ANATOMY CURRICULUM FOR MBBS

Broad 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 human body to provide a basis for understanding the clinical correlation of organs or structures involved and the anatomical basis for the disease presentations.

Programme Objectives:

(A) Knowledge:

At the end of the course the student should:

a. Be able to comprehend the normal disposition, inter-relationships, gross, functional and applied anatomy of the various structures in the body including cross–sectional anatomy.

b. Be able to identify the microscopic structure of various organs and correlate the structure with the functions as a prerequisite for understanding the altered state in various disease processes

c. Be able to comprehend the basic structure and connections of the central nervous system to analyze the integrative and regulative functions of the organs & systems and he/she should be able to locate the site of gross lesions according to the deficits encountered.

d. Know the basic principles and sequential development of the organs and systems, recognize the critical stages of development and the effects of common teratogens, genetic mutations and environmental hazards. He/She should be able to explain the developmental basis of variations and congenital anomalies.

e. Understand the anatomical basis of some common clinical procedures i.e., intramuscular and intravenous injection, lumbar puncture, liver, kidney and bone marrow biopsy, pleural, pericardial and peritoneal paracentesis

f. Be able to comprehend the basic principles of different diagnostic procedures in radiology, normal plain and special X-rays of whole body and newer imaging techniques.

(B) Skills: At the end of the course the student should be able to:

a. Identify all the major structures, organs, viscera of the body and mark the topography of important organs.

b. Identify the tissues and organs under the light microscope.

c. Identify normal anatomical structures, organs and viscera in radiographs, Computerized Tomography (CT) Scan, MRI etc. and correlate with the cross sections of the body.

d. Locate ideal sites of intramuscular and intravenous injection, lumbar puncture, bone marrow, kidney and liver biopsy, pleural, pericardial & peritoneal tapping.

e. Localise important pulsation and the structures against which pressure can be applied in case of bleeding from a particular artery.

f. Demonstrate muscle testing and movements at joints.

g. Locate the site for emergency tracheostomy

h. Interpret common genetic abnormalities in karyotypes.

(C) Integration

From the integrated teaching of other basic sciences, student should be able to comprehend the regulation and integration of the functions of the organs and systems in the body and thus interpret the anatomical basis of disease process.

(D) Scope of training:

Basic fundamentals of human gross, microscopic, developmental and radiological anatomy are covered in this course. Special emphasis is laid on its correlation with functional and applied aspects.

Dissection of cadaver is done by a group of students under the supervision of teacher so that they get accustomed to the structure of the human body .The dissection is preceeded by lectures/ demonstrations and followed by tutorial and seminars on selected topics by the students.

Histology:A lecture is followed by practical .The students are shown demonstration microscopic slides and provided individually with slides to study under the light microscope. They maintain a workbook, which is checked by the teachers. They are introduced to electron micrographs of some selected organs.

Embryology: Lectures and demonstration of models at different developmental stages are taken.

Self-learning is encouraged. The students' progress is evaluated at regular intervals and internal assessment is calculated separately for theory and practicals.

Course Content

General Anatomy

Brief history of anatomy as related to medicine, subdivisions of anatomy; anatomical position descriptive terms, structures met with during dissection; skin, superficial fascia including contents, deep fascia including its modifications; muscles; parts, origin, insertion, tendon, aponeurosis, bursa, synovial sheath; ligament, bone including ossification, joints in general and classification, blood vessels, lymphatic and nervous system in general.

Gross Anatomy

Lectures/ demonstrations in gross anatomy are taken under the general headings of: Introduction, position, important relations, blood, lymphatic and nerve supply, important applied aspects along with radiological features are emphasised wherever applicable. Emphasis is given on applied aspect of each structure dissected so that the student becomes aware of the clinical aspect of the structures in the body. The bones of the body are taught in details, which include general features, attachment of muscles and their actions and ossification of bones in demonstration classes.

The topics covered under the different regions are as follows:

Head & Neck

- Scalp
- Face, eye lid and the lacrimal apparatus
- Parotid gland
- Neck- posterior triangle, back of neck and suboccipital triangle
- Cranial cavity&meninges
- Orbit and its contents
- Anterior triangle& cervical fascia
- Thyroid and parathyroid glands
- Temporal and infratemporal regions
- Temporo-mandibular joint

- Pterygo-palatine fossa
- Submandibular Region
- Prevertebral region and root of neck
- Lymph nodes of head & neck& blood vessels of neck
- Last four cranial nerves and sympathetic trunk
- Oral cavity and tongue
- Pharynx, tonsil and Palate
- Nasal cavity
- Larynx
- Ear
- Seventh and eighth cranial nerves
- Eye ball
- Joints of head & neck
- Bones-Skull bones, mandible, cervical vertebrae, hyoid

Upper limb

- Introduction and pectoral region
- Mammary gland
- Axilla: boundaries, contents, brachial plexus, axillary vessels & lymph nodes
- Back
- Shoulder region
- Shoulder joint, acromioclavicular and sternoclavicular joint
- Flexor and extensor compartment of arm
- Cubital fossa
- Flexor compartment of forearm and palm
- Extensor compartment of forearm
- Elbow and radioulnar joints
- Lymphatic and Venous drainage of upper limb
- Dermatomes and nerve injuries
- Bones-clavicle, scapula, humerus, radius, ulna, skeleton of hand

Thorax

- Thoracic wall, Intercostal spaces
- Blood supply of thoracic wall
- Pleura and lungs
- Mediastinum: subdivisions
- Pericardium and heart
- Coronary circulation
- Superior mediastinum, its contents, arch of aorta
- Posterior Mediastinum, its contents
- Thoracic part of oesophagus, thoracic duct, vena azygus

- Autonomic nervous system
- Joints of thorax
- Mechanism of respiration
- Bones-sternum, ribs, thoracic vertebrae

Lower limb

- Introduction & front of thigh, femoral triangle, boundaries & its contents, femoral hernia
- Medial side of thigh and adductor canal
- Gluteal region, muscles, nerves and vessels
- Popliteal fossa, boundaries and contents
- Back of the thigh, hamstring muscles
- Hip joint
- Front of leg & dorsum of foot
- Lateral & medial side of leg
- Back of leg
- Sole
- Knee joint
- Ankle joint
- Tibio-fibular joint and small joints of foot
- Venous drainage & lymphatic drainage.
- Nerve injuries
- Arches of foot
- Bones-Hip bone, femur, patella, tibia, fibula and bones of foot

Abdomen and Pelvis

- Anterior abdominal wall
- Rectus sheath
- Inguinal canal& hernia
- Male genital organs
- Peritoneum
- Stomach
- Spleen and coeliac trunk
- Small and large intestines
- Mesentric vessels
- Duodenum
- Pancreas
- Liver and extra-hepatic biliary apparatus
- Portal vein
- Kidney, ureter and suprarenal
- Posterior abdominal wall

- Perineum-superficial and deep perineal pouches
- Ishiorectal fossa
- Pelvis-Urinary bladder
- Female genital organs:ovary, fallopian tube, uterus and vagina
- Rectum and anal canal
- Prostate, vas deferens, seminal vesicles
- Male urethra
- Blood vessels, nerves and muscles of pelvis
- Bones-Lumbar vertebrae, sacrum, male and female pelvis

Neuroanatomy

- Introduction, subdivisions of nervous system and meninges

- Spinal cord: external and internal features, nuclei, ascending and descending tracts, blood supply, lesions and their effects.

- Medulla oblongata: external and internal features, motor and sensory decussation, nuclei of cranial nerves, floor of the fourth ventricle, inferior cerebellar peduncle, blood supply and lesions.

- Pons: external and internal features, sections through upper and lower pons, nuclei of cranial nerves; middle cerebellar peduncle; blood supply and lesions.

- Midbrain: external and internal features, sections through superior and inferior colliculus, nuclei of cranial nerves, superior cerebellar peduncle, blood supply and lesions.

- Cerebellum: subdivisions, connections, white matter and nuclear masses, blood supply, functions and effect of lesions. .

- Thalamic complex: dorsal thalamus, metathalamus, epithalamus, subthalamus, connections, functions, blood supply and lesions.

- Hypothalamus: nuclei, connections, functions, blood supply, third ventricle and applied anatomy.
- Cerebral hemispheres: functional areas, basal ganglion, white matter, internal capsule, blood supply, lesions and lateral ventricle.

- Visual and auditary pathways.

- Limbic system: parts and functions.

- Reticular system: parts and functions.

- Cerebrospinal fluid: production, circulation, absorption, functions and applied anatomy.

- Autonomic nervous system: Sympathetic, Parasympathetic.

- Ascending and descending pathways.

Surface Anatomy

Important bony landmarks of the body, important vessels and nerves and projection of the outline of heart, its borders, surfaces and valves, lungs, their borders, fissures and hila, pleura, and various abdominal and pelvic organs.

Radiological anatomy

Identification of normal anatomical features in commonly used skiagrams (plain &contrast), CT scans and MRI.

Embryology

General Embryology

Introduction:

- Relevance of Embryology to medicine; anatomy of male and female reproductive system.
- Oogenesis, ovarian cycle, uterine cycle.
- Spermatogenesis, spermiogenesis, sex determination, principles of family planning

First two weeks of development:

- Fertilization, cleavage& blastocyst formation
- Implantation, formation of decidua.
- Formation of embryoblast and trophoblast, bilaminar germ disc.
- Amnioticsac; yolk sac; extraembryonic mesoderm& extraembryonic coelome; connecting stalk; chorion; formation of prochordal plate.

Third week of development

- Gastrulation: Trilaminar germ disc, formation of intraembryonic mesoderm, notochord, establishment of body axis.
- Trophoblast, secondary yolk sac, intraembryonic coelom
  .

Third to eigth week of development:Embryonic period

- Derivatives of ectoderm, endoderm and mesoderm
- Formation of somites, neural tube, foldings of the embryo, establishment of the body form, formation of the gut and its subdivisions.

Third month to birth :Fetus andFetal membranes

- Development of fetus
- Placenta: formation, functions, features, types, circulation, placental barrier abnormalities
- Umbilical cord; amnion, amniotic fluid, its functions; amniocentesis

Multiple Pregnancies & birth defects:

- Genetical and environmental causative factors for congenital malformations,
  mode of actions of teratogens and critical periods.
- Prenatal diagnosis of birth defects

Systemic Embryology

Development of GIT& Body cavities

- Divisions of gut: foregut, midgut & hepato-pancreatico-biliary system and hindgut
- Body cavities, peritoneal cavity
- Diaphragm, spleen and associated congenital anomalies

Development of respiratory system

- Formation of lung bud, larynx, trachea, bronchi, pleural cavity, maturation of lungs and clinical correlates

Development of genitourinary system:

- Kidney, ureter and urinary bladder
- Testis, ovary, suprarenal gland, descent of gonads
- Genital ducts, their derivatives, external genitalia and associated congenital anomalies

Development of cardiovascular system:

- Establishment of cardiogenic area
- Heart loop and formation of the chambers of the heart
- Intraembryonic vessels
- Major veins and developmental abnormalities
- Foetal circulation and changes after birth

Development of face and pharyngeal arches:

- Pharyngeal arches, pharyngeal pouches, pharyngeal clefts and their derivatives,
  thyroid and parathyroid gland and common birth defects
- Face, nasal cavity, oral cavity, tongue, soft palate and associated anomalies

Development of nervous system:

- Neural tube: brain vesicles and their derivatives, neural crest and its derivatives, hypophysis cerebri and associated anomalies

Development of organs of special senses

- Eye and ear and their anomalies

Development of skin and its appendages

- Skin and its appendages
- Mammary gland and anomalies

Development of musculoskeletal system

- Skull, vertebral column, limb bones, sternum and common congenital anomalies
- Development of muscles in brief

Genetics

Introduction:

Definition:

- Medical genetics
- Cytogenetics
- Clinical genetics

History:

- Gregor Mendel& laws of inheritance
- Cell cycle & division

Chromosomes:

- Structure& classification
- Karyotyping- methodology
- Sex chromatin& Lyon hypothesis

Chromosomal disorders:

- Numerical abnormalities & their causes
  - Polyploidy
  - Aneuploidy
  - Trisomy and monosomy
  - Down's syndrome
  - Patau's syndrome
  - Edwards's syndrome
  - Klienfelter's syndrome
  - Turner's syndrome
  - Mosaicism
- Structural abnormalities
  - Deletion, inversion, translocation and ring chromosomes
  - Isochromosomes, chromosomal fragile sites, fragile X chromosome

Chromosome at molecular level:

- Structure of DNA, RNA, genetic code, mutation, mutagens

Clinical genetics:

- Pedigree chart
- Inheritance

Diagnosis of Genetic disease:

- Prenatal diagnosis
- Indications
- Chorionic villi biopsy
- Maternal sera
- Amniocentesis

Genetic Counselling:

- Indication & basis of gene therapy

Histology

General Histology

Introduction: Cell & Microscope

Microscope and basic principles of microscopy,commonly used stains, basophilic and acidophilic staining reactions and their significance, commonly encountered artifacts. Detailed structure of cell and its components and their functional mechanisms.

Epithelial tissue:

Microscopic characteristics of simple and stratified epithelium, functions& distribution
Glands: mucous, serous and mixed

Connective Tissue:
Classification; cells, fibers and their structural features and functions.
Intercellular substances, amorphous ground substance, types of connective tissue (loose areolar tissue, dense connective tissue) and their distribution.

Cartilage:
Specialized connective tissue, different types of cartilages and their functions and distribution.

Bone:
structural features of compact and cancellous bone, their distribution and functions, ossification.

Muscular tissue:
Structural and functional characteristics of skeletal, cardiac and smooth muscle.

Lymphoid tissue:
Structural and functional characteristics of lymph node, spleen, tonsil and thymus.

Blood vessels:
Conducting and distributing arteries, arterioles, types of capillaries, their structural features and distribution, structural characteristics of large and small veins, lymphatics and sinusoids.

Nervous tissue:
Structural characteristics of a neuron, types of neurons and their structural and functional features and distribution, neuroglia: types, structure and functions, ganglia, peripheral nerves, myelination, degeneration and regeneration in peripheral nerves.

Systemic Histology

Digestive system:
General plan of GIT: Oesophagus, oral cavity, lip, tongue, salivary glands; parotid (serous), sublingual (mucous) and submandibular (mixed), stomach; body, fundus and pylorus ,small and large intestines; appendix and colon.

Glands:
Liver, gall bladder & pancreas.

Urinary system:
Kidney, ureters, urinary bladder and urethra

Male reproductive system:
Testis, epididymis, vas deferens, prostate and seminal vesicle

Female reproductive system:
Ovary, fallopian tube, different stages of functional activity of uterus, vagina
Mammary gland, placenta and umbilical cord

Integumentary system:
Skin: hairy, Non hairy

Respiratory system:
Nose, nasopharynx, larynx, trachea, principal brochi and lung

Endocrine system:
Pituitary, pineal; review of endocrine tissues in the pancreas, testis and ovary, thyroid, parathyroid and adrenal gland

Special sensory organs:
Eyeball
Taste buds
Olfactory mucosa

Nervous System:
Spinal cord, cerebrum, cerbellum

(E) Evaluation

Regular evaluation is done in the form of written and oral examination including dissection and histology practicals.

Internal Assessment: Existing as per MCI recommendations is 20% marks for theory and 20% for practical examination.

(The courses committee felt that internal assessment marks should have more weightage so that the students are regular in internal examinations throughout the academic year .)

University assessment:

Theory: Two papers of 50 marks each **(Total 100 marks)**

Each theory paper has three parts of two questions each.

The pattern and syllabus of question papers is as follows:

PAPER I: **50 marks**

(Head & neck, Neuroanatomy, Upper limb, related Histology and Embryology, General Anatomy and General Histology)

PAPER II **50 marks**

(Thorax, Abdomen, pelvis Lower limb, related Embryology, Histology and General Embryology and Principles of Genetics)

Each Theory paper has:

PART I

Q.1. Five short questions of two marks each (Enumerate type**)** **2 x 5=10**

Q.2 Five short questions of two marks each (Includes diagrams on topics of histology and gross anatomy, short questions on applied, general anatomy and general histology**)** **2 x 5 =10**

PART II

Q.3 Three specific short structured questions **3 x 3 =9**

Q.4 Full question specific structured **6**

PART III

Q.5 Two brief structured specific questions **2 x 3 =6**

Q.6 Three short structured questions on applied anatomy **3 x 3 =9**

The external examiners evaluate 50% of the theory papers.

Practical and viva voce

(a) Viva voce:	**20 marks** (to be added to theory marks)
i) Soft parts viva	10 marks
ii) Hard parts viva	10 marks
(b) Practical	**40 marks**
Dissection/prosection	6 marks
Surface Anatomy	4 marks
Histology	10 marks
Spotting	10 marks
Embryology	6 marks
Radiology	4 marks

Internal Assessment:

Theory	**20 marks**
Practical	**20 marks**

Total (Theory & Practical) **200 marks**

Recommended Books

Gross Anatomy

Romanes, C.J.: **Cunningham's Manual of practical Anatomy**, vol. 1, II, and III, 15th Ed.1999 Oxford University Press.

Chaurasia, B.D **Human Anatomy- Regional & Applied**. Vol. I, II & III, 4th Ed. 2004,CBS Publishers, Delhi.

Indirbir Singh: **Textbook of Anatomy with coloured Atlas**, Vol.I, II, III 4th Ed. 2007, Jaypee Publishers, Delhi.

Applied Anatomy

Snell RS: **Clinical Anatomy by Regions**, 8th Ed.2008 Lippincott Williams & Wilkins Baltimore.

Moore & Dalley: **Clinically oriented Anatomy**, 5th Ed. 2006, Lippincott Williams & Wilkins Baltimore.

Histology

Paul R. Wheater, H. George Surkitt & Victor G. Banials: Functional Histology: **A Text and Colour Atlas**, 4th Ed. 2000,ELBS, Churchill Livingston.

Inderbir Singh: **Textbook of Human Histology with colourAtlas**, 4th ed.2002, Jaypee Publishers, Delhi.

Neuroanatomy

Vishram Singh: **A Textbook of Clinical Neuroanatomy**, 2006, Elsevier India private Ltd.
Inderbir Singh: **Textbook of Human Neuroanatomy**, 7th ed. 2006, Jaypee Publishers
Snell R.S.: **Clinical Neuroanatomy**, 6th ed. 2006, Lippincott Williams & Wilkins.

Surface Anatomy, Radiological Anatomy, GeneralAnatomy&Genetics

Slaby and Jacob: **Radiographic Anatomy**,1990, National Medical Series for Independent Study, Harwal Publishing Philadelphia.
Halim R.: **Surface & Radiological Anatomy,** 2nd Ed, 1993, CBS Publisher
Chaurasia BD: **General Anatomy**, 3rd Ed, 1996, CBS Publishers
Pal: **Basis of Medical Genetics** 1st Ed. 2003, AITBS Publishers.

Embryology

Sadler T.W.: **Langmans Medical Embryology**, 10th edition, Lippincott Williams and Wilkins, Baltimore.
Inderbir Singh**: Introduction to Human Embryology for Medical Students**, 7th Ed.1999 Macmi11an publishers, India.

CURRICULUM OF HUMAN PHYSIOLOGY INCLUDING BIO-PHYSICS FOR UNDERGRADUATE MEDICAL STUDENTS

I. PHYSIOLOGY

A. GOAL

The broad goal of the teaching of undergraduate students in Physiology aims at providing the student comprehensive knowledge of the normal functions of the organ systems of the body to facilitate an understanding of the physiological basis of health and disease.

B. OBJECTIVES

(a) Knowledge

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

1) Understand and explain the normal functioning of all the organ systems and their interactions for well coordinated total body function.
2) Assess the relative contribution of each organ system to the maintenance of the milieu interior.
3) Explain various regulatory mechanisms and their integration.
4) Elucidate the physiological aspects of normal growth and development.
5) Describe the physiological response and adaptations to environment stresses and during disease process.
6) List the physiological principles underlying, pathogenesis and treatment of disease.
7) Understand reproductive physiology as relevant to National Family Welfare Programme.

(Course content: see Appendix 1)

(b) Skills

At the end of the course the learner shall be able to perform and interpret following skills:

1) Conduct experiments designed for study of physiological phenomena.
2) Interpret experimental / investigative data to assess health status.
3) Distinguish between normal and abnormal data derived as a result of tests which he/she has performed and observed in the laboratory.
4) Understand basic laboratory investigations relevant for a rural set up.
5) Acquire a concept of professionalism.
6) Learn to approach the patient with humanity and compassion.

(List of Experiments/Investigation: see Appendix II)

(c) Teaching methodologies to be employed:

- Didactic lectures
- Practicals :Hematology experiments, Human experiments including Clinical examination, Demonstration of frog and mammalian experiments, Demonstration of some human experiments
- Tutorials
- Student seminars
- Graphs and charts to be made in the departments to teach different principles of physiology, as well as pathophysiology, and to provide problem-solving exercises.

(d) Integration

Efforts are to be made to encourage integrated teaching between medical subjects. At the end of this teaching the student shall acquire an integrated knowledge of organ structure, function, its regulatory mechanisms, its pathophysiology and principles of management.

II. BIOPHYSICS

(a) GOAL AND OBJECTIVES:

The broad goal of teaching Biophysics to undergraduate students is that they should understand basic physical principles involved in the functioning of body organs in normal and diseased conditions.

Total time of teaching Biophysics	=	5 hours
Out of which:		
Didactic lectures	=	3 hours
Tutorial/group discussion	=	1 hour
Practical	=	1 hour

(b) TOPIC DISTRIBUTION:

(1) Lectures

1) Physical principles of transport across cell membranes and across capillary wall.
2) The membrane potentials; Gibbs – Donnan membrane equilibrium; Resting membrane potential; Action potential.
3) Biopotentials.
4) Physical principles governing flow of blood in heart and blood vessels.
5) Work done during breathing.
6) Physical principles governing flow of air in air passages.

(2) Tutorial/group discussion: on the topic covered in didactic lectures.

(3) Practicals – Demonstration of:

(i) Electroencephalogram (E.E.G.)
(ii) Electromyogram (E.M.G.)
(iii) Electrocardiogram (E.C.G.)

RECOMMENDED EVALUATION SCHEME FOR PHYSIOLOGY AND BIOPHYSICS

(A) TIME OF EVALUATION

Formative assessment:

There should be regular formative assessment and the day-to-day performance of the student should be given greater importance.

1. It should be based on the evaluation of the student's assignments, preparation for seminars, assessment tutorials etc.
2. Regular periodical tests and viva should be conducted through out the course for e.g. at the end of each system / unit.
3. Formative examination to be held at the end of 1st and 2nd semesters e.g. Terminal examination and Sent-up examination.

Summative assessment:

University (Professional) examination:

Theory, viva and practical, to be held at the end of 2nd semester.

(B) PATTERN OF THEORY PAPERS

There should be two theory papers.
Each paper shall be of 03 hours duration and of 50 marks.

PART 1

Q 1.Structured long question (with distribution of marks)	8 marks
Q 2. Draw labeled diagram/flow chart/table to illustrate (4 questions)	2x4=8 marks

PART II

Q 3. Structured long question (with distribution of marks)	8 marks
Q 4. What happens and why? (4 questions)	2x4=8 marks

PART III

Q 5. Write short notes on following (3 questions)	3x3=9 marks
Q 6. Write physiological/clinical significance of the following (3 questions)	3x3=9 marks

Marking

Theory	50x2	=	100 marks
Oral	10x2	=	20 marks
Internal Assessment		=	20 marks
		Total =	140 marks

(C) PRACTICALS

1. Spotting/OSPE	05 marks
2. Problem solving exercise	05 marks
3. Graph and charts (including those pertaining to Amphibian nerve muscle and heart experiments)	05 marks
4. Human Experiment	05 marks
5. Haematology	10 marks
6. Clinical Exercise	10 marks
Internal Assessment (including practical record book)	20 marks
Total	60 marks

Note:

1. Pass percentage - Minimum of 50% marks in theory including oral and internal assessment and 50% in practicals including internal assessment shall be required to declare a candidate pass in the subject.

2. A candidate obtaining ≥75% marks in theory plus practicals shall be declared to have passed the subjects with Honors.

RECOMMENDED READING

(A) TEXT BOOKS

1. Textbook of Medical Physiology by A.C. Guyton.
2. Textbook of Physiology (Volume I and II) by Dr. A.K. Jain.
3. Understanding Physiology by Dr. R.L. Bijlani.
4. Manual of Practical Physiology for MBBS by Dr. A.K. Jain.
5. Hutchinson's Clinical Methods.

(B) REFERENCE BOOKS

1. Review of Medical Physiology by W.F. Ganong.
2. Samson Wright's Applied Physiology.
3. Experimental Physiology by D.T. Harris.
4. Clinical Haematology by Dacie.
5. Wintrobe's - Clinical haematology.

Appendix I – Course Contents Knowledge

UNITS		Must Know	Desirable to know
I. General Physiology			
1	Structure and function of a generalized cell	√	
2	Principles of homeostasis	√	
3	Intercellular communication and cell functions	√	
4	Apoptosis – programmed cell death.	√	
5	Transport mechanisms across cell membranes	√	
6	Fluid compartments of the body: ionic composition & measuring units	√	
7	Concept of buffer system	√	
8	Molecular basis of resting membrane and action potential	√	
II. Blood			
1	Composition and functions	√	
2	Plasma proteins: origin, forms, variations and functions	√	
3	Haemoglobin :synthesis and functions, breakdown, variations	√	
4	RBC: formation, functions, anemias & jaundice	√	
5	WBC: formation, functions, variation and leukemias	√	
6	Platelets: functions, variations, formation	√	
7	Hemostasis: mechanisms, anticoagulants, bleeding disorders (hemophilia, purpura)	√	
8	Blood groups: basics of blood grouping, clinical importance, blood banking and transfusion.	√	
9	Immunity: development, types, regulation	√	

UNITS		Must Know	Desirable to know
III. Nerve and Muscle Physiology			
1	Structure and functions of a neuron and neuroglia, nerve growth factor	√	
2	Nerve fibers: types, functions, properties	√	
3	Degeneration and regeneration in peripheral nerves	√	
4	Structure and transmission across neuro-muscular junction	√	
5	Neuro-muscular blocking agents		√
6	Pathophysiology of Myasthenia gravis		√
7	Types and structure of muscle fiber	√	
8	Action potential and properties in different muscle types (skeletal, cardiac & smooth)	√	
9	Molecular basis of muscle contraction, motor unit	√	
10	Mode of contraction (isometric and isotonic)	√	
11	Energy source and muscle metabolism		√
12	Gradation of muscular activity		√
13	Muscular dystrophy, myopathies		√
IV. Digestive system/Gastro intestinal tract (GIT)			
1	Structure and function of digestive system	√	
2	Composition, functions and regulation of : saliva, gastric, pancreatic and intestinal juice, bile secretion	√	
3	GIT movements, regulation and functions, dietary fiber, defecation reflex	√	
4	Digestion and absorption in GIT	√	
5	GIT hormones: source, regulation and functions	√	
6	Liver and gall bladder: structure and functions	√	
7	Gastric function tests, pancreatic exocrine function tests, liver function tests		√
8	Pathophysiology of peptic ulcer, gastro-oesophageal reflux disease, vomiting, diarrhoea, constipation, gastrectomy, cholecystectomy, mal-absorption syndrome, adynamic illeus, intestinal obstruction, Hirschsprung's disease		√

UNITS		Must Know	Desirable to know
V. Cardiovascular system (CVS)			
1	Heart: functional anatomy, chambers, sounds, pacemaker tissue	√	
2	Properties of cardiac muscle: morphological, electrical, mechanical and metabolic	√	
3	Electrocardiogram (ECG): physiological basis and applications, cardiac axis	√	
4	Abnormal ECG: heart blocks, arrhythmias, myocardial infarction		√
5	Haemodynamics of circulatory system	√	
6	Cardiovascular regulatory mechanisms: local & systemic	√	
7	Factors affecting and regulation of heart rate, cardiac output, blood pressure	√	
8	Echocardiography		√
9	Regional circulation: coronary, cerebral, capillary, skin, foetal, pulmonary and splanchnic circulation	√	
10	Pathophysiology of shock, syncope, heart failure	√	
VI. Respiratory system			
1	Functional anatomy	√	
2	Mechanics of normal respiration, pressure changes during ventilation, lung volumes and capacities, alveolar surface tension, compliance, airway resistance, ventilation, v/p ratio, diffusion capacity of lungs	√	
3	Transport of respiratory gases: oxygen and carbon dioxide transport	√	
4	Physiology of high altitude and deep sea diving	√	
5	Principles of artificial respiration, oxygen therapy, acclimatization and decompression sickness	√	
6	Pathophysiology- dyspnoea, hypoxia, cyanosis asphyxia; drowning, periodic breathing	√	
7	Lung function tests and their clinical significance		√
VII. Excretory system			
1	Structure and function of kidney	√	
2	Structure and function of a juxta glomerular apparatus, role of renin – angiotensin system	√	
3	Mechanism of urine formation involving processes of filtration, tubular re-absorption and secretion, concentration and diluting mechanism	√	

UNITS		Must know	Desirable to know
4	Renal clearance: significance and application	√	
5	Renal regulation of fluid and electrolyte, acid-base balance	√	
6	Innervation of urinary bladder, physiology of Micturition and its abnormalities	√	
7	Artificial kidney, dialysis and renal transplantation		√
8	Renal function tests		√
VIII.	**Endocrinology**		
1	Estimation and assessment of hormones		√
2	Physiological actions and effect of altered (hypo and hyper) secretion of pituitary gland. thyroid gland, parathyroid gland, adrenal gland. pancreas and hypothalamus	√	
3	Thymus, pineal gland and local hormones	√	
4	Function tests of thyroid gland, adrenal cortex, adrenal medulla and pancreas		√
IX.	**Reproductive system**		
1	Sex determination, sex differentiation and their abnormalities	√	
2	Puberty: control of onset, stages, delayed and precocious puberty	√	
3	Male reproductive system: testis, testicular functions and its control, spermatogenesis and factors influencing it	√	
4	Female reproductive system: ovaries, ovarian function and its control. Menstrual cycle: hormonal, uterine and ovarian changes	√	
5	Physiological effect of sex hormones	√	
6	Contraceptive methods (male and female)	√	
7	Physiological effects of removal of gonads		√

	UNITS	Must Know	Desirable to know
X.	**Nervous system**		
1	Organization of nervous system	√	
2	Functions and properties of synapse, reflex, receptors	√	
3	Somatic sensations, sensory tracts	√	
4	Motor tracts, mechanism of maintenance of muscle tone, control of body movements, posture and equilibrium, vestibular apparatus	√	
5	Structure and function of reticular system, autonomic nervous system (ANS)	√	
6	Spinal cord: functions, lesions-sensory and motor disturbances	√	
7	Functions of cerebral cortex, basal ganglia, thalamus, hypothalamus, cerebellum and limbic system and their abnormalities.	√	
8	EEG and Sleep	√	
9	Higher functions of nervous system (memory, learning, speech) and associated abnormalities	√	
10	Chemical transmission in the nervous system		√
XI.	**Special senses**		
1	Perception of smell and taste sensation	√	
2	Pathophysiology of altered smell and taste sensation		√
3	Functional anatomy of ear, mechanism of hearing	√	
4	Pathophysiology of deafness, hearing tests	√	
5	Functional anatomy of eye, physiology of image formation and color vision, refractory errors, visual reflexes- pupillary and light	√	
6	Effect of lesion in visual pathway	√	
7	Auditory & visual evoke potentials		√

	UNITS	Must Know	Desirable to know
XII.	**Integrated Physiology**		
(A)	Skin and body temperature regulation:		
	mechanism of temperature regulation	√	
	adaptation to altered temperature (heat and cold)	√	
	mechanism of fever, cold injuries and heat stroke	√	
(B)	Physiology of sports, exercise, yoga and meditation:		
	cardio-respiratory and metabolic adjustments during exercise, effects of physical training	√	
	physiological effects of yoga and meditation		√

Appendix II: Experimental/ Investigative Skills			
	UNITS	**Must Know**	**Desirable to know**
I.	**Hematology Experiments**		
1	Estimation of hemoglobin	√	
2	Determination of total erythrocyte count (TRBC)	√	
3	Determination of RBC indices (Blood standards)	√	
4	Determination of total leucocyte count (TLC)	√	
5	Preparation of a peripheral blood smear and Determination of differential leucocyte count (DLC)	√	
6	Determination of Arneth count	√	
7	Determination of bleeding time (BT) and clotting time (CT)	√	
8	Determination of blood groups (A,B,O and Rh system)	√	
9	Determination of specific gravity of blood		√
10	Determination of erythrocyte sedimentation rate (ESR) and packed cell volume (PCV)		√
11	Determination of osmotic fragility of red blood cells	√	
12	Determination of platelet count	√	
13	Determination of reticulocyte count	√	
14	Determination of absolute eosinophil count		√
15	Study of haemopoietic cells present in the bone marrow		√

	UNITS	Must Know	Desirable to know
II.	**ANIMAL EXPERIMENTS: Amphibian (Frog) Experiments: as graphs and charts**		
1	Effect of temperature on simple muscle twitch		√
2	Effect of two successive stimuli (of same strength)		√
3	Effect of increasing strength of stimuli		√
4	Effect of increasing frequency of stimuli (genesis of tetanus)		√
5	Effect of free load and after load		√
6	Effect of repeated stimuli (study of phenomenon of fatigue)		√
7	Determination of conduction velocity of sciatic nerve and effect of variables on it		√
8	Properties of cardiac muscle: refractory period. All or none law, extrasystole and compensatory pause, beneficial effect.		√
9	Regulation of heart, vagus dissection and effect of vagal and WCL stimulation		√
10	Effect of variables on frog's heart		√
III.	**HUMAN PHYSIOLOGY**		
A.	**Clinical Physiology**		
1	Elementary principles of clinical examination	√	
2	General physical examination	√	
3	General principles of Inspection/ Palpation/ Percussion/ Auscultation	√	
B.	**Nerve muscle physiology**		
1	Ergography and hand grip spring dynamography- study of phenomenon of human fatigue	√	
2	Recording of electromyography (EMG)		√

S.No	UNITS	Able to perform independently	Able to perform under guidance	Observe/ Demonstrate
C.	**Cardiovascular system (CVS)**			
1	Clinical examination of CVS	√		
2	Examination of arterial & venous pulses	√		
3	Measurements of arterial blood pressure	√		
4	Recording of 12 lead Electrocardiography (ECG) and its interpretation.		√	
D.	**Respiratory system**	√		
1	Clinical examination of respiratory system	√		
2	Stethography- study of respiratory movements and effect of various factors	√		
3	Assessment of ventilatory functions – vitalography	√		
4	Spriometry- study of lung volume and capacities	√		
5	Measurement of BMR			√
6	Cardio-pulmonary-cerebral resuscitation and artificial respiration.	√		
E.	**Abdominal system:** Clinical examination of abdomen	√		
F.	**Exeretory system**			
	Recording of body temperature	√		
G.	**Reproductive systems**			
	Pregnancy diagnostic test immunological test		√	

S.No	UNITS	Able to perform independently	Able to perform under guidance	Observe/ Demonstrate
H.	**Nervous System including Special Senses**			
1	Clinical examination of the nervous system and its physiological basis	√		
2	Examination of higher mental functions	√		
3	Examination of cranial nerves	√		
4	Examination of sensory system	√		
5	Examination of motor system including reflexes	√		
6	Clinical examination of special senses:			
(i)	Smell and taste	√		
(ii)	Tests for hearing	√		
(iii)	Ophthalmology:	√		
(a)	Clinical examination of the eye and pupillary reflex	√		
(b)	Visual acuity	√		
(C)	Perimetery- mapping out of visual field and blind spot	√		
(d)	Accommodation	√		
(e)	Fundoscopy			√
(f)	Colour vision and colour blindness	√		
7	Reaction (visual and auditory) and reflex time		√	
8	Electroencephalography (EEG)			√
9	Autonomic nervous system (ANS) Testing			√
10	Neuro- electrodiagnostic techniques			√
(i)	Nerve conduction study			√

(ii)	Visual evoked potential (VEP)			√
(iii)	Brainstem auditory evoked potential (BAEP)			√
(iv)	Somato sensory evoked potential (SEP)			√
(v)	Motor evoked potential (MEP)			√
I.	**Others**			
	Tests for physical fitness: Cardio-respiratory responses to steady state exercise using step test, bicycle ergometer, treadmill	√		

CURRICULUM
M.B.B.S

BIOCHEMISTRY

Programme 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 solving clinical problems.

Objectives

(A) Knowledge

At the end of the course the student shall be able to demonstrate his knowledge and understanding on the

(a) Molecular and functional organization of a cell and sub-cellular components.
(b) Structure, function and interrelationship of biomolecules and consequences of deviation from normal.
(c) Summarize the basic and clinical aspects of enzymology and regulation of enzymatic activity.
(d) Understand and describe of diagnostic importance of digestion and assimilation of nutrients and consequences of malnutrition.
(e) Integration of the various aspects of metabolism and their regulatory pathways.
(f) Biochemical basis of inborn errors of metabolism and their associated sequelae.
(g) Mechanisms involved in maintenance of body fluids and pH homeostasis.

(h) Molecular mechanisms of gene expression and regulation, principles of genetic engineering and their application in medicine.

(i) Molecular aspects of body defence and their application in medicine.

(j) Biochemical basis of cancer and carcinogenesis, principles of metabolism and detoxification of xenobiotics.

(k) Principles of various conventional and specialized laboratory investigations and instrumentation, analysis and interpretation of a given data; the ability to suggest experiments to support theoretical concepts and clinical diagnosis.

(B) Skills :

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

(a) Make use of conventional techniques/instruments to perform biochemical analysis relevant to clinical screenings and diagnosis.

a. Analyze and interpret investigative data.
b. Demonstrate the skills of solving 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.

Specific learning objectives

1. While emphasizing the basic concepts, every effort should be made to correlate the clinical/ applied aspects .
2. Tutorial/small group teaching should be undertaken at the end of related group of topics to encourage students to question clear doubts etc.
3. Horizontal integration may be followed in the areas of endocrines, acid base, specialized tissues in close co-operation with department of anatomy and physiology.
4 To. make the subject more interesting and applied demonstration of clinical cases/case discussion with clinical colleagues- vertical integration.
5. Student seminars/ projects by students(review) should be encouraged as means of self learning, use of library etc.
6. Use of molecular models, video films, Cat to strengthen and illustrate basic concepts.

Course content

PAPER-I

Time(3 hrs)

. **1 .Chemistry, biomedical importance of biomolecules `**

(a) Carbohydrates (monosaccharides, + their derivatives-amino sugar, uronic acids, glycosides, disaccharides, polysaccharides,,starch, glycogen, cellulose, glycosaminoglycans, sialic acids etc.)

(b) Lipids(fatty acids, triacylglycerol, phospholipids, glycolipids, sulfolipids, steroids)

(c) Amino acids, biologically active peptides.

(d) Proteins-three dimensional structure/conformation- four levels of architecture structure in relation to biological functions with specific examples viz Hb, collagen etc in health and disease.

(e) Separation of proteins

Clinical correlation:

(a) Mucopolysaccharidoses

(b Lipid storage diseases

(c) Sickle cell anemia

2.Enzymes-

1. Introduction, classification,
2. Coenzymes, isoenzymes,
3. Properties- kinetics, enzyme assay
4. Mechanism of enzyme action
5. Inhibition or enzyme activity
6. Regulation of enzyme activity.

Clinical correlations:

1. Drugs as enzyme inhibitors in antibacterial antiviral & antitumor therapy.
2. Diagnostic significance of isoenzymes e.g. LDH, CPK

3. **Metabolism- overview**

a. Metabolism of carbohydrates

Digestion- absorption, glycolysis TCA cycle – regulation, Glycogen metabolism and its regulation, Cori cycle,. Gluconeogenesis and control of blood glucose, metabolism of fructose, galactose, metabolism of ethanol. Significance of pentose phosphate pathway & uronic acid pathway.

Clinical correlation:

a) Glycogen storage diseases
b) Essential fructosuria, galactosemia
c) Lactic acidosis
d) G6PD deficiency
e) Alcoholism – Methanol poisoning

b. **Metabolism of Lipids**

Digestion, absorption – role of bile salts. Storage and mobilisation of fats, biosynthesis and oxidation of fatty acids, ketone bodies- formation, utilisation. Regulation of ketogenesis- ketosis. Metabolism of unsaturated fatty acids and eicosanoids- prostaglandins, leukotrienes. Lipids transport -structure. metabolism and functions of different classes of lipoproteins. Role of liver. Separation of lipoprotein classes. Cholesterol, synthesis, transport and excretion. Bile acids formation. Role of cholesterol in the development of atherosclerosis -relationship of hypercholesterolemia- and dietary fat intake.

Clinical correlation:

1. Obesity
2. ketoacidosis
3. fatty liver
4. Hyperlipidemias
5. Atherosclerosis

c. **Biological oxidations**

Role of oxido-reductases

Cytochrome P450 system

Free radicals formation, scavenging oxygen free radicals. Antioxidants. Role in diseases.

Respiratory chain and oxidative phosphorylation, components of respiratory chain control, site specific inhibitors, uncouplers.

High energy phosphate compounds

Clinical correlations:

1. Cyanide poisoning
2. Hypoxic injury

d. **Metabolism of amino acids**

Digestion and absorption, pathways of amino acid degradation, transamination oxidative deamination. Metabolism of ammonia-urea cycle. Catabolism of C skeletons. Synthesis of biologically important compounds from amino acids.

Clinical correlations:

1. Inborn errors of metabolism associated with various amino-acids viz PKU, Hartnup disease, Maple syrup, urine disease etc.

e.**Integration and hormonal regulation of mammalian metabolism**. Inter conversion of major foodstuffs, tissue specific metabolism- liver, muscle, erythrocytes, heart, adipose tissue, brain etc.

Clinical correlations:

1. Starvation
2. Uncontrolled diabetes mellitus
3. Metabolic response to stress, injury
4. Haemolysis, erythrocyte membrane stability.

f. **Endocrine biochemistry**

1. General mechanisms of hormone action assay
2. Hormones of pituitary, releasing factors
3. Thyroid and parathyroids
4. Hormones of adrenal cortex
5. Adrenal medullary homones

6. Sex hormones- biochemistry of contraception
7. Hormones of pancreas and GI tract.

g. **Nutrition**

Biochemical role, sources, deficiency, requirement of vitamins Role of carbohydrates- fiber in the diet. Fats- unsaturated fatty acids, Proteins , Biological value, SDA.

Minerals- Ca, P, Mg, Na, K, Cl

Trace elements- Fe ,Cu ,Se, I etc.

Clinical correlations:

1. Deficiency states of vitamins.
2. Protein- energy malnutrition
3. malabosortption syndromes
4. Iron deficiency anemia
5. Wilson's disease
6. Tetany
7. PUFA and risk factors for IHD
8. Cholera/ gastroenteritis

1. Haem Metabolism:-

Formation and catabolism of haem, bile pigments. Tests for liver function

Clinical correlations:

1. Porphyrias
2. Jaundice

i.**Metabolism of Xenobiotics**

Cyctochrome P450 system

Conjugation and other reactions- glucuronidation.

PAPER-II

Time(3 hrs)

Molecular biology

a. Molecular logic of life- chemical unity underlies biological diversity.

b.Molecular cell biology- chemical composition, current concepts of the structure of eukaryotic cell membrane, Membrane assembly- features, targeting proteins to their destinations by signal sequences- signal hypothesis, molecular chaperones, specialized functions- transfer of material and information across membranes-Diffusion, active transport, Endocytosis, exocytosis channels, pores cell surface receptors- signal transduction, signal internalization. Intercellular contact and communication, Micelles, Liposomes.

Clinical correlations:

1. Familial hypercholesterolemia
2. Achondroplasia
3. Metastasis

c. **Extacellular matrix-** structural proteins, specialized proteins, glycos aminoglycans. Molecular biology of bone and cartilage cell adhesion and migration- fibronectin, renal glomerular membrane- basal laminal- laminin

Clinical correlations:

a. Osteoporosis
b. Chondrodypalisas
c. Osterogenesis imperfecta
d. Marfan syndrome

d. **Glucoproteins-** functions, structure, three major classes- O linked, N linked, GPI linked. Mucins, Glucosylation of glycoproteins- factors affecting molecules involved in leukocytes endothelial cell interactions.

Clinical correlations:

1. Influenza
2. Rheumatoid arthritis
3. α- mannosidosis

e.- **Chemistry and metabolism of purines and pyrimidines**.

Nucleosides and nucleotides. Analogues of purines and pyrimidines-application in medicine.

Clinical correlations:

i- Gout

ii- Orolic aciduria

iii- Xanthinurias

f**. Molecular basis of heredity, eukaryotic chromosomes-**

DNA, histones, nucleosomes, nonhistone proteins. Chemistry, Structure of nucleic acids DNA organization and replication. Molecular basis of mutation-DNA repair Gene rearrangements.

Mammalian cell cycle- cyclins. RNA synthesis, processing and metabolism, post transcriptional modification, reverse transcription protein synthesis- post translational modification. Inhibitors of protein synthesis.

Protein targeting, regulation of gene expression in eukaryotes-tissue specific expression, molecular machines that control genes, Human Genome Project

Clinical correlations:

a) Xeroderma pigmentosum
b) Thalassemias
c) Antibiotics and toxins targeting RNA polymerase
d) Staphylococcal resistance to erythromycin

g. **Recombinant DNA and medical biotechnology-**

Isolation and manipulation of DNA chimeric DNA sequencing. Phage and cosmid vectors, Recombinant DNA and cloning Genomic, cDNA libraries, Gene Probes, Blotting & hybridization, selection of specific cloned DNA in libraries. Detection of recombinant DNA, PCR application in medicine.

h. **Molecular basis of inherited diseases-**

molecular analysis of inborn errors of metabolism with examples from different metabolic pathways biochemical diagnosis neonatal screening, prenatal

diagnosis. DNA analysis, RFLP, detection of mutation DNA cloning- PCR probes, southern blotting cues to the diagnosis of and inborn error. Major laboratory tests used in the diagnosis of genetic diseases: Gene therapy.

i Molecular mechanisms in specialized tissues

1. Molecular basis of muscle, contraction - molecular motors, molecular basis of neuronal transmission, nervous tissue, molecular mechanisms of vision, neuropeptides- endorphins and enkephalins.

Clinical correlations:

1. Myasthenia gravis
2. Parkinsonism
3. Night blindness
4. Cataract

2. Molecular mechanisms of cell deaths and aging.

j.**Molecular basis of immunology**

1. Overview of immune system- basic concepts
2. Antigens- epitopes, haptens viral, bacterial mitogens.
3. Immunodermical techniques
4. Immune response, T-cell mediated immunity, Humoral immune response
5. Antigen antibody reactions
6. Antigen processing and presentation, complement , cytokines
7. Hybridomas, monoclonal antibodies
8. Immune system in health and disease- immunodeficiency, hypersensitivity, autoimmunity.
9. Immunoprophylaxis
10. Major histocompatibility complex- transplantation of organs immunosuppressants.
11. Mononuclear phagocytes- macrophages.

k.**Molecular biology of cancer**

Biochemical characteristics of cancer

Morphological & biochemical changes occurring upon malignant transformation

Carcinogenesis- carcinogens physical chemical and biologic

Oncogenes, polypeptide growth factors

Molecular basis of metastasis molecular alterations occurring at the surface of malignant cells, cell adhesions inter cell communications. Tumor markers- biochemical basis of drugs used in cancer chemotherapy.

l.**Molecular basis of differentiation**

m. **Clinical chemistry**

Acid- base homoeostasis- buffers in blood- Hb, plasma buffers.

Role of lungs, kidneys

Plasma proteins- functions, separation alterations in disease

Environmental biochemistry

Biochemical basis of human diseases and laboratory approach

Evaluation

Theory- Two papers of 50 marks each (one applied question of 10 marks in each paper)	100 marks
Oral (viva)	20 marks
Practical	40 marks
Internal assessment (Theory-20; practical-20)	40 marks
Total	200 marks

Pass: in each of the subjexts, a candidate must obtain 50% aggregate with a minimum of 50% theory including oral and minimum of 50% in practicals.