GENERAL ANATOMY

BASIC TISSUES

SHORT ESSAYS

1. Describe the structure and function of skin with its appendages.

Introduction

Skin is the largest organ of the body forming the external covering. It protects the body from physical, chemical and microbial injury.

Structure of Skin

Skin consists of two main layers:

1. Epidermis

- **Outer ectodermal layer.**
- **Made of keratinized stratified squamous epithelium.**
- **Avascular.**
- **Cells present:**
  - **Keratinocytes**
  - **Melanocytes**
  - **Langerhans cells**
  - **Merkel cells**

Layers of epidermis

From deep to superficial:

1. **Stratum basale**
2. **Stratum spinosum**
3. **Stratum granulosum**
4. **Stratum lucidum (only in thick skin)**
5. **Stratum corneum**

2. Dermis

- **Mesodermal in origin.**
- **Composed of connective tissue.**
- **Contains blood vessels, nerves and skin appendages.**

Layers of dermis

1. **Papillary layer**
2. **Reticular layer**

3. Hypodermis (Subcutaneous tissue)

- **Consists of loose connective tissue and fat.**
- **Anchors skin to underlying structures.**

Appendages of Skin

1. **Hair**
2. **Sebaceous glands**
3. **Sweat glands**
4. **Nails**

Hair

- **Develops from epidermis.**
- **Parts:**
  - **Shaft**
  - **Root**
  - **Bulb**

Sebaceous glands

- **Holocrine glands.**
- **Secrete sebum.**
- **Usually associated with hair follicles.**

Sweat glands

Eccrine glands

- **Widely distributed.**
- **Help in thermoregulation.**

Apocrine glands

- **Present in axilla and genital region.**
- **Become active at puberty.**

Nails

- **Modified keratin plates.**
- **Protect terminal phalanges.**

Functions of Skin

1. **Protection**
2. **Regulation of body temperature**
3. **Sensation**
4. **Excretion through sweat**
5. **Vitamin D synthesis**
6. **Storage of fat**
7. **Prevention of water loss**
8. **Immune defense**

Conclusion

Skin acts as a protective covering and performs important sensory, metabolic and thermoregulatory functions.

SHORT NOTES

1. Connective tissue fibres

Connective tissue fibres are components of extracellular matrix.

Types

1. **Collagen fibres**
2. **Elastic fibres**
3. **Reticular fibres**

Collagen fibres

- **Most common.**
- **White in colour.**
- **Strong and inelastic.**
- **Formed by collagen protein.**
- **Provide tensile strength.**

Elastic fibres

- **Yellow fibres.**
- **Composed of elastin.**
- **Stretchable and elastic.**
- **Seen in ligaments and large arteries.**

Reticular fibres

- **Thin branching fibres.**
- **Composed of type III collagen.**
- **Form supporting network in lymphoid organs.**

Functions

1. **Support**
2. **Strength**
3. **Elasticity**
4. **Framework for organs**

2. Compound glands

Compound glands are multicellular exocrine glands with branched ducts.

Classification

Based on secretory part

1. **Compound tubular**
2. **Compound acinar**
3. **Compound tubuloacinar**

Examples

- **Salivary glands**
- **Pancreas**
- **Brunner's glands**

Structure

- **Capsule present.**
- **Septa divide gland into lobes and lobules.**

- **Duct system highly branched.**
- **Secretory units lined by glandular epithelium.**

Functions

- **Secretion of enzymes, mucus or serous fluid.**

BONES AND JOINTS

LONG ESSAYS

1. Classify joints. Give the structure of synovial joint with an example.

Classification of Joints

A. Fibrous joints

Bones united by fibrous tissue.

Types

1. **Suture – skull bones**
2. **Syndesmosis – inferior tibiofibular joint**
3. **Gomphosis – tooth in socket**

B. Cartilaginous joints

Bones united by cartilage.

Types

Primary cartilaginous joint (Synchondrosis)

- **Hyaline cartilage present.**
- **Example: Epiphyseal plate.**

Secondary cartilaginous joint (Symphysis)

- **Fibrocartilage present.**
- **Example: Pubic symphysis.**

C. Synovial joints

- **Freely movable joints.**
- **Have synovial cavity.**

Structure of Synovial Joint

Essential features

1. Articular surfaces

- **Covered by hyaline cartilage.**
- **Smooth and avascular.**

2. Joint cavity

- **Space between articular surfaces.**
- **Contains synovial fluid.**

3. Articular capsule

Fibrous capsule

- **Outer strong layer.**

Synovial membrane

- **Inner vascular membrane.**
- **Secretes synovial fluid.**

4. Synovial fluid

Functions:

- **Lubrication**
- **Nutrition of cartilage**
- **Shock absorption**

Accessory structures

1. **Ligaments**
2. **Articular disc/meniscus**
3. **Labrum**
4. **Fat pads**
5. **Bursae**

Blood supply

- **Articular arteries form periarticular anastomosis.**

Nerve supply

- **Hilton's law.**

Example

Knee joint.

Conclusion

Synovial joints provide maximum mobility and are structurally specialized for movement.

SHORT ESSAYS

1. Describe the structure of synovial joints. Classify synovial joints with examples.

Structure of Synovial Joint

1. **Articular cartilage**
2. **Joint cavity**
3. **Fibrous capsule**
4. **Synovial membrane**
5. **Synovial fluid**
6. **Accessory ligaments and discs**

Classification of Synovial Joints

1. Plane joint

- **Gliding movement.**
- **Example: Intercarpal joints.**

2. Hinge joint

- **Flexion and extension.**
- **Example: Elbow joint.**

3. Pivot joint

- **Rotation.**
- **Example: Superior radioulnar joint.**

4. Condylar joint

- **Biaxial.**
- **Example: Wrist joint.**

5. Ellipsoid joint

- **Example: Metacarpophalangeal joint.**

6. Saddle joint

- **Example: First carpometacarpal joint.**

7. Ball and socket joint

- **Multiaxial.**
- **Example: Shoulder joint.**

2. Classify cartilage with suitable examples. Describe the structure of elastic cartilage.

Classification of Cartilage

1. Hyaline cartilage

Examples:

- **Articular cartilage**
- **Costal cartilage**
- **Tracheal rings**

2. Elastic cartilage

Examples:

- **Pinna**
- **Epiglottis**

- **Auditory tube**

3. Fibrocartilage

Examples:

- **Intervertebral disc**
- **Pubic symphysis**
- **Menisci**

Structure of Elastic Cartilage

- **Yellow flexible cartilage.**
- **Covered by perichondrium.**
- **Chondrocytes present in lacunae.**
- **Matrix contains elastic fibres.**
- **Highly flexible.**

Functions

1. **Provides support.**
2. **Maintains shape.**
3. **Gives elasticity.**

SHORT NOTES

1. Describe the parts and arterial supply of a developing long bone

Parts of developing long bone

1. **Diaphysis**
2. **Metaphysis**
3. **Epiphysis**
4. **Epiphyseal plate**
5. **Articular cartilage**

Arterial supply

1. **Nutrient artery**
2. **Periosteal arteries**
3. **Metaphyseal arteries**
4. **Epiphyseal arteries**

Importance

- **Essential for growth and ossification.**

2. Blood supply of a long bone.

Sources

1. **Nutrient artery**
2. **Periosteal arteries**
3. **Metaphyseal arteries**
4. **Epiphyseal arteries**

Nutrient artery

- **Enters through nutrient foramen.**
- **Supplies medulla and inner cortex.**

Periosteal arteries

- **Supply outer cortex.**

Metaphyseal and epiphyseal arteries

- **Supply ends of bone.**

Venous drainage

Through nutrient and periosteal veins.

Applied anatomy

- **Fracture may disturb blood supply causing avascular necrosis.**

3. Classify synovial joints with an example for each

1. **Plane – Intercarpal joint**
2. **Hinge – Elbow joint**
3. **Pivot – Superior radioulnar joint**
4. **Condylar – Wrist joint**
5. **Saddle – First carpometacarpal joint**
6. **Ball and socket – Shoulder joint**

4. Types of epiphysis

Types

1. **Pressure epiphysis**
2. **Traction epiphysis**
3. **Atavistic epiphysis**
4. **Aberrant epiphysis**

Examples

- **Pressure: Head of femur**
- **Traction: Greater trochanter**
- **Atavistic: Coracoid process**
- **Aberrant: Epiphysis at first metacarpal**

5. Sesamoid bone

Sesamoid bones are bones developed within tendons.

Features

- **Reduce friction.**
- **Modify pressure.**
- **Increase efficiency of muscles.**

Examples

1. **Patella**
2. **Pisiform**
3. **Sesamoid bones of thumb and great toe**

6. Periosteum

Periosteum is fibrous membrane covering bone except at articular surfaces.

Layers

1. **Outer fibrous layer**
2. **Inner osteogenic layer**

Functions

1. **Nutrition**
2. **Appositional growth**
3. **Repair of fractures**
4. **Attachment for tendons and ligaments**

7. Pivot joint

Pivot joint is a uniaxial synovial joint permitting rotation.

Features

- **Rounded process rotates within ring.**

Examples

1. **Superior radioulnar joint**
2. **Median atlantoaxial joint**

Movements

- **Rotation only.**

8. Epiphyseal plate

Epiphyseal plate is hyaline cartilage plate between epiphysis and diaphysis.

Zones

1. **Resting zone**
2. **Proliferation zone**
3. **Hypertrophy zone**
4. **Calcification zone**
5. **Ossification zone**

Functions

- **Responsible for longitudinal growth.**

9. Fibrous joints

Fibrous joints are joints where bones are united by fibrous tissue.

Types

1. **Suture**
2. **Syndesmosis**
3. **Gomphosis**

Features

- **No joint cavity.**
- **Minimal movement.**

10. Epiphysis

Epiphysis is the end part of a long bone developing from secondary ossification center.

Types

1. **Pressure epiphysis**
2. **Traction epiphysis**
3. **Atavistic epiphysis**
4. **Aberrant epiphysis**

Functions

- **Growth of bone.**
- **Articulation.**

11. Osteon

Osteon or Haversian system is the structural unit of compact bone.

Components

1. **Haversian canal**
2. **Concentric lamellae**
3. **Lacunae with osteocytes**
4. **Canaliculi**

Functions

- **Strength and nutrition of compact bone.**

12. Cells of bone tissues

Types

1. **Osteoprogenitor cells**
2. **Osteoblasts**
3. **Osteocytes**
4. **Osteoclasts**

Osteoblasts

- **Bone forming cells.**

Osteocytes

- **Mature bone cells.**

Osteoclasts

- **Bone resorbing cells.**

13. Anterior fontanelle

Anterior fontanelle is diamond-shaped membranous gap between skull bones.

Boundaries

- **Frontal bones anteriorly.**
- **Parietal bones posteriorly.**

Closure

- **Closes by 18 months.**

Importance

1. **Indicates hydration.**
2. **Helps during birth.**
3. **Clinical importance in hydrocephalus.**

MUSCLES

SHORT NOTES

1. Sarcomere

Sarcomere is the structural and functional unit of skeletal muscle.

Extent

- **Between two Z lines.**

Parts

1. **A band**
2. **I band**
3. **H zone**
4. **M line**
5. **Z line**

Filaments

- **Thick filaments: Myosin**
- **Thin filaments: Actin**

Function

- **Muscle contraction by sliding filament mechanism.**

CARDIOVASCULAR SYSTEM

SHORT ESSAYS

1. Describe the various types and structure-function correlation of blood vessels.

Classification of blood vessels

1. **Arteries**
2. **Arterioles**
3. **Capillaries**
4. **Venules**
5. **Veins**

General structure

Blood vessels have three layers:

1. **Tunica intima**
2. **Tunica media**
3. **Tunica adventitia**

Arteries

- **Thick wall.**
- **Narrow lumen.**
- **Thick tunica media.**
- **Carry blood under high pressure.**

Functions

- **Transport blood away from heart.**
- **Maintain blood pressure.**

Arterioles

- **Small arteries.**
- **Regulate blood flow and peripheral resistance.**

Capillaries

- **Only endothelial layer.**
- **Site of exchange.**

Types

1. **Continuous**
2. **Fenestrated**
3. **Sinusoidal**

Veins

- **Thin wall.**
- **Wide lumen.**
- **Valves present.**

Functions

- **Return blood to heart.**
- **Blood reservoir.**

Structure-function correlation

- **Thick arterial wall withstands pressure.**
- **Thin capillary wall permits exchange.**
- **Valves in veins prevent backflow.**

NERVOUS SYSTEM

SHORT NOTES

1. Neuroglia

Neuroglia are supporting cells of nervous tissue.

Types in central nervous system

1. **Astrocytes**
2. **Oligodendrocytes**
3. **Microglia**
4. **Ependymal cells**

Types in peripheral nervous system

1. **Schwann cells**
2. **Satellite cells**

Functions

1. **Support neurons**
2. **Nutrition**
3. **Myelination**
4. **Phagocytosis**
5. **Formation of blood-brain barrier**

GENERAL EMBRYOLOGY

SHORT ESSAYS

1. Describe the formation of placenta. Add a note on placental barrier.

Placenta

Placenta is a fetomaternal organ formed by fetal chorion and maternal decidua basalis.

Formation of placenta

Fetal part

- **Chorion frondosum.**

Maternal part

- **Decidua basalis.**

Development

1. **Formation of trophoblast.**
2. **Formation of chorionic villi.**
3. **Development of intervillous spaces.**
4. **Establishment of uteroplacental circulation.**

Functions

1. **Nutrition**
2. **Respiration**
3. **Excretion**
4. **Endocrine function**
5. **Protection**

Placental barrier

Layers:

1. **Syncytiotrophoblast**
2. **Cytotrophoblast**
3. **Connective tissue of villus**
4. **Endothelium of fetal capillaries**

Functions of placental barrier

- **Exchange of gases and nutrients.**
- **Prevents mixing of maternal and fetal blood.**

2. Describe the formation, subdivisions and fate of intra embryonic mesoderm

Formation

- **Formed during gastrulation from primitive streak.**

Subdivisions

1. **Paraxial mesoderm**
2. **Intermediate mesoderm**
3. **Lateral plate mesoderm**

Lateral plate mesoderm divides into

- **Somatopleuric layer**
- **Splanchnopleuric layer**

Fate

Paraxial mesoderm

- **Somites**
- **Vertebrae**
- **Skeletal muscles**

Intermediate mesoderm

- **Urogenital system**

Lateral plate mesoderm

- **Heart and blood vessels**
- **Serous membranes**
- **Connective tissue**

3. Describe the steps of fertilization and its effects.

Definition

Fertilization is fusion of male and female gametes.

Steps

1. **Capacitation of sperm**
2. **Penetration of corona radiata**
3. **Penetration of zona pellucida**
4. **Fusion of plasma membranes**
5. **Completion of second meiotic division**
6. **Formation of male and female pronuclei**
7. **Fusion of pronuclei**

Effects

1. **Formation of zygote**
2. **Restoration of diploid number**
3. **Determination of sex**
4. **Activation of cleavage**
5. **Mixing of paternal and maternal genes**

4. Describe the formation, fate and embryological significance of primitive streak.

Formation

- **Appears during third week in epiblast.**
- **Develops at caudal end.**

Parts

1. **Primitive groove**
2. **Primitive node**
3. **Primitive pit**

Fate

- **Regresses and disappears by end of fourth week.**

Embryological significance

1. **Establishes body axis.**
2. **Site of gastrulation.**
3. **Formation of mesoderm.**
4. **Formation of notochord.**

Applied anatomy

Persistence may cause sacrococcygeal teratoma.

5. Describe the process of implantation and common abnormal sites of implantation

Definition

Implantation is embedding of blastocyst into endometrium.

Process

1. **Zona pellucida disappears.**
2. **Blastocyst attaches to endometrium.**
3. **Trophoblast differentiates into:**
    - **Cytotrophoblast**
    - **Syncytiotrophoblast**
4. **Blastocyst embeds into endometrium.**

Normal site

Upper posterior wall of uterus.

Abnormal sites

1. **Fallopian tube**
2. **Ovary**
3. **Cervix**
4. **Abdominal cavity**
5. **Lower uterine segment**

Clinical importance

- **Ectopic pregnancy.**

6. Describe the process of neurulation. Name the vesicles in the cranial expanded part of the neural tube and mention their fate.

Neurulation

Formation of neural tube from ectoderm.

Steps

1. **Formation of neural plate.**
2. **Formation of neural groove.**
3. **Fusion of neural folds.**
4. **Formation of neural tube.**

Cranial vesicles

Primary brain vesicles

1. **Prosencephalon**
2. **Mesencephalon**
3. **Rhombencephalon**

Fate

Prosencephalon

- **Telencephalon → cerebral hemispheres**
- **Diencephalon → thalamus**

Mesencephalon

- **Midbrain**

Rhombencephalon

- **Metencephalon → pons and cerebellum**
- **Myelencephalon → medulla**

7. Development of placenta and its associated anomalies.

Development

- **Placenta develops from chorion frondosum and decidua basalis.**
- **Chorionic villi proliferate.**
- **Intervillous spaces form.**

- **Maternal and fetal circulations established.**

Functions

1. **Nutrition**
2. **Respiration**
3. **Endocrine function**
4. **Protection**

Anomalies

1. **Placenta previa**
2. **Placenta accreta**
3. **Succenturiate placenta**
4. **Circumvallate placenta**
5. **Retained placenta**

8. Formation of placenta

Placenta develops from fetal chorion frondosum and maternal decidua basalis.

Steps

1. **Trophoblast differentiation.**
2. **Formation of chorionic villi.**
3. **Development of intervillous spaces.**
4. **Formation of fetal blood vessels.**
5. **Establishment of placental circulation.**

Functions

1. **Nutrition**
2. **Respiration**
3. **Excretion**
4. **Hormone secretion**

9. Formation and fate of notochord.

Formation

- **Cells from primitive node form notochordal process.**
- **Notochordal plate forms.**
- **Plate folds to form notochord.**

Fate

- **Mostly degenerates.**
- **Remnant forms nucleus pulposus of intervertebral disc.**

Functions

1. **Induces neural tube formation.**
2. **Forms axial skeleton basis.**

10. Graafian follicle

Graafian follicle is mature ovarian follicle.

Parts

1. **Secondary oocyte**
2. **Zona pellucida**
3. **Corona radiata**
4. **Antrum**
5. **Granulosa cells**
6. **Theca interna**
7. **Theca externa**

Functions

- **Ovulation.**
- **Hormone secretion.**

11. Process of implantation and its clinical aspects

Implantation

Embedding of blastocyst into endometrium.

Stages

1. **Apposition**
2. **Adhesion**
3. **Invasion**

Clinical aspects

1. **Ectopic pregnancy**
2. **Placenta previa**
3. **Abnormal implantation**

12. Implantation

Implantation is attachment and embedding of blastocyst in endometrium.

Site

Upper posterior uterine wall.

Stages

1. **Hatching**
2. **Attachment**
3. **Invasion**

Importance

- **Establishes pregnancy.**

13. Divisions and derivatives of intraembryonic mesoderm.

Divisions

1. **Paraxial mesoderm**
2. **Intermediate mesoderm**
3. **Lateral plate mesoderm**

Derivatives

Paraxial

- **Vertebrae**
- **Skeletal muscles**

Intermediate

- **Kidneys and gonads**

Lateral plate

- **Heart**
- **Blood vessels**
- **Serous membranes**

14. Notochord

Notochord is midline mesodermal structure.

Formation

From primitive node cells.

Functions

1. **Induces neural plate.**
2. **Basis of vertebral column.**

Fate

Forms nucleus pulposus.

15. Stages and consequences of fertilisation

Stages

1. **Capacitation**
2. **Acrosomal reaction**
3. **Fusion of gametes**
4. **Pronuclear fusion**

Consequences

1. **Zygote formation**
2. **Restoration of chromosome number**
3. **Sex determination**
4. **Genetic variation**

16. Placenta

Placenta is temporary fetomaternal organ.

Parts

1. **Fetal part – chorion frondosum**
2. **Maternal part – decidua basalis**

Functions

1. **Nutrition**
2. **Respiration**
3. **Endocrine secretion**
4. **Protection**

17. Intra embryonic mesoderm

Intraembryonic mesoderm develops during gastrulation.

Divisions

1. **Paraxial**
2. **Intermediate**
3. **Lateral plate**

Derivatives

- **Muscles**
- **Skeleton**
- **Cardiovascular system**

18. Neural crest

Neural crest cells arise from margins of neural folds.

Derivatives

1. **Spinal ganglia**
2. **Autonomic ganglia**
3. **Schwann cells**
4. **Melanocytes**
5. **Adrenal medulla**

Importance

- **Important in peripheral nervous system development.**

SHORT NOTES

1. Blastocyst

Blastocyst is the stage formed after morula during first week of development.

Parts

1. **Trophoblast**
2. **Embryoblast**
3. **Blastocyst cavity**

Functions

1. **Implantation**
2. **Formation of embryo**
3. **Formation of fetal membranes**

2. Describe fertilization and its results

Definition

Fertilization is fusion of male and female gametes.

Steps

1. **Capacitation**
2. **Acrosomal reaction**
3. **Penetration of zona pellucida**
4. **Fusion of gametes**
5. **Formation of zygote**

Results

1. **Restoration of diploid number**
2. **Determination of sex**
3. **Genetic variation**
4. **Initiation of cleavage**

3. Development of interatrial septum

Development

Interatrial septum develops from septum primum and septum secundum.

Septum primum

- **Grows downward from roof of primitive atrium.**
- **Leaves foramen primum.**
- **Later forms foramen secundum.**

Septum secundum

- **Develops right to septum primum.**
- **Forms foramen ovale.**

Fate

- **At birth foramen ovale closes forming fossa ovalis.**

4. Formation and fate of primitive streak

Formation

- **Appears in epiblast during third week.**
- **Located in caudal midline.**

Fate

- **Regresses and disappears by fourth week.**

Importance

1. **Gastrulation**
2. **Formation of germ layers**
3. **Establishment of body axis**

5. Parts of blastocyst

Parts

1. **Trophoblast**
2. **Embryoblast**
3. **Blastocyst cavity**

Trophoblast

- **Forms fetal membranes and placenta.**

Embryoblast

- **Forms embryo proper.**

6. Oogenesis

Oogenesis is formation of ovum from oogonia.

Stages

1. **Multiplication phase**
2. **Growth phase**
3. **Maturation phase**

Sequence

Oogonium → Primary oocyte → Secondary oocyte → Ovum

Features

- **Begins before birth.**
- **Meiosis II completed after fertilization.**

7. Subdivisions and derivatives of neural tube

Subdivisions

1. **Prosencephalon**
2. **Mesencephalon**
3. **Rhombencephalon**

Derivatives

Prosencephalon

- **Cerebrum**
- **Thalamus**

Mesencephalon

- **Midbrain**

Rhombencephalon

- **Pons**
- **Cerebellum**
- **Medulla**

8. Formation and structure of umbilical cord.

Formation

- **Formed from connecting stalk and yolk sac stalk.**
- **Covered by amnion.**

Structure

Contains:

1. **Two umbilical arteries**
2. **One umbilical vein**
3. **Wharton's jelly**

Functions

- **Connects fetus to placenta.**

9. Embryological basis of twinning

Types

1. **Dizygotic twins**
2. **Monozygotic twins**

Dizygotic twins

- **Two ova fertilized by two sperms.**
- **Genetically different.**

Monozygotic twins

- **Single zygote divides.**
- **Genetically identical.**

10. Neural crest cells.

Neural crest cells arise from neural folds.

Derivatives

1. **Spinal ganglia**
2. **Autonomic ganglia**
3. **Schwann cells**
4. **Melanocytes**
5. **Adrenal medulla**

11. Spermatogenesis.

Spermatogenesis is formation of spermatozoa from spermatogonia.

Stages

1. **Multiplication phase**
2. **Growth phase**
3. **Maturation phase**
4. **Spermiogenesis**

Sequence

Spermatogonium → Primary spermatocyte → Secondary spermatocyte → Spermatid → Spermatozoon

12. Decidua

Decidua is modified endometrium during pregnancy.

Parts

1. **Decidua basalis**
2. **Decidua capsularis**
3. **Decidua parietalis**

Functions

1. **Nutrition of embryo**
2. **Formation of maternal placenta**

13. Yolk sac

Yolk sac is extraembryonic membrane lined by endoderm.

Functions

1. **Early nutrition**
2. **Hemopoiesis**
3. **Formation of primordial germ cells**
4. **Part of gut tube formation**

14. Graafian follicle

Graafian follicle is mature ovarian follicle before ovulation.

Parts

1. **Secondary oocyte**
2. **Zona pellucida**
3. **Corona radiata**
4. **Antrum**
5. **Granulosa cells**

Functions

- **Ovulation and hormone secretion.**

15. Zona pellucida

Zona pellucida is glycoprotein membrane surrounding oocyte.

Functions

1. **Species-specific sperm binding**
2. **Prevents polyspermy**
3. **Protection of oocyte**

16. Right atrial development

Development

Right atrium develops from:

1. **Primitive atrium**
2. **Right horn of sinus venosus**

Primitive atrium forms

- **Trabeculated anterior part.**

Right horn forms

- **Smooth posterior wall (sinus venarum).**

17. Inter ventricular septum

Interventricular septum separates right and left ventricles.

Parts

1. **Muscular part**
2. **Membranous part**

Development

- **Muscular part from ventricular floor.**
- **Membranous part from endocardial cushions.**

18. Somites

Somites are segmented blocks of paraxial mesoderm.

Parts and derivatives

1. **Sclerotome → vertebrae**
2. **Myotome → muscles**
3. **Dermatome → dermis**

19. Neural crest derivatives

Derivatives

1. **Spinal ganglia**
2. **Autonomic ganglia**

3. **Schwann cells**
4. **Melanocytes**
5. **Adrenal medulla**
6. **Pia and arachnoid mater**

20. Chorionic villi

Chorionic villi are finger-like projections of chorion.

Types

1. **Primary villi**
2. **Secondary villi**
3. **Tertiary villi**

Functions

- **Maternal-fetal exchange.**

21. Development of lungs

Development

- **Respiratory diverticulum appears from foregut.**
- **Forms bronchial buds.**
- **Repeated branching forms bronchial tree.**

Stages

1. **Pseudoglandular**
2. **Canalicular**
3. **Terminal sac**
4. **Alveolar stage**

22. Dizygotic twins

Dizygotic twins develop from fertilization of two ova by two sperms.

Features

1. **Genetically different**
2. **Separate placenta and membranes**
3. **Resemble ordinary siblings**

23. Fertilisation

Fertilisation is fusion of sperm and ovum.

Site

Ampulla of uterine tube.

Results

1. **Zygote formation**
2. **Restoration of chromosome number**
3. **Determination of sex**

24. Neural tube

Neural tube develops from neural plate.

Development

- **Neural folds fuse in midline.**
- **Cranial end forms brain.**
- **Caudal end forms spinal cord.**

Defects

1. **Spina bifida**
2. **Anencephaly**

25. Spermiogenesis

Spermiogenesis is transformation of spermatid into spermatozoon.

Changes

1. **Formation of acrosome**
2. **Condensation of nucleus**
3. **Formation of tail**
4. **Loss of excess cytoplasm**

26. Implantation

Implantation is embedding of blastocyst into endometrium.

Site

Upper posterior wall of uterus.

Stages

1. **Apposition**
2. **Adhesion**
3. **Invasion**

GENETICS

SHORT ESSAYS

1. Describe the technique of karyotyping with its applications.

Definition

Karyotyping is arrangement of chromosomes in homologous pairs according to size and morphology.

Technique

1. **Collection of peripheral blood.**
2. **Culture of lymphocytes.**
3. **Addition of colchicine to arrest metaphase.**
4. **Hypotonic treatment.**
5. **Fixation and staining.**
6. **Photography and arrangement of chromosomes.**

Applications

1. **Diagnosis of chromosomal disorders.**
2. **Prenatal diagnosis.**
3. **Sex determination.**
4. **Detection of structural abnormalities.**
5. **Genetic counseling.**

2. Describe the karyotyping with its applications

Karyotype

It is the complete chromosomal complement of an individual.

Steps of karyotyping

1. **Cell culture**
2. **Arrest in metaphase**
3. **Hypotonic treatment**
4. **Fixation**
5. **Staining**
6. **Arrangement of chromosomes**

Applications

1. **Diagnosis of Down syndrome**
2. **Turner syndrome**
3. **Klinefelter syndrome**
4. **Prenatal diagnosis**

3. With the help of pedigree charts describe the various modes of inheritance involving the sex chromosomes. Give suitable examples for each type.

Sex-linked inheritance

Inheritance involving genes on sex chromosomes.

Types

X-linked recessive

Features

- **Males commonly affected.**
- **Females are carriers.**

Examples

1. **Hemophilia**

2. **Colour blindness**

X-linked dominant

Features

- **Both sexes affected.**
- **Affected father transmits to daughters.**

Example

Vitamin D resistant rickets.

Y-linked inheritance

Features

- **Only males affected.**
- **Father to son transmission.**

Example

Hypertrichosis of pinna.

4. Describe the structure of chromosomes with classification. Explain any three structural anomalies of chromosomes

Structure of chromosome

1. **Chromatid**
2. **Centromere**
3. **Telomere**
4. **Secondary constriction**
5. **Satellite**

Classification based on centromere

1. **Metacentric**
2. **Submetacentric**
3. **Acrocentric**
4. **Telocentric**

Structural anomalies

1. Deletion

Loss of chromosome segment.

2. Duplication

Repeated chromosome segment.

3. Translocation

Transfer of segment to another chromosome.

5. Karyotyping

Definition

Arrangement of chromosomes according to morphology.

Procedure

1. **Cell culture**
2. **Metaphase arrest**
3. **Staining**
4. **Photography**
5. **Arrangement**

Uses

1. **Diagnosis of chromosomal disorders**
2. **Prenatal diagnosis**

6. Numerical aberrations of chromosomes

Definition

Abnormal number of chromosomes.

Types

Euploidy

Variation in complete sets.

Aneuploidy

Loss or gain of individual chromosome.

Examples

1. **Down syndrome – Trisomy 21**
2. **Turner syndrome – Monosomy X**
3. **Klinefelter syndrome – XXY**

7. Chromosomal aberrations.

Types

1. **Numerical abnormalities**
2. **Structural abnormalities**

Numerical

- **Aneuploidy**
- **Polyploidy**

Structural

1. **Deletion**
2. **Duplication**
3. **Inversion**
4. **Translocation**

8. Describe various modes of inheritance with examples

Modes

1. **Autosomal dominant**
2. **Autosomal recessive**
3. **X-linked dominant**
4. **X-linked recessive**
5. **Y-linked**

Examples

- **Autosomal dominant – Marfan syndrome**
- **Autosomal recessive – Sickle cell anemia**
- **X-linked recessive – Hemophilia**

9. Mendelian inheritance

Mendel's laws

1. **Law of segregation**
2. **Law of independent assortment**
3. **Law of dominance**

Importance

- **Basis of classical genetics.**

10. Down syndrome

Cause

Trisomy of chromosome 21.

Features

1. **Intellectual disability**
2. **Epicanthic fold**
3. **Flat face**
4. **Protruding tongue**
5. **Simian crease**

Karyotype

47, XX/XY +21

SHORT NOTES

1. Describe the principle of genetic counselling

Definition

Genetic counseling is guidance given regarding hereditary disorders.

Principles

1. **Accurate diagnosis**
2. **Risk assessment**

3. Nondirective counseling
4. Confidentiality
5. Psychological support

2. Explain the genetic basis of numerical anomalies of chromosomes

Cause

Usually due to nondisjunction during meiosis.

Types

1. Trisomy
2. Monosomy

Examples

- Down syndrome
- Turner syndrome
- Klinefelter syndrome

3. Karyotype and clinical features of Turner syndrome

Karyotype

45, X

Clinical features

1. Short stature
2. Webbed neck
3. Shield chest
4. Streak gonads
5. Primary amenorrhea

4. What is Barr Body. What is its significance.

Barr body

Condensed inactive X chromosome in female cells.

Significance

1. Sex chromatin identification
2. Detection of chromosomal abnormalities
3. Determination of genetic sex

5. Explain autosomal dominant inheritance in genetic diseases

Features

1. Vertical transmission
2. Both sexes affected equally
3. One affected parent usually present
4. 50% risk to offspring

Examples

1. Marfan syndrome
2. Achondroplasia

6. Karyotype and clinical features of Klinefelter syndrome

Karyotype

47, XXY

Clinical features

1. Tall stature
2. Small testes
3. Gynecomastia
4. Sterility
5. Sparse body hair

7. Karyotyping

Definition

Study and arrangement of chromosomes.

Steps

1. **Cell culture**
2. **Metaphase arrest**
3. **Staining**
4. **Arrangement**

Uses

- **Detection of chromosomal disorders.**

8. Define Karyotype. What are the steps of Karyotyping.

Karyotype

Chromosomal complement of an individual.

Steps

1. **Collection of cells**
2. **Cell culture**
3. **Metaphase arrest**
4. **Hypotonic treatment**
5. **Staining**
6. **Arrangement of chromosomes**

9. Trisomy 21

Trisomy 21 is chromosomal disorder due to extra chromosome 21.

Features

1. **Intellectual disability**
2. **Flat face**
3. **Epicanthic folds**
4. **Congenital heart disease**

10. Describe structure of chromosome with classification.

Structure

1. **Chromatid**
2. **Centromere**
3. **Telomere**
4. **Satellite**

Classification

1. **Metacentric**
2. **Submetacentric**
3. **Acrocentric**
4. **Telocentric**

11. Chromosomes and its classification

Chromosome

Thread-like hereditary structure in nucleus.

Classification

1. **Metacentric**
2. **Submetacentric**
3. **Acrocentric**
4. **Telocentric**

12. Name the structural chromosomal abnormalities

1. **Deletion**
2. **Duplication**
3. **Inversion**
4. **Translocation**
5. **Ring chromosome**
6. **Isochromosome**

13. Barr body

Barr body is inactive condensed X chromosome.

Location

- **Seen at nuclear periphery.**

Importance

1. **Sex determination**

2. **Detection of chromosomal disorders**

14. Genetic counselling

Definition

Process of advising individuals or families regarding the risk, nature and prevention of hereditary disorders.

Indications

- **Family history of genetic disease**
- **Recurrent abortions**
- **Advanced maternal age**
- **Previous child with congenital anomaly**

Importance

- **Early diagnosis**
- **Prevention of genetic disorders**
- **Prenatal diagnosis and family planning**

15. Chromosomal aberrations

Definition

Abnormalities in the structure or number of chromosomes.

Types

Numerical abnormalities

- **Aneuploidy**
- **Polyploidy**

Structural abnormalities

- **Deletion**
- **Duplication**
- **Inversion**
- **Translocation**

Effects

- **Congenital malformations**
- **Mental retardation**
- **Infertility**

16. Numerical chromosomal abnormalities

Definition

Abnormal change in chromosome number.

Types

Aneuploidy

- **Monosomy**
- **Trisomy**

Polyploidy

- **Triploidy**
- **Tetraploidy**

Examples

- **Down syndrome – Trisomy 21**
- **Turner syndrome – 45,X**
- **Klinefelter syndrome – 47,XXY**

17. Down syndrome

Definition

Chromosomal disorder caused by trisomy of chromosome 21.

Karyotype

47,XX,+21 or 47,XY,+21

Features

- **Intellectual disability**

- **Flat face**
- **Epicanthic folds**
- **Protruding tongue**
- **Single palmar crease**
- **Congenital heart defects**

Cause

Meiotic nondisjunction

18. Reciprocal translocation

Definition

Exchange of chromosomal segments between two non-homologous chromosomes.

Features

- **Usually balanced**
- **No loss of genetic material**
- **May produce abnormal gametes**

Importance

- **Recurrent abortions**
- **Congenital anomalies in offspring**

19. Klinefelter's syndrome

Definition

Sex chromosomal abnormality in males due to extra X chromosome.

Karyotype

47,XXY

Features

- **Tall eunuchoid body**
- **Small testes**
- **Infertility**
- **Gynecomastia**
- **Sparse body hair**

20. Turner's syndrome

Definition

Chromosomal disorder due to monosomy X.

Karyotype

45,X

Features

- **Short stature**
- **Webbed neck**
- **Streak gonads**
- **Primary amenorrhea**
- **Shield chest**
- **Infertility**

GENERAL HISTOLOGY

SHORT ESSAYS

1. Illustrate and describe the microscopic anatomy of transverse section of compact bone. Add a note on the functions of periosteum.

Introduction

Compact bone is made up of closely packed bony lamellae arranged in the form of osteons or Haversian systems.

Microscopic anatomy of compact bone

1. Osteon (Haversian system)

- **Structural and functional unit of compact bone.**
- **Cylindrical structure parallel to long axis of bone.**
- **Consists of:**

- Central Haversian canal
- Concentric lamellae
- Lacunae containing osteocytes
- Canaliculi

2. Haversian canal

- **Present at centre of osteon.**
- **Contains blood vessels, lymphatics and nerve fibres.**
- **Lined by endosteum.**

3. Concentric lamellae

- **Arranged concentrically around Haversian canal.**
- **Composed of collagen fibres and calcified matrix.**
- **Fibres in adjacent lamellae run in different directions.**

4. Lacunae

- **Small spaces between lamellae.**
- **Contain osteocytes.**

5. Canaliculi

- **Tiny canals radiating from lacunae.**
- **Contain cytoplasmic processes of osteocytes.**
- **Help in nutrition and communication.**

6. Interstitial lamellae

- **Remnants of old osteons between adjacent osteons.**

7. Circumferential lamellae

- **Outer circumferential lamellae beneath periosteum.**
- **Inner circumferential lamellae around medullary cavity.**

8. Volkmann's canals

- **Transverse or oblique canals connecting Haversian canals.**
- **Carry blood vessels from periosteum.**

Functions of periosteum

- **Nutrition of bone.**
- **Appositional growth of bone.**
- **Repair after fracture.**
- **Attachment for tendons and ligaments.**
- **Contains osteogenic cells for bone formation.**
- **Rich sensory nerve supply.**

Conclusion

Compact bone shows organized osteons adapted for strength, nutrition and resistance to stress.

2. Describe the microscopic structure of hyaline cartilage and elastic cartilage.

Hyaline cartilage

Definition

Most common type of cartilage having glassy matrix.

Microscopic structure

1. Perichondrium

- **Present except at articular surfaces.**
- **Outer fibrous layer and inner chondrogenic layer.**

2. Cells

- **Chondroblasts present beneath perichondrium.**
- **Chondrocytes lie in lacunae.**
- **Isogenous groups commonly seen.**

3. Matrix

- **Homogeneous and basophilic.**
- **Contains type II collagen fibres.**
- **Rich in proteoglycans.**

4. Territorial matrix

- **Dark staining around lacunae.**

5. Interterritorial matrix

- **Lighter staining between lacunae.**

Examples

- **Costal cartilage**
- **Tracheal rings**
- **Nasal septum**
- **Articular cartilage**

Elastic cartilage

Definition

Cartilage containing abundant elastic fibres.

Microscopic structure

- **Similar to hyaline cartilage.**
- **Perichondrium present.**
- **Chondrocytes larger and numerous.**
- **Matrix contains dense network of elastic fibres.**
- **Fibres visible with special stains.**

Examples

- **Pinna**
- **Epiglottis**
- **Auditory tube**

Differences between hyaline and elastic cartilage

Hyaline cartilage	Elastic cartilage
Type II collagen fibres	Elastic fibres abundant
Glassy matrix	Yellow elastic matrix
Less flexible	Highly flexible
Calcification may occur	Calcification rare

3. Describe the structure of transitional epithelium with site of occurrence and its functional significance.

Definition

Transitional epithelium or urothelium is a stratified epithelium specialized for distension.

Structure

1. Basal cells

- **Single layer of cuboidal or columnar cells.**
- **Rest on basement membrane.**

2. Intermediate cells

- **Several layers of polygonal or pear-shaped cells.**

3. Superficial cells

- **Large dome-shaped umbrella cells.**
- **Often binucleate.**
- **Flatten when organ distends.**

Sites of occurrence

- **Renal calyces**
- **Renal pelvis**
- **Ureters**
- **Urinary bladder**
- **Upper part of urethra**

Functional significance

- **Permits distension of urinary passages.**
- **Forms impermeable barrier against urine.**
- **Protects underlying tissues from toxic effects of urine.**

Conclusion

Transitional epithelium is specially adapted for stretching and protection in urinary organs.

4. Illustrate and describe the microscopic anatomy of the large artery and medium-sized artery highlighting how their structure is suited for their function.

Large artery (Elastic artery)

Examples

Aorta, pulmonary trunk.

Microscopic structure

1. Tunica intima

- **Endothelium with subendothelial connective tissue.**
- **Internal elastic lamina inconspicuous.**

2. Tunica media

- **Thickest layer.**
- **Numerous elastic lamellae.**
- **Smooth muscle fibres between elastic lamellae.**

3. Tunica adventitia

- **Thin connective tissue.**
- **Contains vasa vasorum and nerves.**

Functional correlation

- **Elastic fibres allow stretching during systole.**
- **Elastic recoil maintains blood flow during diastole.**

Medium-sized artery (Muscular artery)

Examples

Radial, femoral arteries.

Microscopic structure

1. Tunica intima

- **Endothelium.**
- **Prominent internal elastic lamina.**

2. Tunica media

- **Predominantly smooth muscle.**
- **Few elastic fibres.**

3. Tunica adventitia

- **Thick connective tissue.**
- **External elastic lamina may be present.**

Functional correlation

- **Smooth muscle regulates blood flow.**

- **Vasoconstriction and vasodilatation maintain blood pressure.**

Differences

Elastic artery	Muscular artery
Elastic fibres predominant	Smooth muscle predominant
Internal elastic lamina indistinct	Internal elastic lamina prominent
Conducting artery	Distributing artery

5. Histology of thin skin. Write a note on appendages of skin.

Histology of thin skin

Epidermis

Keratinized stratified squamous epithelium.

Layers:

1. **Stratum basale**
2. **Stratum spinosum**
3. **Stratum granulosum**
4. **Stratum corneum**

Stratum lucidum absent.

Dermis

Papillary layer

- **Loose connective tissue.**
- **Dermal papillae present.**

Reticular layer

- **Dense irregular connective tissue.**
- **Contains vessels, nerves and appendages.**

Appendages of skin

1. Hair follicles

- **Present in dermis.**
- **Associated with sebaceous glands and arrector pili muscle.**

2. Sebaceous glands

- **Holocrine glands.**
- **Secrete sebum.**

3. Sweat glands

Eccrine glands

- **Simple coiled tubular glands.**
- **Help in thermoregulation.**

Apocrine glands

- **Present in axilla and genital region.**

4. Nails

- **Plates of hard keratin.**
- **Protect terminal phalanges.**

6. Explain the microscopic structure of thin skin.

Introduction

Thin skin covers most parts of body except palms and soles.

Epidermis

Keratinized stratified squamous epithelium.

Layers

1. **Stratum basale**

2. **Stratum spinosum**
3. **Stratum granulosum**
4. **Stratum corneum**

- **Stratum lucidum absent.**
- **Melanocytes present in basal layer.**

Dermis

Papillary layer

- **Loose connective tissue.**
- **Capillaries and nerve endings.**

Reticular layer

- **Dense irregular connective tissue.**
- **Collagen and elastic fibres.**

Skin appendages

- **Hair follicles**
- **Sebaceous glands**
- **Sweat glands**

Functions

- **Protection**
- **Sensation**
- **Thermoregulation**
- **Vitamin D synthesis**

7. Classify muscular tissue with suitable examples. Describe the structure of skeletal muscle.

Classification of muscular tissue

Type	Example
Skeletal muscle	Biceps brachii
Cardiac muscle	Myocardium
Smooth muscle	Intestinal wall

Structure of skeletal muscle

1. Muscle fibre

- **Long cylindrical multinucleated cell.**
- **Peripheral nuclei.**
- **Cross striations present.**

2. Sarcolemma

- **Plasma membrane surrounding fibre.**

3. Sarcoplasm

- **Contains myofibrils.**
- **Rich in glycogen and mitochondria.**

4. Myofibrils

- **Composed of actin and myosin filaments.**
- **Show alternating A and I bands.**

5. Connective tissue coverings

- **Endomysium around fibre.**
- **Perimysium around fascicle.**
- **Epimysium around muscle.**

6. Triad

- **One T tubule and two terminal cisternae.**

Functions

- **Voluntary movements.**
- **Maintenance of posture.**
- **Heat production.**

SHORT NOTES

1. Explain the structural and functional differences between elastic and muscular arteries.

Elastic arteries	Muscular arteries
Large arteries	Medium-sized arteries
Tunica media rich in elastic fibres	Tunica media rich in smooth muscle
Internal elastic lamina indistinct	Internal elastic lamina prominent
Conduct blood from heart	Distribute blood to organs
Elastic recoil maintains blood flow	Regulate blood flow and pressure
Example: Aorta	Example: Radial artery

2. Microscopy of lymph node.

Capsule

- **Dense connective tissue.**
- **Trabeculae extend inward.**

Cortex

- **Lymphoid follicles with germinal centres.**
- **B lymphocytes predominant.**

Paracortex

- **Rich in T lymphocytes.**
- **High endothelial venules present.**

Medulla

- **Medullary cords and sinuses.**

Lymphatic circulation

- **Afferent lymphatics enter capsule.**
- **Efferent lymphatic leaves hilum.**

Functions

- **Filtration of lymph.**
- **Immune response.**

3. Transitional epithelium

Definition

Stratified epithelium specialized for distension.

Structure

- **Basal cuboidal cells.**
- **Intermediate polygonal cells.**
- **Superficial umbrella cells.**

Sites

- **Urinary bladder**
- **Ureter**
- **Renal pelvis**

Functions

- **Distension**
- **Protection from urine**

4. Microscopic structure of peripheral nerve

Connective tissue coverings

Endoneurium

- **Surrounds individual nerve fibres.**

Perineurium

- **Surrounds fascicles.**
- **Forms blood-nerve barrier.**

Epineurium

- **Surrounds whole nerve.**

Nerve fibres

- **Myelinated and non-myelinated fibres.**
- **Schwann cells present.**

Nodes of Ranvier

- **Gaps in myelin sheath.**

5. Microscopic structure of thymus

Capsule

- **Thin connective tissue capsule.**
- **Septa divide gland into lobules.**

Cortex

- **Dark staining.**
- **Rich in lymphocytes.**

Medulla

- **Pale staining.**
- **Fewer lymphocytes.**
- **Hassall's corpuscles present.**

Functions

- **T lymphocyte maturation.**
- **Cell-mediated immunity.**

6. Histologic difference between Cardiac and Skeletal Muscles.

Cardiac muscle	Skeletal muscle
Branched fibres	Long cylindrical fibres
Single central nucleus	Multiple peripheral nuclei
Intercalated discs present	Intercalated discs absent
Involuntary	Voluntary
Striated	Striated

7. Microscopic structure of spleen

Capsule

- **Fibroelastic tissue with smooth muscle.**

White pulp

- **Lymphoid tissue around central artery.**
- **Malpighian corpuscles present.**

Red pulp

- **Splenic cords and venous sinusoids.**

Functions

- **Destruction of old RBCs.**
- **Immune function.**
- **Blood reservoir.**

8. Microscopic structure of hyaline cartilage

- **Perichondrium present.**
- **Chondrocytes in lacunae.**
- **Isogenous groups seen.**
- **Matrix homogeneous and basophilic.**
- **Type II collagen fibres present.**

Examples

- **Trachea**
- **Costal cartilage**

9. Microscopic structure of large artery and correlate with its function

Structure

- **Tunica intima thin.**

- **Tunica media very thick with elastic lamellae.**
- **Adventitia contains vasa vasorum.**

Functional correlation

- **Stretching during systole.**
- **Elastic recoil during diastole.**
- **Maintains continuous blood flow.**

10. Microscopic Structure of compact bone

- **Osteons or Haversian systems present.**
- **Haversian canal at centre.**
- **Concentric lamellae arranged around canal.**
- **Osteocytes present in lacunae.**
- **Canaliculi interconnect lacunae.**
- **Volkmann's canals connect adjacent osteons.**

11. Microscopic structure of Elastic artery

- **Intima thin.**
- **Internal elastic lamina indistinct.**
- **Media contains many elastic lamellae.**
- **Smooth muscle between lamellae.**
- **Adventitia thin with vasa vasorum.**

Function

Maintains blood flow by elastic recoil.

12. Labelled diagram of histology of hyaline cartilage

REFER DIAGRAM SECTION

Labels

- **Perichondrium**
- **Chondroblasts**
- **Chondrocytes**
- **Lacunae**
- **Isogenous groups**
- **Matrix**

13. Microscopic structure of skeletal muscle

- **Long cylindrical multinucleated fibres.**
- **Peripheral nuclei.**
- **Cross striations present.**
- **Myofibrils arranged longitudinally.**
- **Endomysium surrounds fibres.**

14. Large artery

Features

- **Thick tunica media.**
- **Elastic lamellae abundant.**
- **Internal elastic lamina indistinct.**

Examples

- **Aorta**
- **Pulmonary artery**

Function

Conduct blood under high pressure.

15. Muscular artery

Features

- **Tunica media rich in smooth muscle.**
- **Prominent internal elastic lamina.**
- **Adventitia relatively thick.**

Function

Controls blood flow by vasoconstriction and vasodilatation.

16. Bone

Definition

Specialized connective tissue with calcified matrix.

Cells

- **Osteoblasts**
- **Osteocytes**
- **Osteoclasts**

Types

- **Compact bone**
- **Spongy bone**

Functions

- **Support**
- **Protection**
- **Haemopoiesis**
- **Mineral storage**

17. Spinal ganglion

Features

- **Collection of sensory neuron cell bodies.**
- **Surrounded by capsule.**
- **Pseudounipolar neurons present.**
- **Satellite cells surround neurons.**
- **Myelinated nerve fibres present.**

18. Hyaline cartilage

- **Most common cartilage.**
- **Matrix glassy and homogeneous.**
- **Type II collagen fibres.**
- **Chondrocytes in lacunae.**
- **Perichondrium usually present.**

19. Hyaline cartilage and locations

Features

- **Homogeneous matrix.**
- **Chondrocytes in lacunae.**
- **Type II collagen fibres.**

Locations

- **Articular surfaces**
- **Costal cartilages**
- **Tracheal rings**
- **Nasal septum**
- **Larynx**

UPPER LIMB

BONES

SHORT NOTES

1. Contents of radial groove

Contents

- **Radial nerve**
- **Profunda brachii artery**

Applied anatomy

Radial nerve injury may occur in fracture of shaft of humerus.

2. Spiral groove

Definition

Oblique groove on posterior surface of shaft of humerus.

Boundaries

- **Between medial and lateral heads of triceps.**

Contents

- **Radial nerve**
- **Profunda brachii artery**

Applied anatomy

Injury in humeral shaft fracture.

3. Coracoid process of scapula

Features

Hook-like projection from superior border of scapula.

Attachments

Muscles

- **Short head of biceps brachii**
- **Coracobrachialis**
- **Pectoralis minor**

Ligaments

- **Coracoacromial ligament**
- **Coracoclavicular ligament**
- **Coracohumeral ligament**

Importance

Provides attachment to muscles and ligaments.

PECTORAL REGION

LONG ESSAYS

1. Describe the mammary gland under the following headings: extent, deep relations, gross structure, arterial supply and lymphatics.

Extent

- **Extends vertically from 2nd to 6th ribs.**
- **Horizontally from lateral border of sternum to midaxillary line.**
- **Axillary tail of Spence extends into axilla.**

Deep relations

- **Skin and superficial fascia superficially.**
- **Retromammary space deep to gland.**
- **Pectoral fascia covering pectoralis major.**
- **Serratus anterior laterally.**

Gross structure

- **Modified sweat gland.**
- **Consists of 15–20 lobes.**
- **Each lobe drained by lactiferous duct.**
- **Lactiferous sinuses present beneath areola.**
- **Nipple situated opposite 4th intercostal space.**
- **Suspensory ligaments of Cooper support gland.**

Arterial supply

- **Internal thoracic artery.**
- **Lateral thoracic artery.**
- **Thoracoacromial artery.**
- **Posterior intercostal arteries.**

Venous drainage

- **Axillary vein.**
- **Internal thoracic vein.**

Lymphatic drainage

75% drains into axillary lymph nodes

- **Mainly anterior (pectoral) group.**

Remaining drains into

- **Parasternal nodes.**
- **Posterior intercostal nodes.**
- **Opposite breast.**

Applied anatomy

Carcinoma breast commonly spreads through lymphatics.

2. A 55-year-old female presented to general surgery outpatient department with pain in left axilla and swelling of left upper limb. On clinical examination the surgeon noted the presence of few enlarged swellings in her left axilla and a swelling in upper lateral quadrant of her left breast. With your knowledge in anatomy, answer the following questions.

Which group of axillary lymph nodes could be enlarged in this patient.

- **Anterior (pectoral) group of axillary lymph nodes.**
- **Central and apical groups may also enlarge.**

Describe the anatomical groups of axillary lymph nodes and specify their areas of drainage.

1. Anterior (pectoral) group

- **Along lateral thoracic vessels.**
- **Drain anterior thoracic wall and breast.**

2. Posterior (subscapular) group

- **Along subscapular vessels.**
- **Drain posterior thoracic wall and scapular region.**

3. Lateral group

- **Along axillary vein.**
- **Drain upper limb.**

4. Central group

- **In axillary fat.**
- **Receive lymph from above groups.**

5. Apical group

- **At apex of axilla.**
- **Receive lymph from all groups.**
- **Drain into subclavian lymph trunk.**

Describe the lymphatic drainage of mammary gland.

- **75% lymph drains to axillary nodes.**
- **Mainly to anterior group.**
- **Medial quadrants drain to parasternal nodes.**
- **Some lymph crosses to opposite breast.**
- **Inferior quadrants may drain to subdiaphragmatic nodes.**

Enumerate the boundaries and contents of axilla.

Boundaries

Apex

- **Cervicoaxillary canal.**

Base

- **Skin, superficial fascia and axillary fascia.**

Anterior wall

- **Pectoralis major.**
- **Pectoralis minor.**

- **Clavipectoral fascia.**

Posterior wall

- **Subscapularis.**
- **Teres major.**
- **Latissimus dorsi.**

Medial wall

- **Serratus anterior over thoracic wall.**

Lateral wall

- **Intertubercular sulcus of humerus.**

Contents

- **Axillary artery and branches.**
- **Axillary vein and tributaries.**
- **Brachial plexus cords and branches.**
- **Axillary lymph nodes.**
- **Fat and areolar tissue.**

3. A painter experienced difficulty in raising the right arm upwards. The physician asked the patient to press his hands against the wall in front. It was found that the medial border and inferior angle of right scapula became prominent.

Name the muscle tested in this person to detect the injury to which nerve.

- **Muscle tested: Serratus anterior.**
- **Nerve injured: Long thoracic nerve.**

What is the name of the deformity.

- **Winging of scapula.**

What is the origin and root value of this nerve.

- **Origin: Roots of brachial plexus.**
- **Root value: C5, C6, C7.**

How this nerve gets damaged

- **During axillary surgeries.**
- **Trauma to lateral thoracic wall.**
- **Repetitive strain.**

What are the attachments and actions of this muscle.

Attachments

Origin

- **Outer surfaces of upper 8 ribs.**

Insertion

- **Costal surface of medial border of scapula.**

Actions

- **Protracts scapula.**
- **Rotates scapula upward.**
- **Holds scapula against thoracic wall.**
- **Essential for overhead abduction.**

4. A 45 years old nulliparous woman reported to the OPD with two small palpable nodules in her left axilla. She was admitted, investigated and taken up for mastectomy (left) in the same week. With your knowledge in anatomy answer the following questions:

What could be the probable diagnosis?

- **Carcinoma of left breast.**

What could be the nodule in the axilla and why?

- **Enlarged axillary lymph nodes due to lymphatic spread of carcinoma.**

Describe the blood supply and lymphatic drainage of the breast.

Blood supply

Arterial supply

- **Internal thoracic artery.**
- **Lateral thoracic artery.**
- **Thoracoacromial artery.**
- **Posterior intercostal arteries.**

Venous drainage

- **Axillary vein.**
- **Internal thoracic vein.**

Lymphatic drainage

- **Mainly to anterior axillary nodes.**
- **Medial quadrants to parasternal nodes.**
- **Some drainage to posterior intercostal nodes.**

Mention the development and developmental anomalies of the breast.

Development

- **Develops from mammary ridge (milk line).**
- **Ectodermal origin.**

Developmental anomalies

- **Polythelia**
- **Polymastia**
- **Athelia**
- **Amastia**
- **Inverted nipple**

SHORT ESSAYS

1. Lymphatic drainage of mammary gland

Axillary drainage

- **75% lymph drains to axillary nodes.**
- **Mainly anterior (pectoral) group.**
- **Then central and apical groups.**

Parasternal drainage

- **Medial quadrants drain to parasternal nodes.**
- **Communication with opposite breast.**

Posterior intercostal drainage

- **Some lymph drains posteriorly.**

Subdiaphragmatic drainage

- **Inferior quadrants may drain below diaphragm.**

Applied anatomy

- **Spread of carcinoma through lymphatics.**
- **Axillary nodes examined clinically.**

2. Serratus anterior

Origin

- **Outer surfaces of upper 8 ribs.**

Insertion

- **Costal surface of medial border of scapula.**

Nerve supply

- **Long thoracic nerve (C5, C6, C7).**

Actions

- **Protraction of scapula.**
- **Upward rotation.**
- **Fixes scapula to thoracic wall.**

Applied anatomy

- **Injury causes winging of scapula.**

3. Lymphatic drainage of mammary gland and its applied significance.

Lymphatic drainage

- **Mainly to axillary nodes.**
- **Medial quadrants to parasternal nodes.**
- **Posterior drainage to posterior intercostal nodes.**
- **Some lymph crosses midline.**

Applied significance

- **Spread of breast carcinoma.**
- **Enlargement of axillary nodes.**
- **Metastasis to opposite breast.**
- **Sentinel lymph node biopsy important.**

SHORT NOTES

1. Clavipectoral fascia

Definition

Fascial sheet deep to pectoralis major.

Extent

- **From clavicle above to axillary fascia below.**

Parts

- **Costocoracoid membrane.**
- **Suspensory ligament of axilla.**

Structures piercing it

- **Cephalic vein**
- **Thoracoacromial artery**
- **Lateral pectoral nerve**
- **Lymphatics**

2. Name four structures piercing clavi-pectoral fascia

1. **Cephalic vein**
2. **Thoracoacromial artery**
3. **Lateral pectoral nerve**
4. **Lymphatics from breast to apical nodes**

3. Pectoralis minor

Origin

- **3rd, 4th and 5th ribs.**

Insertion

- **Coracoid process of scapula.**

Nerve supply

- **Medial pectoral nerve.**

Actions

- **Stabilizes scapula.**
- **Accessory muscle of inspiration.**

4. Lymphatic drainage of breast

- **Mainly to axillary nodes.**
- **Medial quadrants to parasternal nodes.**
- **Posterior drainage to posterior intercostal nodes.**
- **Inferior quadrants to subdiaphragmatic nodes.**

AXILLA

LONG ESSAYS

1. Describe Brachial plexus under the following headings: formation (roots, trunks, divisions, cords), branches and Erb's point. Add a note on Klumpke's paralysis.

Formation

Brachial plexus is formed by anterior rami of C5, C6, C7, C8 and T1.

Roots

- **Five roots: C5 to T1.**

Trunks

- **Upper trunk: C5 + C6**
- **Middle trunk: C7**
- **Lower trunk: C8 + T1**

Divisions

Each trunk divides into:

- **Anterior division**
- **Posterior division**

Cords

Named according to relation to second part of axillary artery.

Lateral cord

- **From anterior divisions of upper and middle trunks.**

Medial cord

- **From anterior division of lower trunk.**

Posterior cord

- **From posterior divisions of all trunks.**

Branches

From roots

- **Dorsal scapular nerve**
- **Long thoracic nerve**

From trunks

- **Suprascapular nerve**
- **Nerve to subclavius**

From lateral cord

- **Musculocutaneous nerve**
- **Lateral root of median nerve**
- **Lateral pectoral nerve**

From medial cord

- **Ulnar nerve**
- **Medial root of median nerve**
- **Medial pectoral nerve**
- **Medial cutaneous nerves**

From posterior cord

- **Axillary nerve**
- **Radial nerve**
- **Upper and lower subscapular nerves**
- **Thoracodorsal nerve**

Erb's point

- **Junction of C5 and C6 roots forming upper trunk.**
- **Site prone for upper brachial plexus injury.**

Klumpke's paralysis

Cause

Injury to lower trunk (C8, T1).

Features

- **Claw hand.**
- **Paralysis of intrinsic hand muscles.**
- **Sensory loss along medial side of forearm and hand.**

2. A 45-year-old man was brought to the casualty following fall from a tree. On examination it was found that there was clawing of little and ring fingers and sensory loss along the medial part of forearm. Brachial plexus injury was diagnosed.

a) Name the part of brachial plexus that is involved in this patient

- **Lower trunk of brachial plexus (C8, T1).**

b) Formation of trunks and cords of brachial plexus

Trunks

- **Upper trunk: C5 + C6**
- **Middle trunk: C7**
- **Lower trunk: C8 + T1**

Cords

- **Lateral cord from anterior divisions of upper and middle trunks.**
- **Medial cord from anterior division of lower trunk.**
- **Posterior cord from posterior divisions of all trunks.**

c) Branches from the cords of brachial plexus mentioning the root value of each branch

Lateral cord

- **Musculocutaneous nerve – C5, C6, C7**
- **Lateral root of median nerve – C5, C6, C7**
- **Lateral pectoral nerve – C5, C6, C7**

Medial cord

- **Ulnar nerve – C8, T1**
- **Medial root of median nerve – C8, T1**
- **Medial pectoral nerve – C8, T1**
- **Medial cutaneous nerve of arm – T1**
- **Medial cutaneous nerve of forearm – C8, T1**

Posterior cord

- **Axillary nerve – C5, C6**
- **Radial nerve – C5 to T1**
- **Upper subscapular nerve – C5, C6**
- **Thoracodorsal nerve – C6, C7, C8**
- **Lower subscapular nerve – C5, C6**

d) Add a note on Erb's point

- **Formed by union of C5 and C6 roots.**
- **Site of upper trunk lesion.**
- **Causes Erb-Duchenne paralysis.**
- **Waiter's tip deformity occurs.**

3. Assisted delivery was required during the birth of a baby at term. The manoeuvre involved an unusually wide stretching at the neck shoulder angle. The neonate on examination by a neurologist

showed upper brachial plexus injury. Answer the following

Describe formation and branches of brachial plexus

Formation

- **Formed by anterior rami of C5–T1.**

Roots

- **C5, C6, C7, C8, T1.**

Trunks

- **Upper, middle and lower.**

Divisions

- **Anterior and posterior divisions.**

Cords

- **Lateral, medial and posterior.**

Important terminal branches

- **Musculocutaneous nerve**
- **Median nerve**
- **Ulnar nerve**
- **Axillary nerve**
- **Radial nerve**

Explain the anatomical basis of the above lesion

- **Excessive separation of neck and shoulder stretches upper trunk.**
- **Upper trunk formed by C5 and C6.**
- **Causes Erb's palsy.**

Clinical features

- **Arm adducted and medially rotated.**
- **Elbow extended.**
- **Forearm pronated.**
- **"Waiter's tip" deformity.**

4. Describe the brachial plexus under the following headings.

Formation

- **Formed by anterior rami of C5–T1.**

Relations

- **In neck between scalenus anterior and medius.**
- **In axilla around second part of axillary artery.**

Branches

Supraclavicular branches

- **Dorsal scapular nerve**
- **Long thoracic nerve**
- **Suprascapular nerve**
- **Nerve to subclavius**

Infraclavicular branches

- **Musculocutaneous nerve**
- **Median nerve**
- **Ulnar nerve**
- **Axillary nerve**
- **Radial nerve**

Applied anatomy

- **Erb's palsy.**
- **Klumpke's paralysis.**
- **Injury during birth or trauma.**

SHORT ESSAYS

1. Axillary artery

Extent

- **Continuation of subclavian artery.**
- **Extends from outer border of first rib to lower border of teres major.**

Parts

Divided into three parts by pectoralis minor.

First part

Branch

- **Superior thoracic artery.**

Second part

Branches

- **Thoracoacromial artery**
- **Lateral thoracic artery**

Third part

Branches

- **Subscapular artery**
- **Anterior circumflex humeral artery**
- **Posterior circumflex humeral artery**

Relations

- **Axillary vein medial.**
- **Brachial plexus cords around artery.**

Applied anatomy

- **Compression to control bleeding.**

2. Brachial plexus

Formation

- **Anterior rami of C5–T1.**

Parts

- **Roots**
- **Trunks**
- **Divisions**
- **Cords**
- **Branches**

Important branches

- **Musculocutaneous**
- **Median**
- **Ulnar**
- **Axillary**
- **Radial**

Applied anatomy

- **Erb's palsy**
- **Klumpke's paralysis**

SHORT NOTES

1. Axillary lymph nodes

Groups

1. **Anterior**
2. **Posterior**
3. **Lateral**
4. **Central**
5. **Apical**

Drainage

- **Upper limb**
- **Breast**
- **Thoracic wall**

Applied anatomy

Enlarged in carcinoma breast.

2. Axillary artery

Extent

Outer border of first rib to lower border of teres major.

Parts

- **First part**
- **Second part**
- **Third part**

Branches

- **Superior thoracic**
- **Thoracoacromial**
- **Lateral thoracic**
- **Subscapular**
- **Circumflex humeral arteries**

3. Erb's point

Definition

Point where C5 and C6 roots unite.

Importance

Site of upper trunk injury.

Effects of injury

- **Erb's palsy.**
- **Waiter's tip deformity.**

4. Erb's paralysis

Cause

Upper trunk lesion (C5, C6).

Causes

- **Birth injury**
- **Fall on shoulder**

Clinical features

- **Adducted arm.**
- **Medially rotated shoulder.**
- **Extended elbow.**
- **Pronated forearm.**

Deformity

Waiter's tip position.

5. Relations of first part of axillary artery

REFER DIAGRAM SECTION

Anterior

- **Skin**
- **Fascia**
- **Pectoralis major**
- **Clavipectoral fascia**

Posterior

- **First intercostal space**
- **Serratus anterior**
- **Medial cord of brachial plexus**

Medial

- **Axillary vein**

Lateral

- **Lateral and posterior cords of brachial plexus**

DELTOID AND SCAPULAR REGION

SHORT ESSAYS

1. Axillary nerve

Introduction

Axillary nerve is a branch of the posterior cord of brachial plexus. It is the chief nerve supply of deltoid and teres minor muscles.

Root value

C5, C6.

Origin

Arises from posterior cord of brachial plexus in the axilla.

Course

1. **Lies posterior to axillary artery.**
2. **Passes inferiorly in front of subscapularis.**
3. **Accompanies posterior circumflex humeral vessels.**
4. **Enters quadrangular space.**
5. **Winds around surgical neck of humerus deep to deltoid.**
6. **Divides into anterior and posterior branches.**

Branches

1. Muscular branches

- **Deltoid**
- **Teres minor**

2. Articular branch

- **To shoulder joint.**

3. Cutaneous branch

- **Upper lateral cutaneous nerve of arm.**

Applied anatomy

- **Injured in fracture of surgical neck of humerus.**
- **Injured in inferior dislocation of shoulder joint.**
- **Causes paralysis of deltoid.**
- **Loss of shoulder contour.**
- **Difficulty in abduction from 15° to 90°.**
- **Sensory loss over regimental badge area.**

2. Intra muscular spaces of scapular region

Introduction

The scapular region contains three important intermuscular spaces:

1. **Quadrangular space**
2. **Upper triangular space**
3. **Lower triangular space**

Quadrangular space

Boundaries

- **Superior – Teres minor**
- **Inferior – Teres major**
- **Medial – Long head of triceps**
- **Lateral – Surgical neck of humerus**

Contents

- **Axillary nerve**
- **Posterior circumflex humeral vessels**

Upper triangular space

Boundaries

- **Superior – Teres minor**
- **Inferior – Teres major**
- **Lateral – Long head of triceps**

Contents

- **Circumflex scapular vessels**

Lower triangular space

Boundaries

- **Superior – Teres major**
- **Medial – Long head of triceps**
- **Lateral – Shaft of humerus**

Contents

- **Radial nerve**
- **Profunda brachii vessels**

Applied anatomy

- **Compression of axillary nerve in quadrangular space syndrome.**
- **Important surgical landmarks in posterior shoulder region.**

3. Deltoid muscle and its deep relations

Deltoid muscle

Origin

- **Lateral one-third of clavicle**
- **Acromion**
- **Spine of scapula**

Insertion

- **Deltoid tuberosity of humerus**

Nerve supply

- **Axillary nerve (C5, C6)**

Actions

- **Chief abductor of shoulder joint from 15°–90°.**
- **Anterior fibers – flexion and medial rotation.**
- **Posterior fibers – extension and lateral rotation.**

Deep relations

Structures deep to deltoid are:

1. **Shoulder joint**
2. **Head of humerus**
3. **Supraspinatus tendon**
4. **Infraspinatus tendon**
5. **Teres minor tendon**
6. **Subdeltoid bursa**
7. **Long head of biceps tendon**
8. **Axillary nerve**
9. **Posterior circumflex humeral vessels**

Applied anatomy

- **Intramuscular injections are given in lower part of muscle.**
- **Axillary nerve may be injured in shoulder dislocation.**

SHORT NOTES

1. Deltoid muscle

Origin

- **Lateral one-third of clavicle**
- **Acromion**
- **Spine of scapula**

Insertion

- **Deltoid tuberosity**

Nerve supply

- **Axillary nerve (C5, C6)**

Actions

- **Abduction of arm from 15°–90°.**
- **Flexion and medial rotation by anterior fibers.**
- **Extension and lateral rotation by posterior fibers.**

Applied anatomy

- **Deltoid paralysis causes flattening of shoulder.**

2. Trapezius muscle

Origin

- **External occipital protuberance**
- **Superior nuchal line**
- **Ligamentum nuchae**
- **Spinous processes of C7–T12**

Insertion

- **Lateral one-third of clavicle**
- **Acromion**
- **Spine of scapula**

Nerve supply

- **Spinal accessory nerve**
- **C3, C4 proprioceptive fibers**

Actions

- **Elevation, retraction and rotation of scapula.**

Applied anatomy

- **Accessory nerve injury causes shoulder droop.**

3. Quadrangular intermuscular space

Boundaries

- **Superior – Teres minor**
- **Inferior – Teres major**
- **Medial – Long head of triceps**
- **Lateral – Surgical neck of humerus**

Contents

- **Axillary nerve**
- **Posterior circumflex humeral vessels**

Importance

- **Transmits axillary nerve to deltoid region.**

4. Biceps brachii muscle

Origin

- **Long head – Supraglenoid tubercle**
- **Short head – Coracoid process**

Insertion

- **Radial tuberosity**
- **Bicipital aponeurosis**

Nerve supply

- **Musculocutaneous nerve**

Actions

- **Flexion of elbow**
- **Supination of forearm**

Applied anatomy

- **Biceps jerk tests C5–C6 spinal segments.**

5. Axillary nerve

Root value

C5, C6.

Course

Passes through quadrangular space around surgical neck of humerus.

Supply

- **Deltoid**
- **Teres minor**
- **Shoulder joint**
- **Skin over regimental badge area**

Applied anatomy

- **Injury causes inability to abduct shoulder.**

SHOULDER JOINT

LONG ESSAYS

1. Describe the shoulder joint under the following headings: type of joint, articulating surfaces, ligaments, movements and muscles causing them and applied anatomy

Type of joint

- **Synovial ball and socket type of multiaxial joint.**

Articulating surfaces

1. **Head of humerus**
2. **Glenoid cavity of scapula**
3. **Glenoid labrum deepens the cavity.**

Ligaments

1. Fibrous capsule

- **Attached medially to margin of glenoid cavity.**
- **Attached laterally to anatomical neck of humerus.**

2. Glenohumeral ligaments

- **Superior**
- **Middle**
- **Inferior**

3. Coracohumeral ligament

- **Extends from coracoid process to greater tubercle.**

4. Transverse humeral ligament

- **Bridges intertubercular sulcus.**

5. Coracoacromial ligament

- **Forms coracoacromial arch.**

Movements and muscles causing them

Flexion

- **Anterior deltoid**
- **Clavicular head of pectoralis major**
- **Coracobrachialis**
- **Biceps brachii**

Extension

- **Posterior deltoid**
- **Latissimus dorsi**
- **Teres major**

Abduction

- **Supraspinatus initiates first 15°.**
- **Deltoid acts from 15°–90°.**
- **Trapezius and serratus anterior rotate scapula beyond 90°.**

Adduction

- **Pectoralis major**
- **Latissimus dorsi**
- **Teres major**

Medial rotation

- **Subscapularis**
- **Pectoralis major**
- **Latissimus dorsi**
- **Teres major**
- **Anterior deltoid**

Lateral rotation

- **Infraspinatus**
- **Teres minor**
- **Posterior deltoid**

Circumduction

Combination of all movements.

Applied anatomy

- **Shoulder joint is most commonly dislocated joint.**
- **Dislocation usually occurs inferiorly.**
- **Rotator cuff tears commonly involve supraspinatus tendon.**
- **Frozen shoulder causes painful restriction of movements.**

2. Describe shoulder joint under the following headings:-

a) Articular surfaces
b) Structures stabilizing the joint
c) Movements and muscles producing each movement
d) Applied importance

a) Articular surfaces

- **Head of humerus articulates with glenoid cavity of scapula.**
- **Glenoid labrum deepens glenoid cavity.**

b) Structures stabilizing the joint

1. **Rotator cuff muscles**
    - **Supraspinatus**
    - **Infraspinatus**
    - **Teres minor**
    - **Subscapularis**
2. **Glenoid labrum**
3. **Coracoacromial arch**
4. **Tendon of long head of biceps**
5. **Glenohumeral ligaments**
6. **Coracohumeral ligament**

c) Movements and muscles producing each movement

Flexion

- **Deltoid (anterior fibers)**
- **Pectoralis major**
- **Coracobrachialis**
- **Biceps brachii**

Extension

- **Posterior deltoid**
- **Latissimus dorsi**
- **Teres major**

Abduction

- **Supraspinatus**
- **Deltoid**

Adduction

- **Pectoralis major**
- **Latissimus dorsi**
- **Teres major**

Medial rotation

- **Subscapularis**
- **Pectoralis major**
- **Latissimus dorsi**

Lateral rotation

- **Infraspinatus**
- **Teres minor**

d) Applied importance

- **Shoulder dislocation is common.**
- **Axillary nerve may be injured.**
- **Rotator cuff tear causes painful abduction.**
- **Frozen shoulder causes stiffness.**

3. A patient was brought with complaints of inability to abduct the right arm. On inspection, bulging in the upper part of the arm was observed

a) Name the joint involved
b) Write on the ligaments of the joint
c) Write on the relations of the joint
d) Write on the movements of the joint with muscles helping in the movements

a) Name the joint involved

- **Shoulder joint.**

b) Ligaments of the joint

1. **Fibrous capsule**
2. **Glenohumeral ligaments**
3. **Coracohumeral ligament**
4. **Transverse humeral ligament**
5. **Coracoacromial ligament**

c) Relations of the joint

Superiorly

- **Supraspinatus**
- **Coracoacromial arch**
- **Subacromial bursa**

Inferiorly

- **Long head of triceps**
- **Axillary nerve**

Anteriorly

- **Subscapularis**
- **Coracobrachialis**

Posteriorly

- **Infraspinatus**
- **Teres minor**

d) Movements of the joint with muscles helping in the movements

Flexion

- **Anterior deltoid**
- **Pectoralis major**

Extension

- **Posterior deltoid**
- **Latissimus dorsi**

Abduction

- **Supraspinatus**
- **Deltoid**

Adduction

- **Pectoralis major**
- **Latissimus dorsi**

Medial rotation

- **Subscapularis**

Lateral rotation

- **Infraspinatus**
- **Teres minor**

4. A 50 years old man came to the casualty with complaints of pain at the shoulder joint. Answer the following questions:

• Name the bones forming the joint
• Movements and muscles causing them
• Nerve supply
• Ligaments
• Blood supply
• Applied aspects

Bones forming the joint

- **Head of humerus**
- **Scapula (glenoid cavity)**

Movements and muscles causing them

Flexion

- **Deltoid**
- **Pectoralis major**

Extension

- **Posterior deltoid**
- **Latissimus dorsi**

Abduction

- **Supraspinatus**
- **Deltoid**

Adduction

- **Pectoralis major**
- **Latissimus dorsi**

Medial rotation

- **Subscapularis**

Lateral rotation

- **Infraspinatus**
- **Teres minor**

Nerve supply

- **Axillary nerve**
- **Suprascapular nerve**
- **Lateral pectoral nerve**

Ligaments

- **Fibrous capsule**
- **Glenohumeral ligaments**
- **Coracohumeral ligament**
- **Transverse humeral ligament**

Blood supply

- **Anterior circumflex humeral artery**
- **Posterior circumflex humeral artery**
- **Suprascapular artery**
- **Circumflex scapular artery**

Applied aspects

- **Dislocation**
- **Rotator cuff tear**
- **Frozen shoulder**

5. A football player dislocated his right shoulder while playing. After one month treatment, he noticed right shoulder was less prominent than the left and there was difficulty to abduct.

• Mention the anatomical features making the shoulder to joint more prone for dislocation
• What is the cause for flattening of shoulder in this case and difficulty to abduct ?
• Name the movements occurring at the

shoulder joint and muscles producing these movements
• State the reason, why head of the humerus is often displaced downwards?

Anatomical features making shoulder joint prone for dislocation

1. **Large head of humerus with small glenoid cavity.**
2. **Loose capsule.**
3. **Weak inferior part of capsule.**
4. **Wide range of movements.**

Cause for flattening of shoulder and difficulty in abduction

- **Injury to axillary nerve.**
- **Paralysis and wasting of deltoid muscle.**
- **Abduction from 15°–90° affected.**

Movements occurring at shoulder joint and muscles producing them

Flexion

- **Anterior deltoid**
- **Pectoralis major**

Extension

- **Posterior deltoid**
- **Latissimus dorsi**

Abduction

- **Supraspinatus**
- **Deltoid**

Adduction

- **Pectoralis major**
- **Latissimus dorsi**

Medial rotation

- **Subscapularis**

Lateral rotation

- **Infraspinatus**
- **Teres minor**

Reason why head of humerus is often displaced downwards

- **Inferior part of capsule is weakest and unsupported by rotator cuff muscles.**

6. A football player fell heavily and dislocated his right shoulder joint while playing. A collar and cuff support was given, after reducing the dislocation. Subsequently an orthopedic surgeon noticed that his right shoulder was less prominent than the left. The player was finding it difficult to abduct the arm to the horizontal level. Based on your anatomical knowledge answer the following questions:

• What anatomical features make the shoulder joint particularly prone to dislocation
• Briefly describe the most stabilizing structure of the joint and why the head of the humerus is often displaced downwards.
• In this case, what is the cause of subsequent flattening of the right shoulder and the difficulty in abducting the arm to a horizontal level.
• Briefly mention the ligaments and the muscles acting at the shoulder joint.

Anatomical features predisposing to dislocation

1. **Large humeral head.**
2. **Small shallow glenoid cavity.**
3. **Loose capsule.**

4. **Weak inferior capsule.**
5. **Extensive mobility.**

Most stabilizing structure of shoulder joint

- **Rotator cuff is the chief stabilizing structure.**
- **Formed by tendons of supraspinatus, infraspinatus, teres minor and subscapularis.**
- **Inferior part lacks rotator cuff support; hence downward dislocation is common.**

Cause of flattening and difficulty in abduction

- **Axillary nerve injury.**
- **Deltoid muscle paralysis.**
- **Loss of shoulder contour.**
- **Abduction to horizontal level affected.**

Ligaments of shoulder joint

- **Fibrous capsule**
- **Glenohumeral ligaments**
- **Coracohumeral ligament**
- **Transverse humeral ligament**
- **Coracoacromial ligament**

Muscles acting at shoulder joint

Flexors

- **Deltoid**
- **Pectoralis major**

Extensors

- **Latissimus dorsi**
- **Posterior deltoid**

Abductors

- **Supraspinatus**
- **Deltoid**

Adductors

- **Pectoralis major**
- **Latissimus dorsi**

Medial rotators

- **Subscapularis**

Lateral rotators

- **Infraspinatus**
- **Teres minor**

SHORT ESSAYS

1. Ligaments of shoulder joint

1. Fibrous capsule

- **Attached to margin of glenoid cavity.**
- **Laterally attached to anatomical neck.**
- **Loose and lax inferiorly.**

2. Glenohumeral ligaments

- **Superior**
- **Middle**
- **Inferior**
- **Strengthen anterior capsule.**

3. Coracohumeral ligament

- **Coracoid process to greater tubercle.**

4. Transverse humeral ligament

- **Bridges intertubercular sulcus.**
- **Holds tendon of long head of biceps.**

5. Coracoacromial ligament

- **Between coracoid and acromion.**
- **Forms protective arch.**

Functions

- **Stabilize shoulder joint.**
- **Prevent dislocation.**

2. Rotator cuff of shoulder joint

Definition

Rotator cuff is a musculotendinous cuff around shoulder joint formed by fusion of tendons of scapular muscles with capsule.

Muscles forming rotator cuff

- **Supraspinatus**
- **Infraspinatus**
- **Teres minor**
- **Subscapularis**

Function

- **Stabilizes head of humerus.**
- **Prevents upward displacement.**
- **Assists shoulder movements.**

Deficiency

- **Inferior part deficient.**

Applied anatomy

- **Supraspinatus tendon commonly torn.**
- **Rotator cuff injuries cause painful abduction.**

SHORT NOTES

1. Rotator cuff of shoulder joint

Muscles

- **Supraspinatus**
- **Infraspinatus**
- **Teres minor**
- **Subscapularis**

Functions

- **Stabilization of shoulder joint.**
- **Holds humeral head in glenoid cavity.**

Applied anatomy

- **Rotator cuff tear causes shoulder pain.**

2. Sagittal section through shoulder

REFER DIAGRAM SECTION

Structures seen

- **Clavicle**
- **Acromion**
- **Coracoid process**
- **Head of humerus**
- **Glenoid cavity**
- **Capsule**
- **Supraspinatus tendon**
- **Deltoid**
- **Subacromial bursa**

ARM

LONG ESSAYS

1. A Patient was brought to the clinic with a history of giddiness since one week. The physician asked the junior doctor to check the blood pressure. It was found that blood pressure was high.

a) Name the artery used to monitor the blood pressure

b) In which fossa is the bell of the stethoscope placed
c) Give the boundaries of the fossa
d) Mention the contents of the fossa in detail

a) Artery used to monitor blood pressure

- **Brachial artery.**

b) Fossa in which bell of stethoscope is placed

- **Cubital fossa.**

c) Boundaries of cubital fossa

Base

- **Imaginary line joining medial and lateral epicondyles.**

Medial boundary

- **Pronator teres.**

Lateral boundary

- **Brachioradialis.**

Apex

- **Meeting point of brachioradialis and pronator teres.**

Roof

- **Skin**
- **Superficial fascia**
- **Deep fascia reinforced by bicipital aponeurosis**

Floor

- **Brachialis**
- **Supinator**

d) Contents of cubital fossa

From medial to lateral:

1. **Median nerve**
2. **Brachial artery and its bifurcation**
3. **Tendon of biceps brachii**
4. **Radial nerve**

Additional contents:

- **Radial recurrent artery**
- **Median cubital vein in roof**

Applied anatomy

- **Site for measuring blood pressure.**
- **Venepuncture commonly performed here.**

2. A 35-year-old rowdy sheeter involved in a fight received a deep cut in the middle of the back of his right arm. He was bleeding profusely and was rushed to the hospital.

• Which nerve and artery at this site are in danger of injury.
• What is the origin and termination of this artery.
• How will you assess the functional integrity of the nerve in this case.
• Which part of the brachial plexus gives origin to this nerve and which other nerves arise from this part.
• Give the motor distribution and cutaneous branches of this nerve.

Nerve and artery in danger

- **Radial nerve**
- **Profunda brachii artery**

Origin and termination of artery

Origin

- **Profunda brachii artery arises from brachial artery.**

Termination

- **Ends by dividing into middle and radial collateral arteries.**

Assessment of functional integrity of radial nerve

1. **Test extension at wrist.**
2. **Test extension of fingers.**
3. **Check triceps reflex.**
4. **Examine sensation over dorsal first web space.**

Part of brachial plexus giving origin

- **Posterior cord.**

Other nerves from posterior cord

- **Axillary nerve**
- **Upper subscapular nerve**
- **Thoracodorsal nerve**
- **Lower subscapular nerve**

Motor distribution of radial nerve

- **Triceps**
- **Anconeus**
- **Brachioradialis**
- **Extensor muscles of forearm**

Cutaneous branches

- **Posterior cutaneous nerve of arm**
- **Lower lateral cutaneous nerve of arm**
- **Posterior cutaneous nerve of forearm**

3. Describe the cubital fossa under following headings.

• Boundaries
• Contents
• Clinical importance

Boundaries

Base

- **Line joining epicondyles.**

Medial

- **Pronator teres.**

Lateral

- **Brachioradialis.**

Roof

- **Skin**
- **Superficial fascia**
- **Deep fascia**
- **Bicipital aponeurosis**

Floor

- **Brachialis**
- **Supinator**

Contents

From medial to lateral:

1. **Median nerve**
2. **Brachial artery**
3. **Biceps tendon**
4. **Radial nerve**

Clinical importance

- **Blood pressure recording.**
- **Venepuncture site.**
- **Brachial artery palpation.**

SHORT ESSAYS

1. Arterial anastomoses around elbow joint

Arteries participating

From arm

- **Superior ulnar collateral**
- **Inferior ulnar collateral**
- **Radial collateral**
- **Middle collateral**

From forearm

- **Anterior ulnar recurrent**
- **Posterior ulnar recurrent**
- **Radial recurrent**
- **Interosseous recurrent**

Importance

- **Maintains collateral circulation around elbow.**

2. Cubital fossa

Definition

Triangular depression in front of elbow joint.

Boundaries

- **Medial – Pronator teres**
- **Lateral – Brachioradialis**
- **Base – Line joining epicondyles**

Contents

- **Median nerve**
- **Brachial artery**
- **Biceps tendon**
- **Radial nerve**

Applied anatomy

- **Venepuncture.**
- **Blood pressure recording.**

SHORT NOTES

1. Boundaries and contents of cubital fossa

Boundaries

- **Medial – Pronator teres**
- **Lateral – Brachioradialis**
- **Roof – Skin and fascia**
- **Floor – Brachialis and supinator**

Contents

- **Median nerve**
- **Brachial artery**
- **Biceps tendon**
- **Radial nerve**

2. Cephalic vein

Formation

- **Begins from lateral end of dorsal venous network.**

Course

- **Ascends along lateral side of forearm and arm.**
- **Passes through deltopectoral groove.**
- **Pierces clavipectoral fascia.**

Termination

- **Ends in axillary vein.**

Applied anatomy

- **Used for intravenous access.**

3. Brachial artery

Extent

- **Continuation of axillary artery.**
- **Extends from lower border of teres major to neck of radius.**

Termination

- **Divides into radial and ulnar arteries.**

Branches

- **Profunda brachii**
- **Nutrient artery**
- **Collateral branches**

Applied anatomy

- **Blood pressure recording.**

4. Median cubital vein

Situation

- **Lies in superficial fascia of cubital fossa.**

Connections

- **Connects cephalic and basilic veins.**

Importance

- **Common site for venepuncture.**

FOREARM

SHORT ESSAYS

1. Movements and the muscles involved in causing each movement at the wrist joint

Flexion

- **Flexor carpi radialis**
- **Flexor carpi ulnaris**
- **Palmaris longus**

Extension

- **Extensor carpi radialis longus**
- **Extensor carpi radialis brevis**
- **Extensor carpi ulnaris**

Abduction

- **Flexor carpi radialis**
- **Extensor carpi radialis longus and brevis**

Adduction

- **Flexor carpi ulnaris**
- **Extensor carpi ulnaris**

Circumduction

Combination of all movements.

2. Radio-ulnar joints

Types

1. **Superior radioulnar joint – Pivot synovial joint.**
2. **Middle radioulnar joint – Fibrous syndesmosis.**
3. **Inferior radioulnar joint – Pivot synovial joint.**

Movements

- **Supination**
- **Pronation**

Muscles

Supination

- **Supinator**

- **Biceps brachii**

Pronation

- **Pronator teres**
- **Pronator quadratus**

3. Supination and pronation

Supination

Movement in which palm faces anteriorly.

Muscles

- **Supinator**
- **Biceps brachii**

Pronation

Movement in which palm faces posteriorly.

Muscles

- **Pronator teres**
- **Pronator quadratus**

Axis

- **Passes through head of radius and head of ulna.**

SHORT NOTES

1. Structures passing under extensor retinaculum of upper limb

First compartment

- **Abductor pollicis longus**
- **Extensor pollicis brevis**

Second compartment

- **Extensor carpi radialis longus**
- **Extensor carpi radialis brevis**

Third compartment

- **Extensor pollicis longus**

Fourth compartment

- **Extensor digitorum**
- **Extensor indicis**

Fifth compartment

- **Extensor digiti minimi**

Sixth compartment

- **Extensor carpi ulnaris**

2. Posterior interosseous nerve

Origin

- **Continuation of deep branch of radial nerve.**

Course

- **Passes through supinator.**
- **Descends in posterior compartment.**

Supply

- **Extensor muscles of forearm.**

Applied anatomy

- **Injury causes finger drop.**

3. Extensor retinaculum of hand

Attachments

Lateral

- **Lower end of radius.**

Medial

- **Pisiform and triquetrum.**

Function

- **Prevents bow-stringing of extensor tendons.**

4. Supination and pronation

Supination muscles

- **Supinator**
- **Biceps brachii**

Pronation muscles

- **Pronator teres**
- **Pronator quadratus**

HAND

SHORT ESSAYS

1. Flexor retinaculum of hand and its clinical implications

Definition

Strong fibrous band stretching across anterior concavity of carpus.

Attachments

Medially

- **Pisiform**
- **Hook of hamate**

Laterally

- **Tubercle of scaphoid**
- **Crest of trapezium**

Structures passing superficial

- **Ulnar nerve**
- **Ulnar artery**
- **Palmaris longus tendon**

Structures passing deep

- **Median nerve**
- **Tendons of flexor digitorum superficialis**
- **Flexor digitorum profundus**
- **Flexor pollicis longus**

Clinical implications

- **Median nerve compression causes carpal tunnel syndrome.**
- **Thenar wasting may occur.**

2. Carpometacarpal joint of thumb

Type

- **Saddle type synovial joint.**

Articular surfaces

- **Trapezium and base of first metacarpal.**

Movements

- **Flexion**
- **Extension**
- **Abduction**
- **Adduction**
- **Opposition**

Muscles for opposition

- **Opponens pollicis**

Applied anatomy

- **Osteoarthritis common.**

3. Ulnar nerve in hand

Course

- **Enters hand superficial to flexor retinaculum.**
- **Passes through Guyon's canal.**

Branches

Superficial branch

- **Cutaneous and palmaris brevis.**

Deep branch

- **Supplies interossei and adductor pollicis.**

Muscles supplied

- **Hypothenar muscles**
- **Interossei**
- **Medial two lumbricals**
- **Adductor pollicis**

Applied anatomy

- **Ulnar claw hand.**

4. Palmar fascial spaces

Types

1. **Midpalmar space**
2. **Thenar space**

Midpalmar space

- **Located beneath flexor tendons.**
- **Infection spreads from medial synovial sheath.**

Thenar space

- **Located lateral to midpalmar space.**

Applied anatomy

- **Spaces may contain pus in hand infections.**

5. Superficial palmar arch

Formation

- **Mainly by ulnar artery.**
- **Completed by superficial palmar branch of radial artery.**

Situation

- **Beneath palmar aponeurosis.**

Branches

- **Common palmar digital arteries.**

Applied anatomy

- **Allen's test assesses arterial supply.**

SHORT NOTES

1. Flexor retinaculum of hand

Attachments

Medial

- **Pisiform**
- **Hook of hamate**

Lateral

- **Scaphoid**
- **Trapezium**

Function

- **Forms roof of carpal tunnel.**

Applied anatomy

- **Carpal tunnel syndrome.**

2. Describe boundaries and contents of anatomical snuff box

Boundaries

Lateral

- **Abductor pollicis longus**
- **Extensor pollicis brevis**

Medial

- **Extensor pollicis longus**

Floor

- **Scaphoid**
- **Trapezium**

Contents

- **Radial artery**
- **Superficial branch of radial nerve**
- **Cephalic vein**

Applied anatomy

- **Tenderness in scaphoid fracture.**

3. Claw hand

Definition

Hyperextension at metacarpophalangeal joints with flexion at interphalangeal joints.

Cause

- **Ulnar nerve palsy.**

Features

- **More marked in ring and little fingers.**

4. Anatomical basis of claw hand

Cause

- **Paralysis of lumbricals and interossei due to ulnar nerve injury.**

Result

- **Hyperextension at metacarpophalangeal joints.**
- **Flexion at interphalangeal joints.**

5. Palmar aponeurosis

Definition

Triangular thickening of deep fascia in palm.

Attachments

- **Apex attached to flexor retinaculum.**
- **Base divides into slips for fingers.**

Functions

- **Protects underlying tendons and vessels.**

Applied anatomy

- **Dupuytren contracture.**

6. Superficial palmar arch

Formation

- **Ulnar artery with superficial branch of radial artery.**

Branches

- **Common palmar digital arteries.**

Importance

- **Supplies palm and fingers.**

7. Midpalmar spaces

Boundaries

- **Anterior – Flexor tendons**
- **Posterior – Metacarpals and interossei**

Importance

- **Site of pus collection.**

8. Wrist joint

Type

- **Ellipsoid synovial joint.**

Articulating surfaces

- **Radius and articular disc with scaphoid, lunate and triquetrum.**

Movements

- **Flexion**
- **Extension**
- **Abduction**
- **Adduction**

9. First carpometacarpal joint

Type

- **Saddle joint.**

Movements

- **Flexion**
- **Extension**
- **Opposition**

Importance

- **Provides mobility of thumb.**

10. Deep palmar arch

Formation

- **Mainly radial artery.**
- **Completed by deep branch of ulnar artery.**

Branches

- **Palmar metacarpal arteries.**

Situation

- **Deep to flexor tendons.**

11. Interossei of hand

Types

1. **Dorsal interossei – abduct fingers.**
2. **Palmar interossei – adduct fingers.**

Nerve supply

- **Deep branch of ulnar nerve.**

Mnemonic

- **DAB – Dorsal abduct.**
- **PAD – Palmar adduct.**

12. Carpal tunnel

Boundaries

Roof

- **Flexor retinaculum.**

Floor

- **Carpal bones.**

Contents

- **Median nerve**
- **Flexor tendons**

Applied anatomy

- **Carpal tunnel syndrome.**

13. Adductor pollicis

Origin

- **Oblique and transverse heads.**

Insertion

- **Base of proximal phalanx of thumb.**

Nerve supply

- **Deep branch of ulnar nerve.**

Action

- **Adduction of thumb.**

14. Lumbricals

Origin

- **Tendons of flexor digitorum profundus.**

Insertion

- **Extensor expansions.**

Nerve supply

- **Lateral two – Median nerve**
- **Medial two – Ulnar nerve**

Action

- **Flex metacarpophalangeal joints and extend interphalangeal joints.**

15. Anatomical snuff box

Boundaries

- **Lateral – Abductor pollicis longus and extensor pollicis brevis**
- **Medial – Extensor pollicis longus**

Contents

- **Radial artery**

Clinical importance

- **Scaphoid tenderness.**

16. Flexor retinaculum

Attachments

- **Medial – Pisiform and hook of hamate**
- **Lateral – Scaphoid and trapezium**

Function

- **Converts carpal groove into carpal tunnel.**

Applied anatomy

- **Compression of median nerve.**

NERVES

LONG ESSAYS

1. A 45 year old man was bought to the casualty following a road traffic accident. He had pain and swelling over his right arm. On clinical examination it was found that he was unable to extend his right wrist joint and joints of his right hand and also sensory loss on dorsum of right hand. X-ray of his right arm showed fracture shaft of humerus. With your knowledge in anatomy answer the following questions

• Name the nerve injured in this patient.
• Give the root value of the nerve.
• Describe the course of the nerve.
• Name the branches given off by the nerve specifying the sites of origin.
• What is the reason behind the patient's inability to extend wrist joint and other joints of right hand.

Answer

Nerve injured

Radial nerve.

Root value

Radial nerve is derived from posterior cord of brachial plexus.
Root value: C5, C6, C7, C8 and T1.

Course of radial nerve

In axilla

• Arises from posterior cord of brachial plexus behind third part of axillary artery.
• Lies posterior to axillary artery.
• Leaves axilla through lower triangular space along with profunda brachii artery.

In arm

• Enters posterior compartment.
• Runs obliquely in radial groove of humerus between medial and lateral heads of triceps.
• Pierces lateral intermuscular septum about 10 cm above lateral epicondyle.
• Comes to anterior compartment between brachialis medially and brachioradialis and extensor carpi radialis longus laterally.
• In front of lateral epicondyle, divides into superficial and deep branches.

In forearm

Superficial branch

• Runs deep to brachioradialis.
• Accompanies radial artery in upper forearm.
• Emerges on dorsum of hand.
• Supplies skin over lateral dorsum of hand and dorsal aspects of lateral 3½ digits.

Deep branch (Posterior interosseous nerve)

• Pierces supinator muscle.
• Winds around neck of radius.
• Enters posterior compartment of forearm.
• Supplies extensor muscles.

Branches of radial nerve with sites of origin

In axilla

1. **Muscular branches to:**
   - **Long head of triceps**
   - **Medial head of triceps**
2. **Cutaneous branches:**
   - **Posterior cutaneous nerve of arm**

In radial groove

1. **Muscular branches to:**
   - **Lateral head of triceps**
   - **Medial head of triceps**
   - **Anconeus**
2. **Cutaneous branches:**
   - **Lower lateral cutaneous nerve of arm**
   - **Posterior cutaneous nerve of forearm**

In anterior compartment of arm

1. **Muscular branches to:**
   - **Brachioradialis**
   - **Extensor carpi radialis longus**
   - **Lateral part of brachialis**

Terminal branches

1. **Superficial branch – cutaneous.**
2. **Deep branch/posterior interosseous nerve – muscular.**

Reason for inability to extend wrist joint and joints of hand

• Radial nerve supplies all extensor muscles of forearm.
• Injury to radial nerve in spiral groove due to fracture shaft of humerus paralyses wrist extensors and finger extensors.
• Paralysis of extensor carpi radialis longus, extensor carpi radialis brevis and extensor carpi ulnaris causes wrist drop.
• Paralysis of extensor digitorum, extensor indicis and extensor digiti minimi causes inability to extend fingers.
• Sensory loss occurs over dorsum of hand due to involvement of superficial branch of radial nerve.

Applied anatomy

• Fracture shaft of humerus commonly injures radial nerve in radial groove.
• Characteristic deformity is wrist drop.

2. A 45 year old man was bought to the casualty with a fracture of shaft of the humerus. On examination he had impaired extension of the wrist. There was also impaired sensation over the dorsum of the forearm and lateral aspect of the hand.

• Name the structure involved and site of injury
• Mention its origin, course and distribution
• Mention its branches at different levels
• Mention the reasons for loss of sensation
• Name the accompanying blood vessel at the site of the injury

Answer

Structure involved and site of injury

• Structure involved – Radial nerve.
• Site of injury – Radial groove of humerus in fracture shaft of humerus.

Origin

• Radial nerve is a branch of posterior cord of brachial plexus.
• Root value: C5–T1.

Course

In axilla

• Lies behind axillary artery.
• Leaves axilla through lower triangular space with profunda brachii artery.

In arm

• Runs in radial groove between heads of triceps.
• Pierces lateral intermuscular septum.
• Descends between brachialis and brachioradialis.
• Divides in front of lateral epicondyle.

In forearm

• Superficial branch supplies skin.
• Deep branch passes through supinator and continues as posterior interosseous nerve.

Distribution

Motor

• Muscles of posterior compartment of arm and forearm.
• Brachioradialis and lateral part of brachialis.

Sensory

• Posterior arm.
• Posterior forearm.
• Lateral dorsum of hand.
• Dorsal aspect of lateral 3½ digits proximally.

Branches at different levels

In axilla

• Muscular branches to triceps.
• Posterior cutaneous nerve of arm.

In radial groove

• Muscular branches to triceps and anconeus.
• Lower lateral cutaneous nerve of arm.
• Posterior cutaneous nerve of forearm.

In front of lateral epicondyle

• Superficial branch.
• Deep branch.

Reasons for loss of sensation

• Posterior cutaneous nerve of forearm supplies dorsum of forearm.
• Superficial branch of radial nerve supplies lateral aspect of dorsum of hand.
• Injury to radial nerve interrupts sensory supply producing sensory loss.

Accompanying blood vessel at site of injury

Profunda brachii artery.

3. A 25 year old cricket player sustained injury in his left arm. On X-ray examination, a fracture of shaft of humerus was observed. Following internal reduction of fracture, he was not able to extend his left wrist. Based on knowledge in anatomy answer the following:

• Injury to which nerve produce inability to extend wrist
• Briefly describe the origin, course and distribution of the nerve involved
• Name the other nerves related to humerus and mention appropriate sites

Answer

Nerve injured

Radial nerve.

Origin

• Branch of posterior cord of brachial plexus.
• Root value: C5–T1.

Course

In axilla

- **Posterior to axillary artery.**
- **Passes through lower triangular space.**

In arm

- **Runs in radial groove with profunda brachii artery.**
- **Pierces lateral intermuscular septum.**
- **Passes anterior to lateral epicondyle.**
- **Divides into superficial and deep branches.**

In forearm

- **Superficial branch is sensory.**
- **Deep branch continues as posterior interosseous nerve.**

Distribution

Motor

- **Triceps.**
- **Anconeus.**
- **Brachioradialis.**
- **Extensor muscles of forearm.**

Sensory

- **Posterior arm.**
- **Posterior forearm.**
- **Dorsolateral aspect of hand.**

Other nerves related to humerus and sites

1. **Axillary nerve – related to surgical neck of humerus.**
2. **Ulnar nerve – related to medial epicondyle.**
3. **Median nerve – related to supracondylar region.**
4. **Musculocutaneous nerve – related to coracobrachialis and anterior compartment.**

Applied anatomy

- **Injury to radial nerve causes wrist drop.**

SHORT ESSAYS

1. Radial nerve- root value, course and branches in axilla, arm and cubital fossa. What is Saturday night palsy

Answer

Root value

C5, C6, C7, C8 and T1.

Origin

- **Largest branch of posterior cord of brachial plexus.**

Course

In axilla

- **Lies behind third part of axillary artery.**
- **Leaves through lower triangular space with profunda brachii artery.**

In arm

- **Winds around posterior aspect of humerus in radial groove.**
- **Lies between heads of triceps.**
- **Pierces lateral intermuscular septum.**
- **Descends between brachialis and brachioradialis.**

In cubital fossa

- **Lies in front of lateral epicondyle.**
- **Divides into superficial and deep branches.**

Branches

In axilla

• Muscular branches to triceps.
• Posterior cutaneous nerve of arm.

In radial groove

• Muscular branches to triceps and anconeus.
• Lower lateral cutaneous nerve of arm.
• Posterior cutaneous nerve of forearm.

In lower arm

• Muscular branches to brachioradialis, extensor carpi radialis longus and brachialis.

Terminal branches

1. **Superficial branch.**
2. **Deep branch.**

Saturday night palsy

• Compression injury of radial nerve in radial groove due to prolonged pressure over arm during deep sleep, especially in intoxicated persons.
• Produces wrist drop and sensory loss over dorsum of hand.

2. Radial nerve

Answer

Origin and root value

• Branch of posterior cord of brachial plexus.
• Root value: C5–T1.

Course

• Passes through lower triangular space.
• Runs in radial groove with profunda brachii artery.
• Pierces lateral intermuscular septum.
• Divides into superficial and deep branches.

Branches

• Muscular branches.
• Cutaneous branches.
• Superficial branch.
• Deep branch.

Distribution

Motor

• Extensor muscles of arm and forearm.

Sensory

• Posterior arm.
• Posterior forearm.
• Dorsolateral hand.

Applied anatomy

• Injury causes wrist drop.
• Commonly injured in fracture shaft of humerus.

3. Median nerve

Answer

Root value

C5, C6, C7, C8 and T1.

Formation

• Formed by lateral and medial roots from lateral and medial cords of brachial plexus.

Course

In arm

• Runs with brachial artery.
• Crosses artery from lateral to medial side.

In cubital fossa

• Lies medial to brachial artery.
• Passes between two heads of pronator teres.

In forearm

• Descends between flexor digitorum superficialis and profundus.
• Gives anterior interosseous nerve.

In hand

• Passes through carpal tunnel.
• Divides into terminal branches.

Distribution

Motor

• Most flexor muscles of forearm.
• Thenar muscles.
• Lateral two lumbricals.

Sensory

• Lateral palm.
• Palmar aspect of lateral 3½ digits.

Applied anatomy

• Injury causes ape thumb deformity.
• Compression in carpal tunnel syndrome.

4. Ulnar nerve

Answer

Root value

C8 and T1 mainly, sometimes C7.

Origin

• Branch of medial cord of brachial plexus.

Course

In arm

• Descends medial to brachial artery.
• Pierces medial intermuscular septum.
• Passes behind medial epicondyle.

In forearm

• Passes between two heads of flexor carpi ulnaris.
• Runs with ulnar artery.

In hand

• Enters superficial to flexor retinaculum through Guyon canal.
• Divides into superficial and deep branches.

Distribution

Motor

• Flexor carpi ulnaris.
• Medial half of flexor digitorum profundus.
• Most intrinsic muscles of hand.

Sensory

• Medial 1½ fingers and adjacent palm.

Applied anatomy

• Injury causes claw hand.

SHORT NOTES

1. Explain the anatomical basis of wrist drop.

Answer

• Wrist drop occurs due to paralysis of extensor muscles of forearm supplied by radial nerve.
• Common causes:

1. **Fracture shaft of humerus injuring radial nerve in radial groove.**
2. **Compression neuropathy – Saturday night palsy.**
   • Paralysed muscles:
   • Extensor carpi radialis longus.
   • Extensor carpi radialis brevis.
   • Extensor carpi ulnaris.
   • Unopposed action of flexors causes flexion at wrist.
   • Patient cannot extend wrist and fingers.

2. Explain the anatomical basis of carpal tunnel syndrome

Answer

• Carpal tunnel is an osseofibrous tunnel deep to flexor retinaculum.
• Contents:
• Median nerve.
• Four tendons of flexor digitorum superficialis.
• Four tendons of flexor digitorum profundus.
• Tendon of flexor pollicis longus.
• Compression of median nerve within tunnel causes carpal tunnel syndrome.

Causes

• Tenosynovitis.
• Rheumatoid arthritis.
• Pregnancy.
• Myxoedema.

Clinical features

• Pain and tingling in lateral 3½ fingers.
• Thenar muscle wasting.
• Weak thumb opposition.
• Ape thumb deformity in severe cases.

3. Compartments deep to extensor retinaculum of hand

Answer

Extensor retinaculum forms six osteofibrous compartments.

1. **First compartment:**
   • Abductor pollicis longus.
   • Extensor pollicis brevis.
2. **Second compartment:**
   • Extensor carpi radialis longus.
   • Extensor carpi radialis brevis.
3. **Third compartment:**
   • Extensor pollicis longus.
4. **Fourth compartment:**
   • Extensor digitorum.
   • Extensor indicis.
5. **Fifth compartment:**
   • Extensor digiti minimi.
6. **Sixth compartment:**
   • Extensor carpi ulnaris.

4. Anatomical basis of claw hand.

Answer

• Claw hand occurs due to ulnar nerve injury.
• Paralysis of lumbricals and interossei causes hyperextension at metacarpophalangeal joints and flexion at interphalangeal joints.
• More marked in ring and little fingers.
• Seen in lesions at elbow or wrist.
• Associated findings:
• Interosseous wasting.
• Loss of finger abduction and adduction.

5. Anterior interosseous nerve

Answer

• Branch of median nerve in forearm.
• Arises between heads of pronator teres.
• Runs on anterior surface of interosseous membrane with anterior interosseous artery.

Supply

• Flexor pollicis longus.
• Lateral half of flexor digitorum profundus.
• Pronator quadratus.

Applied anatomy

• Injury causes inability to make "OK sign".

HEAD AND NECK

BONES

SHORT NOTES

1. Structures passing through foramen ovale of skull

Answer

Structures passing through foramen ovale:

1. **Mandibular nerve.**
2. **Accessory meningeal artery.**
3. **Lesser petrosal nerve.**
4. **Emissary vein connecting cavernous sinus with pterygoid venous plexus.**

2. Styloid apparatus.

Answer

Styloid apparatus consists of:

1. **Styloid process.**
2. **Stylohyoid ligament.**
3. **Muscles attached:**
   - **Styloglossus.**
   - **Stylohyoid.**
   - **Stylopharyngeus.**

Development

Derived from second pharyngeal arch cartilage.

Applied anatomy

• Elongated styloid process causes Eagle syndrome.

3. Structures passing through foramen magnum

Answer

Structures passing through foramen magnum:

1. **Medulla oblongata with meninges.**
2. **Vertebral arteries.**
3. **Anterior spinal artery.**
4. **Posterior spinal arteries.**
5. **Spinal roots of accessory nerve.**
6. **Tectorial membrane.**
7. **Apical ligament of dens.**
8. **Alar ligaments.**

4. Jugular foramen

Answer

Location

Between petrous temporal bone and occipital bone.

Structures passing through

Anterior compartment

• Inferior petrosal sinus.

Intermediate compartment

• Glossopharyngeal nerve.
• Vagus nerve.
• Accessory nerve.

Posterior compartment

• Sigmoid sinus continuing as internal jugular vein.
• Meningeal branches of occipital and ascending pharyngeal arteries.

5. Styloid process

Answer

• Slender pointed projection from inferior surface of temporal bone.

Attachments

Muscles

1. **Styloglossus.**
2. **Stylohyoid.**
3. **Stylopharyngeus.**

Ligaments

1. **Stylohyoid ligament.**
2. **Stylomandibular ligament.**

Development

Derived from Reichert cartilage of second arch.

6. Foramen Magnum

Answer

Situation

Large opening in occipital bone.

Boundaries

• Anterior – Basilar part.
• Lateral – Condylar parts.
• Posterior – Squamous part.

Structures transmitted

1. **Medulla oblongata.**
2. **Vertebral arteries.**
3. **Spinal accessory nerves.**
4. **Spinal arteries.**
5. **Ligaments.**

Applied anatomy

• Herniation of cerebellar tonsils may compress medulla.

SCALP

SHORT ESSAYS

1. Name the layers of the scalp. Why do scalp wounds bleed profusely. Which layer is considered the dangerous layer and why

Answer

Layers of scalp

Mnemonic: SCALP

1. **Skin.**
2. **Connective tissue (dense).**
3. **Aponeurosis (epicranial aponeurosis).**
4. **Loose areolar tissue.**
5. **Pericranium.**

Why scalp wounds bleed profusely

• Scalp has rich arterial supply.
• Blood vessels are firmly attached in dense connective tissue.
• Cut vessels cannot retract after injury.
• Hence bleeding is profuse.

Dangerous layer of scalp

Loose areolar tissue is called dangerous layer.

Reason

• Emissary veins in this layer connect extracranial veins with intracranial venous sinuses.
• Infection can spread from scalp to intracranial venous sinuses causing intracranial complications.

2. Layers of scalp with clinical implications

Answer

Layers

1. **Skin.**
2. **Dense connective tissue.**
3. **Epicranial aponeurosis.**
4. **Loose areolar tissue.**
5. **Pericranium.**

Clinical implications

• Profuse bleeding due to dense connective tissue.
• Gaping wounds occur when epicranial aponeurosis is cut transversely.
• Loose areolar tissue is dangerous area for spread of infection.
• Black eye may occur due to spread of blood into eyelids.
• Cephalhematoma occurs beneath pericranium.

FACE

SHORT ESSAYS

1. Describe the attachments, innervation and actions of muscles of mastication.

Answer

Muscles of mastication

1. **Masseter.**
2. **Temporalis.**
3. **Medial pterygoid.**
4. **Lateral pterygoid.**

Masseter

Attachments

• Origin – Zygomatic arch.
• Insertion – Lateral surface of ramus and angle of mandible.

Nerve supply

Masseteric nerve from mandibular nerve.

Actions

• Elevates mandible.
• Superficial fibres help protrusion.

Temporalis

Attachments

• Origin – Temporal fossa.
• Insertion – Coronoid process and anterior border of ramus.

Nerve supply

Deep temporal nerves.

Actions

• Elevates mandible.
• Posterior fibres retract mandible.

Medial pterygoid

Attachments

• Origin – Medial surface of lateral pterygoid plate and maxillary tuberosity.
• Insertion – Medial surface of angle of mandible.

Nerve supply

Nerve to medial pterygoid.

Actions

• Elevates and protrudes mandible.
• Side to side movements.

Lateral pterygoid

Attachments

• Origin – Greater wing of sphenoid and lateral surface of lateral pterygoid plate.
• Insertion – Neck of mandible and articular disc of temporomandibular joint.

Nerve supply

Nerve to lateral pterygoid.

Actions

• Protrudes mandible.
• Helps opening of mouth.
• Side to side movements.

Nerve supply of muscles of mastication

All supplied by mandibular nerve.

2. Muscles of mastication

Answer

Muscles of mastication are:

1. **Masseter.**
2. **Temporalis.**
3. **Medial pterygoid.**
4. **Lateral pterygoid.**

Nerve supply

All are supplied by mandibular division of trigeminal nerve.

Actions

• Elevation of mandible – Masseter, temporalis, medial pterygoid.
• Depression – Lateral pterygoid.
• Protrusion – Lateral and medial pterygoid.
• Retraction – Posterior fibres of temporalis.

3. Temporomandibular joint

Answer

Type

Modified synovial joint.

Articular surfaces

• Head of mandible.
• Mandibular fossa and articular tubercle of temporal bone.

Articular disc

Fibrocartilaginous disc divides joint into upper and lower compartments.

Ligaments

1. **Fibrous capsule.**

2. **Lateral ligament.**
3. **Sphenomandibular ligament.**
4. **Stylomandibular ligament.**

Movements

• Depression and elevation.
• Protrusion and retraction.
• Side to side movements.

Muscles producing movements

• Masseter.
• Temporalis.
• Pterygoids.

Nerve supply

Auriculotemporal nerve and masseteric nerve.

Applied anatomy

• Dislocation of temporomandibular joint.

4. Orbicularis oculi muscle

Answer

Parts

1. **Orbital part.**
2. **Palpebral part.**
3. **Lacrimal part.**

Origin

• Medial orbital margin.
• Medial palpebral ligament.
• Lacrimal bone.

Insertion

Skin around orbit and eyelids.

Nerve supply

Temporal and zygomatic branches of facial nerve.

Actions

• Closes eyelids.
• Orbital part closes tightly.
• Palpebral part closes gently.
• Lacrimal part aids lacrimal drainage.

Applied anatomy

• Facial nerve palsy causes inability to close eye.

SHORT NOTES

1. Facial artery

Answer

Origin

Branch of external carotid artery.

Course

• Arises in carotid triangle.
• Passes deep to submandibular gland.
• Winds around lower border of mandible.
• Runs tortuously across face to medial angle of eye.

Branches

Cervical branches

1. **Ascending palatine.**
2. **Tonsillar.**
3. **Glandular.**
4. **Submental.**

Facial branches

1. **Inferior labial.**

2. Superior labial.
3. Lateral nasal.
4. Angular artery.

Applied anatomy

• Pulse felt at lower border of mandible.

2. Orbicularis oculi muscle

Answer

• Muscle surrounding orbit and eyelids.
• Supplied by facial nerve.
• Closes eyelids.
• Paralysis causes inability to close eye.

3. Extra cranial branches of facial nerve

Answer

After emerging from stylomastoid foramen facial nerve gives:

1. Posterior auricular nerve.
2. Nerve to posterior belly of digastric.
3. Nerve to stylohyoid.

Within parotid gland it divides into:

1. Temporal.
2. Zygomatic.
3. Buccal.
4. Marginal mandibular.
5. Cervical branches.

4. Routes of spread of infection from dangerous area of face to cavernous sinus

Answer

Dangerous area of face includes upper lip and lower part of nose.

Routes of spread

1. Facial vein → Angular vein → Superior ophthalmic vein → Cavernous sinus.
2. Facial vein → Deep facial vein → Pterygoid venous plexus → Emissary veins → Cavernous sinus.

Reason

• Facial veins are valveless.
• Infection can spread retrogradely.

DRAW AND LABEL

5. Distribution of cutaneous nerves to head and neck

Answer

REFER DIAGRAM SECTION

Sensory nerves of face

• Supraorbital.
• Supratrochlear.
• Infraorbital.
• Mental.
• Auriculotemporal.
• Buccal.

Sensory nerves of scalp

Anterior to auricle:
• Supratrochlear.
• Supraorbital.
• Zygomaticotemporal.
• Auriculotemporal.

Posterior to auricle:
• Lesser occipital.
• Greater auricular.
• Greater occipital.
• Third occipital.

PAROTID GLAND

LONG ESSAYS

1. A 12 year old boy developed fever and painful swelling just in front and below the lobule of right ear. On examination the right ear lobule was found to be lifted by the swelling. Based on your knowledge of anatomy answer the following questions:

a) Identify the gland that is swollen
b) Explain the anatomical basis of pain arising from the swelling
c) Describe the gross features and relations of this gland
d) Describe the secretomotor nerve supply of the gland

Answer

a) Identify the gland that is swollen

Parotid gland.

b) Anatomical basis of pain

• Parotid gland is enclosed in tough unyielding parotid fascia derived from deep cervical fascia.
• Swelling stretches the fascia causing severe pain.
• Great auricular nerve supplies fascia.

c) Gross features and relations

Gross features

• Largest salivary gland.
• Wedge shaped.
• Situated below external acoustic meatus between ramus of mandible and sternocleidomastoid.

Surfaces

1. **Superficial surface.**
2. **Anteromedial surface.**
3. **Posteromedial surface.**

Borders

1. **Anterior.**
2. **Posterior.**
3. **Medial.**

Apex

Directed downwards.

Base

Related to zygomatic arch.

Relations

Superficial surface

• Skin.
• Superficial fascia.
• Great auricular nerve.
• Deep fascia.

Anteromedial surface

• Ramus of mandible.
• Masseter.
• Medial pterygoid.
• Temporomandibular joint.

Posteromedial surface

• Mastoid process.
• Sternocleidomastoid.
• Posterior belly of digastric.
• Styloid apparatus.
• Carotid sheath.

Structures within gland

From superficial to deep:

1. **Facial nerve.**

2. **Retromandibular vein.**
3. **External carotid artery.**

d) Secretomotor nerve supply

• Preganglionic fibres arise from inferior salivatory nucleus.
• Pass through glossopharyngeal nerve.
• Tympanic branch forms tympanic plexus.
• Lesser petrosal nerve carries fibres to otic ganglion.
• Postganglionic fibres pass through auriculotemporal nerve to parotid gland.

2. A 35 year old female came with a history of swelling below the ear lobule on right side. The swelling was associated with pain.

a) Which is the structure involved.
b) What are the coverings, surfaces and borders of the structure.
c) What are the structures passing through it.
d) Write the secretomotor pathway of the structure.

Answer

a) Structure involved

Parotid gland.

b) Coverings, surfaces and borders

Coverings

1. **True capsule.**
2. **False capsule (parotid fascia).**

Surfaces

1. **Superficial surface.**
2. **Anteromedial surface.**
3. **Posteromedial surface.**

Borders

1. **Anterior border.**
2. **Posterior border.**
3. **Medial border.**

c) Structures passing through it

From superficial to deep:

1. **Facial nerve.**
2. **Retromandibular vein.**
3. **External carotid artery.**

d) Secretomotor pathway

Inferior salivatory nucleus → Glossopharyngeal nerve → Tympanic branch → Tympanic plexus → Lesser petrosal nerve → Otic ganglion → Auriculotemporal nerve → Parotid gland.

3. A 50-year-old man presented with a history of rapidly growing painful swelling on the face below the ear lobule on the left side. On examination the left ear lobule was found to be lifted by the swelling. There was an inability to close the left eye and to blow the cheek. The angle of mouth was deviated to the right side.

• Name the surfaces, borders and structures related to the affected organ
• Give the nerve supply of the organ
• Correlate the symptoms seen in relation to the anatomical structures

Answer

Affected organ

Parotid gland.

Surfaces

1. **Superficial.**
2. **Anteromedial.**
3. **Posteromedial.**

Borders

1. **Anterior.**
2. **Posterior.**
3. **Medial.**

Relations

Superficial surface

• Skin.
• Fascia.
• Great auricular nerve.

Anteromedial surface

• Ramus of mandible.
• Masseter.
• Medial pterygoid.

Posteromedial surface

• Mastoid process.
• Sternocleidomastoid.
• Styloid apparatus.
• Carotid sheath.

Nerve supply

Sensory

Auriculotemporal nerve and great auricular nerve.

Secretomotor

Glossopharyngeal nerve through otic ganglion and auriculotemporal nerve.

Correlation of symptoms

• Facial nerve traverses parotid gland.
• Compression of facial nerve causes facial muscle paralysis.
• Orbicularis oculi paralysis causes inability to close eye.
• Buccinator paralysis causes inability to blow cheek.
• Unopposed action of muscles on normal side causes deviation of angle of mouth to opposite side.

4. A 70-yr-old man presented with a rapidly growing swelling below the ear lobule on the left side. The left ear lobule is lifted due to swelling. The person was unable to close the left eye and blow his mouth. Angle of mouth deviated to right side.

• Which is the gland enlarged
• What major structures pass through this gland
• Name the surfaces and relations of this gland.
• Which nerve is involved in this case. Give the extracranial distribution by this nerve.

Answer

Enlarged gland

Parotid gland.

Major structures passing through gland

From superficial to deep:

1. **Facial nerve.**
2. **Retromandibular vein.**
3. **External carotid artery.**

Surfaces and relations

Superficial surface

• Skin.
• Fascia.
• Great auricular nerve.

Anteromedial surface

• Mandible.
• Masseter.
• Temporomandibular joint.

Posteromedial surface

• Mastoid process.
• Sternocleidomastoid.
• Styloid apparatus.
• Carotid sheath.

Nerve involved

Facial nerve.

Extracranial distribution

Branches after stylomastoid foramen

1. **Posterior auricular.**
2. **Nerve to stylohyoid.**
3. **Nerve to posterior belly of digastric.**

Terminal branches within parotid gland

1. **Temporal.**
2. **Zygomatic.**
3. **Buccal.**
4. **Marginal mandibular.**
5. **Cervical.**

5. A 58 year old man presented with rapidly growing swelling of parotid gland. On examination, there was an inability to close the left eye and blow the cheek. The angle of mouth was deviated to right side. Based on your anatomical knowledge answer these :

• External features and secretomotor pathway of parotid gland
• Name the structures within the gland and which of these injured in this patient
• What is the reason for inability to close the eye and blow the cheek
• Mention the course of parotid duct and structures pierced by it

Answer

External features of parotid gland

• Largest salivary gland.
• Wedge shaped.
• Situated below external acoustic meatus.
• Has base, apex, three surfaces and three borders.

Secretomotor pathway

Inferior salivatory nucleus → Glossopharyngeal nerve → Tympanic branch → Tympanic plexus → Lesser petrosal nerve → Otic ganglion → Auriculotemporal nerve → Parotid gland.

Structures within gland

From superficial to deep:

1. **Facial nerve.**
2. **Retromandibular vein.**
3. **External carotid artery.**

Structure injured in this patient

Facial nerve.

Reason for inability to close eye and blow cheek

• Paralysis of orbicularis oculi causes inability to close eye.
• Paralysis of buccinator causes inability to blow cheek.

Course of parotid duct

• Emerges from anterior border of gland.
• Runs over masseter.
• Turns medially at anterior border of masseter.
• Pierces buccal fat pad and buccinator.
• Opens into vestibule opposite upper second molar tooth.

Structures pierced by parotid duct

1. **Buccal fat pad.**
2. **Buccopharyngeal fascia.**
3. **Buccinator muscle.**
4. **Oral mucosa.**

6.A 55 year old man presented with a rapidly growing swelling on the left side of his face just below the ear lobule. On examination, the ear lobule was found to be lifted by the swelling. Following surgical excision of the swelling, the person found difficult to close the left eye and blow the cheek. The angle of mouth was deviated to the right.

Based on your knowledge of anatomy, answer the following:

• which anatomical structure is likely to be involved

• Briefly describe the external features, relations and blood supply of structures involved

• Accidental injury to which nerve is probable cause of man's difficulties

• Briefly explain the reasons for the disabilities

Answer

Anatomical structure involved

Parotid gland.

External features

- **Largest salivary gland.**
- **Pyramidal/wedge shaped.**
- **Situated in parotid bed.**
- **Base directed upward.**
- **Apex directed downward.**
- **Three surfaces and three borders.**

Relations

Superficial surface

- **Skin**
- **Fascia**
- **Great auricular nerve**

Anteromedial surface

- **Ramus of mandible**
- **Masseter**
- **Medial pterygoid**

Posteromedial surface

- **Mastoid process**
- **Sternocleidomastoid**
- **Styloid apparatus**
- **Carotid sheath**

Blood supply

Arterial supply

Branches of:

- **External carotid artery**
- **Superficial temporal artery**
- **Maxillary artery**
- **Transverse facial artery**

Venous drainage

Retromandibular vein.

Nerve injured

Facial nerve.

Reason for disabilities

1. **Orbicularis oculi paralysis → inability to close eye.**
2. **Buccinator paralysis → inability to blow cheek.**
3. **Paralysis of facial muscles → deviation of angle of mouth to opposite side.**

SHORT ESSAYS

1. Parotid gland relations

Answer

Relations of parotid gland

Superficial surface

Related to:

- **Skin**
- **Superficial fascia**
- **Great auricular nerve**
- **Parotid lymph nodes**
- **Deep fascia**

Anteromedial surface

Related to:

- **Posterior border of ramus of mandible**
- **Masseter muscle**
- **Medial pterygoid muscle**
- **Temporomandibular joint**

Posteromedial surface

Related to:

- **Mastoid process**
- **Sternocleidomastoid muscle**
- **Posterior belly of digastric**
- **Styloid process**
- **Stylohyoid**
- **Styloglossus**
- **Stylopharyngeus**
- **Carotid sheath containing internal carotid artery, internal jugular vein and vagus nerve**

Structures passing through gland

From superficial to deep:

1. **Facial nerve**
2. **Retromandibular vein**
3. **External carotid artery**

2. Parotid gland

Answer

Parotid gland

Situation

Largest salivary gland situated below and in front of external acoustic meatus in parotid bed.

External features

- **Wedge-shaped.**
- **Base upward.**
- **Apex downward.**
- **Three surfaces:**
    1. **Superficial**
    2. **Anteromedial**
    3. **Posteromedial**
- **Three borders:**
    1. **Anterior**
    2. **Posterior**
    3. **Medial**

Coverings

1. **True capsule**
2. **False capsule/parotid sheath**

Structures within gland

1. **Facial nerve**
2. **Retromandibular vein**
3. **External carotid artery**

Parotid duct

- **5 cm long.**
- **Crosses masseter.**
- **Pierces buccinator.**
- **Opens opposite upper second molar tooth.**

Nerve supply

Parasympathetic

Glossopharyngeal nerve through otic ganglion and auriculotemporal nerve.

Sympathetic

From superior cervical ganglion.

Sensory

Auriculotemporal and great auricular nerves.

Blood supply

External carotid artery and branches.

SHORT NOTES

1. Anatomical basis of inability to close the right eye following surgery on right parotid gland

Answer

1. **Facial nerve passes through parotid gland.**
2. **During parotid surgery, facial nerve may be injured.**
3. **Temporal and zygomatic branches supply orbicularis oculi muscle.**
4. **Paralysis of orbicularis oculi causes inability to close eye.**
5. **Associated features:**
    - **Loss of blinking**
    - **Watering of eye**
    - **Deviation of angle of mouth to opposite side.**

2. Structures related to antero lateral surface of parotid gland

Answer

Structures related to anterolateral/superficial surface of parotid gland

1. **Skin**
2. **Superficial fascia**
3. **Platysma**
4. **Great auricular nerve**
5. **Parotid lymph nodes**
6. **Investing layer of deep cervical fascia**

SUBMANDIBULAR GLAND

LONG ESSAYS

1. A patient had a swelling below the lower jaw on the right side. The swelling increases in size during eating. The surgeon did a bi-digital examination of the swelling. Based on anatomical knowledge answer these –

• Which gland is palpated and what is the cause?

• Name the parts of this gland and muscle separating them

• Mention the relations of this gland

• What is the length of its duct and where does it open?

• Draw a diagram to secretomotor innervation

• Microscopic structure of the gland

Answer

Which gland is palpated and what is the cause?

Submandibular salivary gland.

Cause

- **Swelling increases during eating due to obstruction of submandibular duct by calculus.**
- **Saliva accumulates causing enlargement.**
- **Bimanual palpation is possible because gland has superficial and deep parts.**

Parts of submandibular gland and muscle separating them

Parts

1. **Superficial part**
2. **Deep part**

Muscle separating them

Mylohyoid muscle.

Relations of submandibular gland

Superficial part

Superficial surface

- **Skin**
- **Platysma**
- **Investing fascia**
- **Facial vein**
- **Submandibular lymph nodes**

Lateral surface

- **Submandibular fossa of mandible**

Medial surface

Anterior part related to:

- **Mylohyoid**

Posterior part related to:

- **Hyoglossus**
- **Styloglossus**
- **Lingual nerve**
- **Hypoglossal nerve**

Deep part

Related to:

- **Mylohyoid laterally**
- **Hyoglossus medially**
- **Lingual nerve superiorly**
- **Hypoglossal nerve inferiorly**

Submandibular duct

- **Length: about 5 cm.**
- **Arises from deep part of gland.**
- **Runs forwards on hyoglossus.**
- **Opens at sublingual papilla beside frenulum of tongue.**

Secretomotor innervation

1. **Preganglionic fibers arise from superior salivatory nucleus.**

2. **Fibers pass through facial nerve.**
3. **Chorda tympani carries fibers.**
4. **Joins lingual nerve.**
5. **Fibers synapse in submandibular ganglion.**
6. **Postganglionic fibers supply submandibular gland directly.**
7. **Some fibers rejoin lingual nerve to supply sublingual gland.**

Microscopic structure

1. **Compound tubuloalveolar gland.**
2. **Mixed salivary gland with predominantly serous acini.**
3. **Serous acini are dark staining.**
4. **Mucous acini are pale.**
5. **Serous demilunes present.**
6. **Duct system includes:**
    - **Intercalated ducts**
    - **Striated ducts**
    - **Interlobular ducts**
7. **Lobules separated by connective tissue septa.**

SHORT ESSAYS

1. Parts, relations and nerve supply of submandibular salivary gland

Answer

Parts

1. **Superficial part**
2. **Deep part**

Separated by posterior border of mylohyoid muscle.

Relations

Superficial part

Superficial surface

- **Skin**
- **Platysma**
- **Deep fascia**
- **Facial vein**
- **Submandibular lymph nodes**

Lateral surface

- **Submandibular fossa of mandible**

Medial surface

- **Mylohyoid**
- **Hyoglossus**
- **Styloglossus**
- **Lingual nerve**
- **Hypoglossal nerve**

Deep part

- **Lies between mylohyoid and hyoglossus.**
- **Related to lingual nerve and hypoglossal nerve.**

Nerve supply

Parasympathetic secretomotor

- **Facial nerve through chorda tympani.**
- **Chorda tympani joins lingual nerve.**
- **Synapse in submandibular ganglion.**

Sympathetic

- **Fibers from superior cervical ganglion.**

Sensory

- **Lingual nerve.**

SHORT NOTES

1. Nerve supply of submandibular salivary gland

Answer

Parasympathetic secretomotor supply

1. **Superior salivatory nucleus.**
2. **Facial nerve.**
3. **Chorda tympani.**
4. **Lingual nerve.**
5. **Synapse in submandibular ganglion.**
6. **Postganglionic fibers supply gland.**

Sympathetic supply

- **From superior cervical ganglion through periarterial plexus.**

Sensory supply

- **Lingual nerve.**

THYROID GLAND

LONG ESSAYS

1. A 35 year old female presented to OPD with complaints of swelling in front of neck for past 3 months. She also complains of progressive weight gain, fatigue, constipation and cold intolerance, a diagnosis of hypothyroidism was made after the lab investigations.

a-Describe the location, external features and coverings of thyroid gland

b-Mention the medial and lateral relations of the gland

c-Describe the arterial supply of the gland with its relation to the corresponding nerves

d-Briefly describe the histology of thyroid gland

Answer

a) Location, external features and coverings of thyroid gland

Location

- **Situated in lower part of anterior neck.**
- **Opposite C5 to T1 vertebrae.**
- **Consists of right and left lobes joined by isthmus.**

External features

Lobes

- **Conical in shape.**
- **Each lobe has:**
  - **Apex**
  - **Base**
  - **Three surfaces**
  - **Two borders**

Isthmus

- **Connects lower parts of lobes.**
- **Lies opposite 2nd, 3rd and 4th tracheal rings.**

Pyramidal lobe

- **May arise from isthmus.**

Coverings

1. **True capsule – condensation of connective tissue.**
2. **False capsule – derived from pretracheal fascia.**
3. **Suspensory ligament of Berry connects gland to cricoid cartilage.**

b) Medial and lateral relations

Lateral relations

- **Sternohyoid**
- **Sternothyroid**
- **Superior belly of omohyoid**
- **Sternocleidomastoid**

Medial relations

- **Larynx**
- **Trachea**
- **Pharynx**
- **Esophagus (especially left lobe)**
- **Cricothyroid muscle**
- **Inferior constrictor**
- **External laryngeal nerve**
- **Recurrent laryngeal nerve**

c) Arterial supply and relation to nerves

Superior thyroid artery

- **Branch of external carotid artery.**
- **Accompanied by external laryngeal nerve near upper pole.**
- **During surgery artery should be ligated close to gland to avoid nerve injury.**

Inferior thyroid artery

- **Branch of thyrocervical trunk.**
- **Closely related to recurrent laryngeal nerve near lower pole.**
- **Ligated away from gland to avoid nerve injury.**

Thyroidea ima artery

- **Occasionally present.**
- **Arises from brachiocephalic trunk or arch of aorta.**

d) Histology of thyroid gland

1. **Made up of follicles.**
2. **Follicles lined by cuboidal epithelium.**
3. **Lumen contains colloid containing thyroglobulin.**
4. **Follicular cells produce T3 and T4.**
5. **Parafollicular cells (C cells) secrete calcitonin.**
6. **Rich vascular connective tissue stroma present.**

2. A 39-year-old female presents to the clinic for a routine health maintenance exam. The patient reports she is feeling nervous and anxious all the time with frequent palpitations, diarrhea and has been losing weight. She has also noticed a change in hair and fingernail. She frequently feels warm while others are cold or comfortable. On examination her heart rate is 110 beats per minute. She has a slight tremor and has increased reflexes in all extremities. A nontender thyroid enlargement is appreciated in the thyroid region. She was diagnosed with hyperthyroidism after biochemical tests. Based on your anatomical knowledge answer the following:

• Parts and relations of thyroid gland.

• Blood supply of thyroid gland.

• Explain the embryological basis for possible abnormal locations of the thyroid gland.

• Microscopic structure of thyroid gland.

Answer

Parts of thyroid gland

1. **Right lobe**
2. **Left lobe**
3. **Isthmus**

4. **Pyramidal lobe (occasionally)**

Relations of thyroid gland

Lateral relations

- **Sternohyoid**
- **Sternothyroid**
- **Superior belly of omohyoid**
- **Sternocleidomastoid**

Medial relations

- **Larynx**
- **Trachea**
- **Pharynx**
- **Esophagus**
- **Cricothyroid muscle**
- **Inferior constrictor**
- **Recurrent laryngeal nerve**
- **External laryngeal nerve**

Posterolateral relations

- **Carotid sheath**

Blood supply

Arteries

1. **Superior thyroid artery**
2. **Inferior thyroid artery**
3. **Thyroidea ima artery (occasionally)**

Veins

1. **Superior thyroid vein → internal jugular vein**
2. **Middle thyroid vein → internal jugular vein**
3. **Inferior thyroid vein → brachiocephalic vein**

Embryological basis for abnormal locations

1. **Thyroid develops from median endodermal diverticulum from floor of primitive pharynx at foramen cecum.**
2. **Gland descends in front of hyoid bone and laryngeal cartilages.**
3. **Thyroglossal duct usually disappears.**
4. **Failure of descent leads to lingual thyroid.**
5. **Persistence of thyroglossal duct causes thyroglossal cyst.**
6. **Ectopic thyroid tissue may occur anywhere along line of descent.**
7. **Pyramidal lobe represents persistent distal part of thyroglossal duct.**

Microscopic structure

1. **Numerous thyroid follicles.**
2. **Follicles lined by cuboidal epithelial cells.**
3. **Colloid present in lumen.**
4. **Follicular cells secrete thyroid hormones.**
5. **Parafollicular cells secrete calcitonin.**
6. **Rich capillary network present.**

3. A 30 year old female visited to the surgical out-patient department with complaints of pain and swelling in the lower part of front of neck. On examination the swelling moves with deglutition. Based on the history and clinical examination a provisional diagnosis of thyroid swelling was made.

With your knowledge in anatomy answer the following questions related to thyroid gland.

• Reason for thyroid swelling moves with deglutition.

• Describe the parts, coverings, relations, blood supply and lymphatic drainage of thyroid gland.

• Microstructure of thyroid gland.

Answer

Reason for movement with deglutition

- **Thyroid gland is attached to cricoid cartilage and upper trachea by pretracheal fascia and ligament of Berry.**
- **During swallowing larynx moves upward carrying thyroid gland with it.**

Parts

1. **Right lobe**
2. **Left lobe**
3. **Isthmus**
4. **Pyramidal lobe**

Coverings

1. **True capsule**
2. **False capsule from pretracheal fascia.**

Relations

Lateral

- **Sternothyroid**
- **Sternohyoid**
- **Omohyoid**
- **Sternocleidomastoid**

Medial

- **Trachea**
- **Larynx**
- **Pharynx**
- **Esophagus**
- **Recurrent laryngeal nerve**

Posterolateral

- **Carotid sheath**

Blood supply

Arterial

1. **Superior thyroid artery**
2. **Inferior thyroid artery**
3. **Thyroidea ima artery**

Venous

1. **Superior thyroid vein**
2. **Middle thyroid vein**
3. **Inferior thyroid vein**

Lymphatic drainage

1. **Prelaryngeal nodes**
2. **Pretracheal nodes**
3. **Paratracheal nodes**
4. **Deep cervical lymph nodes**

Microstructure

1. **Follicles lined by cuboidal epithelium.**
2. **Colloid-filled lumen.**
3. **Follicular cells produce thyroid hormones.**
4. **Parafollicular cells produce calcitonin.**
5. **Rich vascular connective tissue.**

4. A 32 years old woman presented with a swelling infront of her neck and that was moving up and down during swallowing. Following surgical removal of the swelling, she noticed a change in her voice. Based on your knowledge in anatomy, answer the following questions:

• Name the structure that causes the swelling and give the reason why it moves up and down during swallowing.

• Briefly describe the gross anatomical features, relations and the blood supply of the structure involved.

• What could be the probable cause for a change in her voice following surgery.

• What precautions should be taken during surgery to avoid this complication

Answer

Structure involved

Thyroid gland.

Reason for movement during swallowing

- **Thyroid gland is attached to larynx and trachea by ligament of Berry and pretracheal fascia.**
- **During deglutition larynx moves upward and gland moves with it.**

Gross anatomical features

- **Two lateral lobes joined by isthmus.**
- **Situated opposite C5–T1 vertebrae.**
- **Each lobe has apex, base, three surfaces and two borders.**
- **Isthmus lies opposite 2nd–4th tracheal rings.**

Relations

Lateral

- **Sternohyoid**
- **Sternothyroid**
- **Sternocleidomastoid**

Medial

- **Trachea**
- **Larynx**
- **Esophagus**
- **Recurrent laryngeal nerve**
- **External laryngeal nerve**

Blood supply

Arteries

1. **Superior thyroid artery**
2. **Inferior thyroid artery**
3. **Thyroidea ima artery**

Veins

1. **Superior thyroid vein**
2. **Middle thyroid vein**
3. **Inferior thyroid vein**

Probable cause for change in voice

- **Injury to recurrent laryngeal nerve during thyroid surgery causing vocal cord paralysis.**
- **Injury to external laryngeal nerve may also affect voice.**

Precautions during surgery

1. **Identify recurrent laryngeal nerve before ligating inferior thyroid artery.**
2. **Ligate inferior thyroid artery away from gland.**
3. **Ligate superior thyroid artery close to gland to avoid injury to external laryngeal nerve.**
4. **Careful dissection near ligament of Berry.**

5. A 65 year old woman came to the hospital with swelling in front of the neck. It was moving with deglutition. After

surgical excision of the gland, she had hoarseness of the voice. Answer the following.

• Name the structure involved

• Briefly describe coverings, external features, relations and blood supply

• State the reasons for the up and down movement of the swelling

• What's the cause of hoarseness of voice after the surgery

• Add a note on development of the structure involved

Answer

Structure involved

Thyroid gland.

Coverings

1. **True capsule**
2. **False capsule from pretracheal fascia.**

External features

- **Two lateral lobes connected by isthmus.**
- **Pyramidal lobe may be present.**
- **Each lobe has apex, base, three surfaces and two borders.**

Relations

Lateral

- **Sternohyoid**
- **Sternothyroid**
- **Sternocleidomastoid**

Medial

- **Trachea**
- **Larynx**
- **Pharynx**
- **Esophagus**
- **Recurrent laryngeal nerve**

Blood supply

Arteries

1. **Superior thyroid artery**
2. **Inferior thyroid artery**
3. **Thyroidea ima artery**

Veins

1. **Superior thyroid vein**
2. **Middle thyroid vein**
3. **Inferior thyroid vein**

Reason for movement during swallowing

- **Attachment to larynx and trachea by pretracheal fascia and ligament of Berry.**

Cause of hoarseness after surgery

- **Injury to recurrent laryngeal nerve causing paralysis of vocal cord.**

Development of thyroid gland

1. **Develops from median endodermal diverticulum from floor of primitive pharynx.**
2. **Begins at foramen cecum.**
3. **Descends through thyroglossal duct.**
4. **Final position in lower neck.**
5. **Thyroglossal duct disappears normally.**

6. **Remnants may form thyroglossal cyst or pyramidal lobe.**

6. 55 year old woman complained of midline nodular swelling in the front of her neck which moves on swallowing. On examination, she had slight tremors on outstretched hands; pulse was 111 per min, BP 156/100 mm Hg and slight blurring of eyes. She also told that, she had lost weight and feels feverish. Answer the following questions

• Which organ is likely to be involved

• Why does this swelling move during swallowing

• Mention the relations of this organ

• Explain the blood supply of this organ and mention the precautions to be taken while ligating these vessels during surgery

Answer

Organ involved

Thyroid gland.

Why swelling moves during swallowing

- **Thyroid gland is attached to larynx and trachea by pretracheal fascia and ligament of Berry.**
- **During swallowing gland moves upward with larynx.**

Relations of thyroid gland

Lateral relations

- **Sternohyoid**
- **Sternothyroid**
- **Omohyoid**
- **Sternocleidomastoid**

Medial relations

- **Larynx**
- **Trachea**
- **Pharynx**
- **Esophagus**
- **Recurrent laryngeal nerve**
- **External laryngeal nerve**

Posterolateral relations

- **Carotid sheath**

Blood supply

Arterial supply

1. **Superior thyroid artery – branch of external carotid artery.**
2. **Inferior thyroid artery – branch of thyrocervical trunk.**
3. **Thyroidea ima artery – occasional.**

Venous drainage

1. **Superior thyroid vein.**
2. **Middle thyroid vein.**
3. **Inferior thyroid vein.**

Precautions during ligation

1. **Superior thyroid artery should be ligated close to gland to avoid injury to external laryngeal nerve.**
2. **Inferior thyroid artery should be ligated away from gland to avoid injury to recurrent laryngeal nerve.**
3. **Care should be taken near ligament of Berry where recurrent laryngeal nerve is closely related.**

SHORT ESSAYS

1.Relations of thyroid gland

Introduction

The thyroid gland is a highly vascular endocrine gland situated in the lower part of the anterior neck opposite C5–T1 vertebrae. It consists of right and left lobes connected by an isthmus.

Relations of lateral lobe

Superficial (Lateral) relations

From superficial to deep:

1. **Skin**
2. **Superficial fascia**
3. **Platysma**
4. **Deep fascia**
5. **Sternohyoid**
6. **Sternothyroid**
7. **Superior belly of omohyoid**
8. **Anterior border of sternocleidomastoid**

Medial relations

1. **Larynx – thyroid and cricoid cartilages**
2. **Trachea**
3. **Pharynx**
4. **Esophagus (more on left side)**
5. **Cricothyroid muscle**
6. **Inferior constrictor muscle**
7. **External laryngeal nerve**
8. **Recurrent laryngeal nerve in tracheoesophageal groove**

Posterolateral relations

1. **Carotid sheath containing:**
    - **Common carotid artery**
    - **Internal jugular vein**
    - **Vagus nerve**

Posterior border relations

1. **Superior parathyroid gland**
2. **Inferior parathyroid gland**
3. **Anastomosis between superior and inferior thyroid arteries**

Relations of isthmus

Anterior relations

1. **Skin**
2. **Fasciae**
3. **Sternohyoid**
4. **Sternothyroid**
5. **Anterior jugular venous arch**

Posterior relations

1. **2nd, 3rd and 4th tracheal rings**

Applied anatomy

1. **Enlargement of thyroid gland produces goitre.**
2. **Enlargement may compress trachea causing dyspnoea.**
3. **Recurrent laryngeal nerve may be injured during thyroidectomy.**
4. **Thyroid gland moves during deglutition because of attachment to larynx.**

2.Thyroid gland – external features, relations, blood supply and development

External features

1. **Butterfly-shaped endocrine gland.**
2. **Situated in anterior triangle of neck.**
3. **Consists of:**
    - **Right lobe**
    - **Left lobe**
    - **Isthmus**
4. **Weight: about 25 g in adults.**
5. **Each lobe has:**
    - **Apex**

- Base
- Three surfaces: lateral, medial, posterolateral
- Two borders: anterior and posterior

6. Isthmus lies opposite 2nd–4th tracheal rings.
7. Pyramidal lobe may arise from isthmus.

Relations

Lateral surface

Covered by infrahyoid muscles and sternocleidomastoid.

Medial surface

Related to:

- Larynx
- Trachea
- Pharynx
- Esophagus
- Cricothyroid
- Inferior constrictor
- Recurrent laryngeal nerve

Posterolateral surface

Related to carotid sheath.

Posterior border

Related to parathyroid glands.

Blood supply

Arterial supply

1. Superior thyroid artery – branch of external carotid artery.
2. Inferior thyroid artery – branch of thyrocervical trunk.
3. Thyroidea ima artery may be present.

Venous drainage

1. Superior thyroid vein → internal jugular vein
2. Middle thyroid vein → internal jugular vein
3. Inferior thyroid vein → brachiocephalic vein

Lymphatic drainage

1. Prelaryngeal nodes
2. Pretracheal nodes
3. Paratracheal nodes
4. Deep cervical nodes

Development

1. Develops from median endodermal diverticulum from floor of primitive pharynx at foramen cecum.
2. Descends in front of hyoid bone and laryngeal cartilages.
3. Connected to tongue by thyroglossal duct.
4. Thyroglossal duct normally disappears.
5. Parafollicular cells develop from ultimobranchial body.

Applied anatomy

1. Thyroglossal cyst occurs due to persistence of thyroglossal duct.
2. Ectopic thyroid tissue may occur along line of descent.
3. Goitre may cause compression symptoms.

3.Blood supply and microscopic structure of thyroid gland

Blood supply

Arterial supply

1. **Superior thyroid artery from external carotid artery.**
2. **Inferior thyroid artery from thyrocervical trunk.**
3. **Occasionally thyroidea ima artery.**

Venous drainage

1. **Superior thyroid vein → internal jugular vein**
2. **Middle thyroid vein → internal jugular vein**
3. **Inferior thyroid vein → brachiocephalic vein**

Lymphatic drainage

1. **Prelaryngeal nodes**
2. **Pretracheal nodes**
3. **Paratracheal nodes**
4. **Deep cervical nodes**

Microscopic structure

1. **Thyroid gland is enclosed by fibrous capsule.**
2. **Gland is made up of follicles.**
3. **Follicles are lined by cuboidal epithelium.**
4. **Follicles contain colloid rich in thyroglobulin.**
5. **Parafollicular cells (C cells) lie between follicles.**
6. **C cells secrete calcitonin.**
7. **Highly vascular connective tissue stroma is present.**

Functions

1. **Secretion of thyroxine (T4)**
2. **Secretion of triiodothyronine (T3)**
3. **Regulation of metabolism**

SHORT NOTES

1.Explain the surgical importance of thyroid gland

1. **Thyroid gland is highly vascular; severe bleeding may occur during thyroid surgery.**
2. **Recurrent laryngeal nerve lies close to inferior thyroid artery and may be injured during thyroidectomy causing hoarseness.**
3. **External laryngeal nerve may be injured during ligation of superior thyroid artery leading to voice changes.**
4. **Parathyroid glands may be accidentally removed causing tetany.**
5. **Enlarged thyroid gland moves during swallowing.**
6. **Thyroglossal cyst moves on protrusion of tongue.**
7. **Tracheostomy is avoided through isthmus.**

2.Blood supply of thyroid gland

Arterial supply

1. **Superior thyroid artery – branch of external carotid artery.**
2. **Inferior thyroid artery – branch of thyrocervical trunk.**
3. **Thyroidea ima artery may arise from arch of aorta or brachiocephalic trunk.**

Venous drainage

1. **Superior thyroid vein drains into internal jugular vein.**
2. **Middle thyroid vein drains into internal jugular vein.**
3. **Inferior thyroid vein drains into brachiocephalic vein.**

Lymphatic drainage

1. **Prelaryngeal nodes**
2. **Pretracheal nodes**
3. **Paratracheal nodes**
4. **Deep cervical nodes**

3.Relations of thyroid gland

Relations of lateral lobe

Superficial relations

- **Sternohyoid**
- **Sternothyroid**
- **Omohyoid**
- **Sternocleidomastoid**

Medial relations

- **Larynx**
- **Trachea**
- **Pharynx**
- **Esophagus**
- **Recurrent laryngeal nerve**

Posterolateral relation

- **Carotid sheath**

Posterior border

- **Parathyroid glands**

Relations of isthmus

Anterior

- **Sternohyoid**
- **Sternothyroid**
- **Anterior jugular vein**

Posterior

- **2nd–4th tracheal rings**

FASCIAS OF NECK

SHORT NOTES

1.Carotid sheath

Definition

Carotid sheath is a tubular condensation of deep cervical fascia extending from base of skull to root of neck.

Formation

Formed by contributions from:

1. **Investing layer**
2. **Pretracheal layer**
3. **Prevertebral layer**

Contents

1. **Common carotid artery/internal carotid artery – medial**
2. **Internal jugular vein – lateral**
3. **Vagus nerve – posterior**
4. **Deep cervical lymph nodes**
5. **Carotid sympathetic plexus**

Applied anatomy

1. **Carotid pulse felt within sheath.**
2. **Spread of infection may occur along sheath.**
3. **Carotid endarterectomy performed through sheath.**

TRIANGLES OF NECK

SHORT ESSAYS

1.Describe the location, drainage and applied anatomy of cervical lymphnodes. Add a note on microscopy of lymphnode.

Cervical lymph nodes

Location

Cervical lymph nodes are arranged as:

1. **Superficial cervical lymph nodes**
2. **Deep cervical lymph nodes**

Superficial cervical nodes

Lie along external jugular vein superficial to sternocleidomastoid.

Deep cervical nodes

Lie along internal jugular vein deep to sternocleidomastoid.
Important nodes:

- **Jugulodigastric node**
- **Jugulo-omohyoid node**

Drainage

Superficial nodes drain

1. **Scalp**
2. **Face**
3. **Neck**

Deep cervical nodes drain

1. **Tongue**
2. **Pharynx**
3. **Larynx**
4. **Thyroid gland**
5. **Deep structures of head and neck**

Efferents

Drain into jugular lymph trunk.

Applied anatomy

1. **Enlargement occurs in infections.**
2. **Metastatic spread from carcinomas commonly involves cervical nodes.**
3. **Jugulodigastric node enlarges in tonsillitis.**
4. **Jugulo-omohyoid node enlarges in carcinoma tongue.**

Microscopy of lymph node

1. **Covered by fibrous capsule.**
2. **Trabeculae extend inward.**
3. **Cortex contains lymphoid follicles.**
4. **Medulla contains medullary cords and sinuses.**
5. **Reticular connective tissue forms framework.**
6. **Afferent lymphatics enter convex surface.**
7. **Efferent lymphatic leaves hilum.**

2.Classify triangles of neck. Explain digastric triangle in detail

Classification of triangles of neck

The sternocleidomastoid divides neck into:

1. **Anterior triangle**
2. **Posterior triangle**

Subdivisions of anterior triangle

1. **Submental triangle**
2. **Digastric triangle**
3. **Carotid triangle**
4. **Muscular triangle**

Subdivisions of posterior triangle

1. **Occipital triangle**
2. **Supraclavicular triangle**

Digastric triangle

Boundaries

1. **Above – lower border of mandible**
2. **Anteroinferiorly – anterior belly of digastric**
3. **Posteroinferiorly – posterior belly of digastric and stylohyoid**

Roof

1. **Skin**
2. **Superficial fascia**
3. **Platysma**
4. **Investing layer of deep fascia**

Floor

1. **Mylohyoid**
2. **Hyoglossus**
3. **Middle constrictor**

Contents

1. **Submandibular gland**
2. **Facial artery**
3. **Facial vein**
4. **Hypoglossal nerve**
5. **Nerve to mylohyoid**
6. **Submandibular lymph nodes**

Applied anatomy

1. **Submandibular gland enlargement occurs in infections.**
2. **Facial artery can be palpated at lower border of mandible.**

3.Boundaries and contents of carotid triangle

Boundaries

1. **Superoanteriorly – posterior belly of digastric**
2. **Superoposteriorly – anterior border of sternocleidomastoid**
3. **Inferiorly – superior belly of omohyoid**

Roof

1. **Skin**
2. **Superficial fascia**
3. **Platysma**
4. **Investing fascia**

Floor

1. **Thyrohyoid**
2. **Hyoglossus**
3. **Inferior constrictor**
4. **Middle constrictor**

Contents

1. **Common carotid artery and bifurcation**
2. **Internal carotid artery**
3. **External carotid artery and branches**
4. **Internal jugular vein**
5. **Vagus nerve**
6. **Hypoglossal nerve**
7. **Ansa cervicalis**
8. **Deep cervical lymph nodes**
9. **Carotid sinus and carotid body**

Applied anatomy

1. **Carotid pulse is felt here.**
2. **Carotid sinus massage may reduce tachycardia.**

4.Boundaries and contents of sub occipital triangle

Boundaries

1. **Superomedially – rectus capitis posterior major**
2. **Superolaterally – obliquus capitis superior**

3. **Inferolaterally – obliquus capitis inferior**

Roof

1. **Semispinalis capitis**

Floor

1. **Posterior arch of atlas**
2. **Posterior atlanto-occipital membrane**

Contents

1. **Third part of vertebral artery**
2. **Suboccipital nerve**
3. **Venous plexus**

Applied anatomy

1. **Vertebral artery may be compressed during neck movements.**

5.Sternocleidomastoid muscle

Origin

1. **Sternal head – manubrium sterni**
2. **Clavicular head – medial one-third of clavicle**

Insertion

1. **Mastoid process**
2. **Lateral half of superior nuchal line**

Nerve supply

1. **Spinal accessory nerve – motor**
2. **C2 and C3 – proprioception**

Actions

1. **Unilateral contraction – turns face to opposite side.**
2. **Bilateral contraction – flexes neck.**
3. **Accessory muscle of respiration.**

Applied anatomy

1. **Torticollis occurs due to spasm.**
2. **Spinal accessory nerve injury causes weakness.**

6.Boundaries and contents of posterior triangle of neck

Boundaries

1. **Anterior – posterior border of sternocleidomastoid**
2. **Posterior – anterior border of trapezius**
3. **Base – middle one-third of clavicle**
4. **Apex – meeting of sternocleidomastoid and trapezius**

Roof

1. **Skin**
2. **Superficial fascia**
3. **Platysma**
4. **Investing layer of deep fascia**

Floor

1. **Splenius capitis**
2. **Levator scapulae**
3. **Scalenus medius**
4. **Scalenus posterior**

Contents

1. **External jugular vein**
2. **Spinal accessory nerve**
3. **Brachial plexus trunks**
4. **Cervical plexus branches**
5. **Transverse cervical artery**
6. **Suprascapular artery**

Applied anatomy

1. **Spinal accessory nerve is vulnerable to injury.**
2. **Enlarged lymph nodes may occur.**

SHORT NOTES

1.Branches of external carotid artery

Mnemonic

Some Anatomists Like Freaking Out Poor Medical Students

Branches

1. **Superior thyroid artery**
2. **Ascending pharyngeal artery**
3. **Lingual artery**
4. **Facial artery**
5. **Occipital artery**
6. **Posterior auricular artery**
7. **Maxillary artery**
8. **Superficial temporal artery**

2.Contents of carotid triangle

1. **Common carotid artery**
2. **Internal carotid artery**
3. **External carotid artery**
4. **Internal jugular vein**
5. **Vagus nerve**
6. **Hypoglossal nerve**
7. **Ansa cervicalis**
8. **Deep cervical lymph nodes**
9. **Carotid sinus**
10. **Carotid body**

3.Ansa cervicalis

Formation

1. **Superior root – fibers from C1 via hypoglossal nerve.**
2. **Inferior root – fibers from C2 and C3.**

Location

Embedded in anterior wall of carotid sheath.

Supply

Supplies infrahyoid muscles except thyrohyoid.

Applied anatomy

Damage causes difficulty in swallowing and phonation.

4.Posterior triangle of neck

Boundaries

1. **Sternocleidomastoid**
2. **Trapezius**
3. **Clavicle**

Contents

1. **External jugular vein**
2. **Spinal accessory nerve**
3. **Brachial plexus**
4. **Cervical plexus branches**

Clinical importance

Spinal accessory nerve injury causes shoulder droop.

INFRATEMPORAL FOSSA

SHORT ESSAYS

1.Mandibular nerve

Introduction

Mandibular nerve is the largest branch of trigeminal nerve and is mixed in nature.

Origin

Arises from trigeminal ganglion.

Exit from skull

Leaves cranial cavity through foramen ovale.

Branches from main trunk

1. **Meningeal branch**
2. **Nerve to medial pterygoid**

Divisions

1. **Small anterior division – mainly motor**
2. **Large posterior division – mainly sensory**

Branches of anterior division

1. **Masseteric nerve**
2. **Deep temporal nerves**
3. **Nerve to lateral pterygoid**
4. **Buccal nerve**

Branches of posterior division

1. **Auriculotemporal nerve**
2. **Lingual nerve**
3. **Inferior alveolar nerve**

Functional components

1. **General sensory to lower face.**
2. **Motor to muscles of mastication.**

Applied anatomy

1. **Inferior alveolar nerve block during dental extraction.**
2. **Trigeminal neuralgia may involve mandibular nerve.**

SHORT NOTES

1.Middle meningeal artery

Origin

Branch of first part of maxillary artery.

Course

1. **Enters cranial cavity through foramen spinosum.**
2. **Runs deep to pterion.**
3. **Divides into frontal and parietal branches.**

Applied anatomy

1. **Rupture causes extradural hemorrhage.**
2. **Pterion is a weak point of skull.**

2.Temporalis muscle

Origin

Temporal fossa and temporal fascia.

Insertion

Coronoid process and anterior border of ramus of mandible.

Nerve supply

Deep temporal nerves from mandibular nerve.

Actions

1. **Elevates mandible.**
2. **Posterior fibers retract mandible.**

Applied anatomy

Spasm causes trismus.

ORBIT

SHORT ESSAYS

1.Name the extra ocular muscles. Describe their actions, nerve supply and applied aspects.

Extraocular muscles

1. **Superior rectus**
2. **Inferior rectus**
3. **Medial rectus**
4. **Lateral rectus**
5. **Superior oblique**
6. **Inferior oblique**
7. **Levator palpebrae superioris**

Nerve supply

By oculomotor nerve

1. **Superior rectus**
2. **Inferior rectus**
3. **Medial rectus**
4. **Inferior oblique**
5. **Levator palpebrae superioris**

By trochlear nerve

- **Superior oblique**

By abducent nerve

- **Lateral rectus**

Actions

Superior rectus

1. **Elevation**
2. **Adduction**
3. **Intorsion**

Inferior rectus

1. **Depression**
2. **Adduction**
3. **Extorsion**

Medial rectus

Adduction

Lateral rectus

Abduction

Superior oblique

1. **Depression**
2. **Abduction**
3. **Intorsion**

Inferior oblique

1. **Elevation**
2. **Abduction**
3. **Extorsion**

Applied anatomy

1. **Oculomotor nerve palsy causes ptosis and squint.**
2. **Trochlear nerve palsy causes diplopia while looking down.**
3. **Abducent nerve palsy causes medial squint.**
4. **Strabismus results from extraocular muscle imbalance.**

2.Explain the attachments, nerve supply and actions of extra ocular muscles of eyeball

Recti muscles

Common origin

Arise from common tendinous ring.

Insertions

1. **Superior rectus – superior sclera**
2. **Inferior rectus – inferior sclera**
3. **Medial rectus – medial sclera**
4. **Lateral rectus – lateral sclera**

Oblique muscles

Superior oblique

Origin – body of sphenoid.
Insertion – posterolateral sclera.

Inferior oblique

Origin – maxilla.
Insertion – posterolateral sclera.

Nerve supply

1. **Oculomotor – all except lateral rectus and superior oblique.**
2. **Trochlear – superior oblique.**
3. **Abducent – lateral rectus.**

Actions

1. **Medial rectus – adduction**
2. **Lateral rectus – abduction**
3. **Superior rectus – elevation**
4. **Inferior rectus – depression**
5. **Superior oblique – depression and intorsion**
6. **Inferior oblique – elevation and extorsion**

3.Extraocular muscles

List

1. **Four recti**
2. **Two oblique muscles**
3. **Levator palpebrae superioris**

Nerve supply

LR6 SO4 Remaining by 3.

Functions

Produce movements of eyeball.

SHORT NOTES

1.Describe anatomical basis of Horner's syndrome

Horner's syndrome

Occurs due to interruption of cervical sympathetic pathway.

Features

1. **Ptosis**
2. **Miosis**
3. **Anhidrosis**
4. **Enophthalmos**

Causes

1. **Cervical sympathetic chain lesion**
2. **Pancoast tumor**
3. **Neck injury**

2.Superior orbital fissure

Location

Gap between greater and lesser wings of sphenoid.

Structures passing through

1. **Oculomotor nerve**
2. **Trochlear nerve**
3. **Abducent nerve**
4. **Ophthalmic veins**
5. **Ophthalmic division of trigeminal nerve**

Applied anatomy

Superior orbital fissure syndrome causes ophthalmoplegia.

3.Branches of ophthalmic artery

1. **Central artery of retina**
2. **Lacrimal artery**
3. **Supraorbital artery**
4. **Posterior ciliary arteries**
5. **Ethmoidal arteries**
6. **Dorsal nasal artery**

4.Extraocular muscles with nerve supply

1. **Superior rectus – oculomotor nerve**
2. **Inferior rectus – oculomotor nerve**
3. **Medial rectus – oculomotor nerve**
4. **Inferior oblique – oculomotor nerve**
5. **Superior oblique – trochlear nerve**
6. **Lateral rectus – abducent nerve**

5.Lacrimal apparatus

Components

1. **Lacrimal gland**
2. **Lacrimal canaliculi**
3. **Lacrimal sac**
4. **Nasolacrimal duct**

Function

Drainage of tears into inferior meatus.

6.Levator palpebrae superioris

Origin

Lesser wing of sphenoid.

Insertion

Upper eyelid.

Nerve supply

1. **Oculomotor nerve**
2. **Sympathetic fibers to superior tarsal muscle**

Action

Elevates upper eyelid.

Applied anatomy

Paralysis causes ptosis.

EAR

SHORT ESSAYS

1.Tympanic membrane

Introduction

Thin semitransparent membrane separating external and middle ear.

Features

1. **Oval in shape.**
2. **Diameter about 9–10 mm.**
3. **Obliquely placed.**

Parts

1. **Pars tensa**
2. **Pars flaccida**

Attachments

Attached to tympanic sulcus.

Layers

1. **Outer cuticular layer**
2. **Middle fibrous layer**

3. **Inner mucous layer**

Nerve supply

1. **Auriculotemporal nerve**
2. **Vagus nerve**
3. **Glossopharyngeal nerve**

Applied anatomy

1. **Otitis media may rupture membrane.**
2. **Myringotomy performed in posteroinferior quadrant.**

2.Middle ear

Definition

Air-filled cavity in petrous temporal bone.

Parts

1. **Epitympanum**
2. **Mesotympanum**
3. **Hypotympanum**

Walls

1. **Roof – tegmen tympani**
2. **Floor – jugular wall**
3. **Medial wall – promontory**
4. **Lateral wall – tympanic membrane**
5. **Anterior wall – auditory tube opening**
6. **Posterior wall – aditus to mastoid antrum**

Contents

1. **Auditory ossicles**
2. **Muscles**
3. **Nerves**

Functions

Transmission of sound.

Applied anatomy

Otitis media may spread to mastoid antrum.

SHORT NOTES

1.Contents of middle ear cavity

1. **Malleus**
2. **Incus**
3. **Stapes**
4. **Tensor tympani**
5. **Stapedius**
6. **Chorda tympani**
7. **Tympanic plexus**

2.Tympanic membrane

1. **Separates external and middle ear.**
2. **Has pars tensa and pars flaccida.**
3. **Layers – cuticular, fibrous and mucous.**
4. **Cone of light seen in healthy membrane.**
5. **Rupture occurs in otitis media.**

PALATE

1.Muscles of soft palate and their nerve supply

Muscles

1. **Tensor veli palatini**
2. **Levator veli palatini**
3. **Palatoglossus**
4. **Palatopharyngeus**
5. **Musculus uvulae**

Nerve supply

1. **Tensor veli palatini – mandibular nerve.**

2. **All others – cranial part of accessory nerve via pharyngeal plexus.**

Actions

1. **Elevate palate during swallowing.**
2. **Close nasopharynx.**

2.Soft palate

Definition

Fibromuscular movable posterior part of palate.

Features

1. **Contains palatine aponeurosis.**
2. **Ends as uvula.**
3. **Forms palatoglossal and palatopharyngeal arches.**

Muscles

1. **Tensor veli palatini**
2. **Levator veli palatini**
3. **Palatoglossus**
4. **Palatopharyngeus**
5. **Musculus uvulae**

Nerve supply

Mainly through pharyngeal plexus.

Functions

1. **Deglutition**
2. **Phonation**

ORAL CAVITY

LONG ESSAYS

1.A 10-year-old girl underwent bilateral tonsillectomy for chronic tonsillitis. On examination, prior to discharge, the surgeon noted an absence of touch sensation on the posterior ⅓ of the tongue along with an absent gag reflex. Based on your knowledge of anatomy answer the following.

a) Name the nerve damaged during the surgery

Glossopharyngeal nerve.

b) What are the external features on the posterior ⅓ of tongue

1. **Posterior one-third lies behind sulcus terminalis.**
2. **Contains lingual tonsil.**
3. **Mucosa is irregular.**
4. **Vallate papillae lie anterior to sulcus terminalis.**
5. **Median glossoepiglottic fold present.**
6. **Lateral glossoepiglottic folds present.**
7. **Valleculae present.**
8. **Foramen cecum lies at apex of sulcus terminalis.**

c) Correlate the development of the tongue to its nerve supply

Anterior two-thirds

1. **Develops from first pharyngeal arch.**
2. **General sensation by lingual nerve (mandibular nerve).**
3. **Taste by chorda tympani.**

Posterior one-third

1. **Develops from third pharyngeal arch.**

2. **Supplied by glossopharyngeal nerve for general and taste sensation.**

Posterior most part

1. **Develops from fourth arch.**
2. **Supplied by superior laryngeal nerve.**

Muscles

Develop from occipital myotomes and supplied by hypoglossal nerve.

d) Briefly describe the histology of the tonsil

1. **Covered by stratified squamous nonkeratinized epithelium.**
2. **Deep tonsillar crypts are present.**
3. **Lymphoid follicles with germinal centers present.**
4. **Capsule present on lateral surface.**
5. **Mucous glands present near capsule.**

2.A 65-year-old man who was Chronic Smoker and Tobacco chewer for past 15 years, came to hospital with ulcerated lesion on the anterior part of the Tongue, which bleeds on touch. He was unable to swallow and foul smell was emitting from his mouth. O/E he had enlarged Submandibular and lower cervical lymph nodes. He was diagnosed with Carcinoma of the Tongue.

a) Based on anatomical knowledge, what are the external features of Tongue

Parts

1. **Apex**
2. **Body**
3. **Root**

Surfaces

1. **Dorsal surface**
2. **Inferior surface**

Features of dorsum

1. **Median sulcus**
2. **Sulcus terminalis**
3. **Foramen cecum**
4. **Papillae:**
    - **Filiform**
    - **Fungiform**
    - **Vallate**
    - **Foliate**
5. **Lingual tonsil on posterior one-third**

Inferior surface

1. **Frenulum linguae**
2. **Deep lingual veins**
3. **Fimbriated folds**

b) Name the muscles of tongue with their nerve supply

Extrinsic muscles

1. **Genioglossus**
2. **Hyoglossus**
3. **Styloglossus**
4. **Palatoglossus**

Intrinsic muscles

1. **Superior longitudinal**
2. **Inferior longitudinal**
3. **Transverse**
4. **Vertical**

Nerve supply

1. **All muscles supplied by hypoglossal nerve.**

2. **Palatoglossus supplied by cranial accessory via pharyngeal plexus.**

c) Describe the Blood supply and Lymphatic drainage of Tongue

Blood supply

Arterial supply

Lingual artery – branch of external carotid artery.

Branches

1. **Dorsal lingual**
2. **Deep lingual**
3. **Sublingual artery**

Venous drainage

Lingual veins drain into internal jugular vein.

Lymphatic drainage

1. **Tip → submental nodes.**
2. **Lateral anterior two-thirds → submandibular nodes.**
3. **Central anterior two-thirds → deep cervical nodes.**
4. **Posterior one-third → deep cervical nodes especially jugulodigastric.**

d) Explain the development of tongue

Development

1. **Tongue develops in floor of primitive pharynx.**
2. **Anterior two-thirds develops from lateral lingual swellings of first arch.**
3. **Posterior one-third develops from hypobranchial eminence of third arch.**
4. **Posterior most part develops from fourth arch.**
5. **Muscles develop from occipital myotomes.**

Applied anatomy

1. **Ankyloglossia due to short frenulum.**
2. **Carcinoma tongue spreads through lymphatics.**

SHORT ESSAYS

1.Lymphatic drainage of tongue

Drainage of tongue

Tip of tongue

Drains into submental lymph nodes.

Lateral anterior two-thirds

Drain into submandibular lymph nodes.

Central anterior two-thirds

Drain bilaterally into deep cervical nodes especially jugulo-omohyoid node.

Posterior one-third

Drain into upper deep cervical nodes especially jugulodigastric node.

Applied anatomy

1. **Carcinoma tongue spreads early through lymphatics.**
2. **Cross drainage causes bilateral spread.**

SHORT NOTES

1.Nerve supply of tongue

Motor supply

1. **Hypoglossal nerve supplies all muscles except palatoglossus.**
2. **Palatoglossus supplied by cranial accessory via pharyngeal plexus.**

Sensory supply

Anterior two-thirds

1. **General sensation – lingual nerve.**
2. **Taste – chorda tympani.**

Posterior one-third

Glossopharyngeal nerve.

Posterior most part

Internal laryngeal nerve.

2.Dorsum of tongue

Features

1. **Median sulcus**
2. **Sulcus terminalis**
3. **Foramen cecum**
4. **Vallate papillae**
5. **Lingual tonsil**

Papillae

1. **Filiform**
2. **Fungiform**
3. **Vallate**
4. **Foliate**

3.Sensory innervation of tongue

1. **Lingual nerve – general sensation anterior two-thirds.**
2. **Chorda tympani – taste anterior two-thirds.**
3. **Glossopharyngeal – posterior one-third.**
4. **Internal laryngeal – posterior most part.**

4.Structures over hyoglossus

1. **Lingual nerve**
2. **Hypoglossal nerve**
3. **Submandibular duct**
4. **Deep part of submandibular gland**
5. **Sublingual gland**

Structures deep to hyoglossus

1. **Lingual artery**
2. **Glossopharyngeal nerve**

5.Motor and sensory innervation of tongue

Motor

Hypoglossal nerve except palatoglossus.

Sensory

1. **Lingual nerve**
2. **Chorda tympani**
3. **Glossopharyngeal nerve**
4. **Internal laryngeal nerve**

6.Hyoglossus muscle and its relations

Origin

Body and greater horn of hyoid bone.

Insertion

Side of tongue.

Nerve supply

Hypoglossal nerve.

Action

Depresses tongue.

Relations

Superficial

1. **Lingual nerve**
2. **Hypoglossal nerve**
3. **Submandibular duct**

Deep

1. **Lingual artery**
2. **Glossopharyngeal nerve**

NASAL CAVITY

SHORT ESSAYS

1.Lateral wall of nasal cavity

Features

1. **Superior concha**
2. **Middle concha**
3. **Inferior concha**
4. **Superior meatus**
5. **Middle meatus**
6. **Inferior meatus**
7. **Sphenoethmoidal recess**

Openings

Superior meatus

Posterior ethmoidal sinuses.

Middle meatus

1. **Frontal sinus**
2. **Maxillary sinus**
3. **Anterior and middle ethmoidal sinuses**

Inferior meatus

Nasolacrimal duct.

Blood supply

1. **Sphenopalatine artery**
2. **Ethmoidal arteries**

Nerve supply

1. **Olfactory nerve**
2. **Trigeminal nerve branches**

Applied anatomy

1. **Deviated nasal septum.**
2. **Sinusitis.**
3. **Epistaxis.**

SHORT NOTES

1.Lateral wall of nasal cavity

Features

1. **Three conchae**
2. **Three meatuses**
3. **Sphenoethmoidal recess**

Functions

1. **Warms inspired air.**
2. **Filters air.**

2.Draw diagram of nasal septum

REFER DIAGRAM SECTION

Components

1. **Perpendicular plate of ethmoid.**

2. **Vomer.**
3. **Septal cartilage.**
4. **Maxillary crest.**
5. **Palatine crest.**

Applied anatomy

Deviation causes nasal obstruction.

3.Middle meatus of nose

Features

1. **Bulla ethmoidalis**
2. **Hiatus semilunaris**
3. **Ethmoidal infundibulum**

Openings

1. **Frontal sinus**
2. **Maxillary sinus**
3. **Anterior and middle ethmoidal sinuses**

Applied anatomy

Common site of sinus infection.

PHARYNX

SHORT ESSAY

1.Auditory tube

Definition

Fibrocartilaginous canal connecting middle ear to nasopharynx.

Length

About 36 mm.

Parts

1. **Bony part – lateral one-third**
2. **Cartilaginous part – medial two-thirds**

Functions

1. **Equalizes air pressure.**
2. **Drains middle ear secretions.**

Muscles opening tube

1. **Tensor veli palatini**
2. **Levator veli palatini**

Applied anatomy

1. **Infection spreads from nasopharynx to middle ear.**
2. **Otitis media common in children.**

SHORT NOTES

1.Pharyngeal muscles and their nerve supply

Circular muscles

1. **Superior constrictor**
2. **Middle constrictor**
3. **Inferior constrictor**

Longitudinal muscles

1. **Stylopharyngeus**
2. **Palatopharyngeus**
3. **Salpingopharyngeus**

Nerve supply

1. **All muscles by pharyngeal plexus.**
2. **Stylopharyngeus by glossopharyngeal nerve.**

2.Nasopharynx

Extent

From base of skull to soft palate.

Features

1. **Pharyngeal tonsil**
2. **Opening of auditory tube**
3. **Tubal elevation**
4. **Pharyngeal recess**

Nerve supply

Pharyngeal plexus.

Applied anatomy

Enlarged adenoids obstruct breathing.

3.Features of nasopharynx

1. **Pharyngeal tonsil**
2. **Opening of auditory tube**
3. **Tubal tonsil**
4. **Salpingopharyngeal fold**
5. **Pharyngeal recess**

4.Constrictors of pharynx

Muscles

1. **Superior constrictor**
2. **Middle constrictor**
3. **Inferior constrictor**

Nerve supply

Pharyngeal plexus.

Actions

Constriction during swallowing.

5.Auditory tube

1. **Connects middle ear to nasopharynx.**
2. **Equalizes pressure.**
3. **Opened by tensor veli palatini.**
4. **Infection spreads through tube.**

6.Sphincter muscles of pharynx

1. **Cricopharyngeus**
2. **Palatopharyngeus**
3. **Salpingopharyngeus**

Function

Prevent reflux during swallowing.

7.Pharyngeal constrictions

Sites

1. **Junction with base of skull.**
2. **Crossing of aortic arch.**
3. **Crossing of left bronchus.**
4. **Diaphragmatic opening.**

Importance

Foreign bodies commonly lodge here.

LARYNX

LONG ESSAYS

1.4 year old child swallowed a shirt button. Since the child began to suffocate she was rushed to the hospital, where on X-ray examination, impaction of the foreign body in the larynx was confirmed. Based on your knowledge, Answer the following

Which is the narrowest part of laryngeal cavity?

Rima glottidis in adults; subglottic region at cricoid level in children.

Briefly describe the interior of larynx

Parts

1. **Vestibule – from inlet to vestibular folds.**
2. **Middle part – between vestibular and vocal folds.**
3. **Infraglottic cavity – below vocal folds.**

Features

1. **Vestibular folds – false vocal cords.**
2. **Vocal folds – true vocal cords.**
3. **Laryngeal ventricle between folds.**
4. **Rima glottidis – gap between vocal folds.**

Which is the safety muscle of larynx?

Posterior cricoarytenoid muscle.

Name the joints at which the muscles of larynx act and briefly mention the movements taking place at these joints

Cricothyroid joint

Movements

1. **Rotation and gliding.**
2. **Tenses vocal cords.**

Cricoarytenoid joint

Movements

1. **Rotation.**
2. **Gliding.**
3. **Abduction and adduction of vocal cords.**

What anatomical structures in the midline of neck are encountered during surgical approach to trachea below isthmus of thyroid gland

1. **Skin**
2. **Superficial fascia**
3. **Platysma**
4. **Deep fascia**
5. **Sternohyoid muscles**
6. **Sternothyroid muscles**
7. **Pretracheal fascia**
8. **Inferior thyroid veins**
9. **Trachea**

SHORT ESSAYS

1.Interior of larynx

Extent

From laryngeal inlet to lower border of cricoid cartilage.

Parts

1. **Vestibule**
2. **Middle part**
3. **Infraglottic cavity**

Vestibule

Extends from inlet to vestibular folds.

Middle part

1. **Contains vestibular folds.**
2. **Contains vocal folds.**
3. **Laryngeal ventricle lies between them.**
4. **Rima glottidis is narrowest part in adults.**

Infraglottic cavity

Extends from vocal folds to lower border of cricoid.

Applied anatomy

1. **Edema causes airway obstruction.**

2. **Foreign body may lodge in rima glottidis.**

SHORT NOTES

1.Vocal cords

Types

1. **True vocal cords**
2. **False vocal cords**

Formation of true vocal cords

1. **Vocal ligament**
2. **Vocalis muscle**
3. **Mucous membrane**

Functions

Phonation.

Nerve supply

Recurrent laryngeal nerve.

Applied anatomy

Paralysis causes hoarseness.

2.Boundaries and clinical significance of pyriform fossa

Boundaries

1. **Medially – aryepiglottic fold.**
2. **Laterally – thyroid cartilage and thyrohyoid membrane.**

Clinical significance

1. **Foreign bodies may lodge here.**
2. **Internal laryngeal nerve lies deep to mucosa and may be injured.**

3.Cavity of larynx

Parts

1. **Vestibule**
2. **Middle part**
3. **Infraglottic cavity**

Features

1. **Vestibular folds**
2. **Vocal folds**
3. **Rima glottidis**

4.Interior of larynx

1. **Vestibule**
2. **Middle part**
3. **Infraglottic cavity**
4. **Vocal folds**
5. **Vestibular folds**
6. **Laryngeal ventricle**

5.Piriform recess

Location

Depression in laryngopharynx on either side of laryngeal inlet.

Boundaries

1. **Aryepiglottic fold**
2. **Thyroid cartilage**

Applied anatomy

Foreign bodies commonly lodge here.

6.Transverse section through the neck at level of cricoid (C6 vertebrae)

REFER DIAGRAM SECTION

Structures seen

1. **Skin**
2. **Platysma**

3. **Sternocleidomastoid**
4. **Carotid sheath**
5. **Thyroid gland**
6. **Trachea**
7. **Esophagus**
8. **Vertebral artery**
9. **Prevertebral muscles**
10. **Cervical vertebra**

Importance

1. **Level of cricoid cartilage corresponds to C6 vertebra.**
2. **Pharynx continues as esophagus.**
3. **Larynx continues as trachea.**

BLOOD SUPPLY OF HEAD & NECK

SHORT ESSAYS

1. Describe the formation, termination, tributaries and clinical importance of external jugular vein.

Formation

External jugular vein is formed below and behind the angle of mandible by the union of:

1. **Posterior division of retromandibular vein**
2. **Posterior auricular vein**

Course

- **It runs vertically downward superficial to sternocleidomastoid muscle.**
- **It pierces investing layer of deep cervical fascia in the lower part of neck.**
- **Ends in the subclavian vein.**

Termination

- **Terminates into the subclavian vein lateral to venous angle.**

Tributaries

1. **Posterior external jugular vein**
2. **Transverse cervical vein**
3. **Suprascapular vein**
4. **Anterior jugular vein**
5. **Occasionally occipital vein**

Clinical importance

1. **Jugular venous pressure can be assessed through external jugular vein.**
2. **Air embolism may occur if vein is cut because it is attached to deep fascia.**
3. **Used for venous cannulation.**
4. **Vein becomes distended in right-sided heart failure.**

SHORT NOTES

1. Describe the formation, course, termination and tributaries of external jugular vein.

Formation

- **Formed by union of posterior division of retromandibular vein and posterior auricular vein.**

Course

- **Descends superficial to sternocleidomastoid.**
- **Pierces investing layer of deep cervical fascia.**

Termination

- **Ends in subclavian vein.**

Tributaries

1. **Posterior external jugular vein**
2. **Transverse cervical vein**
3. **Suprascapular vein**
4. **Anterior jugular vein**

2. Branches of subclavian artery

First part

1. **Vertebral artery**
2. **Internal thoracic artery**
3. **Thyrocervical trunk**

Second part

1. **Costocervical trunk**

Third part

1. **Dorsal scapular artery**

Important point

- **Right subclavian artery arises from brachiocephalic trunk.**
- **Left subclavian artery arises directly from arch of aorta.**

VERTEBRAL JOINTS

SHORT NOTES

1. Mention the type and movements at atlanto-occipital joints

Type

- **Synovial condylar joint.**

Articular surfaces

- **Occipital condyles of skull with superior articular facets of atlas.**

Movements

1. **Flexion**
2. **Extension**
3. **Slight lateral flexion**
4. **Minimal circumduction**

Muscles producing movements

- **Flexion: Longus capitis, rectus capitis anterior**
- **Extension: Splenius capitis, trapezius**

Applied anatomy

- **Nodding movement of head occurs here.**

CRANIAL NERVES

LONG ESSAYS

1. A 20 years old female underwent right sided mastoidectomy following which she developed weakness of facial muscles on that side. There was also impairment of taste sensation from the anterior two thirds of the tongue on the same side. Based on your knowledge of anatomy, Answer the following questions:

• Name the structure involved during surgery that would have led to the symptoms in this patient.
• Name all the nuclei in the brain stem which are concerned with this structure.
• Describe the intracranial, intra petrous and extra cranial course of the structure.
• Name its branches at different levels

Diagnosis: Facial nerve

Structure involved

- **Facial nerve was injured during mastoid surgery.**

Nuclei concerned with facial nerve

1. **Motor nucleus of facial nerve**
2. **Superior salivatory nucleus**
3. **Lacrimatory nucleus**
4. **Nucleus tractus solitarius**

Course of facial nerve

Intracranial course

- **Emerges at pontomedullary junction.**
- **Has motor root and nervus intermedius.**
- **Enters internal acoustic meatus with vestibulocochlear nerve.**

Intrapetrous course

The nerve passes through facial canal and has three parts:

1. Labyrinthine part

- **Extends to geniculate ganglion.**
- **Greater petrosal nerve arises here.**

2. Tympanic part

- **Runs backward in medial wall of middle ear.**

3. Mastoid part

- **Descends vertically.**
- **Gives nerve to stapedius and chorda tympani.**
- **Exits through stylomastoid foramen.**

Extracranial course

- **Passes forward between superficial and deep lobes of parotid gland.**
- **Divides into temporofacial and cervicofacial divisions.**
- **Forms parotid plexus.**

Branches

Within facial canal

1. **Greater petrosal nerve**
2. **Nerve to stapedius**
3. **Chorda tympani**

After emerging from stylomastoid foramen

1. **Posterior auricular nerve**
2. **Nerve to posterior belly of digastric**
3. **Nerve to stylohyoid**

Terminal branches within parotid gland

1. **Temporal**
2. **Zygomatic**
3. **Buccal**
4. **Marginal mandibular**
5. **Cervical**

Functions

- **Motor to muscles of facial expression**
- **Taste from anterior two-thirds of tongue**
- **Secretomotor to lacrimal and salivary glands**

Applied anatomy

- **Injury causes Bell's palsy.**
- **Hyperacusis occurs due to paralysis of stapedius.**
- **Loss of taste from anterior two-thirds of tongue.**

2. A college student was bought to casualty with history of road traffic accident. Among other clinical findings there was evidence of injury of the facial nerve on the right side. From your knowledge of anatomy, Answer the following:

• Describe the extra cranial course, relations, branches and distribution of the facial nerve
• What clinical features are expected to be seen if the nerve is injured as it emerges from the stylomastoid foramen

Extra cranial course

- **Facial nerve emerges from stylomastoid foramen.**
- **Passes downward and forward.**
- **Enters parotid gland.**
- **Divides into temporofacial and cervicofacial divisions.**
- **Forms parotid plexus.**

Relations

1. **Lies superficial to retromandibular vein.**
2. **External carotid artery lies deep.**
3. **Traverses parotid gland.**

Branches after stylomastoid foramen

1. **Posterior auricular nerve**
2. **Nerve to posterior belly of digastric**
3. **Nerve to stylohyoid**

Terminal branches

1. **Temporal**
2. **Zygomatic**
3. **Buccal**
4. **Marginal mandibular**
5. **Cervical**

Distribution

- **Supplies muscles of facial expression.**
- **Supplies stylohyoid and posterior belly of digastric.**

Clinical features of lesion at stylomastoid foramen

1. **Paralysis of muscles of facial expression**
2. **Loss of forehead wrinkling**
3. **Inability to close eye**
4. **Deviation of mouth to opposite side**
5. **Food collection in vestibule**
6. **Dribbling of saliva**
7. **Bell's phenomenon**

Features absent

- **Taste sensation preserved**
- **Lacrimation preserved**
- **Salivation preserved**

SHORT ESSAYS

1. Facial nerve

Functional components

1. **Branchial motor**
2. **Parasympathetic**
3. **Special sensory**
4. **General sensory**

Nuclei

1. **Motor nucleus**
2. **Superior salivatory nucleus**
3. **Nucleus tractus solitarius**

Course

- **Emerges at pontomedullary junction.**
- **Enters internal acoustic meatus.**
- **Traverses facial canal.**
- **Exits through stylomastoid foramen.**
- **Passes through parotid gland.**

Branches

1. **Greater petrosal nerve**
2. **Nerve to stapedius**
3. **Chorda tympani**
4. **Posterior auricular nerve**
5. **Terminal branches**

Functions

- **Motor to muscles of facial expression.**
- **Taste from anterior two-thirds of tongue.**
- **Secretomotor to lacrimal and salivary glands.**

Applied anatomy

- **Bell's palsy.**

SHORT NOTES

1. Explain anatomical basis of facial nerve palsy

Causes

1. **Infection**
2. **Trauma**
3. **Compression in facial canal**

Features

1. **Paralysis of facial muscles**
2. **Inability to close eye**
3. **Deviation of angle of mouth**
4. **Loss of forehead wrinkling**
5. **Dribbling of saliva**

Additional features

- **Hyperacusis if stapedius affected.**
- **Loss of taste if chorda tympani affected.**

2. Explain anatomical basis of wry neck

Definition

- **Wry neck or torticollis is deformity due to spasm or fibrosis of sternocleidomastoid muscle.**

Causes

1. **Congenital fibrosis of sternocleidomastoid**
2. **Birth injury**
3. **Spasm due to spinal accessory nerve irritation**

Features

- **Head tilted to affected side.**
- **Chin rotated to opposite side.**

Applied anatomy

- **Restricted neck movements.**

3. Chorda tympani nerve

Origin

- **Branch of facial nerve in facial canal.**

Course

- **Traverses middle ear.**
- **Leaves skull through petrotympanic fissure.**
- **Joins lingual nerve.**

Fibres carried

1. **Taste fibres from anterior two-thirds of tongue**
2. **Preganglionic parasympathetic fibres to submandibular ganglion**

Distribution

- **Submandibular gland**
- **Sublingual gland**

Applied anatomy

- **Loss causes impairment of taste.**

NEUROANATOMY

CNS – OVERVIEW

SHORT NOTES

1. DRAW AND LABEL: Median section of brain

REFER DIAGRAM SECTION

Labels to be marked

1. **Corpus callosum**
2. **Septum pellucidum**
3. **Thalamus**
4. **Hypothalamus**
5. **Pineal body**
6. **Midbrain**
7. **Pons**
8. **Medulla oblongata**
9. **Fourth ventricle**
10. **Cerebellum**
11. **Pituitary gland**
12. **Optic chiasma**

SPINAL CORD

SHORT ESSAYS

1. External features and blood supply of spinal cord

Extent

- **Extends from lower border of medulla oblongata to lower border of L1 vertebra.**

External features

1. **Cervical enlargement**
2. **Lumbosacral enlargement**
3. **Conus medullaris**
4. **Filum terminale**
5. **Anterior median fissure**
6. **Posterior median sulcus**

Blood supply

Arteries

1. **One anterior spinal artery**
2. **Two posterior spinal arteries**
3. **Segmental medullary arteries**
4. **Artery of Adamkiewicz**

Veins

- **Six longitudinal veins drain into internal vertebral venous plexus.**

Applied anatomy

- **Compression causes paraplegia.**

2. Spinal cord- gross features, blood supply, and vertebral levels of spinal segments

Gross features

1. **Cylindrical structure**
2. **Two enlargements**
3. **Conus medullaris**
4. **Filum terminale**

Blood supply

- **Anterior spinal artery supplies anterior two-thirds.**
- **Posterior spinal arteries supply posterior one-third.**

Vertebral levels

- **Cervical segments lie opposite corresponding vertebrae.**
- **Lower segments lie higher than corresponding vertebrae.**
- **Lumbar puncture done below L2.**

SHORT NOTES

3. Coverings and blood supply of spinal cord

Coverings

1. **Dura mater**
2. **Arachnoid mater**
3. **Pia mater**

Blood supply

1. **Anterior spinal artery**
2. **Posterior spinal arteries**
3. **Radicular arteries**

Venous drainage

- **Internal vertebral venous plexus.**

BRAIN STEM

SHORT NOTES

1. Medial lemniscus

Formation

- **Formed by internal arcuate fibres after sensory decussation.**

Course

- **Ascends through medulla, pons and midbrain.**

Fibres carried

1. **Fine touch**
2. **Proprioception**
3. **Vibration sense**

Termination

- **Ventral posterolateral nucleus of thalamus.**

Applied anatomy

- **Lesion causes contralateral loss of fine touch.**

2. Crus cerebri

Definition

- **Ventral part of cerebral peduncle in midbrain.**

Fibres

1. **Corticospinal fibres**
2. **Corticonuclear fibres**
3. **Corticopontine fibres**

Blood supply

- **Posterior cerebral artery.**

Applied anatomy

- **Lesion causes contralateral hemiplegia.**

DRAW AND LABEL

3. Transverse section of midbrain at the level of superior colliculus.

REFER DIAGRAM SECTION

Structures to label

1. **Superior colliculus**
2. **Red nucleus**
3. **Oculomotor nucleus**
4. **Medial lemniscus**
5. **Substantia nigra**
6. **Crus cerebri**
7. **Cerebral aqueduct**
8. **Periaqueductal gray matter**

4. Transverse section of midbrain at the level of inferior colliculus.

REFER DIAGRAM SECTION

Labels

1. **Inferior colliculus**
2. **Trochlear nucleus**
3. **Medial lemniscus**
4. **Lateral lemniscus**
5. **Substantia nigra**
6. **Crus cerebri**

5. Transverse section of medulla at the level of motor decussation.

REFER DIAGRAM SECTION

Labels

1. **Pyramidal decussation**
2. **Central canal**
3. **Gracile fasciculus**
4. **Cuneate fasciculus**
5. **Spinal tract of trigeminal nerve**

6. Transverse section of medulla at the level of olive

REFER DIAGRAM SECTION

Labels

1. **Inferior olivary nucleus**
2. **Pyramid**
3. **Medial lemniscus**
4. **Hypoglossal nucleus**
5. **Dorsal motor nucleus of vagus**
6. **Inferior cerebellar peduncle**

7. Transverse section of medulla oblongata at the level of sensory decussation

REFER DIAGRAM SECTION

Labels

1. **Gracile nucleus**
2. **Cuneate nucleus**
3. **Internal arcuate fibres**
4. **Medial lemniscus**
5. **Central canal**

8. Transverse section of the pons at the level of Facial colliculus

REFER DIAGRAM SECTION

Labels

1. **Facial colliculus**
2. **Abducent nucleus**
3. **Facial nerve fibres**
4. **Medial lemniscus**
5. **Fourth ventricle**

9. Transverse section of medulla at the level of pyramidal decussation

REFER DIAGRAM SECTION

Labels

1. **Pyramid**

2. Decussating corticospinal fibres
3. Central canal
4. Spinal nucleus of trigeminal nerve

10. Transverse section at the level of lower part of pons

REFER DIAGRAM SECTION

Labels

1. Trapezoid body
2. Facial nucleus
3. Abducent nucleus
4. Middle cerebellar peduncle

11. Transverse section at the level of upper part of pons

REFER DIAGRAM SECTION

Labels

1. Trigeminal nucleus
2. Superior cerebellar peduncle
3. Medial lemniscus
4. Fourth ventricle

CEREBELLUM

SHORT ESSAYS

1. Cerebellum

Situation

- Lies in posterior cranial fossa behind pons and medulla.

Parts

1. Two hemispheres
2. Vermis

Lobes

1. Anterior lobe
2. Posterior lobe
3. Flocculonodular lobe

Deep nuclei

1. Dentate nucleus
2. Emboliform nucleus
3. Globose nucleus
4. Fastigial nucleus

Functions

1. Maintenance of posture
2. Coordination of movements
3. Maintenance of equilibrium

Applied anatomy

- Cerebellar lesions cause ataxia.

2. Gross anatomy of cerebellum with its nuclei

External features

1. Two hemispheres
2. Vermis
3. Fissures and lobules

Deep nuclei

1. Dentate
2. Emboliform
3. Globose
4. Fastigial

Functions

- Coordination and equilibrium.

3. Cerebellar peduncles

Superior cerebellar peduncle

- Mainly efferent fibres.

Middle cerebellar peduncle

- **Largest peduncle.**
- **Contains pontocerebellar fibres.**

Inferior cerebellar peduncle

- **Connects medulla and cerebellum.**

Functions

- **Connect cerebellum with brain stem.**

SHORT NOTES

1. Superior cerebellar peduncle

Connections

- **Connects cerebellum with midbrain.**

Fibres

- **Mainly efferent fibres.**

Function

- **Carries cerebellothalamic fibres.**

2. Middle cerebellar peduncle

Features

- **Largest cerebellar peduncle.**
- **Connects pons and cerebellum.**

Fibres

- **Pontocerebellar fibres.**

3. Inferior cerebellar peduncle

Connections

- **Connects medulla and cerebellum.**

Fibres

1. **Posterior spinocerebellar tract**
2. **Olivocerebellar fibres**

4. Deep cerebellar nuclei

Nuclei

1. **Dentate**
2. **Emboliform**
3. **Globose**
4. **Fastigial**

Function

- **Relay centres of cerebellum.**

VENTRICLES OF BRAIN

SHORT ESSAYS

1. Describe the boundaries and features of floor of the IV ventricle

Definition

- **Floor of fourth ventricle is rhomboid fossa.**

Boundaries

1. **Upper angle continuous with cerebral aqueduct**
2. **Lower angle continuous with central canal**
3. **Superolateral boundaries formed by superior cerebellar peduncles**
4. **Inferolateral boundaries formed by inferior cerebellar peduncles**

Features

1. **Median sulcus**

2. **Medial eminence**
3. **Facial colliculus**
4. **Sulcus limitans**
5. **Vestibular area**
6. **Hypoglossal triangle**
7. **Vagal triangle**
8. **Area postrema**
9. **Striae medullares**

Applied anatomy

- **Lesions produce cranial nerve deficits.**

2. Floor of fourth ventricle

Features

1. **Median sulcus**
2. **Facial colliculus**
3. **Vestibular area**
4. **Hypoglossal triangle**
5. **Vagal triangle**

Clinical importance

- **Related to cranial nerve nuclei.**

3. Fourth ventricle

Situation

- **Between cerebellum and pons-medulla.**

Boundaries

- **Roof, floor and lateral recesses.**

Communications

1. **Cerebral aqueduct**
2. **Central canal**
3. **Median aperture**
4. **Lateral apertures**

Functions

- **Contains cerebrospinal fluid.**

4. Parts boundaries and features of lateral ventricle.

Parts

1. **Body**
2. **Anterior horn**
3. **Posterior horn**
4. **Inferior horn**

Features

1. **Choroid plexus**
2. **Caudate nucleus**
3. **Hippocampus**

5. Lateral ventricle

Parts

1. **Body**
2. **Anterior horn**
3. **Posterior horn**
4. **Inferior horn**

Communications

- **Interventricular foramen communicates with third ventricle.**

6. Tela choroidea of fourth ventricle

Definition

- **Double layer of pia mater forming part of roof of fourth ventricle.**

Features

1. **Contains choroid plexus.**
2. **Has median and lateral apertures.**

SHORT NOTES

1. Floor of fourth ventricle of brain

Features

1. Median sulcus
2. Facial colliculus
3. Vestibular area
4. Hypoglossal triangle
5. Vagal triangle

2. Features in the floor of fourth ventricle.

Important features

1. Facial colliculus
2. Sulcus limitans
3. Vestibular area
4. Area postrema

3. Third ventricle

Situation

- Midline cavity of diencephalon.

Boundaries

- Formed by thalamus and hypothalamus.

Communications

1. Interventricular foramina
2. Cerebral aqueduct

4. Tela choroidea of fourth ventricle

Features

1. Double layer of pia mater
2. Forms lower roof of fourth ventricle
3. Contains choroid plexus

5. Lateral ventricle of brain

Parts

1. Body
2. Anterior horn
3. Posterior horn
4. Inferior horn

DRAW AND LABEL

6. Floor of fourth ventricle

REFER DIAGRAM SECTION

Labels

1. Median sulcus
2. Facial colliculus
3. Sulcus limitans
4. Vestibular area
5. Hypoglossal triangle
6. Vagal triangle
7. Area postrema

CEREBRUM

SHORT ESSAYS

1. Describe the Sulci, Gyri, functional areas and blood supply on the superolateral surface of cerebrum

Sulci

1. Central sulcus
2. Lateral sulcus
3. Precentral sulcus
4. Postcentral sulcus
5. Superior temporal sulcus

Gyri

1. Precentral gyrus
2. Postcentral gyrus
3. Superior frontal gyrus

4. **Superior temporal gyrus**
5. **Supramarginal gyrus**
6. **Angular gyrus**

Functional areas

1. **Primary motor area – Area 4**
2. **Premotor area – Area 6**
3. **Primary sensory area – Areas 3,1,2**
4. **Visual area – Area 17**
5. **Auditory area – Areas 41,42**
6. **Broca's area – Areas 44,45**
7. **Wernicke's area**

Blood supply

- **Mainly by middle cerebral artery.**
- **Superomedial strip by anterior cerebral artery.**
- **Occipital pole by posterior cerebral artery.**

2. Describe the Functional areas and Blood supply of Superolateral surface of Cerebral hemisphere

Functional areas

1. **Motor area**
2. **Sensory area**
3. **Visual area**
4. **Auditory area**
5. **Speech areas**

Blood supply

1. **Middle cerebral artery – major supply**
2. **Anterior cerebral artery – superomedial margin**
3. **Posterior cerebral artery – occipital area**

3. Functional areas of supero-lateral surface of cerebrum

Motor areas

1. **Primary motor cortex**
2. **Premotor cortex**
3. **Broca's area**

Sensory areas

1. **Primary sensory cortex**
2. **Auditory cortex**
3. **Visual cortex**

Association areas

- **Wernicke's area.**

4. Thalamus

Situation

- **Part of diencephalon.**

Surfaces

1. **Superior**
2. **Medial**
3. **Lateral**

Nuclei

1. **Anterior nucleus**
2. **Medial nucleus**
3. **Lateral nuclei**

Functions

- **Relay station for sensory pathways.**

Applied anatomy

- **Thalamic syndrome.**

SHORT NOTES

1. Broca's area

Situation

- **Inferior frontal gyrus of dominant hemisphere.**

Brodmann areas

- **Areas 44 and 45.**

Function

- **Motor speech area.**

Lesion

- **Motor aphasia.**

2. Functional areas of supero-lateral surface of cerebrum

Areas

1. **Motor area**
2. **Sensory area**
3. **Visual area**
4. **Auditory area**
5. **Speech areas**

3. Lateral sulcus of cerebrum

Features

- **Separates temporal lobe from frontal and parietal lobes.**

Parts

1. **Stem**
2. **Anterior ramus**
3. **Ascending ramus**
4. **Posterior ramus**

4. Pre central gyrus of cerebrum

Situation

- **Between central and precentral sulci.**

Function

- **Contains primary motor cortex.**

Blood supply

- **Middle cerebral artery.**

5. Visual cortex

Situation

- **Around calcarine sulcus.**

Brodmann area

- **Area 17.**

Function

- **Perception of vision.**

Lesion

- **Cortical blindness.**

DRAW AND LABEL

6. Sulci and gyri of superolateral cerebral hemisphere.

REFER DIAGRAM SECTION

Labels

1. **Central sulcus**
2. **Lateral sulcus**
3. **Precentral gyrus**
4. **Postcentral gyrus**
5. **Superior frontal gyrus**
6. **Superior temporal gyrus**

7. Supero-lateral surface of cerebral hemisphere

REFER DIAGRAM SECTION

Labels

1. **Frontal lobe**
2. **Parietal lobe**
3. **Temporal lobe**
4. **Occipital lobe**
5. **Central sulcus**
6. **Lateral sulcus**

BLOOD SUPPLY OF BRAIN

SHORT ESSAYS

1. Formation and branches of circle of Willis

Formation

Circle of Willis is formed by:

1. **Anterior cerebral arteries**
2. **Anterior communicating artery**
3. **Internal carotid arteries**
4. **Posterior communicating arteries**
5. **Posterior cerebral arteries**

Branches

1. **Anterior cerebral artery**
2. **Middle cerebral artery**
3. **Posterior cerebral artery**
4. **Central branches**

Functions

- **Provides collateral circulation.**

Applied anatomy

- **Berry aneurysm may occur.**

2. Circulous arterioses

Definition

- **Arterial circle at base of brain.**

Components

1. **Anterior cerebral arteries**
2. **Anterior communicating artery**
3. **Internal carotid arteries**
4. **Posterior communicating arteries**
5. **Posterior cerebral arteries**

Importance

- **Collateral circulation.**

3. Arterial supply and venous drainage of cerebral cortex

Arterial supply

1. **Anterior cerebral artery**
2. **Middle cerebral artery**
3. **Posterior cerebral artery**

Venous drainage

1. **Superficial cerebral veins**
2. **Deep cerebral veins**
3. **Superior sagittal sinus**
4. **Cavernous sinus**

SHORT NOTES

1. Circle of Willis

Components

1. **Anterior cerebral arteries**
2. **Anterior communicating artery**
3. **Internal carotid arteries**
4. **Posterior communicating arteries**
5. **Posterior cerebral arteries**

Importance

- **Collateral circulation.**

DRAW AND LABEL

2. Circle of Willis

REFER DIAGRAM SECTION

Labels

1. **Anterior cerebral artery**
2. **Anterior communicating artery**
3. **Internal carotid artery**
4. **Posterior communicating artery**
5. **Posterior cerebral artery**
6. **Basilar artery**

3. Blood supply of medial surface of cerebrum

REFER DIAGRAM SECTION

Labels

1. **Anterior cerebral artery**
2. **Posterior cerebral artery**
3. **Pericallosal artery**
4. **Callosomarginal artery**

4. Blood supply of inferior surface of cerebrum

REFER DIAGRAM SECTION

Labels

1. **Middle cerebral artery**
2. **Posterior cerebral artery**
3. **Internal carotid artery**

WHITE MATTER OF BRAIN

LONG ESSAYS

1. A 60-year-old male known hypertensive is on anti-hypertensive drug for 5 years, wakes up in the morning and notices difficulty in moving his right limbs. He was brought to emergency department. Neurological examination revealed right sided hemiplegia. CT scan revealed hemorrhage in the posterior limb of the left internal capsule.

• Name the blood vessel responsible for the haemorrhage.
• Discuss the white matter of cerebrum.
• Parts and fibres of internal capsule.
• Blood supply of internal capsule.

Vessel responsible

- **Lateral striate branches of middle cerebral artery (Charcot artery).**

White matter of cerebrum

Types of fibres

1. **Association fibres**
2. **Commissural fibres**
3. **Projection fibres**

Association fibres

- **Connect areas within same hemisphere.**
- **Example: Superior longitudinal fasciculus.**

Commissural fibres

- **Connect two hemispheres.**
- **Example: Corpus callosum.**

Projection fibres

- **Connect cerebral cortex with lower centres.**

- **Form corona radiata and internal capsule.**

Internal capsule

Parts

1. **Anterior limb**
2. **Genu**
3. **Posterior limb**
4. **Retrolentiform part**
5. **Sublentiform part**

Fibres

Anterior limb

- **Frontopontine fibres**
- **Anterior thalamic radiations**

Genu

- **Corticonuclear fibres**

Posterior limb

- **Corticospinal fibres**
- **Sensory fibres**

Retrolentiform part

- **Optic radiation**

Sublentiform part

- **Auditory radiation**

Blood supply

1. **Lenticulostriate branches of middle cerebral artery**
2. **Anterior choroidal artery**
3. **Recurrent artery of Heubner**

Applied anatomy

- **Hemorrhage causes contralateral hemiplegia.**

Blood supply of internal capsule

Arterial supply

1. **Lenticulostriate branches of middle cerebral artery**
2. **Anterior choroidal artery**
3. **Recurrent artery of Heubner from anterior cerebral artery**

Areas supplied

- **Posterior limb mainly by anterior choroidal artery.**

Applied anatomy

- **Hemorrhage leads to capsular stroke.**

SHORT ESSAYS

1. Classify white matter fibres of cerebrum with suitable examples. Add a note on fibres of internal capsule.

Classification of white matter fibres of cerebrum

White matter of cerebrum consists of myelinated nerve fibres situated deep to the cerebral cortex. The fibres are classified into:

1. Association fibres

These fibres connect different cortical areas within the same cerebral hemisphere.

Types

a) Short association fibres

- **Connect adjacent gyri**
- **Also called arcuate fibres**

b) Long association fibres
Connect distant parts of the same hemisphere.

Examples:

- **Superior longitudinal fasciculus**
- **Inferior longitudinal fasciculus**
- **Uncinate fasciculus**
- **Cingulum**
- **Fronto-occipital fasciculus**

2. Commissural fibres

These fibres connect corresponding cortical areas of the two cerebral hemispheres.

Examples:

- **Corpus callosum**
- **Anterior commissure**
- **Posterior commissure**
- **Hippocampal commissure**

3. Projection fibres

These fibres connect cerebral cortex with lower centres.

Types

a) Ascending fibres
Carry impulses to cerebral cortex.
Examples:

- **Thalamocortical fibres**
- **Medial lemniscus fibres**

b) Descending fibres
Carry impulses from cortex.
Examples:

- **Corticospinal fibres**
- **Corticonuclear fibres**
- **Corticopontine fibres**

Projection fibres converge to form corona radiata and pass through internal capsule.

Note on fibres of internal capsule

Internal capsule contains ascending and descending projection fibres.

Fibres in anterior limb

- **Frontopontine fibres**
- **Anterior thalamic radiations**

Fibres in genu

- **Corticonuclear fibres**

Fibres in posterior limb

- **Corticospinal fibres**
- **Sensory fibres from thalamus**
- **Corticorubral fibres**
- **Corticoreticular fibres**

Fibres in retrolentiform part

- **Optic radiation**
- **Parietopontine and occipitopontine fibres**

Fibres in sublentiform part

- **Auditory radiation**
- **Temporopontine fibres**

Applied anatomy

- **Internal capsule is supplied by lenticulostriate branches of middle cerebral artery.**

- **Hemorrhage causes capsular stroke.**
- **Lesion of posterior limb produces contralateral hemiplegia.**

2. Classify white matter of the brain with an example of each. Describe the white matter bundle seen in the median longitudinal cerebral fissure.

Classification of white matter of brain

White matter fibres are classified into:

1. Association fibres

Connect areas within same hemisphere. Example: Superior longitudinal fasciculus.

2. Commissural fibres

Connect two cerebral hemispheres. Example: Corpus callosum.

3. Projection fibres

Connect cortex with lower centres. Example: Corticospinal tract.

White matter bundle seen in median longitudinal cerebral fissure – Corpus callosum

Corpus callosum is the largest commissural bundle connecting two cerebral hemispheres.

Parts

1. **Rostrum**
2. **Genu**
3. **Body**
4. **Splenium**

Situation

- **Forms floor of longitudinal cerebral fissure.**
- **Lies above septum pellucidum and lateral ventricles.**

Fibres

- **Connect corresponding cortical areas of both hemispheres.**

Radiation of fibres

- **Forceps minor from genu to frontal lobes**
- **Forceps major from splenium to occipital lobes**
- **Tapetum forms roof and lateral wall of posterior and inferior horns**

Functions

- **Interhemispheric transfer of information.**
- **Coordination of bilateral cortical activity.**

Applied anatomy

- **Agenesis causes mental retardation.**
- **Sectioning may be done in severe epilepsy.**

3. Internal capsule of brain

Definition

Internal capsule is a compact band of projection fibres situated between caudate nucleus and thalamus medially, and lentiform nucleus laterally.

Parts

1. **Anterior limb**

2. **Genu**
3. **Posterior limb**
4. **Retrolentiform part**
5. **Sublentiform part**

Relations

Anterior limb

- **Medial: Head of caudate nucleus**
- **Lateral: Lentiform nucleus**

Genu

- **Junction of anterior and posterior limbs**

Posterior limb

- **Medial: Thalamus**
- **Lateral: Lentiform nucleus**

Fibres

Anterior limb

- **Frontopontine fibres**
- **Anterior thalamic radiation**

Genu

- **Corticonuclear fibres**

Posterior limb

- **Corticospinal fibres**
- **Sensory fibres**

Retrolentiform part

- **Optic radiation**

Sublentiform part

- **Auditory radiation**

Blood supply

- **Lenticulostriate branches of middle cerebral artery**
- **Anterior choroidal artery**

Applied anatomy

- **Common site of hemorrhage.**
- **Posterior limb lesion causes contralateral hemiplegia.**
- **Damage to sensory fibres causes hemianesthesia.**

4. Association fibres of the cerebrum

Definition

Association fibres connect different cortical areas within the same cerebral hemisphere.

Classification

1. Short association fibres

- **Connect adjacent gyri.**
- **Called arcuate fibres.**

2. Long association fibres

Superior longitudinal fasciculus

- **Connects frontal, parietal and occipital lobes.**

Inferior longitudinal fasciculus

- **Connects occipital and temporal lobes.**

Uncinate fasciculus

- **Connects frontal and temporal lobes.**

Cingulum

- **Lies in cingulate gyrus.**
- **Connects frontal and parahippocampal gyri.**

Fronto-occipital fasciculus

- **Connects frontal and occipital lobes.**

Functions

- **Integration of cortical functions.**
- **Coordination between different cortical areas.**

Applied anatomy

- **Lesions may produce aphasia, agnosia and apraxia.**

5. Internal capsule- parts, fibre constituents, arterial supply and applied anatomy

Definition

Internal capsule is a compact bundle of projection fibres in the cerebrum.

Parts and fibre constituents

1. Anterior limb

Fibres:

- **Frontopontine fibres**
- **Anterior thalamic radiation**

2. Genu

Fibres:

- **Corticonuclear fibres**

3. Posterior limb

Fibres:

- **Corticospinal fibres**
- **Sensory fibres from thalamus**
- **Corticorubral fibres**

4. Retrolentiform part

Fibres:

- **Optic radiation**
- **Occipitopontine fibres**

5. Sublentiform part

Fibres:

- **Auditory radiation**
- **Temporopontine fibres**

Arterial supply

Anterior limb

- **Lenticulostriate branches of middle cerebral artery**
- **Recurrent artery of Heubner from anterior cerebral artery**

Genu

- **Lenticulostriate branches of middle cerebral artery**

Posterior limb

- **Lenticulostriate branches of middle cerebral artery**
- **Anterior choroidal artery**

Applied anatomy

- **Charcot artery rupture causes cerebral hemorrhage.**

- **Posterior limb lesion causes spastic hemiplegia.**
- **Damage to genu causes cranial nerve palsy.**
- **Optic radiation lesion causes visual defects.**

6. Internal capsule – parts, relations, ascending and descending fibers and applied anatomy.

Definition

Internal capsule is a compact sheet of white matter carrying projection fibres.

Parts

1. **Anterior limb**
2. **Genu**
3. **Posterior limb**
4. **Retrolentiform part**
5. **Sublentiform part**

Relations

Anterior limb

- **Medial: Head of caudate nucleus**
- **Lateral: Lentiform nucleus**

Posterior limb

- **Medial: Thalamus**
- **Lateral: Lentiform nucleus**

Ascending fibres

- **Thalamocortical sensory fibres**
- **Optic radiation**
- **Auditory radiation**

Descending fibres

- **Corticospinal fibres**
- **Corticonuclear fibres**
- **Corticopontine fibres**
- **Corticorubral fibres**

Applied anatomy

- **Common site of hypertensive hemorrhage.**
- **Lesion produces contralateral hemiplegia.**
- **Sensory loss due to thalamocortical fibre involvement.**
- **Internal capsule stroke causes upper motor neuron paralysis.**

7. Describe internal capsule

Definition

Internal capsule is a compact band of projection fibres situated in inferomedial part of each cerebral hemisphere.

Situation

- **Between caudate nucleus and thalamus medially and lentiform nucleus laterally.**

Parts

1. **Anterior limb**
2. **Genu**
3. **Posterior limb**
4. **Retrolentiform part**
5. **Sublentiform part**

Fibres

Anterior limb

- **Frontopontine fibres**
- **Anterior thalamic radiation**

Genu

- **Corticonuclear fibres**

Posterior limb

- **Corticospinal fibres**
- **Sensory fibres**

Retrolentiform part

- **Optic radiation**

Sublentiform part

- **Auditory radiation**

Blood supply

- **Middle cerebral artery**
- **Anterior cerebral artery**
- **Anterior choroidal artery**

Applied anatomy

- **Hemorrhage causes capsular stroke.**
- **Contralateral paralysis occurs due to corticospinal tract involvement.**

8. Association fibres of brain

Association fibres connect different cortical areas within same cerebral hemisphere.

Types

Short association fibres

- **Connect adjacent gyri.**
- **Also called arcuate fibres.**

Long association fibres

1. **Superior longitudinal fasciculus**
2. **Inferior longitudinal fasciculus**
3. **Uncinate fasciculus**
4. **Cingulum**
5. **Fronto-occipital fasciculus**

Functions

- **Integration of sensory and motor activities.**
- **Coordination of cortical functions.**

Applied anatomy

- **Lesions may produce aphasia and agnosia.**

SHORT NOTES

1. Internal capsule

Internal capsule is a compact bundle of projection fibres.

Situation

- **Between thalamus and caudate nucleus medially and lentiform nucleus laterally.**

Parts

1. **Anterior limb**
2. **Genu**
3. **Posterior limb**
4. **Retrolentiform part**
5. **Sublentiform part**

Important fibres

- **Corticospinal fibres**
- **Corticonuclear fibres**
- **Sensory fibres**
- **Optic radiation**
- **Auditory radiation**

Blood supply

- **Lenticulostriate arteries**
- **Anterior choroidal artery**

Applied anatomy

- **Common site of hemorrhage causing hemiplegia.**

2. Fornix of brain

Fornix is a bundle of commissural and projection fibres related to hippocampus.

Parts

1. **Fimbria**
2. **Crus**
3. **Body**
4. **Columns**

Connections

- **Connects hippocampus with mammillary body.**

Functions

- **Part of limbic system.**
- **Concerned with memory.**

Applied anatomy

- **Damage causes memory disturbances.**

3. Corpus callosum

Corpus callosum is the largest commissural bundle of cerebrum.

Parts

1. **Rostrum**
2. **Genu**
3. **Body**
4. **Splenium**

Functions

- **Connects cerebral hemispheres.**
- **Coordinates bilateral cortical activities.**

Applied anatomy

- **Agenesis causes mental retardation.**
- **Callosotomy done in epilepsy.**

BASAL GANGLIA AND LIMBIC SYSTEM

SHORT ESSAYS

1. Describe parts, relations, connections and clinical anatomy of basal ganglia

Definition

Basal ganglia are masses of grey matter situated deep within cerebral hemispheres.

Parts

1. **Caudate nucleus**
2. **Lentiform nucleus**
    - **Putamen**
    - **Globus pallidus**
3. **Claustrum**
4. **Amygdaloid body**

Relations

Caudate nucleus

- **Lies lateral to lateral ventricle.**
- **Related to thalamus.**

Lentiform nucleus

- **Medial: Internal capsule**
- **Lateral: External capsule**

Connections

Afferent connections

- **Cerebral cortex**
- **Thalamus**
- **Substantia nigra**

Efferent connections

- **Thalamus**
- **Brainstem motor nuclei**

Functions

- **Regulation of muscle tone.**
- **Control of posture and voluntary movements.**
- **Suppression of unwanted movements.**

Clinical anatomy

- **Parkinson disease due to substantia nigra degeneration.**
- **Chorea due to caudate nucleus lesions.**
- **Hemiballismus due to subthalamic nucleus lesion.**

2. Basal nuclei

Definition

Basal nuclei are subcortical masses of grey matter in cerebral hemispheres.

Components

1. **Caudate nucleus**
2. **Lentiform nucleus**
3. **Claustrum**
4. **Amygdaloid body**

Corpus striatum

- **Formed by caudate nucleus and lentiform nucleus.**

Functions

- **Control of voluntary movements.**
- **Regulation of posture.**
- **Control of muscle tone.**

Applied anatomy

- **Parkinsonism**
- **Chorea**
- **Athetosis**

3. Basal ganglia

Basal ganglia are collections of grey matter located deep in cerebral hemispheres.

Components

- **Caudate nucleus**
- **Lentiform nucleus**
- **Claustrum**
- **Amygdaloid body**

Functions

- **Planning and execution of movements.**
- **Maintenance of posture.**
- **Control of muscle tone.**

Clinical anatomy

- **Parkinson disease**
- **Huntington chorea**
- **Hemiballismus**

4. Corpus striatum

Definition

Corpus striatum consists of caudate nucleus and lentiform nucleus.

Components

1. **Caudate nucleus**
2. **Lentiform nucleus**
    - **Putamen**
    - **Globus pallidus**

Functions

- **Control and coordination of movements.**
- **Regulation of muscle tone.**

Applied anatomy

- **Parkinsonism**
- **Chorea**

SHORT NOTES

1. Basal nuclei of cerebrum

Basal nuclei are deep masses of grey matter.

Components

- **Caudate nucleus**
- **Lentiform nucleus**
- **Claustrum**
- **Amygdaloid body**

Functions

- **Motor control.**
- **Maintenance of posture.**

Clinical importance

- **Parkinson disease.**

2. Parts of basal ganglia with functional importance

Parts

1. **Caudate nucleus**
2. **Putamen**
3. **Globus pallidus**
4. **Claustrum**
5. **Amygdaloid body**

Functional importance

- **Regulation of voluntary movement.**
- **Maintenance of posture.**
- **Control of muscle tone.**
- **Emotional behaviour through amygdala.**

CRANIAL CAVITY AND CSF CIRCULATION

LONG ESSAYS

1. A male patient was brought to emergency department with head injury following road traffic accident. On examination he was found to have black eye and pulsating exophthalmos on left side. On radiological examination fracture of body of sphenoid was noted.

a) What is the anatomical basis of black eye and pulsating exophthalmos in this patient

Black eye

- **Due to extravasation of blood into loose connective tissue of eyelids.**
- **Blood tracks into eyelids from fracture of anterior cranial fossa.**

Pulsating exophthalmos

- **Due to carotico-cavernous fistula following rupture of internal carotid artery within cavernous sinus.**
- **Increased venous pressure causes protrusion and pulsation of eyeball.**

b) Name the dural venous sinus that is likely to be involved in this patient and describe its relations, tributaries and communications

Cavernous sinus

Situation and extent

- **Situated on either side of body of sphenoid.**
- **Extends from superior orbital fissure to apex of petrous temporal bone.**

Relations

Structures in lateral wall

1. **Oculomotor nerve**
2. **Trochlear nerve**
3. **Ophthalmic nerve**
4. **Maxillary nerve**

Structures within sinus

1. **Internal carotid artery**
2. **Abducent nerve**

Tributaries

- **Superior ophthalmic vein**
- **Inferior ophthalmic vein**
- **Superficial middle cerebral vein**
- **Sphenoparietal sinus**

Communications

- **Opposite cavernous sinus through intercavernous sinuses**
- **Superior petrosal sinus**
- **Inferior petrosal sinus**
- **Pterygoid venous plexus**
- **Facial vein through ophthalmic veins**

Applied anatomy

- **Cavernous sinus thrombosis.**
- **Infection may spread from face.**
- **Involvement of cranial nerves causes ophthalmoplegia.**

c) Classify dural venous sinuses

Unpaired sinuses

1. **Superior sagittal sinus**
2. **Inferior sagittal sinus**
3. **Straight sinus**
4. **Occipital sinus**
5. **Basilar venous plexus**
6. **Intercavernous sinuses**

Paired sinuses

1. **Cavernous sinus**
2. **Superior petrosal sinus**
3. **Inferior petrosal sinus**
4. **Transverse sinus**
5. **Sigmoid sinus**
6. **Sphenoparietal sinus**

2. Classify dural venous sinuses. Describe the Cavernous sinus under the following headings

Classification of dural venous sinuses

Unpaired sinuses

- **Superior sagittal sinus**
- **Inferior sagittal sinus**
- **Straight sinus**
- **Occipital sinus**
- **Intercavernous sinus**

Paired sinuses

- **Cavernous sinus**
- **Superior petrosal sinus**
- **Inferior petrosal sinus**

- **Transverse sinus**
- **Sigmoid sinus**

Cavernous sinus

Situation and extent

- **Located on either side of body of sphenoid.**
- **Extends from superior orbital fissure to apex of petrous temporal bone.**

Relations

Lateral wall

1. **Oculomotor nerve**
2. **Trochlear nerve**
3. **Ophthalmic nerve**
4. **Maxillary nerve**

Within sinus

1. **Internal carotid artery**
2. **Abducent nerve**

Tributaries and communications

Tributaries

- **Superior ophthalmic vein**
- **Inferior ophthalmic vein**
- **Superficial middle cerebral vein**
- **Sphenoparietal sinus**

Communications

- **Facial vein**
- **Pterygoid venous plexus**
- **Superior and inferior petrosal sinuses**
- **Opposite cavernous sinus**

Applied anatomy

- **Cavernous sinus thrombosis.**
- **Infection spread from danger area of face.**
- **Carotico-cavernous fistula causes pulsating exophthalmos.**

3. A patient brought to casualty following road traffic accident had bulging of right eyeball with every radial pulse beat. X ray revealed fracture of right half of body of sphenoid. Answer the following questions

Mention the location and extent to cavernous sinus

- **Cavernous sinus lies on either side of body of sphenoid.**
- **Extends from superior orbital fissure to apex of petrous temporal bone.**

Its relations and its tributaries

Relations

Lateral wall:

- **Oculomotor nerve**
- **Trochlear nerve**
- **Ophthalmic nerve**
- **Maxillary nerve**

Within sinus:

- **Internal carotid artery**
- **Abducent nerve**

Tributaries

- **Superior ophthalmic vein**
- **Inferior ophthalmic vein**
- **Sphenoparietal sinus**
- **Superficial middle cerebral vein**

Mention the reason for pulsating bulge of right eyeball in the above patient

- **Rupture of internal carotid artery into cavernous sinus causes carotico-cavernous fistula.**
- **Arterial pulsations transmitted to orbital veins produce pulsating exophthalmos.**

Classify the cranial dural venous sinuses

Unpaired

- **Superior sagittal**
- **Inferior sagittal**
- **Straight**
- **Occipital**

Paired

- **Cavernous**
- **Transverse**
- **Sigmoid**
- **Petrosal sinuses**

SHORT ESSAYS

1. Confluence of venous sinuses

Confluence of sinuses is the meeting point of several dural venous sinuses.

Situation

- **Located at internal occipital protuberance.**

Sinuses meeting

1. **Superior sagittal sinus**
2. **Straight sinus**
3. **Occipital sinus**
4. **Transverse sinuses**

Functions

- **Drains venous blood from brain.**

Applied anatomy

- **Venous thrombosis may affect cerebral drainage.**

2. Dural venous sinuses.

Definition

Dural venous sinuses are endothelial-lined venous channels between layers of dura mater.

Features

- **Valveless.**
- **No muscular coat.**
- **Drain into internal jugular vein.**

Classification

Unpaired

- **Superior sagittal sinus**
- **Inferior sagittal sinus**
- **Straight sinus**
- **Occipital sinus**

Paired

- **Cavernous sinus**
- **Transverse sinus**
- **Sigmoid sinus**
- **Petrosal sinuses**

Functions

- **Drain venous blood and cerebrospinal fluid.**

3. Cavernous sinus - structures related ,tributaries and applied aspects

Situation

- **On either side of body of sphenoid.**

Structures related

Lateral wall

- **Oculomotor nerve**
- **Trochlear nerve**
- **Ophthalmic nerve**
- **Maxillary nerve**

Within sinus

- **Internal carotid artery**
- **Abducent nerve**

Tributaries

- **Superior ophthalmic vein**
- **Inferior ophthalmic vein**
- **Superficial middle cerebral vein**

Applied aspects

- **Cavernous sinus thrombosis.**
- **Spread of facial infection.**
- **Ophthalmoplegia due to cranial nerve involvement.**

SHORT NOTES

1. Describe the site and structures pierced while performing a lumbar puncture

Site

- **Midline between L3–L4 or L4–L5 vertebrae.**

Structures pierced

1. **Skin**
2. **Superficial fascia**
3. **Supraspinous ligament**
4. **Interspinous ligament**
5. **Ligamentum flavum**
6. **Epidural space**
7. **Dura mater**
8. **Arachnoid mater**
9. **Subarachnoid space**

Importance

- **Used for cerebrospinal fluid examination.**
- **Used for spinal anesthesia.**

2. Explain the clinical importance of cavernous sinus

Clinical importance

- **Infection from danger area of face can spread to cavernous sinus.**
- **Causes cavernous sinus thrombosis.**
- **Cranial nerves III, IV, V1, V2 and VI may be affected.**
- **Internal carotid artery involvement may cause carotico-cavernous fistula.**
- **Produces pulsating exophthalmos and ophthalmoplegia.**

3. Tentorium cerebelli

Tentorium cerebelli is a fold of dura mater separating cerebellum from occipital lobes.

Attachments

- **Attached to petrous temporal bone and occipital bone.**

Features

- **Has tentorial notch for brainstem.**

Functions

- **Supports occipital lobes.**

4. Falx Cerebri

Falx cerebri is a sickle-shaped fold of dura mater.

Attachments

- **Attached anteriorly to crista galli.**
- **Posteriorly blends with tentorium cerebelli.**

Sinuses present

- **Superior sagittal sinus**
- **Inferior sagittal sinus**

Functions

- **Separates cerebral hemispheres.**

5. Cisterna magna

Cisterna magna is the largest subarachnoid cistern.

Situation

- **Between cerebellum and medulla.**

Communications

- **Receives cerebrospinal fluid from fourth ventricle through median aperture.**

Importance

- **Site for cisternal puncture.**

SYSTEMIC EMBRYOLOGY

SHORT ESSAYS

1. Describe the development and congenital anomalies of palate

Development of palate

Palate develops between 6th and 12th weeks.

Parts

1. **Primary palate**
2. **Secondary palate**

Primary palate

- **Develops from intermaxillary segment.**
- **Forms anterior part of hard palate.**

Secondary palate

- **Develops from lateral palatine processes of maxillary prominences.**
- **Palatine shelves fuse in midline.**
- **Fuse with nasal septum.**

Derivatives

- **Hard palate**
- **Soft palate**
- **Uvula**

Congenital anomalies

Cleft palate

- **Failure of fusion of palatine shelves.**

Types

- **Complete cleft palate**
- **Incomplete cleft palate**
- **Bifid uvula**

Clinical importance

- **Difficulty in feeding and speech.**

2. Describe embryological basis of nerve supply of tongue.

Developmental basis

Tongue develops from first, third and fourth pharyngeal arches.

Anterior two-thirds

- **Develops from first arch.**
- **General sensation by lingual nerve.**
- **Taste by chorda tympani.**

Posterior one-third

- **Develops from third arch.**
- **Supplied by glossopharyngeal nerve for general sensation and taste.**

Posterior-most part

- **Develops from fourth arch.**
- **Supplied by internal laryngeal nerve.**

Motor supply

- **Muscles develop from occipital myotomes.**
- **Supplied by hypoglossal nerve.**

Exception

- **Palatoglossus supplied by vagus nerve.**

3. Development of face

Facial prominences

Face develops from:

1. **Frontonasal prominence**
2. **Paired maxillary prominences**
3. **Paired mandibular prominences**

Development

- **Nasal placodes appear on frontonasal prominence.**
- **Medial nasal prominences fuse to form intermaxillary segment.**
- **Maxillary prominences fuse with medial nasal prominences.**
- **Mandibular prominences form lower jaw.**

Derivatives

- **Forehead**
- **Nose**
- **Upper lip**
- **Cheeks**
- **Mandible**

Congenital anomalies

- **Cleft lip**
- **Oblique facial cleft**
- **Macrostomia**
- **Microstomia**

4. First brachial arch

Components

1. **Maxillary process**
2. **Mandibular process**

Cartilage

- **Meckel cartilage**

Skeletal derivatives

- **Malleus**
- **Incus**
- **Mandible**
- **Maxilla**

- **Zygomatic bone**

Muscular derivatives

- **Muscles of mastication**
- **Mylohyoid**
- **Anterior belly of digastric**
- **Tensor tympani**
- **Tensor veli palatini**

Nerve supply

- **Trigeminal nerve (mandibular division)**

Artery

- **Maxillary artery**

SHORT NOTES

1. Mesodermal derivatives of second pharyngeal arch

Muscles derived

- **Muscles of facial expression**
- **Stapedius**
- **Stylohyoid**
- **Posterior belly of digastric**

Nerve supply

- **Facial nerve**

2. Development of thyroid gland

Development

- **Develops from median endodermal diverticulum at foramen caecum.**
- **Descends in neck through thyroglossal duct.**

Derivatives

- **Follicular cells.**

Ultimobranchial body

- **Gives parafollicular cells.**

Congenital anomalies

- **Thyroglossal cyst**
- **Lingual thyroid**

3. Mesodermal derivatives of first pharyngeal arch

Muscles

- **Muscles of mastication**
- **Mylohyoid**
- **Anterior belly of digastric**
- **Tensor tympani**
- **Tensor veli palatini**

Nerve supply

- **Mandibular nerve.**

4. Development of face

Face develops from frontonasal, maxillary and mandibular prominences.

Derivatives

- **Forehead**
- **Nose**
- **Lips**
- **Cheeks**

Anomalies

- **Cleft lip**
- **Facial clefts**

5. First pharyngeal pouch

Derivatives

- **Tubotympanic recess**
- **Tympanic cavity**
- **Auditory tube**

6. Development of pituitary gland

Adenohypophysis

- **Develops from Rathke pouch.**

Neurohypophysis

- **Develops from neuroectoderm of diencephalon.**

Parts formed

- **Pars distalis**
- **Pars intermedia**
- **Pars nervosa**

7. Derivatives of pharyngeal pouches

First pouch

- **Auditory tube and middle ear.**

Second pouch

- **Palatine tonsil.**

Third pouch

- **Inferior parathyroid and thymus.**

Fourth pouch

- **Superior parathyroid.**

8. Cleft palate

Cleft palate occurs due to failure of fusion of palatine shelves.

Types

- **Complete**
- **Incomplete**
- **Bifid uvula**

Clinical importance

- **Feeding and speech difficulty.**

9. Development and congenital anomalies of face

Development

- **From facial prominences.**

Congenital anomalies

- **Cleft lip**
- **Oblique facial cleft**
- **Macrostomia**
- **Microstomia**

10. First brachial arch

Derivatives

- **Maxilla**
- **Mandible**
- **Muscles of mastication**

Nerve

- **Mandibular nerve.**

11. Development of lips

Upper lip

- **Formed by fusion of maxillary prominence with medial nasal prominence.**

Lower lip

- **Formed by mandibular prominences.**

Anomaly

- **Cleft lip.**

SYSTEMIC HISTOLOGY

SHORT ESSAYS

1. Explain the microscopic structure of pituitary gland

Pituitary gland

Pituitary gland is an endocrine gland situated in hypophyseal fossa.

Parts

1. **Adenohypophysis**
2. **Neurohypophysis**

Adenohypophysis

Parts

- **Pars distalis**
- **Pars intermedia**
- **Pars tuberalis**

Cells

Chromophils

1. **Acidophils**
    - **Somatotrophs**
    - **Mammotrophs**
2. **Basophils**
    - **Thyrotrophs**
    - **Gonadotrophs**
    - **Corticotrophs**

Chromophobes

- **Poorly stained cells.**

Neurohypophysis

Parts

- **Pars nervosa**
- **Infundibulum**

Components

- **Unmyelinated nerve fibres**
- **Pituicytes**
- **Herring bodies**

Functions

- **Secretion and storage of hormones.**

SHORT NOTES

1. Compare and contrast the microscopic features of lymph node and spleen

Feature	Lymph node	Spleen
Capsule	Thin	Thick
Sinuses	Present	Absent
Cortex and medulla	Present	Absent
White pulp	Absent	Present
Function	Filters lymph	Filters blood
Afferent lymphatics	Present	Absent

2. Histology of pituitary gland

Parts

- **Adenohypophysis**
- **Neurohypophysis**

Adenohypophysis cells

- **Acidophils**
- **Basophils**

- **Chromophobes**

Neurohypophysis

- **Pituicytes**
- **Herring bodies**

3. Microscopic structure of thymus

Coverings

- **Capsule with septa.**

Lobules

Each lobule has:

- **Cortex**
- **Medulla**

Cortex

- **Dense lymphocytes.**

Medulla

- **Fewer lymphocytes.**
- **Hassall corpuscles present.**

Functions

- **T lymphocyte maturation.**

4. Histology of thyroid

Structure

- **Made of follicles.**
- **Lined by cuboidal epithelium.**

Contents

- **Colloid containing thyroglobulin.**

Cells

1. **Follicular cells**
2. **Parafollicular cells**

5. Microscopic structure of retina

Layers of retina

1. **Pigment epithelium**
2. **Layer of rods and cones**
3. **External limiting membrane**
4. **Outer nuclear layer**
5. **Outer plexiform layer**
6. **Inner nuclear layer**
7. **Inner plexiform layer**
8. **Ganglion cell layer**
9. **Nerve fibre layer**
10. **Internal limiting membrane**

Functions

- **Photoreception.**

6. Microscopic structure of cerebellum

Layers of cerebellar cortex

1. **Molecular layer**
2. **Purkinje cell layer**
3. **Granular layer**

White matter

- **Present centrally.**

Purkinje cells

- **Flask-shaped neurons.**

7. Microscopic anatomy of pituitary gland.

Adenohypophysis

- **Acidophils**
- **Basophils**
- **Chromophobes**

Neurohypophysis

- **Pituicytes**
- **Herring bodies**

8. Microscopic structure of cerebrum

Layers of cerebral cortex

1. **Molecular layer**
2. **External granular layer**
3. **External pyramidal layer**
4. **Internal granular layer**
5. **Internal pyramidal layer**
6. **Multiform layer**

White matter

- **Deep to cortex.**

9. Histology of palatine tonsil

Covering epithelium

- **Stratified squamous non-keratinized epithelium.**

Features

- **Crypts present.**
- **Lymphoid follicles present.**

Capsule

- **Present on deep surface.**

10. Histology of cerebellum

Layers

1. **Molecular layer**
2. **Purkinje cell layer**
3. **Granular layer**

White matter

- **Forms arbor vitae.**

11. Histology of thyroid gland and parathyroid glands

Thyroid gland

- **Follicles lined by cuboidal epithelium.**
- **Colloid present.**

Parathyroid gland

Cells

1. **Chief cells**
2. **Oxyphil cells**

Function

- **Calcium regulation.**

12. Histology of submandibular salivary gland

Type

- **Mixed salivary gland.**

Acini

- **Serous acini predominant.**
- **Mucous acini present.**

Ducts

- **Intercalated ducts**
- **Striated ducts**

13. Spinal ganglion

Structure

- **Collection of pseudounipolar neurons.**

Features

- **Satellite cells surround neurons.**
- **Connective tissue capsule present.**

Function

- **Sensory relay station.**

GENERAL QUESTIONS

SHORT NOTES

1. Describe the correct procedure while handling cadavers.

Procedure while handling cadavers

- **Maintain respect and dignity.**
- **Wear gloves, apron and mask.**
- **Handle instruments carefully.**
- **Do not mutilate structures unnecessarily.**
- **Keep cadaver covered when not dissecting.**
- **Follow dissection hall discipline.**
- **Wash hands after dissection.**
- **Dispose biomedical waste properly.**

2. Write your reflection on the cadaver as a teacher of anatomy

Cadaver is the first teacher of anatomy for a medical student. It helps in understanding the three-dimensional arrangement of structures and develops clinical orientation. Dissection teaches discipline, teamwork and respect for human body. Cadaveric study also builds surgical skills and professional ethics. Hence cadaver should always be treated with gratitude and dignity.

3. Describe briefly the process of cadaver maintenance in the Anatomy department.

Cadaver maintenance

- **Embalming is done using preservative fluids.**
- **Cadavers are stored in tanks with formalin solution.**
- **Regular moistening prevents drying.**
- **Proper ventilation is maintained.**
- **Dissection tables are cleaned regularly.**
- **Biomedical waste disposal protocols are followed.**
- **Cadavers are handled respectfully.**

4. Reflect on how to honor and extend gratitude to the cadaver as a Phase 1 MBBS student

Cadaver donation is a noble act contributing to medical education. As a Phase 1 MBBS student, gratitude can be shown by maintaining respect during dissection, handling the body carefully and observing ethical conduct. Cadavers should be regarded as silent teachers who help students learn anatomy and develop professional values. Participation in memorial ceremonies and maintaining dignity of the body are important ways to honor cadavers.

PAPER-II

Attachments

Muscles attached:

- **Sternocleidomastoid**
- **Sternohyoid**
- **Sternothyroid**
- **Pectoralis major**

Articulations

- **With clavicle**
- **First costal cartilage**
- **Upper half of second costal cartilage**
- **Body of sternum**

Applied anatomy

- **Sternal angle is an important surface landmark.**
- **Marks level of bifurcation of trachea and beginning/end of arch of aorta.**
- **Bone marrow biopsy can be performed through sternum.**

THORAX

BONES

SHORT NOTES

1. Manubrium sterni

Definition:
Manubrium sterni is the upper broad quadrangular part of sternum.

Features

- **Lies opposite T3 and T4 vertebrae.**
- **Articulates with body of sternum at sternal angle.**
- **Superior border presents jugular notch.**
- **Clavicular notches are present on each side for articulation with clavicle.**

DIAPHRAGM

LONG ESSAYS

1. A 23year-old pregnant woman who did not go for regular antenatal screening delivered a full-term baby weighing 2kg. Soon after birth the baby was found to be dyspnoeic and vomited continuously after every feed. CT was done for the newborn and it revealed herniation of stomach and intestines into the left side of thoracic cavity.With your knowledge in anatomy, answer the following:

a) Name the structure that is defectively developed in this newborn.

The defect is due to defective development of the diaphragm, commonly due to failure of closure of pleuroperitoneal membrane causing congenital diaphragmatic hernia.

b) Describe the attachments of this structure.

Attachments of Diaphragm

The diaphragm has:

1. **Sternal origin**
2. **Costal origin**
3. **Vertebral origin**
4. **Central insertion**

1. Sternal part

- **Arises from posterior surface of xiphoid process.**

2. Costal part

- **Arises from inner surfaces of lower six ribs and their costal cartilages.**

3. Vertebral part

Formed by right and left crura and arcuate ligaments.

Right crus

- **Arises from bodies and intervertebral discs of L1–L3 vertebrae.**

Left crus

- **Arises from bodies and intervertebral discs of L1–L2 vertebrae.**

Median arcuate ligament

- **Extends between two crura.**

Medial arcuate ligament

- **Extends from body of L2 to transverse process of L1.**

Lateral arcuate ligament

- **Extends from transverse process of L1 to 12th rib.**

Insertion

- **All fibres converge into central tendon.**

c) Mention the innervation and actions of this structure.

Innervation of diaphragm

Motor supply

- **Phrenic nerve (C3, C4, C5).**

Sensory supply

- **Central part: Phrenic nerve.**
- **Peripheral part: Lower intercostal nerves and subcostal nerve.**

Actions of diaphragm

Principal muscle of inspiration

- **During contraction, domes descend and thoracic cavity enlarges vertically.**
- **Increases intrathoracic volume.**

Increases intra-abdominal pressure

Helps in:

- **Defecation**
- **Micturition**
- **Parturition**
- **Vomiting**
- **Coughing**

d) Mention the openings in this structure and structures passing through them.

Major openings of diaphragm

Opening	Vertebral level	Structures passing through
Caval opening	T8	Inferior vena cava, terminal branch of right phrenic nerve
Esophageal opening	T10	Esophagus, anterior and posterior vagal trunks, esophageal branches of left gastric vessels
Aortic opening	T12	Descending aorta, thoracic duct, azygos vein

Minor openings

- **Greater, lesser and least splanchnic nerves**
- **Sympathetic trunks**
- **Superior epigastric vessels**
- **Musculophrenic vessels**
- **Subcostal nerves and vessels**

e) Describe the development of this structure.

Development of diaphragm

Diaphragm develops from four components:

1. **Septum transversum**

- **Forms central tendon.**

2. **Pleuroperitoneal membranes**

- **Form posterolateral parts.**

3. **Dorsal mesentery of esophagus**

- **Forms crura.**

4. **Muscular ingrowth from lateral body wall**

- **Forms peripheral muscular part.**

Developmental anomaly

- **Failure of fusion of pleuroperitoneal membrane causes congenital diaphragmatic hernia, commonly on left side.**

SHORT ESSAYS

1. List the sources of development of the thoracoabdominal diaphragm. Enumerate the structures passing through its major openings.

Sources of development of diaphragm

1. **Septum transversum**
2. **Pleuroperitoneal membranes**
3. **Dorsal mesentery of esophagus**
4. **Muscular ingrowth from lateral body wall**

Major openings and structures passing through

Caval opening (T8)

- **Inferior vena cava**

- **Terminal branch of right phrenic nerve**

Esophageal opening (T10)

- **Esophagus**
- **Anterior vagal trunk**
- **Posterior vagal trunk**
- **Esophageal branches of left gastric vessels**

Aortic opening (T12)

- **Descending aorta**
- **Thoracic duct**
- **Azygos vein**

2. Thoracic diaphragm

Definition

Thoracic diaphragm is a musculotendinous partition separating thoracic and abdominal cavities.

Parts

- **Central tendon**
- **Peripheral muscular part**

Attachments

Sternal part

- **Xiphoid process**

Costal part

- **Lower six ribs and costal cartilages**

Vertebral part

- **Right and left crura**
- **Arcuate ligaments**

Openings

- **Caval opening – T8**
- **Esophageal opening – T10**
- **Aortic opening – T12**

Nerve supply

- **Motor: Phrenic nerve**
- **Sensory: Phrenic and lower intercostal nerves**

Actions

- **Chief muscle of inspiration**
- **Increases intra-abdominal pressure**

Applied anatomy

- **Diaphragmatic hernia**
- **Phrenic nerve palsy**
- **Hiccough**

SHORT NOTES

1. Openings in the abdominal diaphragm

Major openings

Caval opening (T8)

Contents:

- **Inferior vena cava**
- **Right phrenic nerve**

Esophageal opening (T10)

Contents:

- **Esophagus**
- **Vagal trunks**
- **Esophageal vessels**

Aortic opening (T12)

Contents:

- **Aorta**
- **Thoracic duct**
- **Azygos vein**

Minor openings

- **Sympathetic trunk**
- **Splanchnic nerves**
- **Superior epigastric vessels**
- **Subcostal vessels and nerve**

2. Diaphragm

Definition

Musculotendinous partition between thorax and abdomen.

Attachments

- **Sternal**
- **Costal**
- **Vertebral**

Nerve supply

- **Phrenic nerve**

Actions

- **Principal muscle of inspiration**
- **Raises intra-abdominal pressure**

Applied anatomy

- **Congenital diaphragmatic hernia**
- **Eventration**

3. Major openings of diaphragm

Opening	Level	Contents
Caval opening	T8	Inferior vena cava, right phrenic nerve
Esophageal opening	T10	Esophagus, vagal trunks
Aortic opening	T12	Aorta, thoracic duct, azygos vein

WALL AND RESPIRATION

LONG ESSAYS

1. Describe Typical Intercostal Space under the following headings:-

(a) Muscles (b) Blood vessels
(c) Nerve (d) Applied importance

Typical intercostal space

It is the space between adjacent ribs and costal cartilages.

Boundaries

- **Above – Inferior border of rib above**
- **Below – Superior border of rib below**

Contents

- **Intercostal muscles**
- **Intercostal vessels**
- **Intercostal nerves**

(a) Muscles

External intercostal muscle

- **Fibres directed downward and forward.**
- **Extends from rib tubercle to costochondral junction.**
- **Replaced anteriorly by external intercostal membrane.**
- **Elevates ribs during inspiration.**

Internal intercostal muscle

- **Fibres directed downward and backward.**
- **Extends from sternum to angle of rib.**
- **Replaced posteriorly by internal intercostal membrane.**
- **Assists in expiration.**

Innermost intercostal muscle

- **Incomplete layer.**
- **Separated from internal intercostal by neurovascular bundle.**

(b) Blood vessels

Arteries

- **Posterior intercostal arteries**
- **Anterior intercostal arteries**

Veins

- **Posterior intercostal veins drain into azygos system.**
- **Anterior intercostal veins drain into internal thoracic vein.**

Arrangement in costal groove

From above downwards:

- **Vein**
- **Artery**
- **Nerve**

(VAN)

(c) Nerve

Typical intercostal nerve

- **Anterior primary ramus of thoracic spinal nerve T3–T6.**

Course

- **Runs in costal groove between internal and innermost intercostal muscles.**

Branches

- **Muscular branches**
- **Collateral branch**
- **Lateral cutaneous branch**
- **Anterior cutaneous branch**

Supply

- **Intercostal muscles**
- **Skin of thoracic wall**
- **Parietal pleura**

(d) Applied importance

- **Site for intercostal nerve block.**
- **Thoracocentesis performed in lower part of intercostal space to avoid neurovascular bundle.**
- **Rib fractures may injure intercostal vessels and nerves.**

SHORT ESSAYS

1. Describe the course, branches and applied anatomy of typical intercostal nerve

Typical intercostal nerve

It is the anterior primary ramus of thoracic spinal nerve T3–T6.

Course

- **Runs in intercostal space.**
- **Lies between internal and innermost intercostal muscles.**
- **Occupies costal groove.**
- **Ends as anterior cutaneous nerve.**

Branches

1. **Muscular branches**
2. **Collateral branch**
3. **Lateral cutaneous branch**
4. **Anterior cutaneous branch**
5. **Pleural branches**

Distribution

- **Intercostal muscles**
- **Skin of thoracic wall**
- **Costal pleura**

Applied anatomy

- **Intercostal neuralgia**
- **Herpes zoster infection**
- **Intercostal nerve block**

2. Intercostal vessels

Arteries

Posterior intercostal arteries

- **1st and 2nd from superior intercostal artery.**
- **Remaining from thoracic aorta.**

Anterior intercostal arteries

- **Upper six from internal thoracic artery.**
- **Lower spaces from musculophrenic artery.**

Veins

- **Drain into azygos system.**
- **Right side into azygos vein.**
- **Left side into hemiazygos and accessory hemiazygos veins.**

Arrangement in costal groove

- **Vein**
- **Artery**
- **Nerve**

Applied anatomy

- **Hemothorax due to injury.**
- **Important in thoracocentesis.**

3. Typical intercostal space- Boundaries, Extent, Contents, Applied anatomy

Boundaries

- **Above: Rib above**
- **Below: Rib below**

Extent

- **From vertebral column to sternum.**

Contents

1. **Intercostal muscles**
2. **Intercostal vessels**
3. **Intercostal nerves**
4. **Lymphatics**

Applied anatomy

- **Intercostal nerve block**
- **Thoracocentesis**
- **Rib fractures**

SHORT NOTES

1. Typical intercostal space

Definition

Space between adjacent ribs.

Contents

- **Muscles**

- **Vessels**
- **Nerves**

Neurovascular plane

Between internal and innermost intercostal muscles.

Applied anatomy

- **Thoracocentesis**

2. Briefly explain the intercostal muscles.

Layers

1. **External intercostal**
2. **Internal intercostal**
3. **Innermost intercostal**

Actions

- **External intercostals elevate ribs.**
- **Internal intercostals depress ribs.**
- **Help in respiration.**

Nerve supply

- **Intercostal nerves.**

3. Mechanics and types of respiration

Types of respiration

1. **Thoracic respiration**
2. **Abdominal respiration**

Mechanics

Pump handle movement

- **Increases anteroposterior diameter.**

Bucket handle movement

- **Increases transverse diameter.**

Descent of diaphragm

- **Increases vertical diameter.**

4. Typical thoracic spinal nerve

REFER DIAGRAM SECTION

Formation

Formed by union of dorsal and ventral roots.

Branches

- **Posterior primary ramus**
- **Anterior primary ramus**
- **Meningeal branch**
- **Rami communicantes**

Distribution

- **Muscles and skin of thoracic wall.**

5. Typical intercostal nerve

REFER DIAGRAM SECTION

Definition

Anterior primary ramus of thoracic spinal nerve.

Course

Runs in costal groove.

Branches

- **Collateral**
- **Lateral cutaneous**
- **Anterior cutaneous**

Supply

- **Muscles and skin of thoracic wall.**

6. Typical spinal nerve

REFER DIAGRAM SECTION

Formation

Union of anterior and posterior roots.

Branches

- **Posterior ramus**
- **Anterior ramus**
- **Meningeal branch**
- **Communicating branches**

Functional components

- **Somatic motor**
- **Somatic sensory**
- **Sympathetic fibres**

MEDIASTINUM

LONG ESSAYS

1. Describe mediastinum under the following headings

• Boundaries • Divisions
• Contents • Clinical implications.

Definition

Mediastinum is the interpleural space between two pleural cavities.

Boundaries

- **Superior: Thoracic inlet**
- **Inferior: Diaphragm**
- **Anterior: Sternum**
- **Posterior: Thoracic vertebrae**
- **Lateral: Mediastinal pleura**

Divisions

Plane passing from sternal angle to lower border of T4 vertebra divides mediastinum into:

1. **Superior mediastinum**
2. **Inferior mediastinum**

Inferior mediastinum subdivided into:

- **Anterior**
- **Middle**
- **Posterior mediastinum**

Contents

Superior mediastinum

- **Thymus**
- **Arch of aorta and branches**
- **Superior vena cava**
- **Trachea**
- **Esophagus**
- **Thoracic duct**
- **Vagus and phrenic nerves**

Middle mediastinum

- **Heart**
- **Pericardium**
- **Roots of great vessels**

Posterior mediastinum

- **Descending thoracic aorta**
- **Esophagus**
- **Thoracic duct**
- **Azygos vein**

Clinical implications

- **Mediastinal syndrome**
- **Compression of trachea causes dyspnoea.**

- **Compression of esophagus causes dysphagia.**
- **Compression of superior vena cava causes venous congestion.**

2. A 52 year old man presented with shortness of breath and coughing up small volumes of blood. Clinical examination revealed multiple dilated veins around the neck. A chest X- ray demonstrated a tumor mass involving the upper part of right lung and elevated right dome of diaphragm. Based on your anatomical knowledge answer the following questions.

Compression of which structure is responsible for dilated veins in the head and neck

Compression of superior vena cava causes dilated veins in head and neck.

Mention the extent and relations in the mediastinum

Extent of superior vena cava

- **Formed behind lower border of first right costal cartilage.**
- **Ends at upper border of third right costal cartilage by opening into right atrium.**

Relations

Anterior

- **Thymus**
- **Right pleura and lung**

Posterior

- **Trachea**
- **Right vagus nerve**

Right side

- **Right phrenic nerve**
- **Right lung and pleura**

Left side

- **Ascending aorta**

Briefly describe the other related structures to mediastinal surface of right lung

Structures related to mediastinal surface of right lung

- **Superior vena cava**
- **Inferior vena cava**
- **Arch of azygos vein**
- **Esophagus**
- **Trachea**
- **Right brachiocephalic vein**
- **Cardiac impression**

Injury to which structure is responsible for elevated diaphragm on the right side

Injury to right phrenic nerve causes paralysis and elevation of right dome of diaphragm.

Briefly describe the broncho-pulmonary segments and its applied importance

Bronchopulmonary segment

It is a pyramidal subdivision of lung supplied by a segmental bronchus.

Features

- **Functionally independent.**
- **Separated by connective tissue septa.**
- **Supplied by tertiary bronchus.**

Right lung

10 segments.

Left lung

8–10 segments.

Applied importance

- **Segmental resection possible.**
- **Tuberculosis may remain localized.**
- **Aspiration commonly affects lower lobe segments.**

SHORT ESSAYS

1. Arch of aorta

Extent

Begins and ends at level of sternal angle.

Course

Passes upward, backward and to left.

Branches

1. **Brachiocephalic trunk**
2. **Left common carotid artery**
3. **Left subclavian artery**

Relations

Anterior

- **Left vagus nerve**
- **Left phrenic nerve**

Posterior

- **Trachea**
- **Esophagus**

Applied anatomy

- **Aneurysm may compress recurrent laryngeal nerve.**

2. Superior vena cava

Formation

Formed by union of right and left brachiocephalic veins.

Extent

From first to third right costal cartilage.

Tributaries

- **Azygos vein**
- **Small mediastinal veins**

Relations

- **Right lung and pleura**
- **Ascending aorta**
- **Trachea**

Applied anatomy

- **Superior vena cava obstruction syndrome.**

SHORT NOTES

1. Arch of aorta

Branches

- **Brachiocephalic trunk**
- **Left common carotid**
- **Left subclavian**

Relations

- **Left vagus nerve**
- **Left recurrent laryngeal nerve**

Applied anatomy

- **Aneurysm.**

2. Superior mediastinum

Boundaries

- **Above: Thoracic inlet**
- **Below: Plane of sternal angle**

Contents

- **Thymus**
- **Great vessels**
- **Trachea**
- **Esophagus**
- **Thoracic duct**

3. Thoracic duct

Extent

From T12 to root of neck.

Course

Ascends through posterior mediastinum.

Termination

At junction of left internal jugular and subclavian veins.

Applied anatomy

- **Chylothorax.**

4. Superior vena cava

Formation

Union of brachiocephalic veins.

Tributary

Azygos vein.

Applied anatomy

Superior vena cava syndrome.

HEART

LONG ESSAYS

1. A 60 year old man who is a smoker, alcoholic and known hypertensive suddenly developed pain in the left side of chest radiating along the medial border of left arm. ECG showed myocardial ischaemia.Coronary angiogram was advised for further evaluation. Based on your knowledge of anatomy answer the following

a) Describe the origin, course, branches and distribution of coronary arteries

Right coronary artery

Origin

Arises from anterior aortic sinus.

Course

Runs in coronary sulcus between right atrium and right ventricle.

Branches

- **SA nodal artery**
- **Right marginal artery**
- **AV nodal artery**
- **Posterior interventricular artery**

Distribution

- **Right atrium**
- **Most of right ventricle**
- **Part of left ventricle**

- **SA node and AV node**

Left coronary artery

Origin

Arises from left posterior aortic sinus.

Course

Passes between pulmonary trunk and left auricle.

Branches

1. **Anterior interventricular artery (LAD)**
2. **Circumflex artery**

Distribution

- **Left atrium**
- **Most of left ventricle**
- **Part of right ventricle**
- **Interventricular septum**

b) Add a note on coronary dominance

Coronary dominance

Defined by artery giving posterior interventricular branch.

Right dominance

- **Posterior interventricular artery from right coronary artery.**
- **Seen in majority.**

Left dominance

- **Posterior interventricular artery from circumflex branch.**

Balanced circulation

- **Contribution from both arteries.**

c) Explain the nerve supply of heart

Cardiac plexus

Formed by sympathetic and parasympathetic fibres.

Sympathetic supply

- **From T1–T5 segments.**
- **Increases heart rate and force.**

Parasympathetic supply

- **Vagus nerve.**
- **Decreases heart rate.**

Sensory fibres

- **Pain fibres travel with sympathetic nerves.**

2. Describe the Heart under the following headings:-

a) External features - Surfaces, borders and grooves and sulcus with their contents
b) Describe the blood supply of the heart
c) Add a note on the coronary dominance
d) Applied anatomy

External features of heart

Surfaces

1. **Sternocostal surface**
2. **Diaphragmatic surface**
3. **Right pulmonary surface**
4. **Left pulmonary surface**

Borders

- **Right border – right atrium**

- **Inferior border – right ventricle**
- **Left border – left ventricle and auricle**
- **Superior border – atria and great vessels**

Grooves and sulci

Coronary sulcus

Contains:

- **Coronary arteries**
- **Coronary sinus**

Anterior interventricular groove

Contains:

- **LAD artery**
- **Great cardiac vein**

Posterior interventricular groove

Contains:

- **Posterior interventricular artery**
- **Middle cardiac vein**

Blood supply of heart

Arterial supply

- **Right coronary artery**
- **Left coronary artery**

Venous drainage

- **Coronary sinus**
- **Great cardiac vein**
- **Middle cardiac vein**
- **Small cardiac vein**

Coronary dominance

- **Right dominance common.**
- **Determined by posterior interventricular artery.**

Applied anatomy

- **Coronary artery disease**
- **Myocardial infarction**
- **Angina pectoris**
- **Coronary bypass surgery**

3. A 55-year-old male brought to the emergency department with complaints of severe squeezing chest pain, breathing difficulty, sweating and pain along the inner aspect of left upper limb. After taking an electrocardiogram a provisional diagnosis of acute myocardial infarction was made. Apply your knowledge in anatomy and answer the following questions related to coronary artery.

Describe the origin, course, relations and branches of left coronary artery.

Left coronary artery

Origin

Arises from left posterior aortic sinus.

Course

Passes between pulmonary trunk and left auricle.

Relations

- **Pulmonary trunk**
- **Left auricle**

Branches

1. **Anterior interventricular artery**
2. **Circumflex artery**
3. **Diagonal branches**

Describe the arterial supply of conducting system of heart.

SA node

- **Usually supplied by right coronary artery.**

AV node

- **Usually supplied by right coronary artery.**

AV bundle and bundle branches

- **Supplied mainly by anterior interventricular branch of left coronary artery.**

Describe the venous drainage of heart.

Coronary sinus

Main venous channel opening into right atrium.

Tributaries

- **Great cardiac vein**
- **Middle cardiac vein**
- **Small cardiac vein**
- **Posterior vein of left ventricle**
- **Oblique vein of left atrium**

Anterior cardiac veins

Drain directly into right atrium.

Name two arteries supplying the heart most commonly involved in ischemic heart disease.

1. **Anterior interventricular artery (LAD)**
2. **Right coronary artery**

4. A 50 year old man was brought to medical casualty with complaints of sudden onset of pain in chest with sweating and increased pulse rate. The chest pain was radiating to inner border of left upper limb. ECG showed evidences of ischemic heart disease. Answer the following.

Mention the origin, course and distribution of the arteries possibly affected in the patient.

Right coronary artery

Origin

Anterior aortic sinus.

Course

Runs in coronary sulcus.

Distribution

Right atrium, right ventricle, SA node, AV node.

Left coronary artery

Origin

Left posterior aortic sinus.

Course

Between pulmonary trunk and left auricle.

Distribution

Most of left ventricle and interventricular septum.

Name the veins accompanying the various branches

Artery	Vein
Anterior interventricular artery	Great cardiac vein
Posterior interventricular artery	Middle cardiac vein
Right marginal artery	Small cardiac vein

Why the pain is radiating to the inner border of the left upper limb?

Cardiac pain fibres enter spinal cord through T1–T4 segments. These segments also supply medial side of upper limb through intercostobrachial nerve, causing referred pain.

Add a note on surgical intervention possible

Coronary artery bypass grafting (CABG)

- **Great saphenous vein or internal thoracic artery used.**
- **Bypasses blocked coronary artery.**

Angioplasty

- **Balloon dilatation and stent placement.**

CORONARY ARTERY

SHORT ESSAYS

1. Describe the features of the interior of the right atrium. Add a note on its development

Interior of right atrium

Smooth posterior part

- **Sinus venarum.**

Rough anterior part

- **Pectinate muscles.**

Crista terminalis

Separates smooth and rough parts.

Openings

- **Superior vena cava**
- **Inferior vena cava**
- **Coronary sinus**
- **Right atrioventricular orifice**

Interatrial septum

Contains fossa ovalis.

Development

- **Smooth part from sinus venosus.**
- **Rough part from primitive atrium.**

2. Describe the arterial supply of heart. Add a note on Coronary Artery Bypass Grafting.

Arterial supply

Right coronary artery

Supplies:

- **Right atrium**
- **Right ventricle**
- **SA and AV nodes**

Left coronary artery

Supplies:

- **Left atrium**
- **Left ventricle**
- **Interventricular septum**

Coronary artery bypass grafting

- **Surgical procedure to bypass blocked coronary artery.**
- **Internal thoracic artery or great saphenous vein used.**
- **Improves myocardial blood supply.**

3. Arterial supply of heart

Arteries

1. **Right coronary artery**
2. **Left coronary artery**

Areas supplied

- **Right heart mainly by RCA.**
- **Left heart mainly by LCA.**

Applied anatomy

- **Coronary artery disease.**

4. Coronary arteries

Right coronary artery

- **Origin: Anterior aortic sinus.**
- **Branches: Marginal, posterior interventricular.**

Left coronary artery

- **Origin: Left posterior aortic sinus.**
- **Branches: LAD and circumflex.**

Applied anatomy

- **Atherosclerosis.**
- **Myocardial infarction.**

5. Right atrium

Features

- **Receives superior vena cava, inferior vena cava and coronary sinus.**
- **Contains pectinate muscles.**
- **Fossa ovalis on septum.**

Openings

- **SVC**
- **IVC**
- **Coronary sinus**
- **Tricuspid orifice**

6. Interior of right atrium

Parts

- **Smooth sinus venarum.**
- **Rough pectinate part.**

Septal features

- **Fossa ovalis.**
- **Limbus fossae ovalis.**

7. Right atrium and its development

Development

- **Sinus venosus forms smooth part.**
- **Primitive atrium forms rough part.**

Features

- **Crista terminalis**
- **Pectinate muscles**
- **Fossa ovalis**

8. Blood supply of heart

Arterial supply

- **Right and left coronary arteries.**

Venous drainage

- **Coronary sinus.**
- **Cardiac veins.**

Applied anatomy

- **Ischemic heart disease.**

9. Pericardium

Definition

Fibroserous sac enclosing heart.

Layers

1. **Fibrous pericardium**
2. **Serous pericardium**
    - **Parietal layer**
    - **Visceral layer**

Sinuses

- **Transverse sinus**
- **Oblique sinus**

Blood supply

- **Pericardiacophrenic artery.**

Nerve supply

- **Phrenic nerve.**

Applied anatomy

- **Pericarditis**
- **Cardiac tamponade**

SHORT NOTES

1. Describe the anatomical basis of ischemic heart disease.

Definition:
Ischemic heart disease occurs due to inadequate blood supply to the myocardium because of reduced coronary circulation.

Anatomical basis

1. **Coronary arteries are functional end arteries with poor anastomosis.**
2. **Atherosclerosis commonly affects:**
    - **Anterior interventricular artery**
    - **Right coronary artery**
    - **Circumflex artery**
3. **Narrowing or thrombosis reduces myocardial blood supply.**
4. **Myocardium supplied by blocked artery undergoes ischemia and infarction.**
5. **Left ventricle is most commonly affected due to high oxygen demand.**
6. **Sudden occlusion causes myocardial infarction.**
7. **Gradual occlusion may produce collateral circulation.**

Common sites of coronary occlusion

- **Anterior interventricular artery – 40–50%**
- **Right coronary artery – 30–40%**
- **Circumflex artery – 15–20%**

Clinical features

- **Angina pectoris**
- **Myocardial infarction**
- **Arrhythmias**
- **Cardiac failure**

Applied anatomy

- **Coronary angiography identifies blockage.**

- **Coronary artery bypass grafting and angioplasty are treatment methods.**

2. Draw a neat labelled diagram of the anterior view of arteries supplying the heart.

REFER DIAGRAM SECTION

Labels to be included:

- **Ascending aorta**
- **Right coronary artery**
- **Marginal artery**
- **Posterior interventricular artery**
- **Left coronary artery**
- **Anterior interventricular artery**
- **Circumflex artery**
- **Great cardiac vein**

3. Pericardium

Definition

Pericardium is a fibroserous sac enclosing the heart and roots of great vessels.

Parts

1. **Fibrous pericardium**
2. **Serous pericardium**
    - **Parietal layer**
    - **Visceral layer (epicardium)**

Fibrous pericardium

- **Cone-shaped fibrous sac.**
- **Base fused with central tendon of diaphragm.**
- **Apex continuous with adventitia of great vessels.**

Serous pericardium

- **Parietal layer lines fibrous pericardium.**
- **Visceral layer covers heart.**
- **Pericardial cavity contains fluid.**

Blood supply

- **Pericardiophrenic artery**
- **Musculophrenic artery**
- **Esophageal and bronchial branches**

Nerve supply

- **Fibrous and parietal pericardium: phrenic nerve**
- **Visceral layer: sympathetic and vagal fibers**

Functions

- **Protects heart**
- **Prevents overdistension**
- **Reduces friction**
- **Fixes heart in mediastinum**

Applied anatomy

- **Pericarditis**
- **Pericardial effusion**
- **Cardiac tamponade**
- **Pericardiocentesis**

4. Describe the venous drainage of the heart.

Venous drainage

The venous drainage of heart occurs through:

1. **Coronary sinus**
2. **Anterior cardiac veins**
3. **Venae cordis minimae**

Coronary sinus

- **Main venous channel.**
- **Lies in posterior atrioventricular groove.**
- **Opens into right atrium.**

Tributaries

- **Great cardiac vein**
- **Middle cardiac vein**
- **Small cardiac vein**
- **Posterior vein of left ventricle**
- **Oblique vein of left atrium**

Anterior cardiac veins

- **Drain right ventricle directly into right atrium.**

Venae cordis minimae

- **Small veins opening directly into chambers.**

Applied anatomy

- **Coronary sinus used in cardiac catheterization.**

5. Name tributaries of coronary sinus.

Tributaries

1. **Great cardiac vein**
2. **Middle cardiac vein**
3. **Small cardiac vein**
4. **Posterior vein of left ventricle**
5. **Oblique vein of left atrium**

6. Sinuses of pericardium

Types

1. **Transverse sinus**
2. **Oblique sinus**

Transverse sinus

- **Passage between arterial and venous ends of heart.**
- **Anterior: ascending aorta and pulmonary trunk**
- **Posterior: superior vena cava and left atrium**

Oblique sinus

- **Blind recess behind left atrium.**
- **Bounded by pulmonary veins and inferior vena cava.**

Applied anatomy

- **Surgeons pass finger through transverse sinus during cardiac surgery.**

7. Coronary sinus

Definition

Coronary sinus is the main venous channel of the heart situated in posterior atrioventricular groove.

Extent

- **Begins at union of great cardiac vein and oblique vein of left atrium.**
- **Ends in right atrium.**

Tributaries

- **Great cardiac vein**
- **Middle cardiac vein**
- **Small cardiac vein**
- **Posterior vein of left ventricle**
- **Oblique vein of left atrium**

Features

- **About 3 cm long.**
- **Guarded by Thebesian valve.**

Applied anatomy

- **Used in cardiac pacing procedures.**

8. Left coronary artery

Origin

Arises from left posterior aortic sinus.

Course

Passes between pulmonary trunk and left auricle.

Branches

1. **Anterior interventricular artery**
2. **Circumflex artery**
3. **Diagonal branches**
4. **Marginal branches**

Areas supplied

- **Left atrium**
- **Most of left ventricle**
- **Part of right ventricle**
- **Interventricular septum**

Applied anatomy

- **Commonest artery affected in coronary artery disease.**

DRAW AND LABEL

10. Sterno-costal surface of heart

REFER DIAGRAM SECTION

Labels:

- **Right atrium**
- **Right ventricle**
- **Left ventricle**
- **Left auricle**
- **Superior vena cava**
- **Inferior vena cava**
- **Pulmonary trunk**
- **Ascending aorta**
- **Anterior interventricular groove**

11. Pericardial sinuses

REFER DIAGRAM SECTION

Labels:

- **Transverse sinus**
- **Oblique sinus**
- **Ascending aorta**
- **Pulmonary trunk**
- **Superior vena cava**
- **Left atrium**
- **Pulmonary veins**

12. Borders, surfaces and valves of heart

REFER DIAGRAM SECTION

Borders

- **Right border**
- **Inferior border**
- **Left border**
- **Superior border**

Surfaces

- **Sternocostal surface**
- **Diaphragmatic surface**
- **Base**
- **Right pulmonary surface**
- **Left pulmonary surface**

Valves

- **Tricuspid valve**
- **Pulmonary valve**
- **Mitral valve**
- **Aortic valve**

LUNGS

LONG ESSAYS

1. A 66-year-old man with a smoking history of one pack per day for the past 47 years presents with history of progressive shortness of breath and chronic cough, and production of yellowish sputum for 2 years. On examination, he has moderate respiratory distress, pursed lip breathing. He has a barrel chest and his neck veins are dilated. Lung examination reveals poor air entry bilaterally with moderate inspiratory and expiratory wheeze. Heart and abdominal examination are within normal limits. A chest X-ray was taken and a provisional diagnosis of Chronic Obstructive Pulmonary Disease was made.

a) Explain the relations of apex of lungs

Apex of lung

- **Projects into root of neck about 2.5 cm above medial one-third of clavicle.**
- **Covered by cervical pleura and suprapleural membrane.**

Relations

Anterior

- **Subclavian vein**

Posterior

- **Neck of first rib**
- **First thoracic vertebra**

Medial

- **Trachea**
- **Esophagus**
- **Thoracic duct (left)**
- **Sympathetic trunk**

Lateral

- **Scalenus medius**

Superior

- **Subclavian artery**
- **Lower trunk of brachial plexus**

Applied anatomy

- **Pancoast tumor may involve brachial plexus.**
- **Cervical pleura may be injured during root of neck procedures.**

b) Enumerate the divisions and cells of Tracheo Bronchial tree

Divisions of tracheobronchial tree

1. **Trachea**
2. **Main bronchi**
3. **Lobar bronchi**
4. **Segmental bronchi**
5. **Bronchioles**
6. **Terminal bronchioles**
7. **Respiratory bronchioles**
8. **Alveolar ducts**
9. **Alveolar sacs**
10. **Alveoli**

Cells

1. **Ciliated columnar cells**
2. **Goblet cells**
3. **Basal cells**
4. **Brush cells**
5. **Neuroendocrine cells**
6. **Clara (club) cells**
7. **Type I pneumocytes**
8. **Type II pneumocytes**

9. **Alveolar macrophages**

c) Describe bronchopulmonary segment

Definition

A bronchopulmonary segment is a wedge-shaped subdivision of lung supplied by a segmental bronchus and a branch of pulmonary artery.

Features

1. **Functionally independent.**
2. **Separated by connective tissue septa.**
3. **Veins are intersegmental.**
4. **Pyramid shaped.**
5. **Apex toward hilum and base toward surface.**

Segments of right lung

- **Upper lobe: apical, posterior, anterior**
- **Middle lobe: lateral, medial**
- **Lower lobe: superior, medial basal, anterior basal, lateral basal, posterior basal**

Segments of left lung

- **Upper lobe: apicoposterior, anterior**
- **Lingula: superior lingular, inferior lingular**
- **Lower lobe: superior, anteromedial basal, lateral basal, posterior basal**

Surgical importance

- **Segmentectomy possible because segments are independent.**

d) Briefly describe the histology of lung

Histology

1. **Bronchi lined by pseudostratified ciliated columnar epithelium.**
2. **Cartilage plates present in bronchi.**
3. **Bronchioles lack cartilage and glands.**
4. **Terminal bronchioles lined by cuboidal epithelium.**
5. **Alveoli lined by:**
    - **Type I pneumocytes**
    - **Type II pneumocytes**
6. **Interalveolar septum contains capillaries and elastic fibers.**
7. **Alveolar macrophages present.**

Functions

- **Gas exchange**
- **Surfactant production**

2. A patient was brought with a history of difficulty in breathing and breathlessness to a clinic. On auscultation creps were noted on both sides of the chest.

•Name the organs involved.

•Write on external features of the organ and its coverings

•Write on the differences between right and left side of the organ

•Write a note on bronchial tree and bronchopulmonary segments

Organs involved

- **Right lung**
- **Left lung**

External features of lungs

Apex

- **Projects into neck.**

Base

- **Concave diaphragmatic surface.**

Surfaces

1. **Costal surface**
2. **Mediastinal surface**
3. **Diaphragmatic surface**

Borders

1. **Anterior**
2. **Posterior**
3. **Inferior**

Fissures

- **Right lung: oblique and horizontal fissures**
- **Left lung: oblique fissure**

Coverings

Pleura

1. **Visceral pleura**
2. **Parietal pleura**

Parts of parietal pleura

- **Costal**
- **Diaphragmatic**
- **Mediastinal**
- **Cervical**

Differences between right and left lungs

Right lung	Left lung
Larger and heavier	Smaller and lighter
3 lobes	2 lobes
Horizontal and oblique fissures	Only oblique fissure
No cardiac notch	Cardiac notch present
10 segments	8–10 segments
Shorter and wider	Longer and narrower

Bronchial tree

- **Trachea divides into right and left main bronchi.**
- **Main bronchi divide into lobar bronchi.**
- **Lobar bronchi divide into segmental bronchi.**
- **Further divisions form bronchioles and alveoli.**

Bronchopulmonary segments

Definition

Functionally independent lung units supplied by segmental bronchi.

Features

- **Wedge shaped**
- **Separated by connective tissue**
- **Surgically resectable**

SHORT ESSAYS

1. Explain the subdivisions, innervation and recesses of pleura

Pleura

Pleura is a serous membrane covering lungs and thoracic cavity.

Subdivisions

Visceral pleura

- **Covers lungs.**

Parietal pleura

1. **Costal pleura**
2. **Mediastinal pleura**
3. **Diaphragmatic pleura**
4. **Cervical pleura**

Innervation

Visceral pleura

- **Autonomic nerves**
- **Insensitive to pain**

Parietal pleura

- **Intercostal nerves**
- **Phrenic nerve**
- **Pain sensitive**

Pleural recesses

1. **Costodiaphragmatic recess**
2. **Costomediastinal recess**

Applied anatomy

- **Pleural effusion**
- **Thoracocentesis**

2. Pleura and pleural recesses

Pleura

Serous membrane consisting of visceral and parietal layers.

Pleural cavity

Potential space containing pleural fluid.

Pleural recesses

1. **Costodiaphragmatic recess**
    - **Between costal and diaphragmatic pleura.**
    - **Largest recess.**
2. **Costomediastinal recess**
    - **Between costal and mediastinal pleura.**
    - **More prominent on left side.**

Functions

- **Allows free movement of lungs.**

Applied anatomy

- **Fluid accumulates in costodiaphragmatic recess.**

3. Describe the recesses of pleura and their clinical significance.

Recesses

1. **Costodiaphragmatic recess**
2. **Costomediastinal recess**

Costodiaphragmatic recess

- **Between diaphragm and thoracic wall.**
- **Deepest part of pleural cavity.**

Costomediastinal recess

- **Near sternum.**
- **Larger on left side because of cardiac notch.**

Clinical significance

- **Pleural fluid accumulates in recesses.**
- **Thoracocentesis done in costodiaphragmatic recess.**
- **Pneumothorax affects pleural cavity.**

4. Briefly describe bronchopulmonary segment. Name the broncho-pulmonary segments in each lung. Write about their surgical importance.

Definition

Bronchopulmonary segment is a functionally independent part of lung supplied by a segmental bronchus.

Features

- **Pyramid shaped**
- **Separated by septa**
- **Veins intersegmental**

Right lung segments

1. **Apical**
2. **Posterior**
3. **Anterior**
4. **Lateral**
5. **Medial**
6. **Superior**
7. **Medial basal**
8. **Anterior basal**
9. **Lateral basal**
10. **Posterior basal**

Left lung segments

1. **Apicoposterior**
2. **Anterior**
3. **Superior lingular**
4. **Inferior lingular**
5. **Superior**
6. **Anteromedial basal**
7. **Lateral basal**
8. **Posterior basal**

Surgical importance

- **Segmentectomy possible.**
- **Disease may remain localized to one segment.**

5. Bronchopulmonary segments

Definition

Anatomically and functionally independent subdivisions of lung.

Features

- **Supplied by segmental bronchus.**
- **Supplied by pulmonary artery branch.**
- **Drained by intersegmental veins.**

Importance

- **Surgical resection possible.**

6. Broncho pulmonary segments of left lung

Segments

1. **Apicoposterior**
2. **Anterior**
3. **Superior lingular**
4. **Inferior lingular**
5. **Superior**
6. **Anteromedial basal**
7. **Lateral basal**
8. **Posterior basal**

Features

- **Supplied by segmental bronchi.**
- **Surgically independent.**

7. Medial surface of left lung

Features

- **Concave mediastinal surface.**
- **Large cardiac impression.**
- **Hilum present.**

Impressions

- **Arch of aorta**
- **Descending thoracic aorta**
- **Left subclavian artery**
- **Esophagus**
- **Cardiac impression**

Hilum contents

- **Pulmonary artery**
- **Bronchi**
- **Pulmonary veins**
- **Bronchial vessels**
- **Lymphatics**

8. Pleura- parts, innervations and applied aspects

Parts

1. **Visceral pleura**
2. **Parietal pleura**
    - **Costal**
    - **Diaphragmatic**
    - **Mediastinal**
    - **Cervical**

Innervation

- **Visceral: autonomic fibers**
- **Parietal: intercostal and phrenic nerves**

Applied aspects

- **Pleurisy**
- **Pleural effusion**
- **Pneumothorax**
- **Thoracocentesis**

9. Pleural recesses

Types

1. **Costodiaphragmatic recess**
2. **Costomediastinal recess**

Importance

- **Sites of fluid collection.**
- **Important for pleural tapping.**

10. Mediastinal surface of right lung

Features

- **Concave surface facing mediastinum.**
- **Hilum present centrally.**

Impressions

- **Superior vena cava**
- **Inferior vena cava**
- **Arch of azygos vein**
- **Esophagus**
- **Right atrium**

Hilum contents

- **Bronchus**
- **Pulmonary artery**
- **Pulmonary veins**

SHORT NOTES

1. Parietal pleura

Definition

Outer layer of pleura lining thoracic cavity.

Parts

1. **Costal**
2. **Mediastinal**
3. **Diaphragmatic**
4. **Cervical**

Blood supply

- **Intercostal arteries**

- **Pericardiophrenic artery**

Nerve supply

- **Intercostal nerves**
- **Phrenic nerve**

Applied anatomy

- **Pain sensitive.**

2. Pleura

Definition

Serous membrane enclosing lungs.

Layers

- **Visceral pleura**
- **Parietal pleura**

Functions

- **Reduces friction.**
- **Maintains negative pressure.**

Applied anatomy

- **Pleurisy**
- **Pleural effusion**

3. Left lung

Features

- **Smaller and narrower.**
- **Two lobes.**
- **Oblique fissure.**
- **Cardiac notch and lingula present.**

Surfaces

- **Costal**
- **Mediastinal**
- **Diaphragmatic**

Hilum contents

- **Bronchus**
- **Pulmonary artery**
- **Pulmonary veins**

DRAW AND LABEL

4. Mediastinal surface of right lung

REFER DIAGRAM SECTION

Labels:

- **Apex**
- **Base**
- **Hilum**
- **Superior vena cava impression**
- **Arch of azygos vein**
- **Esophageal groove**
- **Cardiac impression**
- **Oblique fissure**
- **Horizontal fissure**

5. Mediastinal surface of left lung

Labels:

- **Apex**
- **Base**
- **Cardiac notch**
- **Hilum**
- **Aortic arch impression**
- **Descending aorta groove**
- **Cardiac impression**
- **Oblique fissure**
- **Lingula**

6. Medial surface of right lung

Labels:

- **Hilum**
- **Superior vena cava groove**
- **Arch of azygos vein**
- **Cardiac impression**

- **Esophageal groove**
- **Oblique fissure**
- **Horizontal fissure**

POSTERIOR MEDIASTINUM

SHORT ESSAYS

1. What are the boundaries and Contents of Posterior Mediastinum

Boundaries

Anterior

- **Pericardium and diaphragm**

Posterior

- **T5–T12 vertebrae**

Superior

- **Transverse thoracic plane**

Inferior

- **Diaphragm**

Lateral

- **Mediastinal pleura**

Contents

1. **Descending thoracic aorta**
2. **Esophagus**
3. **Thoracic duct**
4. **Azygos vein**
5. **Hemiazygos vein**
6. **Sympathetic trunks**
7. **Splanchnic nerves**
8. **Lymph nodes**

2. Azygos vein

Formation

Union of right ascending lumbar vein and right subcostal vein.

Course

Ascends through posterior mediastinum and arches over root of right lung.

Termination

Opens into superior vena cava.

Tributaries

- **Right posterior intercostal veins**
- **Hemiazygos vein**
- **Accessory hemiazygos vein**
- **Esophageal veins**
- **Bronchial veins**

Importance

Provides collateral circulation.

3. Thoracic part of oesophagus

Extent

From T4 to T10 vertebral levels.

Relations

Anterior

- **Trachea**
- **Left bronchus**
- **Pericardium**

Posterior

- **Vertebral column**
- **Thoracic duct**
- **Azygos vein**

Right

- **Azygos vein**

Left

- **Aortic arch**
- **Descending thoracic aorta**

Blood supply

- **Esophageal branches of aorta.**

Applied anatomy

- **Esophageal varices.**

4. Cervical and Thoracic part of oesophagus

Cervical part

Extent

From C6 to thoracic inlet.

Relations

- **Trachea anteriorly**
- **Vertebral column posteriorly**
- **Recurrent laryngeal nerves laterally**

5. Esophagus – vertebral extent, constrictions, relations in thoracic cavity and applied aspects

Vertebral extent

- **C6 to T11.**

Constrictions

1. **At commencement – 15 cm**
2. **Crossed by aortic arch – 22.5 cm**
3. **Crossed by left bronchus – 27.5 cm**
4. **At diaphragm – 40 cm**

Applied aspects

- **Foreign body impaction**
- **Varices**
- **Carcinoma**
- **Achalasia cardia**

ABDOMEN AND PELVIS

ANTERIOR ABDOMINAL WALL AND INGUINAL CANAL

LONG ESSAYS

1. A 65-year-old man with chronic history of cough and constipation complained he noticed a gradually increasing swelling in the right groin and feels a dragging sensation at that site. On examination, it was noticed a globular swelling above the pubic tubercle which increased in size on coughing. The patient was diagnosed to have Inguinal hernia.

a) Based on the anatomical knowledge, what are the reasons for swellings in the groin region

Causes of groin swelling

1. **Inguinal hernia**
2. **Femoral hernia**
3. **Enlarged inguinal lymph nodes**
4. **Saphena varix**
5. **Undescended testis**
6. **Lipoma of spermatic cord**
7. **Femoral artery aneurysm**

b) What are the boundaries of Inguinal canal

Inguinal canal

An oblique intermuscular passage in lower anterior abdominal wall.

Extent

- **Deep inguinal ring to superficial inguinal ring.**

Boundaries

Anterior wall

- **External oblique aponeurosis**
- **Internal oblique laterally**

Posterior wall

- **Transversalis fascia**
- **Conjoint tendon medially**

Roof

- **Arching fibers of internal oblique and transversus abdominis**

Floor

- **Inguinal ligament**
- **Lacunar ligament medially**

c) What are the contents of Inguinal canal

Contents

Male

1. **Spermatic cord**
2. **Ilioinguinal nerve**

Female

1. **Round ligament of uterus**
2. **Ilioinguinal nerve**

d) What are factors which maintain the Integrity of Inguinal canal

Factors maintaining integrity

1. **Obliquity of canal**
2. **Shutter mechanism**
3. **Slit valve mechanism**
4. **Ball valve mechanism**
5. **Flap valve mechanism**
6. **Conjoint tendon strength**

e) What is Hesselbach's triangle

Hesselbach's triangle

Boundaries

- **Medial: lateral border of rectus abdominis**
- **Lateral: inferior epigastric vessels**
- **Inferior: inguinal ligament**

Importance

- **Site of direct inguinal hernia.**

2. Describe the inguinal canal under the following headings:

•Boundaries and contents.

•Anatomical protective mechanisms for prevention of inguinal hernia.

•Anatomical basis of two types of inguinal hernia.

•What are the coverings of inguinal hernia.

Contents

Male

- **Spermatic cord**
- **Ilioinguinal nerve**

Female

- **Round ligament of uterus**
- **Ilioinguinal nerve**

Protective mechanisms

1. **Oblique canal**
2. **Shutter mechanism**
3. **Slit valve mechanism**
4. **Ball valve mechanism**
5. **Flap valve mechanism**

Types of inguinal hernia

Indirect inguinal hernia

- **Passes through deep ring.**
- **Lateral to inferior epigastric vessels.**
- **May descend into scrotum.**
- **Congenital/common in young.**

Direct inguinal hernia

- **Through posterior wall of canal.**
- **Medial to inferior epigastric vessels.**
- **Through Hesselbach's triangle.**
- **Usually acquired in old age.**

Coverings of inguinal hernia

1. **Skin**
2. **Superficial fascia**
3. **External spermatic fascia**
4. **Cremasteric fascia**
5. **Internal spermatic fascia**
6. **Extraperitoneal tissue**
7. **Peritoneal sac**

3. A 70-year-old man presented with a swelling in the inguinal region on both the sides. He had cough since two months. The swelling reduces on rest and bulges on coughing.

•Which is the canal through which swelling is appearing.

•Write about boundaries of the canal and contents of the canal

•What are the factors which presents the swelling in the normal individuals

•Write on Hesselbach's triangle

Canal involved

- **Inguinal canal.**

Preventive factors

1. **Obliquity of canal**
2. **Shutter mechanism**
3. **Slit valve mechanism**
4. **Ball valve mechanism**
5. **Flap valve mechanism**

SHORT ESSAYS

1. Describe the muscles, nerves and vessels of anterior abdominal wall.

Muscles

Flat muscles

1. **External oblique**
2. **Internal oblique**
3. **Transversus abdominis**

Vertical muscles

1. **Rectus abdominis**
2. **Pyramidalis**

Nerves

- **Lower six thoracic nerves**
- **Subcostal nerve**
- **Iliohypogastric nerve**

- **Ilioinguinal nerve**

Arteries

- **Superior epigastric**
- **Inferior epigastric**
- **Musculophrenic**
- **Deep circumflex iliac**

Veins

Corresponding veins drain into systemic veins.

2. Explain the formation & contents of rectus sheath

Rectus sheath

Fibrous sheath enclosing rectus abdominis.

Formation above costal margin

- **Only anterior wall by external oblique aponeurosis.**

Between costal margin and arcuate line

Anterior wall

- **External oblique**
- **Anterior lamina of internal oblique**

Posterior wall

- **Posterior lamina of internal oblique**
- **Transversus abdominis aponeurosis**

Below arcuate line

- **All aponeuroses pass anteriorly.**
- **Posterior wall absent.**

Contents

1. **Rectus abdominis**
2. **Pyramidalis**
3. **Superior and inferior epigastric vessels**
4. **Terminal parts of thoracoabdominal nerves**

Applied anatomy

- **Rectus sheath hematoma**
- **Incisions through linea alba**

3. Inguinal canal - extent, boundaries, contents and applied anatomy

Extent

- **Deep to superficial inguinal ring.**

Applied anatomy

- **Inguinal hernia.**
- **Hydrocele of cord.**

SHORT NOTES

1. Rectus abdominis muscle

Origin

- **Pubic crest and pubic symphysis.**

Insertion

- **Xiphoid process and 5th–7th costal cartilages.**

Nerve supply

- **Lower six thoracic nerves.**

Actions

- **Flexes trunk.**

- **Compresses abdominal viscera.**

Applied anatomy

- **Divarication of recti.**

2. What is the anatomical basis of umbilical hernia

Anatomical basis

- **Weakness at umbilical ring.**
- **Increased intra-abdominal pressure.**
- **Common in infants and obese adults.**

Types

- **Congenital**
- **Acquired**

Applied anatomy

- **Herniation of abdominal contents through umbilicus.**

3. Anatomical basis of inguinal hernia

Causes

- **Weakness of abdominal wall.**
- **Patent processus vaginalis.**
- **Raised intra-abdominal pressure.**

Types

1. **Indirect inguinal hernia**
2. **Direct inguinal hernia**

Applied anatomy

- **Common in males.**

4. Extent and contents of spermatic cord.

Extent

From deep inguinal ring to testis.

Contents

1. **Ductus deferens**
2. **Testicular artery**
3. **Pampiniform plexus**
4. **Cremasteric artery**
5. **Artery to vas deferens**
6. **Genital branch of genitofemoral nerve**
7. **Lymphatics**
8. **Remnant of processus vaginalis**

5. Rectus sheath

Definition

Fibrous sheath enclosing rectus abdominis.

Contents

- **Rectus abdominis**
- **Pyramidalis**
- **Epigastric vessels**

PERITONEUM

SHORT ESSAYS

1. Lesser sac

Definition

Lesser sac (omental bursa) is a part of peritoneal cavity situated behind stomach and lesser omentum.

Boundaries

Anterior

- **Stomach**

- **Lesser omentum**

Posterior

- **Pancreas**
- **Left kidney**
- **Left suprarenal gland**

Superior

- **Caudate lobe of liver**

Inferior

- **Greater omentum**

Left

- **Spleen and gastrosplenic ligament**

Right

- **Epiploic foramen**

Communications

Communicates with greater sac through epiploic foramen.

Applied anatomy

- **Internal herniation.**
- **Collection of fluid.**

SHORT NOTES

1. Mention the boundaries of epiploic foramen and its clinical anatomy

Boundaries

Anterior

- **Free margin of lesser omentum containing portal triad**

Posterior

- **Inferior vena cava**

Superior

- **Caudate lobe of liver**

Inferior

- **First part of duodenum**

Clinical anatomy

- **Entrance into lesser sac.**
- **Pringle maneuver compresses hepatic artery.**

2. Epiploic foramen

Definition

Communication between greater and lesser sacs.

Importance

- **Surgical access to lesser sac.**

3. Clinical anatomy of pouch of Douglas

Pouch of Douglas

Rectouterine pouch in females.

Clinical importance

- **Lowest part of peritoneal cavity in females.**
- **Fluid accumulates here.**
- **Culdocentesis performed through posterior fornix.**

4. Sub diaphragmatic recesses

Types

1. **Right subphrenic space**
2. **Left subphrenic space**

Importance

- **Site for collection of pus or fluid.**

5. Recto uterine pouch with applied aspects

Definition

Peritoneal pouch between rectum and uterus.

Boundaries

- **Anterior: uterus**
- **Posterior: rectum**

Applied aspects

- **Fluid accumulation.**
- **Culdocentesis.**

STOMACH, DUODENUM, SMALL INTESTINE AND LARGE INTESTINE

LONG ESSAYS

1. A 14-year-old girl was brought to the hospital with complaints of fever, vomiting and acute pain around umbilicus. On examination, the surgeon found that she was having maximum tenderness at Mc Burney's point. From the history and examination, he came to the diagnosis of acute appendicitis. Based on your anatomical knowledge, answer the following questions

a. Why is pain felt around umbilicus b. Where is Mc Burney's point c. What are the various positions of vermiform appendix d. Briefly describe the blood supply, development and microscopy of vermiform appendix.

Answer

a. Why is pain felt around umbilicus

Appendix develops from midgut.

Visceral afferent fibers enter spinal cord at T10 segment.

Therefore pain is referred to umbilical region.

b. Where is Mc Burney's point

Junction of lateral one-third and medial two-third of line joining umbilicus and right anterior superior iliac spine.

Base of appendix lies here.

c. Various positions of vermiform appendix

Retrocecal – most common

Pelvic

Subcecal

Preileal

Postileal

Paracecal

d. Blood supply, development and microscopy of vermiform appendix

Blood Supply

Artery

Appendicular artery from ileocolic artery.

Vein

Appendicular vein drains into superior mesenteric vein.

Lymphatics

Drain into ileocolic lymph nodes.

Development

Develops from postarterial segment of midgut loop.

Appears as diverticulum from cecal bud.

Microscopy

Mucosa lined by simple columnar epithelium.

Numerous lymphoid follicles in submucosa.

Muscular coat with inner circular and outer longitudinal layers.

Serosa covers appendix completely.

2. During endoscopy, the doctor identified an ulcer in the organ situated in epigastric region, identified as stomach. Describe stomach under following headings:

a) Presenting parts and relations b) blood supply and lymphatic drainage c) applied aspects

Answer

Presenting Parts

Cardia

Fundus

Body

Pyloric part

Relations of Stomach

Anterior relations

Left lobe of liver

Diaphragm

Anterior abdominal wall

Posterior relations (stomach bed)

Diaphragm

Spleen

Left kidney

Left suprarenal gland

Pancreas

Splenic artery

Transverse mesocolon

Blood Supply

Arteries

Left gastric artery

Right gastric artery

Right gastroepiploic artery

Left gastroepiploic artery

Short gastric arteries

Veins

Correspond to arteries and drain into portal vein.

Lymphatic Drainage

Along gastric and gastroepiploic vessels.

Ultimately drains to celiac lymph nodes.

Applied Aspects

Peptic ulcer

Carcinoma stomach

Hematemesis due to gastric ulcer.

3. A 12 year old boy was brought to the casualty with complaints of fever, vomiting and periumbilical abdominal pain. On examination, his abdomen was rigid and there was tenderness at the Mc. Burney's point.

a) Name the parts and peritoneal folds of the organ likely to be affected in the boy b) What are the various positions of the organ c) Where is Mc. Burney's point d) Describe the blood supply and microscopic structures of the organ affected

Answer

Organ affected

Vermiform appendix.

a. Parts and peritoneal folds

Parts

Base

Body

Tip

Peritoneal fold

Mesoappendix.

b. Positions of appendix

Retrocecal

Pelvic

Subcecal

Preileal

Postileal

c. Mc Burney's point

Junction of lateral one-third and medial two-third of spino-umbilical line.

d. Blood supply and microscopic structure

Blood supply

Appendicular artery from ileocolic artery.

Vein drains into superior mesenteric vein.

Microscopy

Simple columnar epithelium.

Crypts of Lieberkuhn.

Abundant lymphoid follicles.

Inner circular and outer longitudinal muscle coat.

4. A 30-year-old man came with history of upper abdominal pain and vomiting. On examination tenderness in the epigastric region was noted.

a) Which is the organ involved b) Write about the external features of the organ c) Write about the peritoneal and visceral relations of the organ d) Write on the blood supply of the organ

Answer

a. Organ involved

Stomach.

b. External features

Two surfaces – anterior and posterior

Two curvatures – greater and lesser

Two orifices – cardiac and pyloric

Parts – cardia, fundus, body and pylorus

c. Peritoneal and visceral relations

Peritoneal relations

Covered by peritoneum except along curvatures.

Lesser omentum attached to lesser curvature.

Greater omentum attached to greater curvature.

Visceral relations

Anterior

Liver

Diaphragm

Anterior abdominal wall

Posterior

Pancreas

Spleen

Left kidney

Left suprarenal gland

d. Blood supply

Left and right gastric arteries.

Left and right gastroepiploic arteries.

Short gastric arteries.

Veins drain into portal system.

SHORT ESSAYS

1. Blood supply and lymphatic drainage of stomach.

Answer

Arterial Supply

Left gastric artery

Right gastric artery

Left gastroepiploic artery

Right gastroepiploic artery

- **Short gastric arteries**

Venous Drainage

- **Veins correspond to arteries.**
- **Drain into portal vein directly or indirectly.**

Lymphatic Drainage

- **Along lesser curvature → gastric nodes**
- **Along greater curvature → gastroepiploic nodes**
- **Fundus → pancreaticosplenic nodes**
- **Ultimately drains to celiac nodes.**

Applied Anatomy

- **Metastasis occurs through lymphatics.**

2. Duodenum – parts, relations, openings, blood supply

Answer

Parts

- **First part – 5 cm**
- **Second part – 7.5 cm**
- **Third part – 10 cm**
- **Fourth part – 2.5 cm**

Relations of Second Part

Anterior

- **Liver**
- **Transverse colon**

Posterior

- **Right kidney**
- **Inferior vena cava**

Medial

- **Head of pancreas**

Openings

- **Major duodenal papilla**
- **Minor duodenal papilla**

Blood Supply

- **Superior pancreaticoduodenal artery**
- **Inferior pancreaticoduodenal artery**

3. Parts lymphatic drainage development of stomach

Answer

Parts

- **Cardia**
- **Fundus**
- **Body**
- **Pylorus**

Lymphatic drainage

- **Drains to gastric, pancreaticosplenic and pyloric nodes.**
- **Ultimately to celiac nodes.**

Development

- **Develops from foregut.**
- **Rotation produces greater and lesser curvatures.**

4. Stomach – relations, blood supply and lymphatic drainage

Answer

Relations

Anterior

- **Liver**
- **Diaphragm**
- **Anterior abdominal wall**

Posterior

- **Pancreas**
- **Spleen**
- **Left kidney**
- **Splenic artery**

Blood Supply

- **Left and right gastric arteries**
- **Left and right gastroepiploic arteries**
- **Short gastric arteries**

Lymphatic Drainage

- **Gastric nodes**
- **Gastroepiploic nodes**
- **Pancreaticosplenic nodes**
- **Celiac nodes**

5. Gross anatomy, interior, blood supply and development of second part of duodenum

Answer

Gross Anatomy

- **Descends from L1 to L3 vertebra.**
- **Receives bile and pancreatic ducts.**

Interior

- **Major duodenal papilla.**
- **Minor duodenal papilla.**
- **Circular folds.**

Blood Supply

- **Superior pancreaticoduodenal artery.**
- **Inferior pancreaticoduodenal artery.**

Development

- **Develops from foregut and midgut.**

6. Second part of duodenum

Answer

Features

- **Vertical part of duodenum.**
- **Extends from L1 to L3.**
- **Related to head of pancreas.**

Openings

- **Major duodenal papilla.**
- **Minor duodenal papilla.**

Blood Supply

- **Pancreaticoduodenal arteries.**

7. Duodenum

Answer

Parts

- **First**
- **Second**
- **Third**
- **Fourth**

Blood Supply

- **Superior and inferior pancreaticoduodenal arteries.**

Functions

- **Receives bile and pancreatic secretions.**

Applied Anatomy

- **Duodenal ulcer commonly in first part.**

8. Vermiform appendix

Answer

Features

- **Narrow worm-like diverticulum.**
- **Arises from posteromedial wall of cecum.**
- **Average length 9 cm.**

Blood Supply

- **Appendicular artery.**

Positions

- **Retrocecal most common.**

Applied Anatomy

- **Acute appendicitis.**

SHORT NOTES

1. Origin, course and branches of superior mesenteric artery

Answer

Origin

- **Arises from abdominal aorta at L1.**

Course

- **Passes behind neck of pancreas.**
- **Crosses third part of duodenum.**
- **Enters mesentery.**

Branches

- **Inferior pancreaticoduodenal**
- **Jejunal branches**
- **Ileal branches**
- **Ileocolic artery**

Right colic artery

Middle colic artery

2. Explain the various positions of vermiform appendix and its applied anatomy

Answer

Positions

Retrocecal

Pelvic

Subcecal

Preileal

Postileal

Applied Anatomy

Site of pain depends on position.

Retrocecal appendix may produce less tenderness.

3. Lesser omentum

Answer

Definition

Double layer of peritoneum extending from liver to lesser curvature of stomach and first part of duodenum.

Parts

Hepatogastric ligament

Hepatoduodenal ligament

Contents of hepatoduodenal ligament

Portal vein

Hepatic artery

Bile duct

4. Superior mesenteric artery

Answer

Arises from abdominal aorta at L1.

Supplies midgut structures.

Gives jejunal, ileal, ileocolic, right colic and middle colic branches.

5. Transpyloric plane

Answer

Horizontal plane midway between suprasternal notch and pubic symphysis.

Lies at level of L1 vertebra.

REFER DIAGRAM SECTION

Structures at this level

Pylorus

Neck of pancreas

Origin of superior mesenteric artery

Fundus of gallbladder

Hilum of kidneys

6. Coeliac trunk

Answer

Origin

Arises from abdominal aorta at T12 vertebral level.

Course

Short artery about 1.25 cm long.

Divides into three terminal branches.

Branches

Left gastric artery

Splenic artery

Common hepatic artery

Distribution

Supplies foregut derivatives.

Applied Anatomy

Compression may cause abdominal angina.

7. Lymphatic drainage of stomach

Answer

Lymph Nodes

Left gastric nodes

Right gastric nodes

Left gastroepiploic nodes

Right gastroepiploic nodes

Pancreaticosplenic nodes

Pyloric nodes

Final Drainage

All drain ultimately into celiac lymph nodes.

Applied Anatomy

Spread of carcinoma stomach through lymphatics.

8. Second part of duodenum

Answer

Extent

Extends from L1 to L3 vertebra.

Relations

Anterior

Liver

Transverse colon

Posterior

Right kidney

Inferior vena cava

Medial

Head of pancreas

Interior Features

Major duodenal papilla

Minor duodenal papilla

Applied Anatomy

Common site for opening of bile duct and pancreatic duct.

9. Positions of appendix

Answer

Positions

- **Retrocecal – most common**
- **Pelvic**
- **Subcecal**
- **Preileal**
- **Postileal**
- **Paracecal**

Applied Anatomy

- **Symptoms vary according to position.**

10. Vermiform appendix

Answer

Features

- **Narrow worm-like diverticulum arising from cecum.**
- **Average length 9 cm.**
- **Base attached to posteromedial wall of cecum.**

Blood Supply

- **Appendicular artery.**

Lymphatic Drainage

- **Ileocolic lymph nodes.**

Applied Anatomy

- **Acute appendicitis.**

PANCREAS, LIVER, BILIARY APPARATUS, SPLEEN AND PORTAL VEIN

LONG ESSAYS

1. During an abdominal surgery, the doctor observed a ring of pancreatic tissue surrounding the duodenum and obstructing it. Describe pancreas under

a) Gross features b) Relations c) Development d) Microscopic structure

Answer

Gross Features

- **Soft lobulated gland.**
- **Extends from duodenum to spleen.**
- **Parts: head, neck, body and tail.**

Relations

Head

- **Lies within curve of duodenum.**
- **Posteriorly related to inferior vena cava and bile duct.**

Neck

- **Portal vein formed behind neck.**

Body

- **Related posteriorly to aorta, left kidney and splenic vein.**

Tail

- **Lies in lienorenal ligament near spleen.**

Development

- **Develops from dorsal and ventral pancreatic buds.**
- **Annular pancreas due to abnormal migration of ventral bud.**

Microscopic Structure

- **Exocrine acini lined by pyramidal cells.**
- **Endocrine islets of Langerhans.**
- **Alpha, beta and delta cells present.**

2. Describe the pancreas under following headings:

• Situation and parts. • Relations. • Blood supply. • Duct system. • Lymphatic drainage. • Development.

Answer

Situation and Parts

- **Retroperitoneal gland extending across posterior abdominal wall.**
- **Parts: head, neck, body and tail.**

Relations

Head

- **Duodenum surrounds head.**

Neck

- **Portal vein behind neck.**

Body

- **Crossed anteriorly by stomach.**

Tail

- **Related to spleen.**

Blood Supply

- **Splenic artery branches.**
- **Superior and inferior pancreaticoduodenal arteries.**

Duct System

- **Main pancreatic duct joins bile duct.**
- **Opens at major duodenal papilla.**
- **Accessory duct opens at minor papilla.**

Lymphatic Drainage

- **Pancreaticosplenic and superior mesenteric nodes.**

Development

- **From dorsal and ventral pancreatic buds.**

3. A 43-year-old fair lady reported to surgery outpatient department with a history of intense pain in the upper-right side of the abdomen, often accompanied by nausea and vomiting, that steadily increases for approximately 30 minutes to several hours. She also had pain between the shoulder blades or below the right shoulder. She could correlate the attacks often occurred after a particularly fatty meal and almost always happen at night. Other symptoms included abdominal bloating, intolerance of fatty foods, belching, gas, and indigestion. On examination, Murphy's sign was positive liver function tests were mildly abnormal.

Ultrasound revealed presence of stones in gall bladder.

• What is murphy's sign. • Gross anatomy of extrahepatic biliary apparatus with neat labelled diagram. • Arterial supply of extrahepatic biliary apparatus. • Histology of gall bladder with neat labelled diagram • Relations of the inferior surface of liver

Answer

Murphy's Sign

- **Pain during inspiration on palpation of gallbladder region due to acute cholecystitis.**

Extrahepatic Biliary Apparatus

Components

- **Right hepatic duct**
- **Left hepatic duct**
- **Common hepatic duct**
- **Gallbladder**
- **Cystic duct**
- **Bile duct**

Gallbladder

Parts

- **Fundus**
- **Body**
- **Neck**

Bile Duct

- **Formed by union of common hepatic and cystic ducts.**
- **Opens into second part of duodenum.**

Arterial Supply

- **Cystic artery from right hepatic artery.**
- **Bile duct supplied by hepatic and gastroduodenal arteries.**

Histology of Gallbladder

- **Mucosa with tall columnar epithelium.**
- **Lamina propria present.**
- **Muscular layer irregular.**
- **No submucosa.**
- **Outer serosa/adventitia.**

Relations of Inferior Surface of Liver

- **Stomach**
- **Duodenum**
- **Gallbladder**
- **Right colic flexure**
- **Right kidney**
- **Suprarenal gland**

4. A 55-year-old male presented to the casualty with vomiting of blood. On clinical examination there was an enlarged organ in his right hypochondrium. Also dilated veins were visible in the umbilical region. With your

knowledge in anatomy answer the following questions

• Name the organ enlarged • What could be the reason for vomiting of blood and dilated veins in umbilical region. • Give the important relations of the organ • Give the blood supply of the organ • Microscopic structure of the organ

Answer

Organ enlarged

Liver.

Reason for hematemesis and dilated veins

Portal hypertension.

Esophageal varices cause hematemesis.

Dilated paraumbilical veins produce caput medusae.

Relations of Liver

Diaphragmatic surface

Diaphragm

Pleura

Lungs

Visceral surface

Stomach

Duodenum

Right kidney

Gallbladder

Blood Supply

Hepatic artery.

Portal vein.

Microscopic Structure

Classical hepatic lobules.

Central vein in center.

Hepatocytes arranged in cords.

Sinusoids between cords.

Portal triad at periphery.

5. A 50 years old man came to the casualty with complaints of pain in the abdomen. Diagnostic tests revealed abnormal liver function tests. Answer the following:

• extent and parts of liver • relations • peritoneal reflections • blood supply • applied aspects

Answer

Extent and Parts

Largest gland in body.

Occupies right hypochondrium, epigastrium and part of left hypochondrium.

Anatomical Lobes

Right lobe

Left lobe

Caudate lobe

Quadrate lobe

Relations

Diaphragmatic surface

Diaphragm

Right pleura and lung

Visceral surface

Stomach

Duodenum

Kidney

Gallbladder

Peritoneal Reflections

Falciform ligament

Coronary ligament

Triangular ligaments

Lesser omentum

Blood Supply

Hepatic artery

Portal vein

Applied Aspects

Cirrhosis

Portal hypertension

Liver abscess

6. A 65 years old man presented with dilated veins around the umbilicus and vague pain in the epigastric region. He also had a history of bleeding per rectum.Radiological examination revealed an abnormal growth of head and neck of pancreas. Answer the following

• Name the structure that would have been compressed by the pancreatic growth • Give formation, course, relations and termination of this structure • Name all possible sites where there could be dilated veins, giving the names of the veins involved with reasons and clinical implications • What are the other structures that are likely to be compressed by the growth • Mention the sources of development of the pancreas

Answer

Structure compressed

Portal vein.

Formation

Formed behind neck of pancreas by union of superior mesenteric and splenic veins.

Course

Passes behind first part of duodenum.

Runs in hepatoduodenal ligament.

Relations

Anterior

Neck of pancreas

First part of duodenum

Posterior

- **Inferior vena cava**

Termination

- **Ends at porta hepatis by dividing into right and left branches.**

Sites of Portocaval Anastomosis

- **Lower end of esophagus**
  - **Left gastric with azygos veins.**
  - **Causes esophageal varices.**
- **Around umbilicus**
  - **Paraumbilical with superficial epigastric veins.**
  - **Causes caput medusae.**
- **Anal canal**
  - **Superior rectal with middle and inferior rectal veins.**
  - **Causes hemorrhoids.**
- **Retroperitoneal region**
  - **Colic veins with lumbar veins.**

Other Structures Compressed

- **Bile duct**
- **Inferior vena cava**
- **Duodenum**

Development of Pancreas

- **Ventral pancreatic bud**
- **Dorsal pancreatic bud**

SHORT ESSAYS

1. Describe the gross features and relations of components of extrahepatic biliary apparatus.

Answer

Components

- **Hepatic ducts**
- **Gallbladder**
- **Cystic duct**
- **Bile duct**

Gallbladder

Parts

- **Fundus**
- **Body**
- **Neck**

Relations

- **Superiorly related to liver.**
- **Inferiorly related to transverse colon and duodenum.**

Bile duct Relations

- **Lies in hepatoduodenal ligament.**
- **Passes behind first part of duodenum.**
- **Lies in groove on pancreas.**

2. Describe pancreas under the following headings: Development, blood supply and ducts of pancreas.

Answer

Development

- **Develops from dorsal and ventral pancreatic buds.**
- **Fusion forms pancreas.**

Blood Supply

- **Splenic artery branches.**
- **Pancreaticoduodenal arteries.**

Ducts

- **Main pancreatic duct.**
- **Accessory pancreatic duct.**

3. Describe the development and microscopy of pancreas.

Answer

Development

- **From dorsal and ventral pancreatic buds of foregut.**
- **Ventral bud forms uncinate process and part of head.**

Microscopy

Exocrine part

- **Serous acini.**

Endocrine part

- **Islets of Langerhans.**
- **Alpha and beta cells.**

4. Describe the Gall bladder under the following

a) Location b) Parts c) Applied anatomy

Answer

Location

- **Gallbladder lies in fossa on inferior surface of liver.**

Parts

- **Fundus**
- **Body**
- **Neck**

Applied Anatomy

- **Cholelithiasis**
- **Cholecystitis**
- **Murphy's sign positive in acute inflammation.**

5. Portosystemic anastomosis with clinical significance

Answer

Sites

- **Esophagus**
- **Umbilicus**
- **Anal canal**
- **Retroperitoneal areas**

Clinical Significance

Portal hypertension causes varices.

Hematemesis from esophageal varices.

Caput medusae around umbilicus.

Hemorrhoids in anal canal.

6. Portocaval anastomosis- sites, vessels involved and applied importance

Answer

Sites and Veins

Esophagus – left gastric and azygos veins

Umbilicus – paraumbilical and superficial epigastric veins

Anal canal – superior rectal and middle/inferior rectal veins

Retroperitoneal – colic and lumbar veins

Applied Importance

Seen in portal hypertension.

7. Spleen - surfaces, relations and blood supply

Answer

Surfaces

Diaphragmatic surface

Visceral surface

Visceral Impressions

Gastric impression

Renal impression

Colic impression

Pancreatic impression

Blood Supply

Splenic artery.

Splenic vein drains blood.

Applied Anatomy

Splenic rupture causes hemorrhage.

8. Pancreas - parts, relations and blood supply

Answer

Parts

Head

Neck

Body

Tail

Relations

Head within duodenum.

Tail related to spleen.

Blood Supply

Splenic artery branches.

Pancreaticoduodenal arteries.

9. Bile duct

Answer

Formation

- **Union of common hepatic and cystic ducts.**

Course

- **Lies in hepatoduodenal ligament.**
- **Passes behind first part of duodenum.**
- **Traverses head of pancreas.**

Termination

- **Opens into major duodenal papilla.**

Applied Anatomy

- **Obstructive jaundice due to gallstones.**

SHORT NOTES

1. Gall bladder – gross features with relations

Answer

Features

- **Pear-shaped sac.**
- **Capacity about 50 mL.**

Parts

- **Fundus**
- **Body**
- **Neck**

Relations

- **Superiorly liver.**
- **Inferiorly transverse colon and duodenum.**

2. Explain the anatomical basis of venous engorgements of anterior abdominal wall and anal canal in portal hypertension

Answer

- **Portal hypertension causes opening of portosystemic channels.**
- **Paraumbilical veins enlarge producing caput medusae.**
- **Superior rectal veins anastomose with middle and inferior rectal veins causing hemorrhoids.**

3. Porta hepatis

Answer

Definition

Transverse fissure on visceral surface of liver.

Contents

- **Portal vein**
- **Hepatic artery**
- **Hepatic ducts**
- **Lymphatics and nerves**

4. Explain anatomical basis of hematemesis and caput medusa in portal hypertension

Answer

- **Esophageal varices rupture causing hematemesis.**

Dilatation of paraumbilical veins causes caput medusae.

Due to portal hypertension.

5. Portocaval anastomoses

Answer

Sites

Esophagus

Umbilicus

Anal canal

Retroperitoneal regions

Importance

Become enlarged in portal hypertension.

6. Extra hepatic biliary apparatus

Answer

Components

Right and left hepatic ducts

Common hepatic duct

Gallbladder

Cystic duct

Bile duct

Function

Conducts and stores bile.

POSTERIOR ABDOMINAL WALL

SHORT NOTES

1. Inferior vena cava

Introduction

The inferior vena cava is the largest vein of the body. It drains blood from the lower half of the body into the right atrium.

Formation

Formed by union of right and left common iliac veins.

Formation occurs at the level of L5 vertebra, slightly to the right of the midline.

Course

Ascends on the right side of abdominal aorta.

Pierces the central tendon of diaphragm at T8 vertebral level.

Opens into right atrium.

Tributaries

Common iliac veins

Lumbar veins

Right gonadal vein

Renal veins

Right suprarenal vein

Inferior phrenic veins

Hepatic veins

Relations

Anterior

- **Liver**
- **First part of duodenum**
- **Root of mesentery**

Posterior

- **Vertebral column**
- **Right psoas major**
- **Right renal artery**

Applied anatomy

- **Obstruction produces edema of lower limbs.**
- **Collateral circulation develops in portal hypertension.**
- **Inferior vena cava is important in radiological procedures.**

KIDNEYS AND SUPRARENAL GLANDS

LONG ESSAYS

1. Describe the kidney under following headings

• anterior relations • coverings • microscopic structure • anatomical structure

Kidney

The kidneys are paired bean-shaped excretory organs situated retroperitoneally on the posterior abdominal wall.

Anatomical structure

Situation

- **Lie on posterior abdominal wall on either side of vertebral column.**
- **Extend from T12 to L3 vertebra.**
- **Right kidney is slightly lower than left kidney.**

External features

Surfaces

- **Anterior surface**
- **Posterior surface**

Borders

- **Lateral border: convex**
- **Medial border: concave and presents hilum**

Poles

- **Upper pole**
- **Lower pole**

Hilum

Structures from anterior to posterior:

- **Renal vein**
- **Renal artery**
- **Renal pelvis**

Interior of kidney

- **Covered by fibrous capsule.**
- **Outer cortex and inner medulla.**
- **Medulla consists of renal pyramids.**
- **Apex of pyramid forms papilla.**
- **Papilla opens into minor calyx.**
- **Minor calyces join to form major calyces.**
- **Major calyces form renal pelvis.**

Coverings of kidney

From within outwards:

- **Fibrous capsule**
- **Perirenal fat**
- **Renal fascia**
- **Pararenal fat**

Fibrous capsule

- **Thin fibrous covering closely attached to kidney.**
- **Easily stripped in healthy kidney.**

Perirenal fat

- **Fat surrounding kidney and suprarenal gland.**
- **Protects kidney.**

Renal fascia

- **Anterior layer: fascia of Gerota.**
- **Posterior layer: fascia of Zuckerkandl.**

Pararenal fat

- **Lies outside renal fascia.**

Anterior relations

Right kidney

- **Right suprarenal gland**
- **Liver**
- **Second part of duodenum**
- **Hepatic flexure of colon**
- **Small intestine**

Left kidney

- **Left suprarenal gland**
- **Stomach**
- **Spleen**
- **Pancreas**
- **Jejunum**
- **Left colic flexure**

Microscopic structure

Cortex

Contains:

- **Renal corpuscles**
- **Proximal convoluted tubules**
- **Distal convoluted tubules**

Medulla

- **Contains loops of Henle and collecting ducts.**
- **Arranged into renal pyramids.**

Nephron

Structural and functional unit of kidney.

Parts of nephron

- **Renal corpuscle**
  - **Glomerulus**
  - **Bowman's capsule**
- **Proximal convoluted tubule**
- **Loop of Henle**
- **Distal convoluted tubule**
- **Collecting tubule**

Juxtaglomerular apparatus

Formed by:

- **Juxtaglomerular cells**
- **Macula densa**
- **Lacis cells**

Functions

- **Formation of urine**
- **Regulation of water and electrolyte balance**
- **Acid-base balance**
- **Endocrine functions**

Applied anatomy

- **Hydronephrosis**
- **Polycystic kidney**
- **Renal calculi**
- **Renal transplantation**

2. A person was brought to casualty with a deep stab injury on the left side of back with complaints of passing frank blood in urine. Answer the following questions

• Surface marking of left kidney • Mention its coverings
• Relations of left kidney • Arterial supply
• Development

Surface marking of left kidney

- **Upper end: 2.5 cm from midline at level of T11 vertebra.**
- **Lower end: 2.5 cm from midline at L2 vertebra.**
- **Hilum lies at transpyloric plane about 5 cm from median plane.**
- **Kidney is represented by an oval area measuring about 11 × 6 cm.**

Coverings of kidney

From within outwards:

- **Fibrous capsule**
- **Perirenal fat**
- **Renal fascia**

- **Pararenal fat**

Relations of left kidney

Anterior relations

- **Left suprarenal gland**
- **Stomach**
- **Spleen**
- **Pancreas**
- **Jejunum**
- **Left colic flexure**

Posterior relations

- **Diaphragm**
- **Psoas major**
- **Quadratus lumborum**
- **Transversus abdominis**
- **Subcostal vessels**
- **Subcostal nerve**
- **Iliohypogastric nerve**
- **Ilioinguinal nerve**
- **11th and 12th ribs**

Arterial supply

- **Supplied by renal arteries arising from abdominal aorta at L1 level.**
- **Left renal artery is shorter than right.**
- **Segmental arteries are end arteries.**

Segmental arteries

- **Apical**
- **Upper**
- **Middle**
- **Lower**
- **Posterior**

Development

- **Kidney develops from intermediate mesoderm.**
- **Permanent kidney is metanephros.**
- **Appears in 5th week of intrauterine life.**
- **Develops from:**
    - **Ureteric bud**
    - **Metanephric blastema**

Derivatives of ureteric bud

- **Ureter**
- **Renal pelvis**
- **Major and minor calyces**
- **Collecting tubules**

Derivatives of metanephric blastema

- **Nephrons**

Ascent of kidney

- **Initially pelvic in position.**

Ascends to lumbar region.

Applied anatomy

Congenital polycystic kidney

Horseshoe kidney

Ectopic kidney

SHORT ESSAYS

1. Right kidney - external features, vertebral extent, coverings, relations and development

External features

Surfaces

Anterior surface

Posterior surface

Borders

Lateral border convex

Medial border concave with hilum

Poles

Upper pole related to suprarenal gland

Lower pole rounded

Vertebral extent

Extends from T12 to L3 vertebra.

Right kidney lies slightly lower than left kidney.

Coverings

From within outwards:

Fibrous capsule

Perirenal fat

Renal fascia

Pararenal fat

Relations

Anterior relations

Right suprarenal gland

Liver

Second part of duodenum

Hepatic flexure of colon

Small intestine

Posterior relations

Diaphragm

Psoas major

Quadratus lumborum

Transversus abdominis

Subcostal vessels and nerve

Iliohypogastric nerve

Ilioinguinal nerve

12th rib

Development

Develops from intermediate mesoderm.

Permanent kidney is metanephros.

Derived from ureteric bud and metanephric blastema.

Ascends from pelvis to lumbar region.

Applied anatomy

Horseshoe kidney

Renal agenesis

Ectopic kidney

SHORT NOTES

1. Anterior and posterior relations of right kidney

Anterior relations

Right suprarenal gland

Liver

Second part of duodenum

Hepatic flexure of colon

Small intestine

Posterior relations

Diaphragm

Psoas major

Quadratus lumborum

Transversus abdominis

12th rib

Subcostal vessels and nerve

Iliohypogastric nerve

Ilioinguinal nerve

Applied anatomy

Right kidney is approached surgically from posterior aspect.

2. Right suprarenal gland

Introduction

Right suprarenal gland is an endocrine gland situated on upper pole of right kidney.

Shape

Pyramidal in shape.

Relations

Anterior

Liver

Inferior vena cava

Posterior

Diaphragm

Inferior

Upper pole of right kidney

Blood supply

Arterial supply

Superior suprarenal arteries from inferior phrenic artery

Middle suprarenal artery from abdominal aorta

Inferior suprarenal artery from renal artery

Venous drainage

Right suprarenal vein drains into inferior vena cava.

Nerve supply

Sympathetic fibers from celiac plexus.

Applied anatomy

Pheochromocytoma

Addison disease

3. Blood supply of supra renal glands

Arterial supply

Each suprarenal gland receives arteries from three sources:

Superior suprarenal arteries

Branches of inferior phrenic artery

Middle suprarenal artery

Branch from abdominal aorta

Inferior suprarenal artery

Branch from renal artery

Venous drainage

Right suprarenal vein drains into inferior vena cava.

Left suprarenal vein drains into left renal vein.

Lymphatic drainage

Drains into lateral aortic lymph nodes.

Applied anatomy

Excess bleeding may occur during adrenal surgery.

4. Coverings of kidney

From within outwards:

Fibrous capsule

Perirenal fat

Renal fascia

Pararenal fat

Fibrous capsule

Thin membrane closely attached to kidney.

Protects kidney.

Perirenal fat

Surrounds kidney and suprarenal gland.

Acts as cushion.

Renal fascia

Consists of anterior and posterior layers.

Anchors kidney.

Pararenal fat

Lies outside renal fascia.

Functions

- **Protection**
- **Fixation of kidney**

Applied anatomy

- **Loss of perirenal fat may cause nephroptosis.**

DRAW AND LABEL

1. Draw a neat labelled diagram of relations of anterior surface of right and left kidneys

REFER DIAGRAM SECTION

Labels for right kidney

- **Right suprarenal gland**
- **Liver**
- **Second part of duodenum**
- **Hepatic flexure**
- **Small intestine**

Labels for left kidney

- **Left suprarenal gland**
- **Stomach**
- **Spleen**
- **Pancreas**
- **Jejunum**
- **Left colic flexure**

2. Draw a neat labelled diagram of anterior relations of right and left kidneys

REFER DIAGRAM SECTION

Labels

Right kidney

- **Suprarenal gland**
- **Liver**
- **Duodenum**
- **Hepatic flexure**
- **Small intestine**

Left kidney

- **Suprarenal gland**
- **Stomach**
- **Spleen**
- **Pancreas**
- **Jejunum**
- **Left colic flexure**

3. Anterior surface of right kidney showing its relations

REFER DIAGRAM SECTION

Labels

- **Right suprarenal gland**
- **Liver**
- **Second part of duodenum**

Hepatic flexure

Small intestine

4. Anterior surface of left kidney showing relations

REFER DIAGRAM SECTION

Labels

Left suprarenal gland

Stomach

Spleen

Pancreas

Jejunum

Left colic flexure

5. Anterior relations of right and left kidney

REFER DIAGRAM SECTION

Right kidney

Right suprarenal gland

Liver

Duodenum

Hepatic flexure

Small intestine

Left kidney

Left suprarenal gland

Stomach

Spleen

Pancreas

Jejunum

Left colic flexure

6. Posterior surface of left kidney showing relations

REFER DIAGRAM SECTION

Labels

Diaphragm

Psoas major

Quadratus lumborum

Transversus abdominis

11th rib

12th rib

Subcostal nerve

Iliohypogastric nerve

Ilioinguinal nerve

PELVIS

SHORT NOTES

1. Branches of internal iliac artery

The internal iliac artery divides into anterior and posterior divisions.

Branches of posterior division

Iliolumbar artery

- **Lateral sacral arteries**
- **Superior gluteal artery**

Branches of anterior division

- **Umbilical artery**
- **Superior vesical artery**
- **Obturator artery**
- **Inferior vesical artery in male / vaginal artery in female**
- **Middle rectal artery**
- **Internal pudendal artery**
- **Inferior gluteal artery**
- **Uterine artery in female**

Applied anatomy

- **Internal iliac artery ligation is done to control pelvic hemorrhage.**

2. Components of pelvic diaphragm

Pelvic diaphragm forms the muscular floor of pelvis.

Components

- **Levator ani**
- **Coccygeus**

Parts of levator ani

- **Puborectalis**
- **Pubococcygeus**
- **Iliococcygeus**

Functions

- **Supports pelvic viscera**
- **Maintains continence**
- **Resists increase in intra-abdominal pressure**

Nerve supply

- **Pudendal nerve**
- **Nerve to levator ani**

Applied anatomy

- **Weakness may lead to prolapse of pelvic organs.**

DRAW AND LABEL

3. Median section of male pelvis

REFER DIAGRAM SECTION

Labels

- **Urinary bladder**
- **Prostate**
- **Rectum**
- **Pubic symphysis**
- **Penis**
- **Urethra**
- **Seminal vesicle**
- **Vas deferens**
- **Anal canal**

4. Median section of female pelvis

REFER DIAGRAM SECTION

Labels

- **Urinary bladder**
- **Uterus**
- **Vagina**
- **Rectum**
- **Pubic symphysis**
- **Urethra**
- **Anal canal**

URINARY SYSTEM - URINARY BLADDER AND URETHRA

SHORT ESSAYS

1. Describe the presenting parts, interior, microscopic structure of urinary bladder.

Urinary bladder

The urinary bladder is a muscular reservoir for storage of urine.

Presenting parts

- **Apex**
- **Base or fundus**
- **Superior surface**
- **Two inferolateral surfaces**
- **Neck**

Apex

- **Directed forwards behind pubic symphysis.**
- **Connected to umbilicus by median umbilical ligament.**

Base

- **Triangular posterior surface.**
- **In males related to rectum.**
- **In females related to vagina.**

Neck

- **Lowest and fixed part.**
- **Continuous with urethra.**

Interior of urinary bladder

Features

- **Mucosa shows folds called rugae.**
- **Trigone is smooth triangular area.**

Boundaries of trigone

- **Two ureteric openings**
- **Internal urethral opening**

Interureteric ridge

- **Ridge connecting ureteric openings.**

Microscopic structure

Layers

- **Mucosa**
  - **Transitional epithelium**

- **Submucosa**
- **Muscular coat**
  - **Detrusor muscle**
- **Serous/adventitial coat**

Detrusor muscle

- **Smooth muscle fibers arranged in layers.**
- **Helps in micturition.**

Blood supply

- **Superior and inferior vesical arteries.**

Nerve supply

- **Sympathetic fibers from T11–L2.**
- **Parasympathetic fibers from S2–S4.**

Applied anatomy

- **Cystitis**
- **Urinary retention**
- **Rupture of bladder**

2. Urinary bladder

Situation

- **Situated in pelvis behind pubic symphysis.**

Capacity

- **Average capacity is 300–500 mL.**

Parts

- **Apex**
- **Base**
- **Superior surface**
- **Inferolateral surfaces**
- **Neck**

Supports

- **Pelvic diaphragm**
- **Puboprostatic/pubovesical ligaments**

Blood supply

- **Superior vesical artery**
- **Inferior vesical artery**

Venous drainage

- **Vesical venous plexus**

Lymphatic drainage

- **Internal and external iliac nodes**

Nerve supply

- **Sympathetic and parasympathetic fibers**

Applied anatomy

- **Cystitis**
- **Neurogenic bladder**
- **Catheterization**

SHORT NOTES

1. Interior of urinary bladder

The interior of urinary bladder shows the following features:

1. **Mucosa – Lined by transitional epithelium except over trigone.**
2. **Rugae – Mucosal folds present when bladder is empty.**
3. **Trigone – Smooth triangular area on posterior wall.**
4. **Ureteric orifices – Two openings at superolateral angles of trigone.**
5. **Internal urethral orifice – Situated at inferior angle of trigone.**
6. **Interureteric ridge (Bar of Mercier) – Ridge joining ureteric orifices.**
7. **Uvulla vesicae – Elevation behind internal urethral orifice due to median lobe of prostate in males.**

Applied anatomy

- **Cystitis causes painful micturition.**
- **Enlargement of prostate elevates uvula vesicae causing urinary obstruction.**
- **Trigone is sensitive to stretch and pain.**

2. Ligaments of urinary bladder

The ligaments of urinary bladder are:

True ligaments

1. **Puboprostatic ligaments in males / Pubovesical ligaments in females.**
2. **Lateral ligaments of bladder.**
3. **Median umbilical ligament (urachus).**

False ligaments (Peritoneal folds)

1. **Median umbilical fold.**
2. **Medial umbilical folds.**
3. **Lateral false ligaments formed by peritoneum.**

Functions

- **Support bladder.**
- **Maintain position of bladder.**
- **Prevent downward displacement.**

Applied anatomy

- **Weakening of supports may lead to cystocele.**

3. Internal trigone of urinary bladder

Trigone is a smooth triangular area on the posterior wall of urinary bladder.

Boundaries

- **Superolateral angles – Ureteric orifices.**
- **Inferior angle – Internal urethral orifice.**

Features

- **Smooth mucosa.**
- **Firmly adherent mucosa.**
- **Derived embryologically from mesonephric ducts.**
- **Highly sensitive to stretch.**

Interureteric ridge

A ridge connecting the ureteric openings.

Applied anatomy

- **Common site for infection.**
- **Trigonal irritation causes frequent micturition.**

4. Clinical and microscopic anatomy of uterine tube

Microscopic anatomy

The wall of uterine tube has three layers:

1. **Mucosa**
   - **Highly folded.**
   - **Lined by ciliated columnar epithelium.**
   - **Contains secretory cells.**
2. **Muscular coat**
   - **Inner circular and outer longitudinal smooth muscle.**
3. **Serosa**
   - **Peritoneal covering.**

Clinical anatomy

- **Site of fertilization is ampulla.**
- **Tubal pregnancy commonly occurs in ampulla.**
- **Salpingitis may cause infertility.**
- **Tubectomy is done for sterilization.**

5. Ureter

Ureter is a muscular tube transmitting urine from kidney to urinary bladder.

Length

- **About 25 cm.**

Parts

1. **Abdominal part.**
2. **Pelvic part.**
3. **Intramural part.**

Constrictions

1. **Pelviureteric junction.**
2. **Crossing iliac vessels.**
3. **Vesicoureteric junction.**

Blood supply

- **Renal, gonadal, common iliac, internal iliac and vesical arteries.**

Nerve supply

- **Sympathetic: T11–L2.**
- **Parasympathetic: S2–S4.**

Applied anatomy

- **Ureteric calculi commonly lodge at constrictions.**
- **Pain radiates from loin to groin.**

6. Male urethra

Male urethra extends from internal urethral orifice to external urethral meatus.

Length

- **About 18–20 cm.**

Parts

1. **Preprostatic part.**
2. **Prostatic part.**
3. **Membranous part.**
4. **Spongy part.**

Features

- **Prostatic urethra is widest.**
- **Membranous urethra is narrow and least distensible.**
- **Spongy urethra lies within corpus spongiosum.**

Curvatures

1. **Infrapubic curve.**
2. **Prepubic curve.**

Applied anatomy

- **Common site of urethral rupture – membranous urethra.**
- **Catheterization should be done carefully.**

7. Trigone of urinary bladder

Trigone is a triangular smooth area on posterior wall of bladder.

Boundaries

- **Two ureteric orifices.**
- **Internal urethral orifice.**

Features

- **Smooth mucosa.**
- **Sensitive to stretch.**
- **Derived from mesonephric ducts.**

Functions

- **Funnels urine towards urethra.**
- **Prevents reflux of urine.**

Applied anatomy

- **Common site of infection.**
- **Trigonal edema causes urinary frequency.**

MALE GENITAL ORGANS

SHORT ESSAYS

1. Describe the coverings and lobes of prostate. Add a note on microscopic structure of prostate.

Prostate

Prostate is a fibromusculoglandular organ surrounding the prostatic urethra.

Coverings of prostate

1. **True capsule**
    - **Formed by condensation of fibrous stroma.**
2. **False capsule**
    - **Derived from visceral pelvic fascia.**
    - **Contains prostatic venous plexus.**
3. **Prostatic sheath**
    - **Formed by pelvic fascia.**

Lobes of prostate

Classically five lobes:

1. **Anterior lobe.**
2. **Median lobe.**
3. **Posterior lobe.**
4. **Right lateral lobe.**
5. **Left lateral lobe.**

Importance of lobes

- **Median lobe commonly enlarges in benign hypertrophy.**
- **Posterior lobe commonly affected by carcinoma.**

Microscopic structure

- **Compound tubuloalveolar gland.**
- **Stroma contains fibrous tissue and smooth muscle.**
- **Glands lined by columnar epithelium.**
- **Prostatic concretions (corpora amylacea) present.**

Applied anatomy

- **Benign prostatic hypertrophy causes urinary obstruction.**
- **Prostate examined by digital rectal examination.**

2. Prostate gland

Situation

Located below urinary bladder around prostatic urethra.

Shape and size

- **Chestnut shaped.**
- **Weight about 20 g.**

Surfaces

1. **Base.**
2. **Apex.**
3. **Anterior surface.**
4. **Posterior surface.**
5. **Inferolateral surfaces.**

Lobes

- **Anterior.**
- **Median.**
- **Posterior.**
- **Two lateral lobes.**

Blood supply

- **Inferior vesical, middle rectal and internal pudendal arteries.**

Venous drainage

- **Prostatic venous plexus.**

Lymphatic drainage

- **Internal iliac lymph nodes.**

Applied anatomy

- **Benign enlargement causes urinary retention.**
- **Carcinoma spreads to vertebral column through vertebral venous plexus.**

3. Describe the internal features, lobes and clinical importance of prostate

Internal features

- **Traversed by prostatic urethra.**
- **Ejaculatory ducts open into prostatic urethra.**
- **Prostatic sinuses present.**
- **Seminal colliculus present.**

Lobes

1. **Anterior lobe.**
2. **Median lobe.**
3. **Posterior lobe.**
4. **Right and left lateral lobes.**

Clinical importance

- **Median lobe enlarges in benign hypertrophy.**
- **Posterior lobe is common site for carcinoma.**
- **Enlargement compresses urethra causing retention of urine.**
- **Digital rectal examination used for examination.**

SHORT NOTES

1. Descent of testes

Testes develop in posterior abdominal wall and descend into scrotum.

Stages

1. **Abdominal stage.**
2. **Inguinoscrotal stage.**

Factors responsible

- **Gubernaculum.**
- **Differential growth.**
- **Intra-abdominal pressure.**

- **Hormones.**

Applied anatomy

- **Undescended testis – cryptorchidism.**
- **Ectopic testis.**
- **Congenital inguinal hernia.**

2. Coverings of testis

Coverings from superficial to deep

1. **Skin.**
2. **Dartos fascia.**
3. **External spermatic fascia.**
4. **Cremasteric fascia and muscle.**
5. **Internal spermatic fascia.**
6. **Tunica vaginalis.**
7. **Tunica albuginea.**

Applied anatomy

- **Hydrocele occurs in tunica vaginalis.**

3. Layers of scrotum

Layers from superficial to deep:

1. **Skin.**
2. **Dartos muscle and fascia.**
3. **External spermatic fascia.**
4. **Cremasteric fascia and muscle.**
5. **Internal spermatic fascia.**
6. **Parietal layer of tunica vaginalis.**

Functions

- **Protect testes.**
- **Maintain temperature for spermatogenesis.**

4. Vas deferens

Vas deferens is a thick muscular tube conveying sperm from epididymis to ejaculatory duct.

Length

- **About 45 cm.**

Parts

1. **Scrotal part.**
2. **Inguinal part.**
3. **Pelvic part.**

Features

- **Thick muscular wall.**
- **Ampulla near termination.**

Blood supply

- **Artery to vas deferens.**

Applied anatomy

- **Vasectomy done for sterilization.**

FEMALE GENITAL ORGANS

LONG ESSAYS

1. A 60 years old multiparous woman came to hospital with complaints of mass descending per vaginum. With your knowledge in anatomy answer the following questions.

• Name the clinical condition.
• Describe the parts, normal position, relations,
• Blood supply and lymphatic drainage of uterus.
• Describe the supports of uterus.

Clinical condition

- **Prolapse of uterus.**

Uterus

A hollow pear-shaped muscular organ situated in pelvis between bladder and rectum.

Parts of uterus

1. **Fundus.**
2. **Body.**
3. **Isthmus.**
4. **Cervix.**

Normal position

- **Anteverted.**
- **Anteflexed.**

Relations

Anterior

- **Urinary bladder.**
- **Uterovesical pouch.**

Posterior

- **Rectouterine pouch.**
- **Sigmoid colon.**
- **Rectum.**

Lateral

- **Broad ligament.**
- **Uterine vessels.**
- **Ureter.**

Blood supply

Arterial supply

- **Uterine artery (main).**
- **Ovarian artery.**
- **Vaginal artery.**

Venous drainage

- **Uterine venous plexus.**

Lymphatic drainage

- **Fundus → Para-aortic and superficial inguinal nodes.**
- **Body → External iliac nodes.**
- **Cervix → Internal iliac and sacral nodes.**

Supports of uterus

Primary supports

1. **Pelvic diaphragm.**
2. **Perineal body.**
3. **Urogenital diaphragm.**
4. **Transverse cervical ligaments.**
5. **Pubocervical ligaments.**
6. **Uterosacral ligaments.**

Secondary supports

1. **Round ligament.**
2. **Broad ligament.**
3. **Uterovesical fold.**
4. **Rectovaginal fold.**

Applied anatomy

- **Weakening of supports causes prolapse.**

2. A 50 years old woman came to the casualty with complaints of pain in the pelvic region. A pelvic scan revealed a mass on the uterus. Answer the following:

• Parts of uterus
• Supports
• Applied aspects
• Relations
• Blood supply

Parts of uterus

1. **Fundus.**
2. **Body.**
3. **Isthmus.**
4. **Cervix.**

Relations

Anterior

- **Bladder.**

Posterior

- **Rectouterine pouch.**
- **Rectum.**

Lateral

- **Broad ligament and uterine vessels.**

Supports

Primary supports

- **Pelvic diaphragm.**
- **Perineal body.**
- **Transverse cervical ligament.**
- **Uterosacral ligament.**
- **Pubocervical ligament.**

Secondary supports

- **Round ligament.**
- **Broad ligament.**

Blood supply

- **Uterine artery.**
- **Ovarian artery.**
- **Vaginal artery.**

Applied aspects

- **Fibroid uterus.**
- **Prolapse uterus.**
- **Carcinoma cervix.**
- **Hysterectomy may injure ureter.**

3. 35 year old woman with four living children and history of all vaginal deliveries attended gynaecological out-patient department with complaints of pelvic heaviness, a dragging sensation in the vagina, protrusion of a mass coming down from the vagina and backache. On examination the condition was diagnosed as prolapse of uterus. With your knowledge of anatomy answer the following questions

• Anatomical position of non-gravid uterus
• Peritoneal supports of uterus
• Supports of uterus
• Arterial supply of uterus
• Lymphatics drainage of uterus

Anatomical position of non-gravid uterus

- **Anteverted.**
- **Anteflexed.**

Peritoneal supports

1. **Broad ligament.**
2. **Uterovesical fold.**
3. **Rectouterine fold.**

Supports of uterus

Primary supports

- **Pelvic diaphragm.**
- **Perineal body.**
- **Urogenital diaphragm.**
- **Transverse cervical ligament.**
- **Pubocervical ligament.**
- **Uterosacral ligament.**

Secondary supports

- **Round ligament.**
- **Broad ligament.**

Arterial supply

- **Uterine artery.**
- **Ovarian artery.**
- **Vaginal artery.**

Lymphatic drainage

- **Fundus → Para-aortic and superficial inguinal nodes.**
- **Body → External iliac nodes.**
- **Cervix → Internal iliac and sacral nodes.**

Applied anatomy

- **Multiparity weakens pelvic supports causing prolapse.**

SHORT ESSAYS

1. Describe the supports of uterus and their clinical significance.

Supports of uterus

Primary supports

1. **Pelvic diaphragm.**
2. **Perineal body.**
3. **Urogenital diaphragm.**
4. **Pubocervical ligaments.**
5. **Transverse cervical (cardinal) ligaments.**
6. **Uterosacral ligaments.**

Secondary supports

1. **Round ligament of uterus.**
2. **Broad ligament.**
3. **Uterovesical fold.**
4. **Rectouterine fold.**

Clinical significance

- **Weakening causes prolapse uterus.**
- **Damage during childbirth predisposes prolapse.**
- **Cardinal ligament supports cervix.**
- **Round ligament maintains anteversion.**

2. Describe the supports of uterus

Primary supports

1. **Pelvic diaphragm.**
2. **Perineal body.**
3. **Urogenital diaphragm.**
4. **Pubocervical ligament.**
5. **Transverse cervical ligament.**
6. **Uterosacral ligament.**

Secondary supports

1. **Round ligament.**
2. **Broad ligament.**
3. **Uterovesical fold.**
4. **Rectouterine fold.**

Functions

- **Maintain normal position.**
- **Prevent prolapse.**

3. Supports of uterus and its applied anatomy

Supports

Primary supports

- **Pelvic diaphragm.**
- **Perineal body.**
- **Urogenital diaphragm.**
- **Cardinal ligament.**
- **Uterosacral ligament.**

- **Pubocervical ligament.**

Secondary supports

- **Round ligament.**
- **Broad ligament.**

Applied anatomy

- **Uterine prolapse due to weakened supports.**
- **Multiparity predisposes prolapse.**
- **Episiotomy prevents excessive tearing of perineal body.**

SHORT NOTES

1. Supports of uterus

Supports of uterus are:

Primary supports

1. **Pelvic diaphragm.**
2. **Perineal body.**
3. **Urogenital diaphragm.**
4. **Pubocervical ligament.**
5. **Transverse cervical ligament.**
6. **Uterosacral ligament.**

Secondary supports

1. **Broad ligament.**
2. **Round ligament.**

Functions

- **Maintain anteverted and anteflexed position.**

2. True ligaments of uterus

True ligaments are fibromuscular supports of uterus.

1. **Round ligament.**
2. **Pubocervical ligament.**
3. **Transverse cervical ligament.**
4. **Uterosacral ligament.**

Functions

- **Maintain position of uterus.**
- **Prevent prolapse.**

3. Broad ligament of uterus

Broad ligament is a double layer of peritoneum extending from sides of uterus to lateral pelvic wall.

Parts

1. **Mesometrium.**
2. **Mesosalpinx.**
3. **Mesovarium.**

Contents

- **Uterine tube.**
- **Round ligament.**
- **Ovarian ligament.**
- **Uterine vessels.**
- **Nerves and lymphatics.**

Functions

- **Supports uterus.**

4. Fallopian tube

Fallopian tube extends from uterus to ovary.

Length

- **About 10 cm.**

Parts

1. **Infundibulum.**
2. **Ampulla.**

3. **Isthmus.**
4. **Intramural part.**

Blood supply

- **Uterine and ovarian arteries.**

Applied anatomy

- **Fertilization occurs in ampulla.**
- **Tubal pregnancy common in ampulla.**

PERINEUM

SHORT ESSAYS

1. Perineal pouches

Perineal pouches are spaces in urogenital triangle.

Types

1. **Superficial perineal pouch.**
2. **Deep perineal pouch.**

Superficial perineal pouch

Boundaries

- **Superficial fascia below.**
- **Perineal membrane above.**

Contents in male

- **Root of penis.**
- **Muscles: Ischiocavernosus, bulbospongiosus, superficial transverse perineal.**
- **Branches of pudendal vessels and nerves.**

Contents in female

- **Crura of clitoris.**
- **Bulbs of vestibule.**
- **Greater vestibular glands.**

Deep perineal pouch

Boundaries

- **Perineal membrane below.**
- **Superior fascia above.**

Contents

- **Membranous urethra.**
- **External urethral sphincter.**
- **Deep transverse perineal muscles.**

Applied anatomy

- **Urine extravasation in urethral rupture.**

2. Describe the boundaries and contents of perineal pouches

Superficial perineal pouch

Boundaries

- **Roof – Perineal membrane.**
- **Floor – Membranous layer of superficial fascia.**
- **Lateral – Ischiopubic rami.**

Contents in male

- **Root of penis.**
- **Superficial transverse perineal muscle.**
- **Ischiocavernosus.**
- **Bulbospongiosus.**

Contents in female

- **Clitoris.**
- **Bulbs of vestibule.**
- **Greater vestibular glands.**

Deep perineal pouch

Boundaries

- **Inferior – Perineal membrane.**
- **Superior – Superior fascia.**

Contents

- **Membranous urethra.**
- **External urethral sphincter.**
- **Deep transverse perineal muscle.**

3. Describe the boundaries, contents and applied anatomy of ischiorectal fossa

Ischiorectal fossa

A wedge-shaped fat-filled space on either side of anal canal.

Boundaries

Lateral

- **Obturator internus muscle.**

Medial

- **External anal sphincter and levator ani.**

Base

- **Skin.**

Apex

- **Junction of obturator internus and levator ani.**

Contents

1. **Ischioanal fat pad.**
2. **Inferior rectal vessels.**
3. **Inferior rectal nerve.**
4. **Pudendal canal on lateral wall.**

Applied anatomy

- **Ischiorectal abscess.**
- **Spread of infection across deep postanal space.**

4. Boundaries and contents of ischiorectal fossa

Boundaries

- **Lateral – Obturator internus.**
- **Medial – Levator ani and anal canal.**
- **Base – Skin.**
- **Apex – Junction of muscles.**

Contents

- **Fat.**
- **Inferior rectal vessels and nerve.**
- **Pudendal canal.**

5. Describe ischio rectal fossa with clinical significance.

Definition

Fat-filled wedge-shaped space beside anal canal.

Boundaries

- **Lateral – Obturator internus.**
- **Medial – Levator ani and external anal sphincter.**
- **Base – Skin.**
- **Apex – Junction of obturator internus and levator ani.**

Contents

- **Fat.**
- **Inferior rectal vessels and nerves.**

- **Pudendal canal.**

Clinical significance

- **Ischiorectal abscess common.**
- **Infection spreads through deep postanal space.**

6. Ischiorectal fossa

Boundaries

- **Lateral – Obturator internus.**
- **Medial – Levator ani and anal canal.**
- **Base – Skin.**
- **Apex – Junction of muscles.**

Contents

- **Fat.**
- **Inferior rectal nerve and vessels.**
- **Pudendal canal.**

Applied anatomy

- **Abscess formation.**

7. With the help of a neat diagram, describe ischio- rectal fossa. Give its clinical importance

REFER DIAGRAM SECTION

Definition

A wedge-shaped fat-filled space on either side of anal canal.

Boundaries

- **Lateral – Obturator internus.**
- **Medial – Levator ani and external anal sphincter.**
- **Base – Skin.**
- **Apex – Junction of obturator internus and levator ani.**

Contents

1. **Fat pad.**
2. **Inferior rectal vessels.**
3. **Inferior rectal nerve.**
4. **Pudendal canal.**

Clinical importance

- **Ischiorectal abscess.**
- **Spread of infection through deep postanal space.**
- **Pudendal nerve block performed near pudendal canal.**

SHORT NOTES

1. Draw a neat labelled diagram showing contents of superficial perineal pouch in males

REFER DIAGRAM SECTION

Contents of superficial perineal pouch in males

1. **Root of penis.**
2. **Bulb of penis.**
3. **Crura of penis.**
4. **Ischiocavernosus muscle.**
5. **Bulbospongiosus muscle.**
6. **Superficial transverse perineal muscle.**
7. **Perineal branches of pudendal vessels and nerves.**

2. Perineal membrane in males

Perineal membrane is a triangular fibrous sheet in urogenital triangle.

Attachments

- **Sides attached to ischiopubic rami.**
- **Posterior border fused with perineal body.**

Structures piercing it

- **Urethra.**
- **Ducts of bulbourethral glands.**
- **Arteries and nerves.**

Functions

- **Supports pelvic viscera.**

3. Superficial perineal pouch

Boundaries

- **Floor – Membranous superficial fascia.**
- **Roof – Perineal membrane.**

Contents in male

- **Root of penis.**
- **Ischiocavernosus.**
- **Bulbospongiosus.**
- **Superficial transverse perineal.**

Applied anatomy

- **Extravasation of urine.**

4. Ischiorectal fossa

Ischiorectal fossa is a wedge-shaped fat-filled space lateral to anal canal.

Boundaries

- **Medial – Anal canal.**
- **Lateral – Obturator internus.**

Contents

- **Fat.**
- **Inferior rectal vessels and nerve.**

Applied anatomy

- **Ischiorectal abscess.**

5. Boundaries and contents of superficial perineal pouch

Boundaries

- **Roof – Perineal membrane.**
- **Floor – Colles fascia.**
- **Lateral – Ischiopubic rami.**

Contents in male

- **Root of penis.**
- **Muscles of root.**
- **Pudendal vessels and nerves.**

6. Urogenital diaphragm

Urogenital diaphragm consists of muscles and fascia in anterior perineum.

Components

1. **Deep transverse perineal muscle.**
2. **External urethral sphincter.**
3. **Superior and inferior fascia.**

Functions

- **Supports pelvic viscera.**
- **Maintains urinary continence.**

7. Structures piercing perineal membrane in females

1. **Urethra.**
2. **Vagina.**
3. **Arteries.**
4. **Nerves.**

8. Perineal body

Perineal body is a fibromuscular mass between anal canal and vagina.

Muscles attached

- **Bulbospongiosus.**
- **External anal sphincter.**
- **Superficial and deep transverse perineal muscles.**
- **Levator ani.**

Importance

- **Maintains pelvic floor integrity.**

Applied anatomy

- **Damage during childbirth causes prolapse.**

9. Pudendal canal

Pudendal canal is a fascial tunnel in lateral wall of ischiorectal fossa.

Contents

1. **Pudendal nerve.**
2. **Internal pudendal vessels.**

Clinical anatomy

- **Pudendal nerve block.**

10. Deep perineal pouch and its contents

Boundaries

- **Inferior – Perineal membrane.**
- **Superior – Superior fascia.**

Contents

1. **Membranous urethra.**
2. **External urethral sphincter.**
3. **Deep transverse perineal muscles.**
4. **Bulbourethral glands in males.**

RECTUM AND ANAL CANAL

LONG ESSAYS

1. Describe the Anal canal under the following Headings

a) Extent of the Canal
b) Interior features of the Anal canal
c) Blood and Nerve supply of the Anal canal
d) Anatomical basis of haemorrhoids

Anal canal

Terminal part of large intestine situated below pelvic diaphragm.

a) Extent of the canal

- **Length – About 4 cm.**
- **Extends from anorectal junction to anal verge.**

b) Interior features of anal canal

1. **Anal columns.**
2. **Anal valves.**
3. **Anal sinuses.**
4. **Pectinate line.**
5. **White line of Hilton.**

c) Blood supply

Arterial supply

- **Superior rectal artery.**
- **Middle rectal artery.**
- **Inferior rectal artery.**

Venous drainage

- **Internal rectal venous plexus.**
- **External rectal venous plexus.**

Nerve supply

Above pectinate line

- **Autonomic nerves.**

Below pectinate line

- **Inferior rectal nerve.**

d) Anatomical basis of haemorrhoids

- **Internal hemorrhoids occur due to dilatation of internal rectal venous plexus above pectinate line.**
- **External hemorrhoids occur below pectinate line.**
- **Common sites are 3, 7 and 11 o'clock positions.**

2. A middle aged man visited the surgical OPD with history of bleeding per anum since three months. On clinical examination, he was found to have internal haemorrhoids. From your knowledge of anatomy describe the anal canal under the following headings

• Mucosal anatomy
• Blood supply
• Sphincteric muscles
• Clinical aspects

Mucosal anatomy

1. **Anal columns.**
2. **Anal valves.**
3. **Anal sinuses.**
4. **Pectinate line.**
5. **White line of Hilton.**

Blood supply

Arterial

- **Superior rectal artery.**
- **Middle rectal artery.**
- **Inferior rectal artery.**

Venous

- **Internal and external rectal venous plexuses.**

Sphincteric muscles

1. **Internal anal sphincter – involuntary.**
2. **External anal sphincter – voluntary.**

Clinical aspects

- **Internal hemorrhoids above pectinate line are painless.**
- **External hemorrhoids are painful.**
- **Fissure in ano commonly occurs in posterior midline.**

3. A 62 year old man with progressive weight loss complains of pain and bleeding near the anal orifice. His condition is diagnosed as carcinoma of anal canal. At this stage of the disease, the neoplasm is located entirely below the pectinate line.Based on your anatomical knowledge, answer the following.

• To which group of lymph nodes, cancer from this part of anal canal is likely to spread?
• Name the nerve carrying pain sensation from this part of the anal canal.
• Describe briefly the interior of anal canal with the help of a diagram
• How the development, arterial supply, venous drainage and the nature of epithelial lining of the anal canal differ from each other above and below pectinate line?
• What is the significance of knowing the venous drainage of the anal canal?

Lymphatic drainage

- **Superficial inguinal lymph nodes.**

Nerve carrying pain sensation

- **Inferior rectal nerve.**

Interior of anal canal

1. **Anal columns.**
2. **Anal valves.**
3. **Anal sinuses.**
4. **Pectinate line.**
5. **White line of Hilton.**

Differences above and below pectinate line

Feature	Above pectinate line	Below pectinate line
Development	Endoderm	Ectoderm
Epithelium	Columnar	Stratified squamous
Arterial supply	Superior rectal artery	Inferior rectal artery
Venous drainage	Portal system	Systemic system
Nerve supply	Autonomic	Somatic
Lymphatics	Internal iliac nodes	Superficial inguinal nodes

Significance of venous drainage

- **Site of porto-systemic anastomosis.**
- **Internal hemorrhoids occur due to portal hypertension.**

SHORT ESSAYS

1. Briefly describe the internal features of the anal canal.

Internal features

1. **Anal columns.**
2. **Anal valves.**
3. **Anal sinuses.**
4. **Pectinate line.**
5. **White line of Hilton.**

Pectinate line

Divides upper and lower parts differing in development, blood supply and nerve supply.

Applied anatomy

- **Internal hemorrhoids occur above pectinate line.**

2. Anal canal

Extent

- **About 4 cm long.**

Interior features

- **Anal columns.**
- **Anal valves.**
- **Anal sinuses.**
- **Pectinate line.**

Blood supply

- **Superior, middle and inferior rectal arteries.**

Nerve supply

- **Above pectinate line – autonomic.**
- **Below pectinate line – inferior rectal nerve.**

Applied anatomy

- **Hemorrhoids.**

- **Fissure in ano.**

SHORT NOTES

1. Interior of anal canal

1. **Anal columns.**
2. **Anal valves.**
3. **Anal sinuses.**
4. **Pectinate line.**
5. **White line of Hilton.**

Importance of pectinate line

- **Divides visceral and somatic parts.**

LOWER LIMB

BONES

SHORT NOTES

1. Head of femur

Features

- **Two-thirds of a sphere.**
- **Directed medially, upward and forward.**
- **Articulates with acetabulum.**
- **Fovea present for ligament of head.**

Blood supply

- **Retinacular arteries.**
- **Artery to head of femur.**

Applied anatomy

- **Fracture neck femur may cause avascular necrosis.**

2. Linea aspera

Linea aspera is a rough ridge on posterior surface of femur.

Lips

1. **Medial lip.**
2. **Lateral lip.**

Attachments

- **Adductor muscles.**
- **Vastus medialis.**
- **Vastus lateralis.**
- **Short head of biceps femoris.**

Functions

- **Provides attachment to muscles.**

GLUTEAL REGION

LONG ESSAYS

1. A 15-year-old boy came with Altered Gait to the OPD after intramuscular Injection in the right buttock. On examination, he was found to be having Foot drop on the right side.

a) Based on the above case what is the Anatomical reason for the Boy's condition
b) Describe the origin, insertion and Nerve supply of Gluteus maximus
c) What are structures under the cover of Gluteus maximus
d) Anatomical basis of Trendelenburg sign

a) Anatomical reason

- **Sciatic nerve injury due to improper intramuscular injection.**
- **Common peroneal component affected causing foot drop.**

b) Gluteus maximus

Origin

- **Ilium behind posterior gluteal line.**
- **Dorsal surface of sacrum and coccyx.**
- **Sacrotuberous ligament.**

Insertion

- **Iliotibial tract.**
- **Gluteal tuberosity.**

Nerve supply

- **Inferior gluteal nerve.**

Actions

- **Powerful extensor of hip.**
- **Lateral rotator of thigh.**

c) Structures under cover of gluteus maximus

1. **Gluteus medius.**
2. **Piriformis.**
3. **Superior gemellus.**
4. **Obturator internus.**
5. **Inferior gemellus.**
6. **Quadratus femoris.**
7. **Sciatic nerve.**
8. **Posterior cutaneous nerve of thigh.**
9. **Superior and inferior gluteal vessels and nerves.**
10. **Pudendal nerve.**
11. **Internal pudendal vessels.**
12. **Trochanteric bursa.**

d) Anatomical basis of Trendelenburg sign

- **Due to paralysis of gluteus medius and minimus.**
- **Pelvis drops on opposite side during standing on affected limb.**
- **Superior gluteal nerve injury is responsible.**

2. A 12 year old boy following an inadvertent intra-muscular injection in the gluteal region developed certain neurological deficits including difficulty to dorsiflex the foot. Answer the following questions

• Mention structures undercover of gluteus maximus
• Name the structure which is affected in this case.
• Give its origin, course and distribution in thigh
• Give the cutaneous innervations of lower limb below knee
• Name the muscles responsible for dorsiflexion and eversion of foot

Structures under cover of gluteus maximus

1. **Gluteus medius.**
2. **Piriformis.**
3. **Obturator internus.**
4. **Gemelli.**
5. **Quadratus femoris.**
6. **Sciatic nerve.**
7. **Pudendal nerve.**
8. **Internal pudendal vessels.**
9. **Posterior femoral cutaneous nerve.**

Structure affected

- **Sciatic nerve.**

Origin, course and distribution of sciatic nerve

Origin

- **Ventral rami of L4, L5, S1, S2, S3.**

Course

- **Leaves pelvis through greater sciatic foramen below piriformis.**
- **Descends deep to gluteus maximus.**
- **Runs in posterior compartment of thigh.**
- **Divides into tibial and common peroneal nerves.**

Distribution in thigh

- **Supplies hamstring muscles.**
- **Articular branches to hip joint.**

Cutaneous innervation below knee

- **Saphenous nerve.**
- **Superficial peroneal nerve.**
- **Deep peroneal nerve.**
- **Sural nerve.**
- **Tibial nerve branches.**

Muscles responsible for dorsiflexion and eversion

Dorsiflexion

- **Tibialis anterior.**
- **Extensor hallucis longus.**
- **Extensor digitorum longus.**
- **Peroneus tertius.**

Eversion

- **Peroneus longus.**
- **Peroneus brevis.**

SHORT NOTES

1. Gluteus maximus

Origin

Outer surface of ilium behind posterior gluteal line

Dorsal surface of sacrum and coccyx

Sacrotuberous ligament

Thoracolumbar fascia

Insertion

Iliotibial tract

Gluteal tuberosity of femur

Nerve supply

Inferior gluteal nerve (L5, S1, S2)

Actions

Powerful extensor of hip joint

Lateral rotation of thigh

Helps in rising from sitting position

Stabilizes knee through iliotibial tract

Applied anatomy

Intramuscular injections are given in superolateral quadrant to avoid sciatic nerve injury.

2. Piriformis

Origin

Pelvic surface of sacrum

Insertion

Upper border of greater trochanter

Nerve supply

Nerve to piriformis (S1, S2)

Actions

- **Lateral rotation of extended thigh**
- **Abduction of flexed thigh**
- **Stabilizes hip joint**

Relations/Importance

- **Divides greater sciatic foramen into suprapiriform and infrapiriform compartments.**
- **Sciatic nerve usually emerges below piriformis.**

Applied anatomy

- **Piriformis syndrome may compress sciatic nerve.**

3. Structures under cover of gluteus maximus

Muscles

- **Gluteus medius**
- **Piriformis**
- **Superior gemellus**
- **Obturator internus**
- **Inferior gemellus**
- **Quadratus femoris**
- **Upper hamstring muscles**

Bones and bursae

- **Greater trochanter**
- **Ischial tuberosity**
- **Trochanteric bursa**
- **Ischial bursa**

Nerves

- **Sciatic nerve**
- **Posterior cutaneous nerve of thigh**
- **Inferior gluteal nerve**
- **Pudendal nerve**

Vessels

- **Inferior gluteal vessels**
- **Internal pudendal vessels**

4. Greater sciatic notch

Definition

- **Large notch on posterior border of hip bone.**

Boundaries

- **Above: Posterior inferior iliac spine**
- **Below: Ischial spine**

Converted into greater sciatic foramen by

- **Sacrospinous ligament**
- **Sacrotuberous ligament**

Structures passing through

- **Piriformis**
- **Sciatic nerve**

- Superior and inferior gluteal vessels and nerves
- Pudendal nerve
- Internal pudendal vessels
- Posterior cutaneous nerve of thigh

Applied anatomy

- Important route for neurovascular structures entering gluteal region.

FRONT OF THIGH

LONG ESSAYS

1. Describe the boundaries, contents and applied anatomy of femoral triangle.

Definition

Femoral triangle is a triangular depression present in the upper one-third of front of thigh below inguinal ligament.

Boundaries

Base (Superior)

- Inguinal ligament

Medial boundary

- Medial border of adductor longus

Lateral boundary

- Medial border of sartorius

Apex

- Junction of sartorius and adductor longus

Floor

- Iliopsoas laterally
- Pectineus medially
- Adductor longus medially

Roof

- Skin
- Superficial fascia
- Deep fascia (fascia lata)

Contents

From lateral to medial (NAVEL):

- Femoral nerve and branches
- Femoral artery and branches
- Femoral vein and tributaries
- Femoral canal with deep inguinal lymph node

Other contents

- Femoral sheath
- Lateral cutaneous nerve of thigh
- Femoral branch of genitofemoral nerve

Femoral sheath

A funnel-shaped fascial sleeve enclosing:

- Femoral artery
- Femoral vein

- **Femoral canal**

Femoral canal

- **Medial compartment of femoral sheath**
- **Contains lymphatics and Cloquet's node**

Applied anatomy

- **Femoral artery can be palpated at midinguinal point.**
- **Site for femoral arterial catheterization.**
- **Femoral hernia occurs through femoral canal.**
- **Femoral vein is used for venous access.**
- **Enlargement of inguinal lymph nodes may occur in infections.**

SHORT ESSAYS

1. Femoral sheath

Definition

Funnel-shaped fascial sleeve enclosing femoral vessels below inguinal ligament.

Formation

- **Anterior wall: Transversalis fascia**
- **Posterior wall: Iliac fascia**

Extent

- **Extends 3–4 cm below inguinal ligament.**

Compartments

- **Lateral compartment – Femoral artery**
- **Intermediate compartment – Femoral vein**
- **Medial compartment – Femoral canal**

Functions

- **Allows free movement of femoral vessels.**

Applied anatomy

- **Femoral hernia occurs through femoral canal.**

2. Inguinal lymph nodes

Superficial inguinal lymph nodes

Arranged in:

- **Horizontal group**
- **Vertical group**

Drainage

- **Lower limb**
- **External genitalia**
- **Lower anal canal**
- **Lower anterior abdominal wall**

Deep inguinal lymph nodes

- **Located medial to femoral vein**
- **Includes Cloquet's node**

Applied anatomy

- **Enlarged in infections and malignancy.**

3. Femoral triangle

Boundaries

- **Base: Inguinal ligament**
- **Medial: Adductor longus**
- **Lateral: Sartorius**

Floor

- **Iliopsoas and pectineus**

Roof

- **Fascia lata**

Contents

NAVEL:

- **Femoral nerve**
- **Femoral artery**
- **Femoral vein**
- **Femoral canal**

Applied anatomy

- **Femoral pulse palpation**
- **Femoral hernia**

4. Femoral canal and its applied anatomy

Definition

Medial compartment of femoral sheath.

Boundaries

Anterior – Inguinal ligament
Posterior – Pectineal ligament
Medial – Lacunar ligament
Lateral – Femoral vein

Contents

- **Fat**
- **Lymphatics**
- **Cloquet's node**

Functions

- **Allows expansion of femoral vein.**

Applied anatomy

- **Femoral hernia passes through femoral canal.**
- **More common in females.**
- **Strangulation may occur at femoral ring.**

5. Femoral artery

Origin

- **Continuation of external iliac artery behind inguinal ligament.**

Course

- **Passes through femoral triangle and adductor canal.**
- **Ends as popliteal artery at adductor hiatus.**

Branches

Superficial epigastric

Superficial circumflex iliac

External pudendal

Profunda femoris

Descending genicular

Relations

Femoral vein medial in upper part.

Applied anatomy

Femoral pulse palpation.

Arterial cannulation.

6. Adductor canal- boundaries and contents

Definition

Intermuscular passage extending from apex of femoral triangle to adductor hiatus.

Boundaries

Anteromedial wall – Sartorius
Lateral wall – Vastus medialis
Posterior wall – Adductor longus and magnus

Contents

Femoral artery

Femoral vein

Saphenous nerve

Nerve to vastus medialis

Applied anatomy

Compression of vessels may occur.

7. Femoral sheath and applied aspects

Femoral sheath

Fascial sleeve enclosing femoral vessels.

Compartments

Lateral – artery

Intermediate – vein

Medial – femoral canal

Applied aspects

Femoral hernia

Femoral vein cannulation

Spread of infection along sheath

SHORT NOTES

1. Describe the origin, insertion, nerve supply and action of rectus femoris muscle.

Origin

Straight head from anterior inferior iliac spine

Reflected head from ilium above acetabulum

Insertion

Base of patella and tibial tuberosity through patellar ligament

Nerve supply

- **Femoral nerve (L2, L3, L4)**

Actions

- **Extension of knee**
- **Flexion of hip**

2. Describe the anatomical basis of femoral hernia.

- **Femoral hernia protrudes through femoral ring into femoral canal.**
- **More common in females due to wider pelvis.**
- **Hernial sac may emerge through saphenous opening.**
- **Strangulation common because of rigid boundaries.**

3. Adductor canal

Extent

- **Apex of femoral triangle to adductor hiatus.**

Boundaries

- **Sartorius**
- **Vastus medialis**
- **Adductor longus and magnus**

Contents

- **Femoral artery**
- **Femoral vein**
- **Saphenous nerve**

4. Femoral sheath

Formation

- **Transversalis fascia and iliac fascia.**

Compartments

- **Artery**
- **Vein**
- **Femoral canal**

Applied anatomy

- **Femoral hernia.**

5. Superficial inguinal lymph nodes

Groups

- **Horizontal group**
- **Vertical group**

Drainage

- **Lower limb**
- **External genitalia**
- **Lower abdominal wall**

Applied anatomy

- **Enlarged in infections.**

6. Femoral artery

Origin

- **Continuation of external iliac artery.**

Course

- **Femoral triangle and adductor canal.**

Branches

- **Profunda femoris**
- **Superficial branches**

Applied anatomy

- **Femoral pulse.**

BACK OF THIGH

SHORT NOTES

1. Briefly describe the attachments and innervation of hamstring muscles.

Hamstring muscles

- **Semitendinosus**
- **Semimembranosus**
- **Long head of biceps femoris**
- **Hamstring part of adductor magnus**

Common features

- **Arise from ischial tuberosity**
- **Cross hip and knee joints**
- **Supplied by tibial division of sciatic nerve**

Insertions

- **Semitendinosus – upper medial tibia**
- **Semimembranosus – medial condyle of tibia**
- **Biceps femoris – head of fibula**

2. Hamstring muscles

Muscles

- **Semitendinosus**
- **Semimembranosus**
- **Biceps femoris**

Nerve supply

- **Tibial division of sciatic nerve**

Actions

- **Extension of hip**
- **Flexion of knee**

Applied anatomy

- **Hamstring strain common in athletes.**

POPLITEAL FOSSA

SHORT ESSAYS

1. Popliteal fossa

Definition

Diamond-shaped space behind knee joint.

Boundaries

Superolateral – Biceps femoris
Superomedial – Semimembranosus and semitendinosus
Inferolateral – Lateral head of gastrocnemius and plantaris
Inferomedial – Medial head of gastrocnemius

Roof

- **Skin**
- **Superficial fascia**
- **Deep fascia**

Floor

- **Popliteal surface of femur**
- **Capsule of knee joint**
- **Popliteus muscle**

Contents

From superficial to deep:

- **Tibial nerve**
- **Popliteal vein**
- **Popliteal artery**

Also:

- **Common peroneal nerve**
- **Lymph nodes**

Applied anatomy

- **Popliteal pulse palpation.**
- **Baker cyst may occur.**

LEG

SHORT ESSAYS

1. Soleus muscle

Origin

- **Posterior surface of head and upper shaft of fibula**
- **Soleal line of tibia**

Insertion

- **Calcaneus through tendo calcaneus**

Nerve supply

- **Tibial nerve (S1, S2)**

Actions

- **Plantar flexion of foot**
- **Maintains posture**

Applied anatomy

- **Called peripheral heart due to venous pumping action.**

2. Extensor retinaculum of lower limb

Superior extensor retinaculum

- **Thickening of deep fascia above ankle.**

Inferior extensor retinaculum

- **Y-shaped band on dorsum of foot.**

Structures passing deep to it

From medial to lateral:

- **Tibialis anterior tendon**
- **Extensor hallucis longus tendon**
- **Anterior tibial vessels**
- **Deep peroneal nerve**

Extensor digitorum longus tendon

Peroneus tertius tendon

Functions

Prevent bow-stringing of tendons.

SHORT NOTES

1. Structures passing beneath the extensor retinaculum of the foot

From medial to lateral:

Tibialis anterior tendon

Extensor hallucis longus tendon

Anterior tibial artery/dorsalis pedis artery

Deep peroneal nerve

Extensor digitorum longus tendon

Peroneus tertius tendon

Mnemonic: Tom Has A Dirty Nasty Dog.

FOOT

LONG ESSAYS

1. A 20-year-old male had applied for selection into defence academy in India. His application was rejected during physical examination on the grounds of Bilateral Flat Foot.

a) What is the anatomical basis of flat foot.

b) Classify arches of foot.

c) What are the components and features of each type of arches of foot.

d) What are the factors that maintain the arches of foot

Answer

Anatomical basis of flat foot

Flat foot (pes planus) occurs due to collapse of medial longitudinal arch.

Common causes:

Weakening of plantar ligaments

Tibialis posterior dysfunction

Weak plantar muscles

Obesity and prolonged standing

Classification of arches of foot

Longitudinal arches

Medial longitudinal arch

Lateral longitudinal arch

Transverse arches

Anterior transverse arch

Posterior transverse arch

Components and features

Medial longitudinal arch

Bones

- **Calcaneus**
- **Talus**
- **Navicular**
- **Three cuneiforms**
- **First three metatarsals**

Characteristics

- **Higher and more elastic**
- **Talus acts as keystone**

Lateral longitudinal arch

Bones

- **Calcaneus**
- **Cuboid**
- **Fourth and fifth metatarsals**

Characteristics

- **Lower and more rigid**

Transverse arch

Bones

- **Cuboid**
- **Cuneiforms**
- **Bases of metatarsals**

Factors maintaining arches

Passive factors

- **Shape of bones**
- **Plantar aponeurosis**
- **Spring ligament**
- **Long plantar ligament**
- **Short plantar ligament**

Active factors

- **Tibialis anterior**
- **Tibialis posterior**
- **Peroneus longus**
- **Flexor hallucis longus**
- **Intrinsic muscles of sole**

Functions of arches

- **Weight transmission**
- **Shock absorption**
- **Provide elasticity during walking**

2. Describe the arches of foot under following headings:

• Classification

• Formation

• Factors responsible for maintenance of arches

• Functions

Answer

Classification

- **Longitudinal arches**

- **Medial**
- **Lateral**

Transverse arches

Formation

Medial longitudinal arch

- **Calcaneus, talus, navicular, cuneiforms and medial metatarsals.**

Lateral longitudinal arch

- **Calcaneus, cuboid and lateral metatarsals.**

Transverse arch

- **Cuboid, cuneiforms and metatarsal bases.**

Factors maintaining arches

Static factors

- **Shape of bones**
- **Ligaments**
- **Plantar aponeurosis**

Dynamic factors

- **Muscles and tendons**

Functions

- **Shock absorption**
- **Weight distribution**
- **Adaptation to uneven surfaces**
- **Propulsion during walking**

SHORT ESSAYS

1. Describe the longitudinal arches of foot and their clinical anatomy.

Medial longitudinal arch

Bones

- **Calcaneus**
- **Talus**
- **Navicular**
- **Cuneiforms**
- **First three metatarsals**

Keystone

- **Talus**

Lateral longitudinal arch

Bones

- **Calcaneus**
- **Cuboid**
- **Fourth and fifth metatarsals**

Maintenance

- **Plantar ligaments**
- **Plantar aponeurosis**
- **Muscles**

Clinical anatomy

Flat foot due to collapse of medial arch.

Pes cavus due to exaggerated arch.

2. Arches of foot

Types

Longitudinal arches

Transverse arches

Functions

Shock absorption

Weight transmission

Maintenance

Ligaments

Muscles

SHORT NOTES

1. Inversion and eversion

Inversion

Sole turns medially.

Muscles: Tibialis anterior and tibialis posterior.

Eversion

Sole turns laterally.

Muscles: Peroneus longus and brevis.

Joints involved

Subtalar joint

Transverse tarsal joint

2. Explain the course, branches and clinical importance of dorsalis pedis artery

Course

Continuation of anterior tibial artery.

Runs on dorsum of foot.

Ends in first intermetatarsal space.

Branches

Lateral tarsal

Arcuate artery

First dorsal metatarsal artery

Deep plantar artery

Clinical importance

Dorsalis pedis pulse palpated lateral to extensor hallucis longus tendon.

Absent pulse indicates peripheral vascular disease.

3. Medial longitudinal arch of foot

Bones

Calcaneus

Talus

Navicular

Cuneiforms

First three metatarsals

Keystone

Talus

Maintenance

Spring ligament

Tibialis posterior

Plantar aponeurosis

Applied anatomy

Flat foot.

4. Plantar aponeurosis

Definition

Strong deep fascial thickening in sole.

Attachments

Calcaneus proximally

Divides into slips distally

Functions

Supports longitudinal arch

Protects deeper structures

Applied anatomy

Plantar fasciitis.

5. Dorsalis pedis artery

Origin

Continuation of anterior tibial artery.

Course

Between extensor hallucis longus and extensor digitorum longus.

Branches

Arcuate artery

Deep plantar artery

Applied anatomy

Pulse palpation.

6. Longitudinal arches foot

Types

Medial longitudinal arch

Lateral longitudinal arch

Functions

Weight bearing

Shock absorption

NERVES

LONG ESSAYS

1. Describe sciatic nerve under following headings: root value, course and relations, branches and clinical anatomy.

Root value

L4, L5, S1, S2, S3

Formation

Largest branch of sacral plexus.

Course and relations

Leaves pelvis through greater sciatic foramen below piriformis.

Enters gluteal region deep to gluteus maximus.

Descends in posterior compartment of thigh.

Lies on adductor magnus.

Divides into tibial and common peroneal nerves near upper angle of popliteal fossa.

Relations

Crossed superficially by long head of biceps femoris.

Accompanied by posterior cutaneous nerve of thigh.

Branches

Muscular branches

Semitendinosus

Semimembranosus

Biceps femoris

Hamstring part of adductor magnus

Terminal branches

Tibial nerve

Common peroneal nerve

Clinical anatomy

Sciatica due to compression of nerve roots.

Injury during intramuscular injection.

Foot drop in common peroneal nerve injury.

Posterior dislocation of hip may injure sciatic nerve.

2. 60 year old lady was brought to the casuality following a history of fall at her residence. On clinical examination, the anatomical orientation of her right lower limb was disturbed. X-ray showed posterior dislocation of her right hip joint. With your anatomical knowledge answer the following questions.

• Name the nerve which can be injured in this patient.

• Give the root value of the nerve.

• Name one clinical procedure that can cause injury to this nerve.

• Describe the course of this nerve.

• Name the branches of this nerve and the muscles supplied by those branches.

Answer

Nerve injured

Sciatic nerve

Root value

L4, L5, S1, S2, S3

Clinical procedure causing injury

Improper intramuscular injection in gluteal region.

Course

- **Leaves pelvis through greater sciatic foramen below piriformis.**
- **Descends deep to gluteus maximus.**
- **Passes through posterior thigh.**
- **Divides into tibial and common peroneal nerves.**

Branches and muscles supplied

Tibial division

- **Semitendinosus**
- **Semimembranosus**
- **Long head of biceps femoris**
- **Hamstring part of adductor magnus**

Common peroneal division

- **Short head of biceps femoris**

3.A middle aged male patient complained of low back pain radiating to leg on right side and numbness and weakness in various parts of leg and foot. The condition was diagnosed as sciatica.With your knowledge of anatomy answer the following questions.

• Describe the root value, formation and course of sciatic nerve

• Name the functional groups of muscles innervated by this nerve and its branches at various levels.

• Name the cutaneous branches of this nerve at various levels along its course

Answer

Root value

- **L4, L5, S1, S2, S3**

Formation

- **From sacral plexus.**

Course

- **Through greater sciatic foramen below piriformis.**
- **Descends in posterior thigh.**
- **Divides into tibial and common peroneal nerves.**

Functional groups supplied

In thigh

- **Hamstring muscles**

In leg by tibial nerve

- **Posterior compartment muscles**

In leg by common peroneal nerve

- **Anterior and lateral compartment muscles**

In foot

- **Intrinsic muscles of sole and dorsum**

Cutaneous branches

Tibial nerve branches

- **Medial sural cutaneous nerve**
- **Medial calcaneal branches**

Plantar nerves

Common peroneal branches

Lateral sural cutaneous nerve

Superficial peroneal nerve

Deep peroneal nerve

SHORT ESSAYS

1. Femoral nerve

Root value

L2, L3, L4

Course

Emerges from lateral border of psoas major.

Passes below inguinal ligament.

Divides in femoral triangle.

Branches

Muscular

Cutaneous

Saphenous nerve

Muscles supplied

Quadriceps femoris

Sartorius

Pectineus

Applied anatomy

Loss of knee jerk in femoral nerve injury.

2. Sciatic nerve

Root value

L4 to S3

Course

Below piriformis.

Posterior thigh.

Branches

Tibial nerve

Common peroneal nerve

Applied anatomy

Sciatica.

3. Common peroneal nerve

Root value

L4, L5, S1, S2

Course

Along medial border of biceps femoris.

Winds around neck of fibula.

Branches

Superficial peroneal nerve

Deep peroneal nerve

Applied anatomy

Injury causes foot drop.

4. Cutaneous innervation of lower limb below knee

Medial side

Saphenous nerve

Lateral side

Sural nerve

Dorsum of foot

Superficial peroneal nerve

First web space

Deep peroneal nerve

Sole

Medial and lateral plantar nerves

SHORT NOTES

1. Obturator nerve

Root value

L2, L3, L4

Course

Emerges from medial border of psoas major.

Passes through obturator canal.

Supply

Adductor muscles of thigh.

Applied anatomy

Injury causes weakened adduction.

2. Anatomical basics of foot drop

Definition

Inability to dorsiflex foot.

Cause

Common peroneal nerve injury.

Features

High stepping gait.

3. Common peroneal nerve

Course

Winds around neck of fibula.

Branches

Superficial and deep peroneal nerves.

Applied anatomy

Injury causes foot drop.

4. Sciatic nerve

Root value

L4–S3

Course

Through gluteal region and posterior thigh.

Branches

Tibial and common peroneal nerves.

5. Saphenous nerve

Origin

Branch of femoral nerve.

Course

Through adductor canal.

Along medial side of leg.

Supply

Skin of medial leg and foot.

6. Cutaneous innervation of lower limb below knee

Nerves involved

Saphenous

Sural

Superficial peroneal

Deep peroneal

Plantar nerves

JOINTS

LONG ESSAYS

1. Describe knee joint under the following headings: Articular surfaces, Capsule and intracapsular structures, Movements and muscles causing each movement.

Type

Modified hinge synovial joint.

Articular surfaces

Femoral condyles

Tibial condyles

Posterior surface of patella

Capsule

Thin and fibrous.

Deficient anteriorly.

Intracapsular structures

Anterior cruciate ligament

Posterior cruciate ligament

Medial meniscus

Lateral meniscus

Movements

Flexion

Muscles:

Hamstrings

Gastrocnemius

Extension

Muscles:

Quadriceps femoris

Medial rotation

Semitendinosus

Semimembranosus

Lateral rotation

Biceps femoris

Applied anatomy

- **Meniscal injuries**
- **Cruciate ligament tears**

2. Describe the type and articular surfaces, ligaments, movements of Hip joint. Add a note on blood supply to head and neck of femur and its related clinical anatomy.

Type

- **Ball and socket synovial joint.**

Articular surfaces

- **Head of femur**
- **Acetabulum**

Ligaments

- **Iliofemoral ligament**
- **Pubofemoral ligament**
- **Ischiofemoral ligament**
- **Ligament of head of femur**

Movements

- **Flexion**
- **Extension**
- **Abduction**
- **Adduction**
- **Medial and lateral rotation**
- **Circumduction**

Blood supply to head and neck of femur

- **Retinacular branches of medial circumflex femoral artery**
- **Lateral circumflex femoral artery**
- **Artery through ligamentum teres**

Clinical anatomy

- **Fracture neck of femur may cause avascular necrosis.**
- **Posterior dislocation may injure sciatic nerve.**

3. A football player fell down while playing football and injured his knee.

Describe the knee joint under following headings:

a) Bones articulating

b) Capsule and intracapsular structures

c) Movements and muscles causing each of the movement

Answer

Bones articulating

- **Femur**
- **Tibia**
- **Patella**

Capsule and intracapsular structures

- **Fibrous capsule**
- **ACL**

PCL

Medial and lateral menisci

Movements and muscles

Flexion

Hamstrings

Extension

Quadriceps femoris

Rotation

Semimembranosus and biceps femoris

Applied anatomy

Sports injuries commonly involve menisci and cruciate ligaments.

4. There was a posterior dislocation of hip joint in a 30-year old man injuring his sciatic nerve. Answer the following regarding hip joint.

a) Name the bones articulating

b) Ligaments

c) Movements & muscles causing them

d) Nerve supply

e) Applied aspects

Answer

Bones articulating

Head of femur

Acetabulum of hip bone

Ligaments

Iliofemoral

Pubofemoral

Ischiofemoral

Ligament of head of femur

Movements and muscles

Flexion

Iliopsoas

Extension

Gluteus maximus

Abduction

Gluteus medius and minimus

Adduction

Adductor group

Medial rotation

Gluteus medius and minimus

Lateral rotation

Piriformis and obturator internus

Nerve supply

Femoral nerve

Obturator nerve

Sciatic nerve

Superior gluteal nerve

Applied aspects

- **Posterior dislocation of hip joint may injure sciatic nerve.**
- **Fracture neck of femur can lead to avascular necrosis of head of femur due to interruption of retinacular arteries.**
- **Congenital dislocation of hip may occur due to shallow acetabulum.**
- **Osteoarthritis commonly affects hip joint causing pain and restricted movements.**
- **Trendelenburg gait occurs due to paralysis of gluteus medius and minimus.**
- **Hip joint replacement is done in severe arthritis and fractures of neck of femur.**

5. Describe the intracapsular structures of knee joint. Explain the clinical importance of any two of them.

Intracapsular Structures of Knee Joint

The intracapsular structures of the knee joint are:

- **Medial meniscus**
- **Lateral meniscus**
- **Anterior cruciate ligament (ACL)**
- **Posterior cruciate ligament (PCL)**
- **Transverse ligament of knee**
- **Meniscofemoral ligaments**
- **Infrapatellar synovial fold and alar folds**

Menisci

Medial Meniscus

- **C-shaped fibrocartilage.**
- **Attached to tibial collateral ligament and capsule.**
- **Peripheral border thick, inner border thin.**
- **Less mobile.**
- **Anterior horn attached to anterior intercondylar area.**
- **Posterior horn attached to posterior intercondylar area.**

Lateral Meniscus

- **Nearly circular.**
- **More mobile.**
- **Not attached to fibular collateral ligament.**
- **Related to tendon of popliteus.**
- **Horns attached to intercondylar area.**

Functions of Menisci

- **Deepen articular surfaces.**
- **Shock absorption.**
- **Improve stability.**
- **Aid lubrication.**

Distribute body weight.

Cruciate Ligaments

Anterior Cruciate Ligament (ACL)

Extends from anterior intercondylar area of tibia to posterior part of medial surface of lateral femoral condyle.

Prevents anterior displacement of tibia on femur.

Taut in extension.

Posterior Cruciate Ligament (PCL)

Extends from posterior intercondylar area of tibia to lateral surface of medial femoral condyle.

Prevents posterior displacement of tibia.

Stronger than ACL.

Transverse Ligament

Connects anterior ends of medial and lateral menisci.

Meniscofemoral Ligaments

Connect posterior horn of lateral meniscus to medial femoral condyle.

Two ligaments:

Ligament of Humphrey

Ligament of Wrisberg

Clinical Importance (Any Two)

1. Injury to Medial Meniscus

Commonly injured because it is less mobile and attached to tibial collateral ligament.

Twisting movements in semiflexed knee may tear it.

Produces pain, locking and swelling.

2. Anterior Cruciate Ligament Tear

Common sports injury.

Causes instability of knee.

Positive anterior drawer and Lachman tests.

Tibia moves anteriorly on femur.

3. Posterior Cruciate Ligament Tear

Occurs in dashboard injury.

Positive posterior drawer test.

Posterior displacement of tibia occurs.

6. An 18-year-old boy was hit down by car while walking on the road and sustained injury to his right knee joint. He visited to orthopaedic clinic with complaints of pain, swelling and while walking his right knee is giving out (instability). On examination, soft tissue swelling and tenderness present around right knee joint. Lachman test was performed and shows abnormal forward & backward movement of right tibia. With your anatomical knowledge, answer the following questions related to knee joint.

Describe the articular surfaces of knee joint.

The knee joint is formed by:

- **Lower end of femur**
- **Upper end of tibia**
- **Posterior surface of patella**

Femoral Articular Surfaces

- **Medial and lateral femoral condyles.**
- **Covered with hyaline cartilage.**
- **Separated posteriorly by intercondylar notch.**
- **Patellar surface present anteriorly.**

Tibial Articular Surfaces

- **Superior surfaces of medial and lateral tibial condyles.**
- **Medial surface oval and larger.**
- **Lateral surface circular.**
- **Intercondylar area lies between them.**

Patellar Articular Surface

- **Posterior surface divided into medial and lateral facets.**
- **Articulates with patellar surface of femur.**

Describe the ligaments of knee joint.

Extracapsular Ligaments

- **Patellar ligament**
- **Tibial collateral ligament**
- **Fibular collateral ligament**
- **Oblique popliteal ligament**
- **Arcuate popliteal ligament**

Intracapsular Ligaments

- **Anterior cruciate ligament**
- **Posterior cruciate ligament**
- **Menisci**
- **Transverse ligament**
- **Meniscofemoral ligaments**

Name the structure(s) that maintain the anteroposterior stability of knee joint.

- **Anterior cruciate ligament (ACL)**
- **Posterior cruciate ligament (PCL)**

What is locking and unlocking of knee joint.

Locking of Knee Joint

- **Occurs during terminal extension.**
- **Medial rotation of femur on tibia in weight-bearing limb.**
- **Produces maximum stability.**
- **Called screw-home mechanism.**

Unlocking of Knee Joint

- **Initiated by popliteus muscle.**

Causes lateral rotation of femur on tibia.

Flexion becomes possible.

Nerves that supply knee joint

Femoral nerve

Tibial nerve

Common peroneal nerve

Obturator nerve

7. 35 years male patient was bought to the casualty with a swollen right knee and a history of a fall during mountain climbing. There was severe pain and restricted mobility at the joint. Answer the following.

Describe the attachments and relations of ligaments of this joint

Tibial Collateral Ligament

Attachments

Medial femoral condyle to medial surface of tibia.

Attached to medial meniscus.

Relations

Tendons of sartorius, gracilis and semitendinosus superficial.

Medial meniscus deep.

Fibular Collateral Ligament

Attachments

Lateral femoral condyle to head of fibula.

Relations

Tendon of popliteus deep.

Biceps femoris tendon superficial.

Common peroneal nerve related.

Anterior Cruciate Ligament

Attachments

Anterior intercondylar area of tibia to medial surface of lateral femoral condyle.

Relation

Covered by synovial membrane.

Posterior Cruciate Ligament

Attachments

Posterior intercondylar area of tibia to lateral surface of medial femoral condyle.

Relation

Strongest ligament of knee.

What are the movements at this joint and which muscles are involved?

Flexion

Muscles:

Hamstrings

Sartorius

Gracilis

Gastrocnemius

Popliteus

Extension

Muscle:

Quadriceps femoris

Medial Rotation

Muscles:

Semimembranosus

Semitendinosus

Sartorius

Gracilis

Popliteus

Lateral Rotation

Muscle:

Biceps femoris

8. A 50 year old man came to the casualty with complaint of pain in the hip joint. Answer the following questions

Bones forming hip joint

Head of femur

Acetabulum of hip bone

Movements and muscles causing them

Flexion

Iliopsoas

Rectus femoris

Sartorius

Extension

Gluteus maximus

Hamstrings

Abduction

Gluteus medius

Gluteus minimus

Adduction

Adductor longus

Adductor brevis

Adductor magnus

Gracilis

Medial Rotation

Anterior fibers of gluteus medius and minimus

Lateral Rotation

Piriformis

Obturators

Gemelli

Quadratus femoris

Gluteus maximus

Blood supply

Medial circumflex femoral artery

Lateral circumflex femoral artery

Acetabular branch of obturator artery

Superior and inferior gluteal arteries

Ligaments

Iliofemoral ligament

Pubofemoral ligament

Ischiofemoral ligament

Ligament of head of femur

Transverse acetabular ligament

Nerve supply

Femoral nerve

Obturator nerve

Nerve to quadratus femoris

Superior gluteal nerve

Applied aspects

Congenital dislocation of hip

Fracture neck of femur

Osteoarthritis

Posterior dislocation of hip

Avascular necrosis of femoral head

9. A 30-years old man was brought to the casualty following a road traffic accident. On examination, his right lower limb was shorted, flexed and internally rotated. X-ray of his right hip showed posterior displacement of head of femur. Following surgical correction of dislocation of hip, the patient was not able to dorsiflex his right foot. Based on your knowledge in anatomy answer the following questions.

Injury to which nerve in posterior dislocation of hip, can produce inability to dorsiflex the foot.

Sciatic nerve, especially common peroneal division.

Briefly describe the articular surfaces, capsule and ligaments, blood supply and nerve supply of the hip joint.

Articular Surfaces

Head of femur except fovea.

Lunate surface of acetabulum.

Capsule

Proximal Attachment

Margin of acetabulum and transverse acetabular ligament.

Distal Attachment

Intertrochanteric line anteriorly.

Neck of femur posteriorly.

Ligaments

Iliofemoral ligament

Pubofemoral ligament

Ischiofemoral ligament

Ligament of head of femur

Blood Supply

- **Medial circumflex femoral artery**
- **Lateral circumflex femoral artery**
- **Acetabular branch of obturator artery**

Nerve Supply

- **Femoral nerve**
- **Obturator nerve**
- **Nerve to quadratus femoris**
- **Superior gluteal nerve**

Name the muscles acting at the hip joint and mention the appropriate movements produced by them

Flexors

- **Iliopsoas**
- **Rectus femoris**
- **Sartorius**

Extensors

- **Gluteus maximus**
- **Hamstrings**

Abductors

- **Gluteus medius**
- **Gluteus minimus**

Adductors

- **Adductor group**
- **Gracilis**

Medial Rotators

- **Gluteus medius and minimus**

Lateral Rotators

- **Piriformis**
- **Obturators**
- **Gemelli**
- **Quadratus femoris**

Mention the anatomical features render this joint prone to dislocation.

- **Weak posterior capsule.**
- **Hip flexion reduces stability.**
- **Posterior dislocation common in dashboard injury.**
- **Femoral head partly uncovered inferiorly.**

10. A footballer is suffering from sustained injury to his right knee while kicking. His leg got forcefully abducted in a slightly flexed position.

Which is the likely meniscus has injured in this case.

- **Medial meniscus.**

Why this meniscus is more prone to injury as compared to the other one.

- **Firmly attached to tibial collateral ligament and capsule.**
- **Less mobile.**

- Gets trapped during twisting injuries.

Enumerate the other intra capsular structures of the knee joint

- Lateral meniscus
- ACL
- PCL
- Transverse ligament
- Meniscofemoral ligaments
- Infrapatellar synovial fold

Briefly describe the process of locking and unlocking at the knee joint

Locking

- Occurs during terminal extension.
- Medial rotation of femur on tibia.
- Provides stability.

Unlocking

- Initiated by popliteus.
- Lateral rotation of femur.
- Flexion starts.

SHORT ESSAYS

1. Describe the cruciate ligaments and menisci of knee joint and their clinical importance

Cruciate Ligaments

Anterior Cruciate Ligament

- Extends from anterior intercondylar area of tibia to medial surface of lateral femoral condyle.
- Prevents anterior displacement of tibia.
- Taut in extension.

Posterior Cruciate Ligament

- Extends from posterior intercondylar area of tibia to lateral surface of medial femoral condyle.
- Prevents posterior displacement of tibia.
- Strongest ligament.

Menisci

Medial Meniscus

- C-shaped.
- Attached to tibial collateral ligament.
- Less mobile.

Lateral Meniscus

- Circular.
- More mobile.
- Related to tendon of popliteus.

Functions

- Shock absorption.
- Stability.
- Lubrication.

- **Weight distribution.**

Clinical Importance

- **ACL tear causes instability.**
- **Medial meniscus frequently injured.**
- **PCL injury in dashboard accidents.**
- **Locking of knee may occur.**

2. Ligaments of knee joint

Extracapsular Ligaments

- **Patellar ligament**
- **Tibial collateral ligament**
- **Fibular collateral ligament**
- **Oblique popliteal ligament**
- **Arcuate popliteal ligament**

Intracapsular Ligaments

- **ACL**
- **PCL**
- **Menisci**
- **Transverse ligament**
- **Meniscofemoral ligaments**

Functions

- **Stabilize knee joint.**
- **Prevent abnormal movements.**
- **Maintain anteroposterior stability.**

3. Movements at knee joint

Flexion

Muscles:

- **Hamstrings**
- **Sartorius**
- **Gracilis**
- **Gastrocnemius**

Extension

Muscle:

- **Quadriceps femoris**

Medial Rotation

- **Semitendinosus**
- **Semimembranosus**
- **Sartorius**
- **Gracilis**

Lateral Rotation

- **Biceps femoris**

Locking

- **Medial rotation during terminal extension.**

Unlocking

- **Popliteus initiates flexion.**

4. Hip joint

Type

Synovial ball and socket joint.

Articular Surfaces

Head of femur.

Acetabulum.

Ligaments

Iliofemoral

Pubofemoral

Ischiofemoral

Ligament of head of femur

Movements

Flexion

Extension

Abduction

Adduction

Rotation

Circumduction

Blood Supply

Circumflex femoral arteries.

Nerve Supply

Femoral

Obturator

Nerve to quadratus femoris

Applied Anatomy

Congenital dislocation.

Fracture neck femur.

Osteoarthritis.

SHORT NOTES

1. Describe the factors stabilizing the ankle joint.

Shape of trochlea of talus.

Strong collateral ligaments.

Tibia and fibula forming mortise.

Tendons around joint.

Muscle tone.

2. Ankle joint

Type

Synovial hinge joint.

Bones

Tibia

Fibula

Talus

Ligaments

Medial

Deltoid ligament.

Lateral

Anterior talofibular

Calcaneofibular

Posterior talofibular

Movements

Dorsiflexion

Plantar flexion

Nerve Supply

Deep peroneal nerve

Tibial nerve

3. Lateral rotators of hip joint.

Piriformis

Obturator internus

Obturator externus

Superior gemellus

Inferior gemellus

Quadratus femoris

Gluteus maximus

Functions:

Lateral rotation and stabilization of hip.

4. Deltoid ligament of ankle

Attachments

From medial malleolus to talus, calcaneus and navicular.

Parts

Tibionavicular

Tibiocalcaneal

Anterior tibiotalar

Posterior tibiotalar

Functions

Prevents eversion.

Stabilizes ankle.

5. Ligamentum patella

Continuation of quadriceps tendon.

Extends from apex of patella to tibial tuberosity.

Provides anterior support.

Patellar reflex tested through it.

6. Tibial collateral ligament

Strong flat band.

Extends from medial femoral condyle to medial tibia.

Attached to medial meniscus.

Prevents abduction.

Commonly injured.

7. Medial collateral ligament of knee joint

Same as tibial collateral ligament.

Attached to medial meniscus.

Prevents valgus stress.

Injury associated with medial meniscus tear.

8. Cruciate ligaments

ACL

- **Prevents anterior displacement of tibia.**

PCL

- **Prevents posterior displacement.**

Functions

- **Maintain stability.**
- **Guide movements.**

Applied Anatomy

- **Sports injuries.**
- **Drawer tests positive.**

9. Intra articular structures of knee joint

- **Medial meniscus**
- **Lateral meniscus**
- **ACL**
- **PCL**
- **Transverse ligament**
- **Meniscofemoral ligaments**
- **Infrapatellar synovial fold**

Functions:

- **Stability and shock absorption.**

10. Locking and unlocking

Locking

- **Medial rotation during terminal extension.**
- **Provides stability.**

Unlocking

- **Popliteus muscle initiates flexion.**
- **Lateral rotation occurs.**

VEINS

LONG ESSAYS

1. A 50 year old traffic police man came to a surgeon with a complaint of swollen vessels in the leg which appears prominent on standing for long periods. On examination it was found to be superficial veins of lower limb involved

What is the name of this condition and which are the vessels involved.

- **Varicose veins.**
- **Mainly great saphenous vein and tributaries.**

What is the test performed in this condition

- **Trendelenburg test**
- **Perthes test**
- **Schwartz test**

Describe the origin course and termination of these vessels

Great Saphenous Vein

Origin

Continuation of medial marginal vein of foot.

Course

Passes anterior to medial malleolus.

Ascends along medial side of leg and thigh.

Pierces cribriform fascia.

Termination

Opens into femoral vein.

Small Saphenous Vein

Origin

Continuation of lateral marginal vein.

Course

Passes behind lateral malleolus.

Ascends posteriorly in leg.

Termination

Opens into popliteal vein.

Describe the communication between superficial and deep veins and their role in venous drainage of lower limb

Perforating Veins

Connect superficial and deep veins.

Valves direct blood from superficial to deep veins.

Role

Aid venous return.

Calf muscle pump assists drainage.

Prevent venous stasis.

2. A 40 year old shopkeeper whose job requires standing up to 15 hours per day developed abnormally swollen (Varicose) veins in left leg leading to non-healing ulcers above left medial malleolus. The condition was diagnosed by a surgeon as dilated and incompetent saphenous vein and associated incompetent perforators. Based on your basic knowledge of anatomy answer the following questions.

Describe the course and relations of great saphenous vein

Course

Begins at medial end of dorsal venous arch.

Passes anterior to medial malleolus.

Ascends medial side of leg.

Passes behind medial condyle.

Ascends medial thigh.

Pierces cribriform fascia.

Terminates into femoral vein.

Relations

Accompanied by saphenous nerve in leg.

Name the tributaries of great saphenous vein

Superficial epigastric vein

Superficial circumflex iliac vein

Superficial external pudendal vein

Anterior accessory vein

Posterior accessory vein

What are perforating veins and what is its function.

Veins connecting superficial and deep veins.

Valves direct blood towards deep veins.

Help venous return.

Describe the various perforating veins in lower limb.

Cockett perforators

Boyd perforator

Dodd perforator

Name the tests performed for observing competence of superficial veins

Trendelenburg test

Perthes test

Schwartz test

SHORT ESSAYS

1. Anatomical basis of varicose veins and deep vein thrombosis in lower limbs.

Varicose Veins

Dilated tortuous superficial veins.

Due to valve incompetence.

Common in great saphenous vein.

Causes

Prolonged standing.

Pregnancy.

Obesity.

Applied Anatomy

Venous ulcers near medial malleolus.

Deep Vein Thrombosis

Clot formation in deep veins.

Common in deep veins of leg.

Predisposing Factors

Immobilization.

Surgery.

Hypercoagulable states.

Complication

Pulmonary embolism.

2. Formation, course, tributaries and termination of great saphenous vein. Give its applied importance.

Formation

Continuation of medial marginal vein.

Course

Anterior to medial malleolus.

Medial side of leg and thigh.

Pierces cribriform fascia.

Tributaries

Superficial epigastric

Superficial circumflex iliac

External pudendal veins

Termination

Femoral vein.

Applied Importance

Varicose veins.

Venous cut down.

Used for grafts in bypass surgery.

3. Venous drainage of lower limb

Superficial Veins

Great saphenous vein

Small saphenous vein

Deep Veins

Accompany arteries.

Perforators

Connect superficial and deep systems.

Mechanism of Venous Return

Muscle pump.

Venous valves.

SHORT NOTES

1. Clinical importance of venous drainage of lower limb

Varicose veins.

Deep vein thrombosis.

Venous ulcers.

Pulmonary embolism.

Venous cut down.

2. Great saphenous vein

Longest vein in body.

Origin from medial marginal vein.

Ends in femoral vein.

Accompanied by saphenous nerve.

Applied:

Varicose veins.

Coronary bypass graft.

3. Anatomical basis of dilated veins of lower limb.

Valve incompetence.

Increased venous pressure.

Failure of muscle pump.

Common in prolonged standing.

SYSTEMIC EMBRYOLOGY RELATED TO THORAX, ABDOMEN & PELVIS, LOWER LIMB

LONG ESSAYS

1. A 2-month old male child was brought to the hospital since the mother noticed the left scrotum of the boy was empty. On examination it was noticed that the right testis was in the scrotum. A swelling of 1.5 cm diameter was noted in the left inguinal region. On ultrasound examination it was confirmed that the left testis was in inguinal canal.

Mention any two conditions resulting in empty scrotum in newborn.

- **Undescended testis (cryptorchidism)**
- **Ectopic testis**

Describe the development and descent of testis.

Development of Testis

- **Develops from genital ridge.**
- **Primordial germ cells migrate into ridge.**
- **Testis cords form seminiferous tubules.**
- **Interstitial cells form Leydig cells.**

Descent of Testis

- **Governed by gubernaculum.**
- **Testis descends from posterior abdominal wall.**
- **Passes through inguinal canal.**
- **Reaches scrotum before birth.**

Coverings of testis

- **Skin**
- **Dartos fascia**
- **External spermatic fascia**
- **Cremasteric fascia and muscle**
- **Internal spermatic fascia**
- **Tunica vaginalis**
- **Tunica albuginea**

Microscopic structure of testis

- **Covered by tunica albuginea.**
- **Divided into lobules.**
- **Seminiferous tubules lined by germinal epithelium.**
- **Sertoli cells support spermatogenesis.**
- **Interstitial Leydig cells produce testosterone.**

SHORT ESSAYS

1. Describe the development of kidney and its associated anomalies.

Development

- **Kidney develops from intermediate mesoderm.**
- **Three stages:**
  - **Pronephros**
  - **Mesonephros**
  - **Metanephros**
- **Metanephros forms permanent kidney.**

Ureteric bud forms collecting system.

Metanephric blastema forms nephrons.

Anomalies

Horseshoe kidney

Pelvic kidney

Polycystic kidney

Renal agenesis

Duplex ureter

2. Midgut – Derivatives, Rotation and Associated anomalies

Derivatives

Distal duodenum.

Jejunum.

Ileum.

Cecum.

Appendix.

Ascending colon.

Proximal two-thirds transverse colon.

Rotation

Physiological herniation occurs.

Midgut rotates 270° anticlockwise around superior mesenteric artery.

Anomalies

Nonrotation

Malrotation

Volvulus

Meckel diverticulum

SHORT NOTES

1. Development and congenital anomalies of hindgut.

Development

Hindgut forms distal one-third transverse colon, descending colon, sigmoid colon, rectum and upper anal canal.

Cloaca divided by urorectal septum.

Congenital Anomalies

Imperforate anus

Rectourethral fistula

Hirschsprung disease

2. Briefly explain the fetal circulation and changes taking place in newborn after birth

Fetal Circulation

Oxygenated blood from placenta through umbilical vein.

Ductus venosus bypasses liver.

Foramen ovale allows right to left atrial shunt.

Ductus arteriosus connects pulmonary trunk to aorta.

Changes After Birth

Closure of umbilical vessels.

Closure of foramen ovale.

Closure of ductus arteriosus.

Pulmonary circulation established.

3. Development of interatrial septum

Septum primum grows downward.

Ostium primum closes.

Ostium secundum forms.

Septum secundum develops.

Foramen ovale persists in fetus.

Closes after birth.

4. Para mesonephric duct

Also called Müllerian duct.

Forms uterine tube, uterus and upper vagina in females.

Regresses in males.

5. Formation and fate of the para mesonephric duct

Formation

Invagination of coelomic epithelium.

Fate

Female

Forms uterine tubes, uterus and upper vagina.

Male

Mostly regresses.

6. Development of pancreas

Develops from dorsal and ventral pancreatic buds.

Ventral bud rotates posteriorly.

Buds fuse.

Derivatives

Ventral bud forms uncinate process and part of head.

Dorsal bud forms remaining pancreas.

Anomalies

Annular pancreas.

Pancreas divisum.

7. Inter ventricular septum

Muscular part develops upward from ventricular floor.

Membranous part forms from endocardial cushions.

Defect causes ventricular septal defect.

8. List the derivatives of mesonephric duct in males

Epididymis

Ductus deferens

Seminal vesicle

Ejaculatory duct

Appendix epididymis

9. Right atrial development

Primitive atrium forms trabeculated part.

Right horn of sinus venosus forms smooth part.

Crista terminalis separates two parts.

10. Meckel's diverticulum

Persistence of vitellointestinal duct.

Located on ileum.

May contain ectopic gastric mucosa.

Causes bleeding and inflammation.

11. Development of portal vein

Develops from vitelline veins.

Anastomosis between vitelline veins forms portal vein.

12. Development of lungs

Respiratory diverticulum arises from foregut.

Bronchial buds form lungs.

Branching forms bronchial tree.

Stages

Pseudoglandular

Canalicular

Saccular

Alveolar

13. Developmental descent of testis

Testis develops on posterior abdominal wall.

Guided by gubernaculum.

Passes through inguinal canal.

Reaches scrotum before birth.

Applied Anatomy

Cryptorchidism.

Inguinal hernia.

14. Derivatives of midgut

Distal duodenum

Jejunum

Ileum

Cecum

Appendix

Ascending colon

Proximal two-thirds transverse colon

15. Derivatives of pre-arterial segment of midgut loop

The midgut loop is supplied by the superior mesenteric artery. The artery divides the loop into:

Pre-arterial (cranial) segment

Post-arterial (caudal) segment

Derivatives of Pre-arterial Segment

The pre-arterial segment gives rise to:

- **Distal part of duodenum**
- **Jejunum**
- **Part of ileum**

Features

- **Forms upper part of intestinal loops**
- **Develops rapidly during physiological herniation**
- **Forms most of the small intestine**

Blood Supply

- **Superior mesenteric artery**

Applied Anatomy

- **Malrotation of midgut may produce intestinal obstruction.**
- **Failure of return of midgut loop causes congenital umbilical hernia.**

16. Development of anal canal

The anal canal develops from two embryological sources:

- **Upper part from hindgut endoderm**
- **Lower part from proctodeum (ectoderm)**

Development

Upper Two-Thirds

- **Develops from dorsal part of cloaca**
- **Endodermal in origin**
- **Lined by columnar epithelium**

Lower One-Third

- **Develops from proctodeum**
- **Ectodermal in origin**
- **Lined by stratified squamous epithelium**

Pectinate Line

- **Junction between endoderm and ectoderm**
- **Represents site of anal membrane**

Anal Membrane

- **Initially separates hindgut from proctodeum**
- **Ruptures during development to establish communication**

Differences Above and Below Pectinate Line

Above Pectinate Line	Below Pectinate Line
Endodermal origin	Ectodermal origin
Columnar epithelium	Stratified squamous epithelium
Superior rectal artery supply	Inferior rectal artery supply
Portal venous drainage	Systemic venous drainage
Autonomic nerve supply	Somatic nerve supply

Applied Anatomy

Internal hemorrhoids occur above pectinate line.

External hemorrhoids occur below pectinate line.

SYSTEMIC HISTOLOGY related to THORAX, ABDOMEN & PELVIS, LOWER LIMB

SHORT ESSAYS

1. Describe the microanatomy of the kidney. What are the components of the juxtaglomerular apparatus

Microanatomy of Kidney

The kidney is composed of an outer cortex and inner medulla.

1. Renal Cortex

It contains:

- **Renal corpuscles**
- **Proximal convoluted tubules**
- **Distal convoluted tubules**
- **Medullary rays**

Renal Corpuscle

It consists of:

- **Glomerulus – tuft of capillaries**
- **Bowman's capsule**
  - **Parietal layer – simple squamous epithelium**
  - **Visceral layer – podocytes**
- **Bowman's space**

Proximal Convoluted Tubule

- **Lined by simple cuboidal epithelium with brush border**
- **Cells are eosinophilic**
- **Lumen appears narrow**
- **Site of maximum reabsorption**

Distal Convoluted Tubule

- **Lined by simple cuboidal epithelium without brush border**
- **Wider lumen**
- **Less eosinophilic**
- **Involved in ion exchange**

2. Renal Medulla

Contains:

- **Loops of Henle**
- **Collecting tubules and ducts**
- **Vasa recta**

Loop of Henle

- **Thin segment lined by simple squamous epithelium**
- **Thick segment lined by cuboidal epithelium**

Collecting Ducts

- **Lined by cuboidal to columnar epithelium**

- Unite to form ducts of Bellini

Blood Supply

Renal artery → Interlobar arteries → Arcuate arteries → Interlobular arteries → Afferent arterioles → Glomerular capillaries → Efferent arterioles → Peritubular capillaries/vasa recta.

Functions

- Formation of urine
- Regulation of electrolyte balance
- Maintenance of acid-base balance
- Endocrine function (renin, erythropoietin)

Components of Juxtaglomerular Apparatus

Juxtaglomerular apparatus is located near the vascular pole of renal corpuscle.

It consists of:

- Juxtaglomerular cells
  - Modified smooth muscle cells of afferent arteriole
  - Secrete renin
- Macula densa
  - Specialized cells of distal convoluted tubule
  - Detect sodium concentration
- Extraglomerular mesangial cells (Lacis cells)
  - Present between afferent and efferent arterioles
  - Provide support and communication

Functions of Juxtaglomerular Apparatus

- Regulation of blood pressure
- Regulation of glomerular filtration rate
- Secretion of renin

2. Describe the microscopic features of fundus and pyloric part of stomach

General Structure of Stomach

Wall of stomach consists of:

- Mucosa
- Submucosa
- Muscularis externa
- Serosa

Fundus of Stomach

Mucosa

- Lined by simple columnar mucus secreting epithelium
- Gastric pits are short
- Gastric glands are long, straight and branched tubular glands

Cells of Fundic Glands

- Mucous neck cells

- Secrete mucus
- Chief cells
  - Basophilic cells
  - Secrete pepsinogen
- Parietal cells
  - Large eosinophilic cells
  - Secrete hydrochloric acid and intrinsic factor
- Enteroendocrine cells
  - Secrete hormones

Submucosa

- Dense connective tissue
- Contains blood vessels and Meissner's plexus

Muscularis Externa

Three layers:

- Inner oblique
- Middle circular
- Outer longitudinal

Serosa

- Thin connective tissue covered by mesothelium

Pyloric Part of Stomach

Mucosa

- Gastric pits are deep
- Pyloric glands are short, branched and coiled

Cells

- Mucous cells
  - Predominant
  - Secrete mucus
- Enteroendocrine cells
  - G cells secrete gastrin

Features Differentiating Fundus and Pylorus

Fundus	Pylorus
Short pits	Deep pits
Long straight glands	Short coiled glands
Numerous parietal and chief cells	Predominantly mucous cells
Acid secretion	Mucus secretion

3. Explain the microscopic structure of small intestine

Layers of Small Intestine

- Mucosa
- Submucosa
- Muscularis externa
- Serosa/adventitia

Mucosa

Epithelium

- Simple columnar epithelium

- **Contains absorptive cells with microvilli**
- **Goblet cells present**

Intestinal Villi

- **Finger-like projections**
- **Covered by epithelium**
- **Core contains lamina propria and lacteal**

Crypts of Lieberkuhn

Tubular glands present between villi.

Cells present:

- **Absorptive cells**
- **Goblet cells**
- **Paneth cells**
- **Enteroendocrine cells**
- **Stem cells**

Lamina Propria

- **Loose connective tissue**
- **Contains blood vessels, lymphatics and lymphoid tissue**

Muscularis Mucosa

- **Thin smooth muscle layer**

Submucosa

- **Dense connective tissue**
- **Contains Meissner's plexus**
- **Duodenum contains Brunner's glands**

Muscularis Externa

- **Inner circular layer**
- **Outer longitudinal layer**
- **Myenteric plexus present between layers**

Serosa

- **Outer covering of mesothelium**

Regional Differences

Duodenum

- **Broad villi**
- **Brunner's glands present**

Jejunum

- **Long villi**
- **No Brunner's glands or Peyer's patches**

Ileum

- **Short villi**
- **Peyer's patches present**
- **More goblet cells**

Functions

- **Digestion**
- **Absorption**
- **Secretion**

4. Microscopic structure of stomach with neat labelled diagram

Microscopic Structure of Stomach

The wall of stomach has four layers:

- **Mucosa**
- **Submucosa**
- **Muscularis externa**
- **Serosa**

1. Mucosa

Epithelium

- **Simple columnar mucus secreting epithelium**

Gastric Pits

- **Invaginations of surface epithelium**
- **Open into gastric glands**

Gastric Glands

Contain:

- **Mucous neck cells**
- **Chief cells**
- **Parietal cells**
- **Enteroendocrine cells**

Lamina Propria

- **Loose connective tissue between glands**

Muscularis Mucosa

- **Thin smooth muscle layer**

2. Submucosa

- **Dense irregular connective tissue**
- **Contains blood vessels and Meissner's plexus**

3. Muscularis Externa

Three layers:

- **Inner oblique**
- **Middle circular**
- **Outer longitudinal**

Auerbach's plexus lies between muscle layers.

4. Serosa

- **Connective tissue covered by mesothelium**

Functions

- **Digestion of food**
- **Secretion of hydrochloric acid and enzymes**
- **Protection by mucus**

Diagram

REFER DIAGRAM SECTION

5. Uterus - Microscopic anatomy and changes in different phases of uterine cycle

Microscopic Anatomy of Uterus

Wall of uterus consists of:

- **Endometrium**
- **Myometrium**
- **Perimetrium**

1. Endometrium

Consists of:

- **Surface epithelium**
- **Lamina propria**
- **Uterine glands**

Epithelium

- **Simple columnar epithelium**
- **Ciliated and secretory cells present**

Uterine Glands

- **Simple tubular glands**

Layers

- **Stratum functionalis**
- **Stratum basalis**

2. Myometrium

- **Thick smooth muscle layer**
- **Contains blood vessels**

3. Perimetrium

- **Outer serous covering**

Changes During Uterine Cycle

1. Menstrual Phase

- **Shedding of stratum functionalis**
- **Rupture of blood vessels**
- **Hemorrhage occurs**

2. Proliferative Phase

- **Under estrogen influence**
- **Regeneration of endometrium**
- **Glands are straight and narrow**
- **Spiral arteries lengthen**

3. Secretory Phase

- **Under progesterone influence**
- **Endometrium thickens**
- **Glands become tortuous and secrete glycogen**
- **Spiral arteries become coiled**

Functions of Uterus

- **Implantation**
- **Nourishment of embryo**
- **Menstruation**

6. Histology of ovary

Coverings of Ovary

- **Germinal epithelium**
  - **Simple cuboidal epithelium**

Tunica albuginea

Dense connective tissue

Regions of Ovary

Cortex

Medulla

Cortex

Contains ovarian follicles in different stages.

Primordial Follicle

Primary oocyte surrounded by flattened follicular cells

Primary Follicle

Cuboidal granulosa cells

Zona pellucida appears

Secondary Follicle

Multiple granulosa cell layers

Theca interna and externa develop

Mature Graafian Follicle

Large antrum present

Oocyte attached by cumulus oophorus

Corpus Luteum

Formed after ovulation

Secretes progesterone

Corpus Albicans

Fibrous scar tissue

Medulla

Loose connective tissue

Blood vessels, nerves and lymphatics present

Functions

Oogenesis

Hormone secretion

7. Histology of pancreas

Pancreas is a mixed gland with exocrine and endocrine parts.

Capsule

Thin connective tissue capsule

Septa divide gland into lobules

Exocrine Part

Composed of serous acini.

Acinar Cells

Pyramidal cells

Basal basophilia

Apical zymogen granules

Centroacinar Cells

Present within acini

Beginning of intercalated ducts

Duct System

Intercalated ducts → Intralobular ducts → Interlobular ducts.

Pancreas does not contain striated ducts.

Endocrine Part

Represented by Islets of Langerhans.

Types of Cells

- **Alpha cells – glucagon**
- **Beta cells – insulin**
- **Delta cells – somatostatin**
- **PP cells – pancreatic polypeptide**

Functions

- **Exocrine secretion of digestive enzymes**
- **Endocrine regulation of blood glucose**

SHORT NOTES

1. Histology of suprarenal gland

Suprarenal gland consists of:

- **Capsule**
- **Cortex**
- **Medulla**

Cortex

Has three zones:

Zona Glomerulosa

- **Cells arranged in arches**
- **Secretes mineralocorticoids**

Zona Fasciculata

- **Largest zone**
- **Cells arranged in cords**
- **Secretes glucocorticoids**

Zona Reticularis

- **Cells form network**
- **Secretes sex hormones**

Medulla

- **Contains chromaffin cells**
- **Secretes adrenaline and noradrenaline**

2. Histology of Testes

Testis is covered by tunica albuginea.

Seminiferous Tubules

Lined by germinal epithelium containing:

- **Spermatogenic cells**
- **Sertoli cells**

Spermatogenic Cells

- **Spermatogonia**
- **Primary spermatocytes**
- **Secondary spermatocytes**
- **Spermatids**
- **Spermatozoa**

Sertoli Cells

Functions:

- **Support and nourishment**
- **Blood-testis barrier**

Interstitial Cells of Leydig

- **Present between tubules**
- **Secrete testosterone**

3. Describe the microscopic structure of liver

Liver is covered by thin connective tissue capsule.

Classical Hepatic Lobule

- **Hexagonal structure**
- **Central vein in center**
- **Portal triads at corners**

Hepatocytes

- **Arranged in cords**
- **Polygonal cells with central nucleus**

Sinusoids

- **Present between hepatic cords**
- **Lined by endothelial and Kupffer cells**

Portal Triad

Contains:

- **Branch of portal vein**
- **Branch of hepatic artery**
- **Bile ductule**

Bile Canaliculi

- **Present between hepatocytes**

Functions:

- **Bile secretion**
- **Metabolism**
- **Detoxification**

4. Histology of kidney

Kidney consists of cortex and medulla.

Cortex

Contains:

- **Renal corpuscles**
- **Proximal convoluted tubules**
- **Distal convoluted tubules**

Renal Corpuscle

Consists of glomerulus and Bowman's capsule.

Proximal Convoluted Tubule

- **Cuboidal cells with brush border**

Distal Convoluted Tubule

- **Cuboidal cells without brush border**

Medulla

Contains:

- Loops of Henle
- Collecting ducts

Functions:

- Urine formation
- Electrolyte balance

5. Microscopic structure of spleen

Spleen is surrounded by fibroelastic capsule.

Components

- White pulp
- Red pulp

White Pulp

- Lymphoid tissue around central artery
- Contains Malpighian corpuscles

Red Pulp

Contains:

- Splenic cords of Billroth
- Venous sinusoids

Functions

- Filtration of blood
- Destruction of old red blood cells
- Immune function

6. Histology of appendix

Appendix resembles large intestine.

Mucosa

- Simple columnar epithelium
- Numerous goblet cells
- Crypts of Lieberkuhn present

Lamina Propria

- Extensive lymphoid tissue present

Submucosa

- Contains lymphoid follicles

Muscularis Externa

- Inner circular and outer longitudinal layers

Characteristic Feature

- Abundant lymphoid tissue

7. Histology of ureter

Wall of ureter consists of:

- Mucosa
- Muscularis
- Adventitia

Mucosa

- Lined by transitional epithelium
- Mucosa forms folds

Lamina Propria

- Fibroelastic connective tissue

Muscularis

- **Upper two-thirds: inner longitudinal and outer circular layers**
- **Lower one-third: additional outer longitudinal layer**

Adventitia

- **Connective tissue with vessels and nerves**

Function:

- **Transport of urine**

8. Histology of pancreas

Pancreas is a mixed gland.

Exocrine Part

- **Serous acini present**
- **Acinar cells contain zymogen granules**
- **Centroacinar cells present**

Endocrine Part

- **Islets of Langerhans present**

Types of Cells

- **Alpha cells**
- **Beta cells**
- **Delta cells**

Function:

- **Digestive enzyme secretion**
- **Hormone secretion**

9. Microscopic structure of prostate

Prostate is a fibromusculoglandular organ.

Capsule

- **Fibrous capsule present**

Glands

- **Compound tubuloalveolar glands**
- **Lined by columnar epithelium**

Stroma

- **Fibromuscular tissue**

Corpora Amylacea

- **Rounded eosinophilic bodies in lumen**

Function:

- **Secretion of prostatic fluid**

10. Microscopic structure of supra renal gland

Suprarenal gland has:

- **Capsule**
- **Cortex**
- **Medulla**

Cortex

Zona Glomerulosa

- **Mineralocorticoid secretion**

Zona Fasciculata

Glucocorticoid secretion

Zona Reticularis

Sex hormone secretion

Medulla

Chromaffin cells present

Secretes catecholamines

11. Histology of hepatic and portal lobule

Classical Hepatic Lobule

Hexagonal unit

Central vein at center

Portal triads at corners

Blood flows from periphery to center

Portal Lobule

Triangular unit

Bile duct at center

Central veins at corners

Represents bile secretion unit

Difference

Hepatic Lobule	Portal Lobule
Functional unit for blood flow	Functional unit for bile secretion
Central vein at center	Portal triad at center
Hexagonal	Triangular

GENERAL QUESTIONS

SHORT NOTES

1. Reflect on the following scenarios in the dissection hall:

i) Placing anatomy books and dissection instruments on the cadaver

ii) Taking pictures of tablemates around the cadaver table and uploading them on social media

i) Placing anatomy books and dissection instruments on the cadaver

Cadaver should be treated with dignity and respect.

Cadaver is considered the first teacher in anatomy.

Keeping books or instruments on cadaver is unethical and disrespectful.

It may damage the cadaver and reflects poor professional attitude.

Proper discipline and decorum should be maintained in dissection hall.

ii) Taking pictures of tablemates around the cadaver table and uploading them on social media

Taking photographs in dissection hall is unethical unless officially permitted.

Uploading cadaver images on social media violates confidentiality and dignity of donor.

It may hurt sentiments of family members and society.

- **Medical students should maintain professionalism and ethical conduct.**
- **Respect for body donors should always be maintained.**

2. How should a medical practitioner communicate to patients.

A medical practitioner should communicate effectively and compassionately with patients.

Principles of Good Communication

- **Listen attentively to patient complaints.**
- **Use simple and understandable language.**
- **Maintain eye contact and empathy.**
- **Respect patient privacy and confidentiality.**
- **Explain diagnosis and treatment clearly.**
- **Encourage patient questions.**
- **Obtain informed consent before procedures.**
- **Avoid rude or judgmental behavior.**
- **Maintain professional attitude.**
- **Provide emotional support and reassurance.**

Importance

- **Builds trust between doctor and patient**
- **Improves treatment compliance**
- **Reduces anxiety and misunderstandings**
- **Enhances doctor-patient relationship**

3. Describe the importance of communication skill in medical profession

Importance of Communication Skills

- **Establishes good doctor-patient relationship.**
- **Helps in accurate history taking.**
- **Improves patient satisfaction.**
- **Increases treatment compliance.**
- **Helps in counseling patients and relatives.**
- **Reduces medical errors and misunderstandings.**
- **Essential for teamwork among healthcare workers.**
- **Important in obtaining informed consent.**
- **Improves professional ethics and empathy.**
- **Enhances overall quality of healthcare.**

Conclusion

Good communication is an essential clinical skill for every doctor and improves patient care.

4. Reflect on the statement "Respect for Cadaver in the dissection hall".

Cadaver is regarded as the first teacher of medical students.

Importance of Respect for Cadaver

- **Cadaver donation is a noble act for medical education.**
- **Students learn anatomy through dissection.**
- **Respectful behavior reflects professional ethics.**
- **Proper handling preserves dignity of donor.**
- **Silence and discipline should be maintained in dissection hall.**
- **Photography and disrespectful acts should be avoided.**
- **Cadaver should be covered properly after dissection.**
- **Gratitude towards body donors should be maintained.**

Conclusion

Respect for cadaver develops professionalism, ethics and empathy in future doctors.