Histology and Embryology

Curated preclinical study track (not a medical degree, no licensure claim). Original explanations and practice only, following the reviewed course handout.

The fabric and its weaving

- Tissues first (preparation, four types), then organs as tissue architecture, then development as the weaving that mis-weaves.
- Tissue architecture is organ function; the anomaly names the week.

Preparation: making the picture

1. **Sequence** Fix (formalin cross-links) → dehydrate → embed (paraffin) → section (microtome, 3–5 µm) → stain (**H&E**).
2. **Resolution** Light microscopy caps at ~200 nm; Electron wavelengths are much shorter than visible light; EM reveals ultrastructure in prepared specimens.
3. **Logic** Basic haematoxylin stains acidic nuclei BLUE; acidic eosin stains basic cytoplasm PINK - charge pairing.

Preparation - five steps and their risks



fixation	dehydration	embedding	sectioning	staining
formalin cross-links	alcohol removes water	paraffin supports	microtome 3–5 µm	H&E colour
keeps structure	shrinkage risk	hardens block	knife artefacts	charge logic

H = acidic structures blue (nuclei) · E = basic pink (cytoplasm)

> Fix → dehydrate → embed → section → stain: five steps, five failure modes.

The classification grid

1. **Grid** Layer $\times$ shape: **simple squamous** = exchange (~0.5 µm); **stratified** squamous = abrasion; cuboidal = transport; columnar = absorption.
2. **Matrix** Connective tissue = cells + collagen/elastic/ground substance: areolar $\rightarrow$ tendon $\rightarrow$ cartilage $\rightarrow$ bone $\rightarrow$ blood.
3. **Pseudo** Pseudostratified LOOKS layered but is one layer: all cells touch the basement membrane.

The tissue classification grid

layer × shape

	squamous	cuboidal	columnar
simple	exchange capillary	transport tubule	absorption gut
stratified	abrasion skin	wet barrier ureter	protection conj.

connective spectrum

cells + matrix

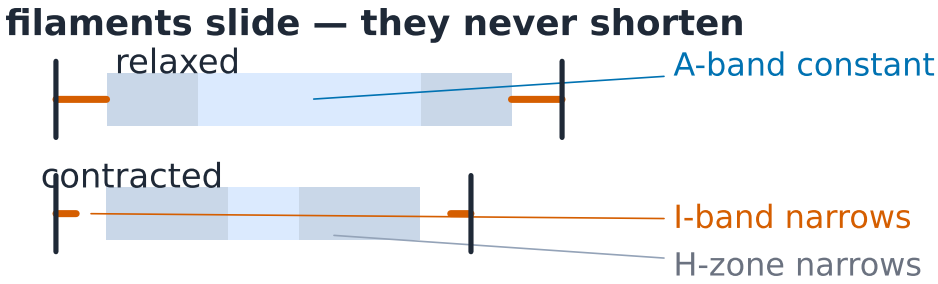
loose areolar	cell wrap
dense regular	tendon
cartilage	joint
bone	scaffold
blood	plasma matrix

> Layer × shape classifies every **epithelium**; fibre density classifies **connective tissue**.

The machinery you can see

1. **Fingerprints** Skeletal: striated, peripheral nuclei. Cardiac: striated, branched, intercalated discs. Smooth: unstriated spindles.
2. **Bands** A-band (myosin) CONSTANT in contraction; I-band and H-zone narrow; filament lengths never change.
3. **Glia** Astrocytes support; oligodendrocytes/Schwann myelinate; microglia scavenge - glial disease is nervous disease.

Relaxed vs contracted: A constant, I and H narrow.

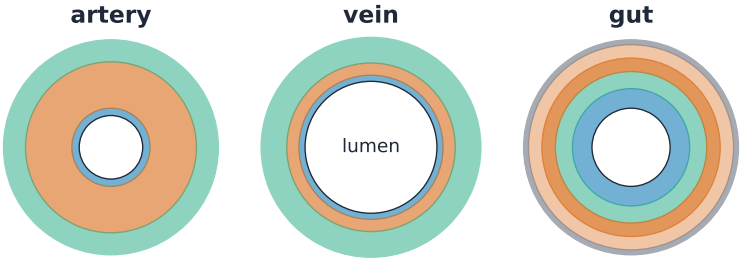


Relaxed vs contracted: A constant, I and H narrow.

Circulatory and digestive organ histology

1. **Vessels** Intima / **media** / **adventitia**: media $\propto$ pressure - artery mostly media, vein mostly lumen.
2. **Gut Mucosa** (absorptive frontline) / submucosa / muscularis externa (two directions) / serosa.
3. **Alveolus** Everything removed: simple squamous + basement membrane + capillary $\approx$ 0.5 µm blood–air barrier.

Circulatory walls: artery, vein, gut compare



artery	vein	gut
intima	intima	mucosa
media: thick muscle	media: thin	submucosa
adventitia	adventitia: thickest	muscularis: 2 layers
		serosa

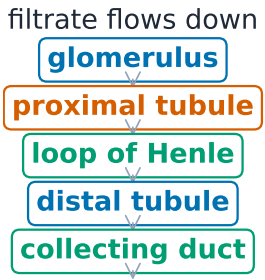
labels read from the lumen outward

Lining, **muscle**, **connective tissue**: the same three, in different proportions.

Urinary and endocrine organ histology

1. **Nephron** Glomerular tuft → proximal (brush border, ~65% back) → loop (thin **squamous** / thick **cuboidal**) → distal → collecting duct (cuboidal to **columnar**).
2. **Endocrine** Secretory cords directly on fenestrated capillaries - no ducts, shortest path to blood.
3. **Skin** Keratinised stratified squamous over vascular dermis; ~4-week turnover; basement membrane survival decides regeneration.

Urinary histology - the nephron and its segments



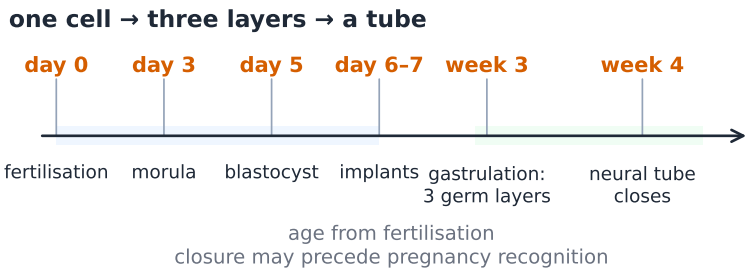
glomerulus	fenestrated capillary tuft
proximal tubule	cuboidal + BRUSH BORDER (~65% back)
loop of Henle	thin: squamous; thick: cuboidal
distal tubule	cuboidal, no brush
collecting duct	cuboidal → columnar; water channels

The **nephron** segments with their epithelial signatures.

Fertilisation to gastrulation: early development

1. **Timeline** Day 0 **fertilisation** → day 5 **blastocyst** → day 6–7 implants → week 3 **gastrulation** → day 26–28 neural tube closes.
2. **Layers** Ectoderm (nervous + epidermis); mesoderm (muscle, bone, blood, heart, kidney); endoderm (gut lining, liver, pancreas).
3. **Timing** The tube closes about two weeks after the first missed period, often before the pregnancy is known: folate must start before conception.

Early development - one cell to three layers.

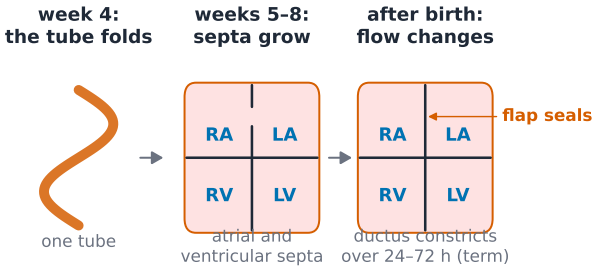


From one cell to three layers in three weeks.

Organogenesis and congenital anomalies

1. **Windows** Weeks 3–4 tube formation; weeks 4–8 **septation**, palate fusion (7–10), diaphragm (7), limb patterning.
2. **Shunts** Fetal shunts bypass high-resistance lungs. Breathing closes the foramen flap functionally; the ductus normally constricts over the first 24–72 hours in term infants.
3. **Logic** Organs built in the same weeks can share one cause: a cleft palate prompts a heart check.

Organogenesis - heart septation stages



Tube → septa → four chambers, with the fetal shunts.

Check yourself

- Microscope resolution limit? (~200 nm.)
- Which **sarcomere** band never changes? (The A-band.)
- Blood–air barrier thickness? (~0.5 µm.)
- When does the neural tube close? (Day 26–28.)