions. The content of the syllabus has been divided into 3 categories: "must know", "desirable to know" and "nice to know".

Total number of hours recommended: 112

	TOPIC	MUST KNOW	DESIRABLE TO KNOW	NICE TO KNOW	TEACHING HOURS RECOMMENDED
1.	**CELL**				**2 hours**
	Cell and cellular organelles	Basics of structure of a eukaryotic cell. Overview of cellular organelles and their functions (mitochondria, nucleus, ribosomes, proteasomes, lysosomes, endoplasmic reticulum and golgi apparatus)	Functions of peroxisomes. Markers of sub- cellular organelles		
2.	**ENZYMES**				**5 hours**
	Nomenclature and classification	Systematic and recommended nomenclature.	IUBMB classification of enzymes - main classes of enzymes only (names, definition, general reaction catalysed and one example for each class)		
	Properties of enzymes	Mechanism of action of an enzyme with regard to its effect on activation energy of a reaction. Concept of active site in enzymes. Specificity of enzymes: reaction and substrate specificity, with an example for each. Cofactors - metals and coenzymes (definition, examples of coenzymes) and	Lock and key and induced fit models of enzyme-substrate binding		

		examples of enzymes that require them			
	Factors that influence enzyme activity	Effect of pH (concept of optimal pH with examples). Effect of temperature (concept of optimal temperature). Effect of substrate concentration (Michaelis-Menten equation [no derivation of equation required], concept of K_m and V_{max}). Effects of enzyme and product concentration.			
	Inhibition of enzymes	Types of enzyme inhibition - competitive, non-competitive, suicide inhibition. Effects of competitive and non-competitive inhibition on Km and Vmax of the enzyme. Examples of commonly used drugs that act by competitive inhibition of enzymes. Examples of non-competitive enzyme inhibition – organophosphorus/cyanide poisoning			
	Isoenzymes	Definition and examples Clinical significance of elevated plasma levels of isoenzymes of creatine kinase (CK)	Isoenzymes of lactate dehydrogenase (LDH) and ALP		

	Diagnostic and therapeutic enzymes (clinically useful enzymes)	Aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), lactate dehydrogenase (LDH), creatine kinase (CK) and amylase as markers of various disease conditions. Plasma markers of myocardial infarction and liver damage. Examples of enzymes used in treatment and indications for their use.	Clinical utility of 5-nucleotidase and gamma-glutamyl transferase		
	Regulation of enzyme activity		Overview of mechanisms involved in regulating the activity of enzymes: allosteric activation and inhibition, covalent modifications (phosphorylation and dephosphorylation), induction and repression; concept of feedback inhibition Process of regulation of glycogen metabolism may be used as an example to explain the mechanisms of enzyme regulation, as listed above.		
3	**CHEMISTRY AND METABOLISM OF CARBOHYDRATES**				**15 hours**
	Chemistry of carbohydrates	Overview of classification of carbohydrates, with physiologically important examples and functions of each of these. Benedict's test for reducing sugars. Components of physiologically important disaccharides and polysaccharides.	Concept of deoxy and amino sugars and their functions. Heteropolysaccharides (heparin, hyaluronic acid, chondrointinsulphate, heparansulphate, dermatan sulphate) and their importance in the body.		

		Homopolysaccharides – starch, glycogen and cellulose			
	Digestion of carbohydrates	Examples of common dietary carbohydrates and the foods that they are present in. Enzymes involved in digestion of carbohydrates. Sources, sites and actions of the enzymes that digest carbohydrates. End products of digestion and their absorption. Rationale for the composition and use of oral rehydration solution (ORS) in the treatment of dehydration. Lactose intolerance. Importance of dietary fibre.			
	Glucose transporters	Types, functions, tissue specificity and physiological relevance			
	Glycolysis	Definition, importance, cellular site and pathway involved (with emphasis on the importance of the pathway, sites of utilization and generation of energy and irreversible reactions involved). Importance of aerobic and anaerobic forms of glycolysis. Energetics. Concept of substrate level phosphorylation. Overview of regulation of glycolysis.			

		Rapaport- Leubering shunt and its physiological importance. Concept of lactic acidosis and common causes and conditions in which it occurs. Importance of inhibition of enolase by fluoride in blood samples collected for glucose estimation.			
	Citric acid cycle/ Krebs' cycle / tricarboxylic acid (TCA) cycle	Pyruvate dehydrogenase as a link between glycolysis and Krebs' cycle (no details of reaction mechanism required). Definition, importance, cellular site, pathway (including intermediates and enzymes involved, but excluding details of reactions involved). Concept of anaplerosis, amphibolic nature of Krebs' cycle. Energetics.		Overview of regulation of pathway (no details required).	
	Pentose phosphate pathway (PPP)	Importance of pathway - ribose for nucleic acid synthesis and NADPH for synthesis of various lipids, maintenance of reduced form of iron in haemoglobin, reduced glutathione and its importance in maintaining red cell membrane integrity. Clinical relevance of the deficiency of glucose-6-phosphate dehydrogenase (G6PDH).	Definition, cellular site and overview of pathway, showing starting material and products (intermediates not required).		

	Glycogenesis	Physiological importance of glycogen in the body (including role of glycogen in the liver and in the muscle). Overview of pathway of synthesis (starting material, action of glycogen synthase and branching enzyme and the end product).	Glycogen storage disorders		
	Glycogenolysis	Physiological importance of glycogen breakdown in the body. Overview of pathway of breakdown in the liver and muscle (starting material, action of glycogen phosphorylase and debranching enzyme and products obtained).	Role of insulin and glucagon in reciprocal regulation of glycogenesis and glycogenolysis (details of reactions involved in regulation not required). Examples of glycogen storage diseases (Von Gierke's disease and McArdle's disease) may be used to illustrate functions of glycogen in the liver and muscle and the reasons for different manifestations of the diseases.		
	Gluconeogenesis	Definition, substrates used, physiological importance, sites in the body and in cell where the pathway occurs. Overview of pathway with key intermediates and enzymes. Importance of Cori's cycle and glucose-alanine cycle.	Concept of reciprocal regulation of glycolysis and gluconeogenesis (no details required). Role of insulin and glucagon in regulation.		
	Uronic acid pathway			Overview of pathway showing starting material (glucose) and product	

				(glucuronic acid). Importance of glucuronic acid in conjugation of bilirubin and drugs and synthesis of heteropolysaccharides. Essential pentosuria	
	Metabolism of galactose	Dietary sources of galactose. Overview of pathway by which galactose is metabolized (showing the sites of 3 main enzymes involved). Eventual fate of galactose in the body. Galactosemia (definition, causes, biochemical basis of clinical manifestations and rationale of treatment).			
	Metabolism of fructose	Dietary sources of fructose. Overview of pathway by which fructose is metabolized (showing entry into glycolysis and formation of triacylglycerol). Importance of fructose in seminal fluid.		Disorders of fructose metabolism	
	Minor pathways of carbohydrate metabolism	Polyol pathway and its importance in pathogenesis of complications of diabetes mellitus.			

	Regulation of blood glucose levels	Factors maintaining blood glucose levels - role of dietary carbohydrates, role of hormones (insulin, glucagon, glucocorticoids and catecholamines) and roles of liver and kidney.			
	Diabetes mellitus	Types and pathogenesis of diabetes mellitus. Concept of insulin resistance. Metabolic derangements and clinical features. Diagnostic criteria (ADA criteria). Concept of impaired fasting glucose and impaired glucose tolerance. Gestational diabetes – definition and diagnosis Acute and chronic complications of diabetes mellitus. Pathogenesis of diabetic ketoacidosis.		Pathogene-sis of chronic complicati-ons of diabetes mellitus.	
	Laboratory investigations in diabetes mellitus	Blood glucose estimations (fasting and post-prandial). Glycated haemoglobin (HbA1c). Urinalysis for detection of glucose, ketone bodies and proteins in urine. Detection and importance of microalbuminuria. Role of glucose tolerance test in diagnosis of diabetes mellitus.			

		Indications for and interpretation of results of glucose tolerance test (OGTT), including use in gestational diabetes mellitus (GDM). Serum lipid profile in diabetics.			
	Hypoglycemia	Definition, importance, causes, clinical manifestations.			
4	**CHEMISTRY AND METABOLISM OF LIPIDS**				**15 hours**
	General featuresof lipids	Definition of a lipid. Properties with regard to solubility and hydrophobicity. Important functions of lipids in the human body. Concept of importance of lipids in causation of disease (atherosclerosis with subsequent myocardial infarction and stroke; obesity, cholelithiasis, etc).			
	Classification of lipids	Major types of lipids in the body (classification into simple, complex and precursor or derived lipids). Relevant examples of each type and the importance of each type in the body.			
	Fatty acids	Concept of system of nomenclature (concept of systematicnames and symbols), with C and n numbering of fatty acids. Classification system based on chain length, degree of saturation (saturated and mono- and polyunsaturated fatty			

		acids), and nutritional requirement. Concept of saturated fatty acids in animal fat and unsaturated fatty acids in plant fats. Names of essential fatty acids and their functions. Importance of ω3 and ω6 fatty acids (dietary sources and their health benefits).			
	Simple lipids (fats)	Concept of importance of saturated and unsaturated fats in one's diet (including hydrogenation of oils). Basic concept of cis and trans forms of fatty acids and the health hazards of trans fats. Basic concept of mono, di- and triacylglycerols and where they are found in the body.			
	Derived lipids – steroids	Functions of cholesterol Health hazards associated with high blood levels of cholesterol.			
	Complex lipids	Lipoproteins - definition, general structure, types, components of each type, function of each type, role of apoproteins, importance in health and disease.	Phospholipids (definition, types, components, amphipathic nature, functions, clinically relevant examples) Importance of each type of phospholipid: phosphatidylcholine (including importance of surfactant in health and disease, concept of lecithin/sphingomye-lin [L/S] ratio),	Glycolipids - definition, types, components, functions, examples. Basic concepts of cerebrosides and gangliosides and importance of each type in the body. Basic concept	

			phosphatidylinositol and sphingomyelin Liposomes (definition, structure and importance)	of abnormalities in lipids in demyelinating diseases and sphingolipido-sis	
	Miscellaneous	Micelles (definition, structure and importance). Biological membranes (structure and importance).	Basic concepts of transport mechanisms across membranes		
	Metabolism of lipids				
	Digestion of lipids	Names of main lipids present in the diet. Enzymes responsible for digestion of lipids and their sources and sites of action. Role of bile in lipid digestion and absorption. End-products of lipid digestion. Process of absorption of lipids. Steatorrhoea. Salient features of formation, metabolism and physiological importance of chylomicrons.			
	Fate of fatty acids				
	Fatty acid oxidation	Importance of oxidation of fatty acids in the body. Types of oxidation of fatty acids. Beta-oxidation of even chain fatty acids (site, activation of a fatty acid, the role of carnitine, steps	End-products of beta- oxidation of odd chain fatty acids. Alpha oxidation of fatty acids.	Conditions where fatty acid oxidation is impaired.	

		involved and energetics of the process).			
	Biosynthesis of fatty acids (lipogenesis)	Conditions under which it occurs and sites involved. Starting material and end products of fatty acid synthesis. Source of acetyl CoA. Regulatory role of acetyl CoA carboxylase. Overall reaction catalyzed by fatty acid synthase (individual enzymes and reactions not required). Importance of NADPH in the pathway and its sources. Role of the nutritional state and insulin as factors that regulate synthesis of fatty acids			
	Metabolism in the adipose tissue		Metabolism in the adipose tissue with regard to lipogenesis and lipolysis (conditions where it occurs, and products obtained) and its regulation by hormones, including enzymes involved		
	Metabolism of ketone bodies	Names of the ketone bodies and their importance. Pathway of ketogenesis and utilization of ketone bodies and sites where these occur. Factors that favour ketone body formation. Causes and clinical importance of			

		ketoacidosis.			
	Metabolism of cholesterol	Functions of cholesterol. Sources of cholesterol in the body (dietary and endogenous). Importance of HMG CoA reductase in the regulation of biosynthesis of cholesterol. Importance of maintaining normal cholesterol levels in blood and ways to reduce blood cholesterol levels (including mechanism of action of statins and other lipid lowering agents). Bile acids (names, source and functions). Enterohepatic circulation of bile acids.	Cellular site of biosynthesis of cholesterol. Basic overview of biosynthesis of cholesterol (showing starting material, HMG CoA [HMG CoA synthase], mevalonate [action of HMG CoA reductase] and formation ofcholesterol, without showing any other intermediates). Overview of synthesis (including regulatory enzyme).	Role of lipids in formation of gall stones.	
	Metabolism of lipoproteins	Association of high levels of LDL with atherosclerosis. Anti-atherogenic effect of HDL	Brief overview of metabolism of VLDL, LDL and HDL (including reference values). Lipoprotein (a) Dyslipidemias – causes (with emphasis on secondary causes of dyslipidemia and familial hypercholesterol-emia) and consequences. Risk factors for atherosclerosis and coronary artery disease; prevention of coronary artery disease.		

			Overview of metabolic syndrome.		
	Eicosanoids	Names and functions of various eicosanoids. Role of aspirin as an anti-platelet agent.	Mechanism of action of NSAIDs and their effect as anti-inflammatory agents	Therapeutic uses of prostaglandins.	
	Phospholipids	Clinical relevance of lecithin-sphingomyelin (L/S) ratio in amniotic fluid	Biochemical defect and clinical features of Niemann-Pick's, Tay- Sach's and Gaucher's disease.	Sites of action of various phospholipases . Sphingolipido-sis other than the examples specified.	
	Miscellaneous	Role of liver in lipid metabolism. Fatty liver (causes, including role of lipotropic factors, and consequences).			
5	**CHEMISTRY AND METABOLISM OF PROTEINS**				**15 hours**
	Amino acids	Classification based on nutritional requirement and metabolic fates. Peptide bond formation by amino acids. Reaction with ninhydrin as a general reaction for all amino acids (details of reaction not required).	Classification of amino acids based on side chain		
	Peptides and proteins	Structural organization of proteins - primary, secondary, tertiary and quaternary structures. Denaturation of proteins – definition, agents causing denaturation and consequences (loss of biological activity of protein). Overview of structure-function relationship of haemoglobin, myoglobin and collagen.	Oxygen dissociation curve of haemoglobin; Bohr effect.		

		Hemoglobinopathies: sickle cell anaemia and thalassemia			
	Digestion and absorption	Mechanism of activation of enzymes involved in the digestion of proteins in the stomach and small intestine (conversion of zymogens to active proteases) – proteolytic enzymes of the gastric and pancreatic secretions. Role of gastric acid in protein digestion. Overview of amino acid absorption.	Disorders associated with amino acid absorption (cystinuria/ Hartnup's disease).		
	General pathways of amino acid catabolism	Overview and biochemical importance of the processes of transamination and oxidative deamination. Enzymes and coenzymes involved in the above processes.			
	Ammonia metabolism	Sources of ammonia in the body. Urea cycle - overview of reactions involved, including regulatory enzyme. Role of glutamine in detoxification of ammonia in the brain. Hepatic coma (hepatic encephalopathy);biochemical basis of clinical features Reference range for blood urea and blood urea nitrogen (BUN).	Overview of disorders of the urea cycle		

	Metabolism of individual amino acids	Functions of individual amino acids. Important specialized products from tyrosine – melanin, catecholamines, thyroid hormones. Formation of tyrosine from phenylalanine. Pathogenesis, clinical features, diagnosis and treatment of phenylketonuria.	Metabolism of methionine and homocysteine Roles of folic acid, vitamin B_{12} and pyridoxine in their metabolism. Role of homocysteine as a risk factor for cardiovascular diseases. Important specialized products from glycine (glutathione, creatine, creatinine, haem and purines) and tryptophan (serotonin, melatonin and niacin). Neurotransmitters derived from amino acids (glutamate – gamma-amino butyric acid [GABA], histidine [histamine], arginine [nitric oxide]).	Uncommon disorders of amino acid metabolism: maple syrup urine disease (MSUD), alkaptonuria, tyrosinemias, methymalonyl aciduria, disorders of glycine metabolism, etc. Importance of neonatal screening for inborn errors of amino acid metabolism. Principle of the technique of chromatography	
	Plasma proteins	Functions of albumin. Examples of specialized transport proteins present in plasma. Reference values of total proteins and albumin. Common clinical conditions in which plasma protein levels are abnormal and the reasons why these changes occur (malnutrition, cirrhosis of the liver, nephrotic syndrome, chronic renal failure, multiple myeloma). Importance of the albumin: globulin ratio (A: G ratio). ‘ Normal value for the A:G ratio	Classification of plasma proteins, based on electrophoretic mobility.	Principle of the technique of electrophoresis	

		and common clinical conditions in which the ratio is abnormal.			
6	**VITAMINS**				**10 hours**
	General properties of vitamins	Definition, classification, comparison of clinically relevant features of fat- and water-soluble vitamins. Concepts of hypo- and hypervitaminosis and recommended dietary allowances (RDA).			
	Fat-soluble vitamins				
	Vitamin A	Dietary sources. Various forms of vitamin A and their functions Precursor form. Biochemical functions. Role in Wald's visual cycle. RDA Deficiency – causes, manifestations and treatment.	Hypervitaminosis A		
	Vitamin D	Dietary sources of vitamin D. Synthesis in the body and conversion to calcitriol. Biochemical functions. Role in calcium absorption in small intestine, calcium homeostasis and bone mineralization. RDA Deficiency (rickets and osteomalacia) – causes, manifestations, biochemical findings in blood			
	Vitamin E	Dietary sources Role as an antioxidant. Relationship to action of glutathione peroxidase. RDA Deficiency leading to fragility of RBCs.			
	Vitamin K	Sources. RDA. Deficiency – causes, manifestations (including hemorrhagic disease of the new born).	Biochemical role in gamma carboxylation reactions. Vitamin K cycle. Basis of action of warfarin and other dicumarol derivatives.		

	Water-soluble vitamins				
	Thiamine	Dietary sources. Functions (coenzyme form, physiologically important reactions for which it is required). RDA Deficiency (beri-beri) – causes and manifestations Wernicke-Korsakoff syndrome - causes, clinical features			
	Riboflavin	Dietary sources. Functions (coenzyme forms, physiologically important reactions for which they are required). RDA Deficiency – causes and manifestations.			
	Niacin	Sources (including from tryptophan). Functions (coenzyme forms, examples of physiologically important reactions for which they are required). RDA Deficiency – causes and manifestations of pellagra.			

	Pyridoxine	Dietary sources. Functions (coenzyme form, physiologically important reactions for which they are required, including transamination and decarboxylation of amino acids). RDA. Deficiency – causes and manifestations. Rationale for supplementation in treatment of tuberculosis.			
	Pantothenic acid	Sources, functions and RDA			
	Biotin	Sources. Role in carboxylation reactions. Examples of important enzymes that require biotin.			
	Folic acid	Dietary sources. Functions (coenzyme forms, physiologically important reactions for which they are required).	Role of folic acid in one-carbon metabolism (one-carbon donor reactions (e.g., serine		

		RDA Relationship with vitamin B_{12} and concept of "folate trap". Deficiency – causes and manifestations (megaloblastic anemia). Importance of supplementation in peri-conceptual period. Folate antagonists (action of methotrexate, aminopterin and sulphonamides).	hydroxymethyl transferase), one-carbon acceptor reactions (methionine synthase, thymidylate synthase and de novo purine synthetic pathway).		
	Vitamin B_{12}	Dietary sources. Absorption and role of intrinsic factor of Castle. Functions (coenzyme forms, reactions for which they are required). Role in folic acid metabolism (concept of "folate trap" in B_{12} deficiency) RDA Deficiency – causes and manifestations (megaloblastic and pernicious anemia). Importance of combined B_{12} and folic acid administration in treatment of megaloblastic anemia.			
	Vitamin C	Dietary sources. Functions (in collagen synthesis, iron absorption and as an anti-oxidant). RDA. Deficiency – causes and manifestations of scurvy.		Role of vitamin C in the conversion of tyrosine to catecholamines, cholesterol to bile acids and in catabolism of tyrosine.	
	Vitamin-like substances Lipoic acid			Role in reactions involving pyruvate dehydrogenase and alpha-ketoglutarate dehydrogenase.	

7	**NUCLEOTIDE CHEMISTRY AND METABOLISM**				**6 hours**
	Nucleotide chemistry	Purine and pyrimidine bases found in DNA and RNA. Definition and types of	Examples of synthetic analogues of purine and pyrimidine bases and nucleosides used		

		nucleosides and nucleotides. Functions of physiologically important nucleotides.	as therapeutic agents (anti-cancer drugs, anti-viral drugs and allopurinol).		
	Nucleotide metabolism	Role of folic acid in purine synthesis. Overview of the pathway of degradation of purines to form uric acid, including role of xanthine oxidase. Hyperuricemia and gout (causes, clinical features, principles of treatment, including mechanism of action of allopurinol and probenecid).	Names of compounds required for purine and pyrimidine synthesis. Salvage pathway for purine bases and nucleosides. Lesch- Nyhan syndrome (cause and biochemical basis of clinical features). Mechanism of action of methotrexate and 5-flurouracil, as examples of drugs used in cancer chemotherapy.	Overview of the pathway of de novo synthesis of purine nucleotides (names of only starting material and end products - AMP and GMP - required). Overview of pathway of de novo synthesis of pyrimidine nucleotides, showing only starting material, rate-limiting enzyme and end products. Disorders of pyrimidine metabolism: orotic aciduria	
8.	**INTEGRATED METABOLISM**				**3 hours**
		Overview of metabolism in the fed and fasting states	Overview of metabolism in liver, brain and adipose tissue		
9	**BIOENERGETICS**				**3 hours**
	Role of ATP	Role of ATP as the "energy currency" of the cell.		Role of high energy phosphates in energy capture and transfer e.g., role of creatine phosphate in muscle.	

	The respiratory chain and oxidative phosphorylation	Sources of reducing equivalents in the cell (NADH and $FADH_2$). Role of mitochondria as the "power house" of the cell. Substrate level and oxidative phosphorylation. Schematic representation of the electron transport chain. Role of the respiratory chain as an electron transporter and a proton pump. Chemiosmotic theory of oxidative phosphorylation. Amount of ATP synthesized when NAD and FAD act as hydrogen acceptors.		Transport of cytosolic NADH into the mitochondria (mitochondrial shuttle systems). Examples of inhibitors of electron transport chain (carbon monoxide, cyanide) and uncouplers of oxidative phosphorylation (free fatty acids, thyroxine, thermogenin). Role of brown fat (non-shivering thermogenesis and role of uncoupling protein/ thermogenin). Overview of complex V (ATP synthase).	
10	**HOMEOSTATIC MECHANISMS IN THE BODY**				**4 hours**

	Acid base balance	Definitions of acid, base and buffer. Normal pH of body fluids and importance of maintaining normal pH Sources of hydrogen ions in the body. Mechanisms involved in regulation of pH Buffers of body fluids Henderson – Hasselbalch equation. Role of buffers (with emphasis on the bicarbonate buffer system) Role of the lungs and kidneys in maintaining acid- base balance. Simple acid-base disorders: Major causes and clinical features of: • Metabolic acidosis (including importance of anion gap) and alkalosis • Respiratory acidosis and alkalosis. Arterial blood gases (ABG) analysis and interpretation of results. Compensatory mechanisms in metabolic/respiratory acidosis/alkalosis.			

	Fluid and electrolyte balance	Distribution of water in various body compartments. Intra- and extracellular fluid composition (sodium and potassium) Blood volume and osmolality. Major causes and clinical features of dehydration. ***Sodium:*** Normal levels in the blood. Physiological functions. Regulation of sodium homeostasis (including the role of renin-angiotensin-aldosterone system). Major causes, clinical features of hyponatremia and hypernatremia ***Potassium:*** Normal levels in the blood. Physiological functions. Regulation of potassium homeostasis. Major causes and clinical features of hypokalemiaandhyperkalemia.	Regulation of osmolality– role of anti-diuretic hormone (ADH).		
11	**IMMUNOLOGY**				**2 hours**
	Immunology	Introduction to immunoglobulins Types, properties and functions of different classes of immunoglobulins. Multiple myeloma – biochemical abnormalities and laboratory diagnosis.			
12	**MINERALS**				**5 hours**
		Concept of macro and micro minerals and examples. Sources and daily requirement.			
	CALCIUM	Normal blood levels. Functions of calcium. Role of vitamin D in absorption of calcium. Regulation - role of parathyroid hormone (PTH), calcitonin and			

		vitamin D in calcium homeostasis. Important causes, clinical features, laboratory diagnosis of hypocalcemia and hypercalcemia Osteoporosis and osteomalacia - major causes, clinical features.			
	Iron	Sources and daily requirement. Distribution of iron in the body. Functions of iron. Absorption of dietary iron in the duodenum - overview of role of divalent metal transporter-1 (DMT-1), duodenal cytochrome b (dcytb), hephaestin, ferroportin. Storage and transport (role of ferritin and transferrin). Causes, clinical features of iron deficiency anemia.	Iron overload conditions, e.g., hereditary haemochromatosis.		
	Copper	Biochemical functions of copper. Role of ceruloplasmin. Genetic basis, clinical features of Wilson's disease.	Biochemical basis of Menke's disease		
	Zinc	Functions of zinc. Causes and clinical features of zinc deficiency.			
	Magnesium and manganese: **Iodine:** **Flouride:** **Selenium**	 Sources and daily requirement of iodine. Functions of iodine. Causes and clinical features of iodine deficiency. Sources and daily requirement of fluoride. Functions of fluoride. Causes and clinical features of fluorosis. Functions of selenium	Functions of magnesium and manganese.		
13	**HAEM METABOLISM**				**6 hours**
	Heme synthesis	Importance of haem (heme-containing proteins – hemoglobin, myoglobin, cytochromes).	Heme synthesis and its regulation in the liver and bone marrow.		

		Porphyrias: Definition, biochemical basis of clinical features of porphyrias (neurological features and photosensitivity). Acquired porphyria: lead poisoning.			
	Heme degradation	Degradation of haem and fate of bilirubin. Hyperbilirubinemia – causes and role of laboratory investigations in the differential diagnosis of jaundice. Jaundice in the newborn	Congenital disorders of conjugation and excretion of bilirubin – Crigler-Najjar syndrome, Dubin-Johnson syndrome, Gilbert's syndrome and Rotor's syndrome.		
14	**FUNCTION TESTS:**				**4 hours**
	Renal function test:	Functions of the kidney Clinical importance of blood urea and serum creatinine levels in renal disease.			
		Estimation of GFR: Creatinine clearance and its importance. Nephrotic syndrome – major clinical features and laboratory diagnosis.	Proteinuria – types (glomerular, tubular and overflow proteinuria) and characteristic proteins present in urine in each type. Microalbuminuria and its importance. Concepts of tests to assess tubular function – measurement of plasma and urine osmolality	Renal tubular acidosis. Lab investigations in acute kidney injury and chronic kidney disease Laboratory tests to diagnose pre-renal, renal and post- renal causes of acute renal failure.	
	Liver function tests	Functions of the liver. Major causes of liver dysfunction. Tests done to assess liver			

		function in clinical practice: 1. Tests to assess ability to detoxify and excrete substances: conjugated and unconjugated bilirubin (van den Bergh's test), blood ammonia levels. 2. Tests to assess biosynthetic functions: total protein and serum albumin levels, prothrombin time 3. Markers of liver injury: alanine transaminase (ALT) and aspartate transaminase (AST) 4. Marker of cholestasis: alkaline phosphatase (ALP). Differential diagnosis of jaundice, based on liver function tests.			

	Thyroid function test:	Regulation of secretion of thyroid hormones.		Importance of estimation of TSH in assessment of thyroid function. Measurement of total and free thyroxine levels. Role of TSH and free thyroxine in laboratory diagnosis of hypothyroidism and hyperthyroidism	
	Adrenal function tests			Hormones produced by the adrenal cortex and medulla. Regulation of secretion of adrenocortical	

				hormones. Basic tests done for the laboratory diagnosis of adrenal hypofunction and hyperfunction (serum and urine cortisol)	
15	**MOLECULAR BIOLOGY**				**12 hours**
	The cell cycle, DNA and RNA structure	Watson and Crick model of DNA structure (including simple diagrammatic representation of the salient features of DNA structure). Types and functions of different types of RNA. Overview of organization of DNA in a chromosome.		Overview of the cell cycle Differences between nuclear and mitochondrial DNA.	
	DNA replication and repair	Overview of the process of DNA replication in eukaryotes Roles of DNA polymerase, helicase, primase, topoisomerase and DNA ligase Diagrammatic representation of the events at the replication fork Okazaki fragments and its importance in replication.	Inhibitors of DNA replication as anti-cancer drugs. Overview of role of major DNA repair mechanisms – mismatch repair, base excision repair, nucleotide excision repair and double strand break repair. Diseases associated with abnormalities of DNA repair systems – xeroderma Pigmentosa and hereditary non-polyposis colon cancer (HNPCC).	Importance of telomeres and telomerase	

	Transcription	Structure of a gene - concepts of exons and introns, promoter, enhancers/repressors and response elements. Overview of the process of transcription in eukaryotes – initiation, elongation and termination Post-transcriptional processing – capping, tailing and splicing.			
	Translation and genetic code:	Genetic code - definition. Characteristics of the genetic code – universal, unambiguous, degenerate, without punctuation (continuous/commaless). Basis of degeneracy of the genetic code (wobble hypothesis). Components of eukaryotic ribosomes. Structure of tRNA (diagram of clover leaf model of tRNA structure) and its function in protein synthesis. Function of aminoacyl tRNA synthase.	Overview of the process of translation – initiation, elongation and termination Inhibition of prokaryotic translation by antibiotics. Post-translational modifications – examples.		
	Mutations and regulation of gene expression	**Mutations:** Definition. Mutagens- examples of physical, chemical and biological mutagens. Types of mutations. point mutation (deletion, insertion, substitution – transition and transversion, frame shift mutation, • missense mutation, nonsense mutation and silent mutation • chromosomal mutations (deletion, inversion and	Relationship of mutations with specific diseases – eg, sickle cell anemia and chronic myeloid leukemia.	Prokaryotes: The operon concept in prokaryotes (using Lac operon as an example). Eukaryotes: Overview of regulation of initiation of eukaryotic transcription: role of general and gene-specific transcription	

		translocation).		factors	
	Recombinant DNA technology and techniques in molecular biology:	Importance and applications of recombinant DNA technology Importance and applications of Polymerase chain reaction (PCR) •	Restriction endonucleases. Vectors for cloning – plasmids and phages. Genomic and cDNA libraries. Principles and applications of techniques in molecular biology: (Southern, northern and western blotting, restriction fragment length polymorphism [RFLP]) Applications of recombinant DNA technology in medicine. General principles of production of therapeutic proteins, e.g., insulin Gene therapy Diagnosis of genetic diseases and genetic counseling Forensic investigation	Human genome project DNA fingerprinting DNA sequencing Microarrays Fluorescent in-situ hybridization (FISH) DNA vaccines Transgenic animals	

16.	**METABOLISM OF XENOBIOTICS**				**2 hours**
		Xenobiotics- definition and examples Biochemical importance of the two phases of xenobiotic metabolism Conjugation reactions: • Biochemical role of conjugation reactions (with suitable, clinically relevant examples) - glucuronidation,	The cytochrome P450 enzyme system • Functions • Properties (especially induction by drugs) Overview of metabolism of alcohol. Health hazards associated with alcohol consumption.		

		sulfation, conjugation with glutathione, acetylation.	Metabolic alterations induced by alcohol metabolism.		
17.	**OXIDATIVE STRESS**				**1 hour**
				Concepts of reactive oxygen species (ROS), free radicals and oxidative stress and antioxidants. Mechanisms of generation of reactive oxygen species (ROS) in cells. Role of antioxidants – vitamin E and glutathione. Role of antioxidant enzymes – glutathione peroxidase, superoxide dismutase	
18.	**NUTRITION**				**3 hours**
		Importance of various macro and micro-nutrients in diet. Components and importance of each type in diet. Concept of balanced diet and glycemic index of food. Importance of dietary fibre. Basal metabolic rate. Specific dynamic action (thermogenic effect of food) and respiratory quotient Common sources of saturated, polyunsaturated and monounsaturated fats in diet and	Calorific value of various macronutrients. Principles of calculation of energy requirements of a person.	Dietary protein quality – biological value and net protein utilization. Concept of nitrogen balance.	

		their impact on health. Importance of trans fats Concept of limiting amino acids and supplementary action of dietary proteins. Protein-energy malnutrition (PEM): marasmus and kwashiorkor - causes and main differences. Obesity (including calculation and interpretation of body mass index [BMI]; health risks associated with obesity)			
19.	**IMPORTANCE OF LABORATORY MEDICINE** **ETHICAL ISSUES IN LABORATORY MEDICINE**				**2 hours**
		The concept that laboratory testing should respect principles of medical ethics (non-maleficence, beneficence, patient autonomy, informed consent, respect for patient, etc)		Ensuring quality and integrity of laboratory services, role and responsibilities when participating in clinical research, optimal use of resources, confidentiality of laboratory results, use of results from screening and testing programs, etc.	

PRACTICAL SYLLABUS

Estimation of important biochemical analytes in blood (glucose, creatinine, urea, uric acid and total protein)

Identification of abnormal constituents in urine; interpretation of the findings and correlation of the findings with pathological states
Tests (including dipstick tests) to detect abnormal constituents in urine include heat coagulation test, sulphosalicylic acid test and Heller's test for proteins, Benedict's test for reducing sugar, benzidine test for blood, Rothera's test for ketone bodies, Hay's test for bile salts and Fouchet's test for bile pigments
Interpretation of laboratory results in the context of a patient's presenting complaints.

Principles of spectrophotometry (including the Beer-Lambert Law)

Principles of electrophoresis (with specific reference to separation of serum proteins) and paper chromatography

Practical classes: Total: 125 hours

Serial no.	***Topic***	***Number of hours***
1.	Estimations of biochemical analytes	40
2.	Qualitative tests	20
3	Demonstrations	15
4	Charts and integrated teaching	25
5	Small group discussions/tutorials	25
	Total	125 hours

INTERNAL ASSESSMENT : (40 marks)

(Theory 20 marks + Practical 15 marks + Record 5 marks)

Theory - To access knowledge.

Practical - To access skill.

Vivo voce - To access communication.

Internal Assessment test will be conducted on 3rd Saturday.

Given below is a division of topics for periodic assessments.

Unit I - September

Cell and chemistry carbohydrates, lipids and proteins

Unit II - October

Enzymes and vitamins

Unit III - December

Metabolism of carbohydrates and biological oxidation and electron transport chain

Unit IV - January

Metabolism of lipids

Unit V - February

Metabolism ofproteins and metabolism of heme

Unit VI - April

Organ function tests, acid–base homeostasis and associated disorders, water and electrolyte balance and associated disorders

Unit VII - May

Nutrition, minerals and metabolism of xenobiotics

Unit VIII - June

Chemistry and metabolism of nucleotides and molecular biology

Model exam -1st week of July

RECOMMENDED TEXTBOOKS

The most recent editions of the following books are suggested.

1. Text book of Biochemistry for Medical Students by DM Vasudevan, SreeKumari S and Kannan Vaidyanathan
2. Medical Biochemistry by AR Aroor
3. Principles and Applications of Biochemistry in Medicine by Rafi
4. Biochemistry – Lippincott's Illustrated Reviews

5. Harpers Illustrated Biochemistry

Theory Examination - Pattern of Question Paper I and II

Essays	1 X 10 Marks	=	10 Marks
Brief Answers	5 X 4 Marks	=	20 Marks
Short Answers	10 X 2 Marks	=	20 Marks
	TOTAL		**50 Marks**

PRACTICAL EXAMINATION (Total: 40 marks)

1. A short paper-based clinical scenario will be given to each student. The student will be asked to estimate one of the relevant analytes (glucose, creatinine, urea, uric acid and total protein) in a serum sample provided and asked to interpret this in the context of the given clinical scenario. The clinical relevance and metabolism of the analytes estimated will be discussed. (12 marks)

2. Clinical case histories and laboratory results with 3 clinical charts
Students will be expected to interpret laboratory results supplied, with reference to the history of the patient and to make a provisional diagnosis. (12 marks)

3. Identification of abnormal constituents in urine
Students will be expected to carry out of relevant tests and interpret and discuss their results (12 marks)

4. Objective structured practical exercise (OSPE) (2 stations x 2 marks each = 4 marks)
Only performance stations may be kept. Suggested questions for OSPE are given below.

a. Perform a test to identify the presence of bile salts in the given sample.
b. Perform a test to demonstrate the presence of areducing sugar /protein/ ketone bodies in the given sample.
c. Demonstrate the presence of heat-coagulable proteins in the given sample.

VIVA VOCE: 20 marks
The viva voce is meant to assess understanding, comprehension and applications of the subject and not rote memory.

The topics in Biochemistry will be divided into 4, as detailed below, for the viva voce. Each examiner will assess the students in one of these areas and will award marks out of 5.

Serial no.	***Topics***	***Marks***
1.	Carbohydrates, cell, biological oxidation and vitamins	5 marks
2.	Proteins, enzymes, plasma proteins, function tests, metabolism of xenobiotics, basics of immunology	5 marks
3	Lipids, minerals, nutrition, metabolism of haem, oxidative stress	5 marks
4	Nucleic acids, molecular biology, water and electrolyte balance, acid- base balance	5 marks

5		
	Total marks	20 marks

RECORD BOOKS

It is suggested that students be issued a printed Biochemistry Record Notebook in which they are expected to write only the observations, inferences and calculations of experiments they do in the practical classes conducted.

INTEGRATED TEACHING:

Suggested topics that may be used for integrated teaching:

Clinically important enzymes, plasma markers of myocardial, infarction and liver and renal damage, rationale of oral rehydration solutions, lactose intolerance, galactosemia, diabetes mellitus, ketoacidosis, dyslipidemias, atherosclerosis and coronary artery disease, liver disease, haemoglobinopathies, phenylketonuria, hyperuricemia and gout, deficiencies of vitamins A, D, K, B_{12}, thiamine, pyridoxine and folic acid, acid-base and electrolyte disorders, disorders of calcium homeostasis, iron deficiency anemia, iodine deficiency, disorders of bilirubin metabolism, renal and thyroid function tests, protein-energy malnutrition.

RECORD

Record should be followed as recommended by the University.

This Syllabus and Curriculum is applicable for the First MBBS Students admitted from the academic year 2016-2017 and appearing for the Examination from August 2017 session onwards