



Histology of a Freshwater Mussel

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Outline

- Shell morphology
- Gross morphology of soft tissues
- Processing tissue for histology
- Histology of major tissues

Shell morphology of *Villosa nebulosa*

posterior

dorsal

umbo

10 mm

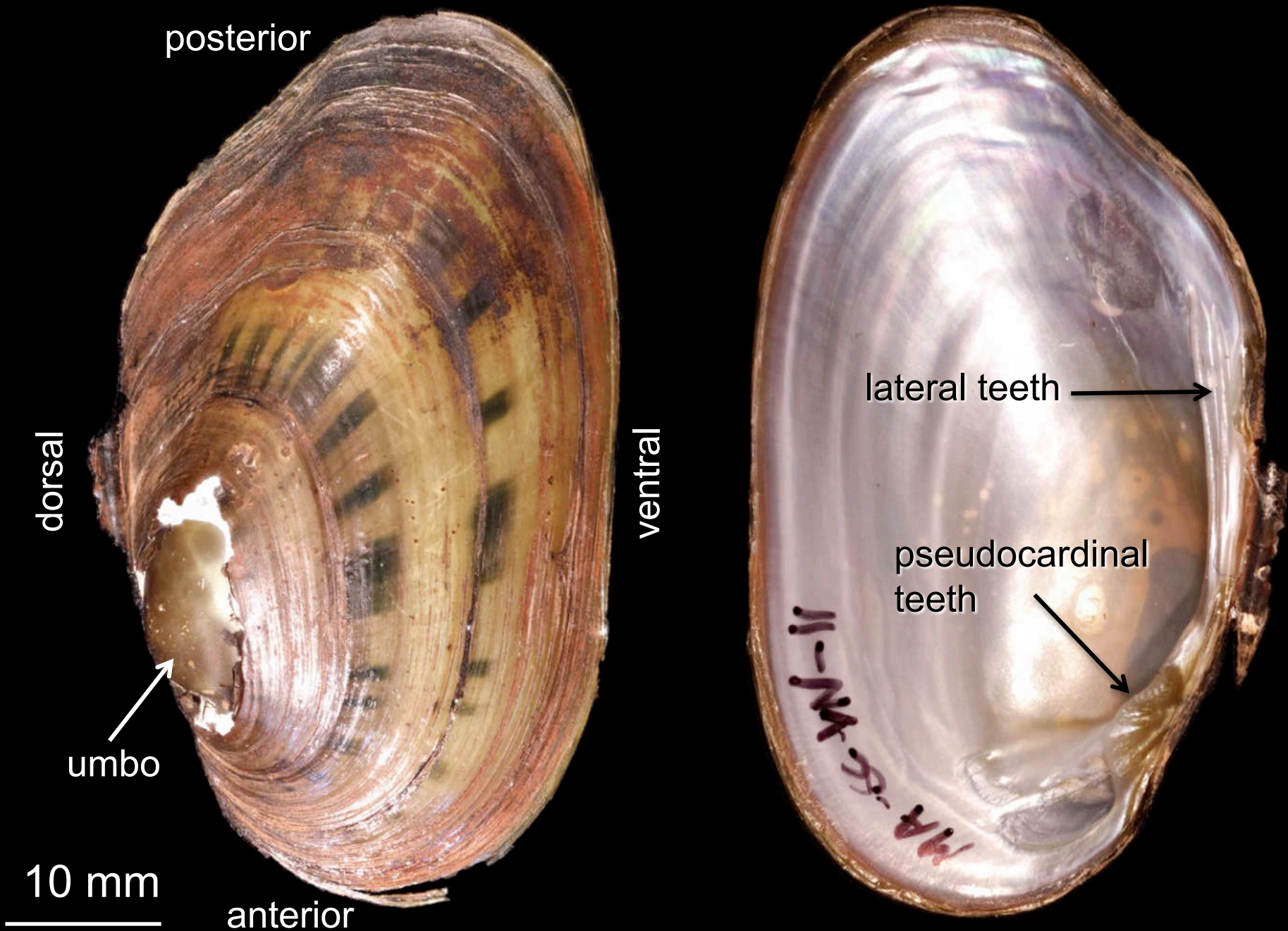
anterior

ventral

lateral teeth

pseudocardinal
teeth

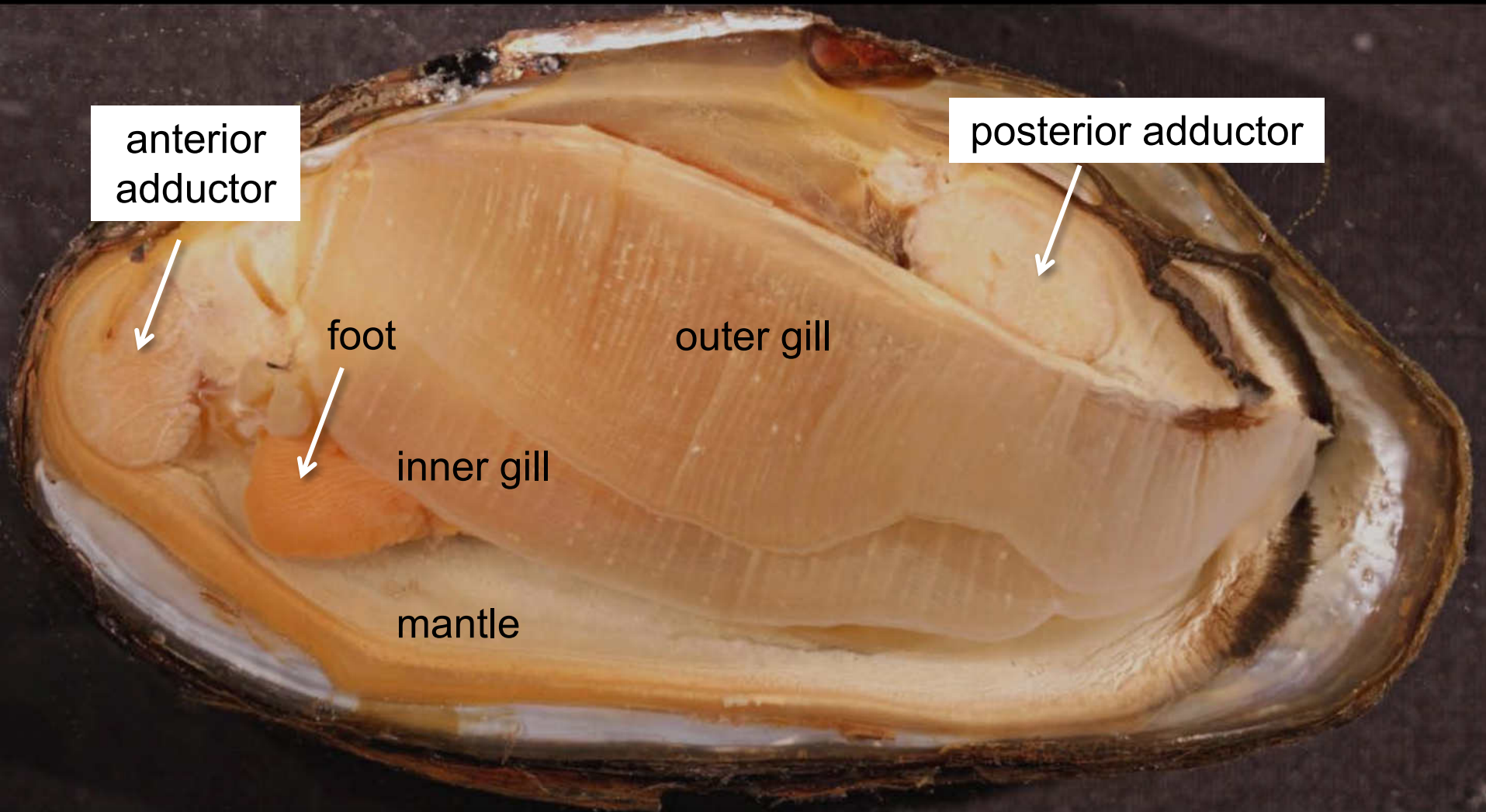
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Processing Tissue for Histology

- Transport mussels to the lab in aerated cooler or in wet towels with freezer packs, do not use store-bought ice
- Cut adductors or prop shell open or anesthetize
- Fix whole mussels in 10% formalin for at least 48 hr
- After 48 hr in formalin, shell will start to dissolve forming a precipitate
- Immerse tissues or whole mussels in a graded ethanol series
- Can leave mussels in 70% ethanol indefinitely
- Process whole mussels for paraffin embedding
- Cut 4 μm sections from each block
- Stain slides with hematoxylin and eosin

Gross Morphology of Mussel Tissues



Brooding Mussels

Villosa nebulosa

Fusconaia cerina

mantle lure

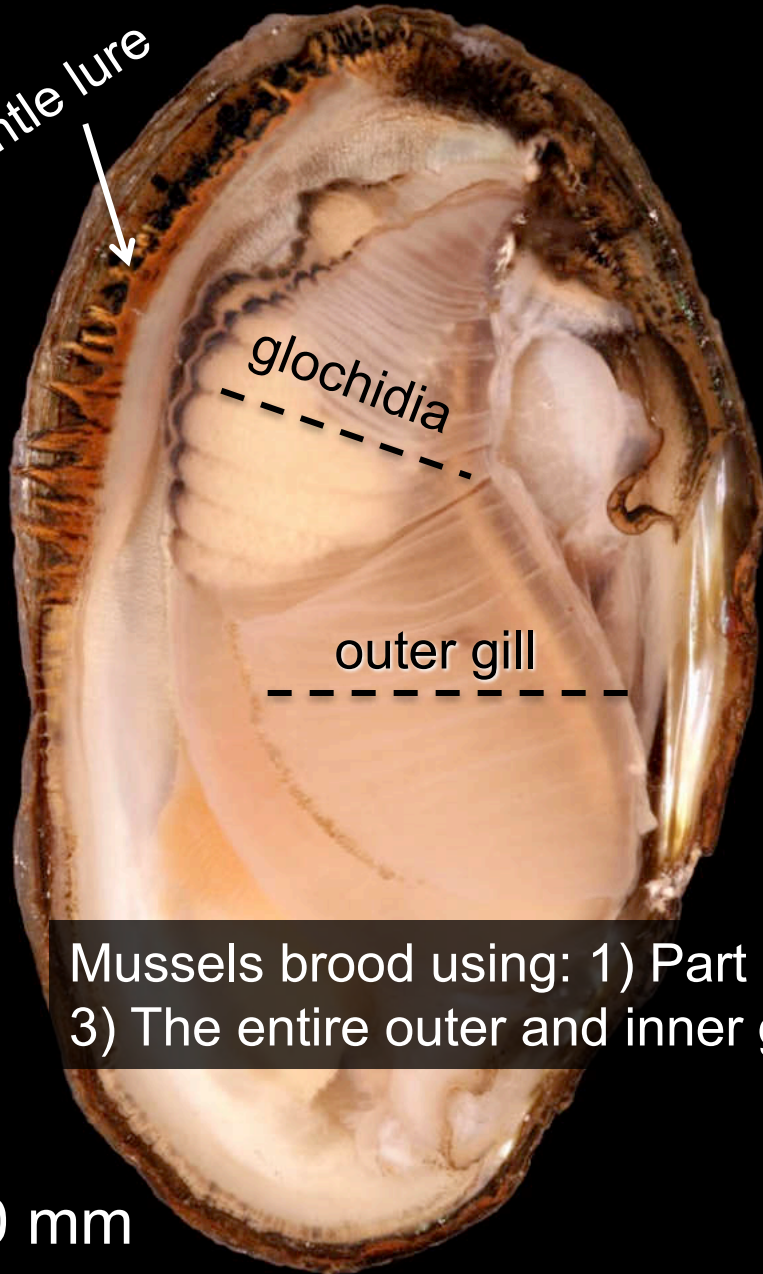
glochidia

outer gill

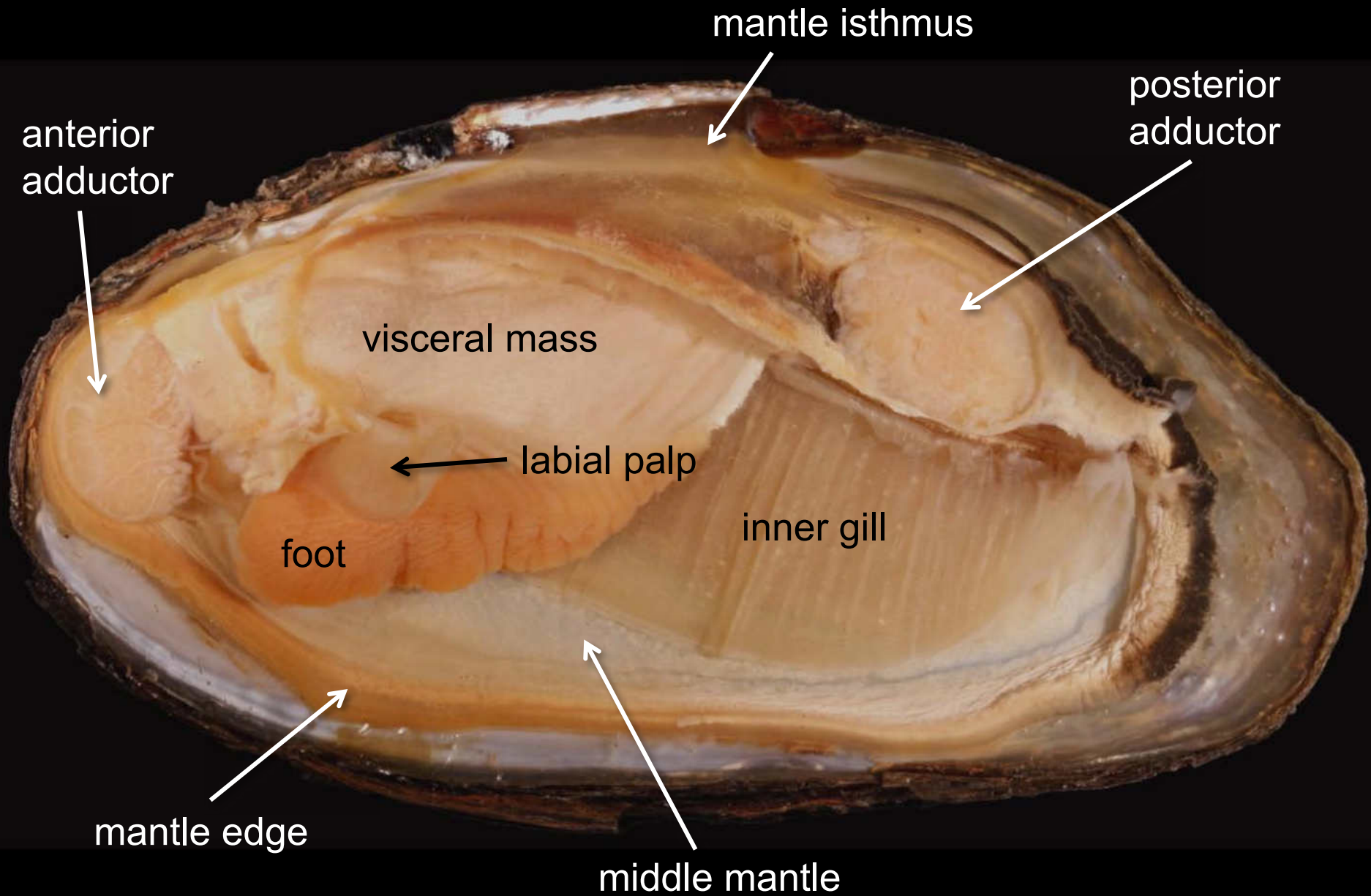
glochidia

Mussels brood using: 1) Part of one gill, 2) The entire outer gill or 3) The entire outer and inner gills

10 mm



Gross Morphology of Mussel Tissues



Histology of a Whole Mussel



Histology of a Whole Mussel



1 mm

Most Significant Organs and Tissues

1. Mantle edge
2. Middle mantle
3. Mantle isthmus
4. Gills
5. Marsupium (gill)
6. Foot
7. Labial palps
8. Adductor
9. Pedal protractor/retractor
10. Esophagus
11. Digestive gland
12. Stomach
13. Crystalline style sac and intestine
14. Statocysts
15. Nerves
16. Ganglia
17. Heart
18. Blood vessels
19. Hemolymph
20. Pericardial gland
21. Nephridium
22. Ovaries and testes

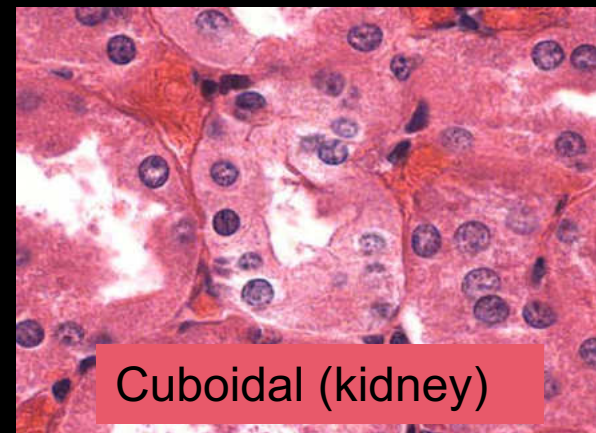
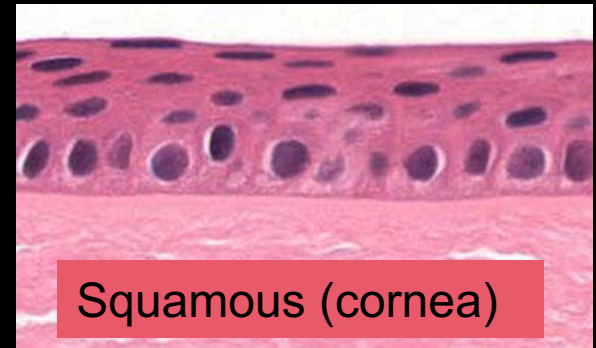
Introduction to animal Histology

Types of tissue

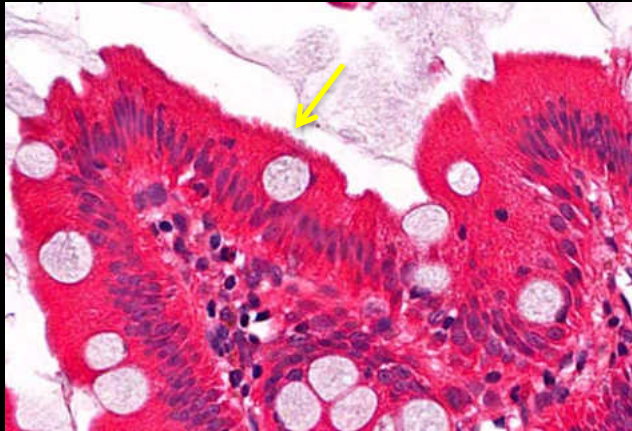
- Epithelial tissue
- Connective tissue
- Muscle tissue
- Nervous tissue

Animal Histology: Epithelial tissue

- **Epithelial tissue** lines or covers bodily surfaces, secretes chemical substances
- Tissue types:
 1. **Squamous epithelium** (flat cells)
 2. **Cuboidal epithelium** (cubed shaped cells)
 3. **Columnar epithelium** (column-shaped cells)
- Epithelial tissue further classified as either a **simple** or **stratified** epithelium
- **Simple epithelium** has only one cell layer
- **Stratified epithelium** has more than one cell layer



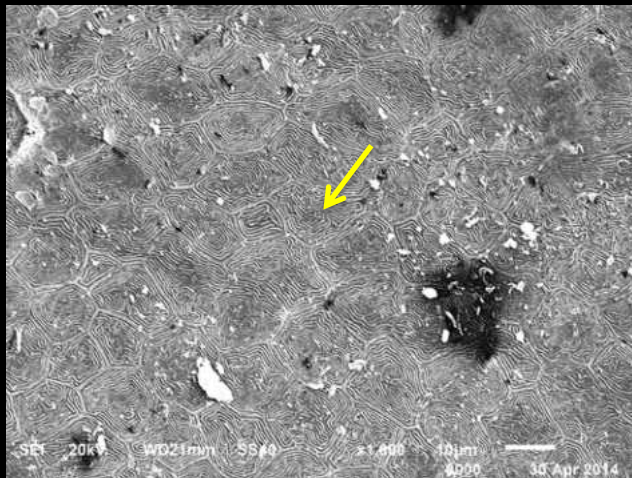
Apical domain of epithelial cells



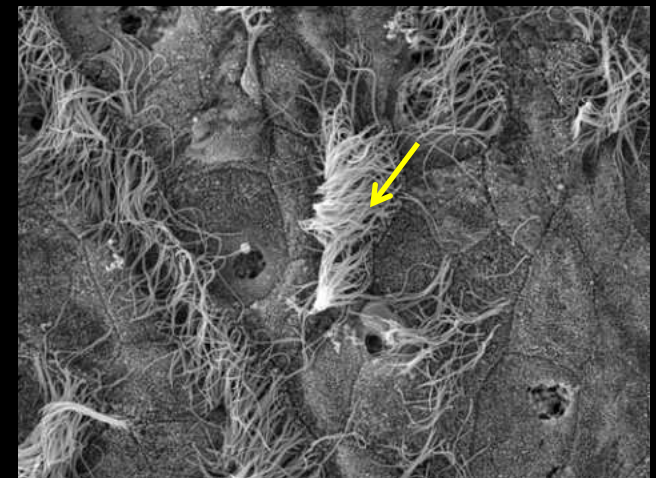
Microvilli (intestine)



Cilia (trachea)



Microvilli (fish skin)

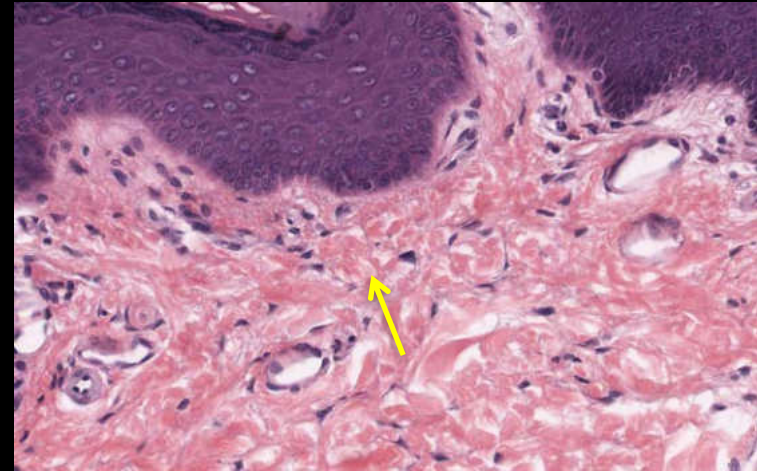


Cilia (mollusk mantle)

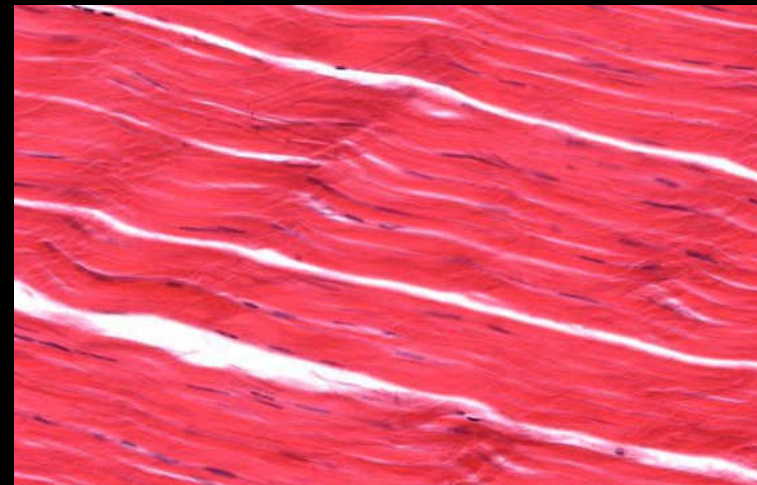
Microvilli are shorter than cilia and may not show up as well with light microscopy

Animal Histology: Connective tissue

- **Connective tissue** provides structural or physiological support
- Tissue types:
 1. Connective tissue proper (fibrous)
 2. Special connective tissue (adipose tissue, blood, bone, cartilage)
- Connective tissue proper includes dermis layer of skin, tendons, ligaments, elastic tissue, mesentery
- CTP mostly consists of fibroblasts and different types of collagen fibers

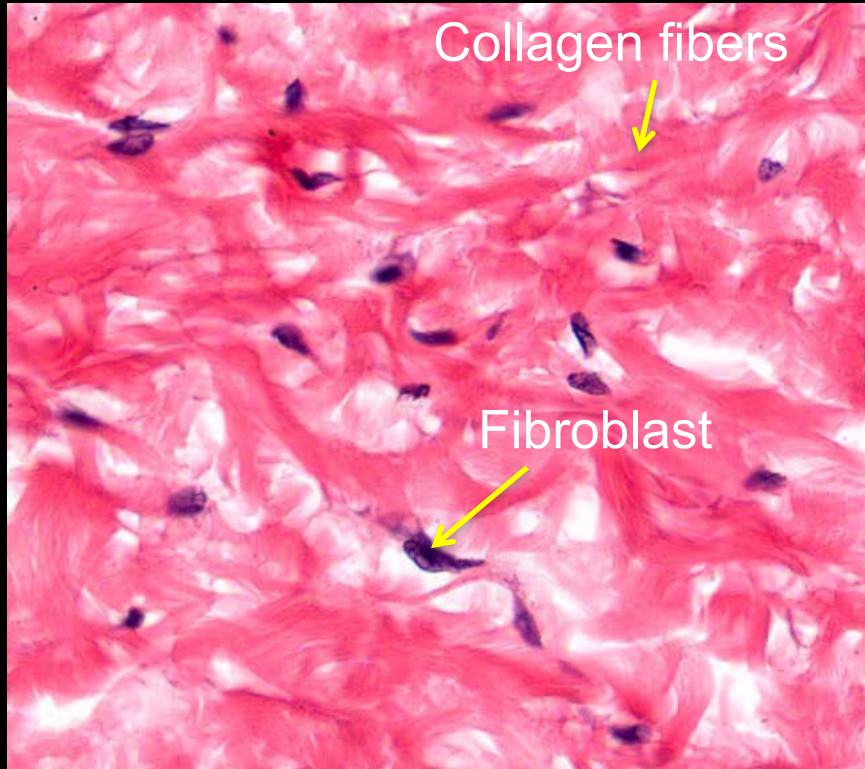


Connective tissue (dermis)



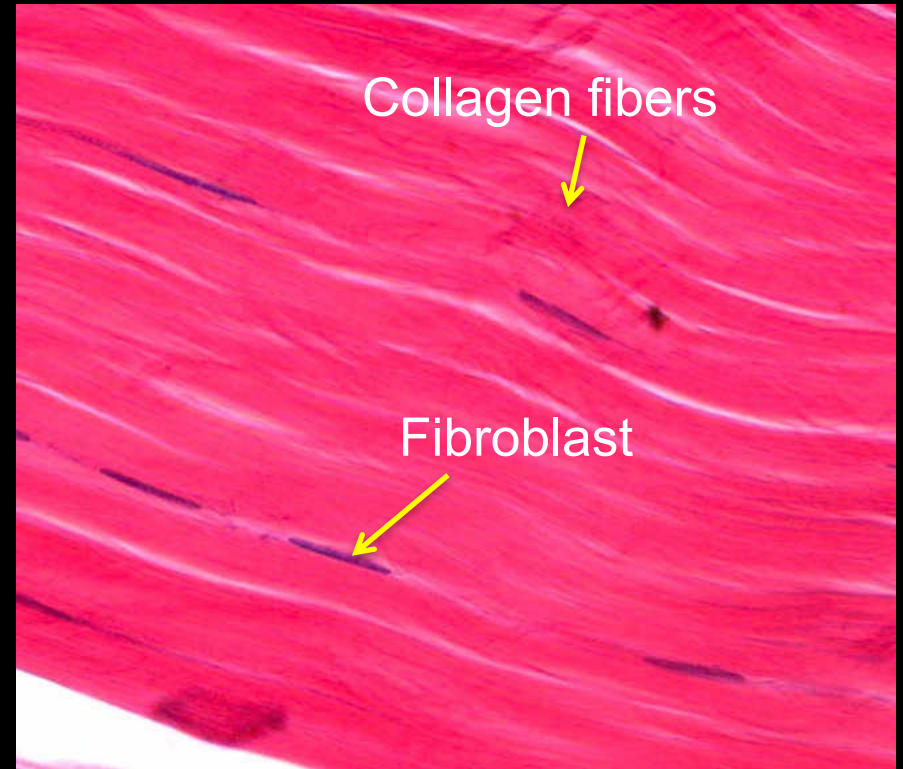
Connective tissue (tendon)

Connective tissue proper



Dermis

Note the irregular arrangement of collagen fibers

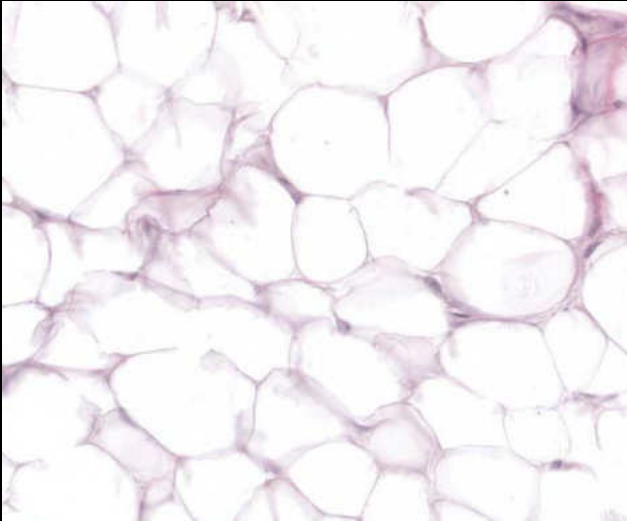


Tendon

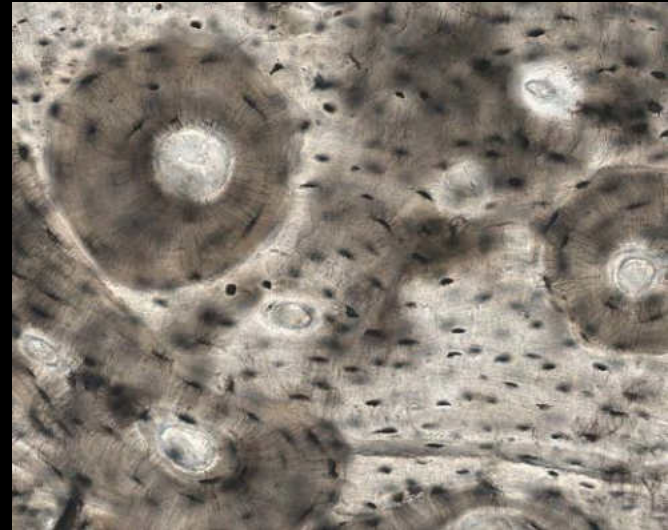
Note the parallel arrangement of collagen fibers

Animal Histology: Connective tissue

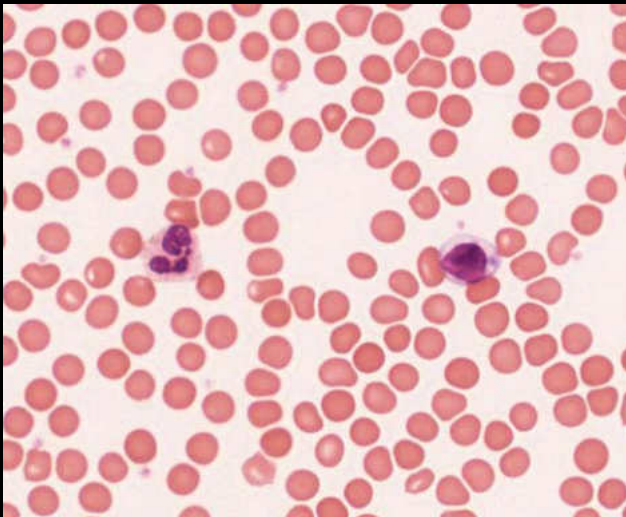
- **Special connective tissue** include adipose tissue (fat), blood, bone, cartilage



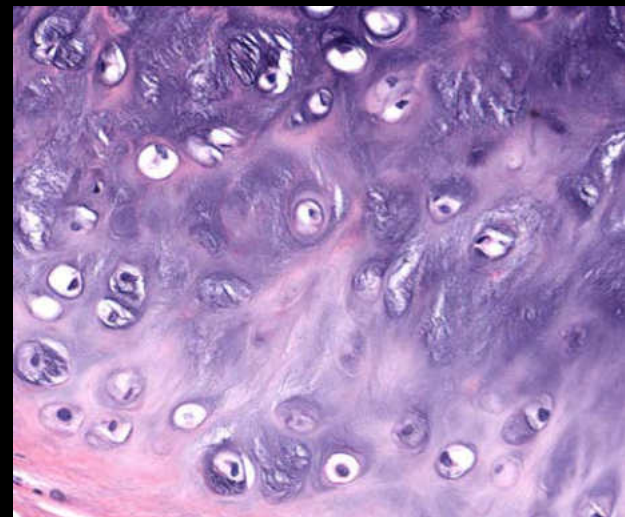
Adipose tissue



Bone (non-decalcified bone)



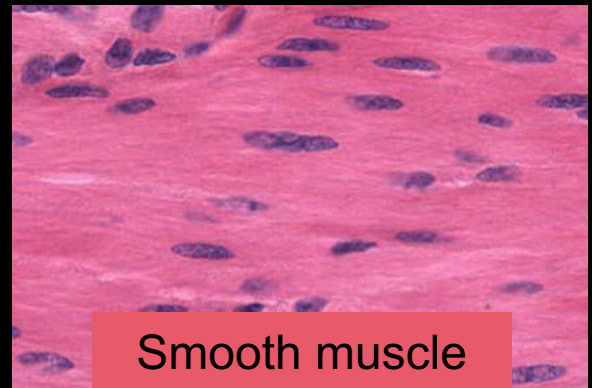
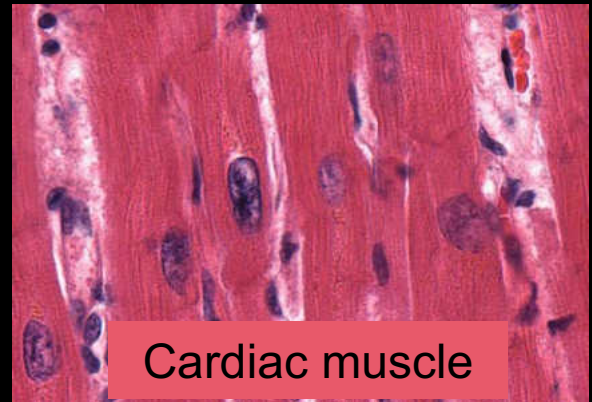
Blood



Cartilage

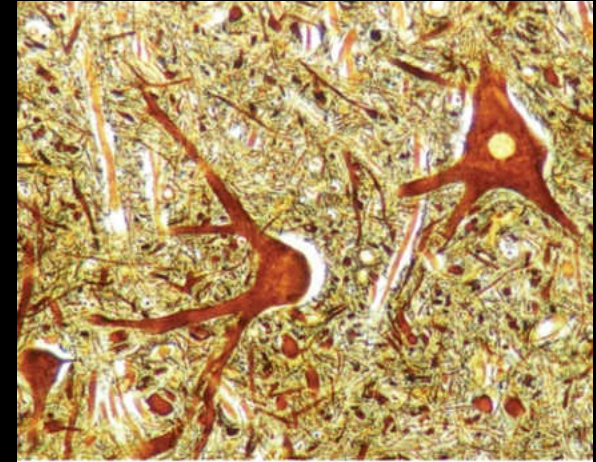
Animal Histology: Muscle tissue

- Muscle tissue is contractile and muscular contractions are based on the sliding filament mechanism
- Tissue types:
 1. **Skeletal muscle**
 2. **Cardiac muscle**
 3. **Smooth muscle**
- Skeletal muscle contractions based on conscious control
- Smooth muscle and cardiac muscle contractions generally occur automatically
- Muscle fibers may be organized into bundles in different orientations (longitudinal, transverse, oblique)

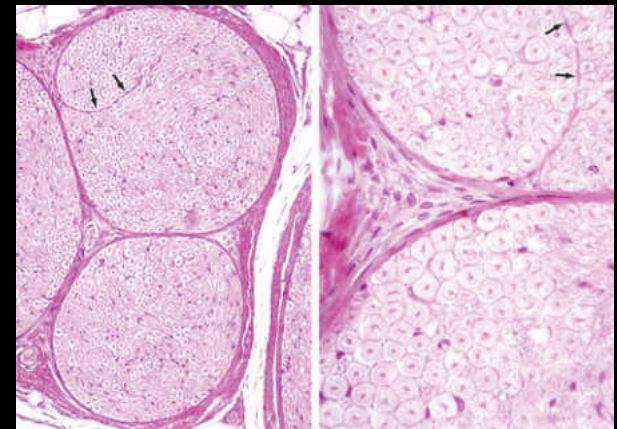


Animal Histology: Nervous tissue

- Nervous tissue consists of **neurons** that generate or conduct nerve impulses, and **glial cells** (supporting cells)
- Central nervous system consists of brain and spinal cord
- Peripheral system generally consists of nervous tissue throughout the rest of the body
- Difficult to distinguish nervous system cell types mainly because of complex composition of nervous and other tissues

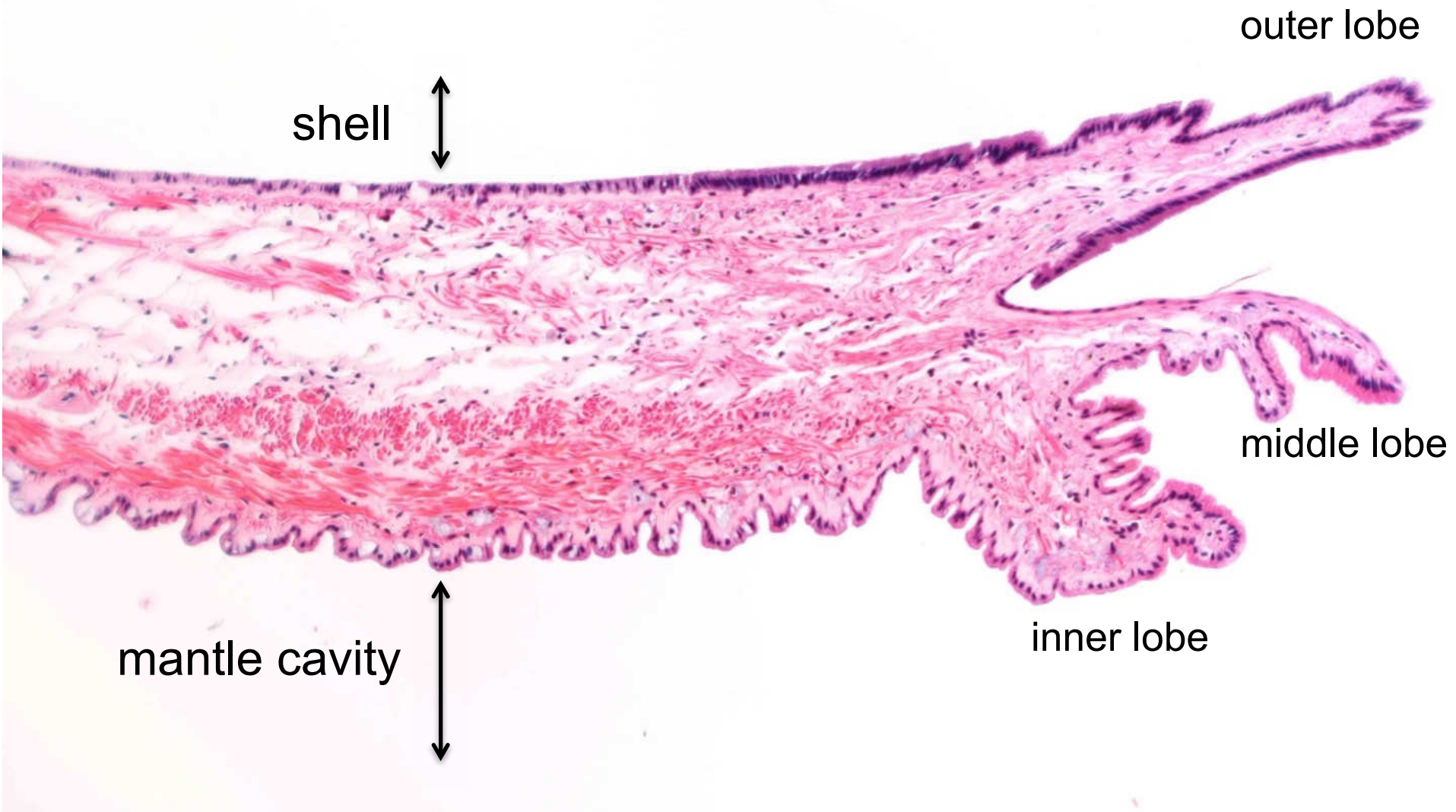


Neurons (spinal cord)



Nerve

Mantle Edge

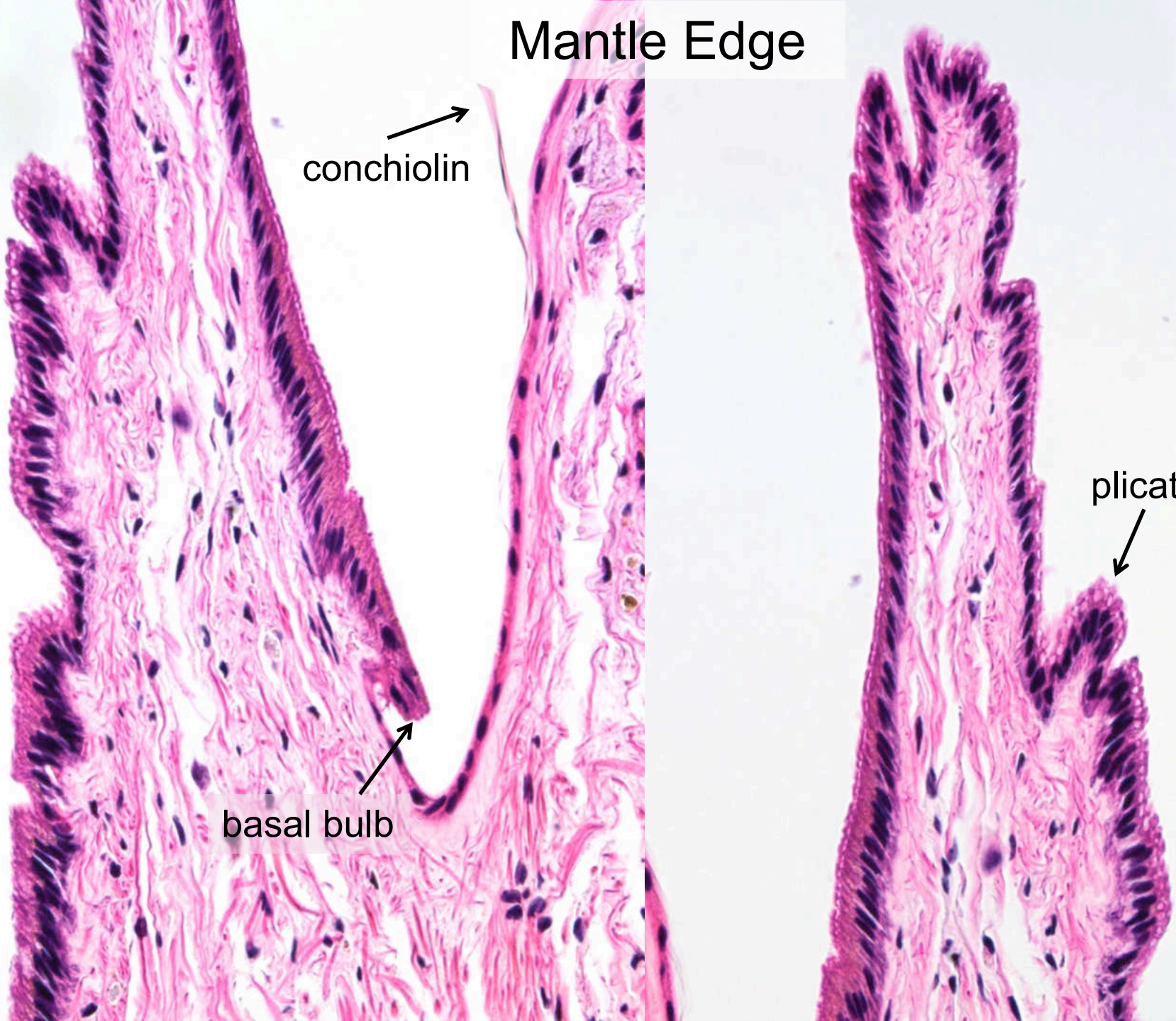


Mantle Edge

conchiolin

basal bulb

plication



Middle Mantle

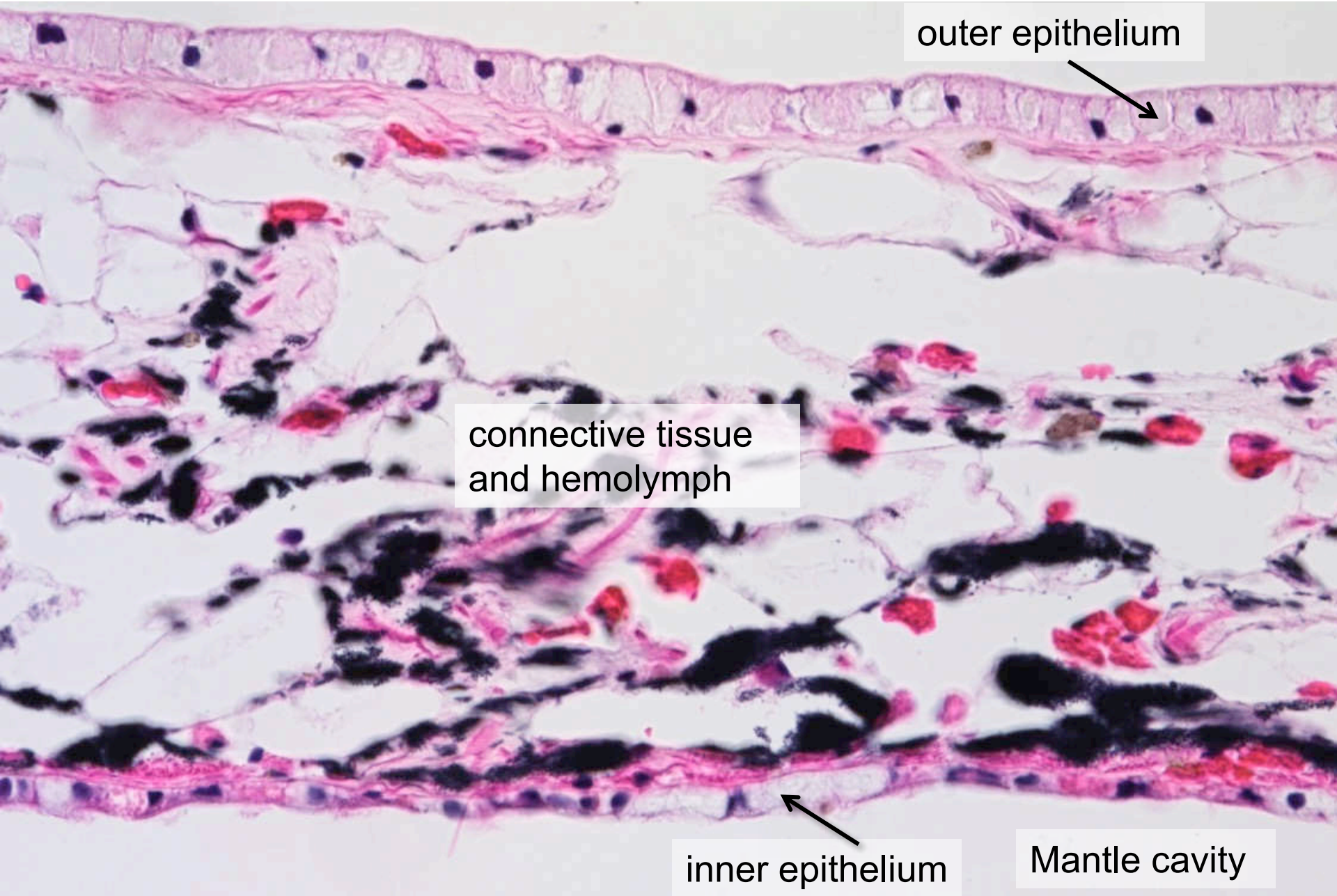
Shell

outer epithelium

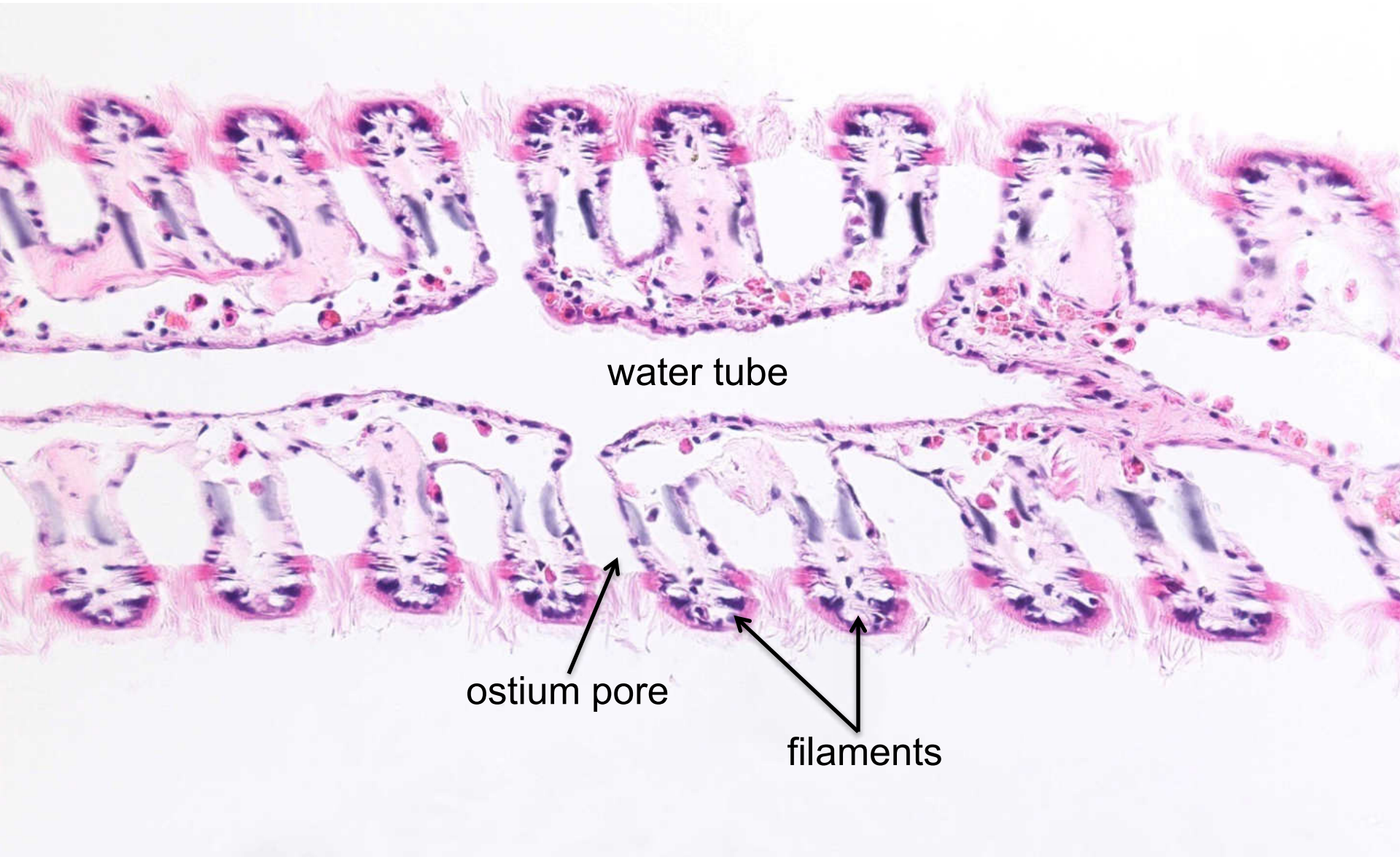
connective tissue
and hemolymph

inner epithelium

Mantle cavity



Gill



Gill

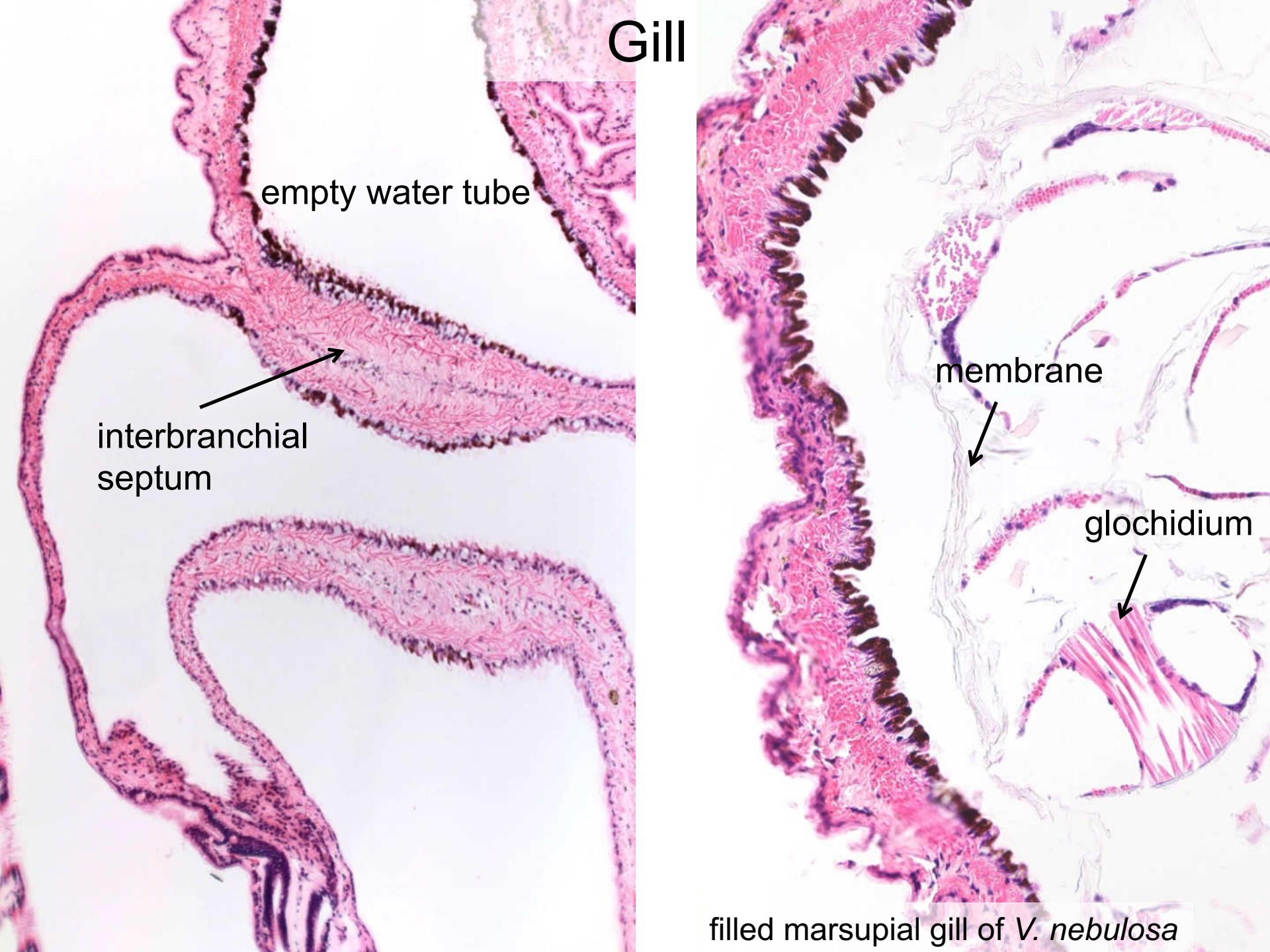
empty water tube

interbranchial
septum

membrane

glochidium

filled marsupial gill of *V. nebulosa*



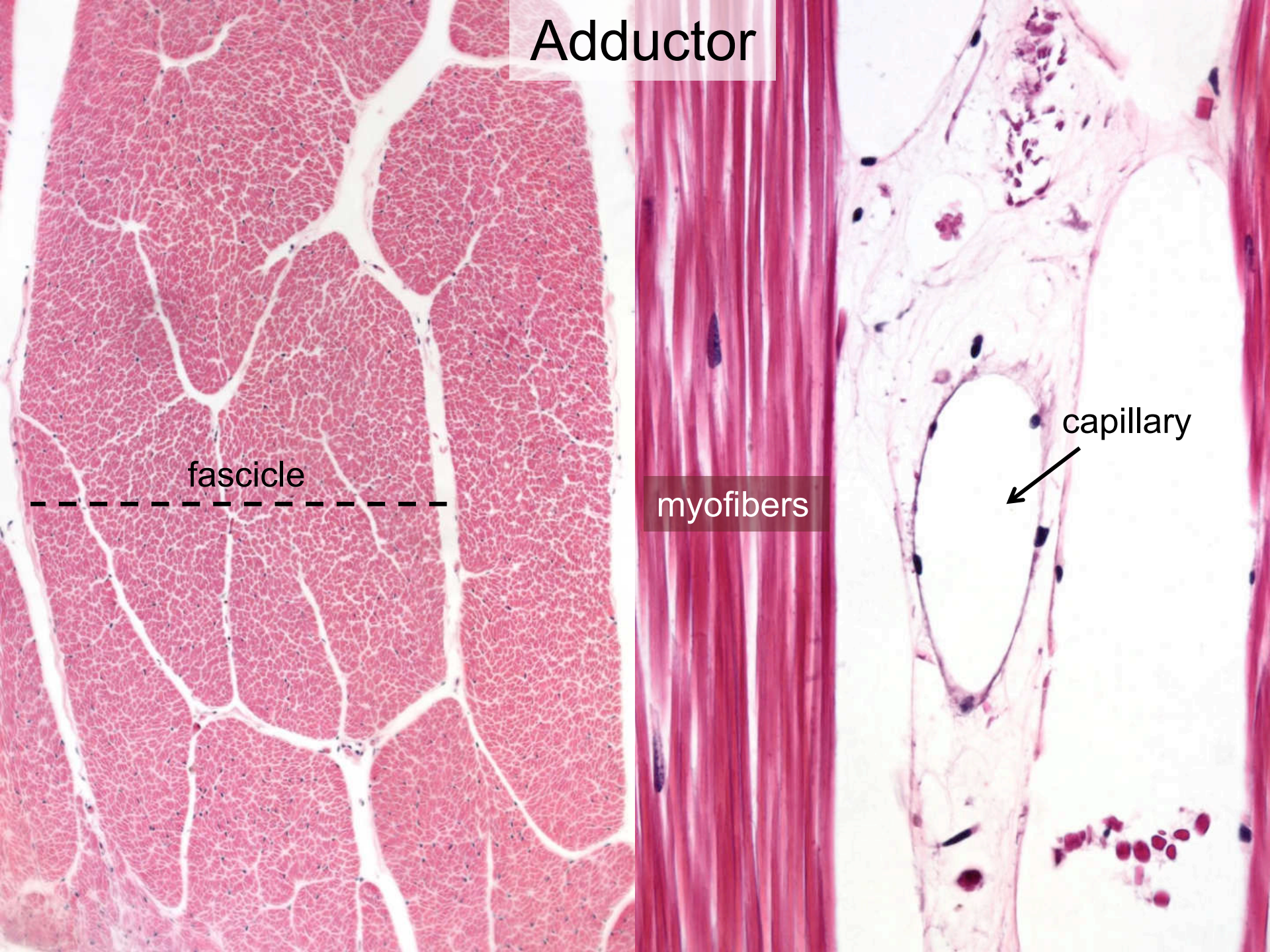
Adductor

fascicle



myofibers

capillary

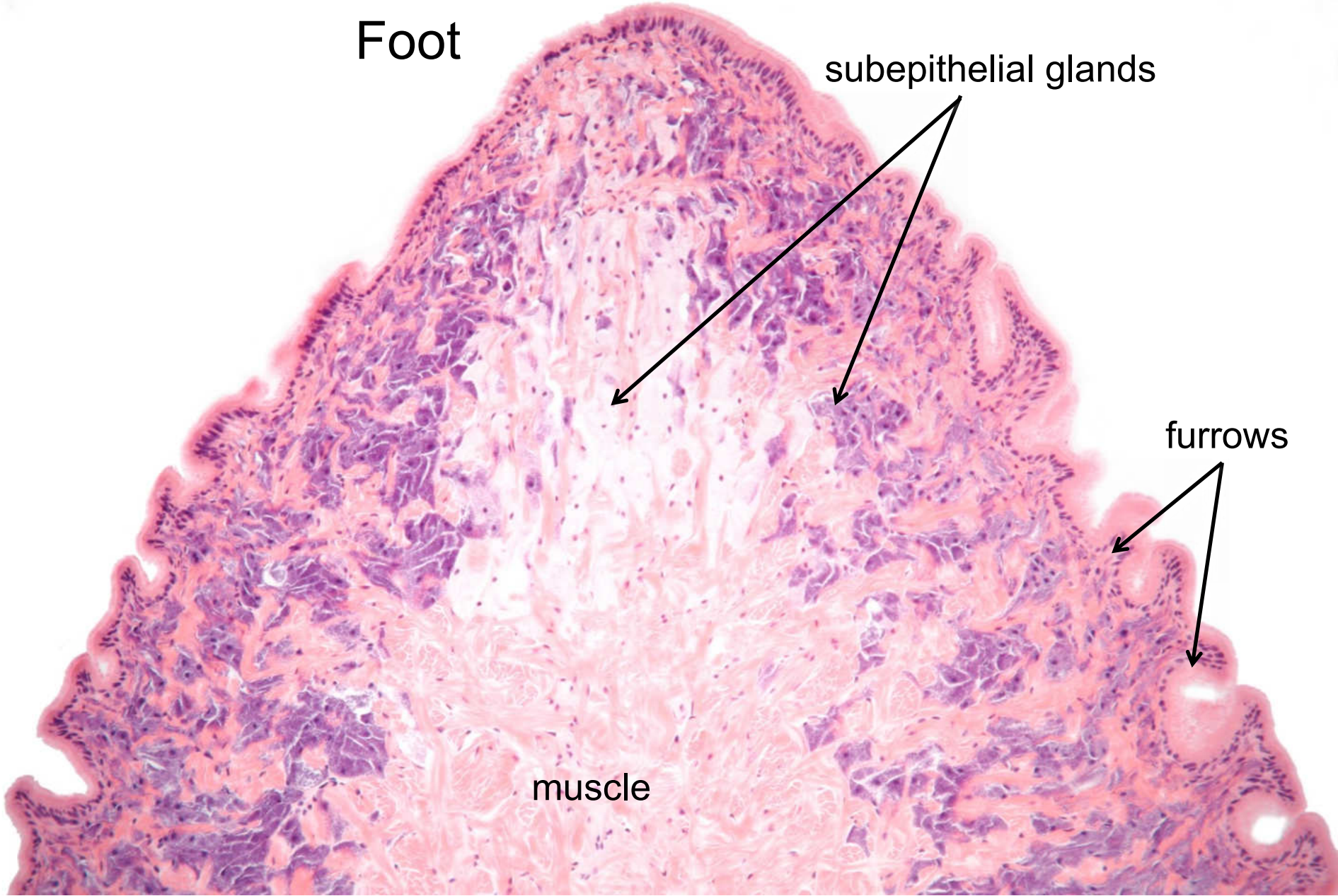


Foot

subepithelial glands

furrows

muscle

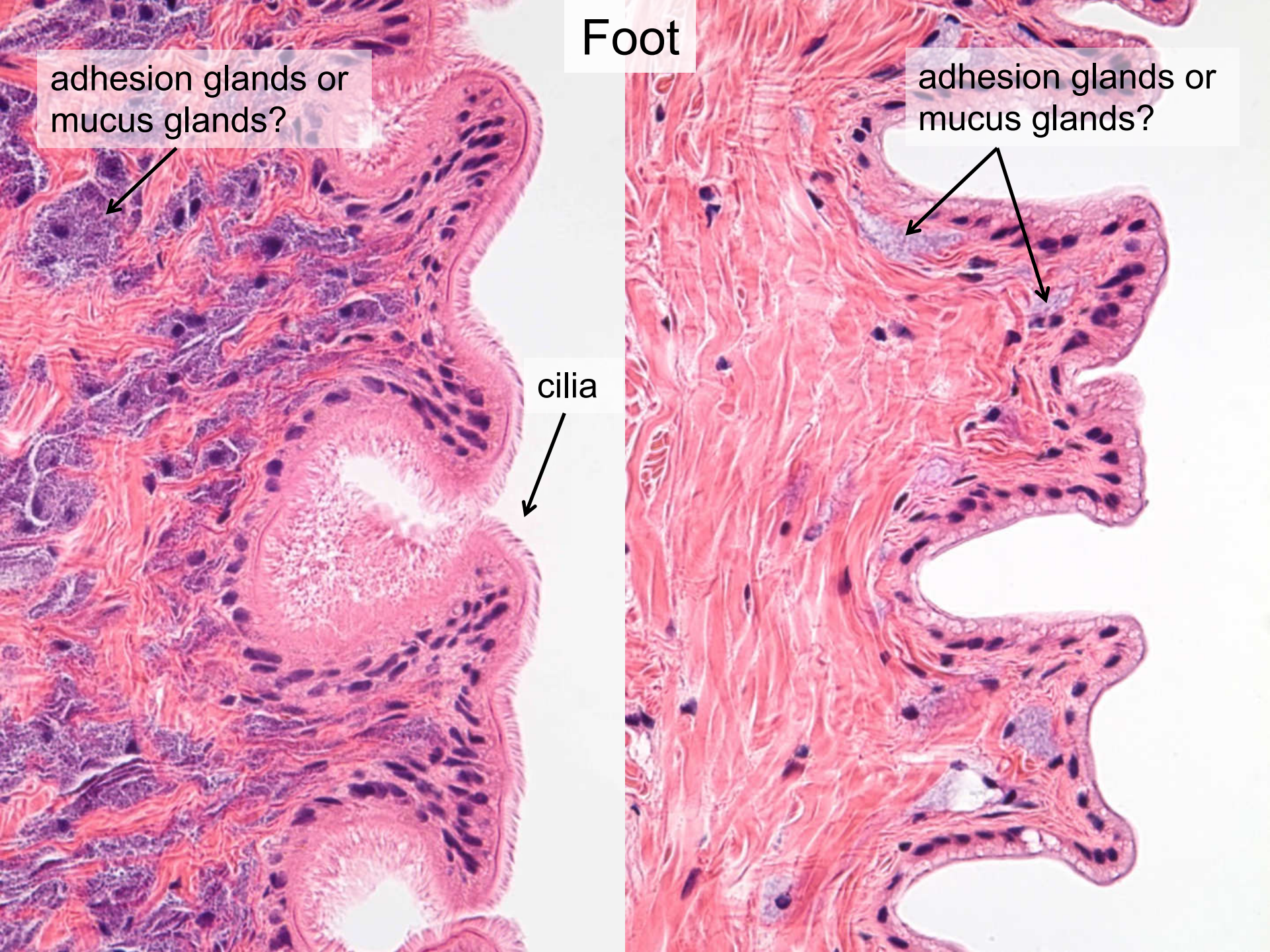


Foot

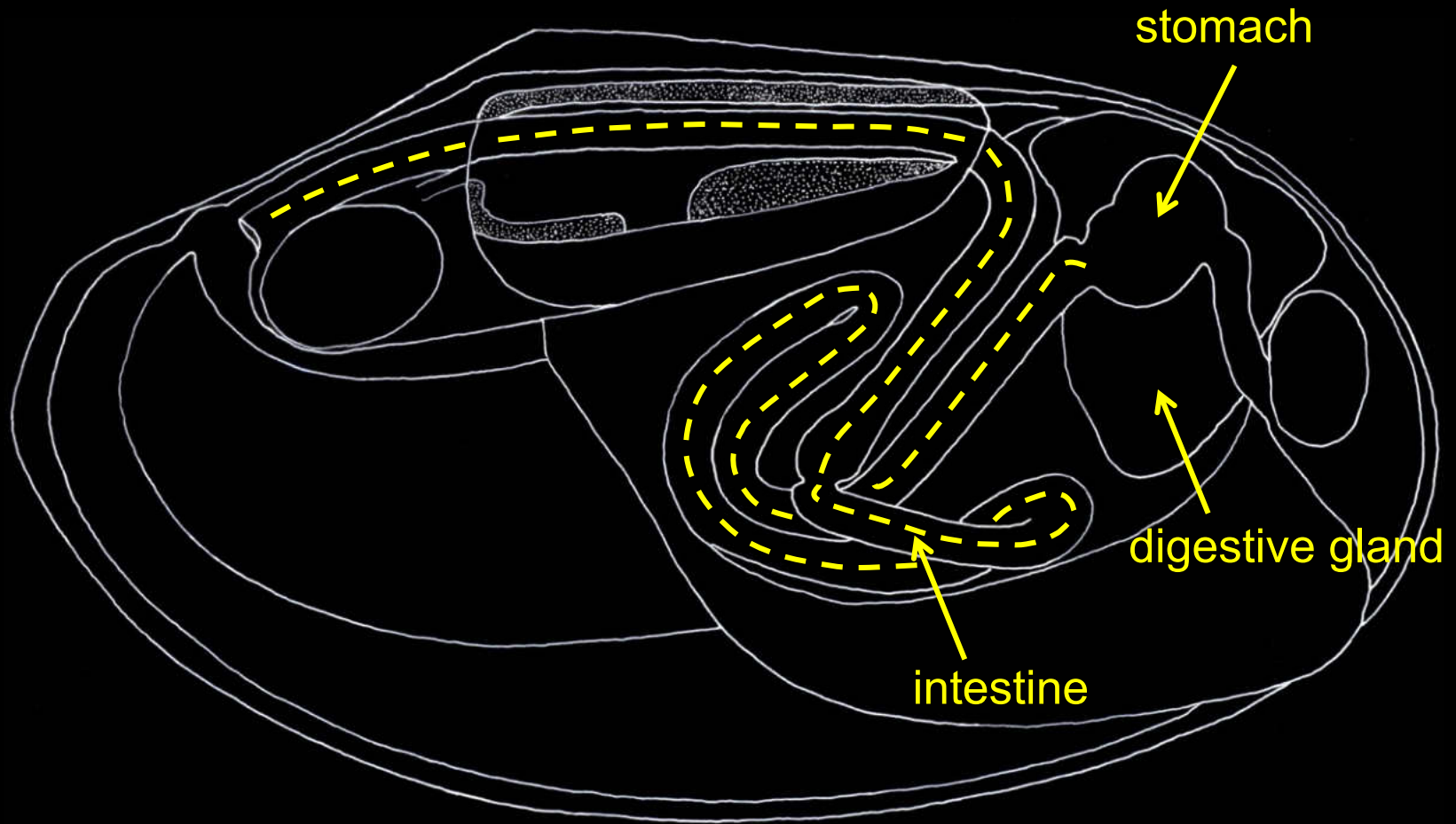
adhesion glands or
mucus glands?

adhesion glands or
mucus glands?

cilia



Digestive tract



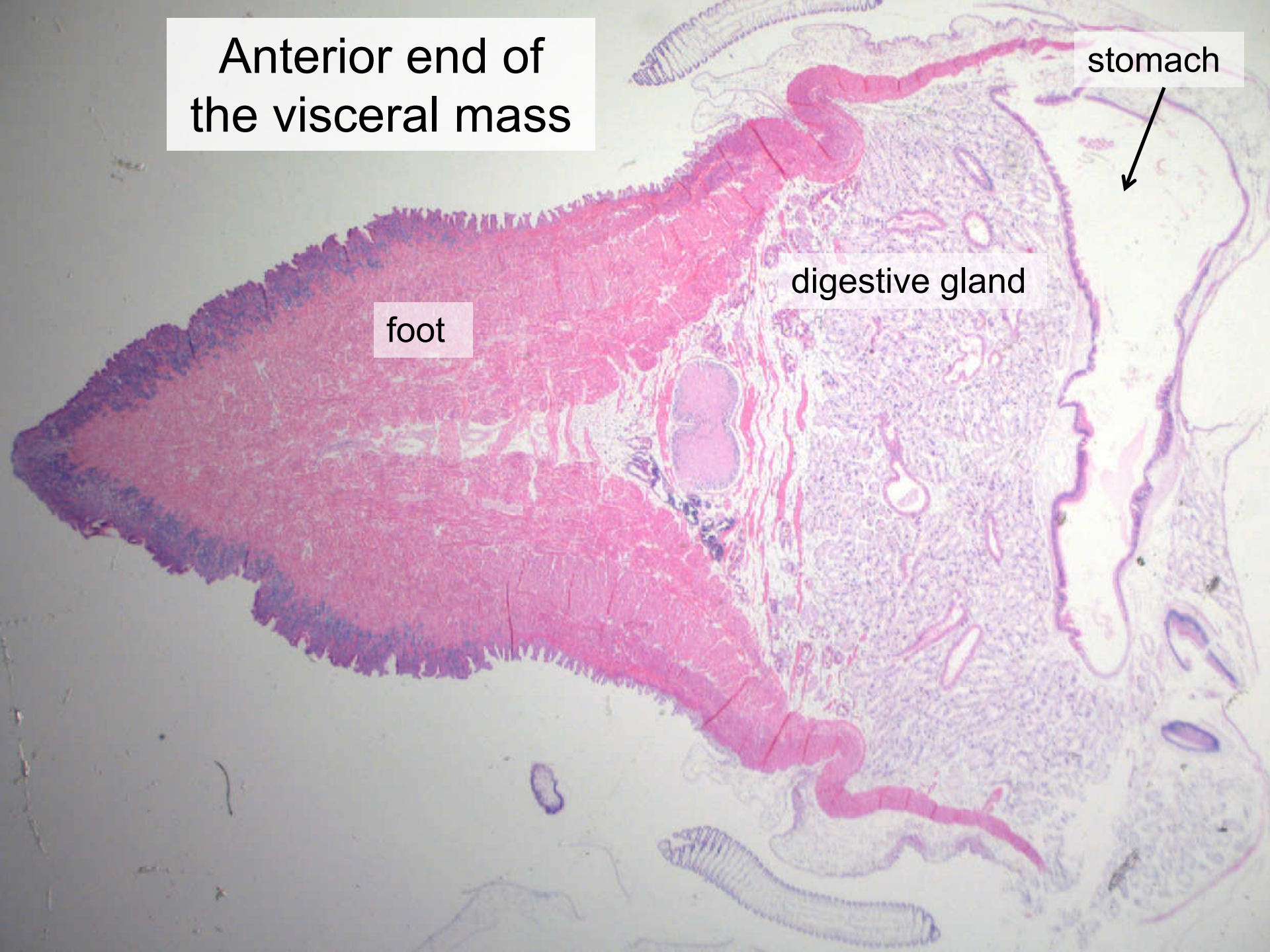
From: Gutheil, (1912)

Anterior end of
the visceral mass

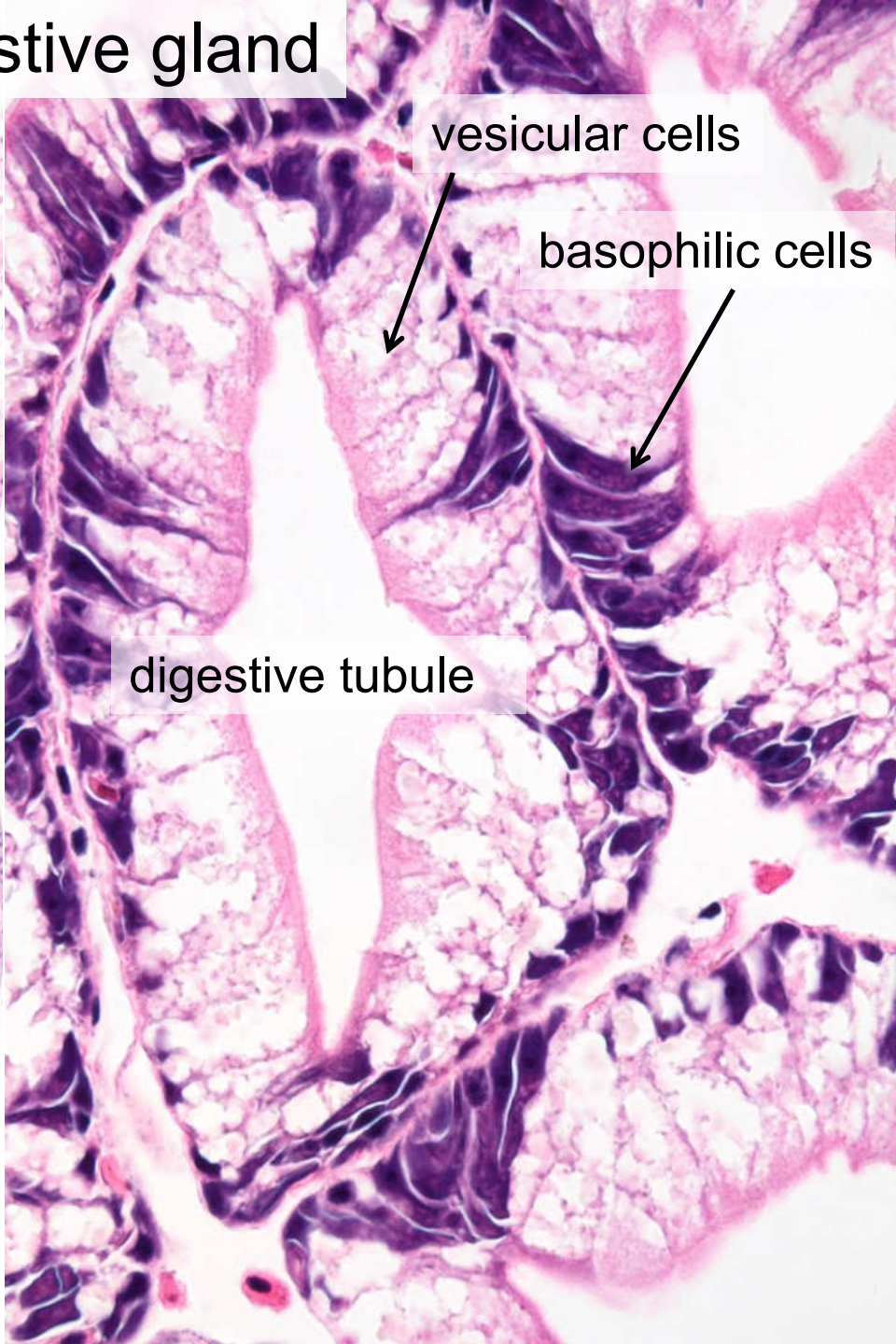
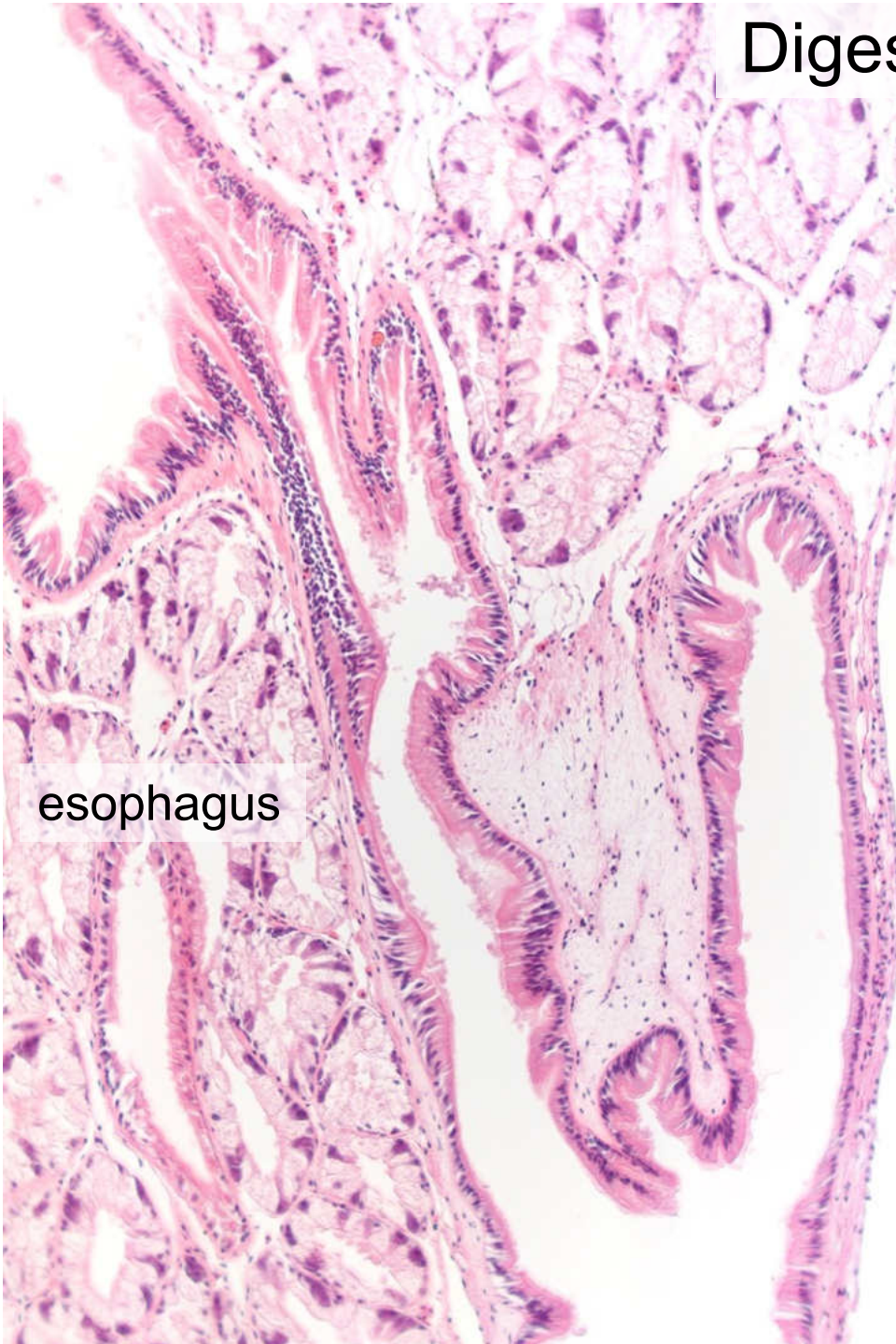
stomach

foot

digestive gland



Digestive gland



Digestive gland

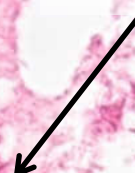
primary tubules have plicae and cilia

secondary tubules have microvilli, vesicles

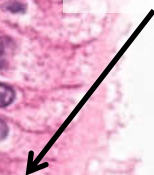
cilia



microvilli



vesicles



digestive tubule 1

digestive tubule 2

Stomach

ventral

dorsal

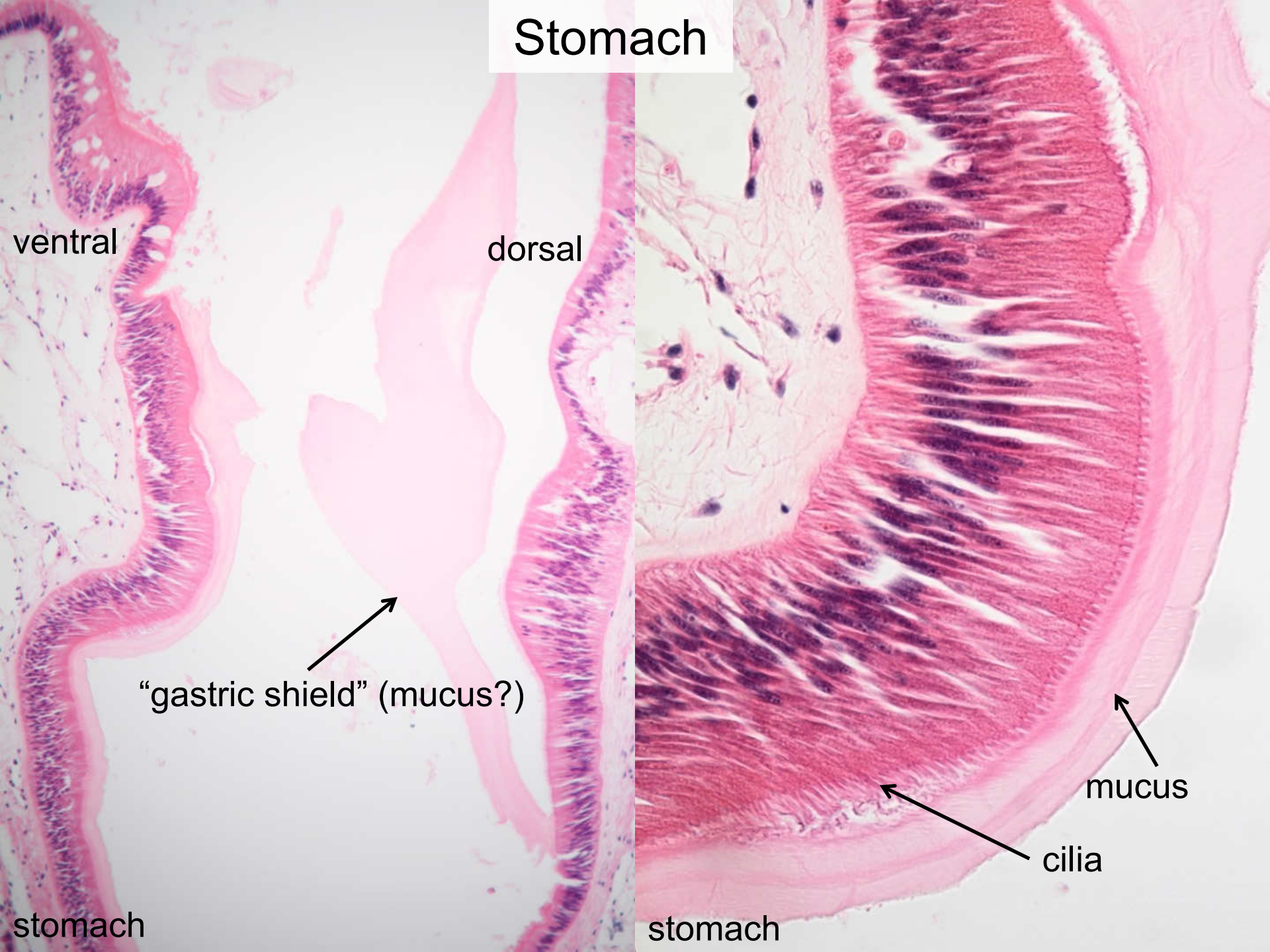
“gastric shield” (mucus?)

mucus

cilia

stomach

stomach

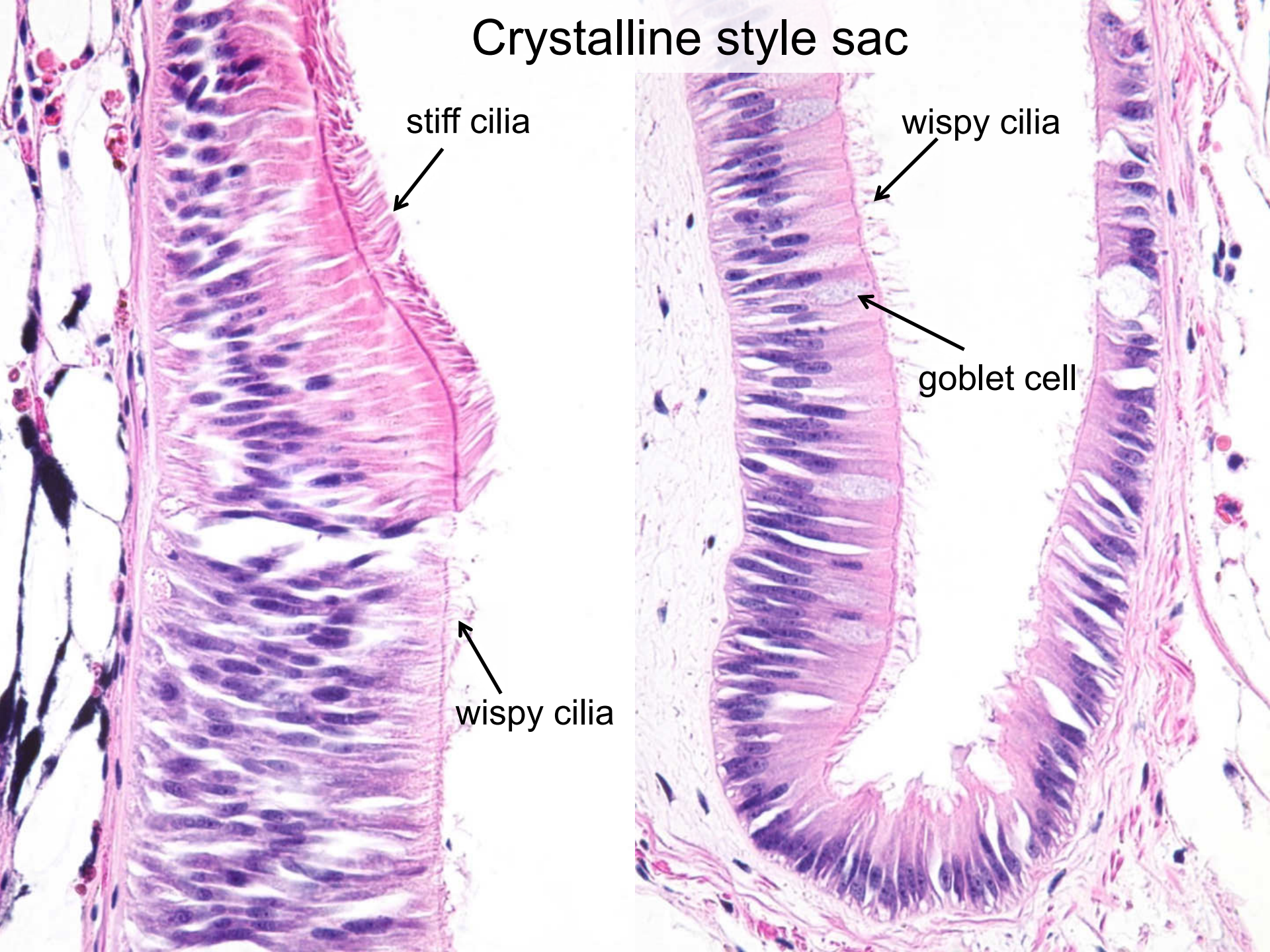


Crystalline style sac (first limb of the intestine)

rotation of style may pull food matter into intestine forming a bolus



Crystalline style sac



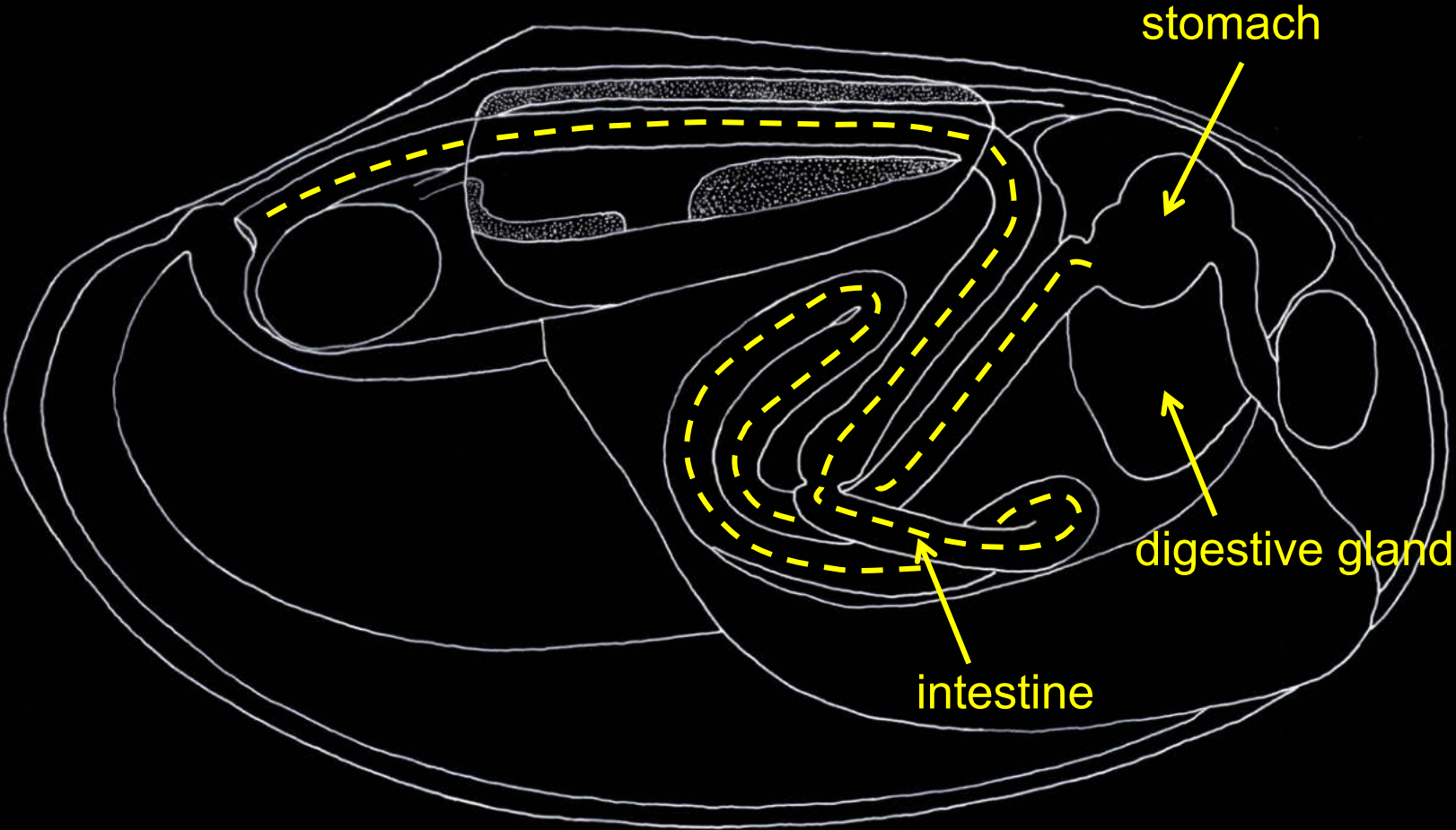
stiff cilia

wispy cilia

goblet cell

wispy cilia

Digestive tract

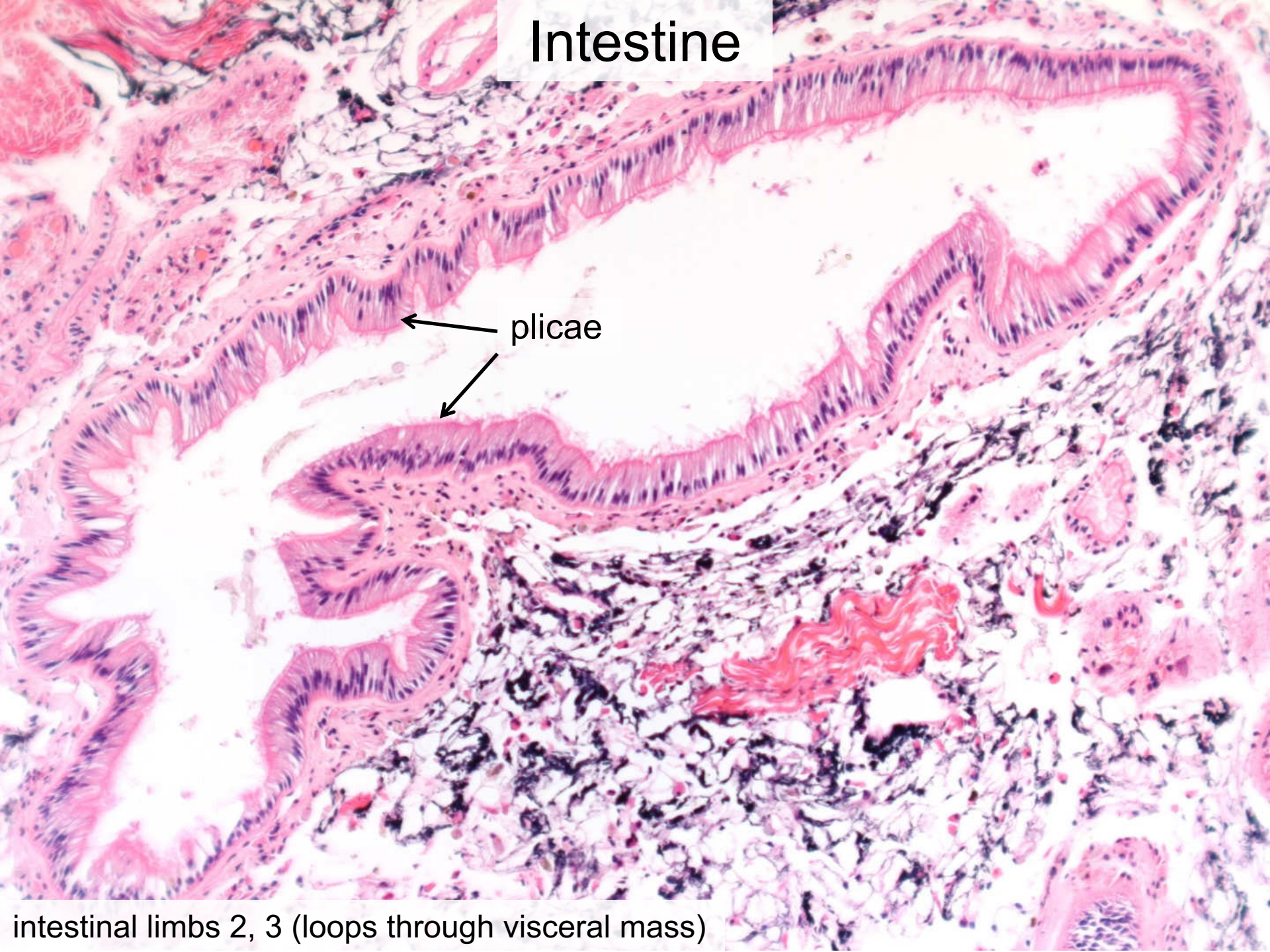


Gutheil, (1912)

Intestine

plicae

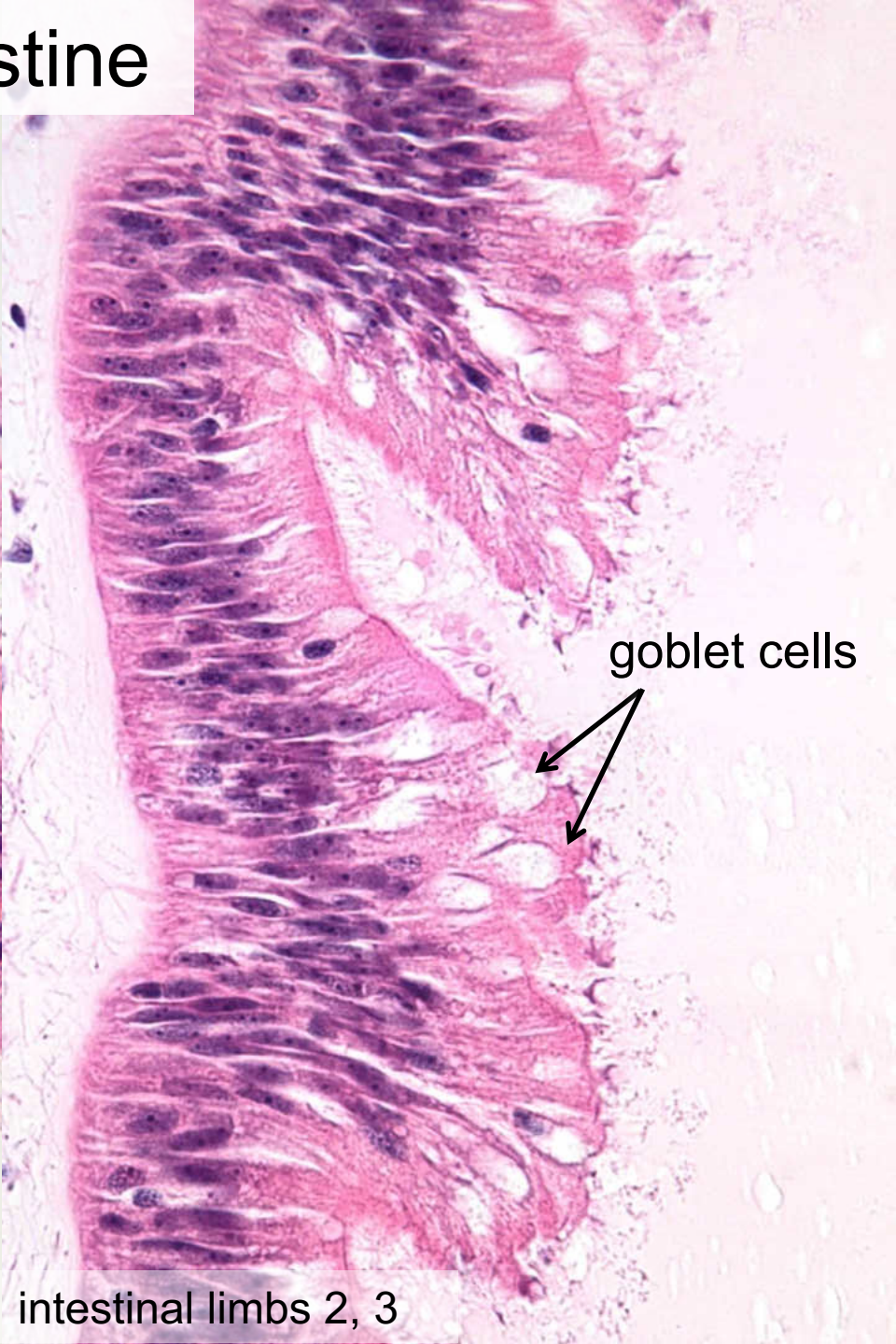
intestinal limbs 2, 3 (loops through visceral mass)



Intestine



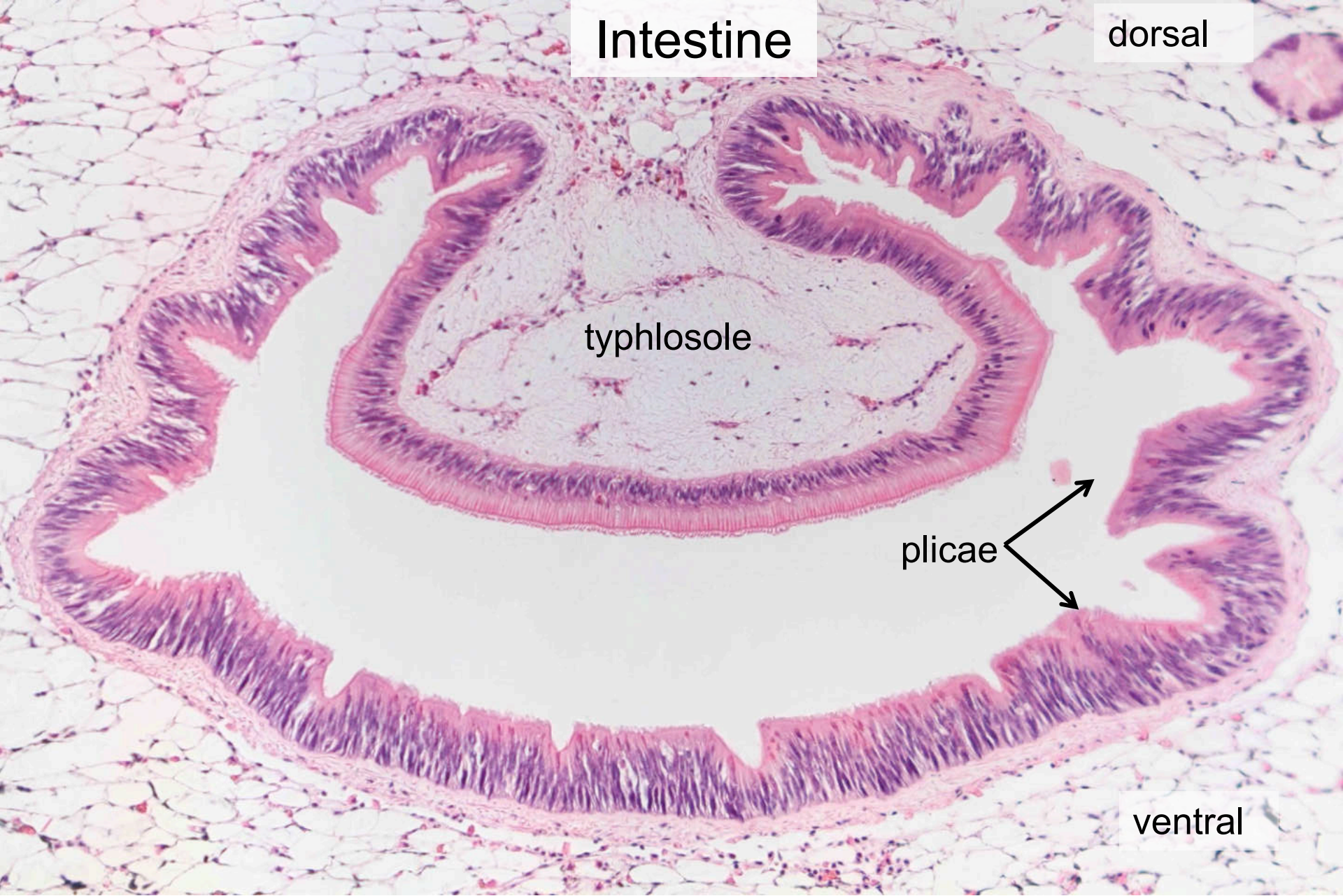
cilia



goblet cells

intestinal limbs 2, 3

intestinal limbs 2, 3



Intestine

dorsal

typhlosole

plicae

ventral

fourth intestinal limb (along the hinge)

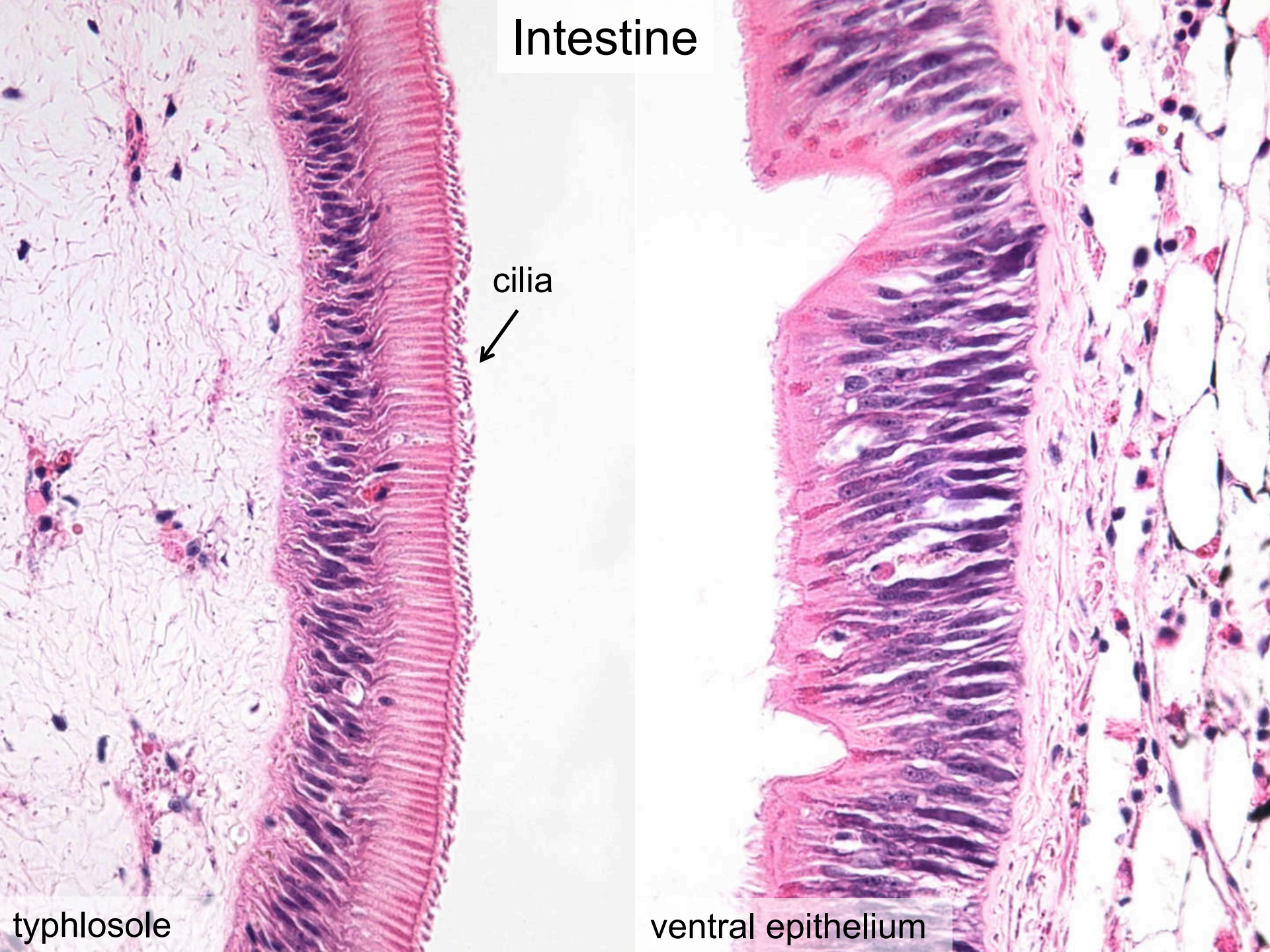
Intestine

cilia



typhlosole

ventral epithelium

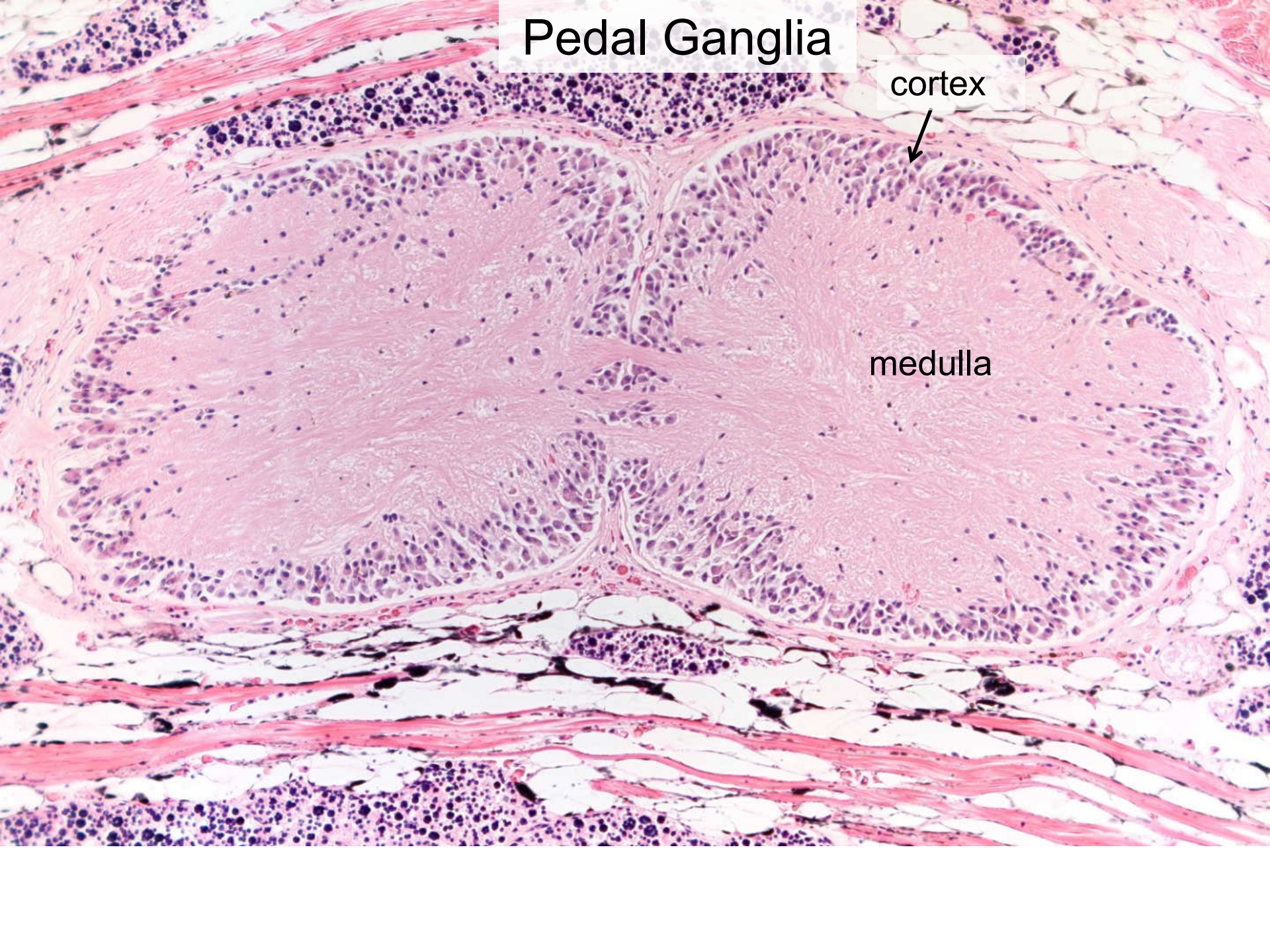


Pedal Ganglia

cortex



medulla



Pedal Ganglia

neuron cell bodies



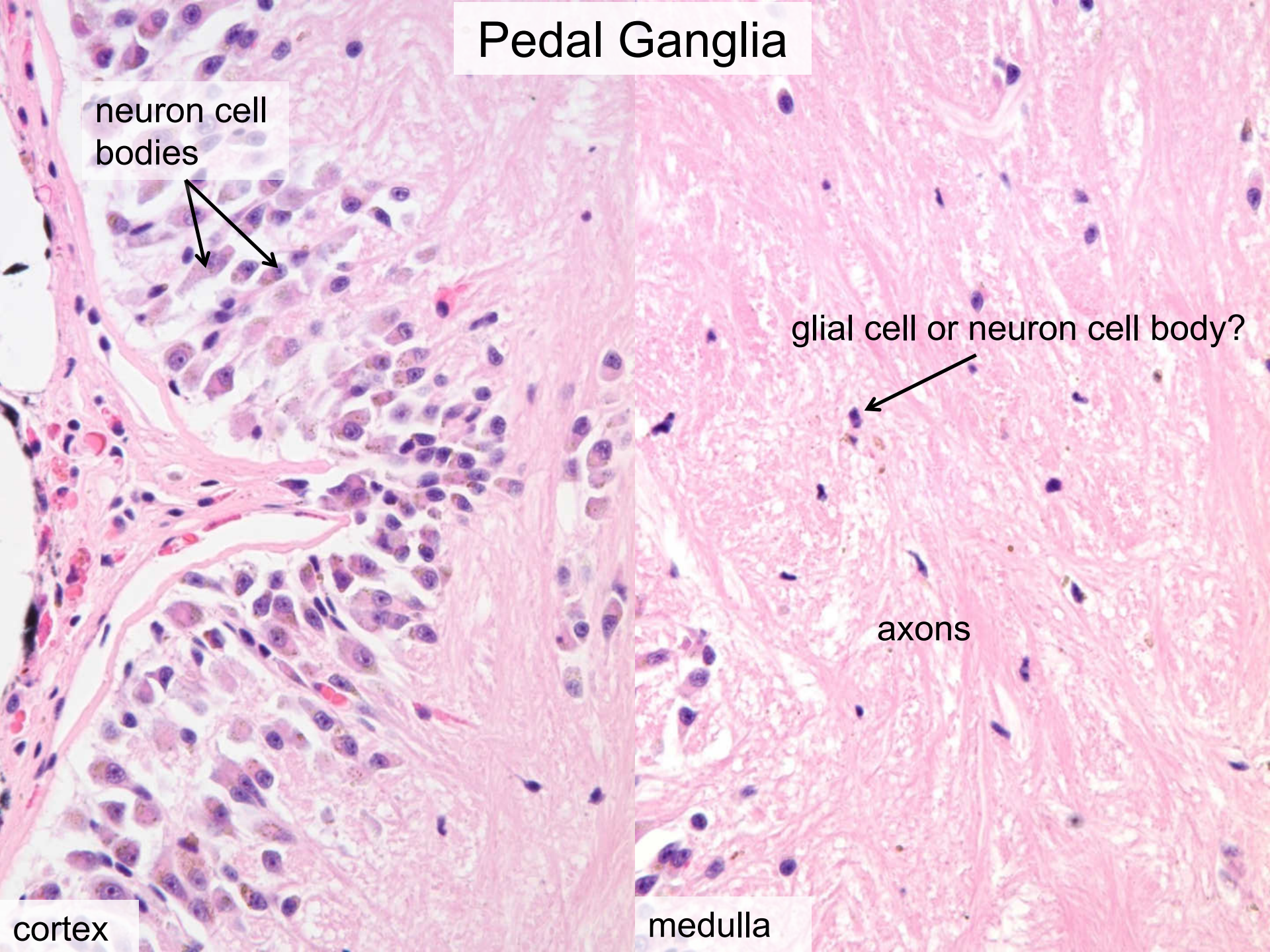
glial cell or neuron cell body?



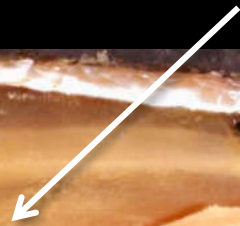
axons

cortex

medulla



heart



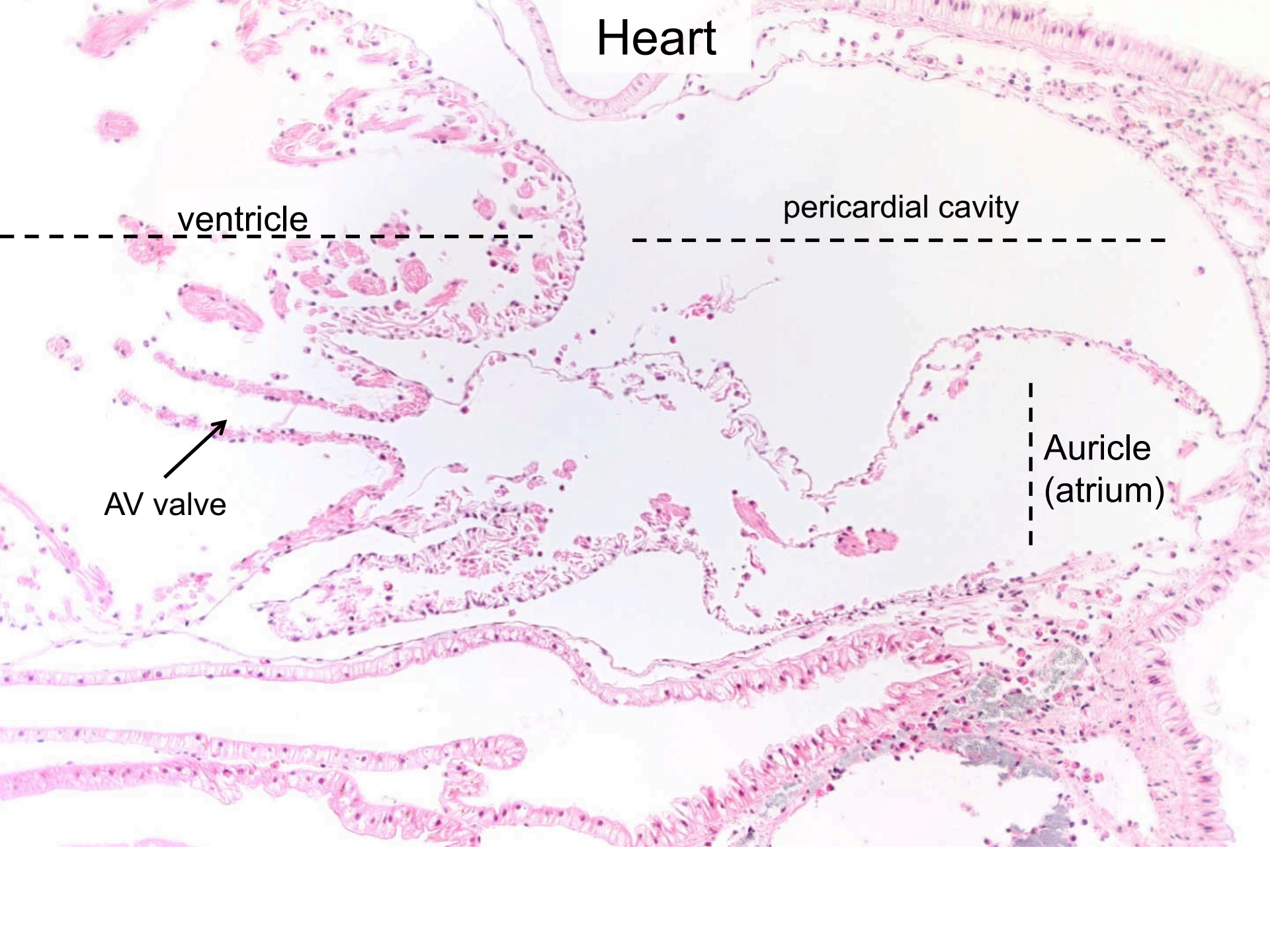
Heart

ventricle

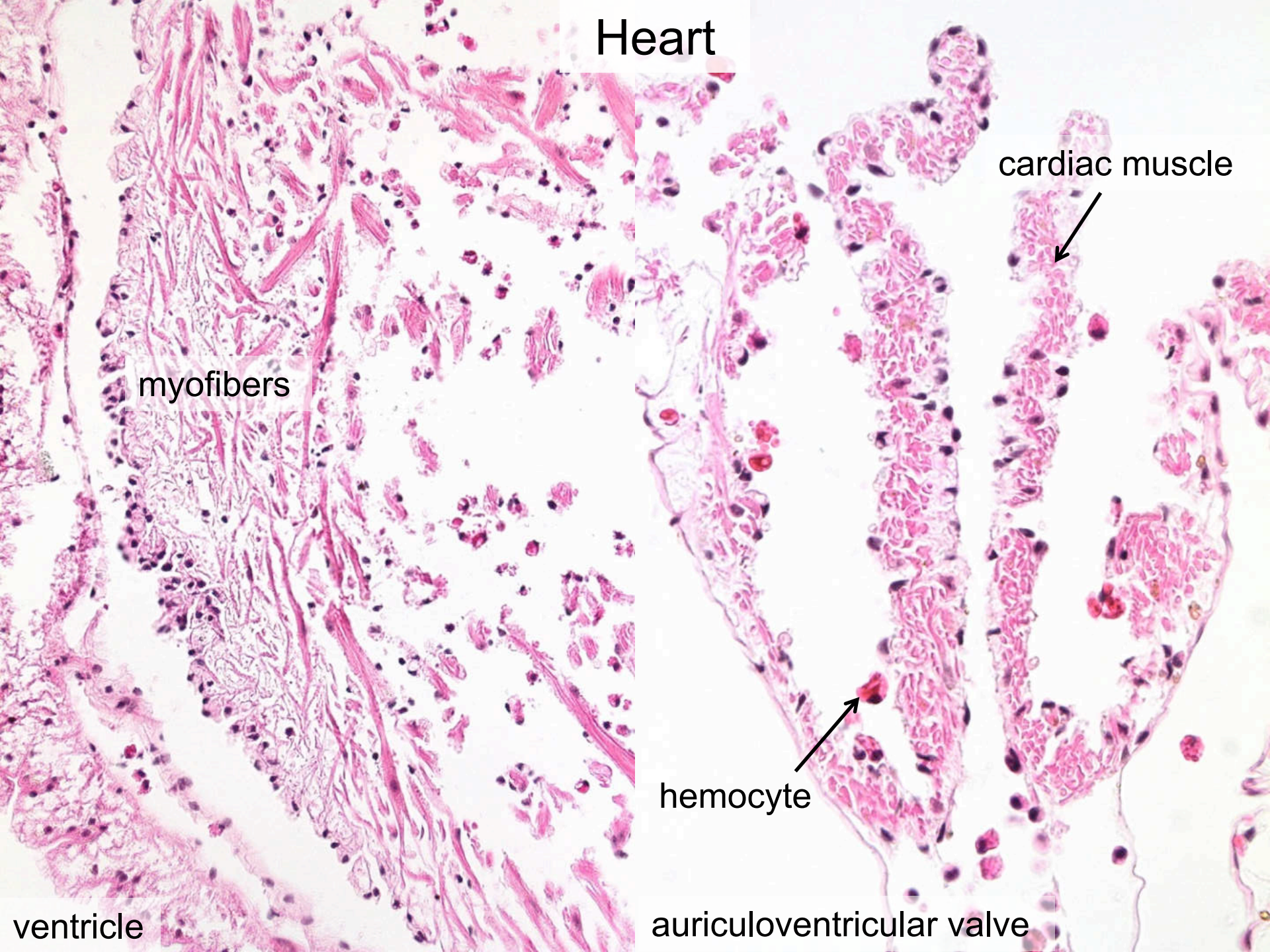
pericardial cavity

AV valve

Auricle
(atrium)



Heart



myofibers

cardiac muscle

hemocyte

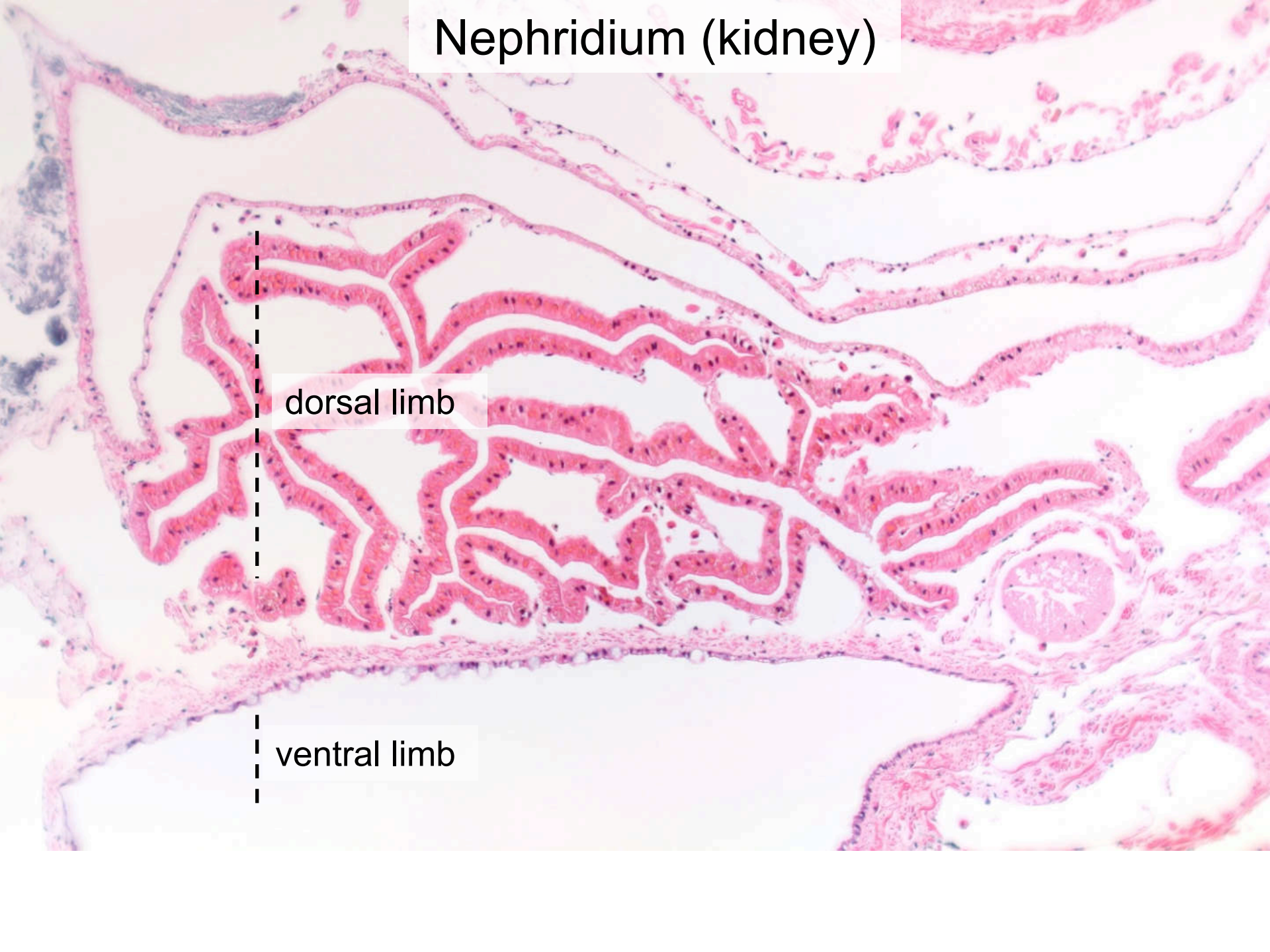
ventricle

auriculoventricular valve

Nephridium (kidney)

dorsal limb

ventral limb



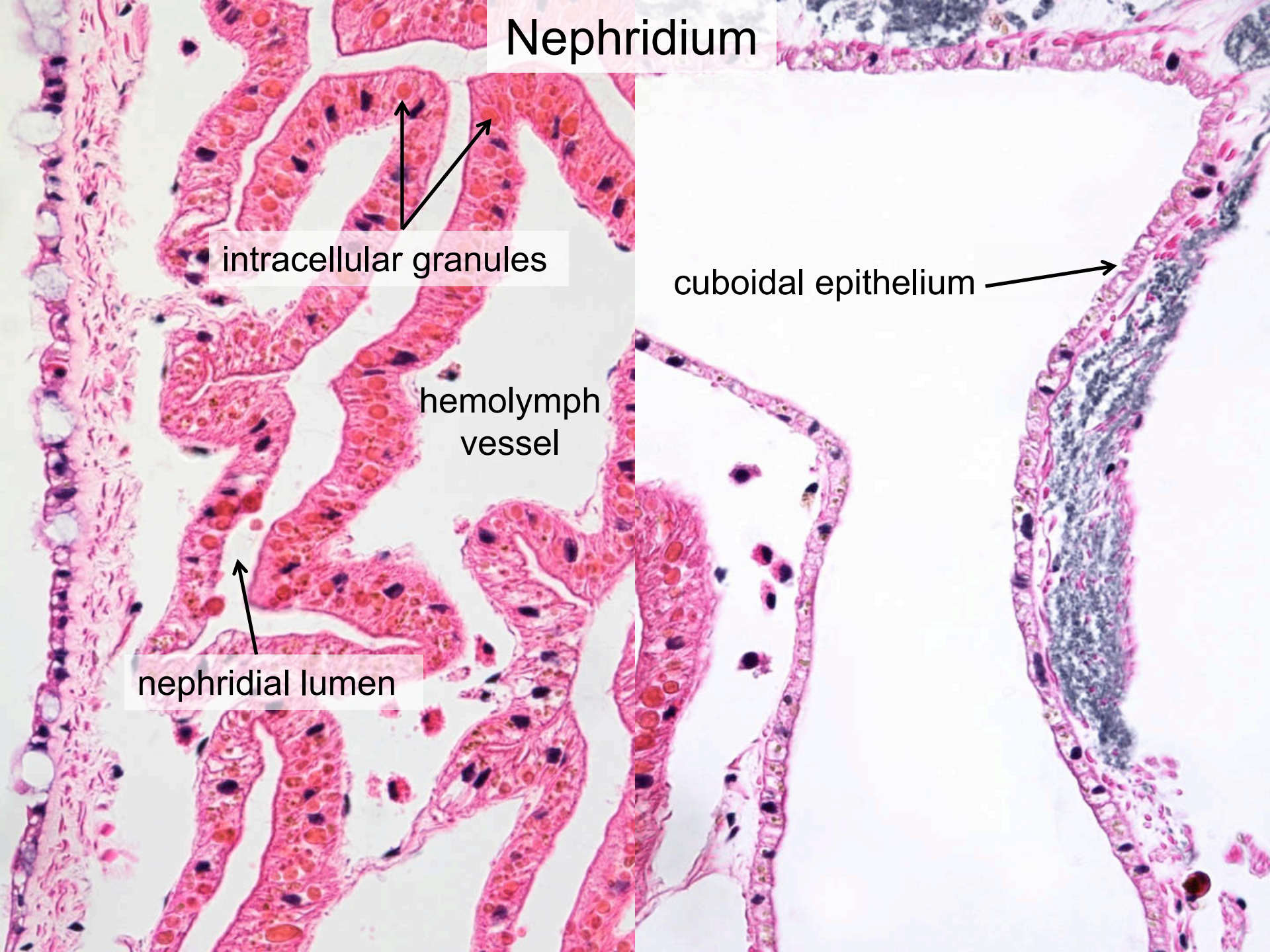
Nephridium

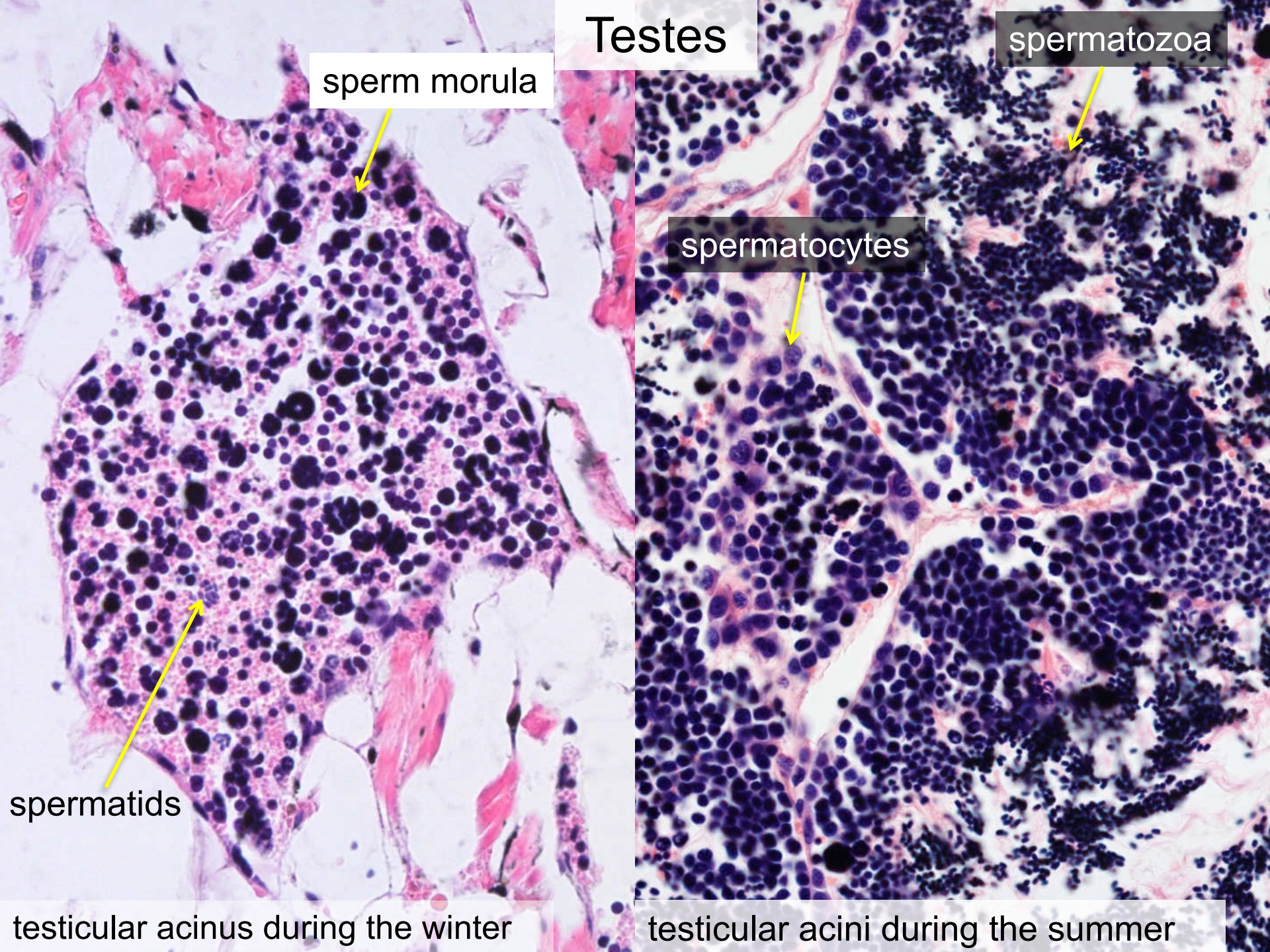
intracellular granules

hemolymph vessel

nephridial lumen

cuboidal epithelium





Testes

sperm morula

spermatozoa

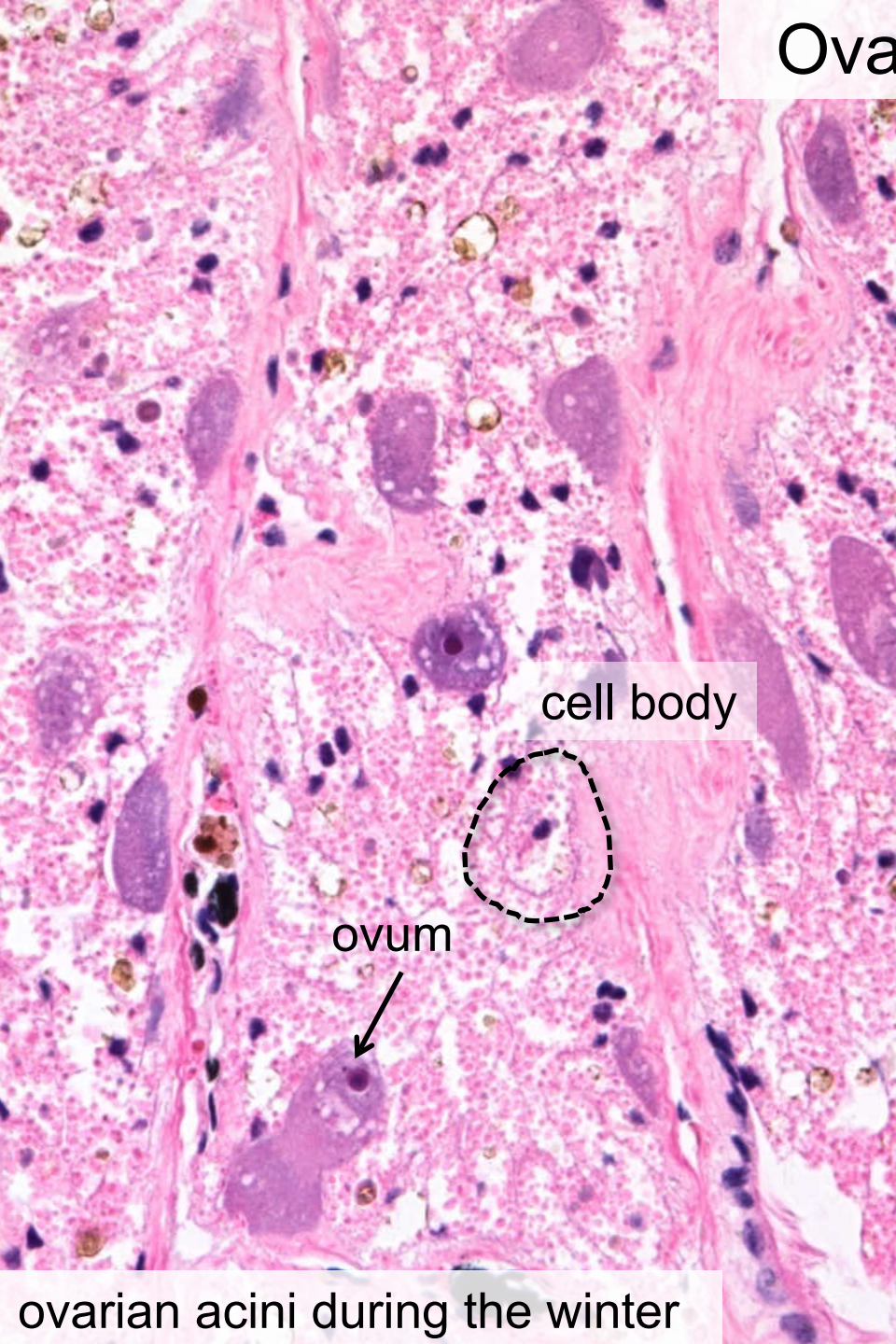
spermatocytos

spermatids

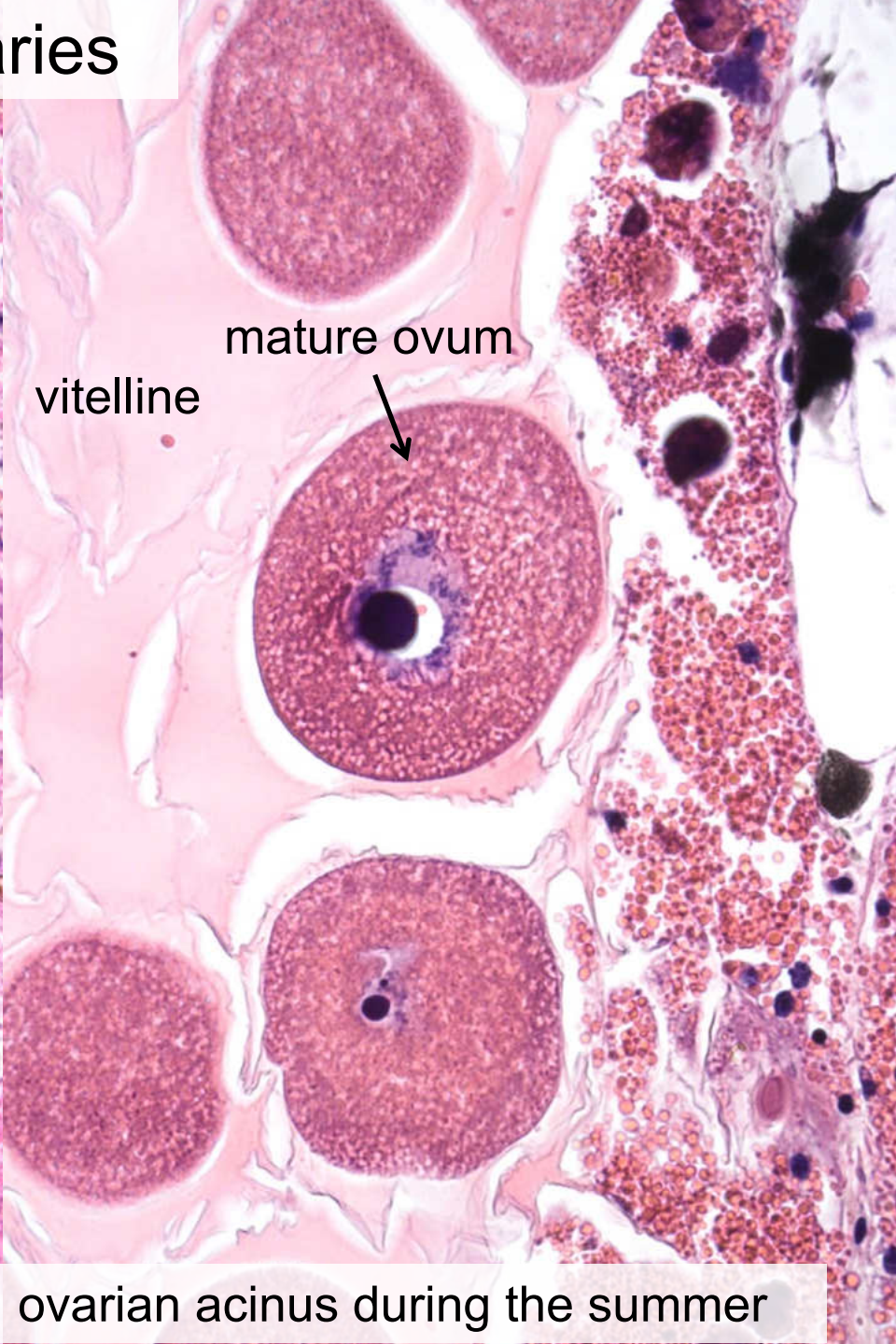
testicular acinus during the winter

testicular acini during the summer

Ovaries



ovarian acini during the winter



ovarian acinus during the summer

References

- www.Histologyguide.org
- McElwain, A., and S. A. Bullard. 2014. Histological atlas of freshwater mussels (Bivalvia, Unionidae): *Villosa nebulosa* (Ambleminae, Lampsilini), *Fusconaia cerina* (Ambleminae: Pleurobemini), and *Strophitus connasaugaensis* (Unioninae: Anodontini). *Malacologia* 57: 99–239.