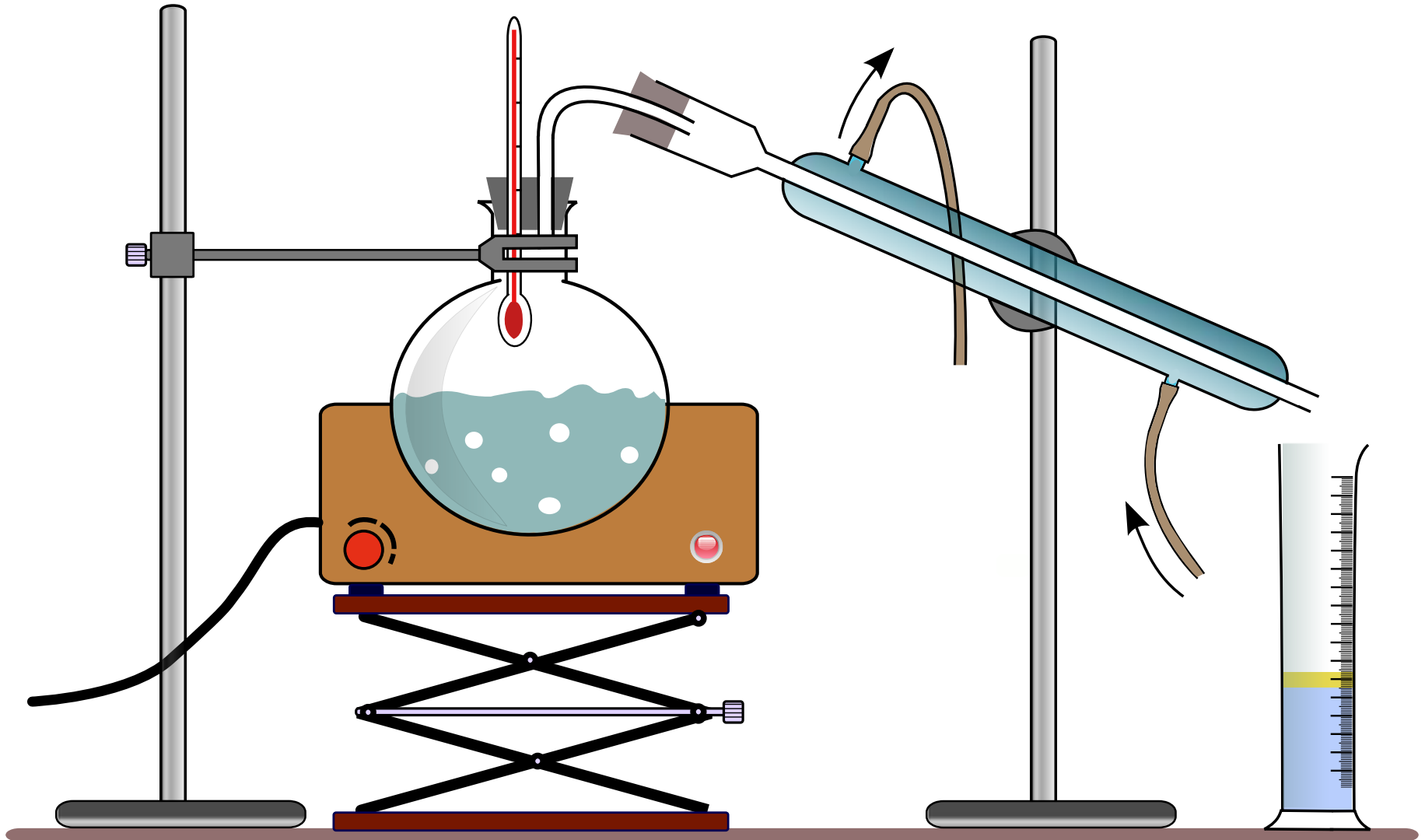
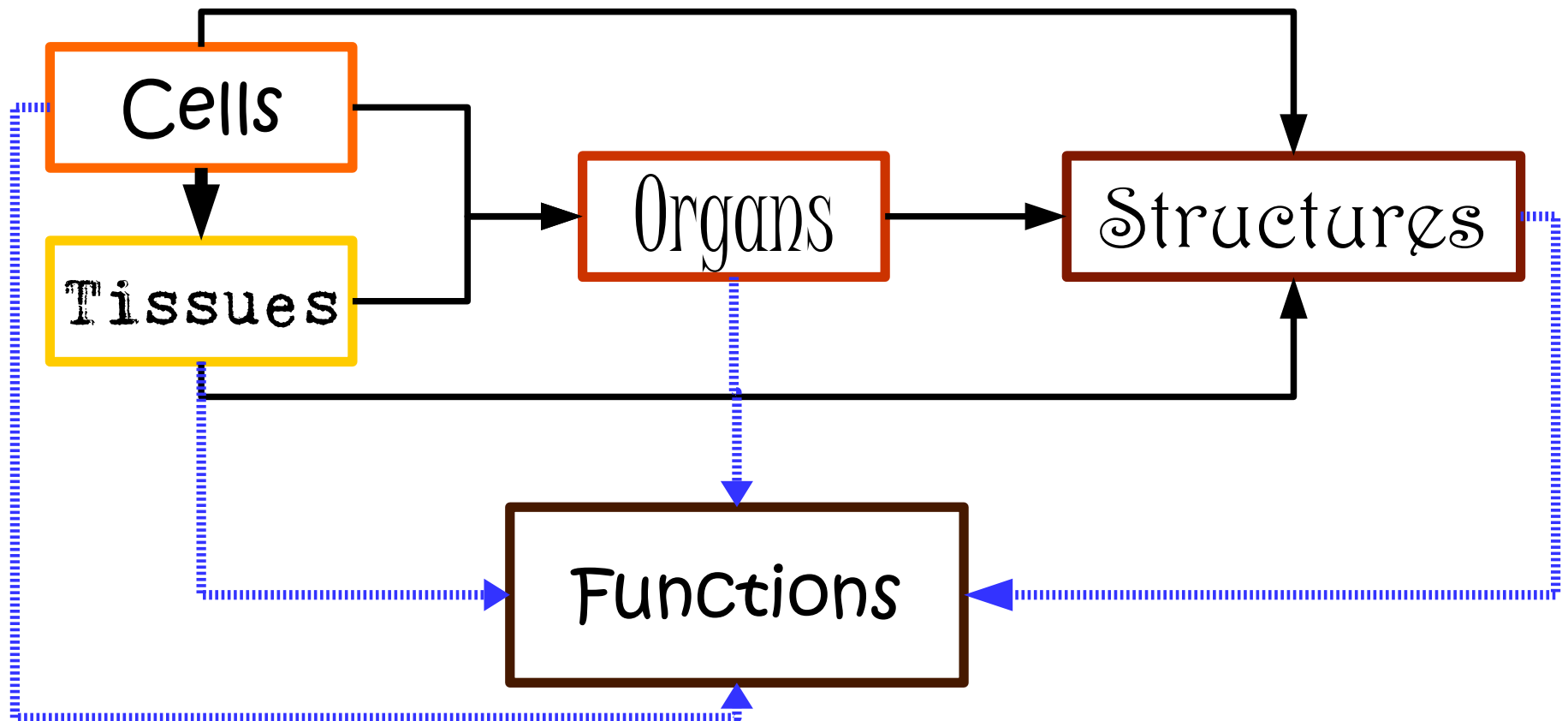


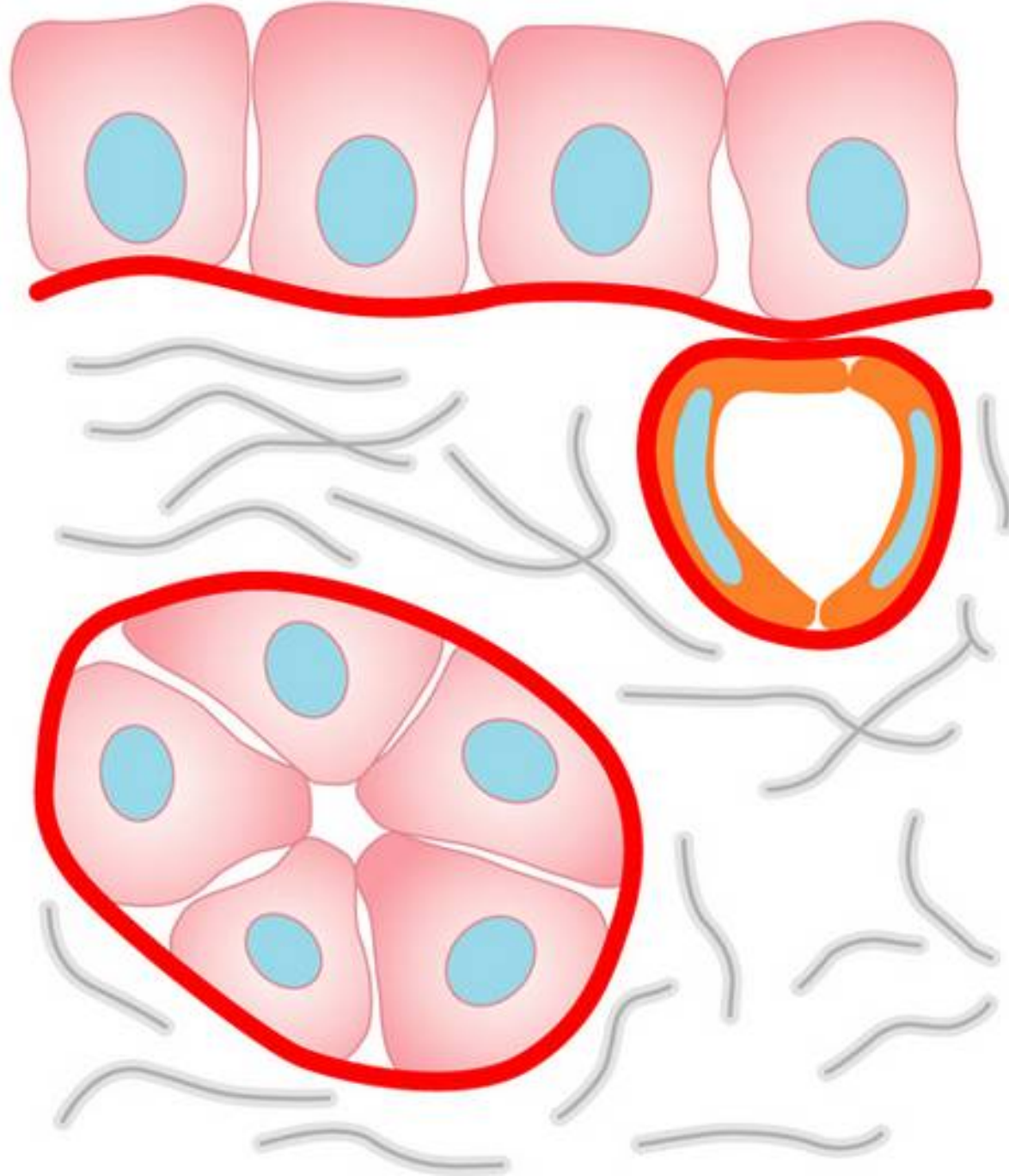
Urinary system



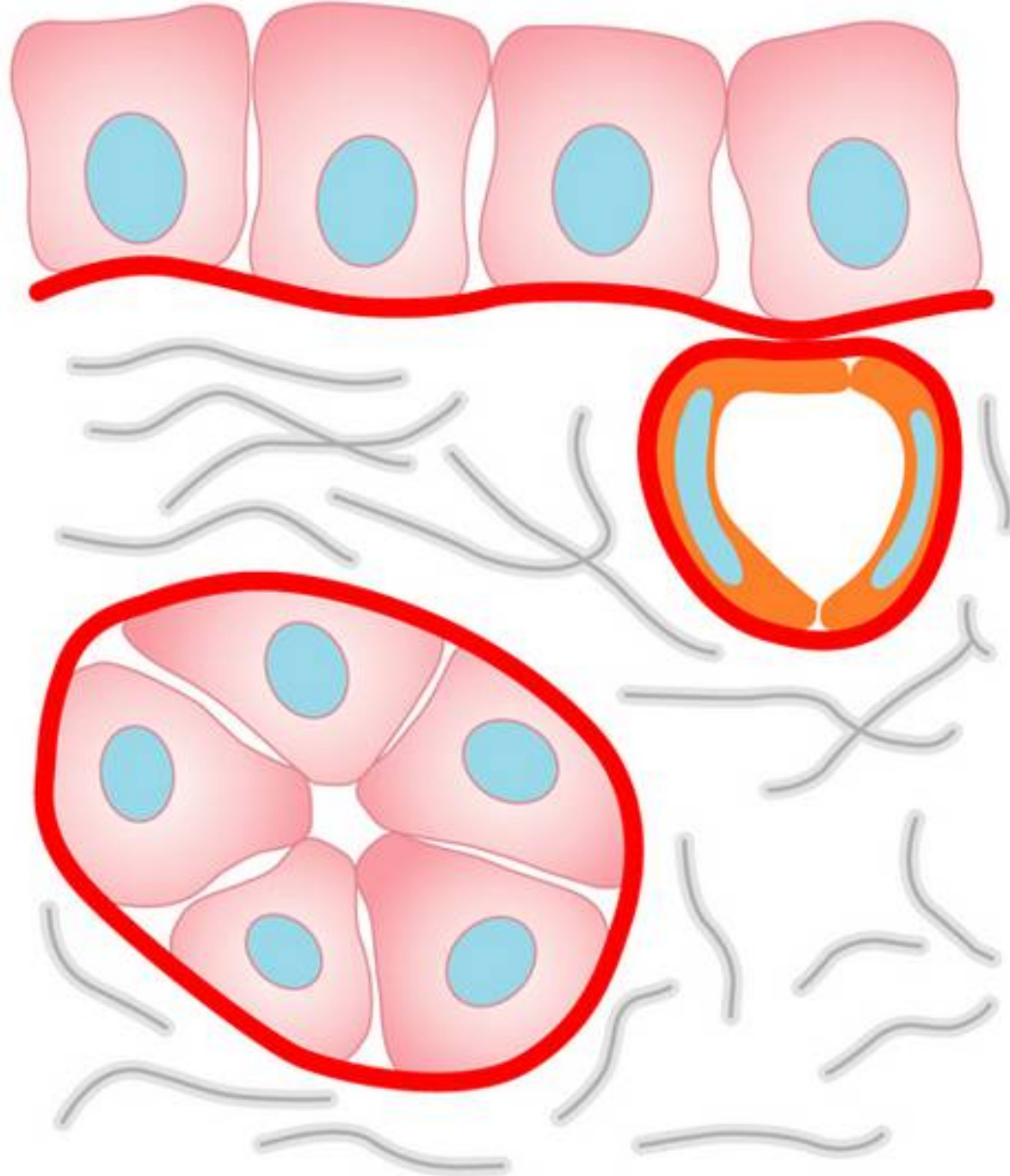
what stuff could there be?



what structure is indicated by the red lines?



Basement membrane



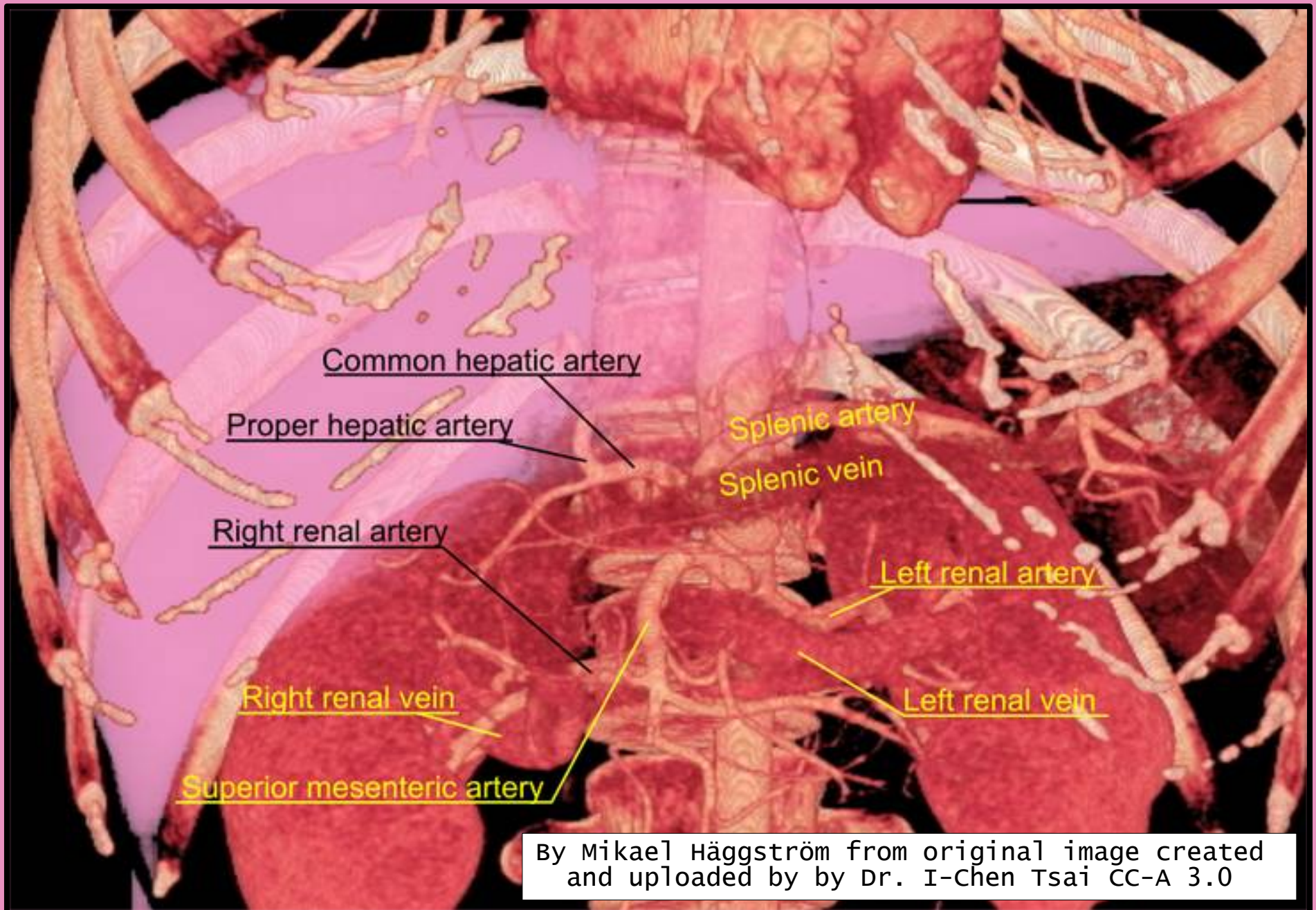
With which organ would you commonly
associate cuboidal epithelium?

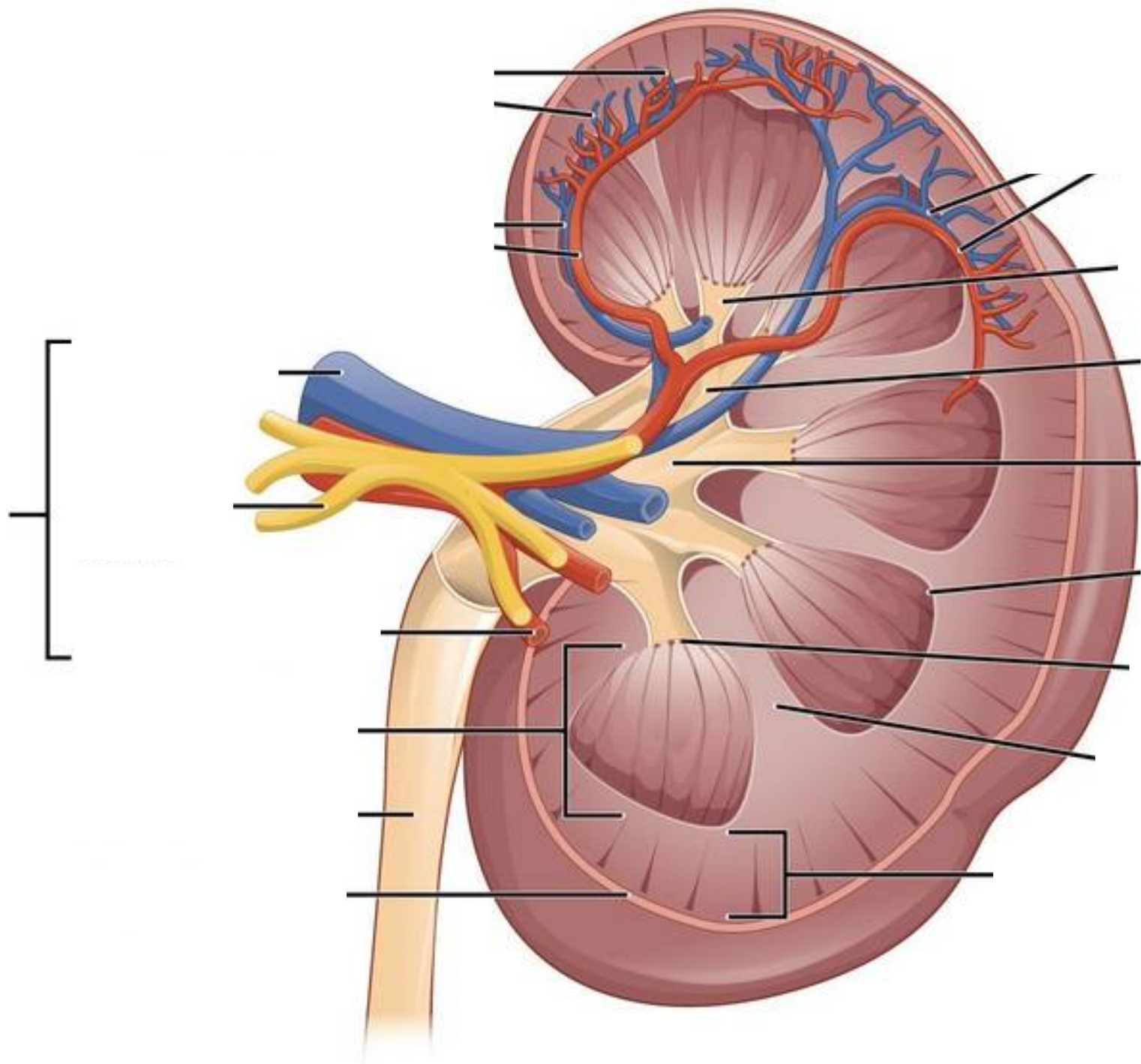
The ducts of the kidney are lined with simple cuboidal epithelium with small variations along the length of the nephron.

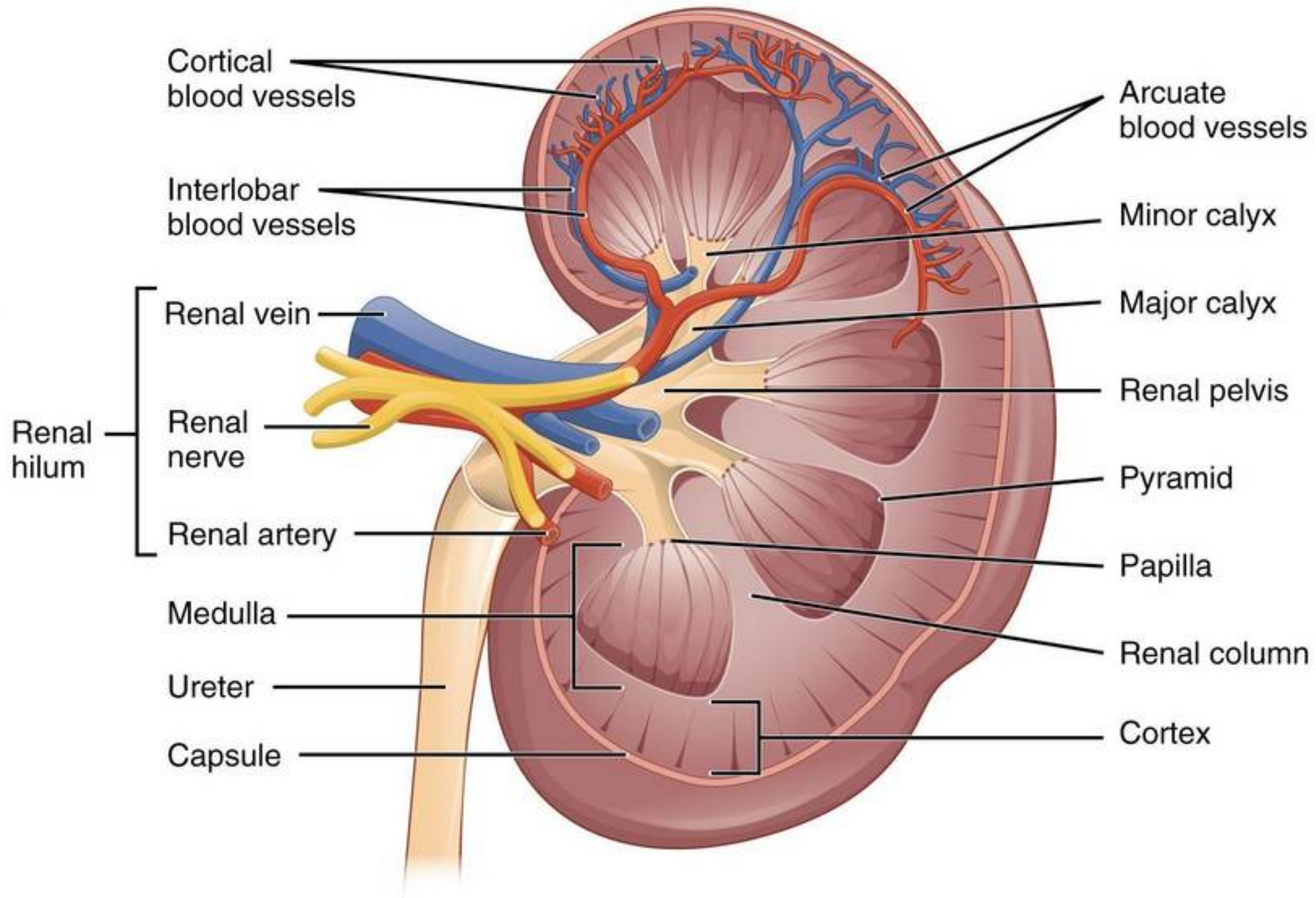
Kidney

slide 28 & 76

3D rendered computed tomography of abdominal aortic branches and kidneys. Inferior vena cava is not visible.





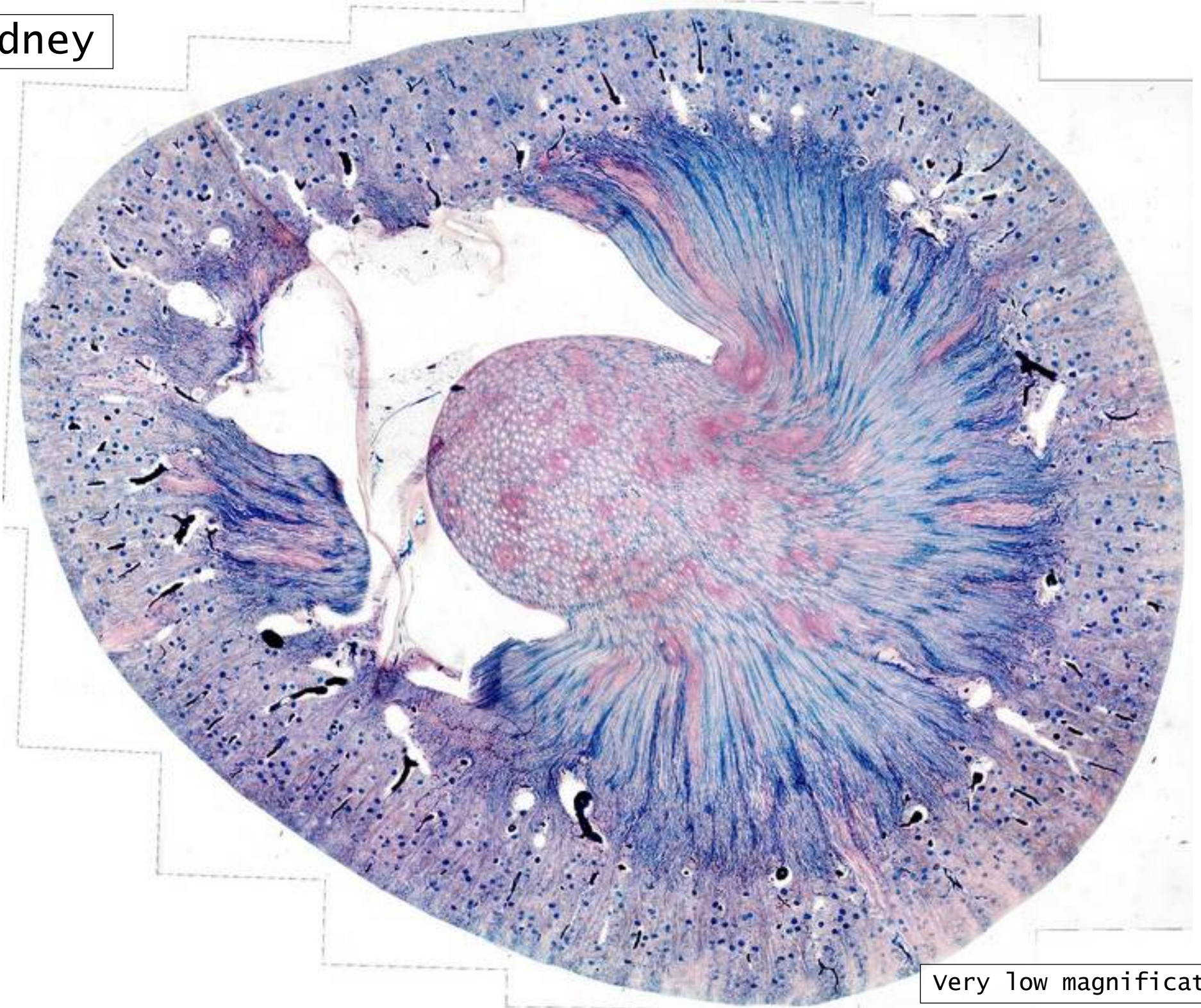


Kidney



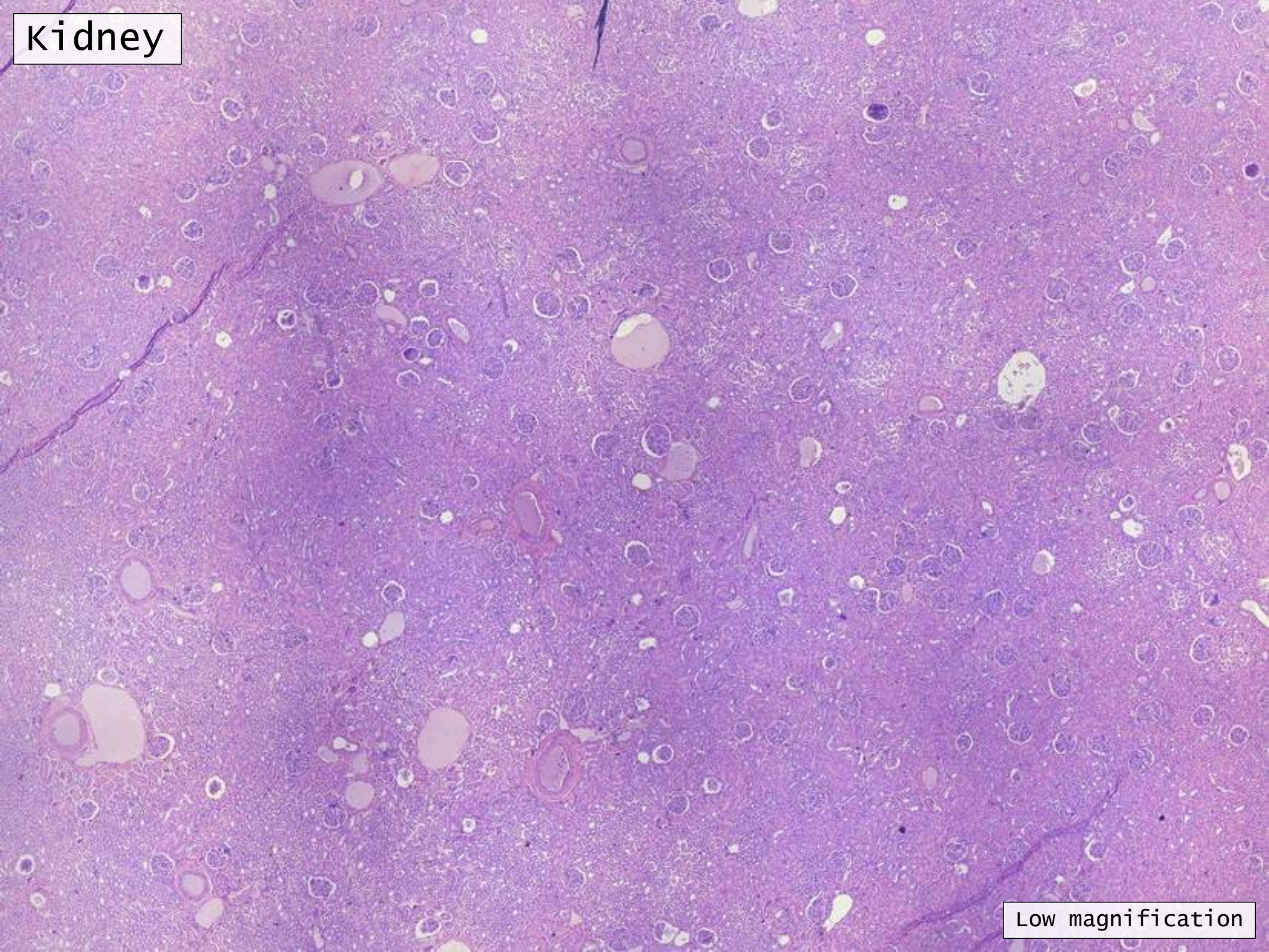
very low magnification

Kidney



very low magnification

Kidney



Low magnification

Kidney: Objectives

1. Basic anatomy of the kidney
2. Basic arrangement of nephrons and collecting tubules in the kidney
3. Structure of the nephron and collecting tubules
4. The renal corpuscle

Kidney: Tasks

1. Make an annotated drawing of the macroscopic view of the kidney.
2. Make an annotated diagram of a nephron, including the juxtaglomerular apparatus. Indicate the flow of blood and water in each part, and how solutes are filtered, secreted and reabsorbed.
3. Complete the drawings for each slide in the practical workbook.

Kidney

- Capsule
- Cortex
- Medulla
- Multilobar

Multilobar

- Conical mass (pyramid)
 - Medullary tissue
- capped with
 - Cortex
- Delineated by
 - Renal columns
- Apex of pyramid
 - Papilla
 - Projects into renal pelvis

Pyramid

- Simple columnar epithelium
- Continuous with transitional epithelium

Capsule

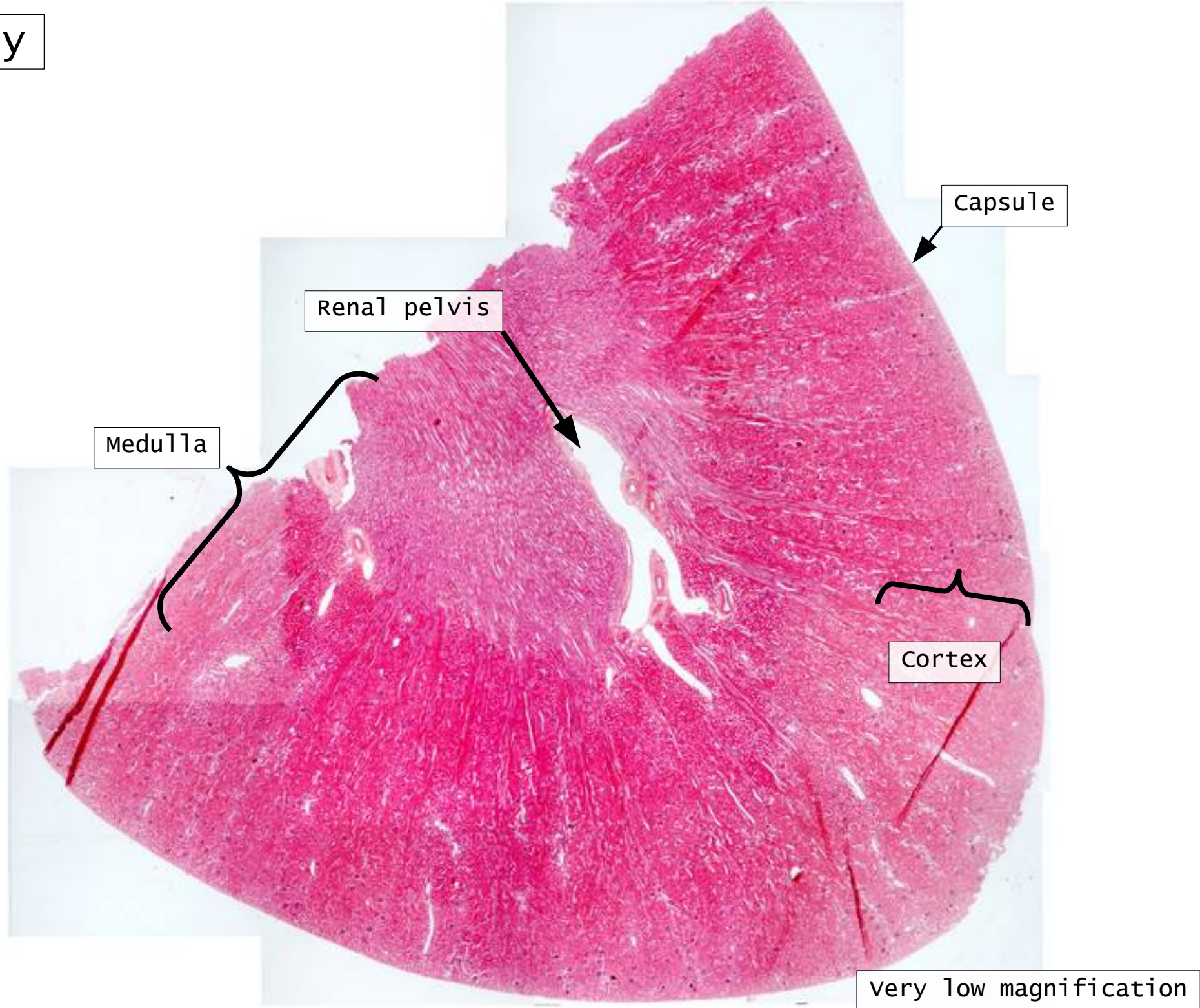
- Irregular dense CT
- Surrounded adipose tissue

Kidney

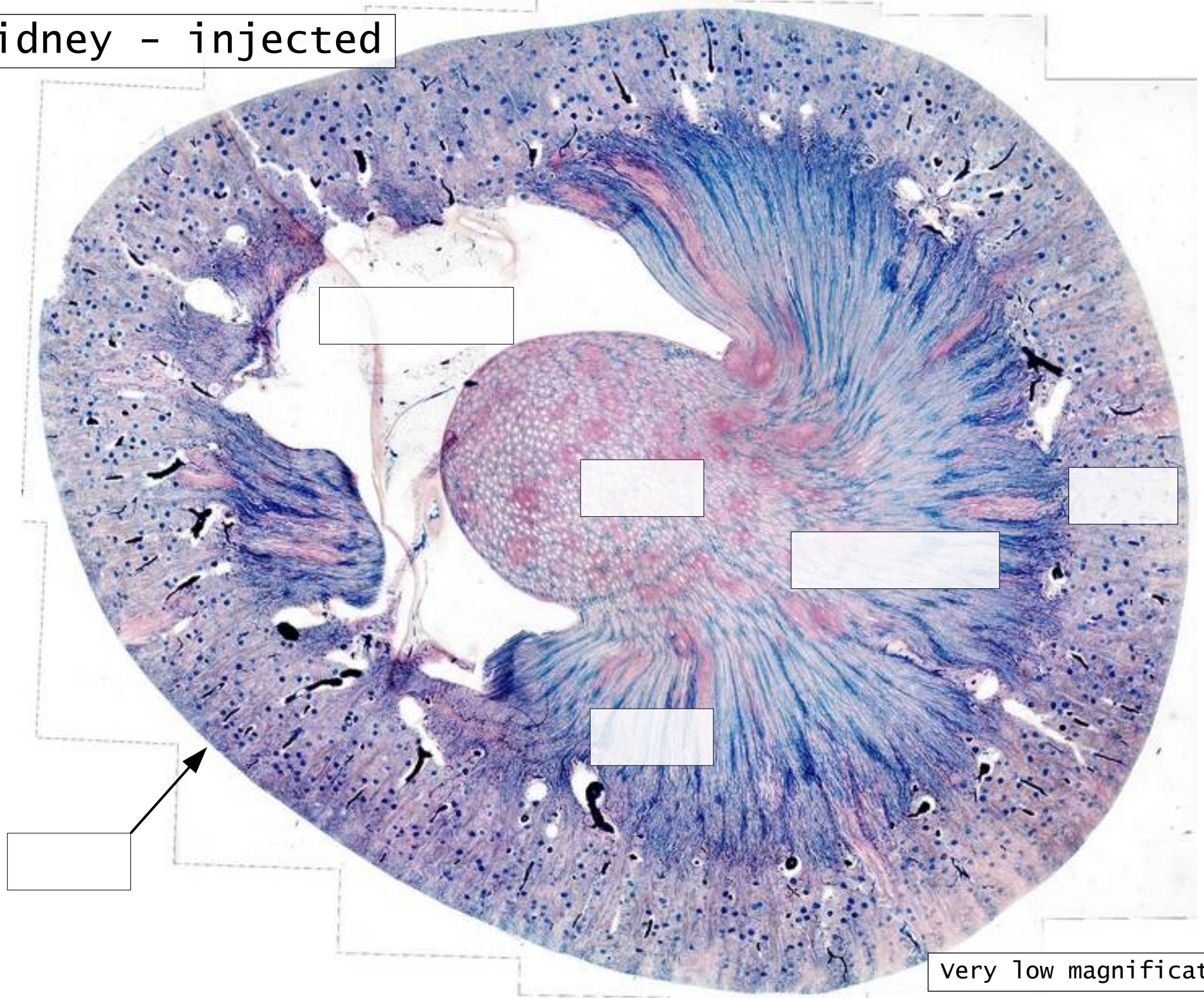


very low magnification

Kidney

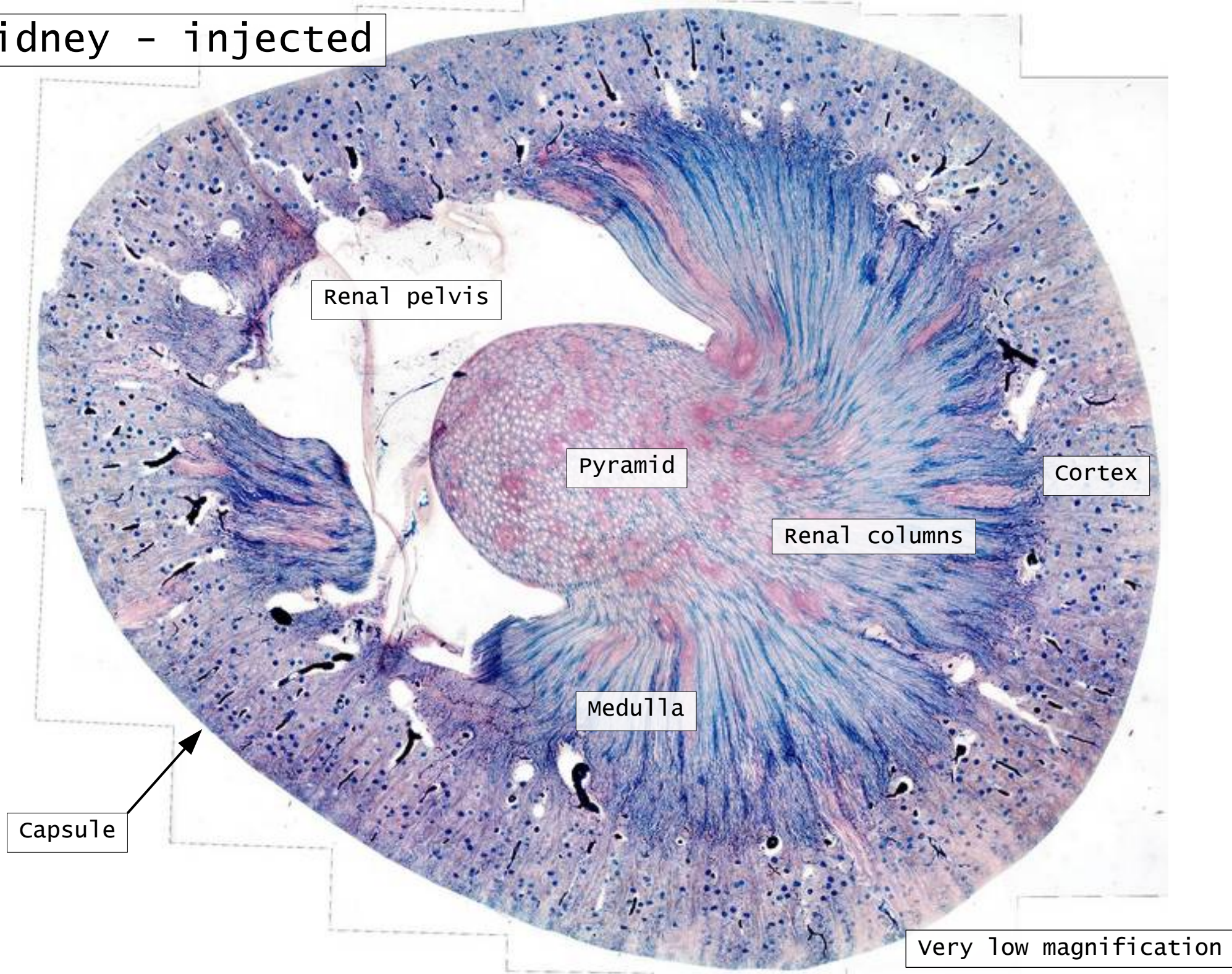


kidney - injected



very low magnification

Kidney - injected



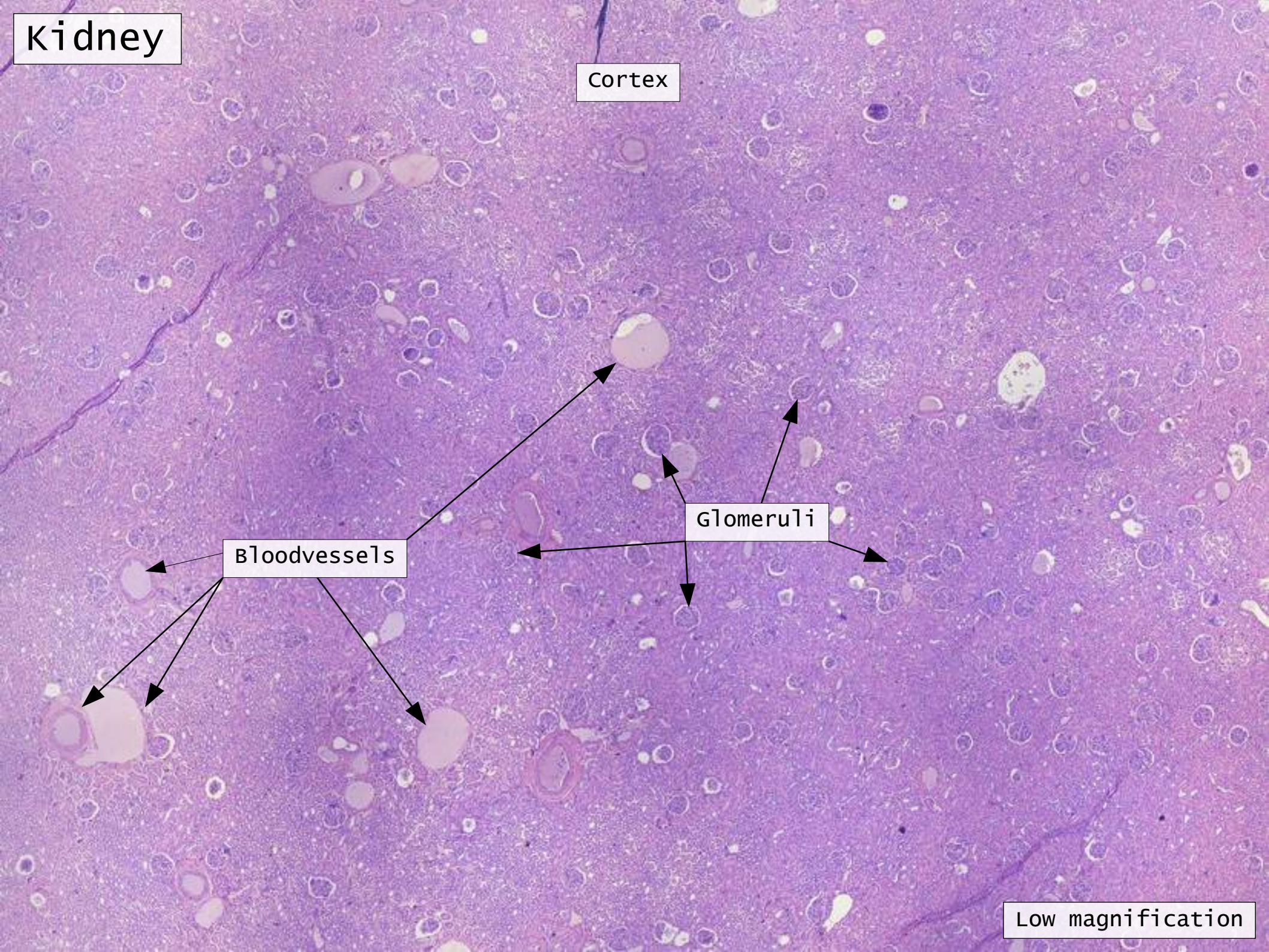
Kidney

Cortex

Bloodvessels

Glomeruli

Low magnification

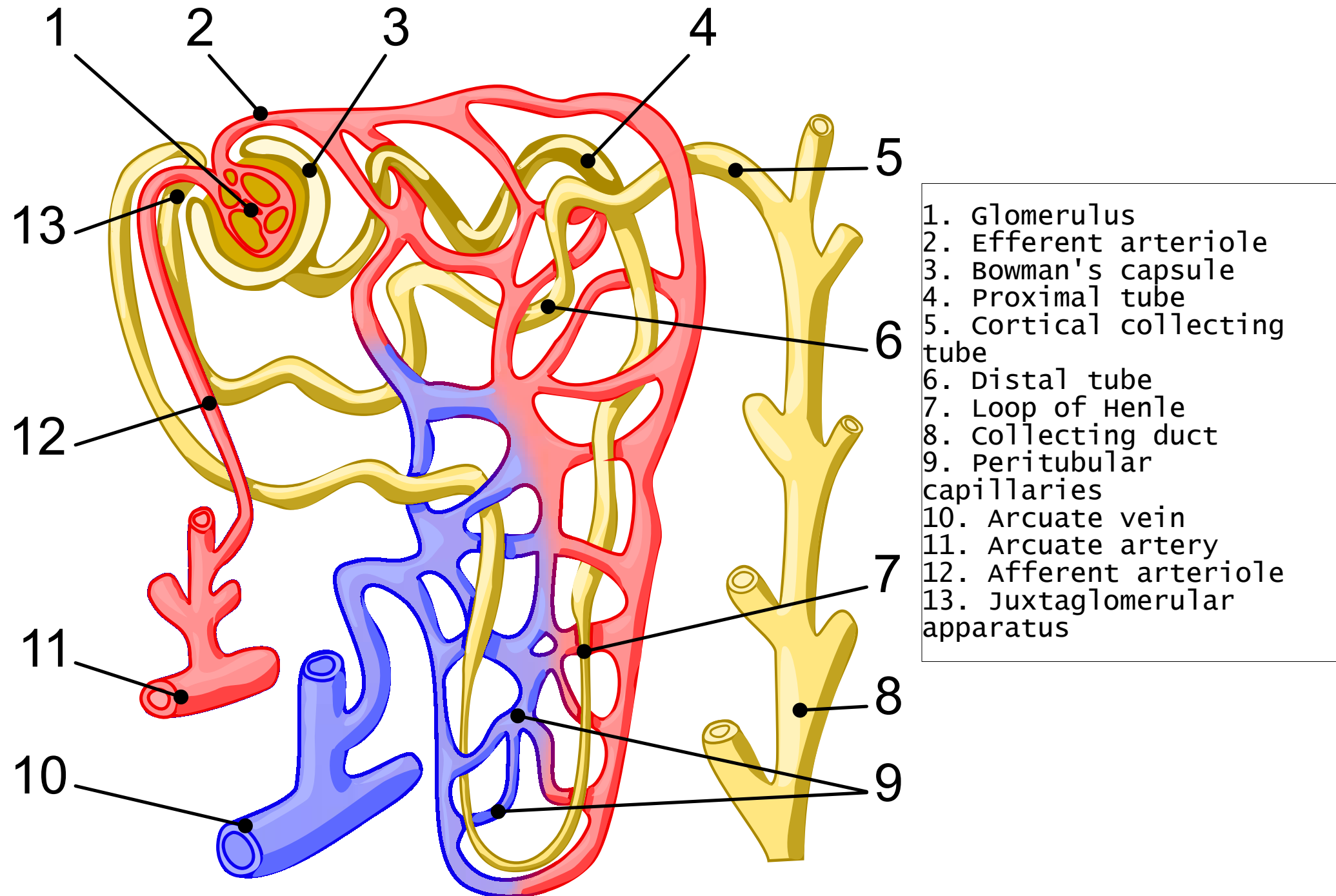


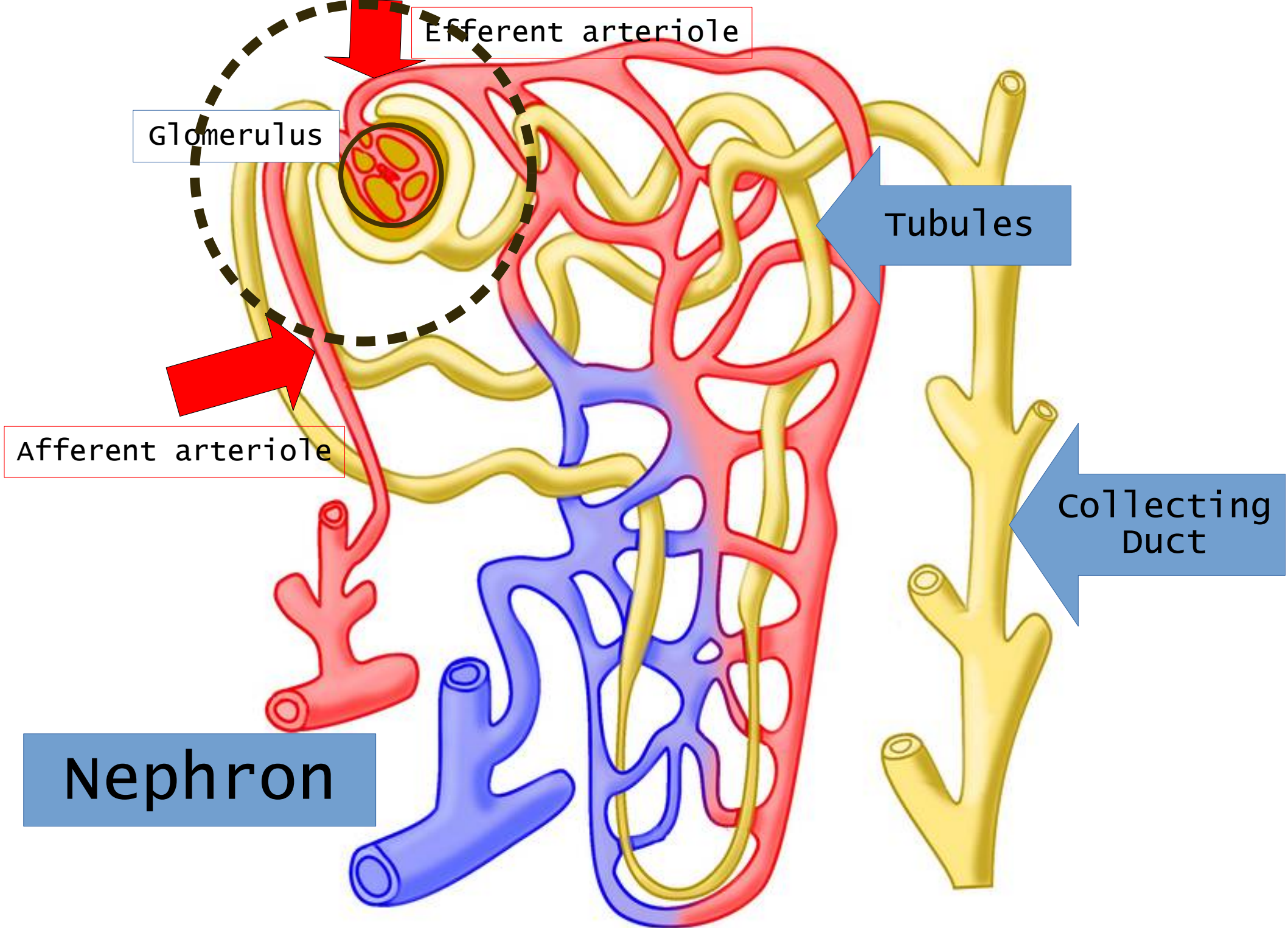
Nephron

- Unit responsible for
 - Filtration
 - Excretion
 - Resorption
- Include
 - Kidney tubule
 - Glomerulus
- Exclude
 - Collecting tubule

Nephron

- Renal corpuscle
- Proximal convoluted segment
- Long loop of Henle
 - Descending portion
 - Ascending portion
- Distal convoluted segment





Appearance

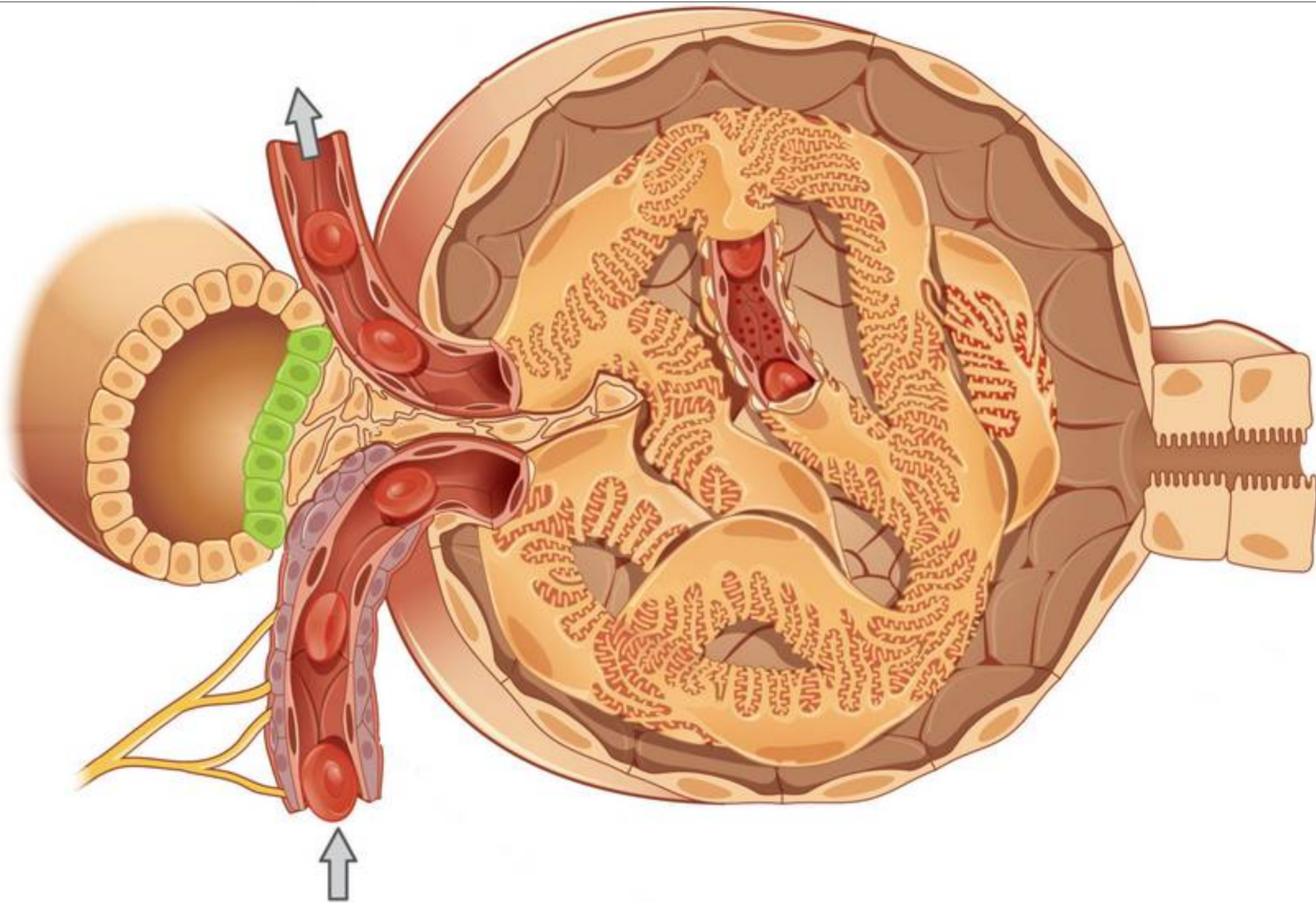
- Cortex
- Renal corpuscles
- Convoluted tubules
- Medulla
- Loops of Henle
- Collecting tubules

Kidney Lobule

- Group of nephrons
- Open into branches
- Same collecting duct
- Not clearly demarcated
- Interlobular arteries/veins

Renal corpuscle

- Tuft of capillaries
- grow into
- Blind end of nephron
- Several layers of epithelium
- Two sides
 - Vascular pole
 - Tubular pole



Efferent arteriole

Bowman's space

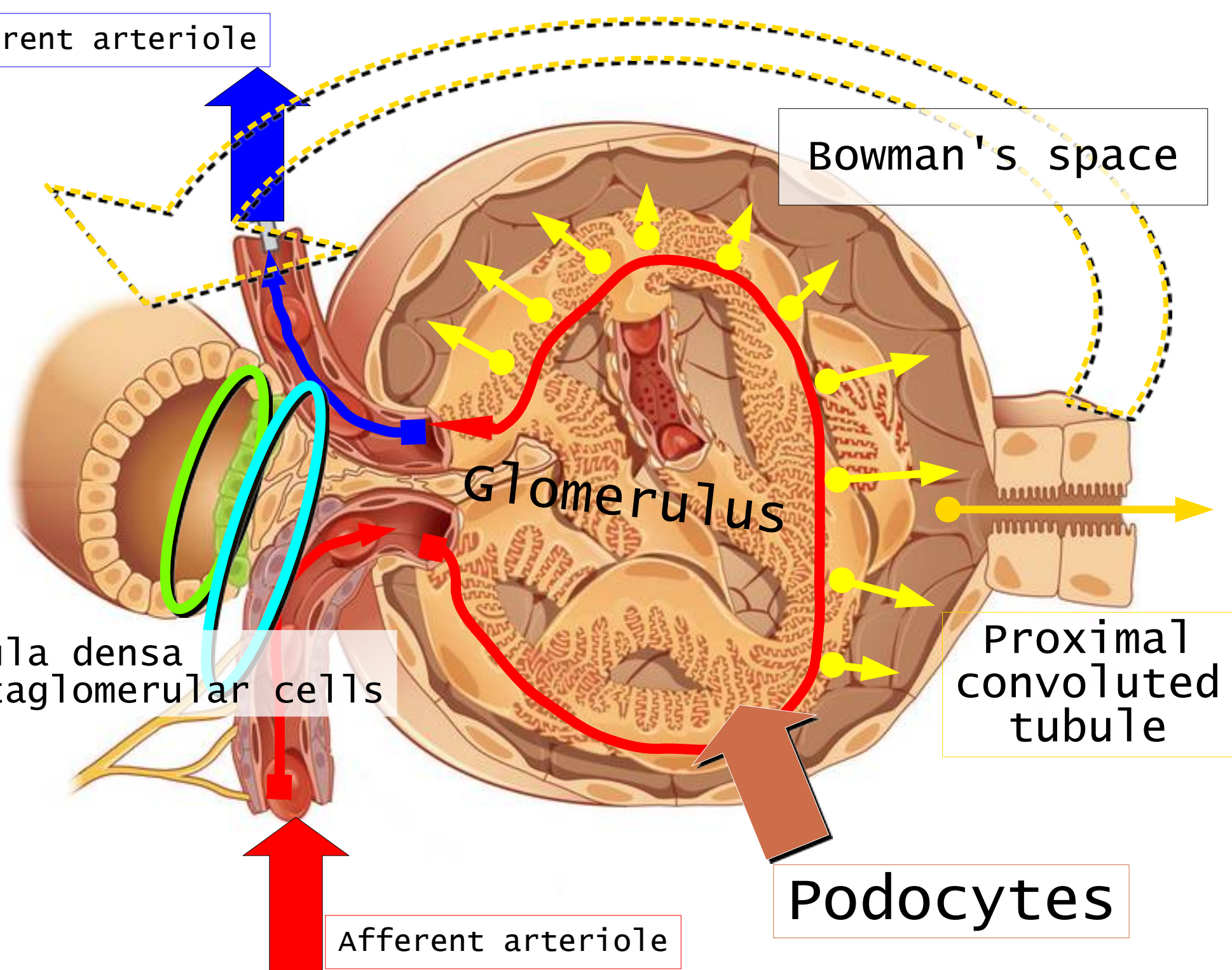
Glomerulus

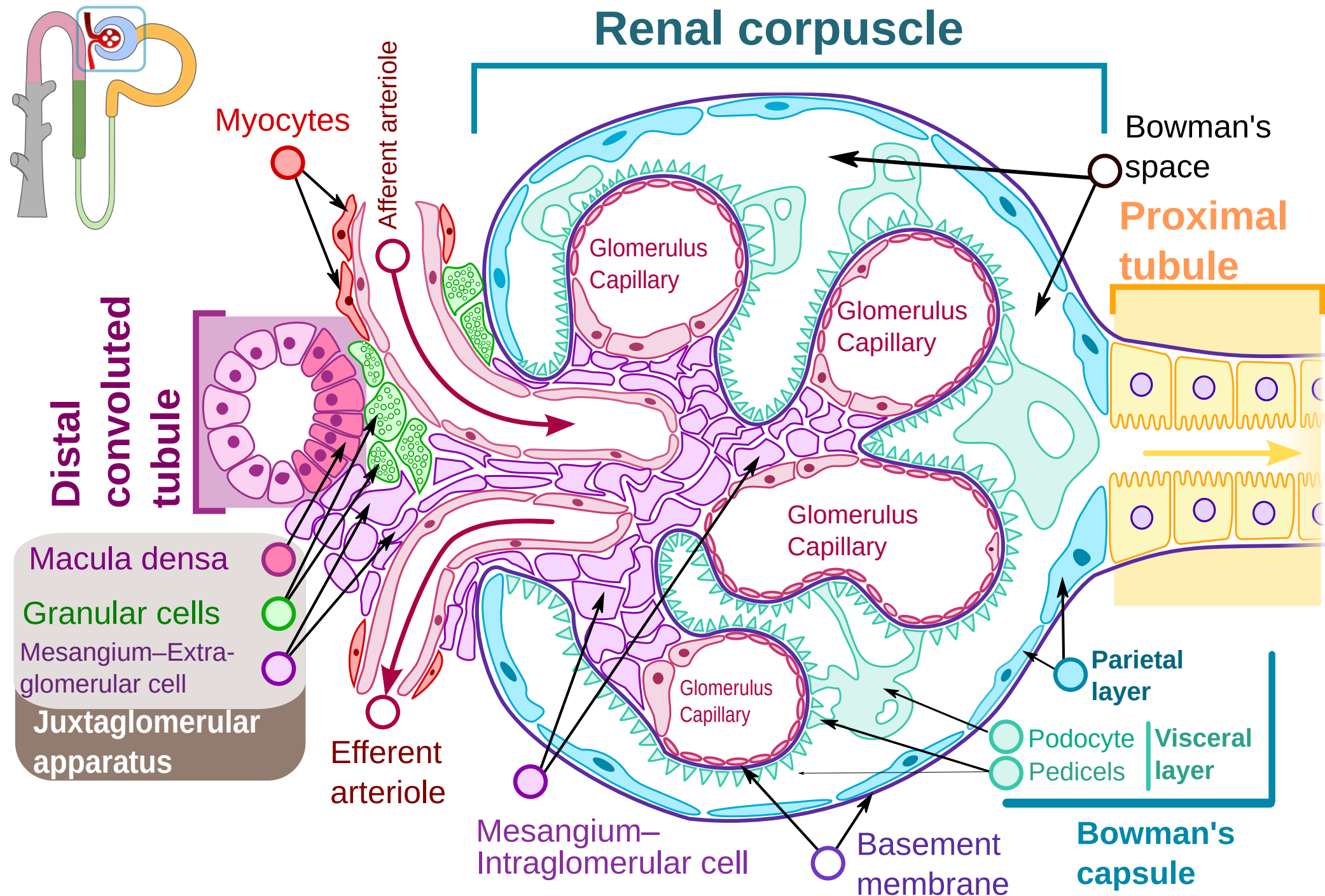
Proximal convoluted tubule

Podocytes

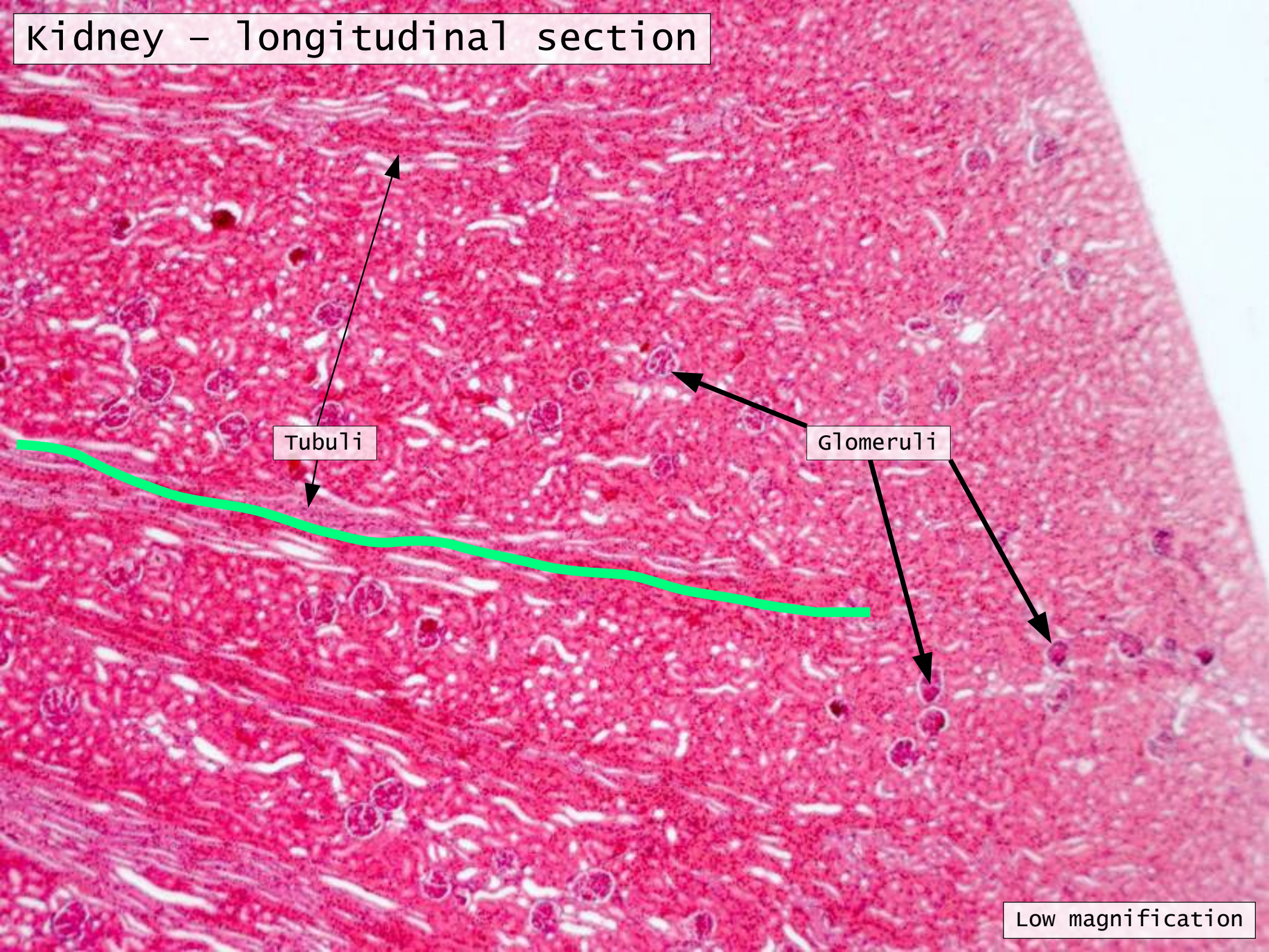
Afferent arteriole

Macula densa
Juxtaglomerular cells





Kidney – longitudinal section

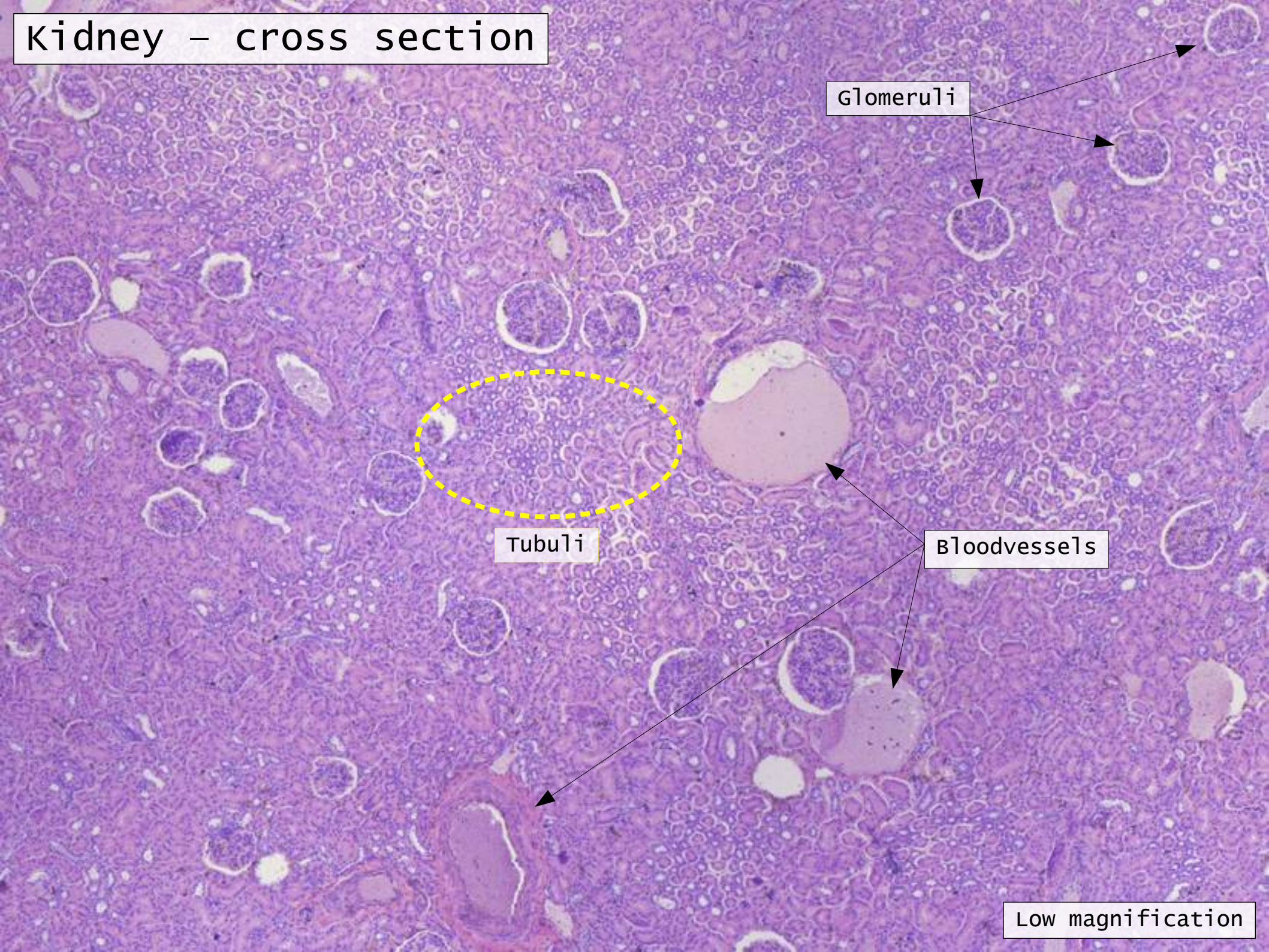


Tubuli

Glomeruli

Low magnification

Kidney – cross section



Glomeruli

Tubuli

Bloodvessels

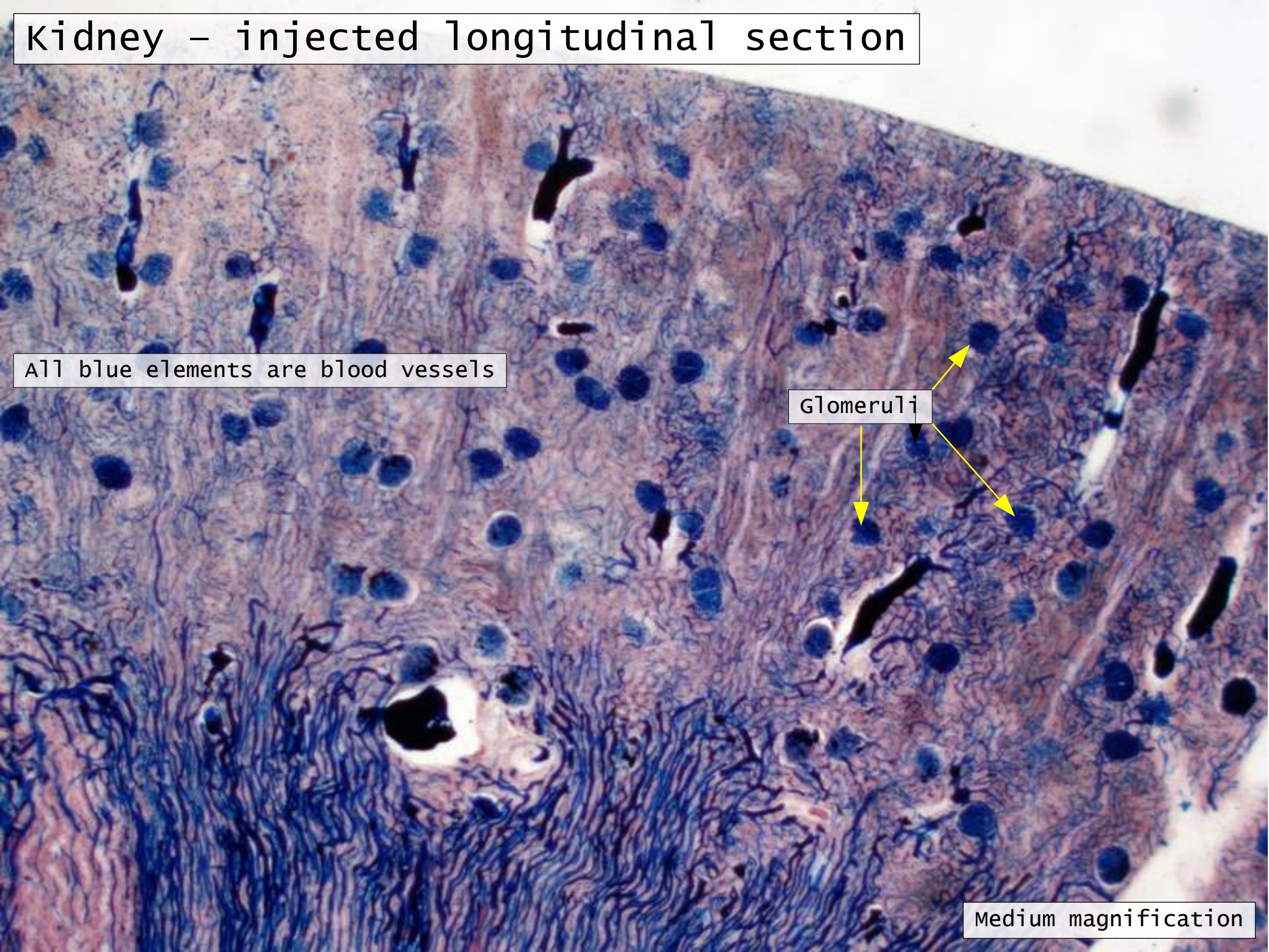
Low magnification

Kidney – injected longitudinal section

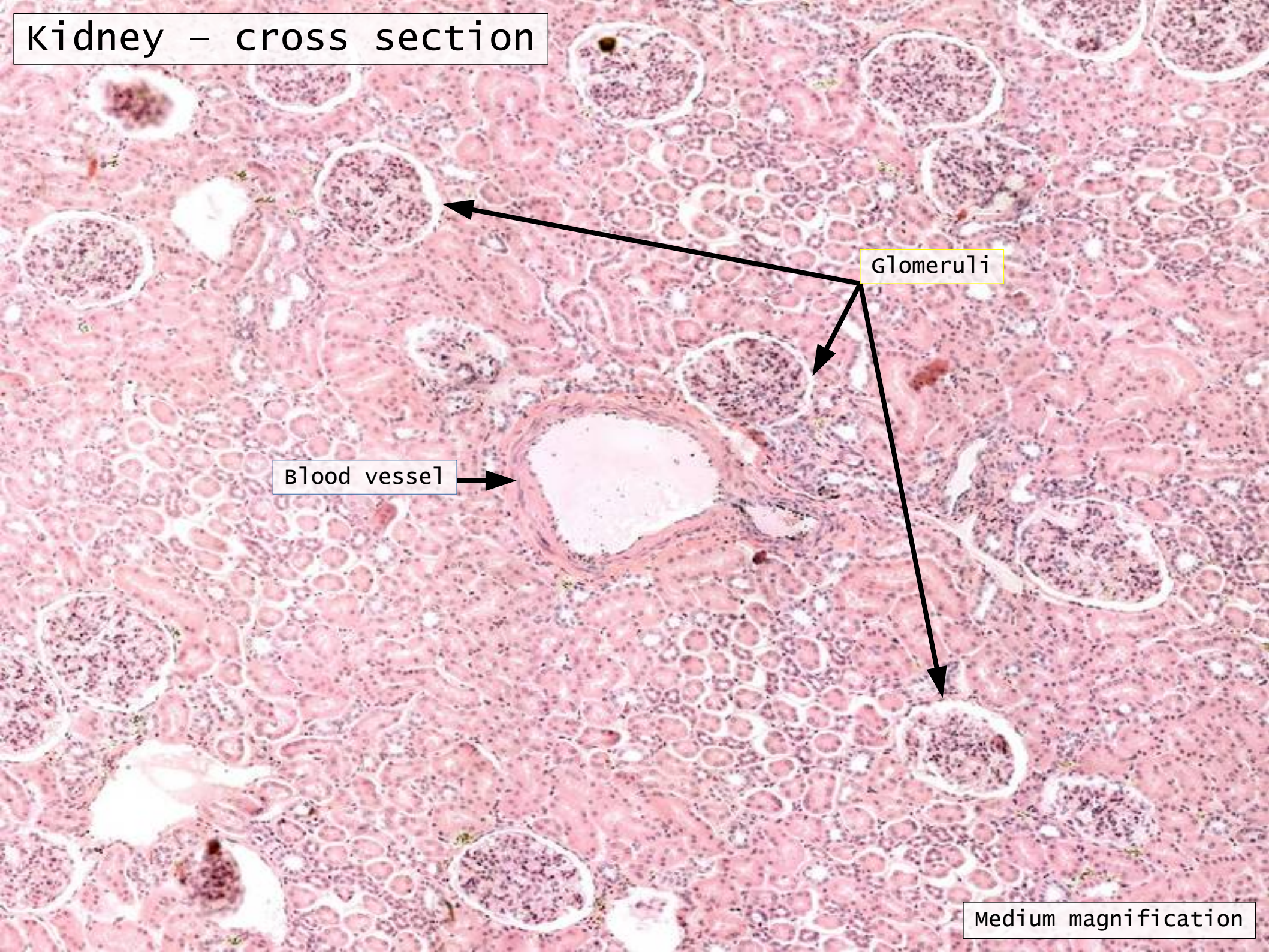
All blue elements are blood vessels

Glomeruli

Medium magnification



Kidney – cross section



Glomeruli

Blood vessel

Medium magnification

Vein – cross section

Glomerulus

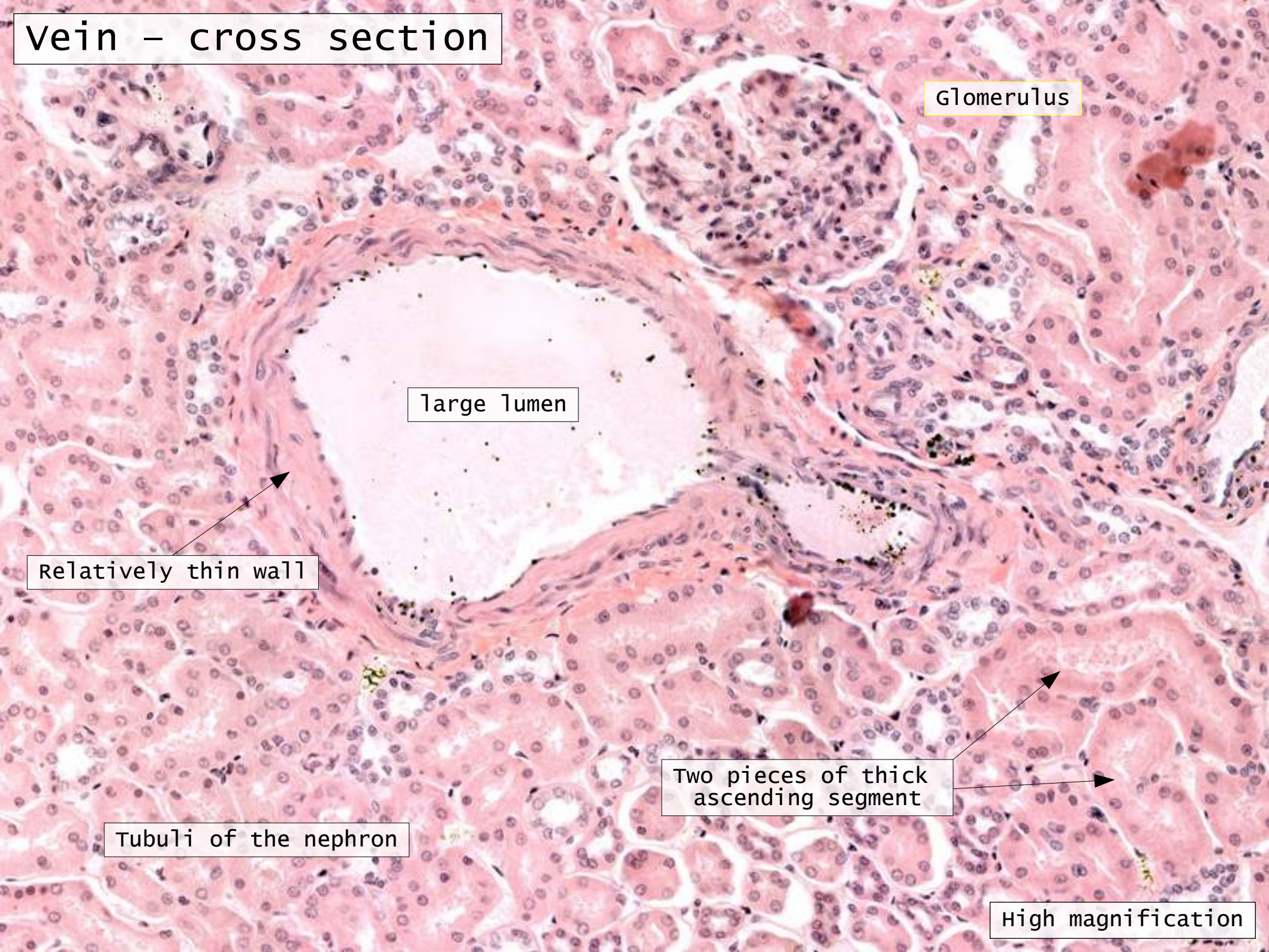
Large lumen

Relatively thin wall

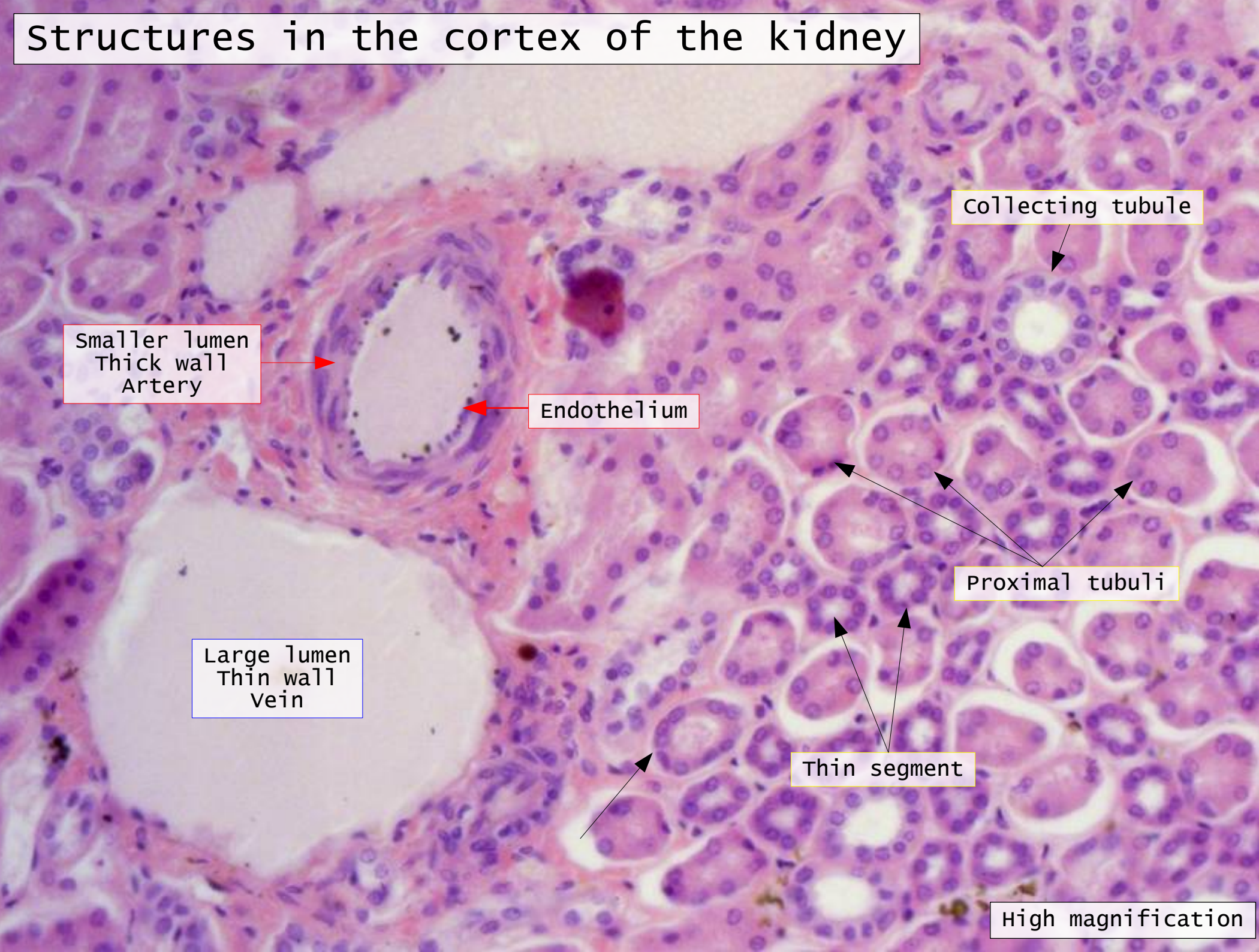
Tubuli of the nephron

Two pieces of thick ascending segment

High magnification



Structures in the cortex of the kidney



Glomerulus

Capsular (parietal) epithelium

Thick ascending segment

Cuboidal epithelium

Bowman's space

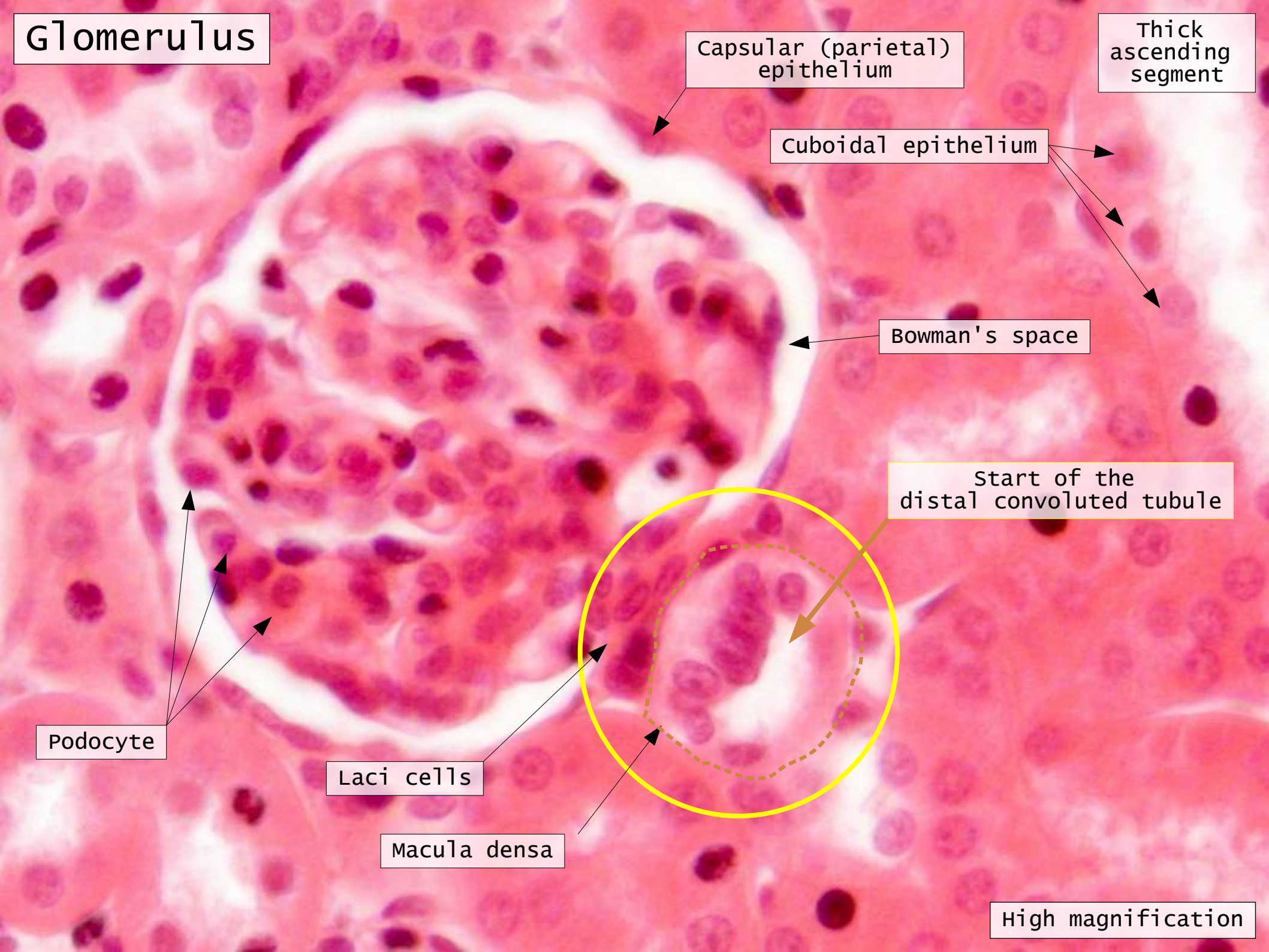
Start of the distal convoluted tubule

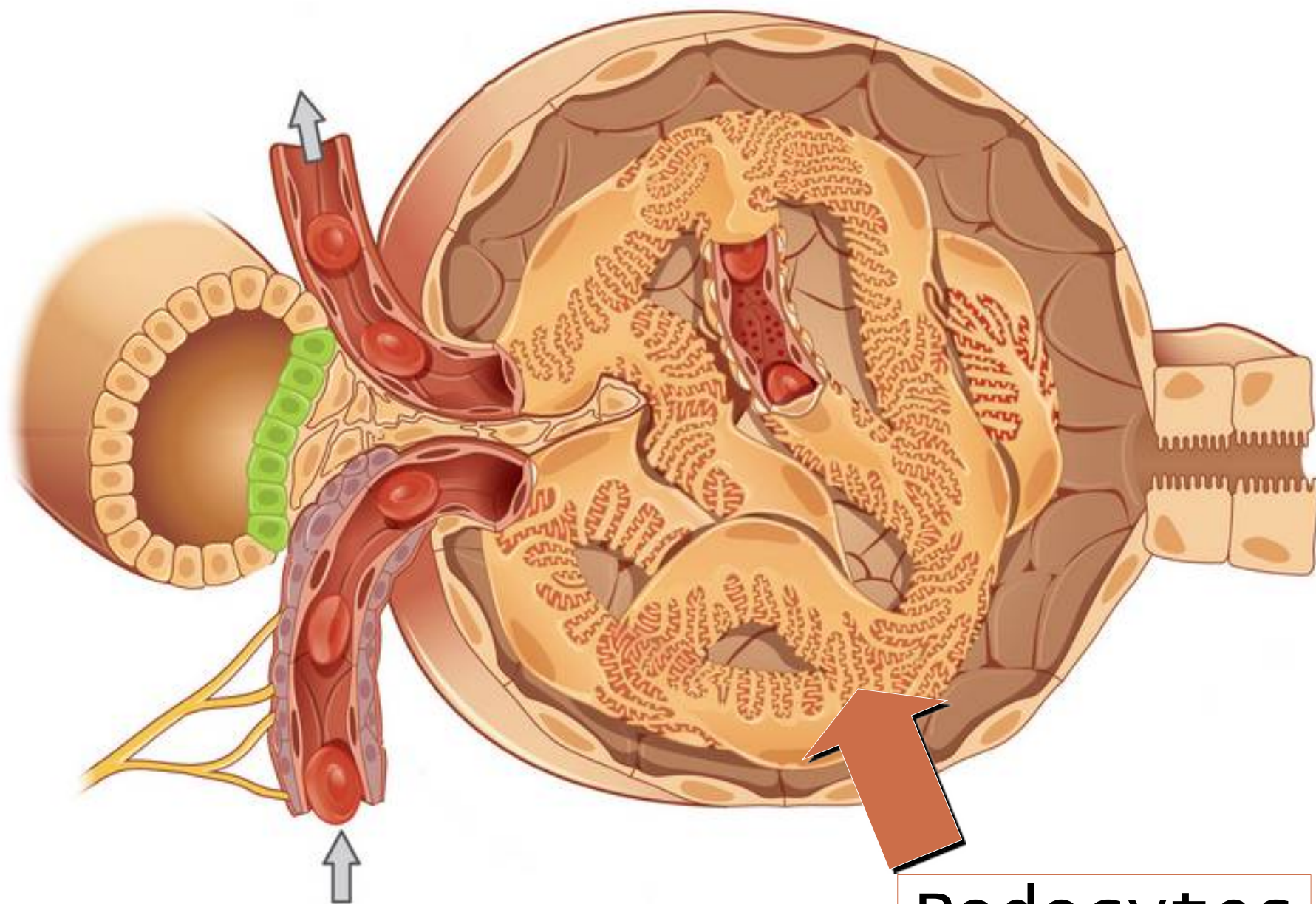
Podocyte

Laci cells

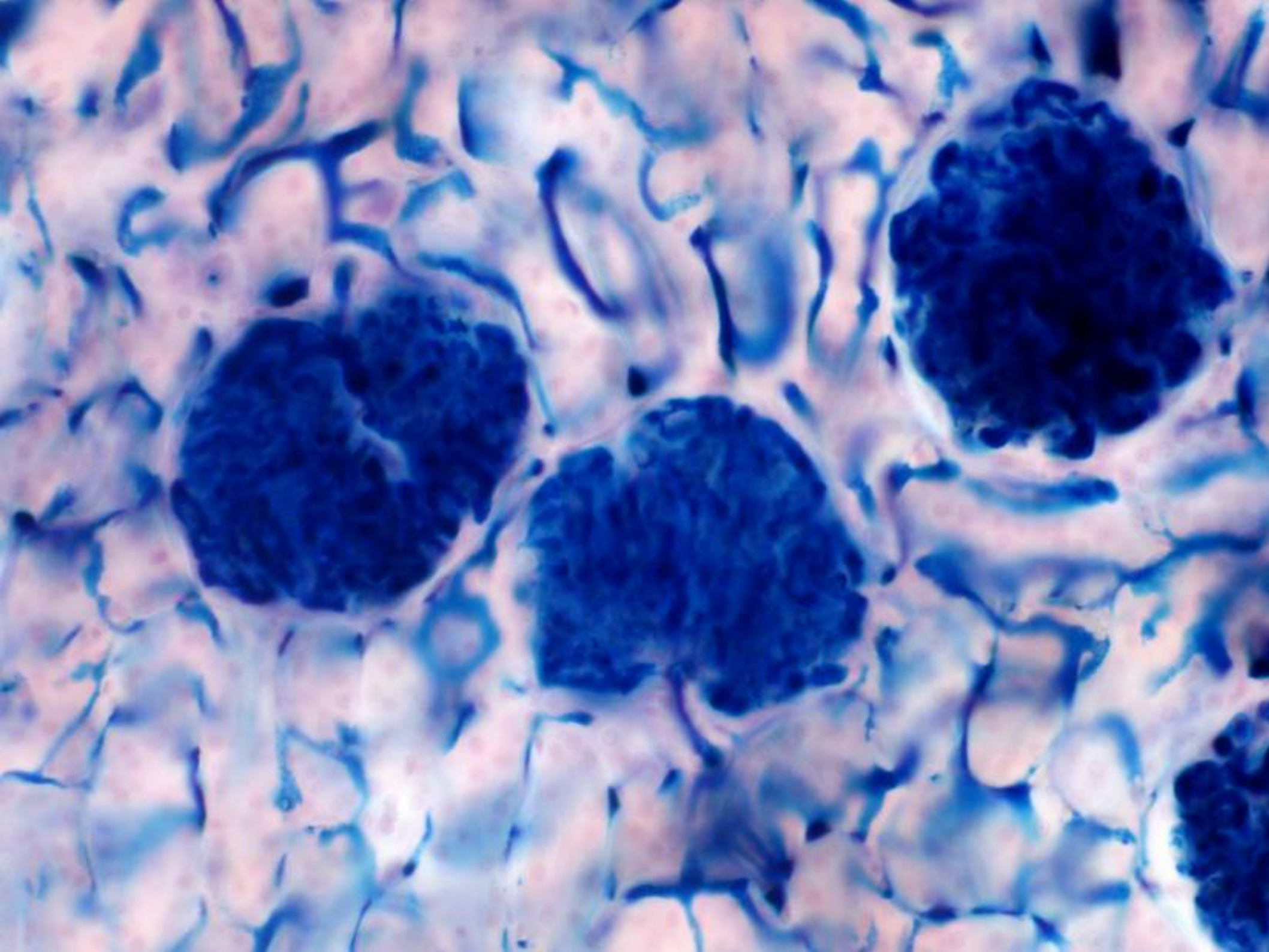
Macula densa

High magnification





Podocytes



Kidney – injected longitudinal section

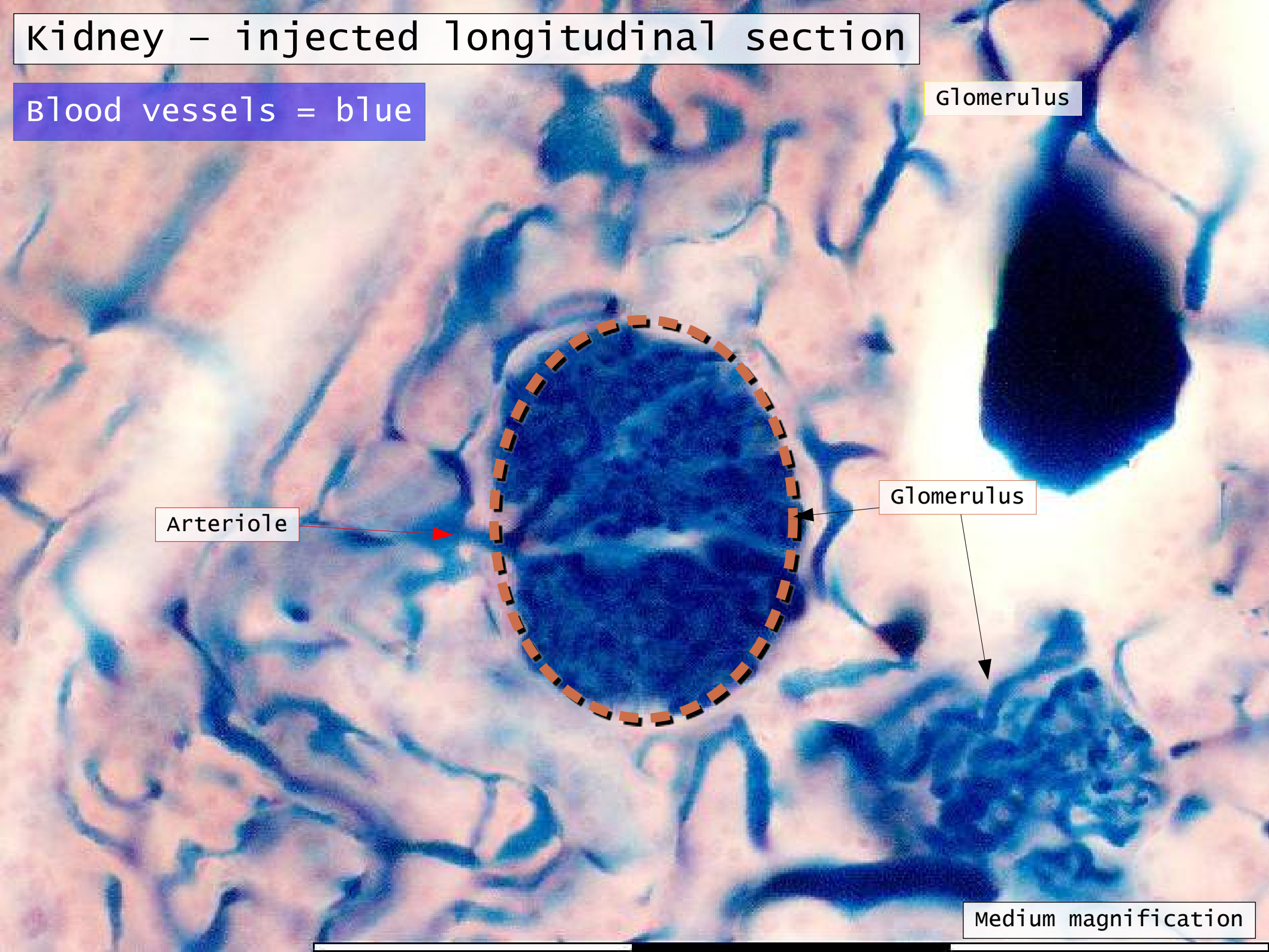
Blood vessels = blue

Glomerulus

Arteriole

Glomerulus

Medium magnification



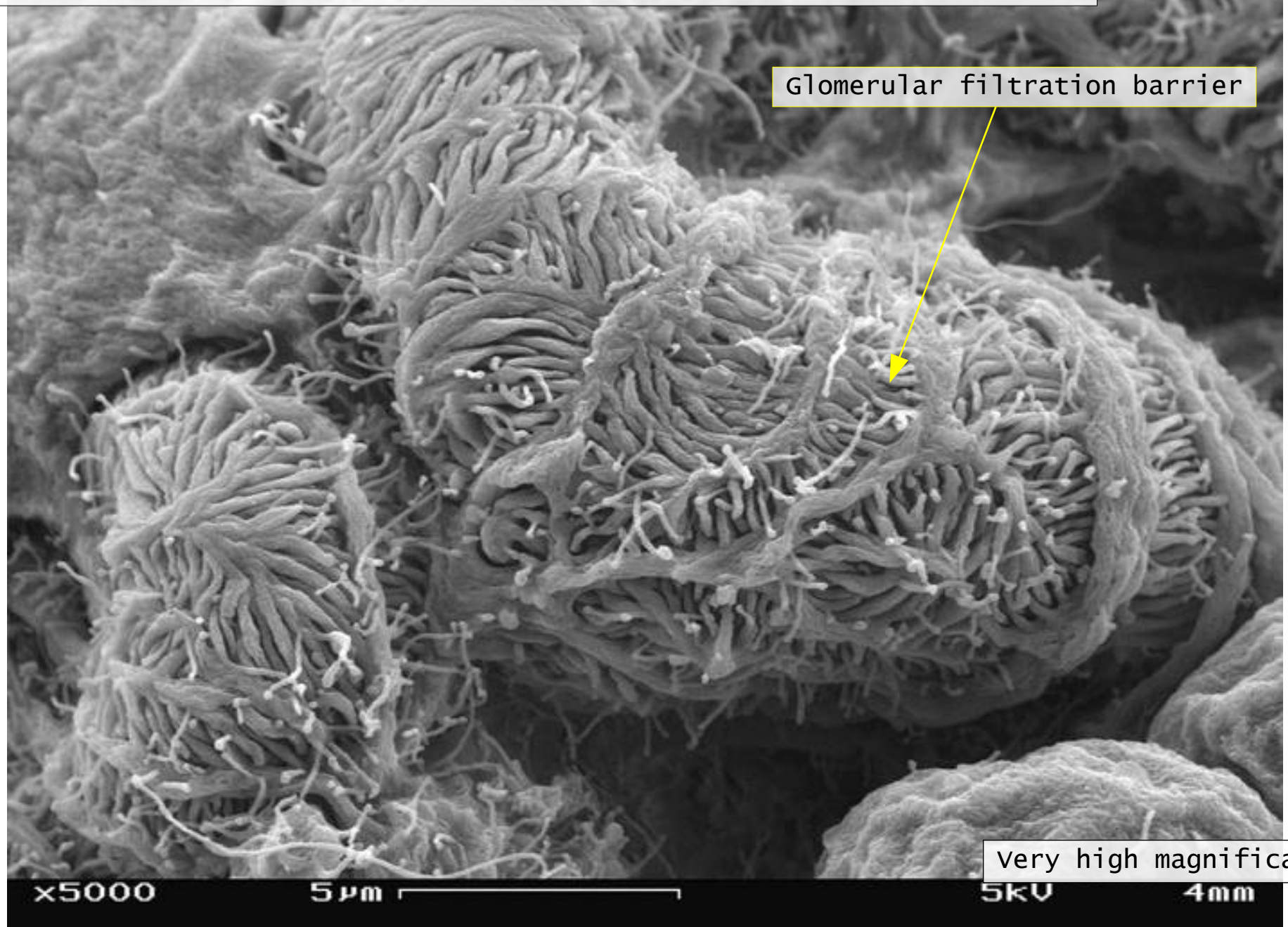
Glomerulus - scanning electron microscope

Glomerulum of mouse kidney from Wikimedia Commons by SecretDisc, CC-BY-SA 3.0

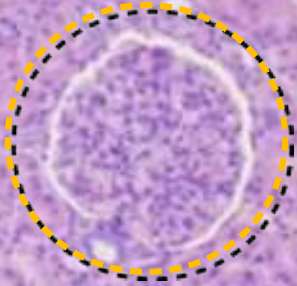


Podocytes - scanning electron microscope

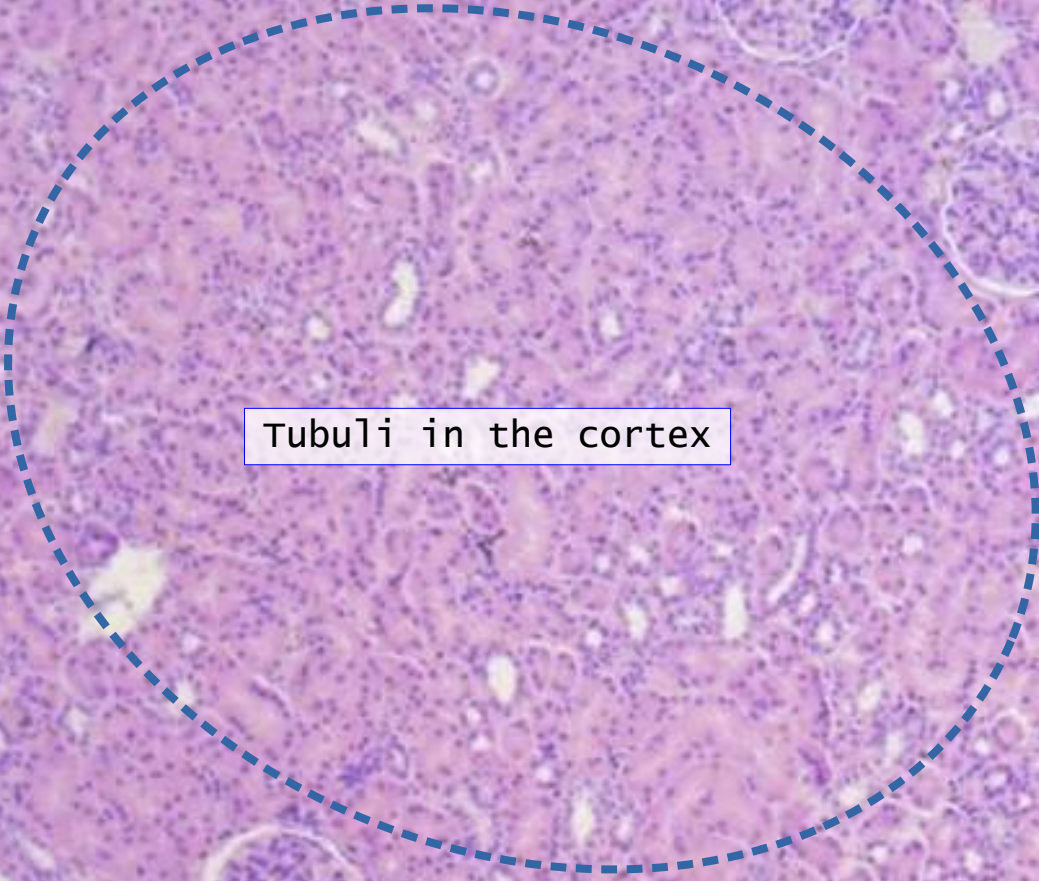
Glomerulum of mouse kidney from Wikimedia Commons by SecretDisc, CC-BY-SA 3.0



Glomeruli



Tubuli in the cortex



Medium magnification

Blood flow

- Efferent arteriole
 - Smooth muscle in media
- Capillaries
 - Fenestrated
- Afferent arteriole
 - Smooth muscle in media

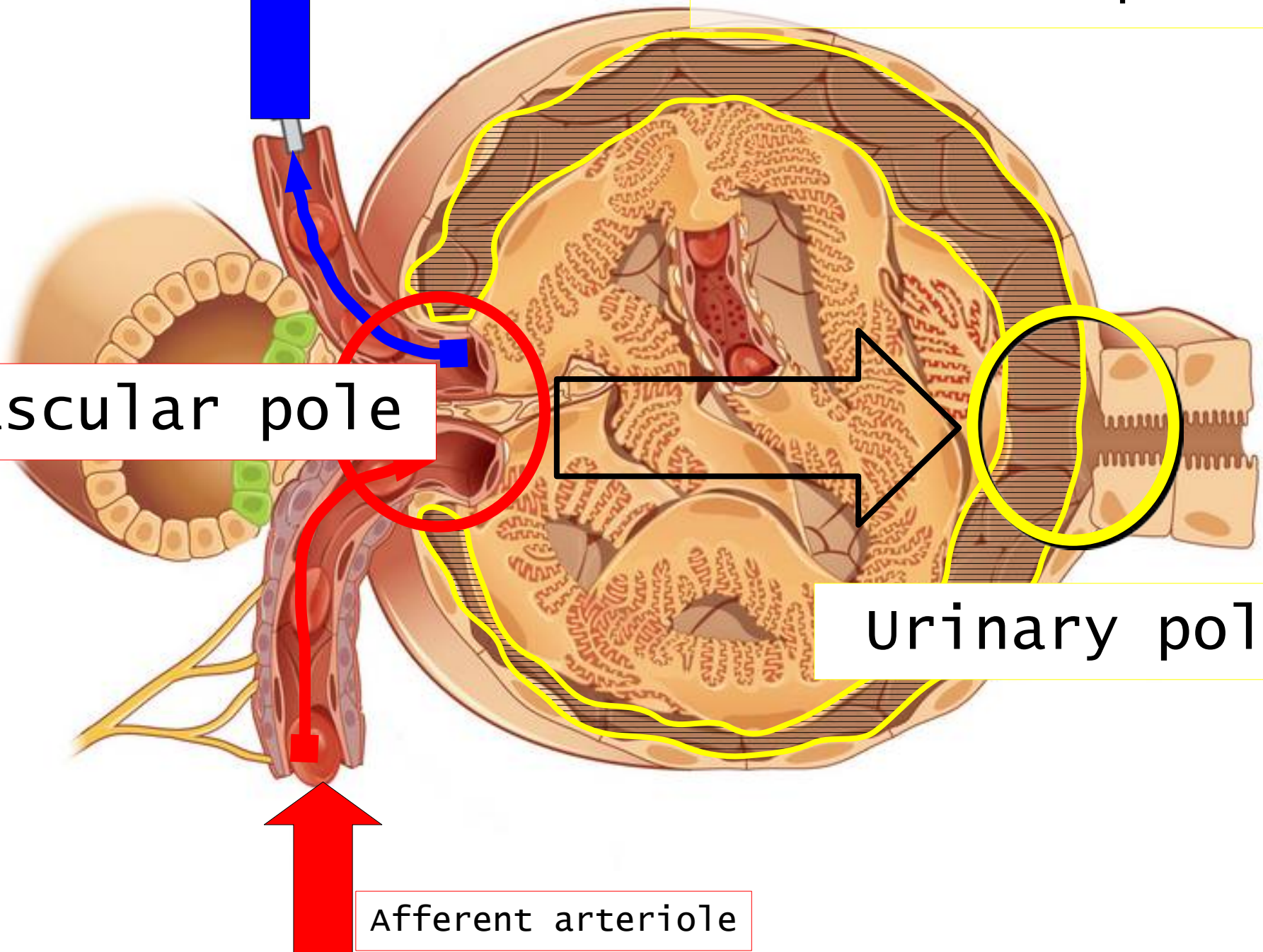
Efferent arteriole

Bowman's space

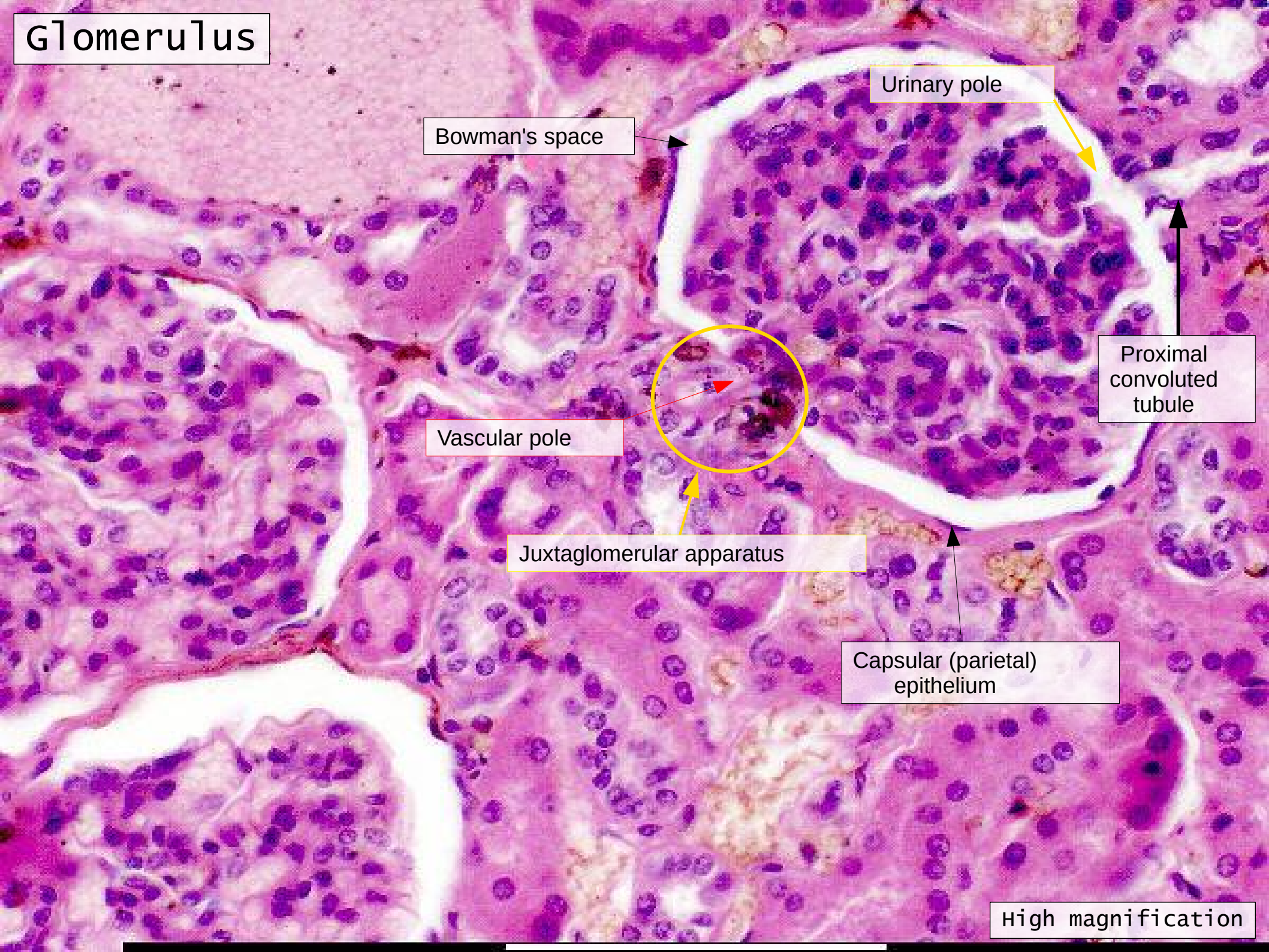
vascular pole

Urinary pole

Afferent arteriole



Glomerulus



Bowman's space

Urinary pole

Proximal convoluted tubule

Vascular pole

Juxtaglomerular apparatus

Capsular (parietal) epithelium

High magnification

Epithelium layers

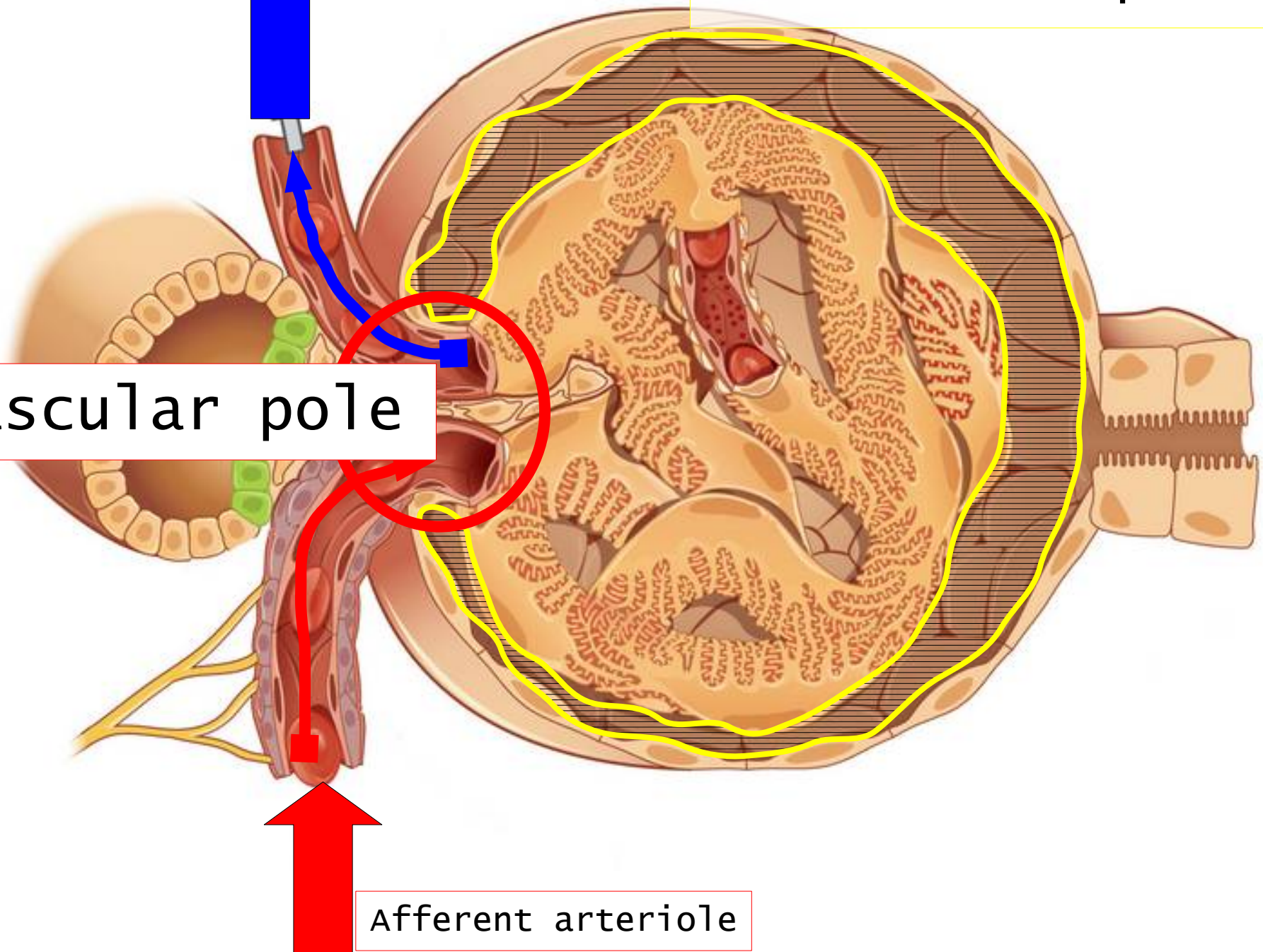
- Capillary endothelium
- Visceral layer of epithelium
 - Podocytes
 - Resting on glomerular basement membrane
- Capsular space
- Parietal layer of epithelium
 - Simple squamous epithelium

Efferent arteriole

Bowman's space

vascular pole

Afferent arteriole



Glomerulus

Juxtaglomerular apparatus

Vascular pole

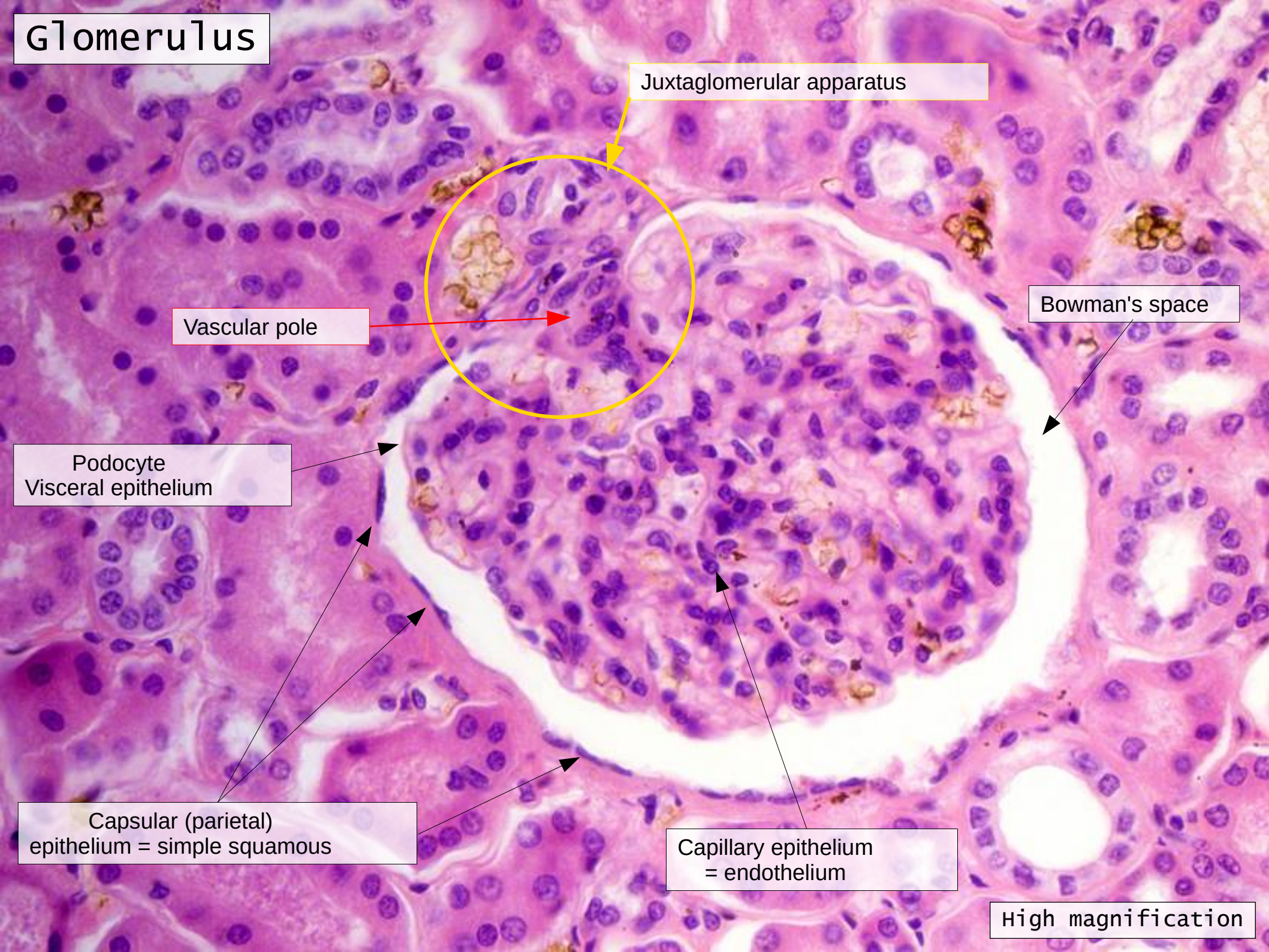
Bowman's space

Podocyte
Visceral epithelium

Capsular (parietal)
epithelium = simple squamous

Capillary epithelium
= endothelium

High magnification



Glomerular filtration barrier

- Three layers
- Fenestrated epithelium
 - Exclude blood cells & platelets
- Glomerular basement membrane
 - Main filtration barrier
 - Thick
 - Fused epithelial & endothelial BM
 - Replenished by podocytes due to removal by mesangial cells
- Glomerular epithelium
 - Through filtration slit

Juxtaglomerular complex

Area where distal convoluted tubule return to glomerulus and pass through the notch between the afferent and efferent arterioles.

Modification of the wall of the tubule and afferent arteriole and presence of specialised cells in the connective tissue.

Modifications

- Distal convoluted tubule
 - Macula densa
 - Narrow epithelial cells
 - Nuclei densely packed
- CT cells
 - Laci cells
 - Similar to mesangial cells
- Afferent arteriole
 - Modified smooth muscle cells
 - Juxtaglomerular cells
 - Secretory function

Capillaries

- Supported by
 - Mesangial cells
 - Mesangial matrix
- Phagocytic
 - Maintain basement membrane
 - Remove macromolecular deposits

Mesangial cells

- Around capillary loops at vascular pole
- Phagocytic
- Maintain basement membrane
- Remove macromolecular deposits

Glomerulus

Juxtaglomerular apparatus

Macula densa

Laci cells

Vascular pole

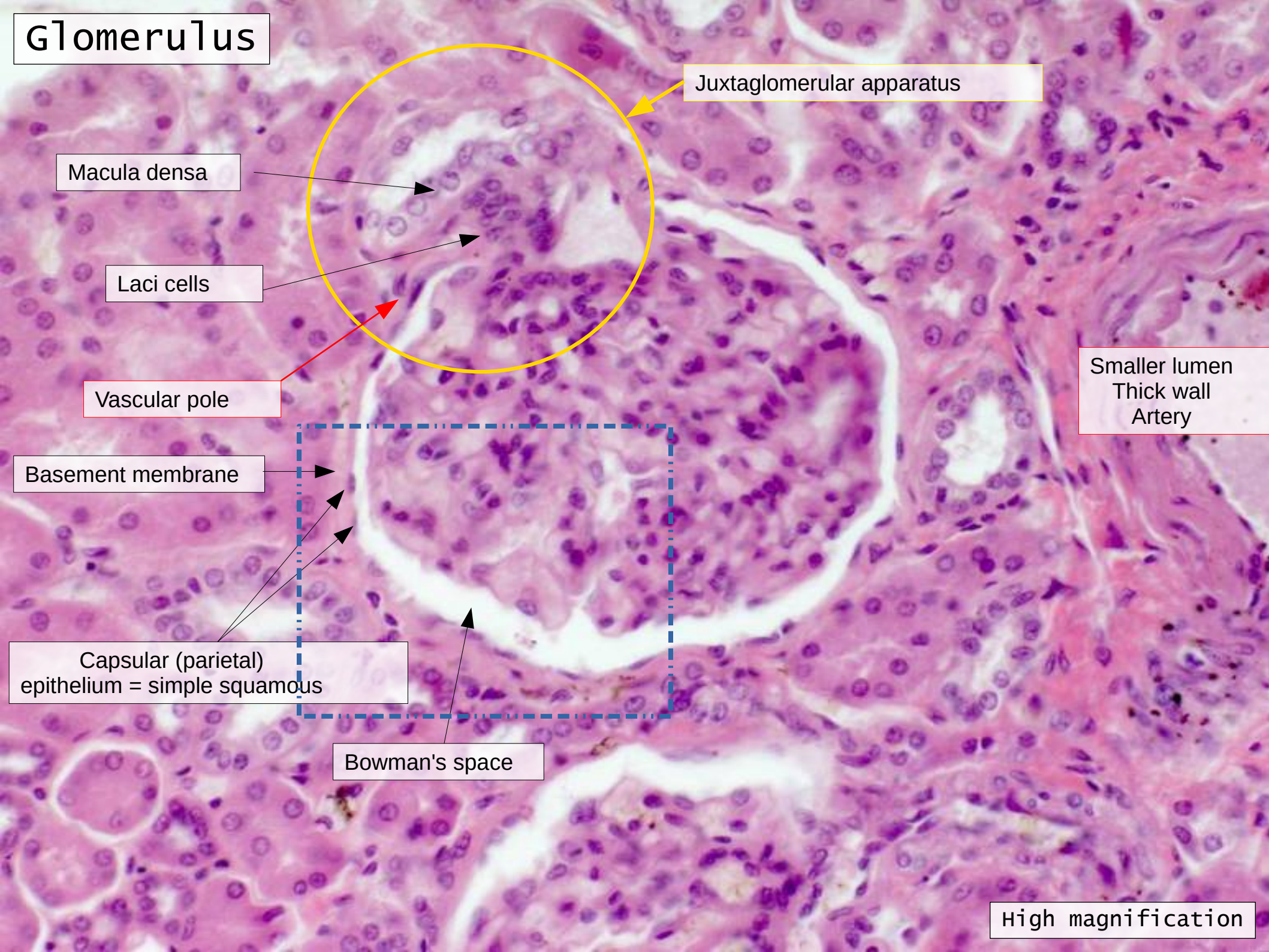
Basement membrane

Smaller lumen
Thick wall
Artery

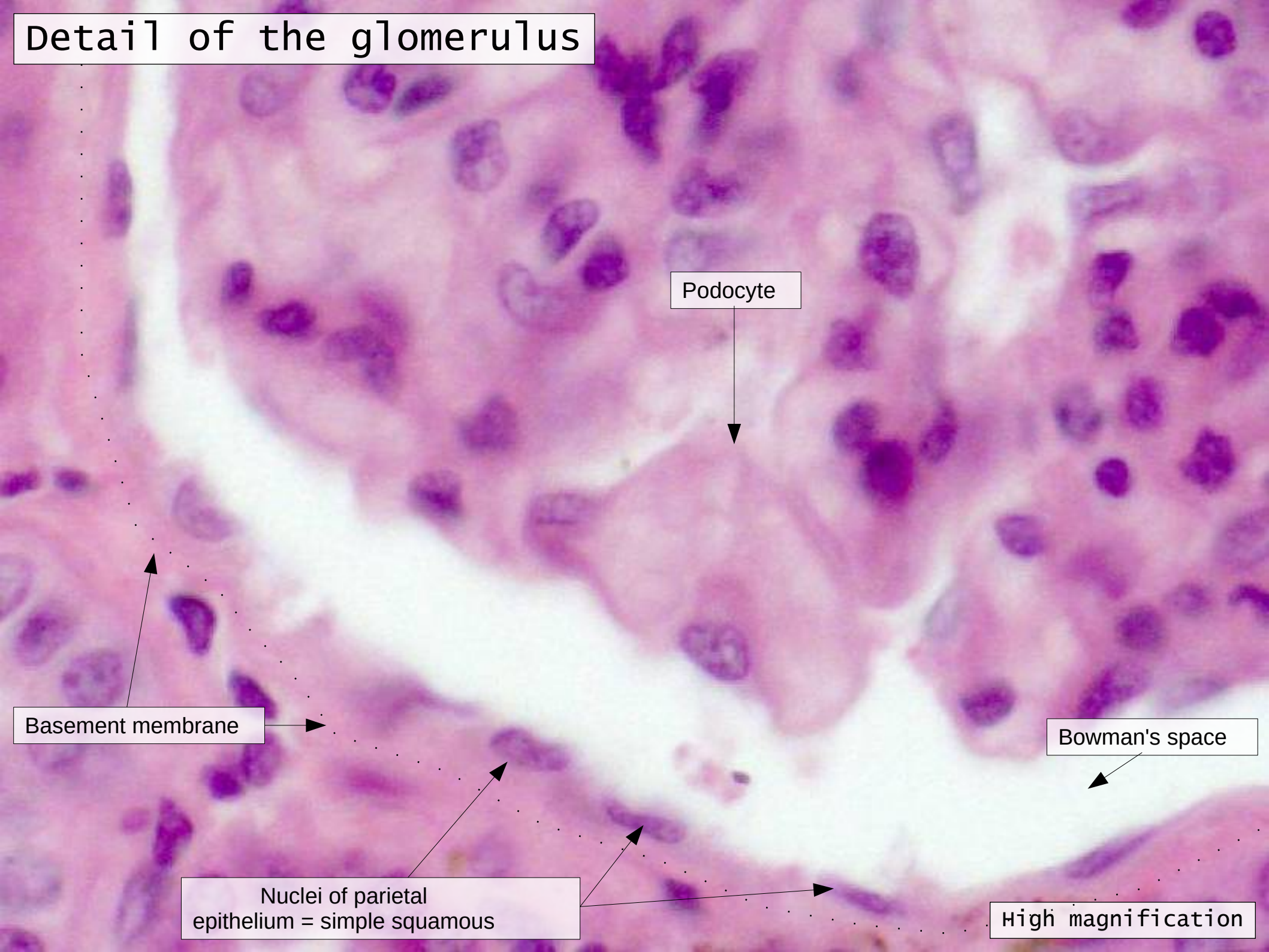
Capsular (parietal)
epithelium = simple squamous

Bowman's space

High magnification



Detail of the glomerulus



Podocyte

Basement membrane

Bowman's space

Nuclei of parietal
epithelium = simple squamous

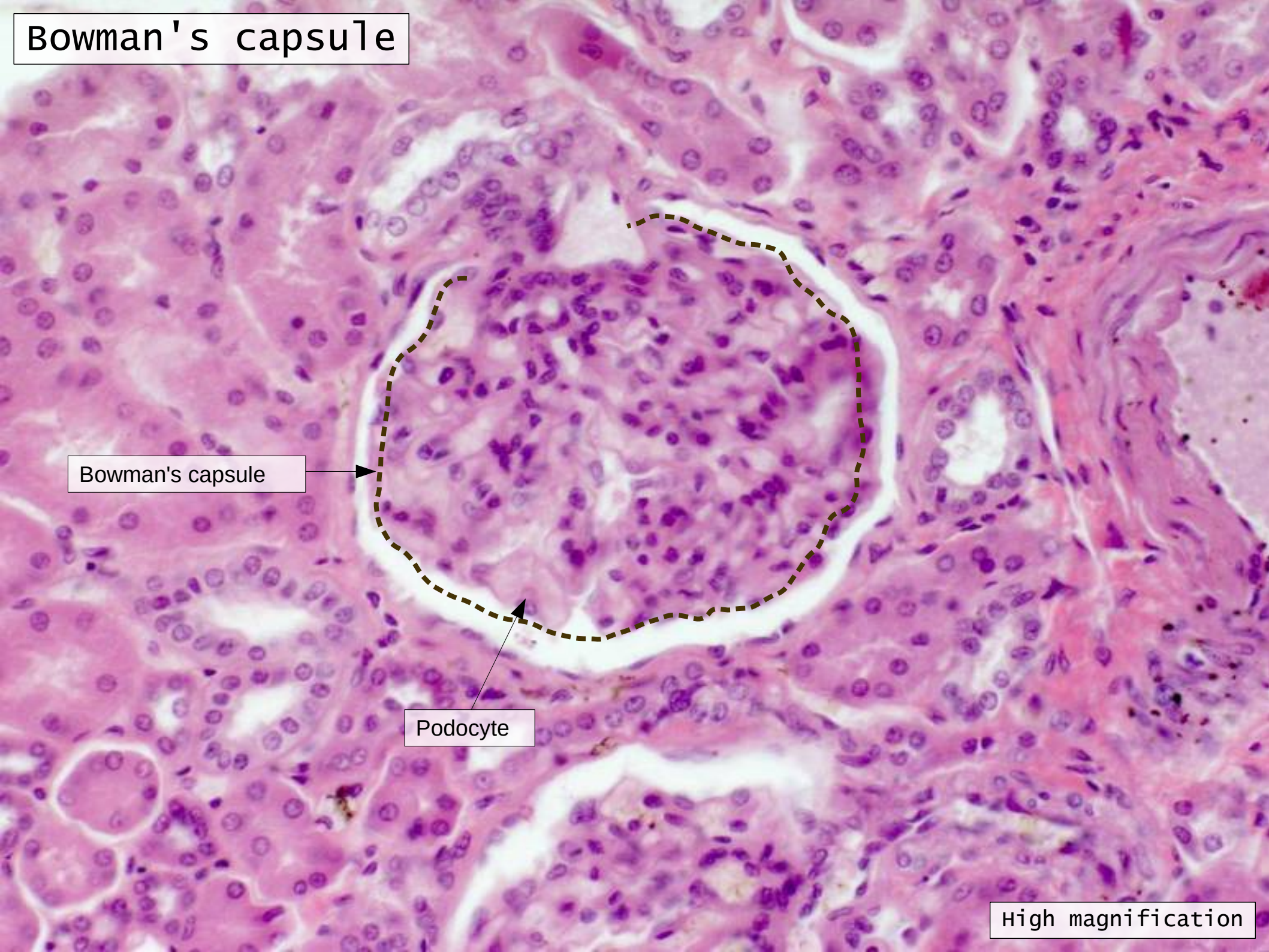
High magnification

Bowman's capsule

Bowman's capsule

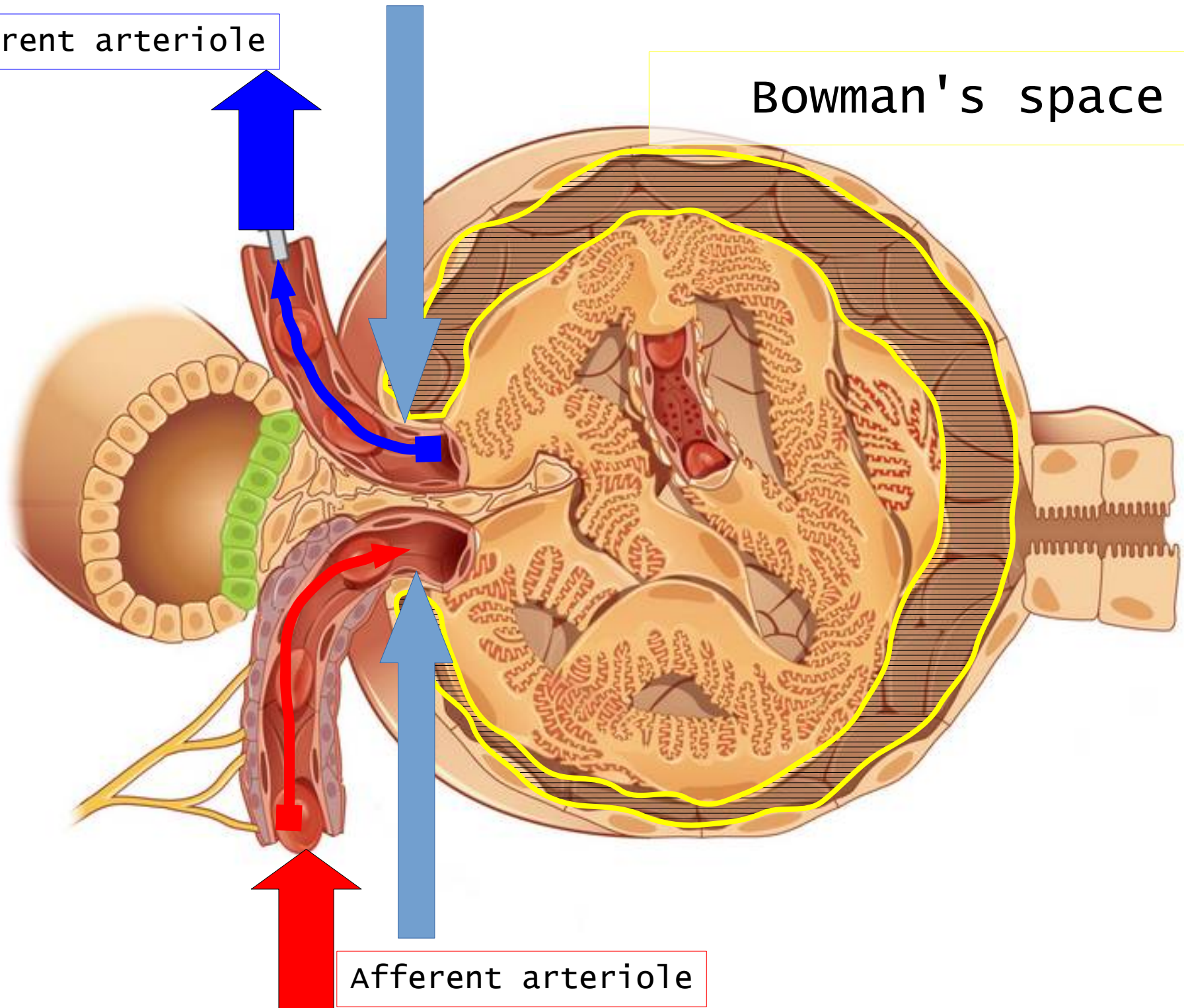
Podocyte

High magnification



Efferent arteriole

Bowman's space



Afferent arteriole

Bowman's space

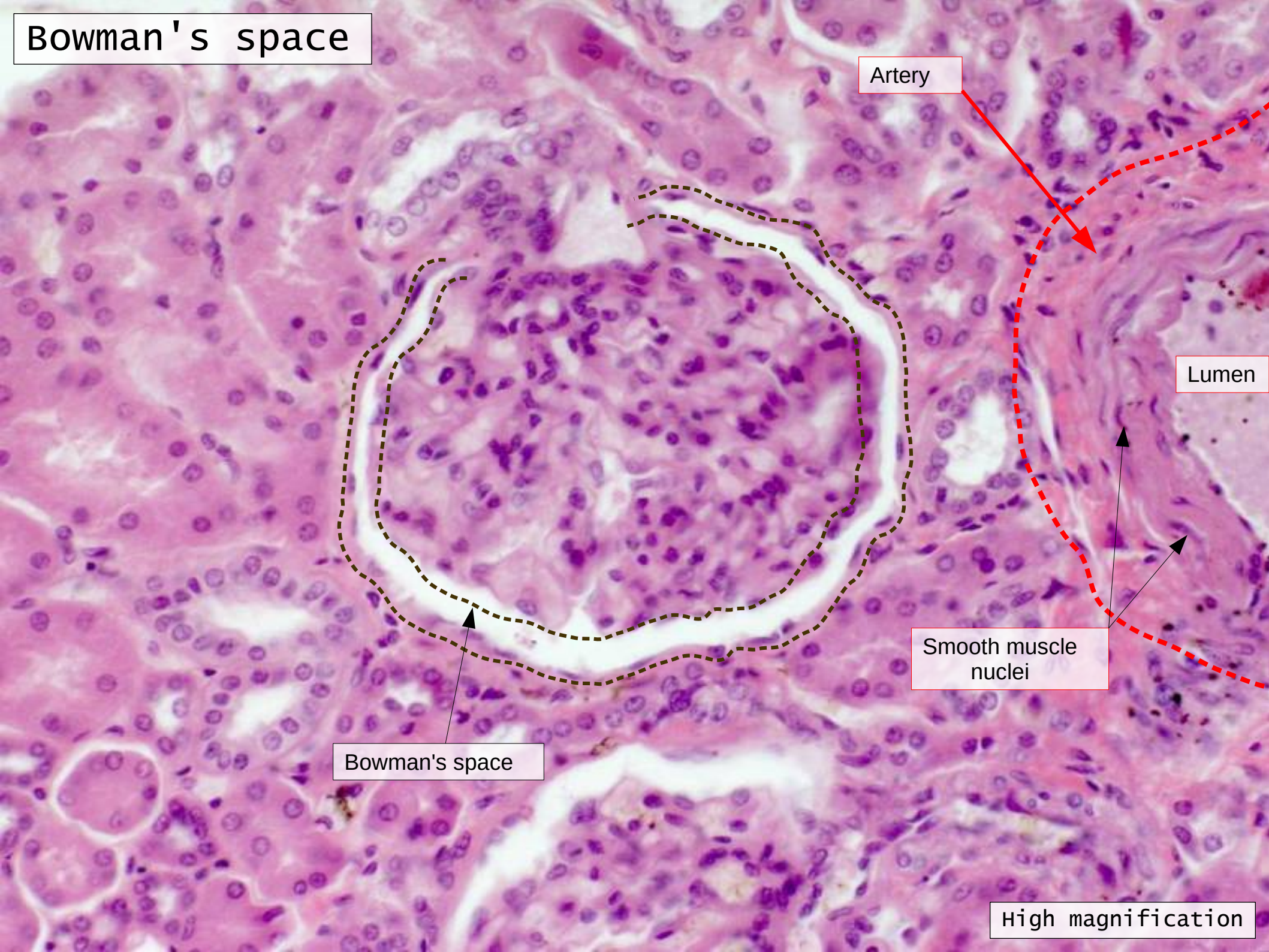
Artery

Lumen

Smooth muscle
nuclei

Bowman's space

High magnification



Artery

White cell nucleus
in blood vessel

Smaller lumen
Thick wall
Artery

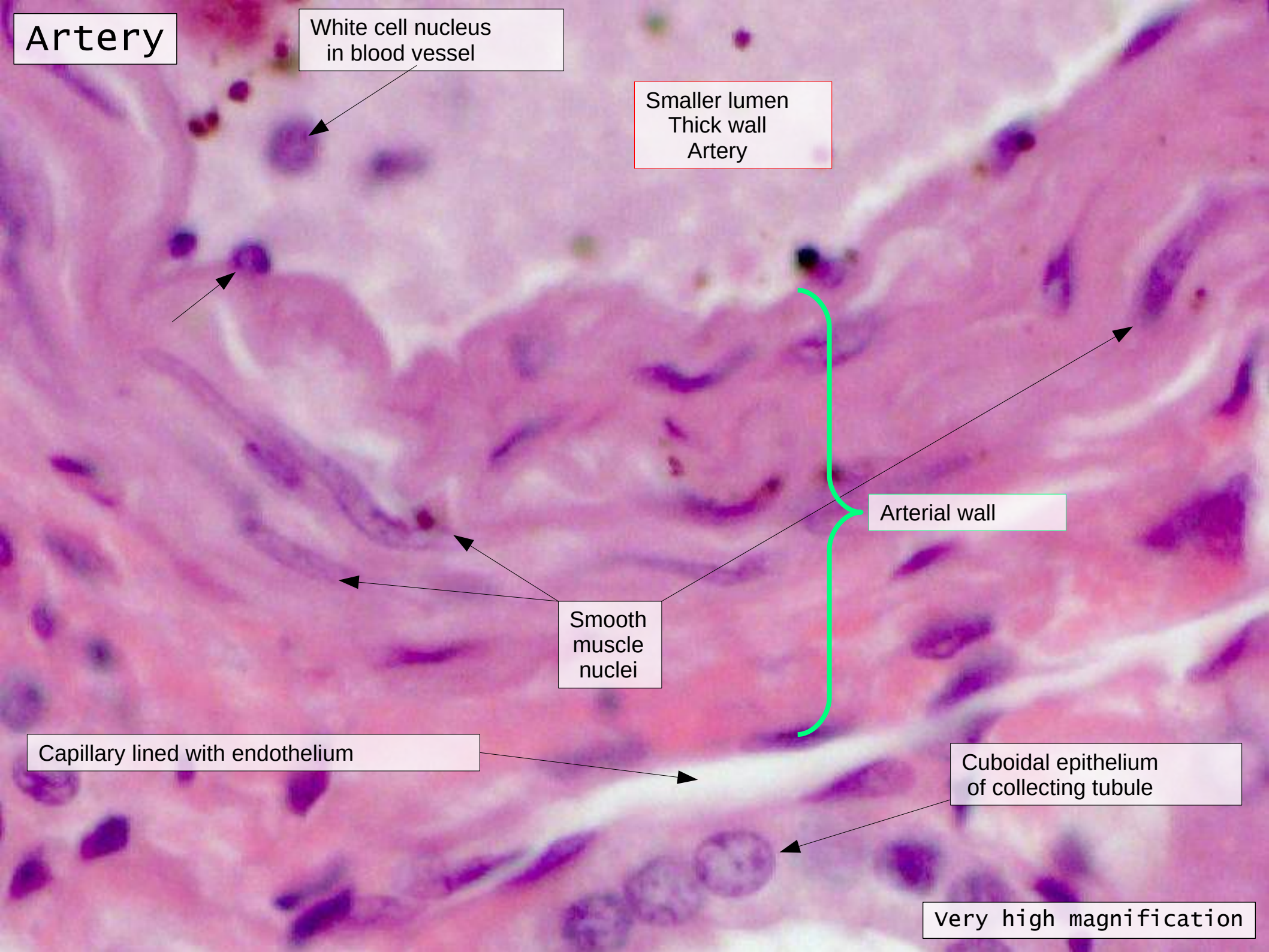
Arterial wall

Smooth
muscle
nuclei

Capillary lined with endothelium

Cuboidal epithelium
of collecting tubule

very high magnification



Podocytes

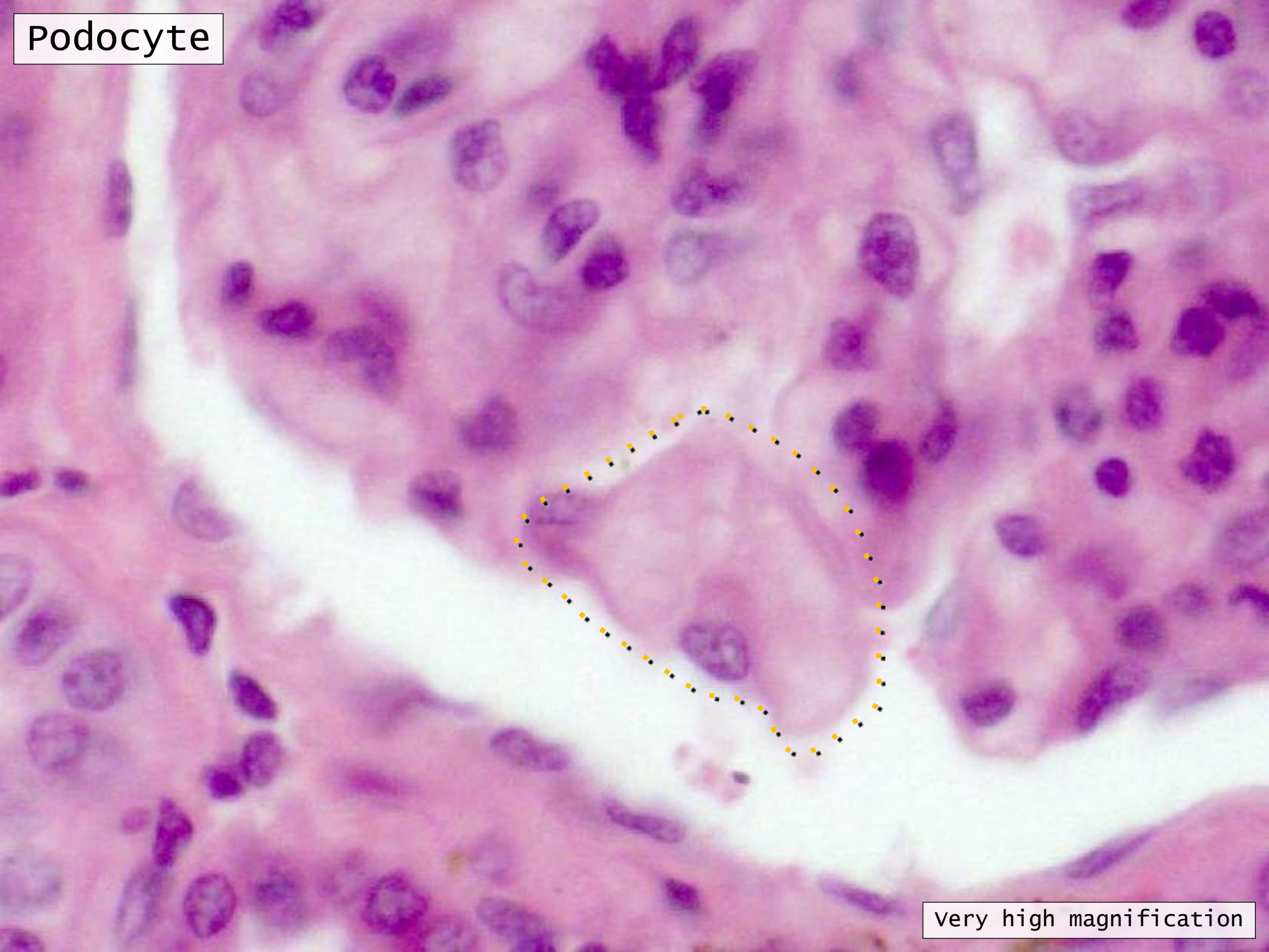
- Visceral layer of epithelium
- Protrude into capsular space
- Attached to basement membrane
- Long cytoplasmic extensions
- Primary processes
- Secondary processes
- Podocyte feet
- Tightly spaced
- Filtration slits 20 – 30 nm wide

Podocytes



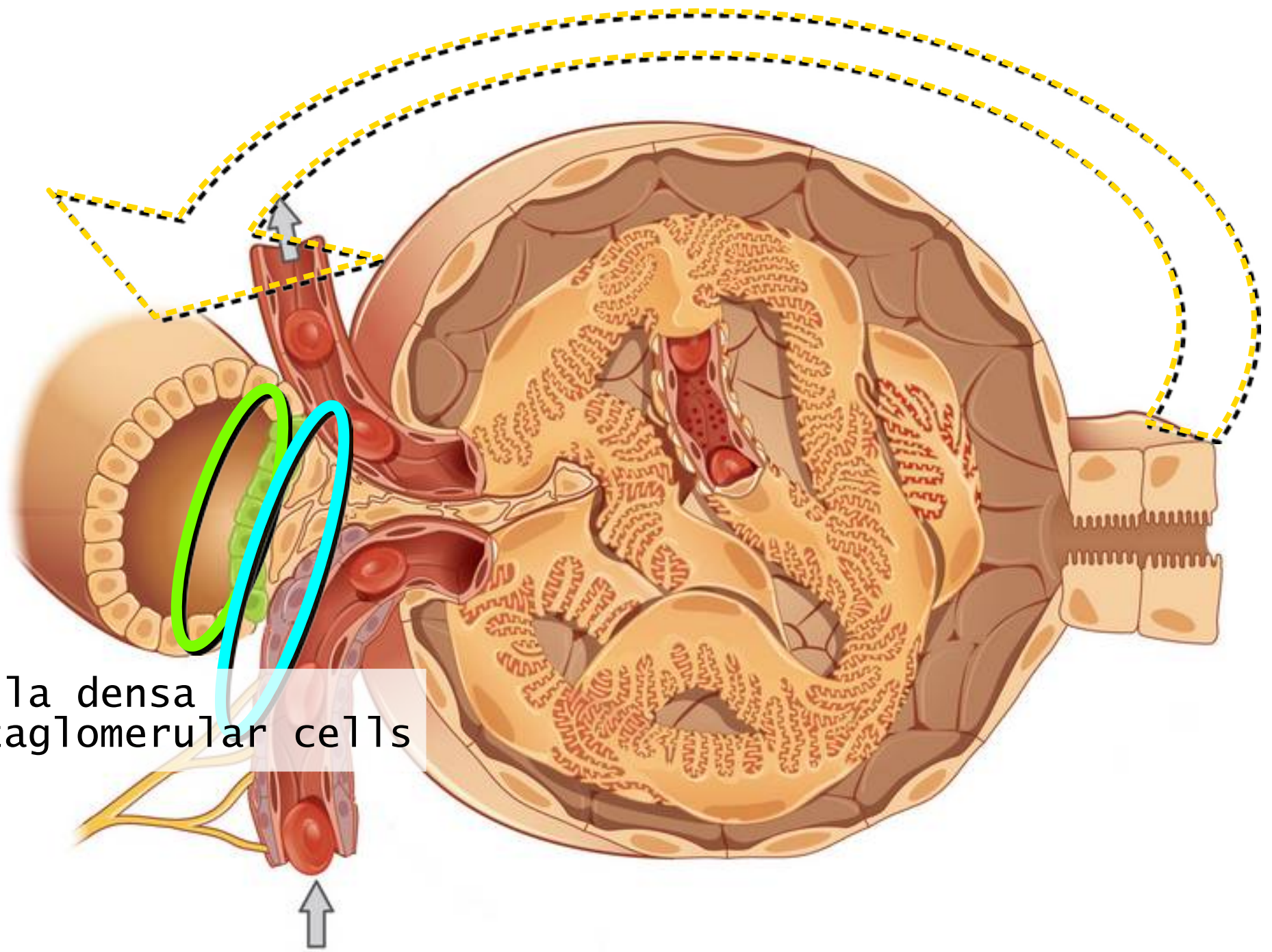
High magnification

Podocyte

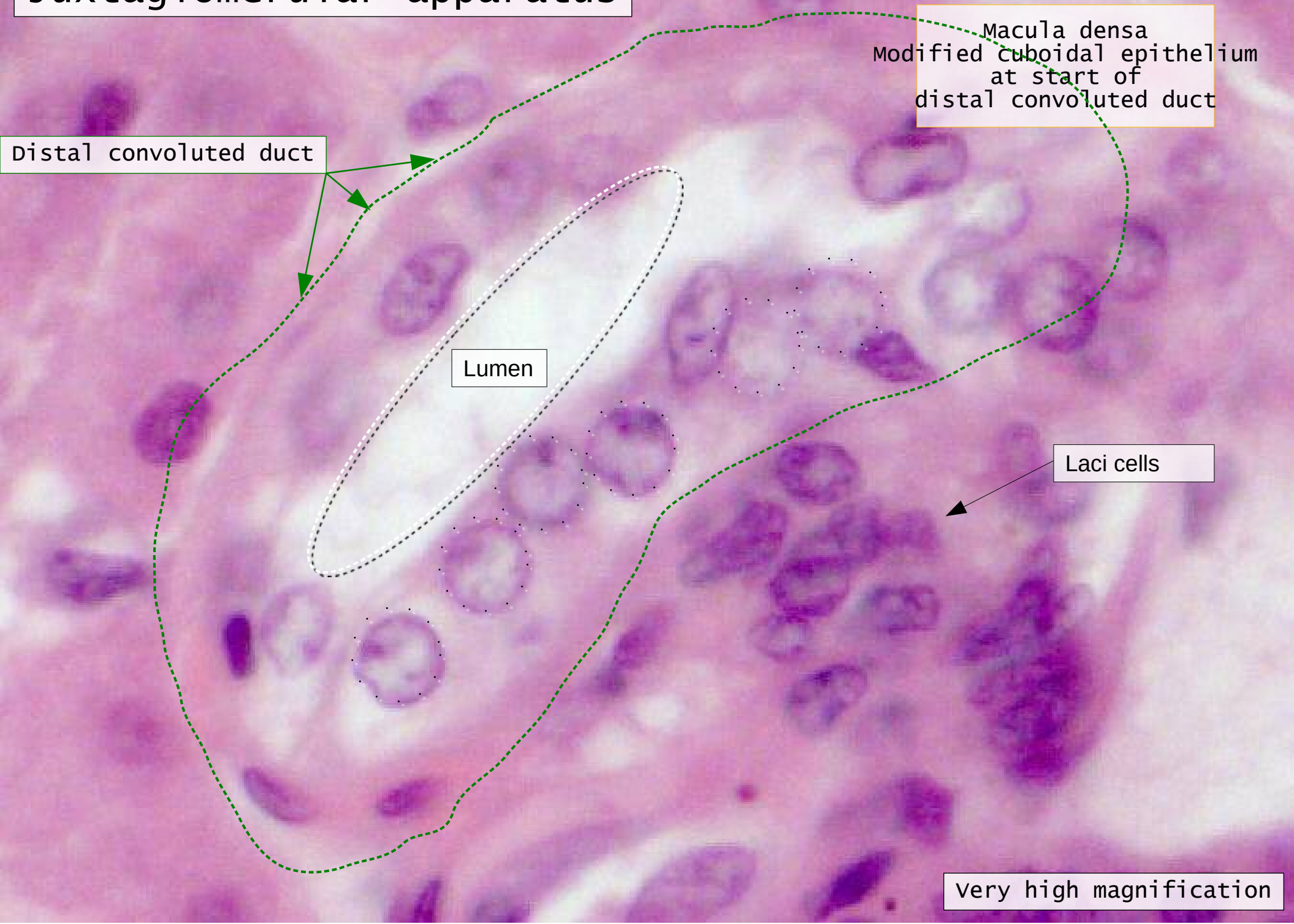


very high magnification

Macula densa
Juxtaglomerular cells



Juxtaglomerular apparatus



Proximal convoluted segment

- Longest part of nephron
- Wide triangular cell
- Spherical nucleus
- Indistinct cell borders
- Luminal surface
 - Striated brush border

Long loop of Henle

- Descending portion
- Thick
- Thin
- Ascending portion
- Thin
- Thick

Loop of Henle – thin

- Narrow lumen
- Thin wall
- Squamous epithelium
- Looks like capillaries

Loop of Henle – thick

Continuation of descending and
ascending tubuli

Distal convoluted tubuli

- Joins collecting tubule
- Cuboidal epithelium
- Light stained
- Wide looking lumen
- Indistinct borders

Glomerulus

Juxtaglomerular apparatus

Macula densa

Laci cells

Vascular pole

Basement membrane

Smaller lumen
Thick wall
Artery

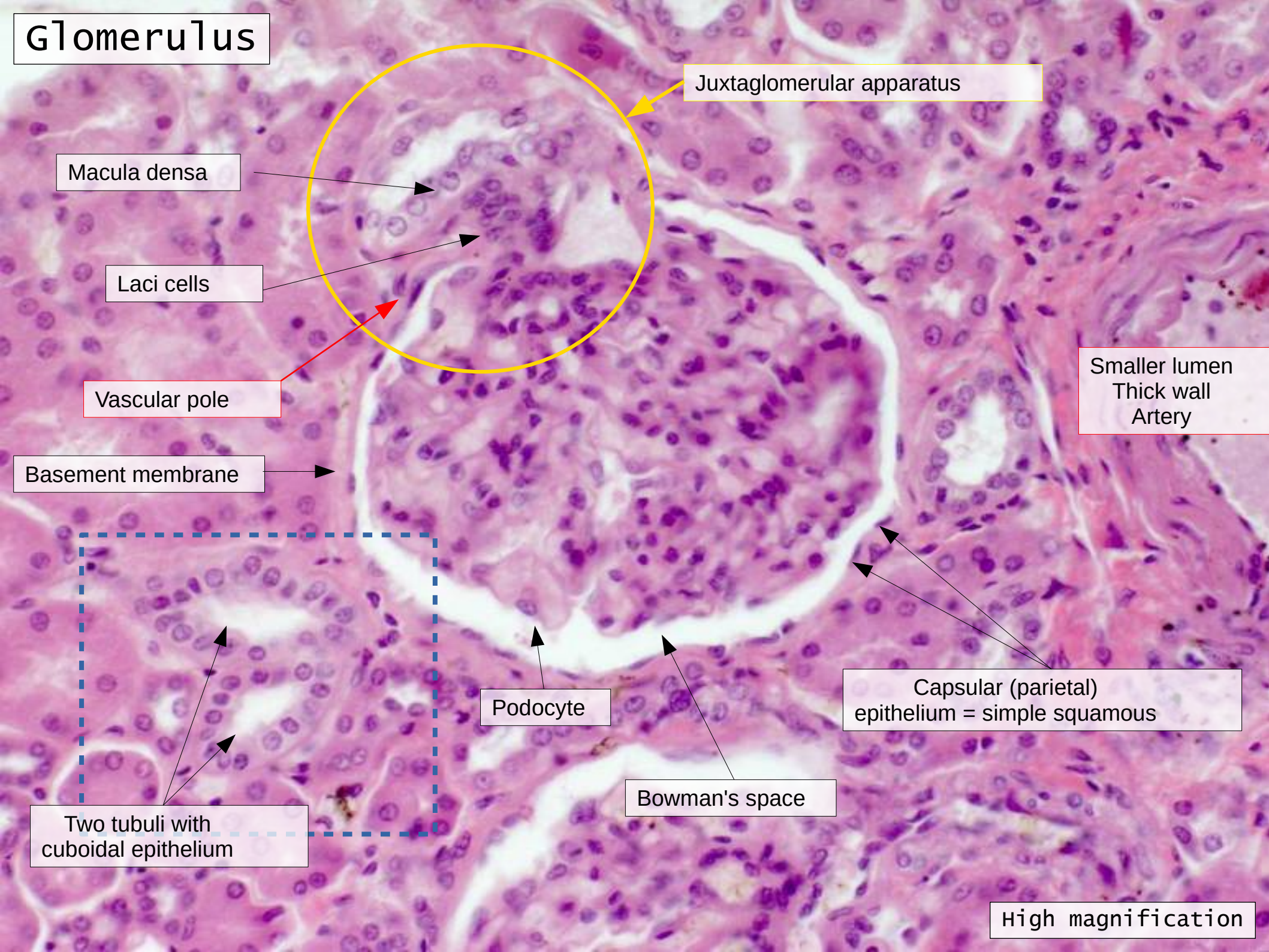
Podocyte

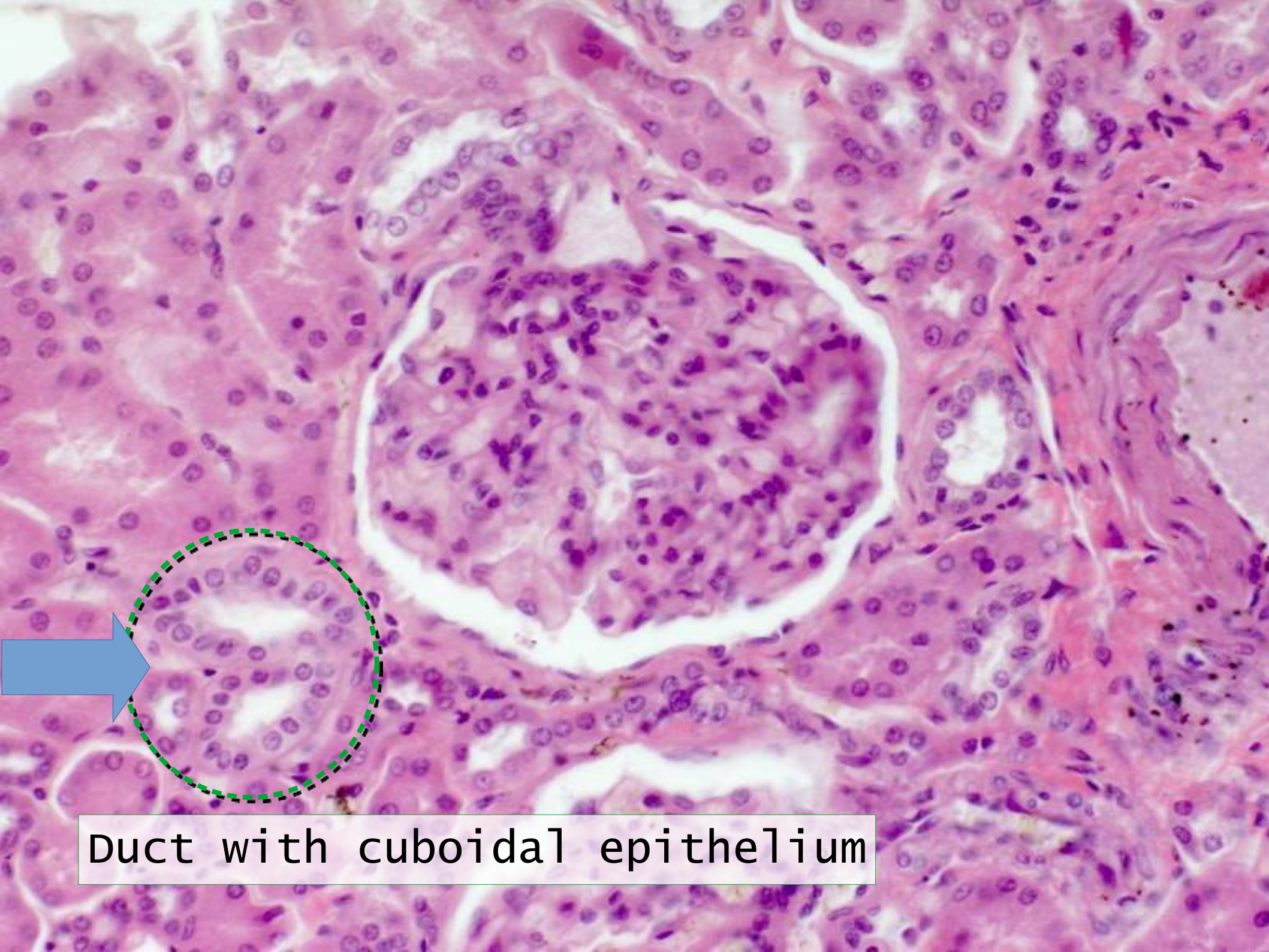
Capsular (parietal)
epithelium = simple squamous

Bowman's space

Two tubuli with
cuboidal epithelium

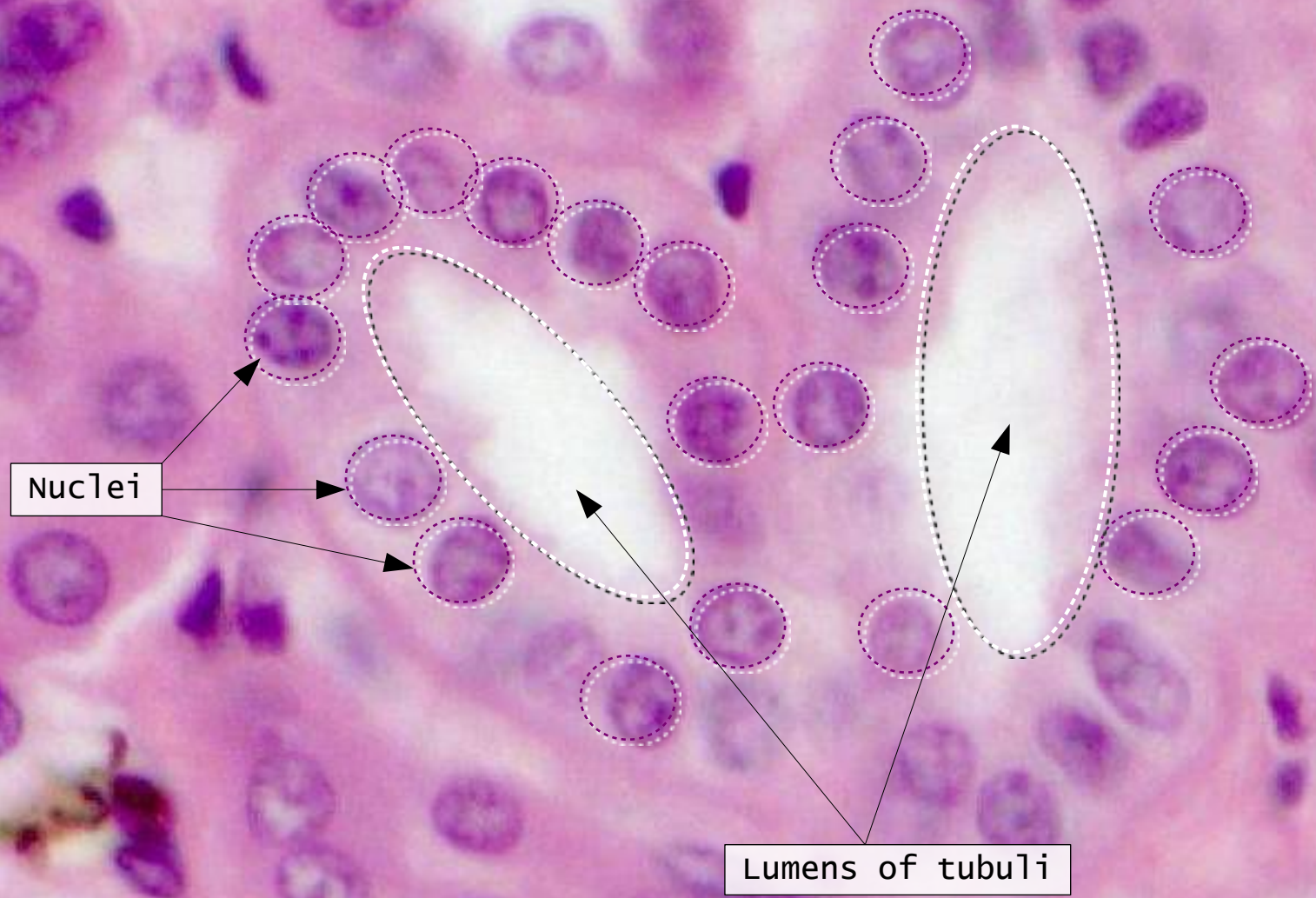
High magnification





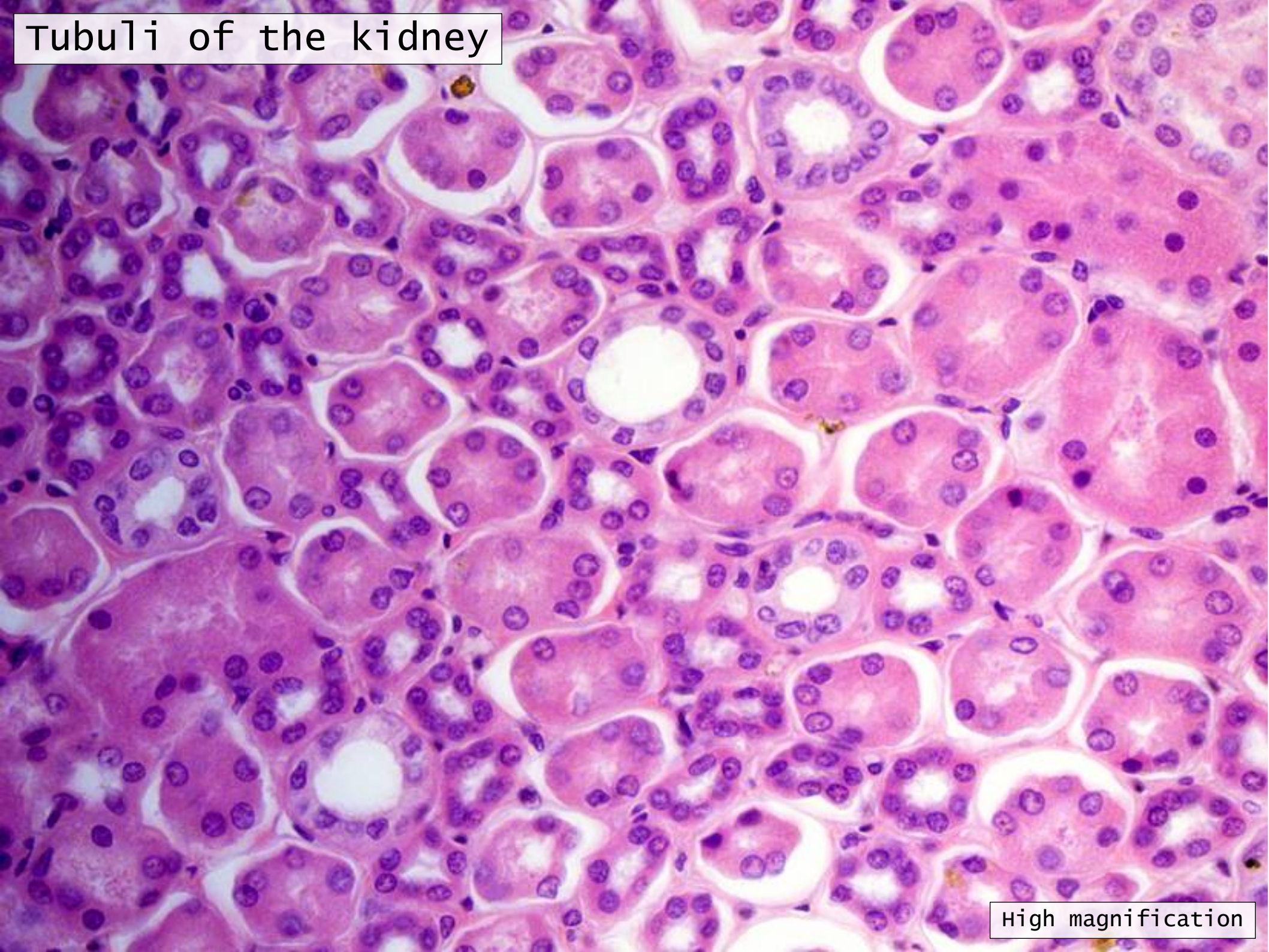
Duct with cuboidal epithelium

Cuboidal epithelium



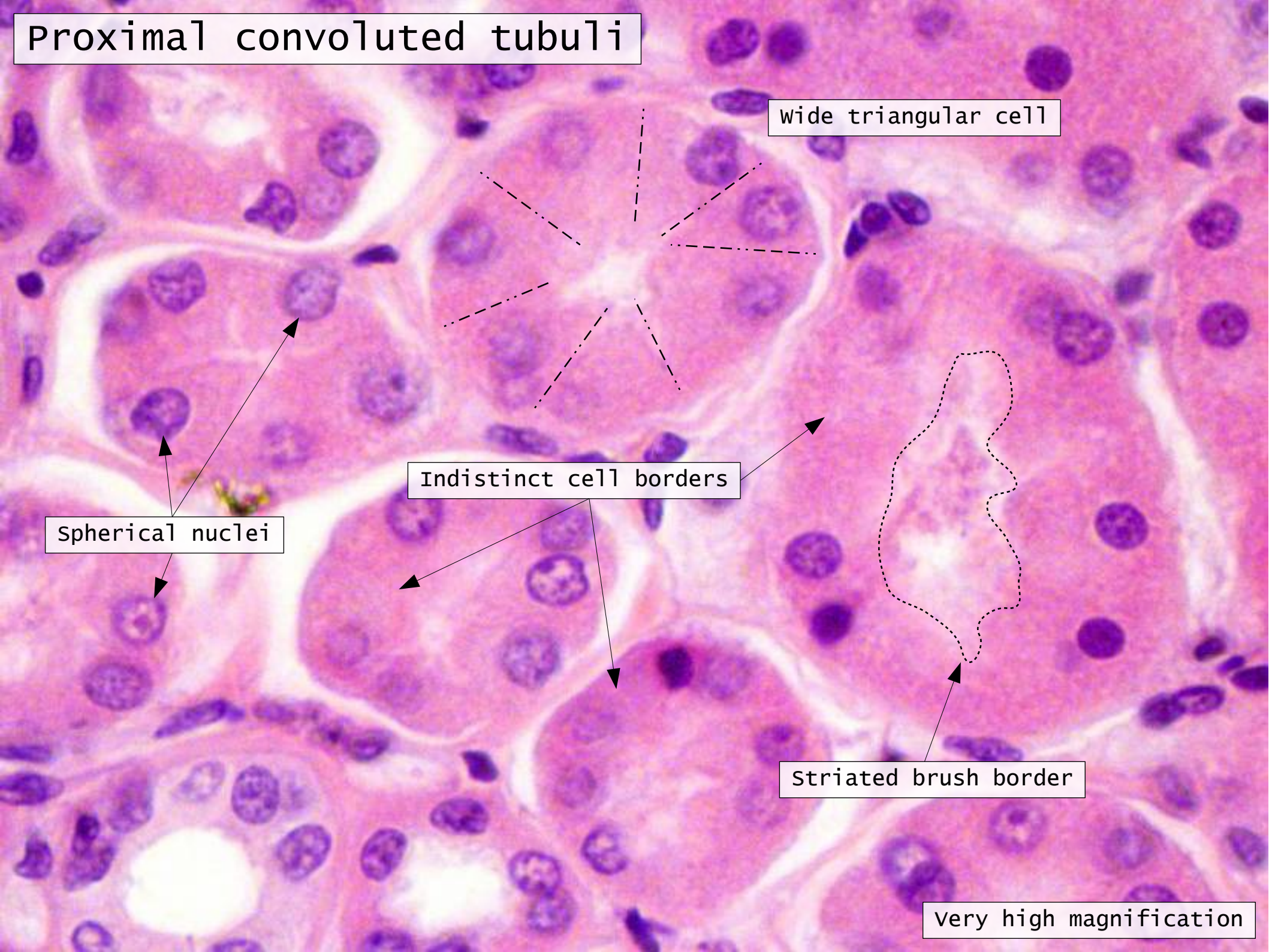
very high magnification

Tubuli of the kidney



High magnification

Proximal convoluted tubuli



wide triangular cell

Indistinct cell borders

Spherical nuclei

Striated brush border

very high magnification

Distal convoluted tubule

Proximal convoluted tubule

Darker stained

Lighter stained

Distal convoluted tubule

Striated brush border
creates indistinct
small lumen

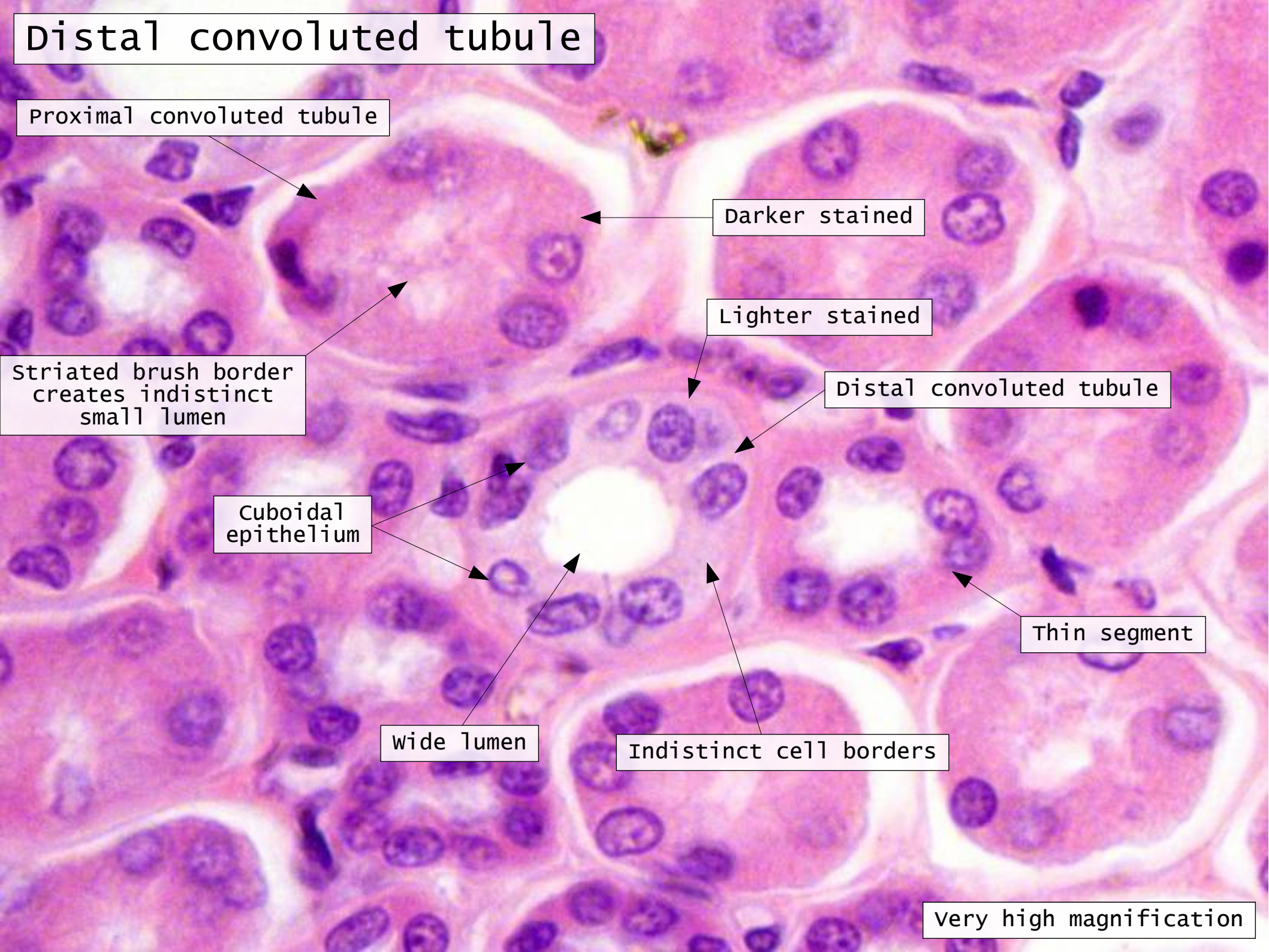
Cuboidal
epithelium

Thin segment

wide lumen

Indistinct cell borders

very high magnification



Collecting tubule

- Cuboidal to columnar epithelium
- Distinct lateral borders

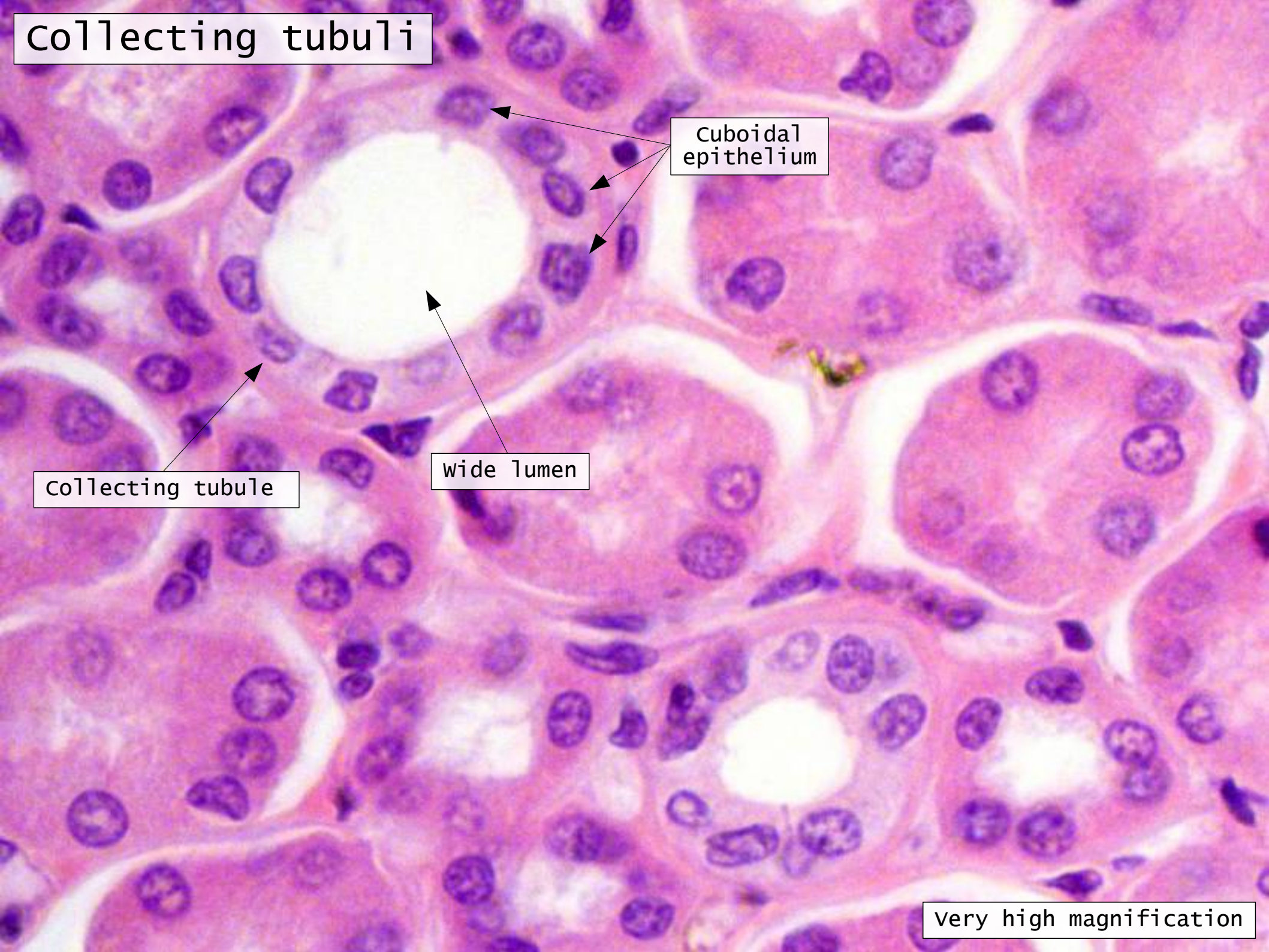
collecting tubuli

Cuboidal
epithelium

collecting tubule

wide lumen

very high magnification



Structures in the cortex of the kidney

Thick
ascending
segment

collecting tubule

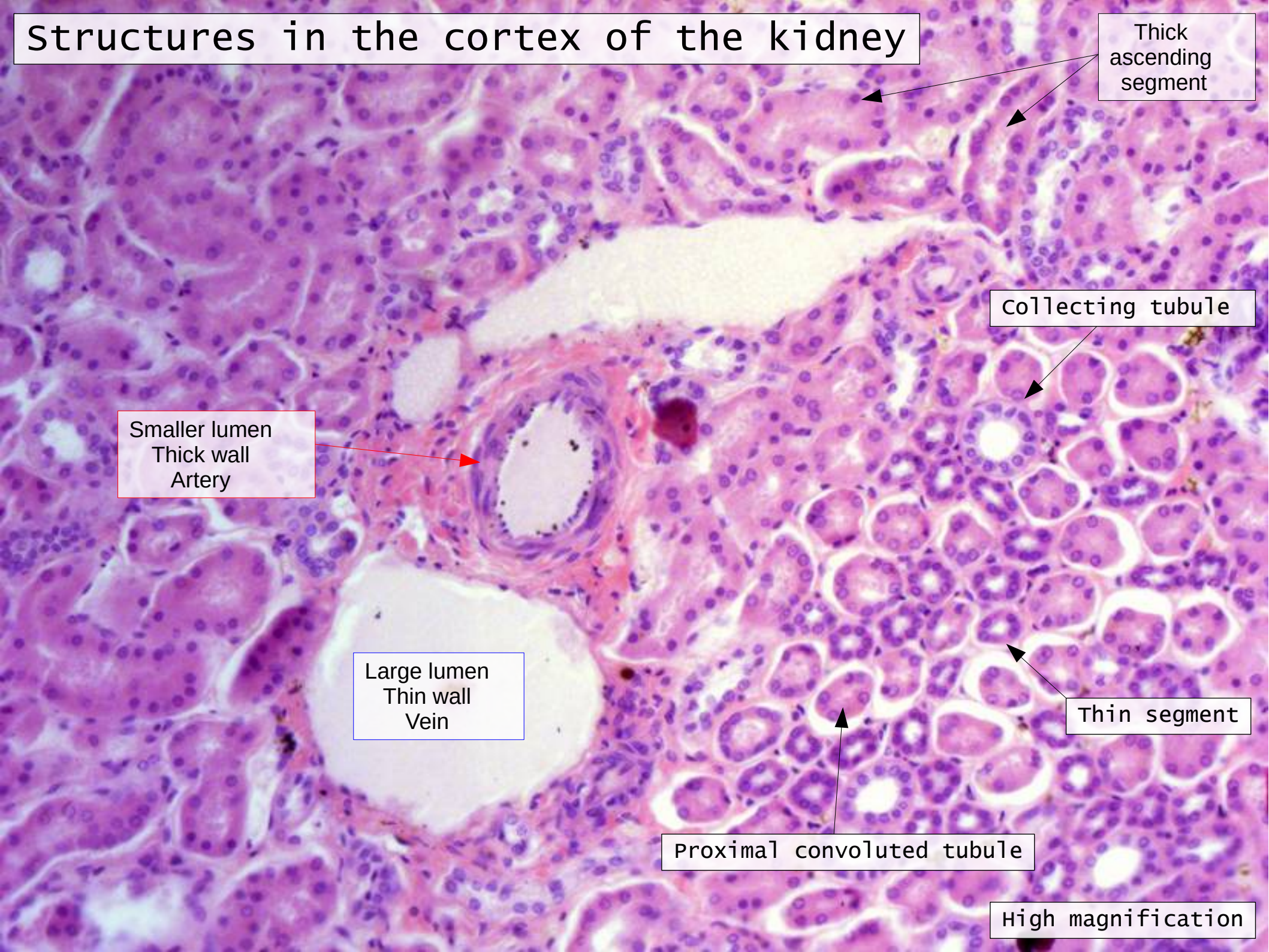
Smaller lumen
Thick wall
Artery

Large lumen
Thin wall
Vein

Thin segment

Proximal convoluted tubule

High magnification



Artery in the cortex of the kidney

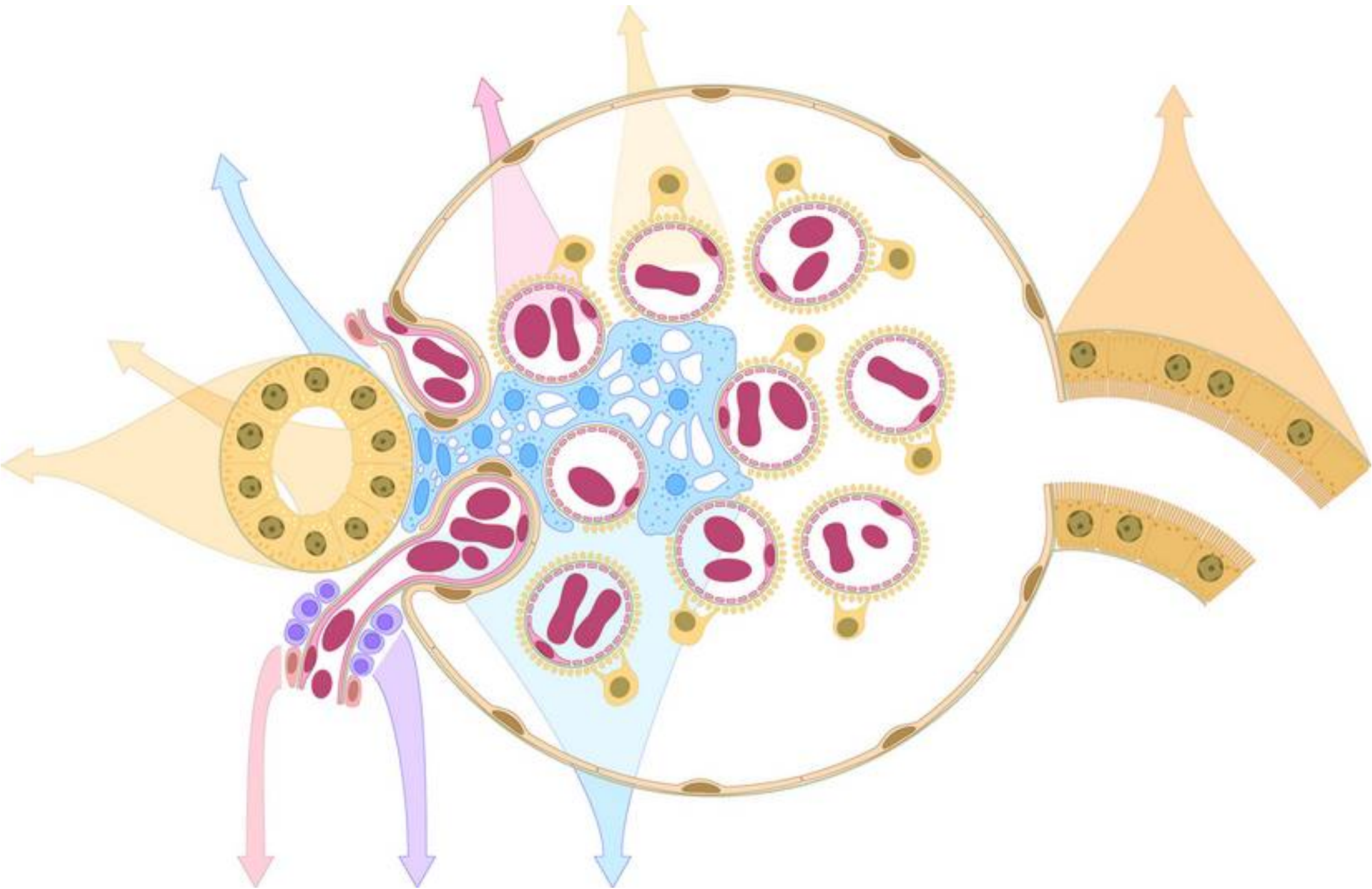


Smooth
muscle
nuclei

High magnification

Main collecting ducts

- wide lumen
- Pale staining columnar cells



Ureter

slide 78

Ureter



very low magnification

Ureter

- Transitional epithelium
 - Thicker than calyces
 - More cell layers
- Muscle
 - Upper 2/3
 - Inner longitudinal
 - Outer circular
 - Lower 1/3
 - Inner longitudinal
 - Middle circular
 - Outer longitudinal

Ureter

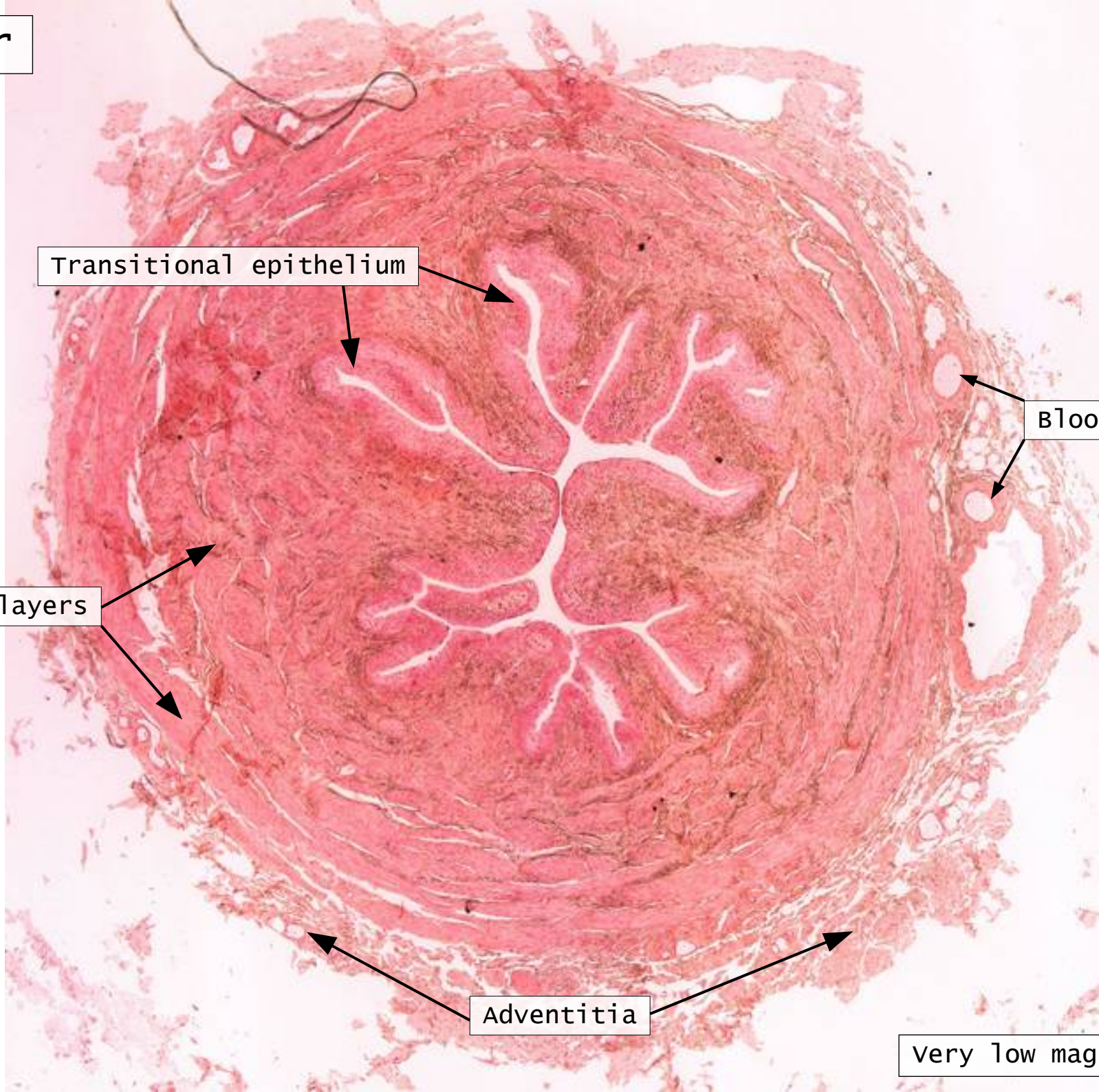
Transitional epithelium

Blood vessels

Muscle layers

Adventitia

very low magnification



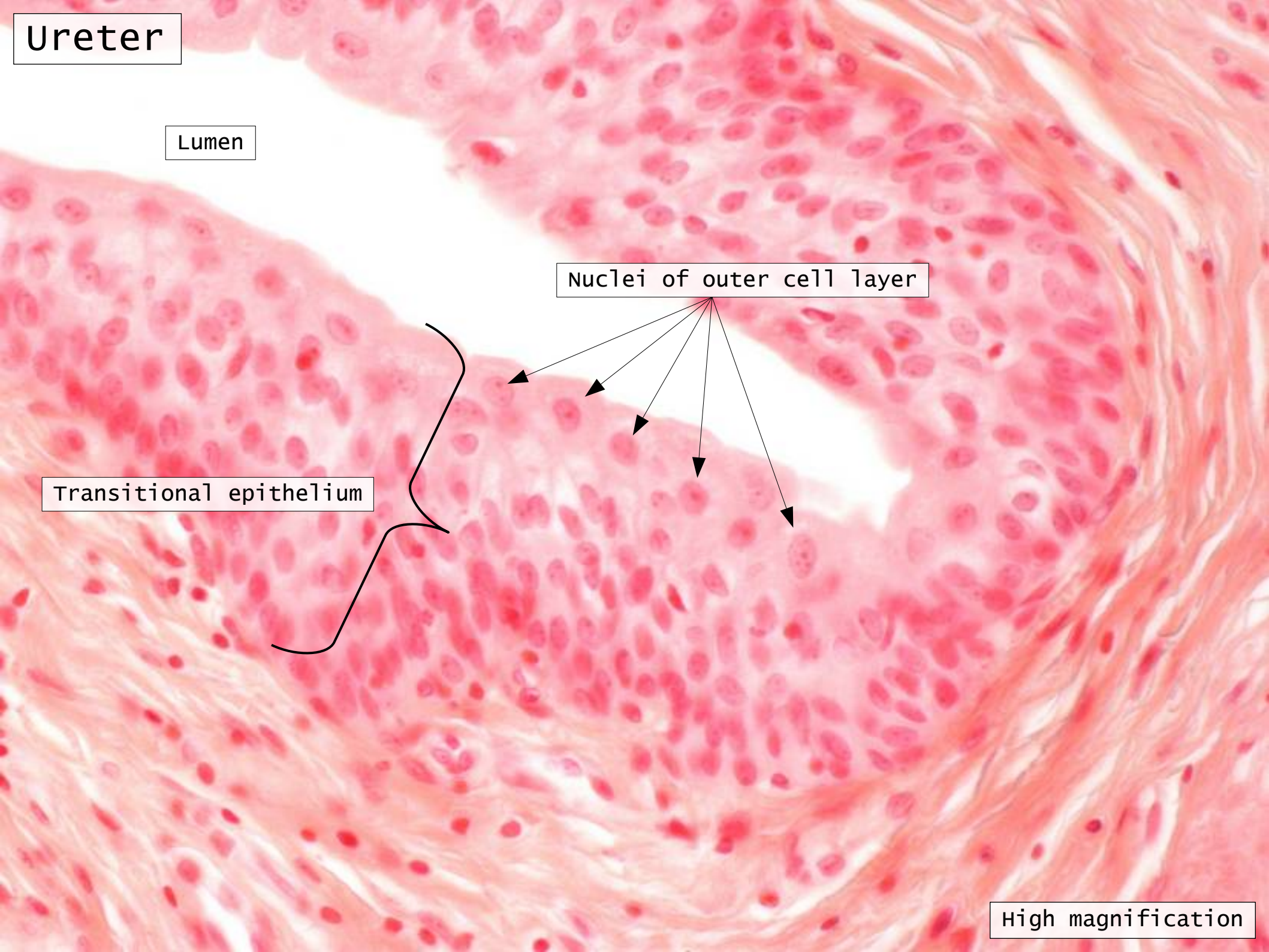
Ureter

Lumen

Transitional epithelium

Nuclei of outer cell layer

High magnification



Ureter

Nuclei of outer cell layer,
also known as umbrella cells

Transitional epithelium
Notice
varying thickness
due to folds

Lumen

High magnification



Umbrella cell



Lumen

very high magnification

Transitional epithelium



very high magnification

Transitional epithelium



very high magnification

Urinary bladder

slide 79

Urinary bladder

- Transitional epithelium
 - Scalloped contour
 - Due to dome-shaped surface cells
- Thin basal lamina on fibro-elastic CT
- Muscle
 - Inner longitudinal
 - Middle circular
 - Outer longitudinal

Bladder

Transitional epithelium

Lumen

Medium magnification



Bladder



Dome shaped surface cells

Lumen

High magnification

Bladder

Fibro-elastic
connective tissue
layer

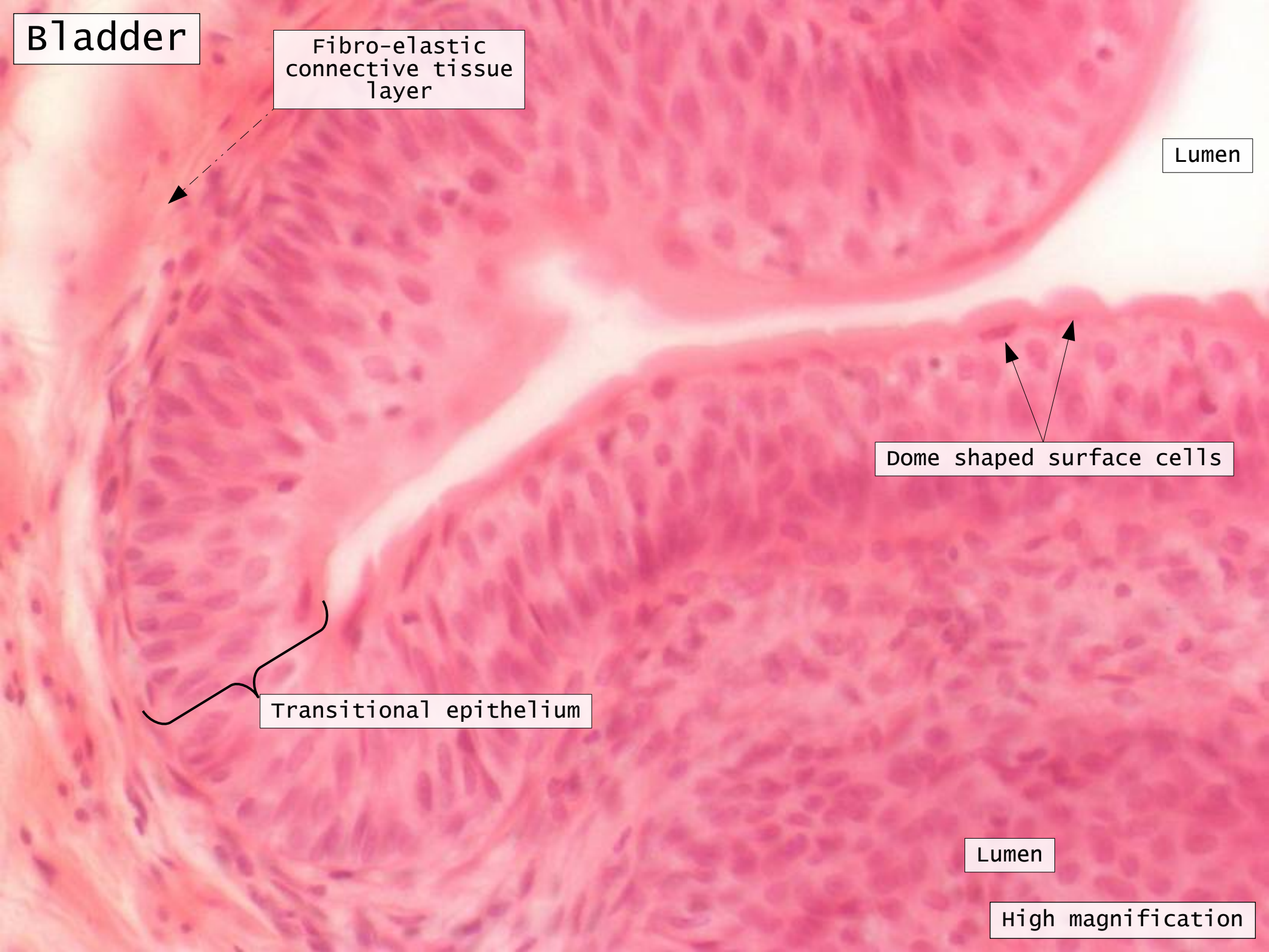
Lumen

Dome shaped surface cells

Transitional epithelium

Lumen

High magnification



Urethra – Male

- 3 Parts
- Prostatic
 - Transitional epithelium
- Membranous &
- Cavernous
 - Pseudostratified to columnar
- Thin basement membrane on
 - Subepithelial CT with
 - Mucous secreting glands (Littré)
- Muscle
 - Inner longitudinal
 - Outer circular
- Distal end stratified squamous → Skin

Urethra – Female

- Primarily stratified squamous epithelium
- Patches pseudostratified columnar
- Thin basement membrane on
 - Subepithelial CT with
 - Mucous secreting glands (Littre)
- Muscle
 - Inner longitudinal
 - Outer circular