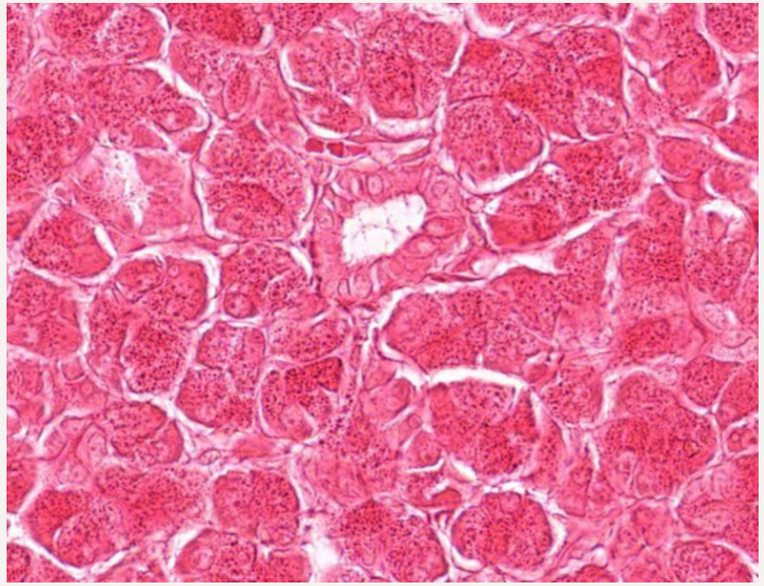
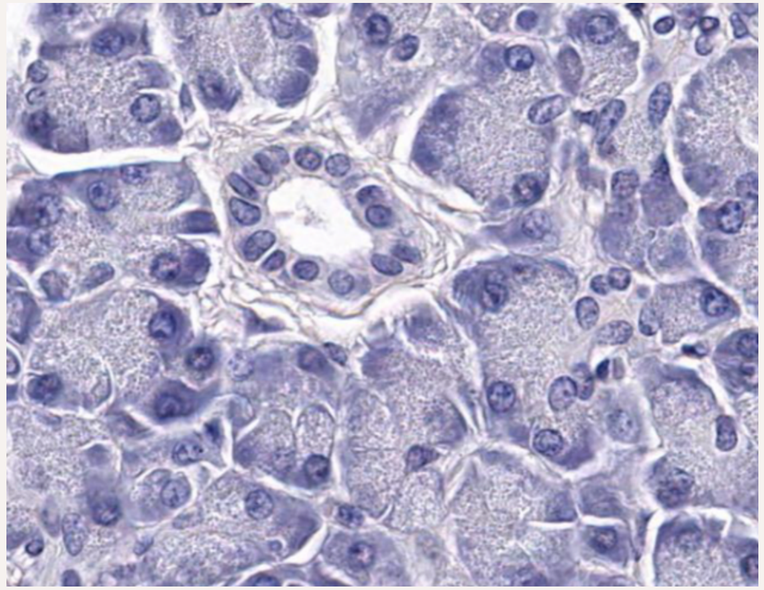
HISTOLOGY (L22)
MUSCLES (L23)
HAEMATOPOIETIC SYSTEM (L24+25)
SKIN (L26)



Eosin

- An Acidic dye
- Negatively charged
- Stains basic (or acidophilic) structures pink/red

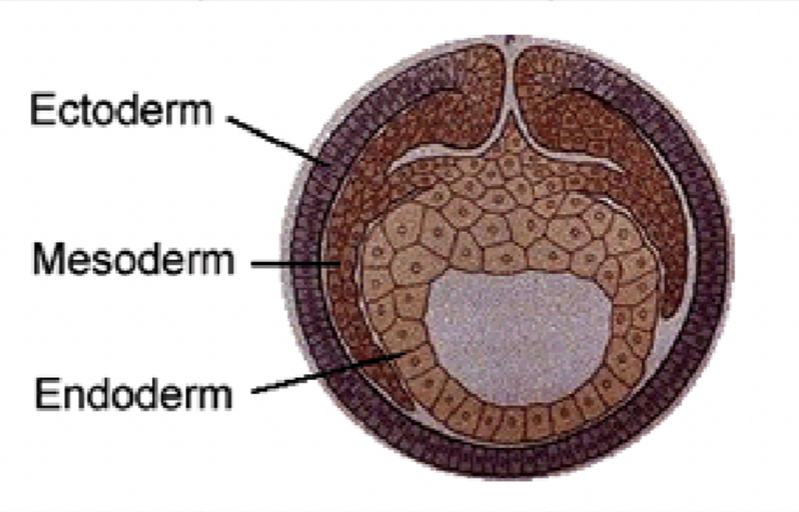


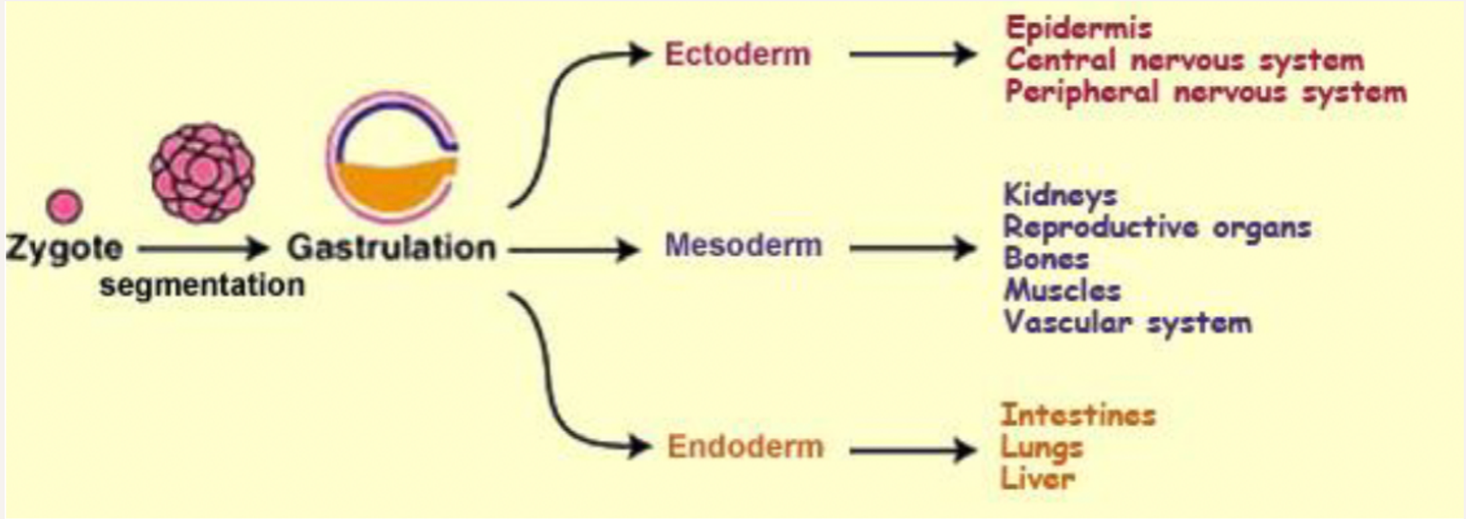
Haemotoxylin

- A Basic dye
- Positively charged
- Stains acidic (or basophilic) structures blue/black

Cellular Differentiation

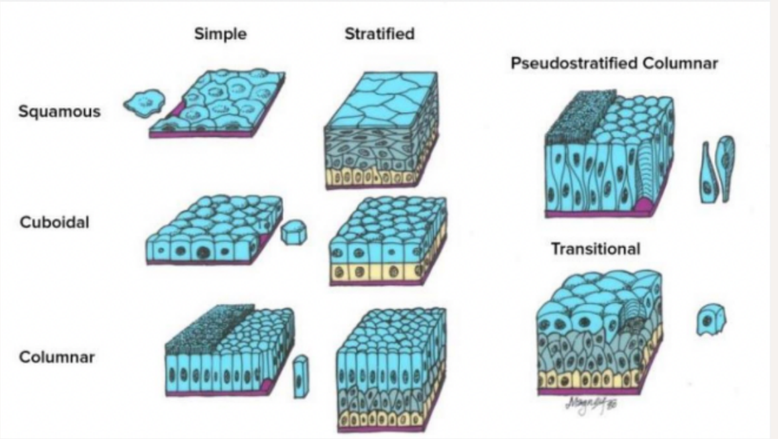
The process by which a less specialised cell type becomes a more specialised cell type.





EPITHELIUM

- Continuous sheets of cells which line the internal surfaces and cover the external surface of the body
- A selective barrier which protects tissues and is often involved in absorption or secretion
- Separated from the underlying tissue by a basement membrane
- They are highly polarised



3 DOMAINS OF EPITHELIAL CELLS

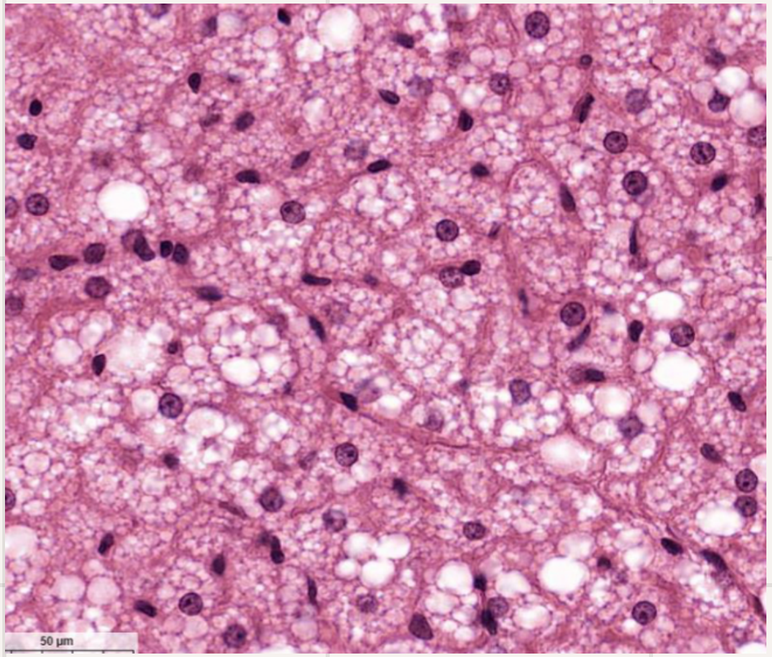
The APICAL domain: Separated from the underlying tissue by a basement membrane

The LATERAL domain: Faces the adjacent cells

The BASAL domain: The surface that attaches to the basement membrane

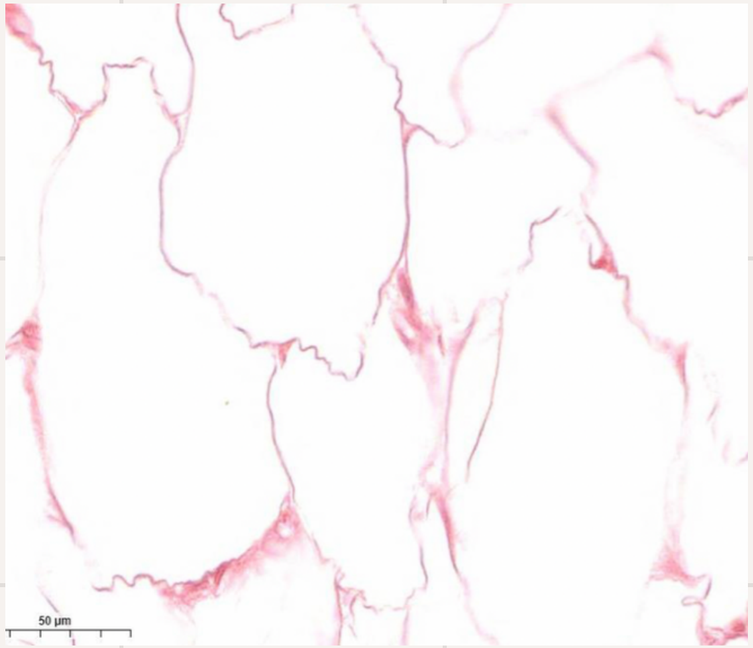
TYPE	DESCRIPTION	EXAMPLE
Simple squamous epithelium	→ Single layer of flattened cells → The thinness of these cells facilitates the transfer of materials (e.g. gases, fluids or nutrients) across the epithelium	→ the alveoli of the lung
Simple cuboidal epithelium	→ Single layer of cuboidal cells → This epithelium is often associated with absorption, secretion, or excretion of waste matter	→ pancreatic ducts
Simple columnar epithelium	→ Single layer of cells that are taller than they are wide → This epithelium is often associated with absorption or secretion	→ ileum
Pseudo-stratified columnar epithelium	→ Appears to be stratified because the nuclei of the epithelial cells are at different levels → However, every cell is in contact with the basement membrane, but not all cells each the lumen	→ trachea
Stratified squamous epithelium	→ Multiple layers of cells becoming flattened as they move from the basal layer to the apical layers → It provides protection from abrasion and is keratinised on the external surface of the body	→ skin is lined by keratinising squamous epithelium → the oesophagus and ectocervix are lined by non-keratinising squamous epithelium
Stratified columnar epithelium	→ Seen in some ducts from exocrine glands	→ duct from the oesophageal wall
Urothelium (previously known as transitional epithelium)	→ Adapted for extensibility and is restricted to the urinary tract → It has multiple layers of cells with an outermost layer of much larger, dome-shaped cells (umbrella cells) that change shape during contraction and distention	→ urinary tract cells

ADIPOSE TISSUE



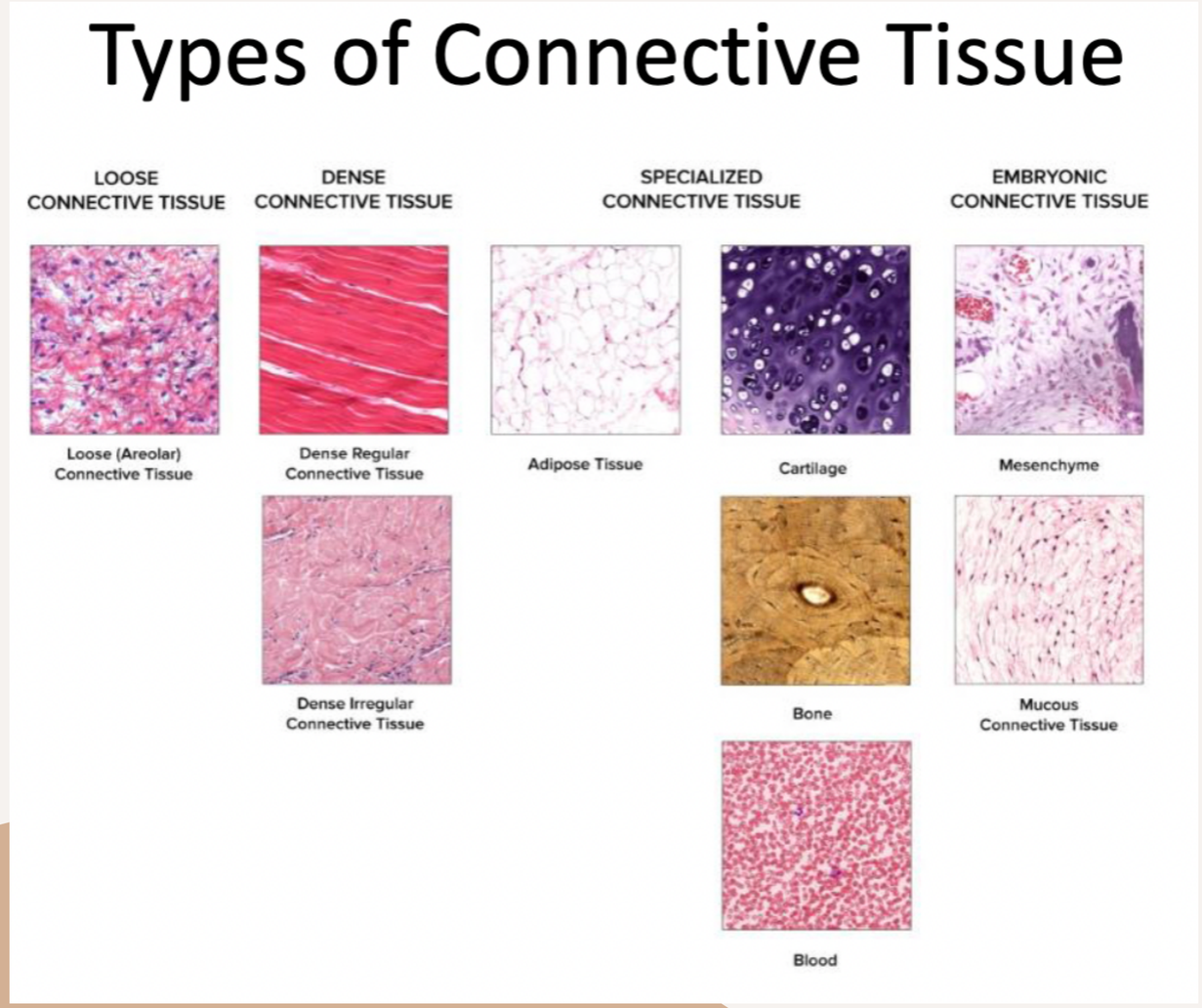
Brown fat

generation of heat (thermogenesis)



White fat

long-term storage of energy



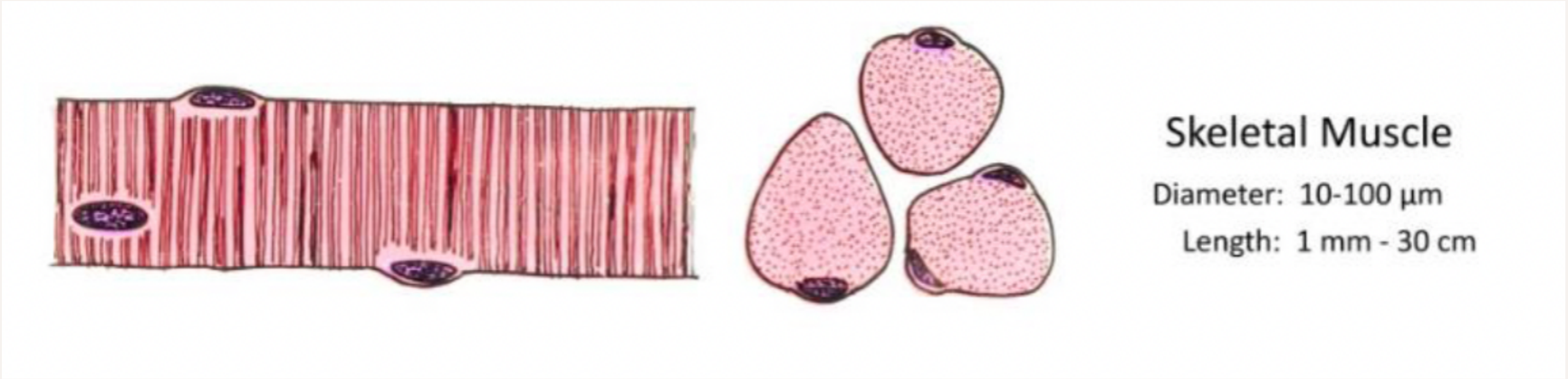
CONNECTIVE TISSUE

- Provides support, binds together, and protects tissues and organs of the body
- Comprises cells, protein fibres, and an amorphous ground substance
- Together the fibres and ground substance make up the extracellular matrix

CONNECTIVE TISSUE TYPE	DESCRIPTION
Collagen fibres	→ most are type I collagen (most abundant protein in the body) → tensile strength: resistance to stretching
Elastic fibres	→ contain elastin and fibrillin → elasticity: can be stretched but will still return to its original length
Reticular fibres	→ contain type III collagen

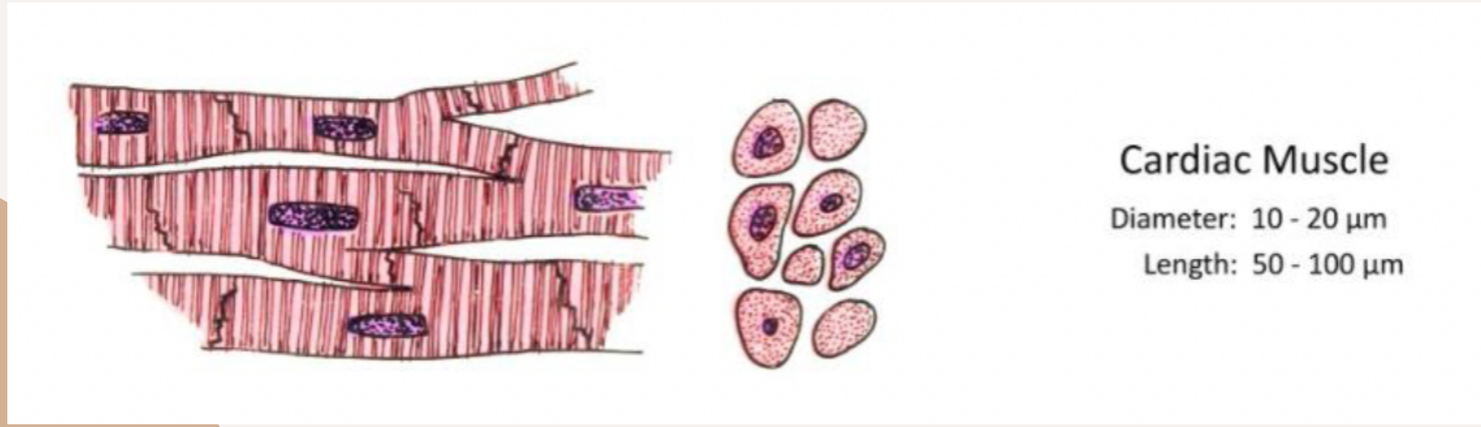
SKELETAL MUSCLE

- Connected to bone (or cartilage) by way of ligaments and produce all movements of parts of the body
- Long cylindrical cells
- Multinucleated cells with many peripheral nuclei
- Striated muscle : exhibit cross-striations
- Voluntary control: innervated by the somatic nervous system (motor neurons)
- Respond quickly to stimuli
- Satellite cells: skeletal muscle stem cells



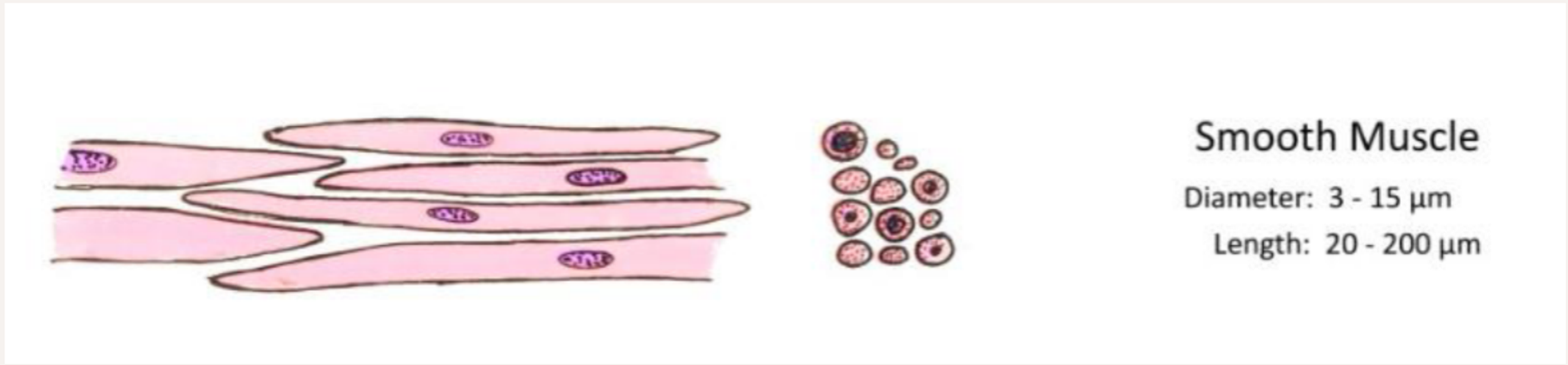
CARDIAC MUSCLE

- Short, branched cells that form a syncytium (coupled by gap junctions)
- Generally single centrally located nucleus (occasionally binucleate)
- Striated muscle: exhibit cross-striations
- Intercalated discs ion cells end-to-end
- Involuntary control: innervated by the autonomic nervous system
- Automatic rhythmic contractions for life
- Long-lived cells
- Poor capacity for regeneration

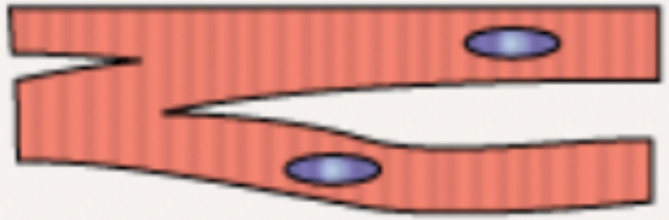
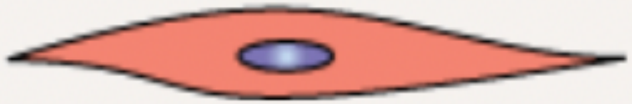


SMOOTH MUSCLE

- Used to apply pressure to organs (such as the stomach, intestines and uterus) and blood vessels.
- Spindle-shaped cells of variable size
- Single centrally located nucleus
- Non-striated muscle
- Involuntary control - innervated by the autonomic nervous system
- Responds slowly to stimuli and capable of long-time sustained contractions
- Retain the ability to divide



YOU MUST KNOW THIS

Skeletal		Voluntary	Striated	Multinucleated	Non-branched
Cardiac		Involuntary	Striated	Single nucleus	Branched
Smooth		Involuntary	Nonstriated	Single nucleus	Tapered

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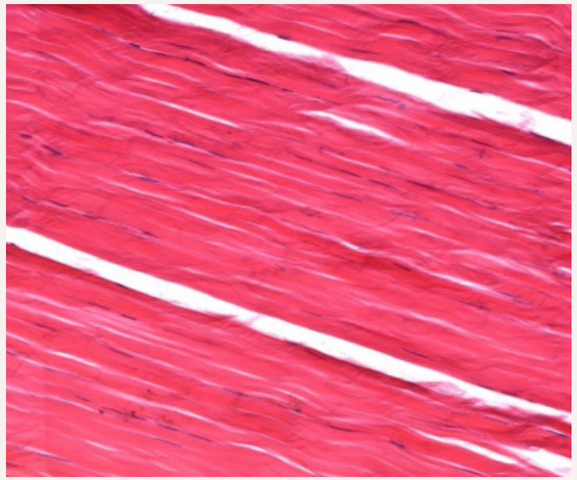
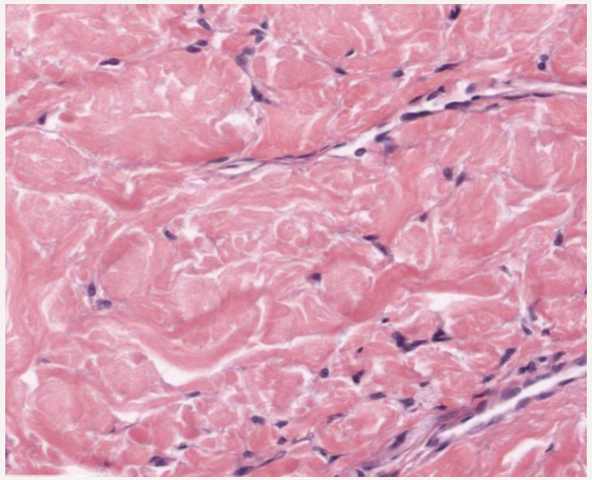
Dense Regular Connective Tissue

- Composed of type I collagen fibres oriented in the same direction
- Provides tensile strength in one direction
- Example: TENDONS



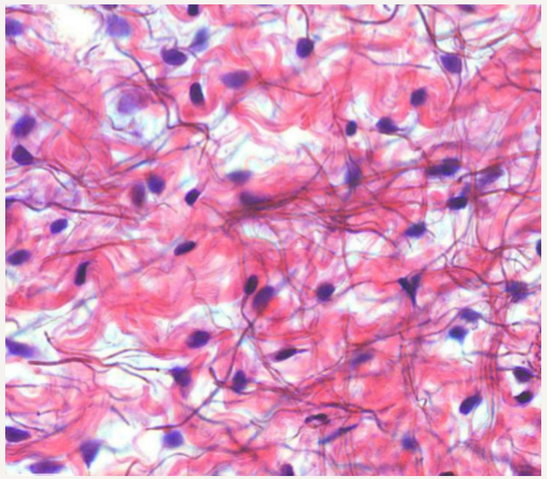
Dense Irregular Connective Tissue

- Contains type I collagen fibers woven in multiple directions.
- Provides tensile strength in multiple directions
- Example: DERMIS OF SKIN



Loose (Areolar) Connective Tissue

- Has a sparse, irregular network of collagen and elastic fibres suspended within a large amount of ground substance
- Example: MESENTERY



CELLS FOUND IN CONNECTIVE TISSUE

Fibroblasts	→ produce and maintain the extracellular matrix → they are the most common cell type in connective tissue
Macrophages	→ phagocytic cells that engulf and digest microbes, cellular debris, and foreign substances
Mast cells	→ release molecules that dilate blood vessels and recruit more immune cells to a site of mast cell activation
Transient cells	→ are leukocytes (white blood cells) → that circulate in the bloodstream and migrate into connective tissue at sites of an immune response

QUESTIONS

1. **THE ILEUM IS LINED BY WHICH OF THE FOLLOWING TYPE OF CELL?**

A. SIMPLE CUBOIDAL EPITHELIUM
B. SIMPLE COLUMNAR EPITHELIUM
C. UROTHELIUM/TRANSITIONAL EPITHELIUM
D. SIMPLE SQUAMOUS EPITHELIUM
E. PSEUDOSTRATIFIED COLUMNAR EPITHELIUM

QUESTIONS

1. THE ILEUM IS LINED BY WHICH OF THE FOLLOWING TYPE OF CELL?

A. SIMPLE CUBOIDAL EPITHELIUM

B. SIMPLE COLUMNAR EPITHELIUM

C. UROTHELIUM/TRANSITIONAL EPITHELIUM

D. SIMPLE SQUAMOUS EPITHELIUM

E. PSEUDOSTRATIFIED COLUMNAR EPITHELIUM

QUESTIONS

2. WHICH OF THE FOLLOWING IS TRUE?

A. THE APICAL DOMAIN FACES THE ADJACENT CELLS
B. THE MESODERM CAN DIFFERENTIATE TO FORM THE EPIDERMIS
C. SKIN IS LINED BY NON-KERATINISING SQUAMOUS EPITHELIUM
D. CARDIAC + SMOOTH MUSCLES ARE SINGLE NUCLEATED, SKELETAL MUSCLE IS MULTINUCLEATED
E. CARDIAC MUSCLES ARE SHORT LIVED AND DO NOT HAVE THE CAPACITY TO REGENERATE

QUESTIONS

2. WHICH OF THE FOLLOWING IS TRUE?

A. THE APICAL DOMAIN FACES THE ADJACENT CELLS
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MUSCLES

A motor unit consists of a motor neuron and the muscle fibers it innervates

REGULATION OF MUSCLE CONTRACTION

1. Nerve impulse at neuromuscular junction
2. Release of acetylcholine which binds to receptors at the sarcolemma
3. Depolarisation of the muscle cell which is conducted deep into the muscle fibre
4. The action potential triggers the release of calcium from the sarcoplasmic reticulum
5. Relaxed muscle: tropomyosin blocks the active sites of myosin binding to actin
6. Activated muscle: calcium binds to troponin causing a position change in in tropomyosin allowing access of myosin heads to actin
7. Use of ATP (myosin ATPase)
8. Contraction proceeds as long as calcium and ATP are available

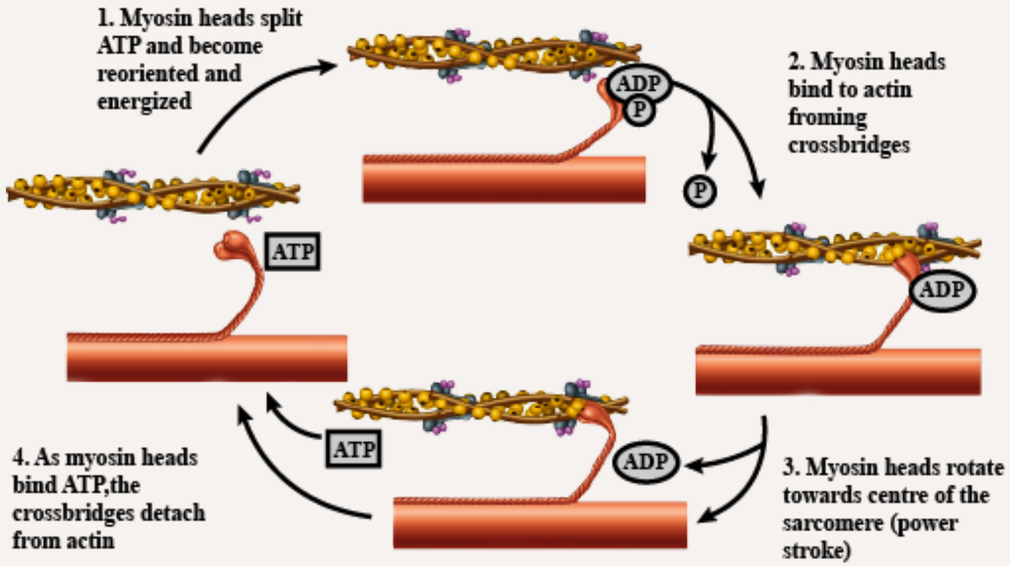
SLIDING – FILAMENT HYPOTHESIS

1. Muscle activation: The motor nerve stimulates an action potential (impulse) to pass down a neuron to the neuromuscular junction. This stimulates the sarcoplasmic reticulum to release calcium into the muscle cell

2. Muscle contraction: Calcium floods into the muscle cell binding with troponin allowing actin and myosin to bind. The actin and myosin cross bridges bind and contract using ATP as energy

3. Recharging: ATP is re-synthesised allowing actin and myosin to maintain their strong binding state

4. Relaxation: Relaxation occurs when stimulation of the nerve stops. Calcium is then pumped back into the sarcoplasmic reticulum breaking the link between actin and myosin. Actin and myosin return to their unbound state causing the muscle to relax. Alternatively, relaxation will also occur when ATP is no longer available



TYPE 1 VS TYPE 2 FIBRES

VERY HIGH YIELD

TYPE 1	TYPE 2
Red	White
Slow	Fast
Slow relaxation	Fast relaxation
Less fatiguable	Highly fatiguable
More mitochondria	Less mitochondria
Highly oxidative	Less oxidative
More fat	Less fat

CREDS TO FATIMAH PATEL (Y3) FOR THIS TABLE

QUESTIONS

3. WHICH OF THE FOLLOWING IS INCORRECT?

A . TYPE 1 FIBRES ARE SLOW AND RED
B. TYPE 2 FIBRES ARE FAST AND HAVE LESS MITOCHONDRIA
C. TYPE 2 FIBRES ARE WHITE AND FAST
D. TYPE 2 FIBRES HAVE LESS FAT AND ARE MORE OXIDATIVE
E. TYPE 1 FIBRS ARE LESS FATIGUABLE

QUESTIONS

3. WHICH OF THE FOLLOWING IS INCORRECT?

A . TYPE 1 FIBRES ARE SLOW AND RED
B. TYPE 2 FIBRES ARE FAST AND HAVE LESS MITOCHONDRIA
C. TYPE 2 FIBRES ARE WHITE AND FAST
D. TYPE 2 FIBRES HAVE LESS FAT AND ARE MORE OXIDATIVE
E. TYPE 1 FIBRS ARE LESS FATIGUABLE

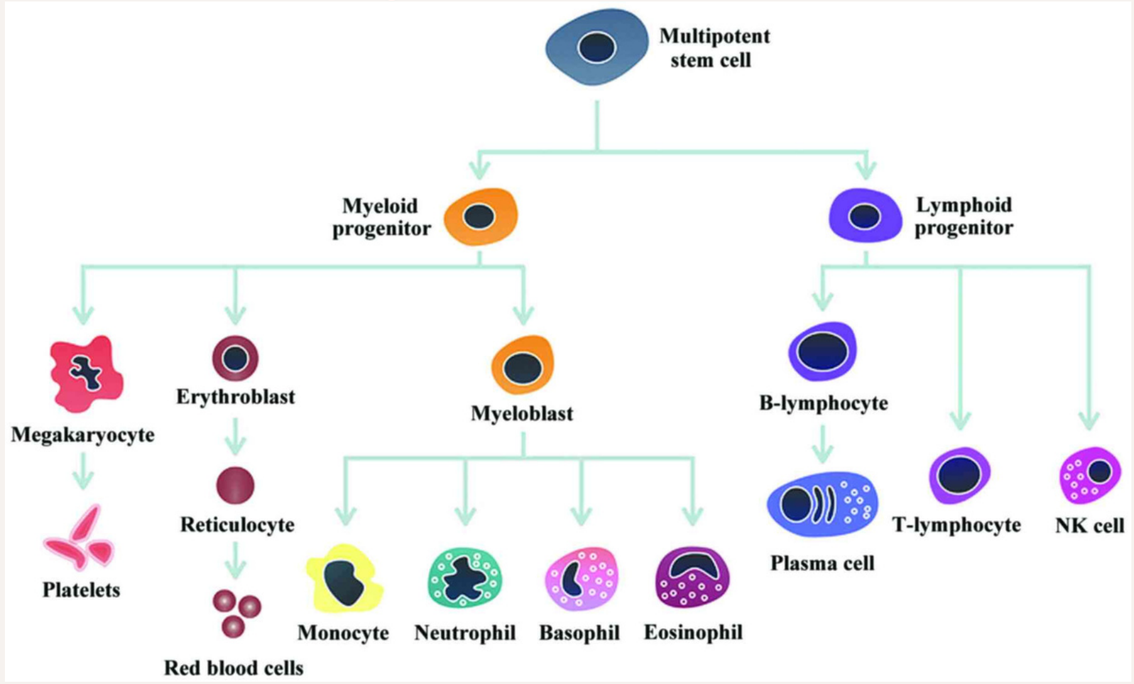
TYPE 2 FIBRES ARE LESS OXIDATIVE

The primary metabolic pathway used by a muscle fiber determines whether the fiber is classified as oxidative or glycolytic. If a fiber primarily produces ATP through aerobic pathways, then it is classified as oxidative

HAEMATOPOIETIC SYSTEM SUMMARY

What is Haematopoiesis?

- **The differentiation of cells to form different blood cells**
- Blood cells all derive from haemangioblast cells
- Reticulocyte = immature red blood
- cell
- Erythrocyte = mature red blood cell
- Platelets prevent excessive bleeding by forming a platelet plug
- Platelets are formed by Megakaryocytes!
- Mono-blasts form Monocytes form macrophages once they have matured



COMPONENTS OF BLOOD

1: THE PLASMA COMPONENT

Plasma makes up around 55% of blood

CONTAINS:

> 95% water

6-8% dissolved proteins, glucose, electrolytes, hormones and CO_2

2: CELLULAR COMPONENT

WBCS + PLATELETS: LESS than 1% of blood

RBC's: makes up around 45% of blood

CLOTTING FACTORS

If you take the clotting factors out of plasma, then you have SERUM

This occurs in blood centrifugation

WHERE DOES HAEMATOPOIESIS OCCUR?

FETUS

Yolk Sac

Spleen

Liver

ADULTS

Red bone marrow

Vertebral Column

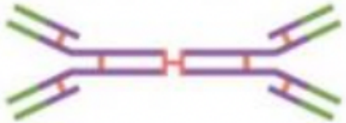
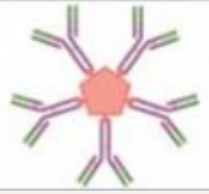
Pelvis

Thymus

NAME	WHAT IT DOES	STRUCTURE
NEUTROPHILS	• Phagocytose bacteria and combat tissue infection. •Neutrophils engulf bacteria to form a phagocytic vacuole. The cytoplasmic granules fuse with the phagocytic vacuole deliver bactericidal products. • Most abundant type of granulocyte.	•Multi-lobed nucleus
EOSINOPHILS	• Defends against parasites • Causes allergic inflammation • Secretes lysozymes and toxic proteins	• Two lobed nucleus • Granules stain orange
BASOPHILS	• Defends against parasites • Causes allergic inflammation • Causes release of histamine	• Two lobed nucleus • Granules stain purple
MONOCYTES/MACROPHAGES	• Monocytes are maturing cells on their way from bone marrow to tissues where they form macrophages. • Macrophages function as long-lived tissue phagocytes associated with chronic inflammation and chronic infections.	• Horse-shoe shaped nucleus

CREDS TO FATIMAH PATEL (Y3) FOR THIS TABLE

Brief overview, DONT SKIP THIS, VVV IMPORTANT!

Name	Properties	Structure
IgA	Found in mucous, saliva, tears, and breast milk. Protects against pathogens.	
IgD	Part of the B cell receptor. Activates basophils and mast cells.	
IgE	Protects against parasitic worms. Responsible for allergic reactions.	
IgG	Secreted by plasma cells in the blood. Able to cross the placenta into the fetus.	
IgM	May be attached to the surface of a B cell or secreted into the blood. Responsible for early stages of immunity.	

“GAMED”

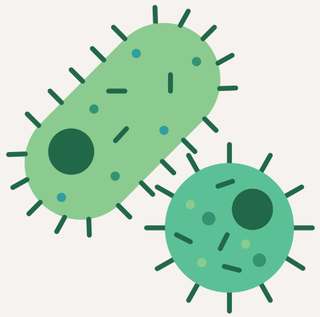
growth factors for blood cell development

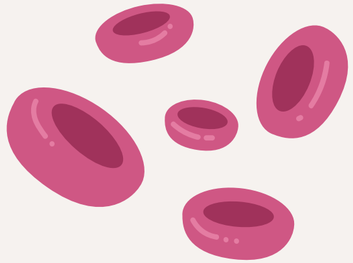
Interleukins:

- proteins that mediate communication between cells

Granulocyte-colony stimulating Factor (G-CSF):

- produced by macrophages, endothelial cells
- stimulates production and maturation of neutrophils





EPO: Erythropoietin

- produced by interstitial fibroblasts of the juxtaglomerular apparatus in the kidney
- these stimulate the production of RBCs

Thrombopoietin (TPO):

- produced in liver
- aids production of platelets

QUESTIONS

1. Which of the following is the definition of a reticulocyte?

A. AN IMMATURE PLATELET WHICH HELPS FORM THE PLATELET PLUG

B. A MATURE ERYTHROCYTE WHICH DOES NOT HAVE A NUCLEUS

C. AN IMMATURE WHITE BLOOD CELL

D. AN IMMATURE ERYTHROCYTE WHICH DOES NOT HAVE A NUCLEUS

E. AN IMMATURE ERYTHROCYTE WHICH DOES HAVE A NUCLEUS

2. Which of the following immunoglobulins has a pentameric structure?

A: IgG

B: IgA

C: IgM

D: IgE

E: IgD

F: IgL

ANSWERS

1: D

2: C

What are the 5 functions of the skin?

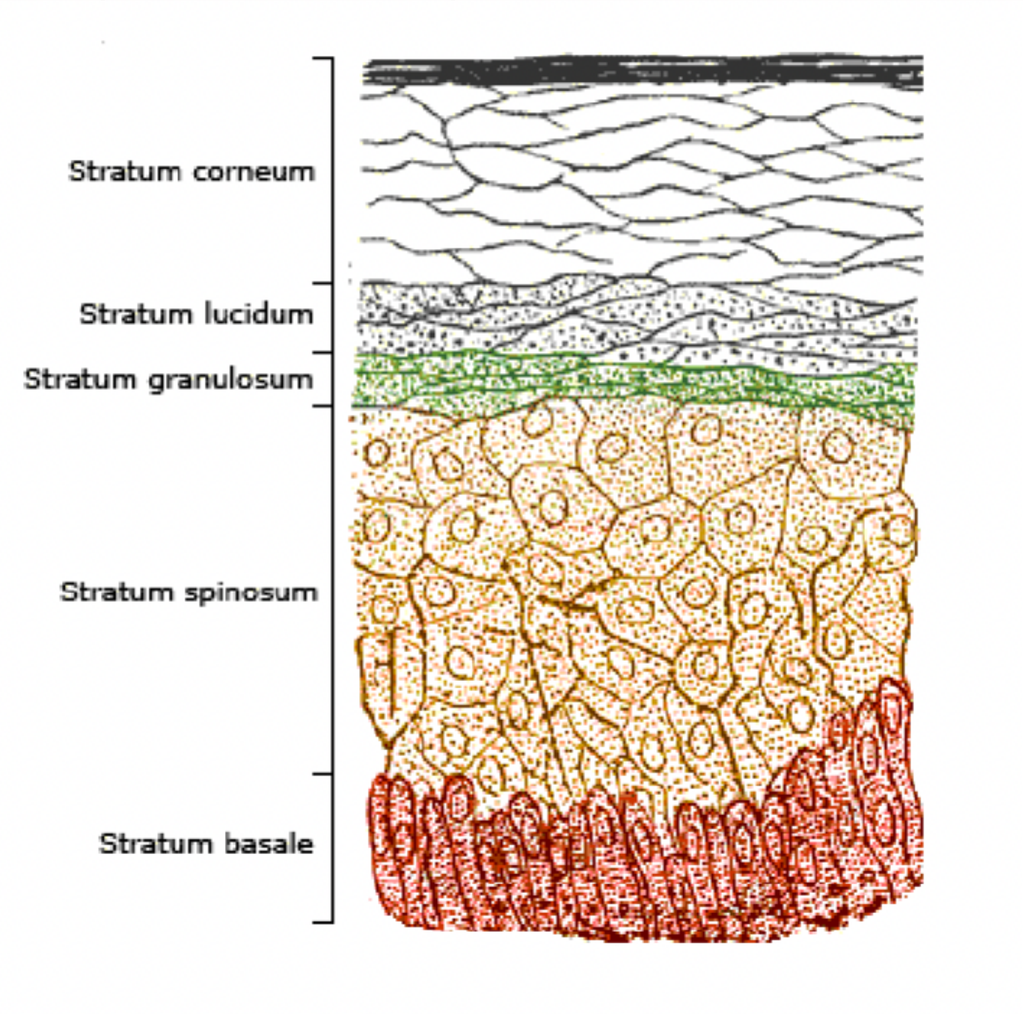
1. Protection
2. Temperature regulation
3. Sensory detection
4. Interpersonal activity
5. Vitamin D production

What 3 things does the skin protect against?

1. Trauma/ irritants
2. Infection
3. UV radiation

SKIN

SKIN LAYERS



LAYER	DESCRIPTION
Stratum Corneum	• Corneocytes: Dead squamous stratified cells • Corneocytes are filled with keratin • Acts as a barrier to disease • The thickness depends on site • Semipermeable layer of cells without nuclei
Stratum Lucidum	• Only present on thicker skin • Is an extra 3-5 layer of dead cells • Present on palms and soles
Stratum Granulosum	• These cells prepare to form the corneal layer • Mostly 1-3 cells thick • Transitioning keratinocytes called keratohyalin granules are water repellant so they are an important layer as a barrier to water loss
Stratum Spinosum	• Strength & stability with desmosomes = passage of water and cell movements • 5/10 cells thick • Progressive flattening of cells towards the surface
Stratum Basale	• Single layer of cuboidal keratinocytes • Most proliferative area (new keratinocytes) • Attached to basement membrane by hemidesmosomes • Connected to adjacent cells by desmosomes • Basal cells divide to produce new skin cells which migrate upwards •Takes about 2 weeks for basal cells to reach corneal layer and then 2 more weeks to shed

"Come Lets Get Some Bread"

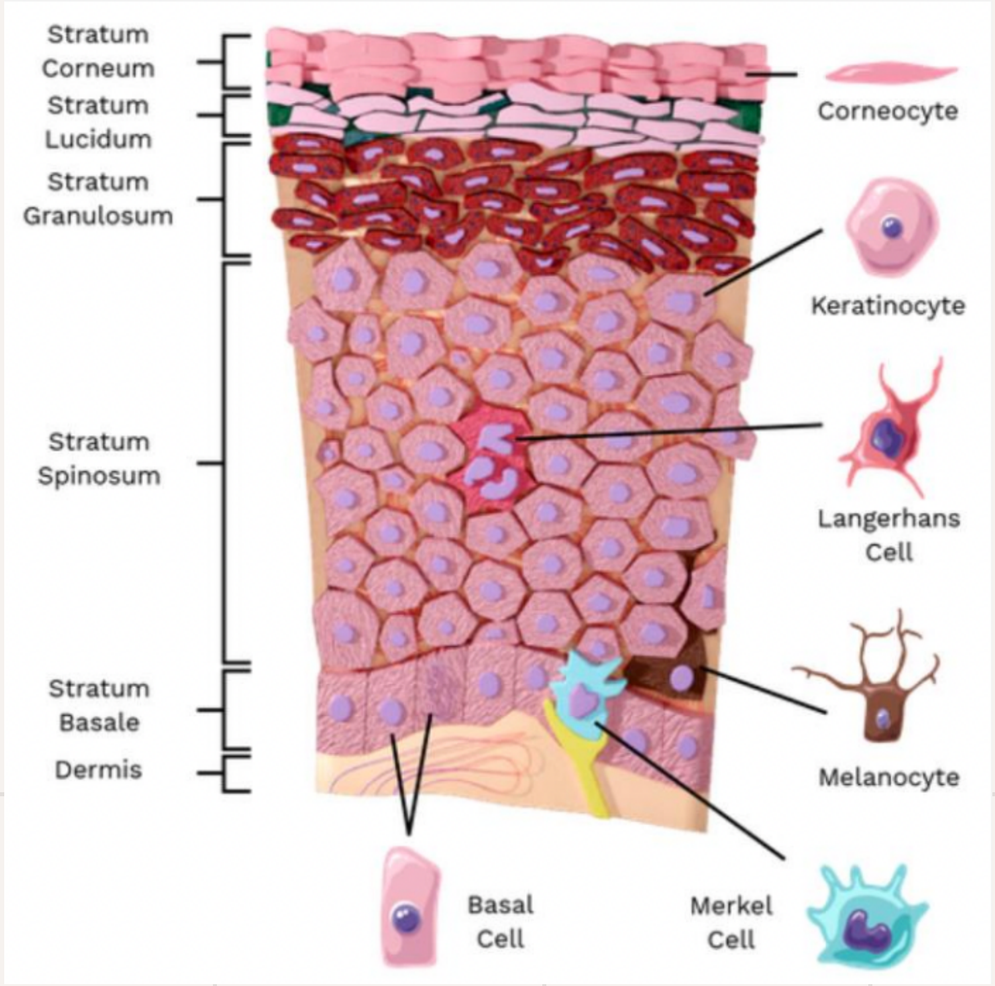
SKIN CELL TYPES

KERATINOCYTE

- Absorb UVB to synthesise Vitamin D
- Becomes increasingly dead as you get closer to the superficial layer of skin

LANGERHANS CELLS

Dendritic (APCs), initiate adaptive immune response



MELANOCYTE

- In the basal cell layer
- Make pigmented melanin which will absorb UVB
- Responsible for colour + photo-protection
- through the Tyrosinase gene are capable of secreting melanin

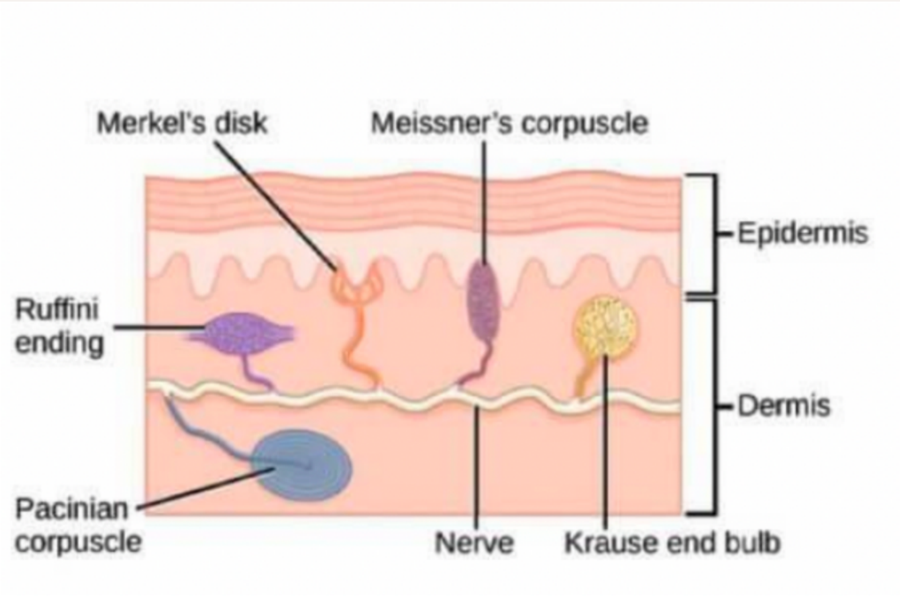
MERKEL CELLS

- Mechanoreceptors
- feel LIGHT pressure

creds to Fatimah Patel again :)

Glands

1. **Sebaceous glands** – release sebum into skin and hair via holocrine secretion
2. **Apocrine gland** – sweat (scent) glands, secretes into hair follicles. Located at armpit, groin, nipples of breasts.
3. **Eccrine Glands** – major sweat gland, found everywhere (in deep dermis)



CORPUSCLES

Ruffini's End-Organ: *Skin stretch receptor*

End-bulbs of Krause: *Thermoreceptors*

Meissner's corpuscles: *Mechanoreceptors, detect fine touch*

Pacinian corpuscles: *Deep pressure mechanoreceptors*

Dermatome definition: area of skin supplied by a single nerve

Myotome definition: area of muscle supplied by a single nerve

Nail generation: matrix produces cells that become the nail plate, and this pushes the old nail plate further

Hair Growth (w/ Alpha Keratin)

1. Telogen: epidermal cells of follicle are forming. Cells of hair matrix divide and are added to the base
- 2. Anagen: hair growth phase
- 3. Catagen: hair falls off the follicle

TRUE/FALSE?

1. The epidermal basal layer varies a lot depending on body site
2. It takes about a month for new keratinocytes to be shed
3. The nail grows from the nail bed
4. Hair is produced from follicles
5. Keratinocyte: absorbs UVB to synthesise vitamin B12

TRUE/FALSE?

1. The epidermal basal layer varies a lot depending on body site
2. It takes about a month for new keratinocytes to be shed
3. The nail grows from the nail bed
4. Hair is produced from follicles
5. Keratinocyte: absorbs UVB to synthesise vitamin B12

1. False, this is true for the corneal layer
2. True
3. False, its from the nail matrix
4. True
5. False, it is vitamin D