# HBB Notes

## Topics Covered:

Week 1: Terms, Tissues and Imaging

Week 2: Skeletal System

Week 3: Muscles and Movement

Week 4: Introduction to the Nervous System

Week 5: Central Nervous System

Week 6: Peripheral Nervous System

Week 7: Autonomic Nervous System + Special Senses

Week 8: The Back

Week 9: Thoracic Cavity

Week 10: Abdominopelvic cavity

## Week 1: Terms, Tissues and Imaging

### Learning objectives: (refer to 'Terminology readings and checklist')

**Terminology:**

1. Define anatomical fact, concept and principle. Apply principle D1 to some of the organs or organ systems you studied in HBA. Suggest ways in which the use of principles can assist in your learning of anatomy.

D1: Structure reflects function.

2. Explain what is meant by 'anatomical relationships.' Describe how you might use the following pairs of terms: anterior and posterior (or ventral and dorsal); superior and inferior (or cranial and caudal); proximal and distal; medial and lateral; superficial and deep.

Give an example of how principle D2 (The anatomy of the human body has a commonly accepted pattern but there may be variation from one person to another) may apply to this objective.

3. Describe and demonstrate: the anatomical position of reference (or standard anatomical position); median sagittal plane and parasagittal planes; coronal (or frontal) plane; transverse (or horizontal) plane.

Using appropriate anatomical terminology, describe the relative position of the two parts of the body separated by each of these planes.

4. Define each of the following terms and then, using principle M1 and the body planes for reference, demonstrate and describe the following movements: flexion and extension; dorsiflexion and plantarflexion (ankle); abduction and adduction; pronation and supination (forearm); elevation and depression (jaw); protraction and retraction (jaw); circumduction.

Suggest why principle M1 (*Simple movements of the body or its parts take place in directions parallel to the body's planes of reference*) does not apply to the last movement.

**Tissues:**

5. List the four basic tissue types found in the human body. What is each tissue's basic function? Give an example of each tissue type in the body.
6. Describe the special characteristics of epithelial tissue and give examples of the following epithelial layers:

- simple squamous
- simple cuboidal
- simple columnar
- stratified squamous

7. List the typical components of connective tissue and describe the function(s) of each component.

Using principle T1, and with reference to these components, explain the differences in structure for the different types of connective tissue listed and give an example of a location, in the body, of each of the following types of connective tissue:

- Loose connective tissue - including the subcutaneous layer (also called the hypodermis or superficial fascia) and adipose tissue;
- Dense connective tissue - deep fascia, tendon and ligament:
- Cartilage - hyaline and fibrocartilage;
- Bone - compact and cancellous.

T1: Tissues with common components which are present in different amounts or arranged in different ways have different functions.

8. Revise the locations of the major body cavities and the major subdivisions. Name these cavities and their major subdivisions and list the major organs found within each one.

Explain what is meant by “viscera”. Name the serous membranes that line each of the anterior body cavities and name the tissue types that they are made from. Use principles RV1 and RV6 to describe their function(s) and determine if they perform a common function.

Describe the tissue layers of the body from superficial to deep and state the type of tissue contained in each layer. Define the terms 'somatic' and 'visceral' and describe the layers as either somatic or visceral.

RV1: Body cavities may have hard and/or soft tissue walls and are generally lined with secretory membranes.

RV6: In serous fluid-filled cavities which occur within the major body cavities, friction between organs and the body wall and between the organs themselves is limited, and mobility enhanced, by serous fluid derived from the membranes lining the walls of the cavity.

9. Use principle T2 to explain why a cut to the skin will heal quickly, while a torn tendon will take weeks or months to heal.

T2: Tissue growth, tissue maintenance and repair depend on a good blood supply.

**Medical Imaging:**

10. Use principle R1 to describe the relationship between tissue density and absorption of x-rays and state how these differences contribute to image grey scale and contrast.
11. Using principle R3, describe why the body part to be examined is placed closest to the x-ray plate.
12. Consider principle R2, and then list some of the potential effects of radiation on human health.
13. State what is meant by the term 'projection' when used in radiology. Define the common radiographic positioning terminology by describing the orientation of the body segment relative to the film and the orientation of the beam relative to the body segment. Discuss why a minimum of two views that are perpendicular to each other are required to exclude any abnormality.

Projections:

- AP
- PA
- Axial
- lateral

14. Describe the physical basis of the other main imaging modalities (listed below) and list the tissue types best visualized with each modality.

Modalities:

- Fluoroscopy
- Computerized tomography (CT)
- Ultrasound
- Magnetic resonance imaging (MRI)
- Nuclear medicine.

15. State the advantages and disadvantages, compared to plain radiographs, of these other imaging modalities in terms of tissues visualized, risks and cost.

**Notes from Workshop:**

- Hypodermis/superficial fascia is layer immediately under external skin
- Next layer under is deep fascia
- Intermuscular septum is deep fascia going to bone
- Also consider adipose tissue (fatty) layer
- Veins are represented by small ovals

NOTE: Refer to page 27 for labelled diagrams.

## Terminology:

**What is anatomy?**

Anatomy is the study of structure of the body in relation to its function.

*Examples*: systematic anatomy, regional anatomy, functional anatomy, embryology, histology, medical imaging

**Studying anatomy by using anatomical facts, concepts and principles:**

*Fact, concept and principle = ways of learning anatomy*

Anatomical facts:

- Isolated observations or statements about structures (body parts) or events (happenings).
- Taken in isolation each of these facts does not convey much information to link structure to function

Examples:

- An example of a muscle is quadriceps femoris.
- There are 206 bones making up the skeleton.

Anatomical concepts:

Structures (or classes of structures) or events each with common, defining characteristics:

- Components (what)
- Relationships (where)
- Functions (why)

E.g. Quadriceps femoris – as a concept:

- *What:* a skeletal muscle with four parts
- *Where: in the anterior compartment of the thigh and crossing the knee joint anteriorly*
- *Why:* knee extensor – because the muscle crosses the knee joint anteriorly, it will cause an anterior movement, called extension, at this joint.

Anatomical principles:

- Generalisations about recurring patterns of association of concepts in different parts of the body
- Each principle gives a guideline which can be applied in a number of different locations in different parts of the body where the same association of structures or events occur

- *Example:* structure reflects function (principle); for the knee joint, movement occurs in a sagittal plane in an anterior or posterior direction (application)

**Anatomical relationships:**

The relationships of an anatomical structure can be described in terms of where it is relative to something else, i.e. what lies anterior, posterior, superior, inferior, etc.

*Terms used to describe the relationships:*

- Anterior and posterior (or ventral and dorsal)
- Superior and inferior (or cranial and caudal)
- Proximal and distal
- Medial and lateral
- Superficial and deep
- Left and right

Anterior (ventral): at the front of the body

Posterior (dorsal): at the back of the body

Superior (cranial): towards the head end or the upper part of a structure or a body

Inferior (caudal): away from the head end or toward the lower part of a structure or body

Proximal: closer to the origin of the body part or the point of attachment of a limb to the body trunk (e.g. upper arm)

Distal: farther from the origin of a body part or the point of attachment of a limb to the body trunk (e.g. fingers)

Medial: towards or at the middle of the body

Lateral: away from the middle of the body

Superficial: towards or at the body surface (external)

Deep: away from the body surface (internal)

Left/Right: refers to the left and right from the perspective of the person you're analysing (opposite to your own)

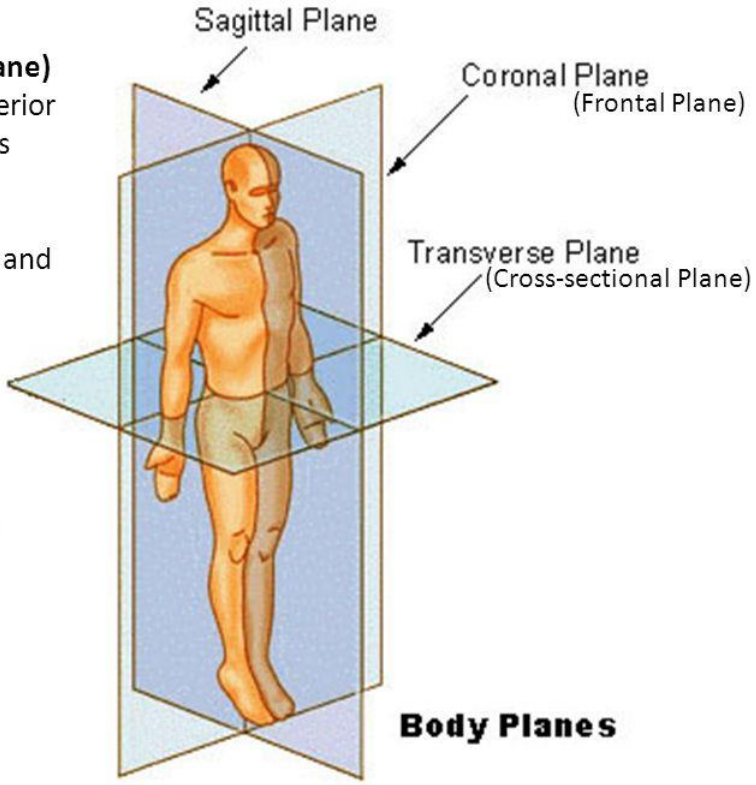
**Anatomical position and planes of reference:**

Anatomical position of reference aka. standard anatomical position:

- Eyes facing forward
- Palms facing forward and near sides
- Toes forward and feet slightly apart
- Standing up straight

# Planes of Reference

- **Coronal Plane (Frontal Plane)**
  - Divides body into anterior and posterior portions
- **Sagittal Plane**
  - Divides body into left and right portions
  - Midsagittal Plane
  - Parasagittal Plane
- **Transverse Plane (Cross-sectional Plane)**
  - Divides the body into superior and inferior portions




*Coronal plane (frontal plane):*

- Runs from left to right of body

*Sagittal Plane:*

- Sagittal plane runs from anterior to posterior
- Midsagittal (or median sagittal) plane divides body into equal left and right sections
- Parasagittal planes are parallel to midsagittal planes but shifted left or right

*Transverse plane (horizontal plane):*

- Runs horizontal to the ground

<u>How do we use these planes</u>?

- Looking at structures deep to the surface of the body
- The body can be cut in a number of ways – the planes easily describe the principle ways in which the body has been cut
- Simple movement of the body are described as movements along the planes

**Movement terminology:**

*Movements you need to know:*

- Flexion and extension

- Dorsiflexion and plantarflexion (ankle)
- Abduction and adduction
- Pronation and supination (forearm)
- Inversion and eversion
- Circumduction
- Movements of the jaw (depression and elevation; protraction and retraction)

Flexion: bending movement that decreases the angle of a joint or between two parts of the body (e.g. bending elbow)

Extension: straightening movement that increases the angle of a joint or between two parts of the body (e.g. stretching arm out)

Dorsiflexion: moving the toes up (flexion superiorly)

Plantarflexion: moving the toes down (flexion inferiorly)

Abduction: away from the body

Adduction: towards the body

Pronation: movement so the palm faces downwards

Supination: movement so the palm faces upwards (remember: holding a bowl of soup = supination)

Inversion: movement of the sole of the foot towards the midline of the body

Eversion: movement of the sole of the foot away from the midline of the body

Circumduction: combination of flexion, extension, abduction and adduction (circle motion; best performed at ball and socket joints: e.g. hip and shoulder)

Depression: opening jaw (downwards)

Elevation: shutting jaw (upwards)

Protraction: moving jaw forwards

Retraction: moving jaw backwards

*Planes that the movements occur in:*

Flexion and extension: sagittal plane

Dorsiflexion and plantarflexion (ankle): sagittal plane

Abduction and adduction: coronal plane

Pronation and supination (forearm): transverse plane (thumb follows the plane)

Elevation and depression (jaw): coronal plane

Protraction and retraction (jaw): sagittal plane

Circumduction: all planes

*Application of principle M1 to movement:*

Simple movements of the body or its parts take place in directions parallel to the body's planes of reference.

NOTE: This applies to all of the movements except circumduction.

## Tissues:

| *Basic tissue types* | *Function* |
|---|---|
| Epithelial tissue | Covers |
| Connective tissue | Supports |
| Muscular tissue | Moves |
| Nervous tissue | Controls |

**Epithelial tissues:**

- Covers a body surface or lines a body cavity
- Lines passageways that communicate with outside world
- Covers walls and organs in the ventral body cavities

*Characteristics of epithelial tissue:*

- Specialised contacts between epithelial cells
- <u>One free surface</u>
- Supported by connective tissue
- Good nerve supply (<u>innervated</u>) but no blood vessels in tissue (<u>avascular</u>); blood comes from below, not the tissue itself
- Regeneration

*Types of epithelial cells:*

Named according to:

- Shape of cell
- Type of layering of cells

Shape types:

- Squamous (flat)
- Cuboidal
- Columnar (elongated)

Layering types:

- Simple (one layer)
- Stratified (many layers)

*Combinations:*

<u>Simple squamous</u>:

Found in:

- Alveoli of lungs
- Serous membranes
- Lining of heart and blood vessels

Stratified squamous:

Found in:

- Outer layer of skin
- Linings of oesophagus, trachea

NOTE: Even if damage occurs here, there are multiple layers, so it can recover.

Simple cuboidal:

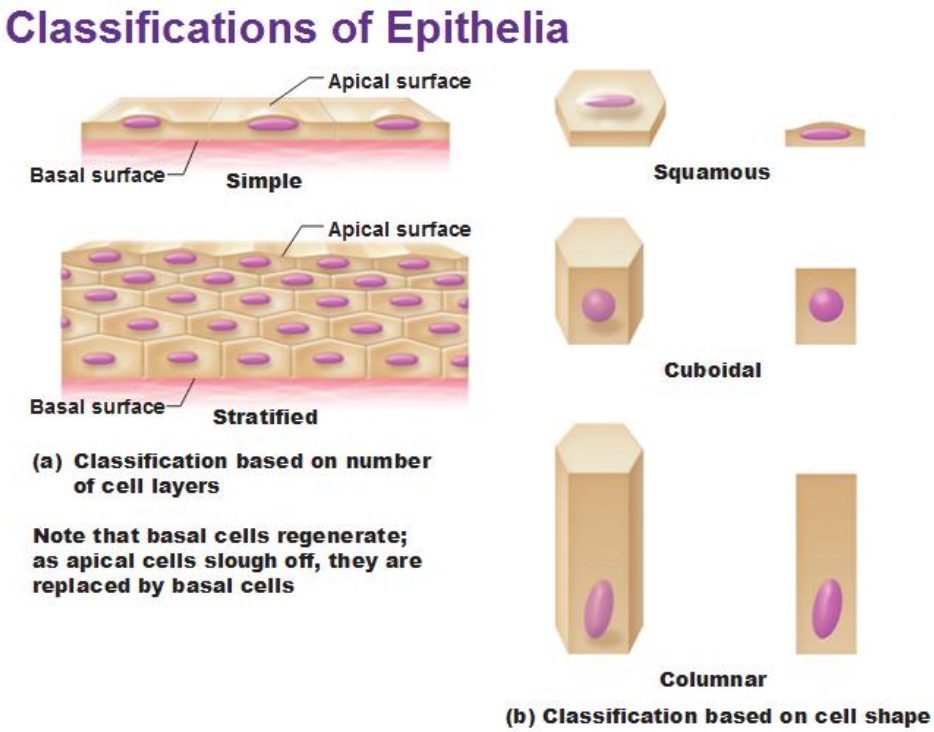
Found in:

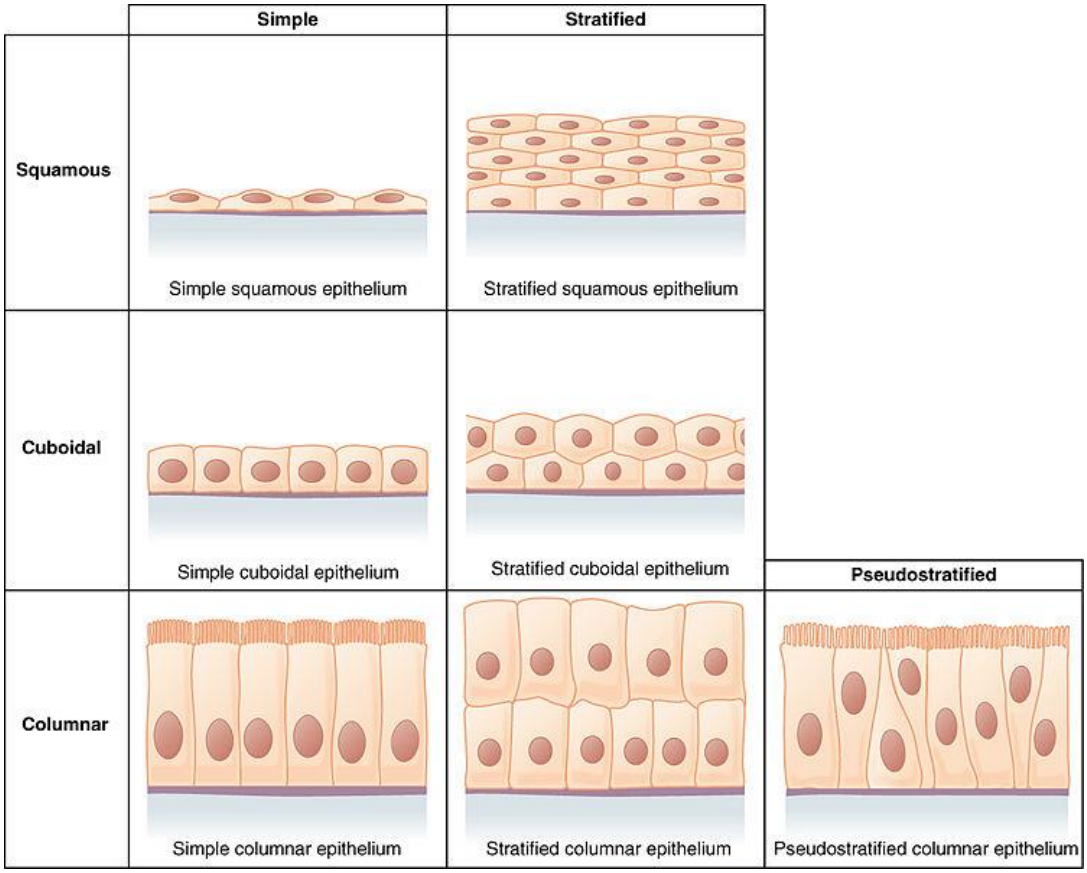
- Kidney tubules
- Ducts and secretory sections of small glands

Simple columnar:

Found in:

- Digestive tract (secretory)
- Bronchi, uterine tubes (ciliated: hair like projections on end of cell to aid movement)






**Connective tissue:**

Connective tissue is made of:

1. Specialised cells
2. Fibres: collagen (dense fibre), elastin (elastic fibre), reticular (fine fibre)
3. Ground substance

2 + 3 = the <u>extracellular matrix</u> that surrounds the cells (connective tissue is embedded in this)

**Classification of connective tissues: (in order of increasing density of ground substance)**

<u>Blood</u>

<u>Connective tissue proper:</u>

Types:

- Loose connective tissue (e.g. areolar tissue, adipose tissue)
- Dense connective tissue (e.g. deep fascia: layer under the skin, tendon and ligament)

*Loose connective tissue:*

- Semifluid or gelatinous ground substance
- Variety of cell types present
- Loose arrangement of fibres

Examples:

Areolar:

- Appears to be full of holes (i.e. areolar)

Adipose tissue (fatty tissue):

- Found in the hypodermis
- Found all over the body and around viscera (internal organs e.g. kidneys)

*Dense connective tissue:*

Fibres are the predominant feature of:

- Tendon and ligament (regular)
- Deep fascia (irregular)

Cartilage:

- Dense ground substance obvious feature
- Cells contained in small spaces (called lacunae) in ground substance
- Tough but flexible

Types:

- Hyaline cartilage
- Fibrocartilage

*Hyaline cartilage:*

Found:

- On the bone ends at joints
- Forms developing bones
- Forms the medial border of the rib cage

*Fibrocartilage:*

Examples:

- Intervertebral disks of the vertebral column
- Disk in the pubic symphysis of the pelvis

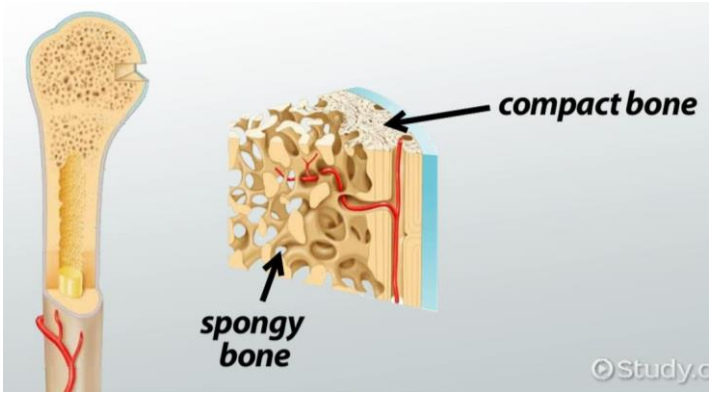
NOTE: 'Fibro' = has thin fibres

Bone:

- Calcified (calcium) matrix is the most obvious feature
- Cells found in lacunae

Types:

- Compact bone
- Cancellous bone (spongy)




*Summary: connective tissues types in order of increasing density of ground substance:*

- Blood (least as it is fluid)
- Loose connective tissue
- Dense connective tissue
- Cartilage
- Bone

**Anatomical Principle for Tissues:**

T1: Tissues with common components which are present in different amounts, or arranged in different ways, have different functions.

Common components:

- Specialised cells
- Fibres
- Ground substance

**Body Cavities:**

*Major body cavities and their subdivisions:*

Dorsal cavity (back):

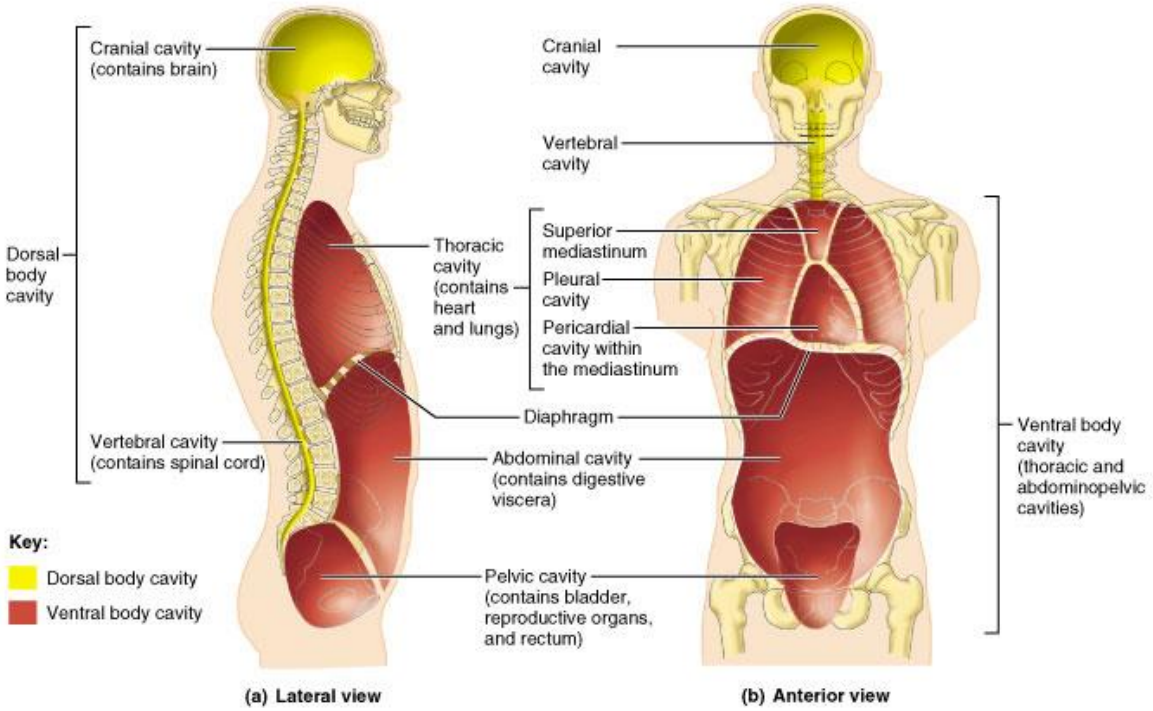
- Cranial cavity: brain
- Vertebral cavity: spinal cord

Ventral cavity (front):

- Thoracic cavity (pulmonary cavity: lungs; pericardial cavity: heart)
- Abdominopelvic cavity: major digestive/reproductive system organs

*Application of principle:*

Principle RV1: Body cavities may have hard and/or soft tissue walls and are generally lined with secretory membranes.




**Serous membranes:**

- From Latin (serum)
- Line the ventral body cavities (called <u>parietal membranes</u>); other type is <u>visceral</u> (covering organs)
- Are <u>formed of a simple squamous epithelial layer lying on a loose connective tissue layer</u>

*Why are serous membranes there?*

<u>Principle RV6</u>: In serous fluid-filled cavities which occur within the major body cavities, friction between organs and the body wall and between the organs themselves is limited, and mobility enhanced, by serous fluid derived from the membranes lining the walls of the cavity.

*Naming serous membranes according to location:*

- Pleural cavity (e.g. parietal pleural lines thoracic wall)
- Pericardial cavity (e.g. parietal pericardium lines pericardial wall)
- Abdominopelvic cavity (parietal peritoneum lines abdominal wall)

*Functions of serous membranes:*

- Produce serous fluid
- Provide lubrication for viscera allowing organs to slide across body wall

**Somatic and visceral structures:**

<u>Viscera</u>: organs of the body cavities (from Latin 'viscus': innermost part)

Examples:

- In abdominal cavity: intestines

- In pleural cavity: lungs

Somatic: structures surrounding the body cavities (from Latin ‘soma’: the body)

Examples: ribs, skeletal muscle

**Tissue Repair:**

*Principle:* tissue growth and repair is dependent on a good blood supply.

*Blood supply of various tissues:*

Avascular:

- Cartilage
- Epithelium

Poorly vascularised:

- Dense connective tissue

Rich blood supply:

- Bone
- Loose connective tissue

*Scenario:*

Summary of injuries:

- Ruptured cruciate ligament in the knee
- A hairline fracture to the fibula near his right ankle
- A graze to his right elbow

Therefore tissues damaged are:

- Ligament in knee: dense connective tissue
- Fracture to fibula: bone
- Graze to right elbow: skin

Based on blood supply to tissue, order of healing (fastest to slowest):

- Graze: skin receives a very good blood supply from the hypodermis (layer under: loose connective tissue)
- Fracture: bone has a very good blood supply
- Ruptured ligament: dense connective tissue has a poor blood supply

## Medical Imaging:

**Types of Radiation:**

Ionising radiation:

- E.g. x rays, nuclear medicine (gamma), fluoroscopy, CT

- All ionising radiation is harmful (principle R2)

Non-ionising radiation:

- E.g. ultrasound, MRI

**X-ray image production:**

- X-ray tube
- Image receptors (computed radiography: CR; digital radiography: DR)

**Image Quality (objective 10):**

*Principle R1:* Tissues of greater density absorb more x rays, therefore appear whiter on a radiograph.

- Lighter/white regions on image = less x rays reaching the receptor
- Black/dark regions = many x rays reaching the receptor

**Image Sharpness (objective 11):**

Refer to medical imaging slides (page 5 of 11).

- To ensure the anatomical area is displayed with the best image resolution (sharpness), body area must be positioned close to image receptor or detector
- As the anatomical area is moved further away from the image receptor or detector, it becomes magnified, but less sharp

*Principle R3:* Divergence of x-rays results in increased magnification and decreased image sharpness of structures further from the receptor.

**Effects of radiation on health: (incomplete)**

- Australian natural background radiation = 2.0msv per year (world average 2.4msv)
- Tissue sensitivity

**Standard practices:**

- Radiation protection
- Correct referral

ALARA principle:

- As Low As Reasonably Achievable
- Lowest radiation dose for maximum amount of information

**What medical imaging modalities are available?**

- General x-rays
- Fluoroscopy
- Computerised tomography (CT)
- Ultrasound
- Magnetic resonance imaging (MRI)
- Nuclear medicine (NM)

NOTE: Other and new techniques are available or being developed (i.e. mammography and angiography).

**Positioning/projections:**

*What is meant by the term 'projection' when used in radiology?*

The path taken by an x-ray beam as it passes through the body. More specifically, the path of the central ray (CR) as it exits the x-ray tube and goes through the patient to the image receptor (IR).

Types of positioning/projections:

- Anteroposterior (AP)
- Posteroanterior (PA)
- Lateral
- Supine
- Prone

NOTE: Refer to medical imaging slides for types of positions/projections (page 3 of 11).

AP and PA:

- Terms are relative to X-ray machine and film plate

AP:

- Patient's back is against film plate (image receptor is behind patient)
- Beam enters the anterior (front) of the body and exits the posterior (back)
- X-ray machine is in front of patient

PA:

- The x-ray beam enters the back of the person and exits the front of the person
- The image receptor is in front of the patient

Lateral:

- Position in which the body is on the side at 90 degrees or perpendicular or at a right angle to a true AP or PA projection. Specific positions are described by the side closest to IR.

Supine:

- Lying on back, facing upward

Prone:

- Lying on front

Axial view:

- The x-ray beam enters the anterior aspect at an angle and exits the posterior aspect
- Is the same as a transverse or horizontal section

**Why 2 or more views?**

- Because the body is a 3D surface (what may appear to be normal in one projection may be completely abnormal in another)
- To accurately demonstrate any anatomy a minimum of two views perpendicular to each other need to be taken

**Advantages/Disadvantages of Imaging Modalities:**

General x-rays:

| *Positives* | *Negatives* |
|---|---|
| - Cost effective<br>- Readily available in most towns and cities<br>- Quick, easy, good starting point for suspected injury<br>- Excellent visualisation of bones | - Uses x-rays (ionising radiation) to produce images<br>- Relatively low dose<br>- Poor visualisation of soft tissues |

Fluoroscopy:

| *Positives* | *Negatives* |
|---|---|
| - Excellent for functional studies<br>- Simple and low cost tests for diagnosis<br>- Real time imaging | - Uses x-rays to produce images<br>- Need to introduce contrast<br>- Increased dose compared to plain x-rays |

Computerised tomography (CT):

| *Positives* | *Negatives* |
|---|---|
| - Excellent visualisation of bones when high resolution is required<br>- Excellent visualisation of blood vessels (post contrast) and internal organs<br>- Non-invasive | - Uses x-rays to produce images<br>- Limited soft tissue (muscles and tendons) demonstrated<br>- Increased dose when compared to x-rays<br>- Increased cost compared to x-rays, still low compared to MRI |

Ultrasound:

| *Positives* | *Negatives* |
|---|---|
| - Uses sound waves to produce images | - Operator dependent |

| | |
|---|---|
| - Non ionising radiation<br>- Safe to use for pregnant women<br>- Low cost<br>- Excellent for soft tissues, internal organs and musculoskeletal imaging | - Large body habitus (physical state) |

Magnetic resonance imaging (MRI):

| *Positives* | *Negatives* |
|---|---|
| - Magnetic field to produce images<br>- Non ionising radiation<br>- Greater soft tissue resolution than other imaging<br>- Non-invasive | - High cost compared to other imaging<br>- Long scan time (45+ mins) compared to CT (<10mins)<br>- Some patients excluded due to foreign bodies (i.e. metal shavings and pacemakers)<br>- Claustrophobia |

Nuclear medicine:

| *Positives* | *Negatives* |
|---|---|
| - Unique information<br>- Can help to find disease and assess the extent<br>- Less expensive and less invasive than exploratory surgery<br>- Can be used for pregnant or lactating women (when essential) | - Uses radiation to produce images<br>- Poor contrast in images<br>- Patient can be radioactive when they leave department |