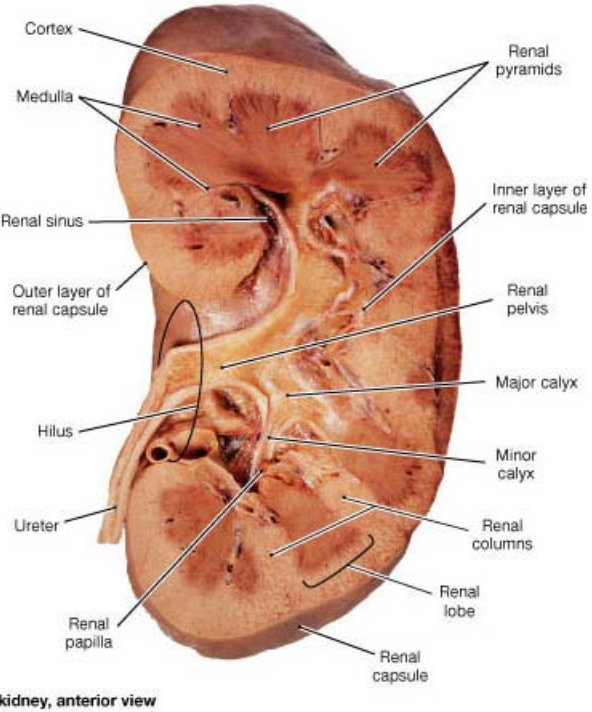
Urinary system



kidney, anterior view

Urea, uric acid, creatine
drugs, food additives
dissolved in water

Functions of the urinary system

- Micturition-(removal of metabolic wastes)
- Regulate ionic concentration of plasma by controlling the amount lost in the urine
- pH balance-removal of ammonia for body fluids
- Regulates blood volume/pressure by controlling the amount of urine produced
- Stimulates erythrocyte production

Removal of wastes from the body

- The urinary system maintains homeostasis of the blood concentration, volume, pressure, pH and removes toxins.

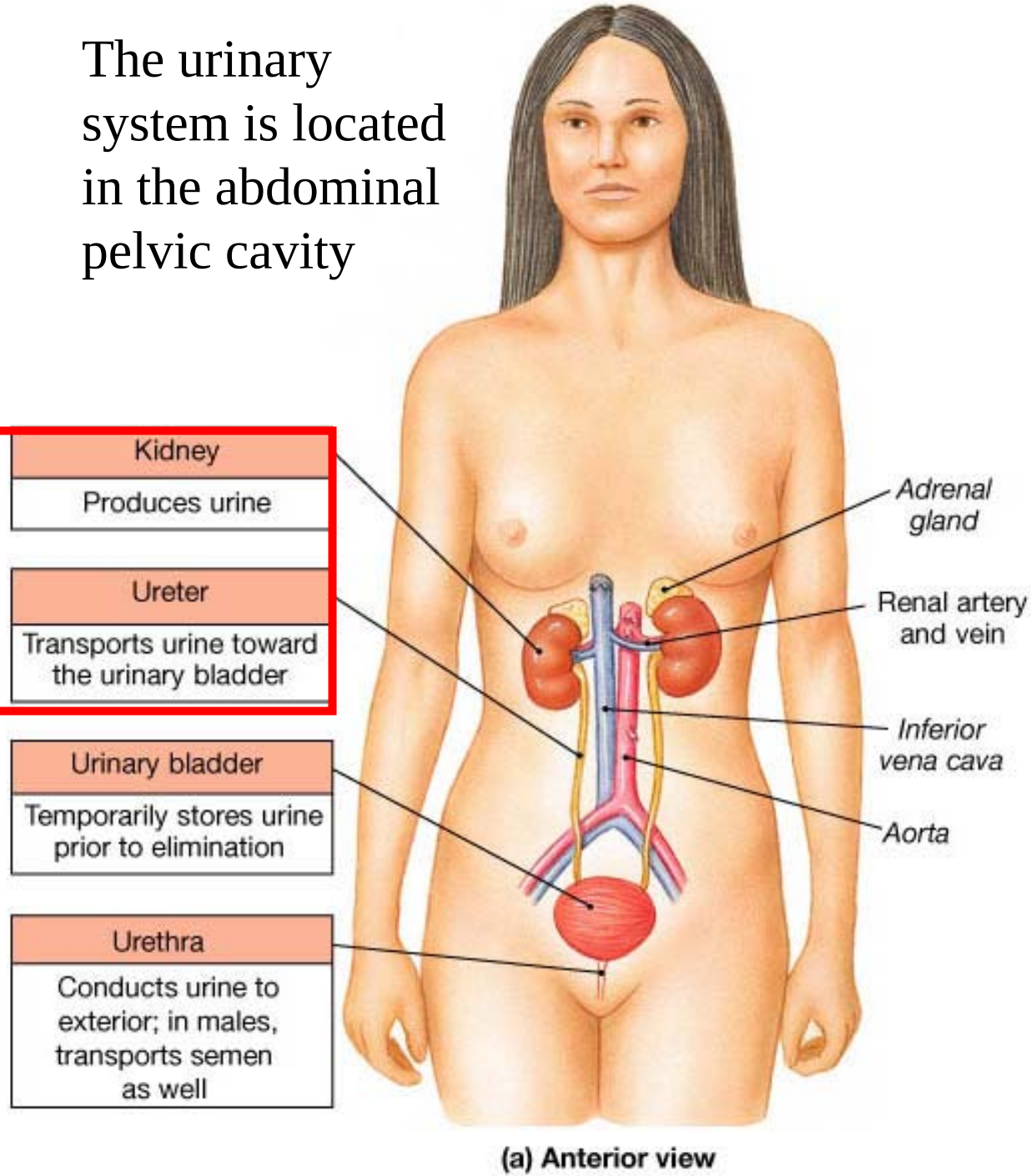
- Functional unit of the kidney is the nephron
- 1.25 million nephrons per kidney

Fig

26.1

The urinary system is located in the abdominal pelvic cavity

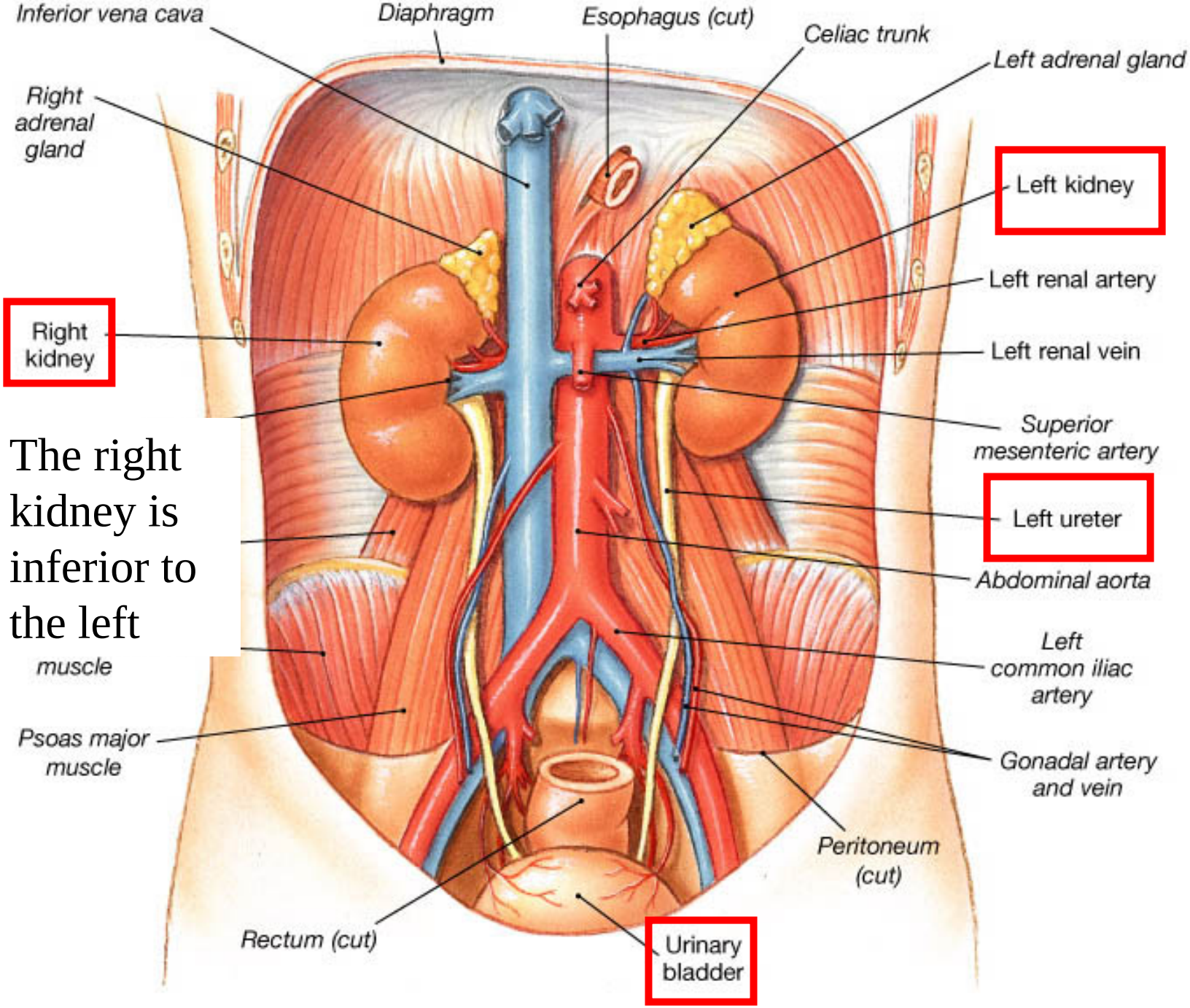
Kidneys and ureters are in the retroperitoneal space



Kidneys

- Located between T12 and L-3
- Right kidney lower than left (liver in the way)
- Located retroperitoneal
- Renal Capsule-collagen fibers on surface of kidney
- Perarenal fat-helps protect kidneys, adipose tissue
- Renal Fascia -Anchored to back abdominal wall
  - Runs from capsule through fat to wall

Fig 26.2



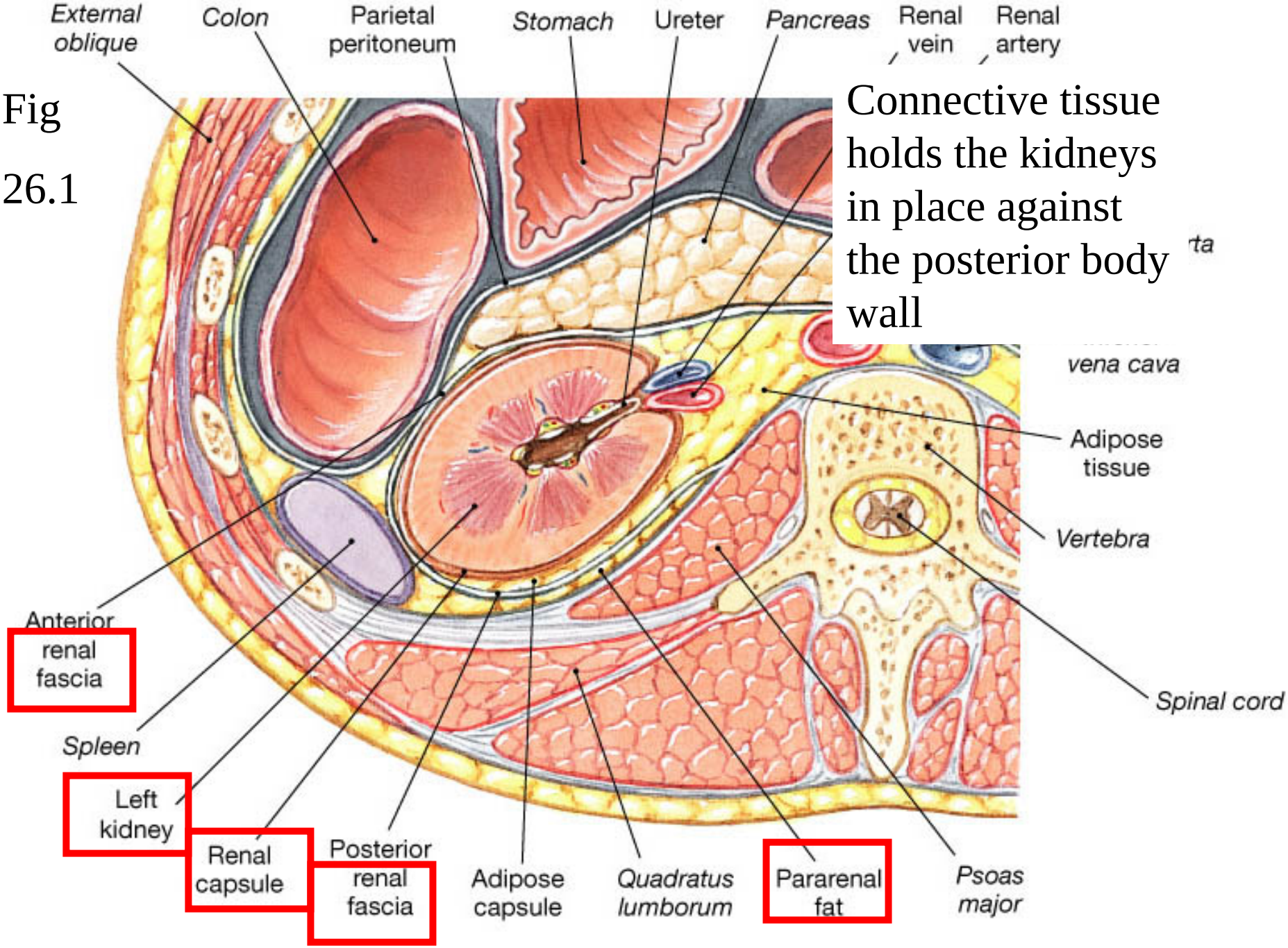
(a) Anterior view

The right kidney is inferior to the left

muscle

Fig 26.1

Connective tissue holds the kidneys in place against the posterior body wall



(c) Transverse section at L_1

Anatomy of the kidney

- Renal Cortex-Superficial region
- Renal Medulla-deeper region
  - Similar idea to adrenal cortex and medulla

FYI

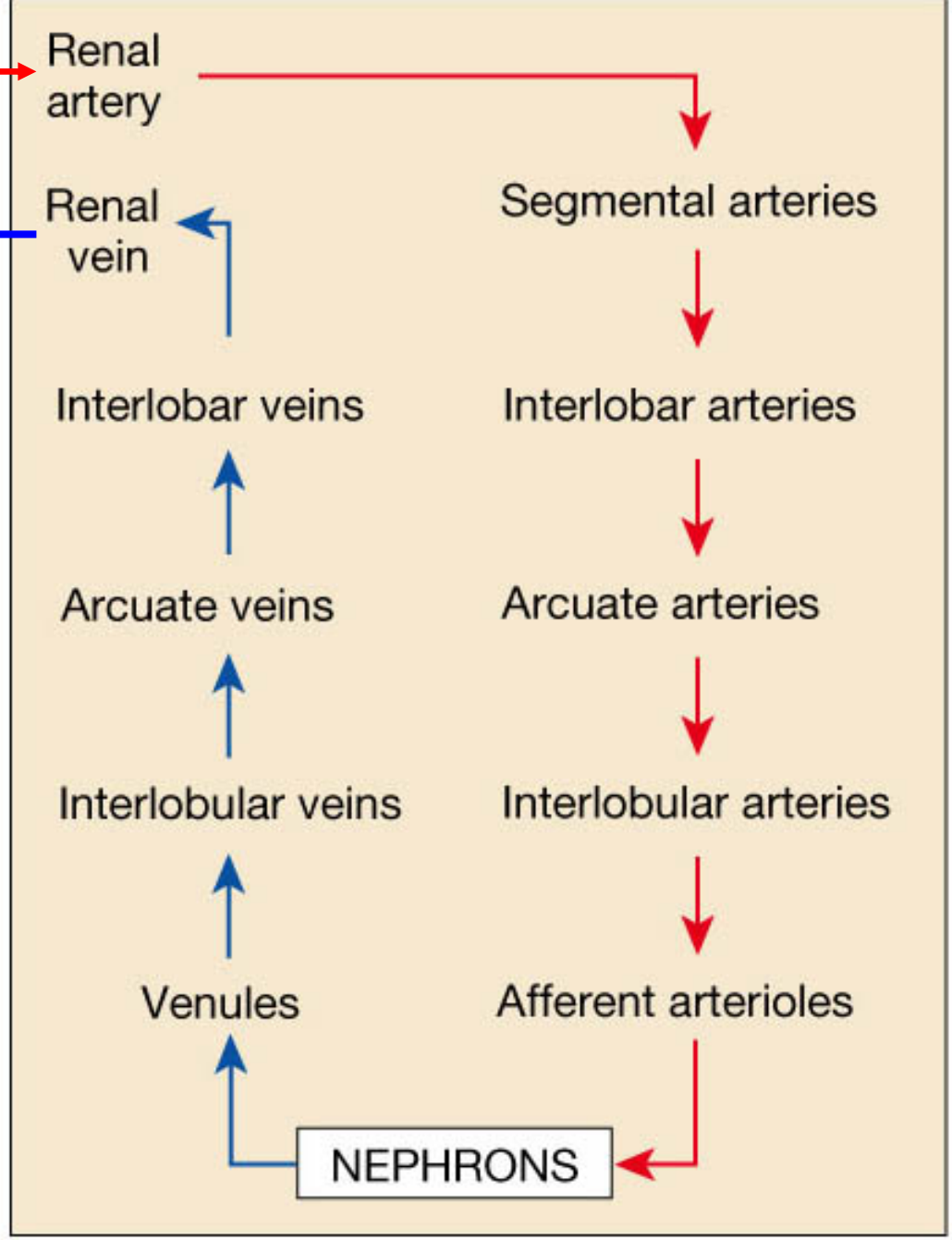
- 4900ml of blood leaves the heart per minute
- About 1200ml of blood flows through the kidneys/per minute
- The liver and kidneys receive about half of the blood that leaves the aorta

FYI

Aorta

Inferior vena cava

Blood flow to & from the kidneys



(c)

Nephron

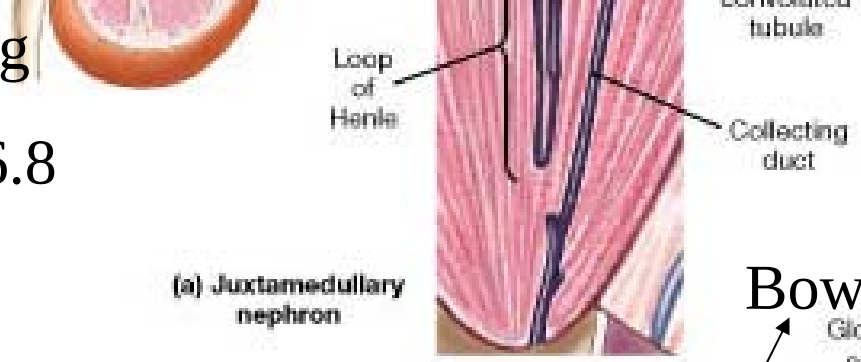
- The functional unit of the kidney
- 1.25 million nephrons per kidney
- Urine is formed in the nephrons

- The blood is filtered to remove wastes, toxins, & ions inside the nephrons

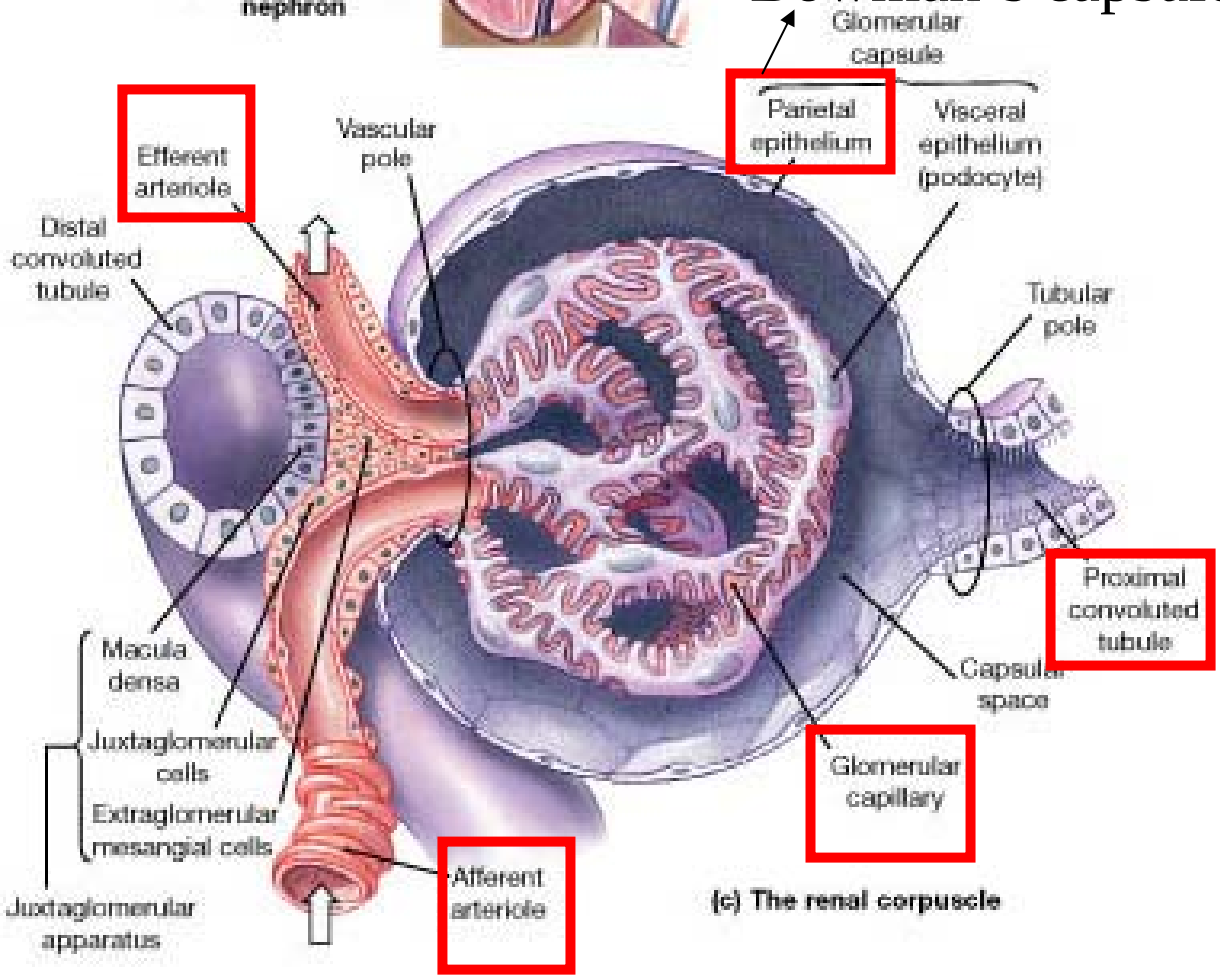
- Glomerulus is a cluster of capillaries inside the nephron
- Blood that exits the glomerulus enters the nephron to start filtration (removal of wastes)

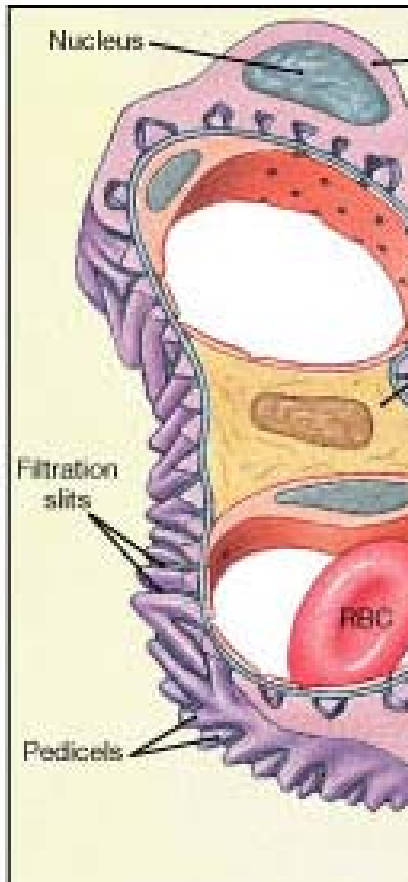
Fig

26.8



Bowman's capsule





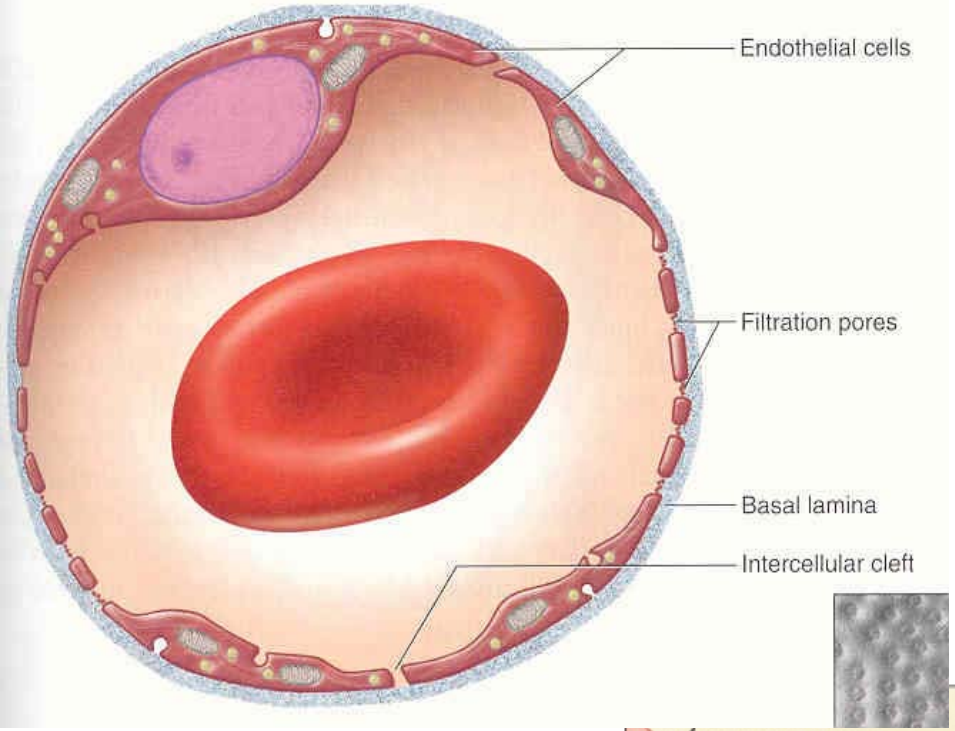
filtration

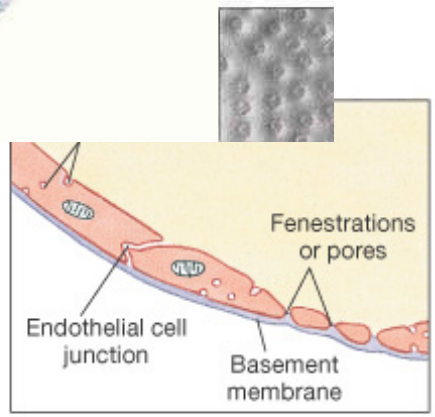
- Filtering of plasma across three layers:
- Capillary endothelium-fenestrated capilaries capillaries with pores
- Basement membrane-blocks filtering of large proteins
- Glomerular epithelium-podocytes cover most of the BM. Gaps –filtration slits

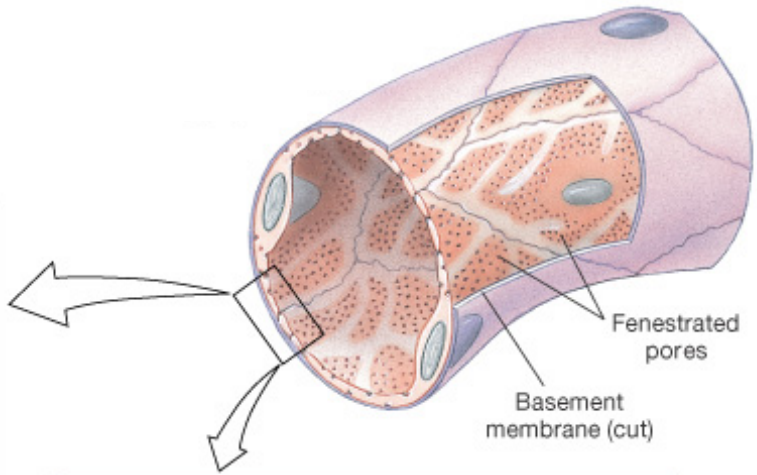
2. Fenestrated Capillary Bed

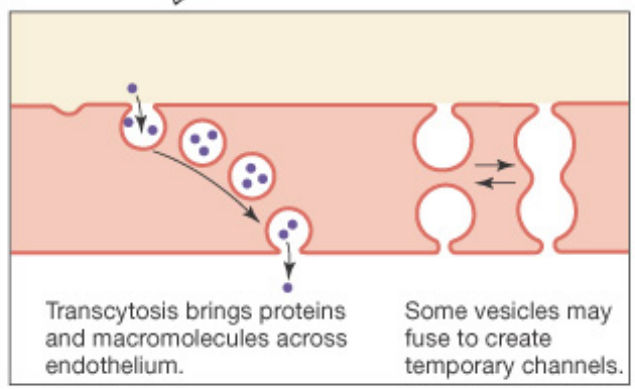
- have ‘pores’ called *fenestrations.*

- more ‘leaky’ than continuous.









- specific locations in body:
  kidney, capillaries of endocrine organs, synovial joints.

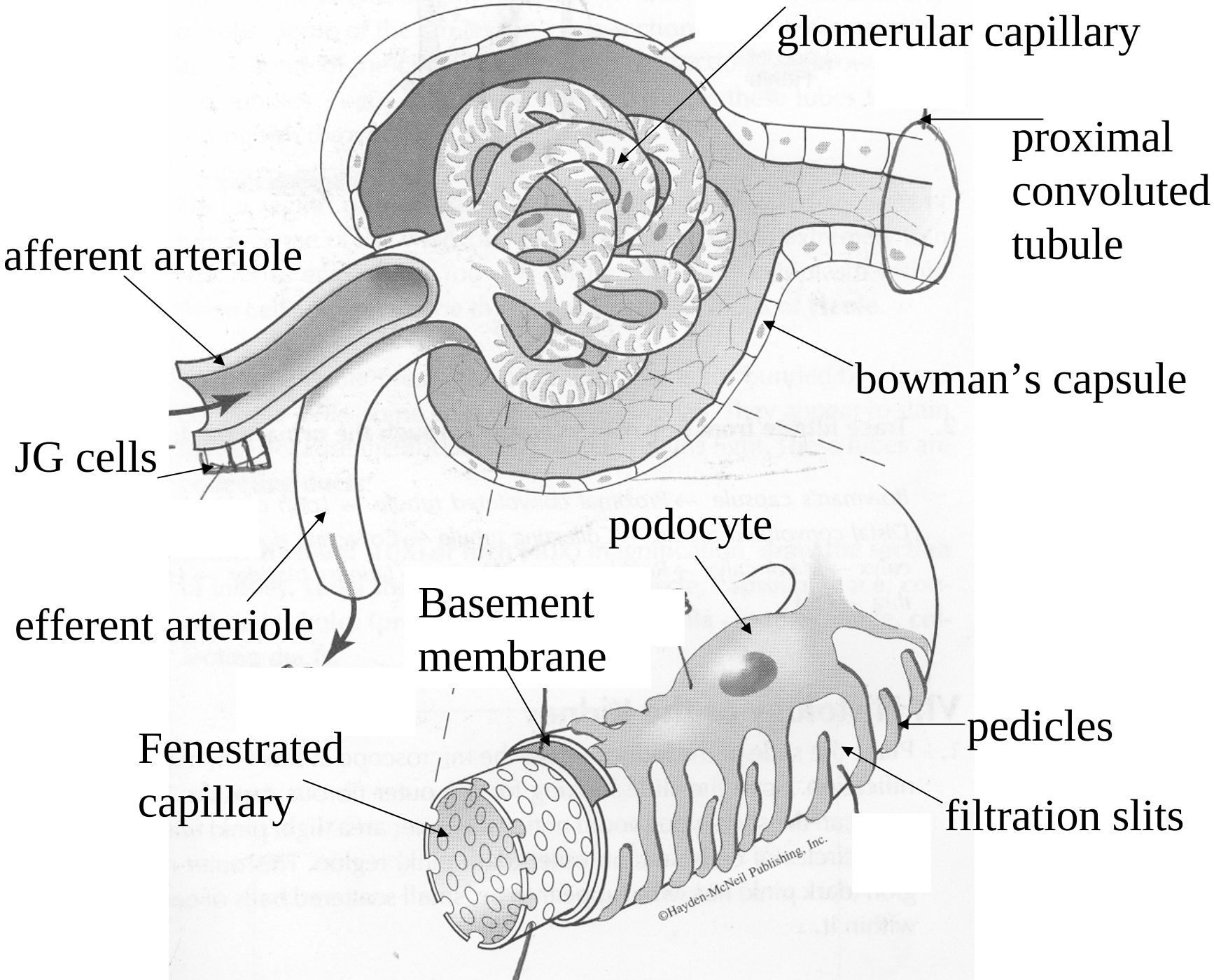

glomerular capillary
proximal convoluted tubule
afferent arteriole
bowman's capsule
JG cells
podocyte
efferent arteriole
Basement membrane
pedicles
Fenestrated capillary
filtration slits
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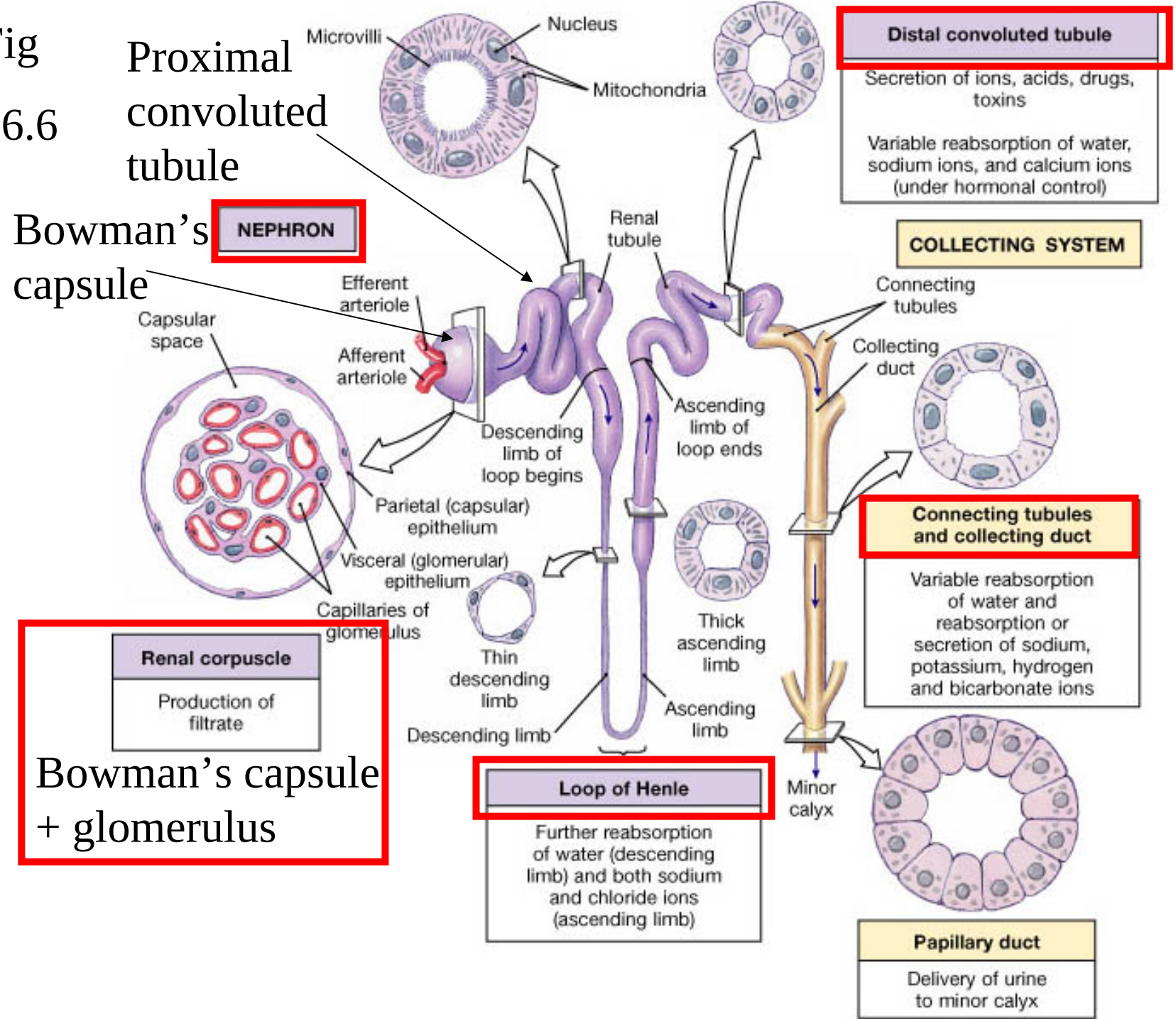
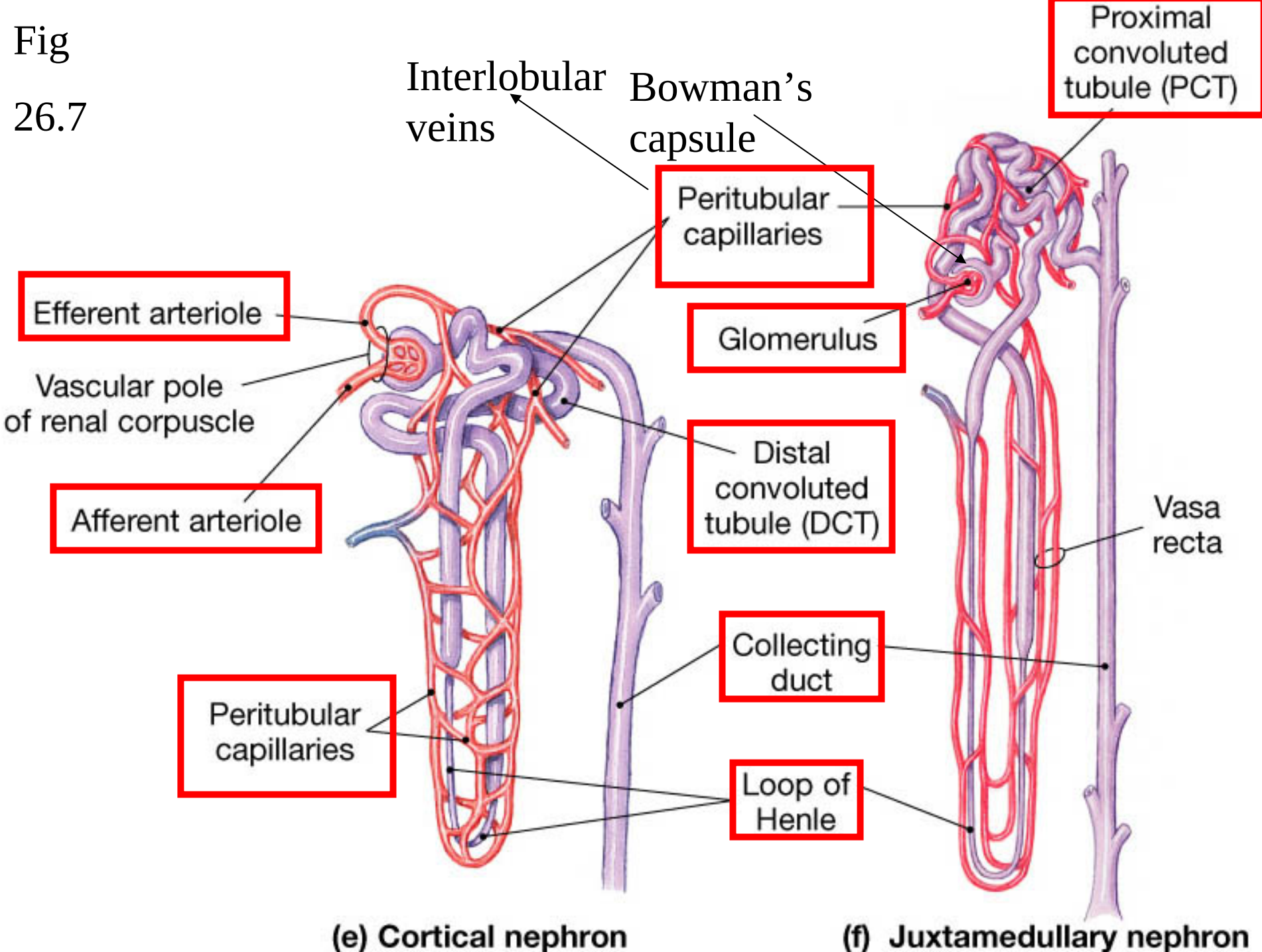
Fig 26.6


Proximal convoluted tubule
Bowman's capsule
NEPHRON
Microvilli
Nucleus
Mitochondria
Distal convoluted tubule
Secretion of ions, acids, drugs, toxins
Variable reabsorption of water, sodium ions, and calcium ions (under hormonal control)
Renal tubule
COLLECTING SYSTEM
Efferent arteriole
Afferent arteriole
Capsular space
Connecting tubules
Collecting duct
Ascending limb of loop ends
Descending limb of loop begins
Parietal (capsular) epithelium
Visceral (glomerular) epithelium
Capillaries of glomerulus
Connecting tubules and collecting duct
Variable reabsorption of water and reabsorption or secretion of sodium, potassium, hydrogen and bicarbonate ions
Thick ascending limb
Thin descending limb
Ascending limb
Descending limb
Renal corpuscle
Production of filtrate
Bowman's capsule + glomerulus
Loop of Henle
Further reabsorption of water (descending limb) and both sodium and chloride ions (ascending limb)
Minor calyx
Papillary duct
Delivery of urine to minor calyx

Fig

26.7


Interlobular veins
Bowman's capsule
Proximal convoluted tubule (PCT)
Peritubular capillaries
Efferent arteriole
Glomerulus
Vascular pole of renal corpuscle
Distal convoluted tubule (DCT)
Afferent arteriole
Vasa recta
Collecting duct
Peritubular capillaries
Loop of Henle
(e) Cortical nephron
(f) Juxtamedullary nephron

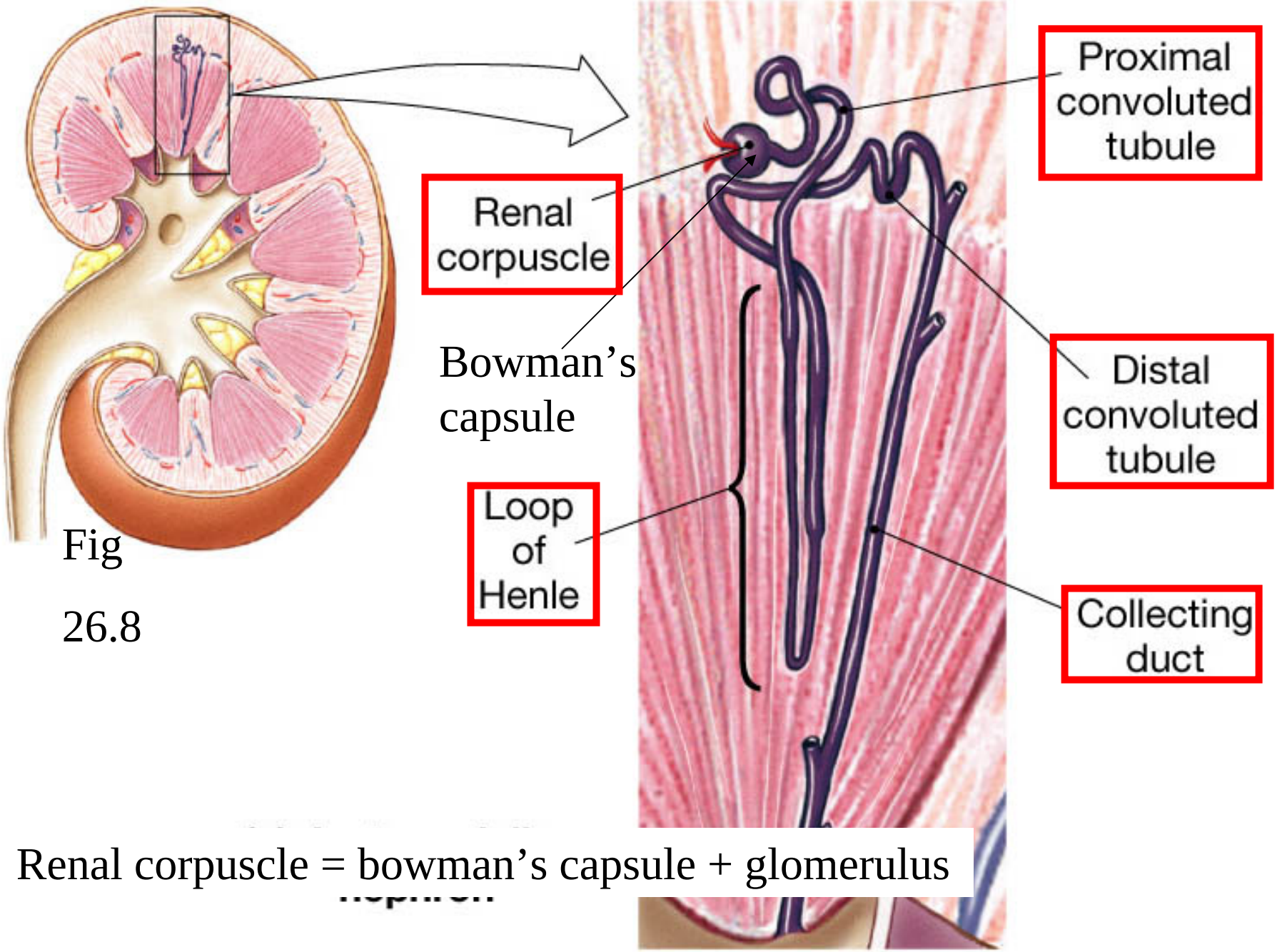
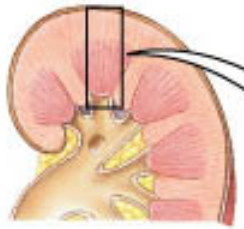


Fig 26.8

Renal corpuscle = bowman's capsule + glomerulus

Fig

26.7

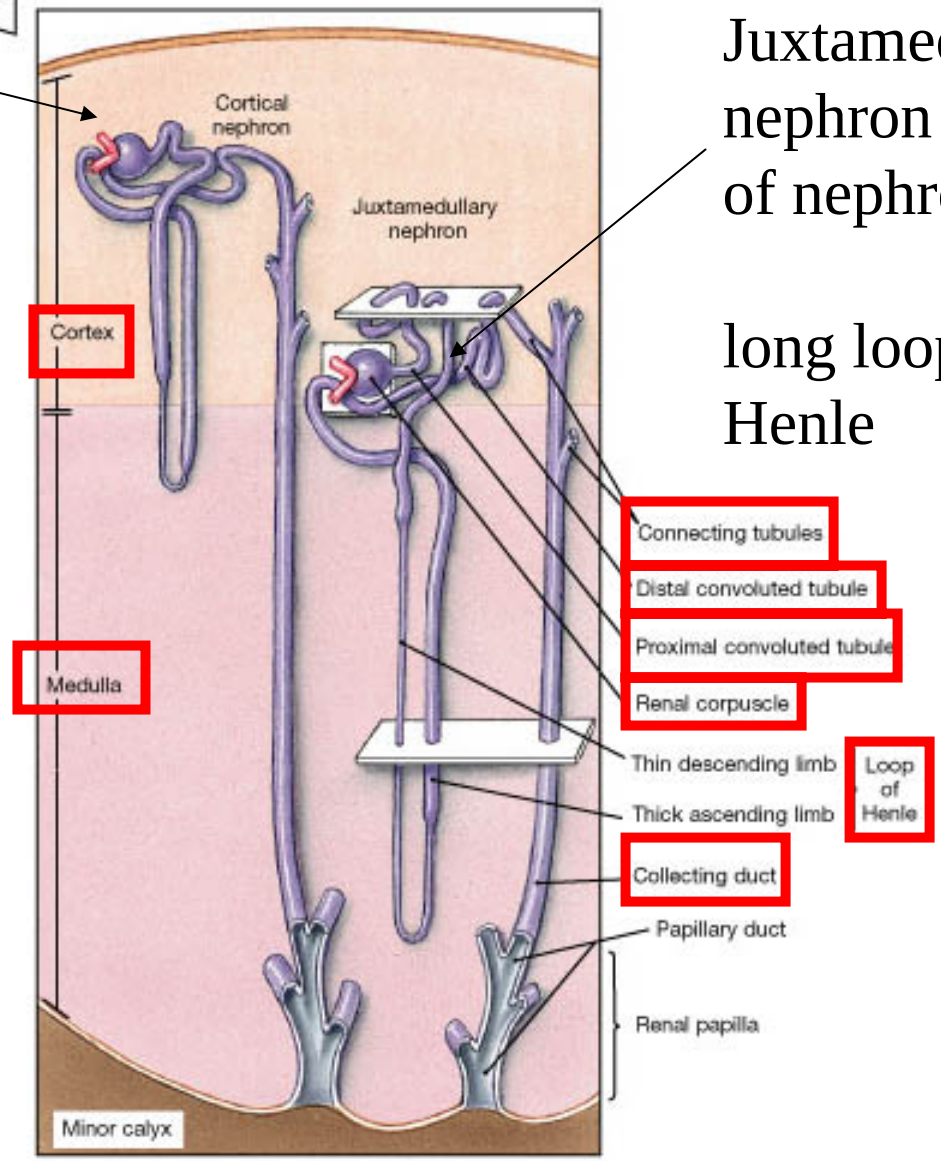


Cortical nephron

85% of nephrons

short loop of Henele

Majority of reabsorption occurs at the proximal convoluted tubule have microvilli



(a) Cortical and juxtamedullary nephrons

Juxtamedullary nephron 15% of nephrons

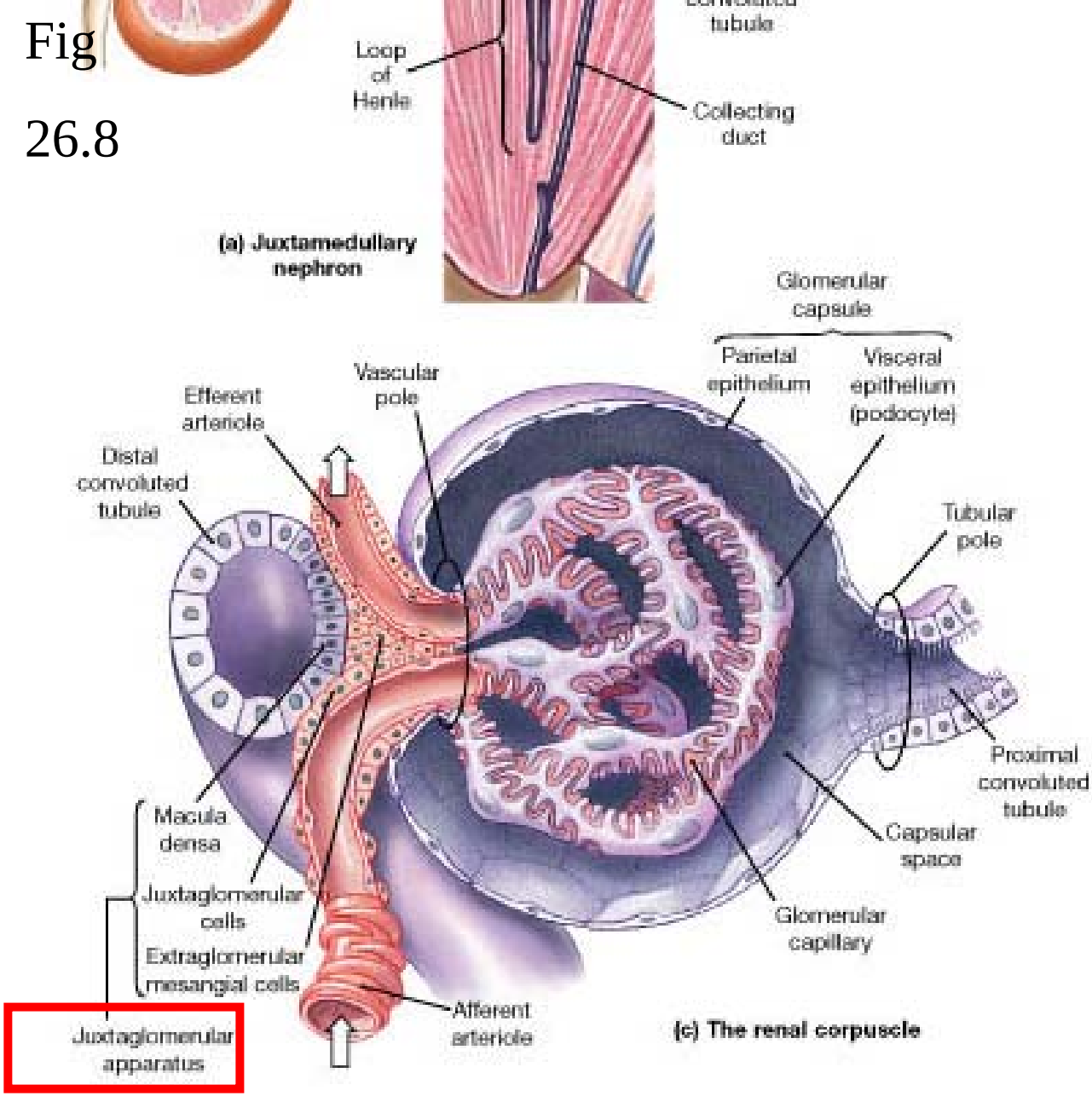
long loop of Henle

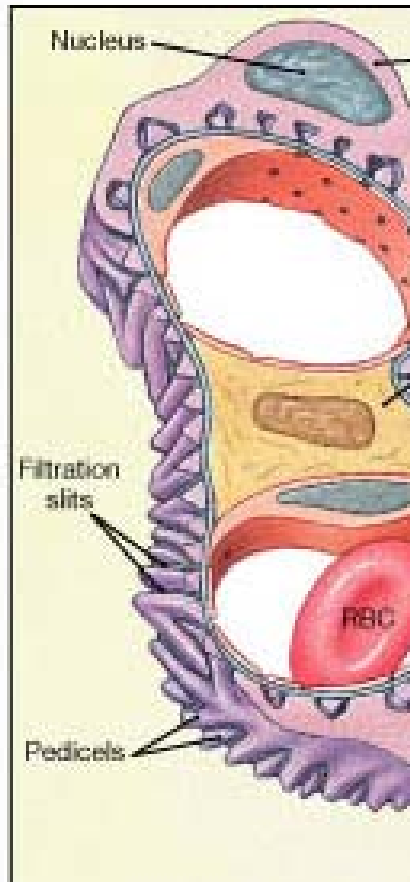
Juxtaglomerular apparatus

- Releases factors that effect blood:
- Rennin-enzyme-leads to reduced urine volume
- Erythropoietin-hormone-stimulates production of erythrocytes

Fig

26.8


Loop of Henle
Collecting duct
(a) Juxtamedullary nephron
Glomerular capsule
Parietal epithelium
Visceral epithelium (podocyte)
Vascular pole
Efferent arteriole
Distal convoluted tubule
Tubular pole
Proximal convoluted tubule
Macula densa
Juxtaglomerular cells
Extraglomerular mesangial cells
Juxtaglomerular apparatus
Capsular space
Glomerular capillary
Afferent arteriole
(c) The renal corpuscle


Nucleus
Filtration slits
RBC
Pedicels

Not a tracing to memorize!

- Aorta
- Renal artery
- Segmental artery
- Lobar artery
- Interlobar artery
- Arcurate artery
- Interlobular artery
- Afferent arteriole
- Glomerulus → nephron
- Efferent arteriole
- Peritubular capillary network
- Interlobular vein
- Arcurate vein
- Interlobar vein
- Lobar vein
- Renal vein
- Inferior vena cava

Wastes dissolved in water form the urine in at the minor calyces

“Cleansed” blood

Remember there are about 2.5 million nephrons doing this simultaneously

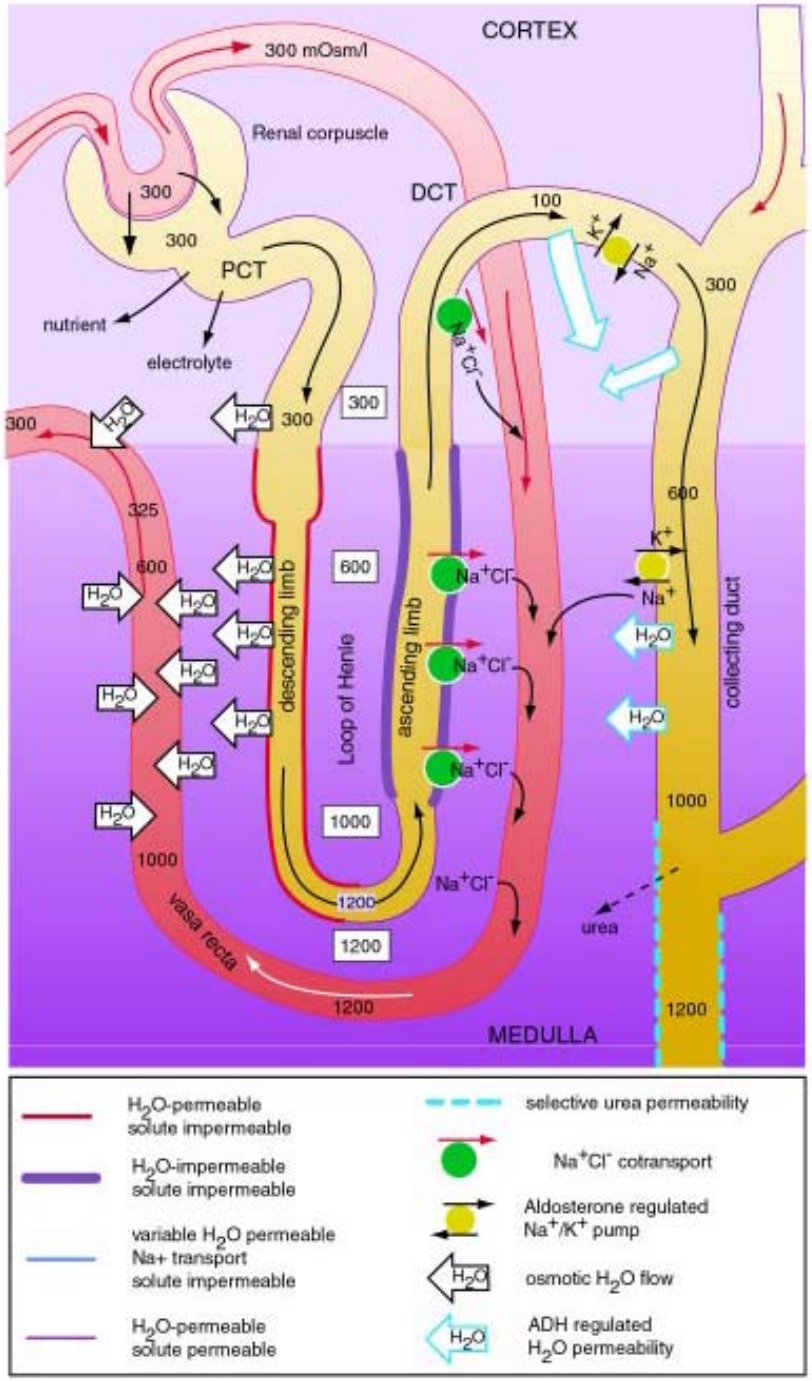
Nutrients, hormones etc. return to the cardiovascular system

Blood doping-FYI

- Taking erythropoietin to increase erythrocyte levels
  - Increase oxygen levels in the blood
- There is a another very clever way to do this.

Kidney physiology-FYI

- Filtration-glomerulus to bowmans capsule
- Secretion-capillaries to nephron
- Reabsorbtion-nephron to blood
- Excretion-nephron to minor calyx

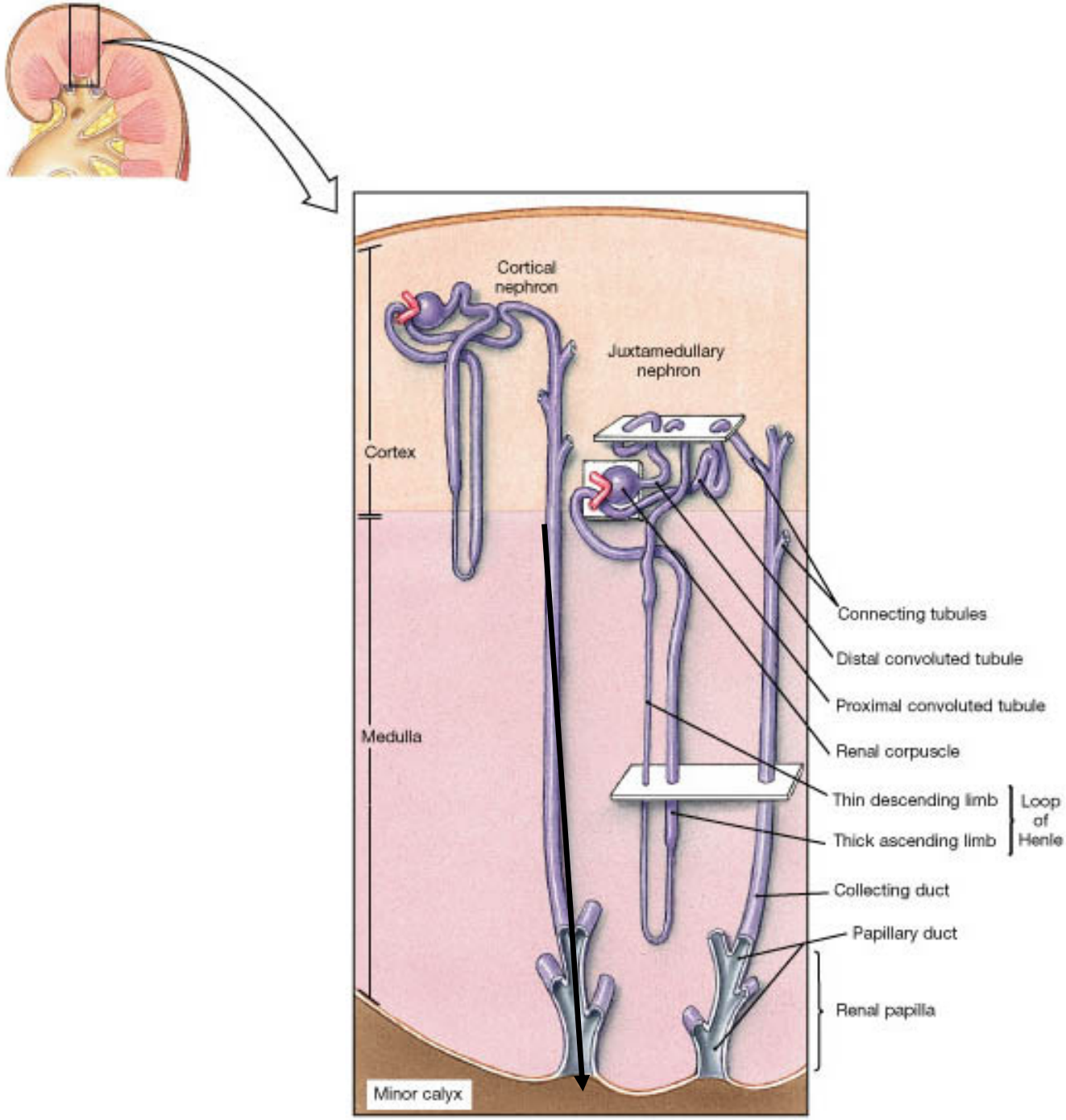


FYI

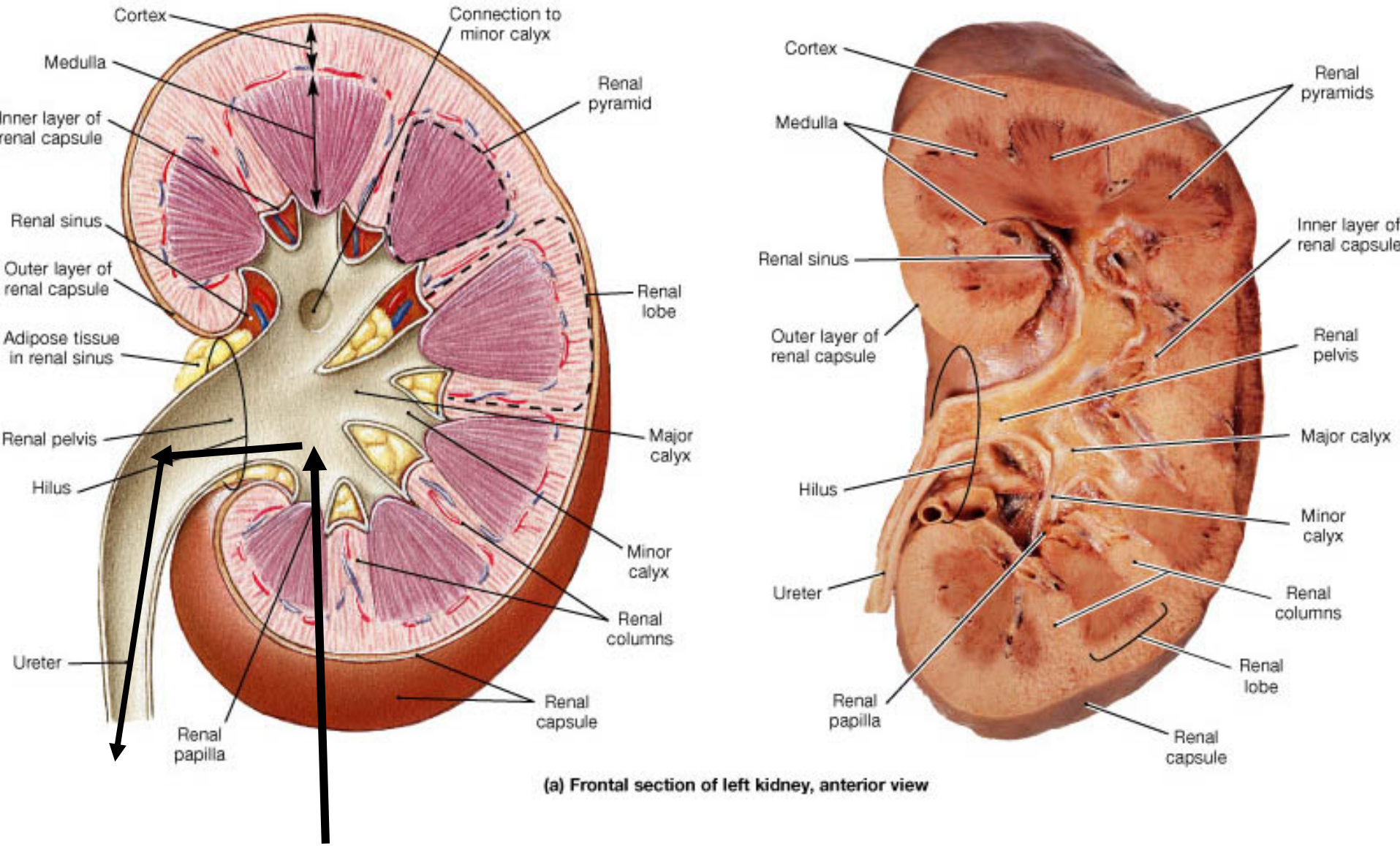
- Kidney failure-kidney no loner function to remove toxins from the blood
  - Uremia-toxicity of the blood
- Dialysis- a machine that does the function of the kidneys
- The peritoneal membrane can be used for dialysis
- Having only one kidney is good enough but two kidneys are better than one!

ADH-antidieuretic hormone

- ADH produced in the hypothalamus
- Released by the neurohypophysis (posterior)
- Effects cells of the collecting ducts
- ADH signal these cells to reabsorb (transfer from nephron to blood) water
- Alcohol inhibits the release of ADH from the neurohypophysis causing increased urine volume



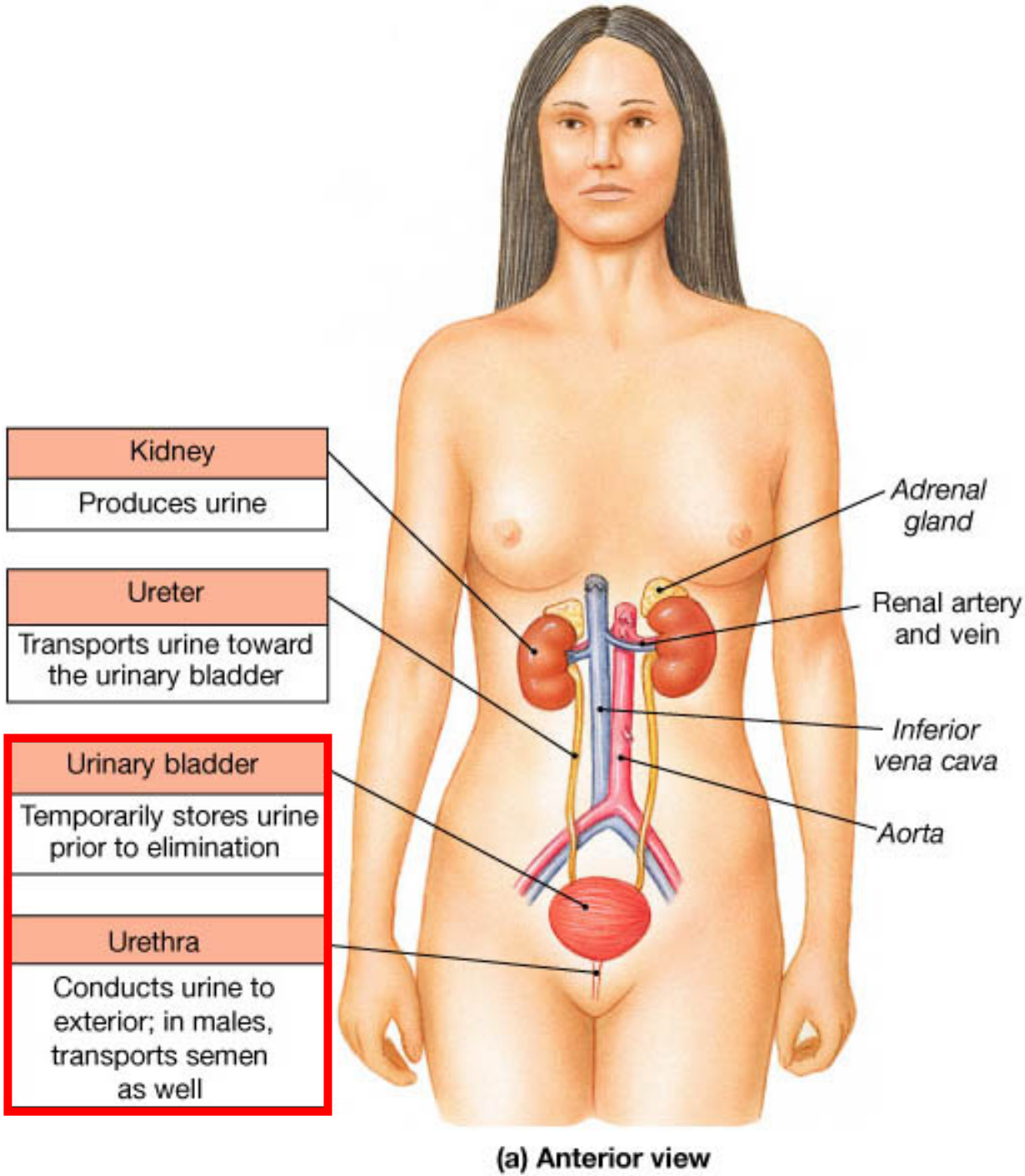
(a) Cortical and juxtamedullary nephrons



(a) Frontal section of left kidney, anterior view

Fig

26.1


Kidney
Produces urine
Ureter
Transports urine toward the urinary bladder
Urinary bladder
Temporarily stores urine prior to elimination
Urethra
Conducts urine to exterior; in males, transports semen as well
Adrenal gland
Renal artery and vein
Inferior vena cava
Aorta
(a) Anterior view

Ureters-

- 12 inches long
- descend from Renal Pelvis to bladder
- opens to bladder in a posterior-lateral side
- enter bladder through slit-like orifice (membrane covered)
  - open when relaxed
  - closed when bladder muscles contract
- Transitional epithelium in musoca- found in areas of stretching
- strong muscular tunic actively moves urine to bladder→peristaltic contractions

Urinary Bladder-

- Hollow muscular, temporary storage organ
- Trigone- funnel-shaped region formed between 3 openings
  - Infection more common in females
- Detrusor muscles- 3 smooth muscles layers of bladder
  - 1 circular musc. Between 2 longitudinal musc.
- Micturition controlled through spinal reflex. But can overridewith somatic motor!

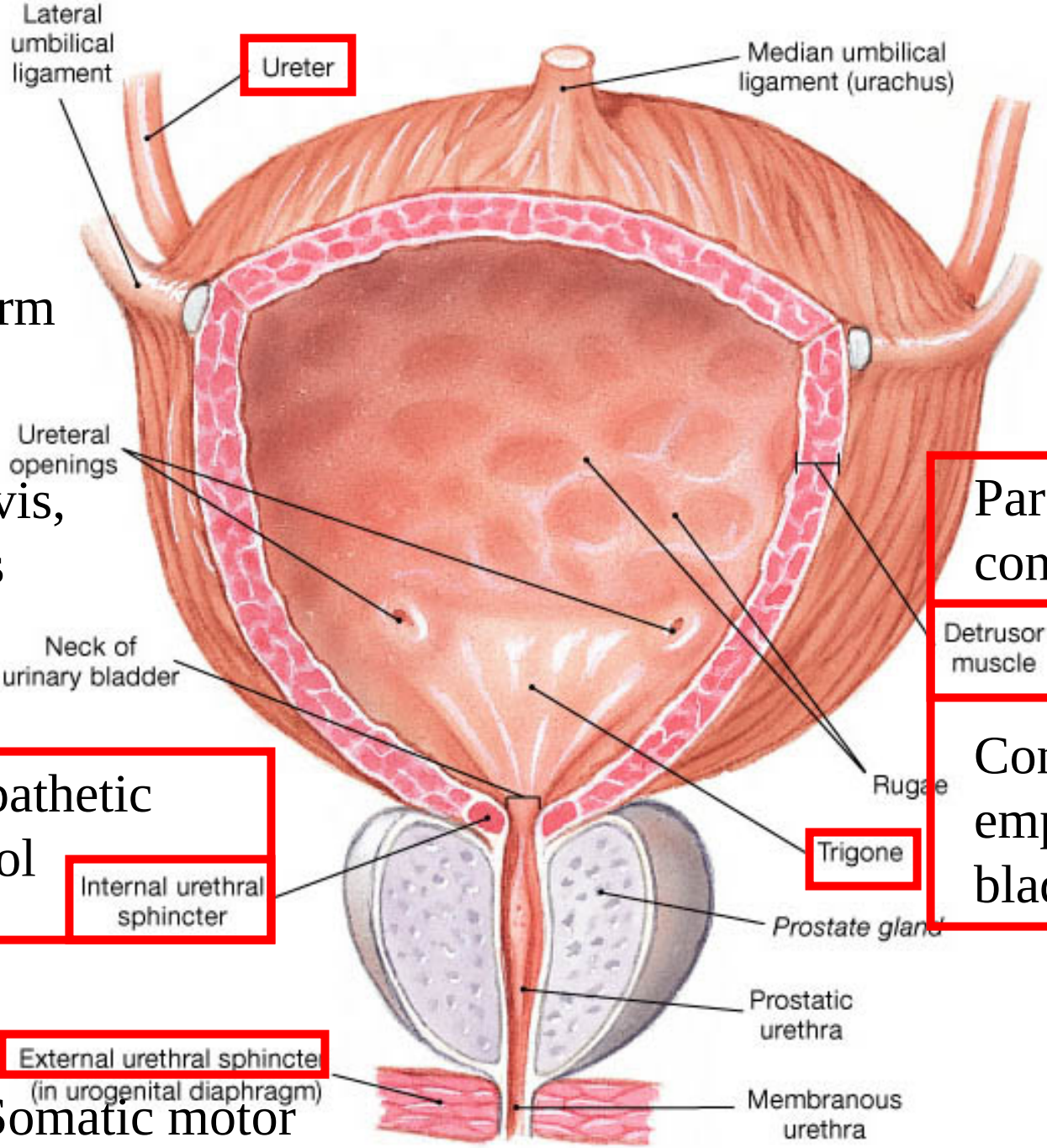
Urethra-

- Controlled by sphincter muscles
- Involuntary → Internal urethral sphincter (smooth muscle)
- Voluntary → External urethral sphincter (skeletal muscle)
- Female 1-1 ½ inches-urinary organ
- male 7-8 inches (three regions)-reproductive and urinary organ

Fig

26.10

Kidney stones form in the calyces, renal pelvis, & ureters



(c) Male bladder, anterior view

Sympathetic control

Parasympathetic control

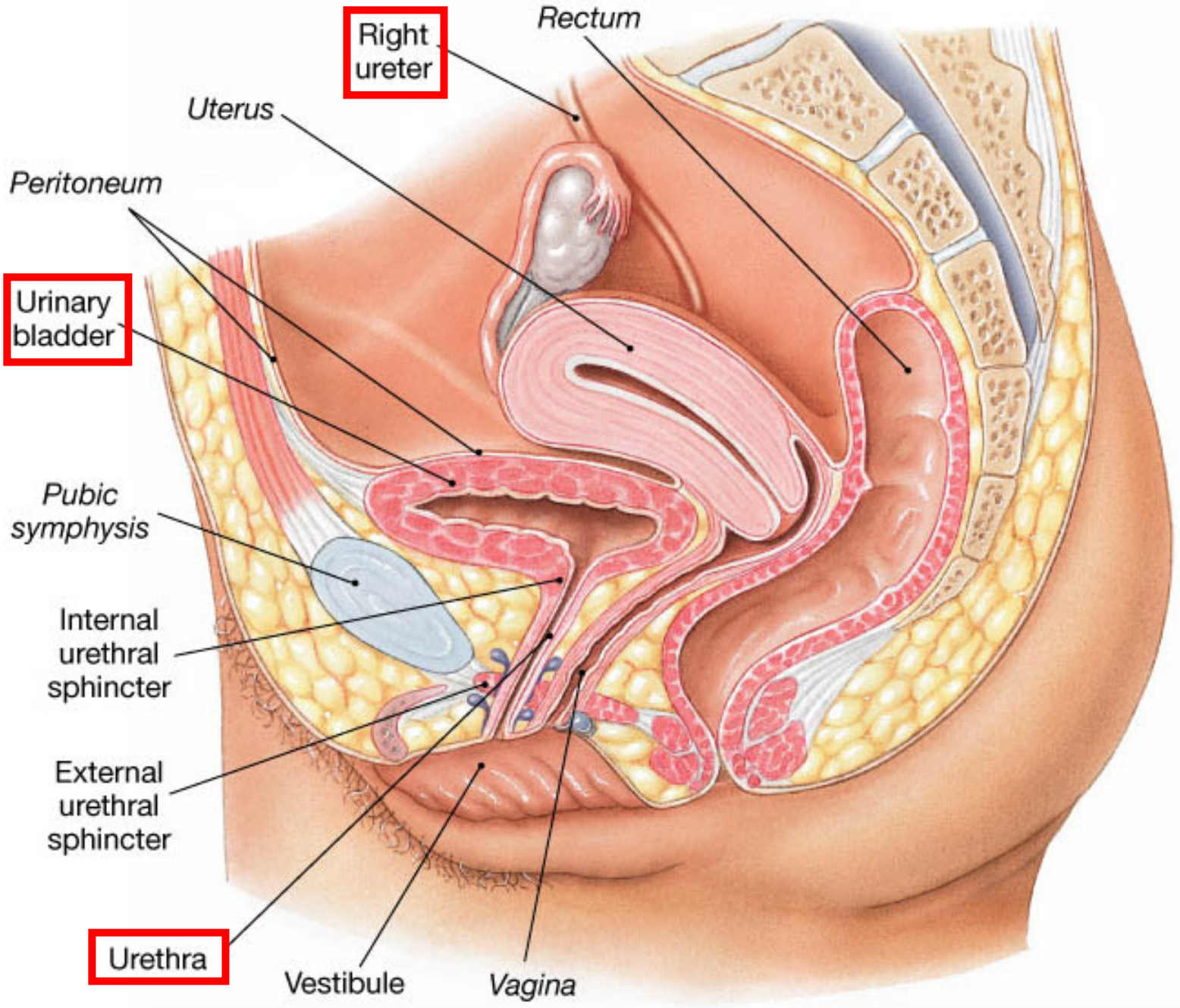
Detrusor muscle

Contracts to empty urinary bladder

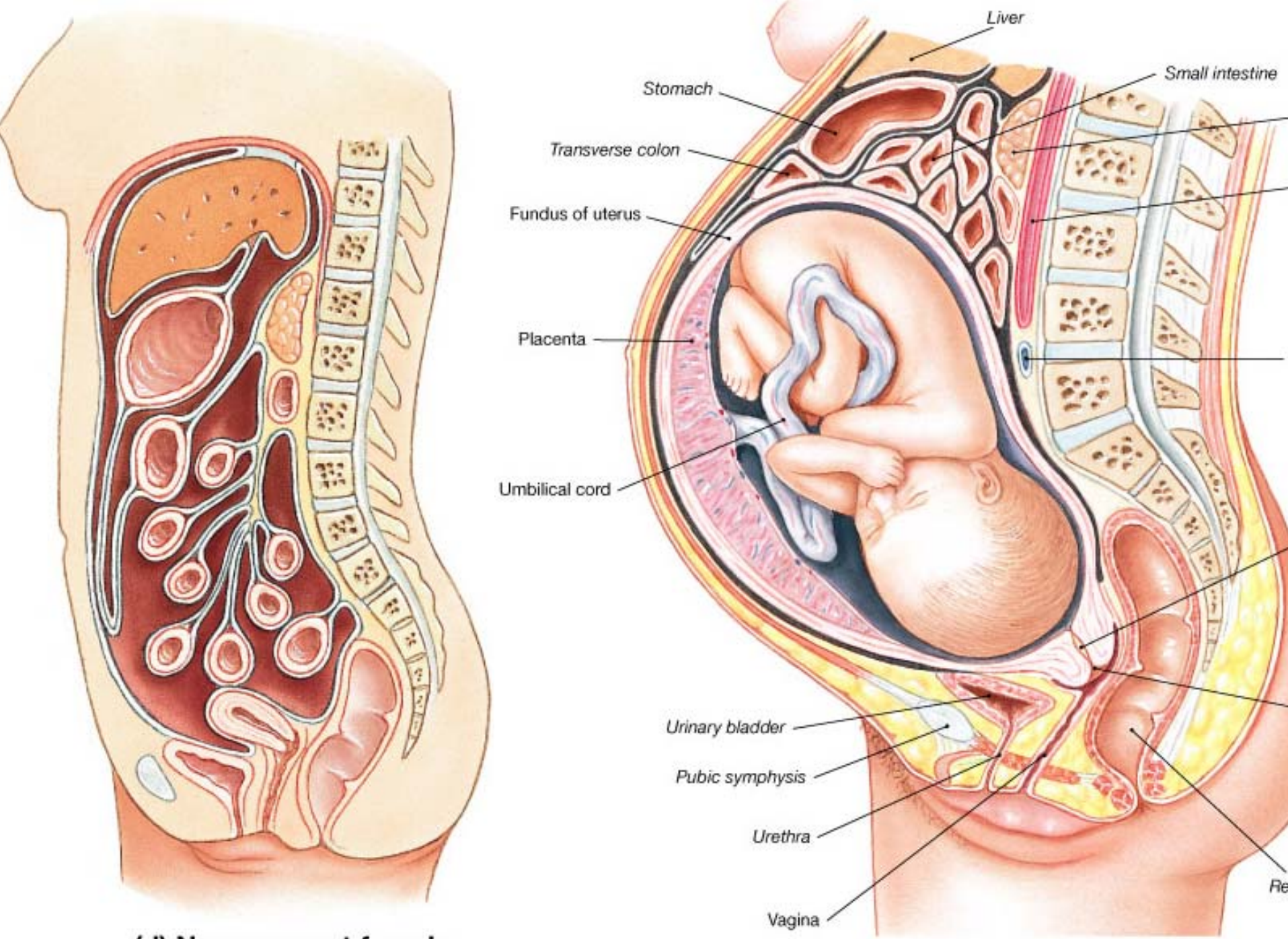
Somatic motor

Fig

26.10



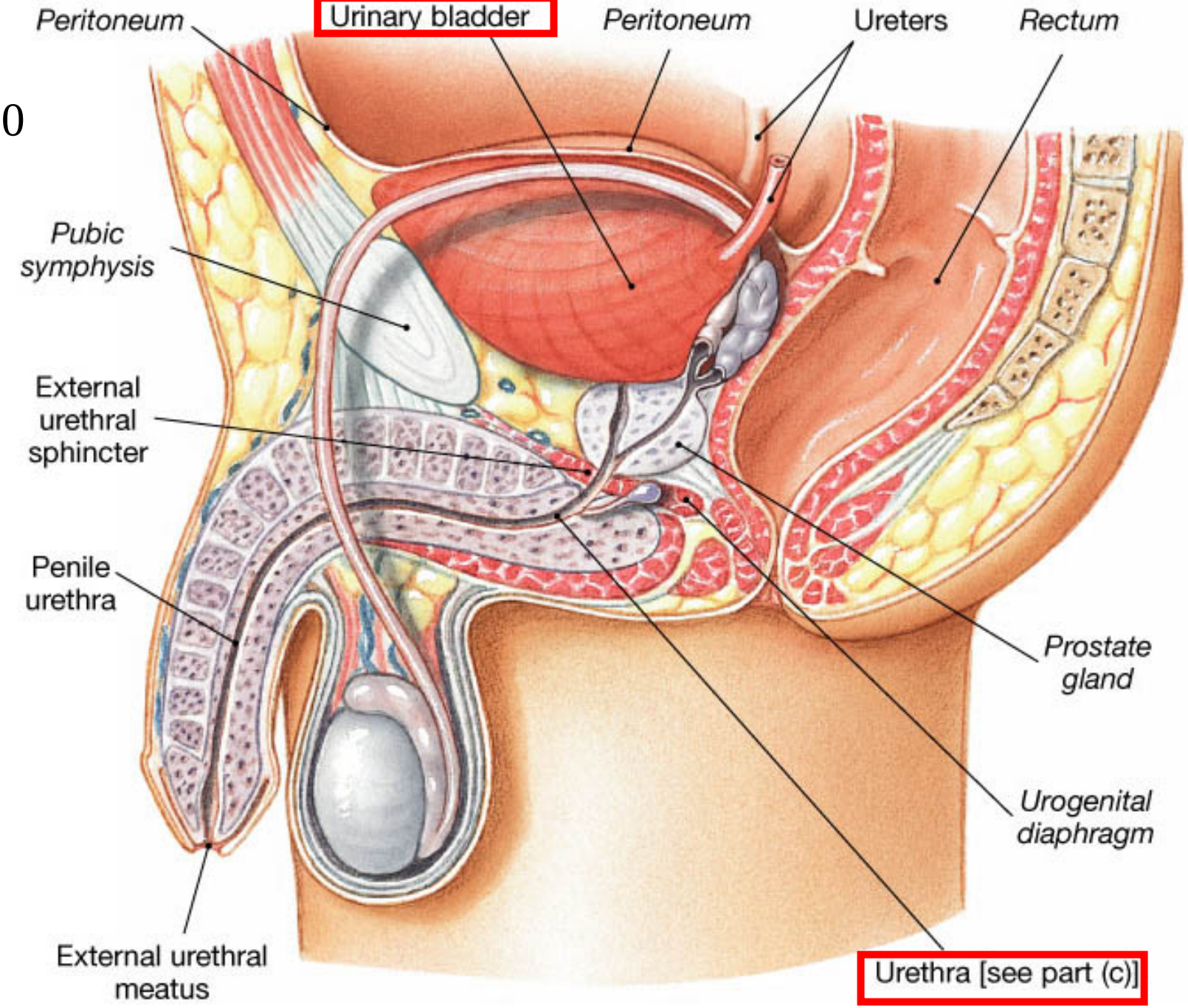
(b) Female pelvis, sagittal section



(d) Nonpregnant female

(c) Pregnancy at full term

Fig 26.10



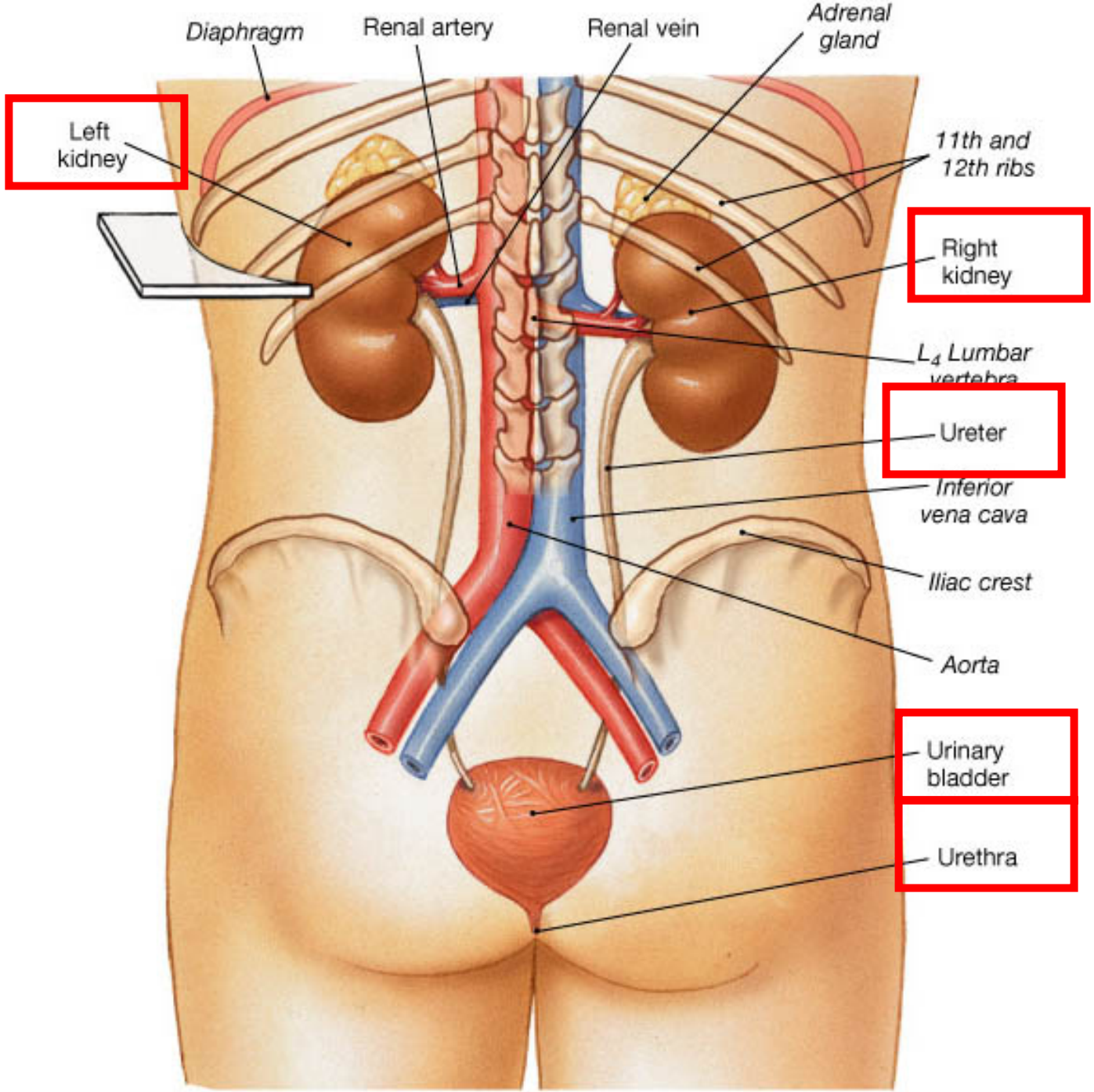
(a) Male pelvis, sagittal section

Substance	Amount filtered per day	Amount excreted per day	Percent reabsorbed
Water	180L	1.8L Without ADH 6X	99
Sodium-ion	630g	3.2g	99.5
Glucose-nutrient	180g	0g	100
Urea-cellular waste product	54g	30g	44 can be used to synthesize amino acids

- Break
- Histology

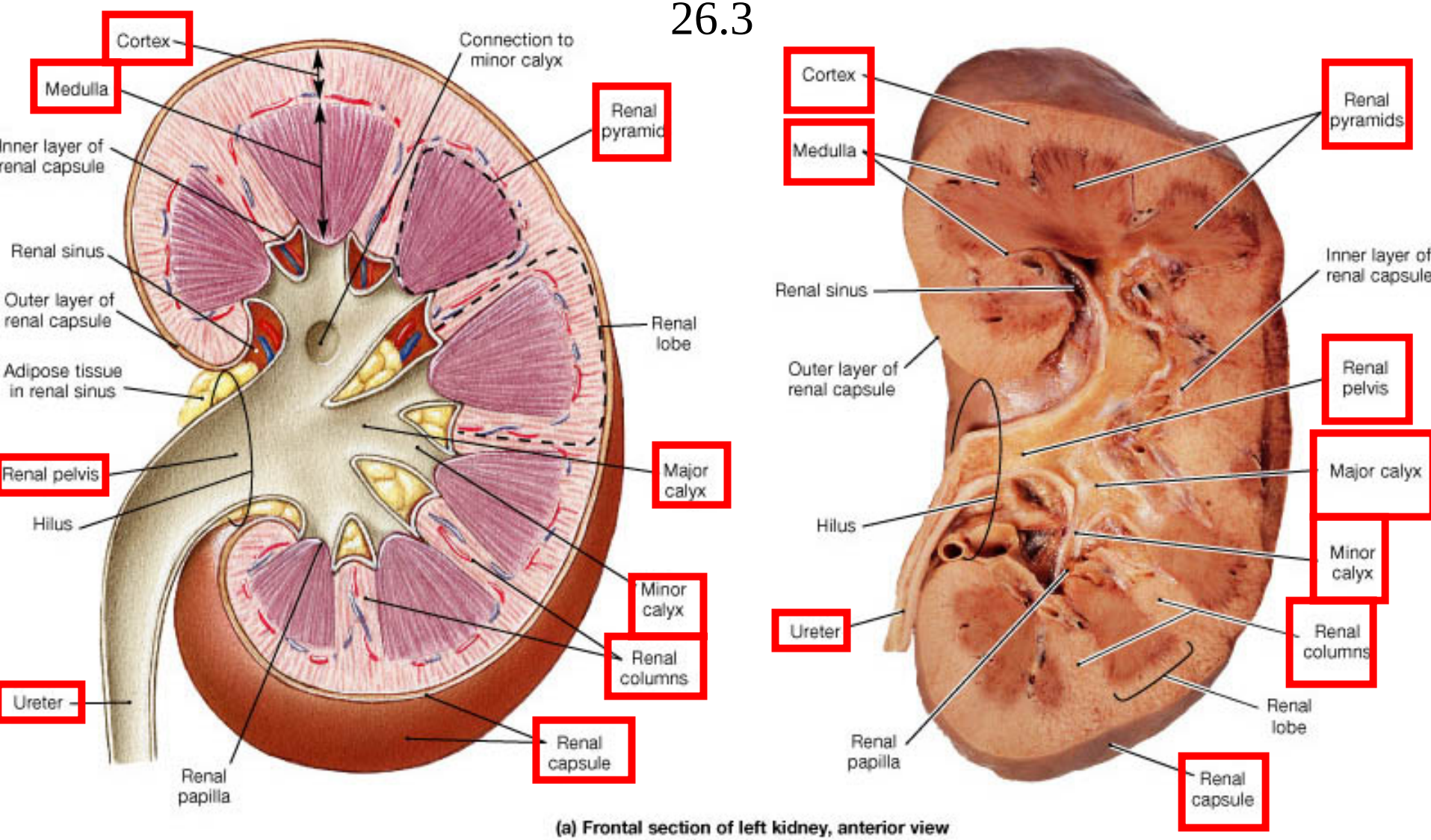
Fig

26.1



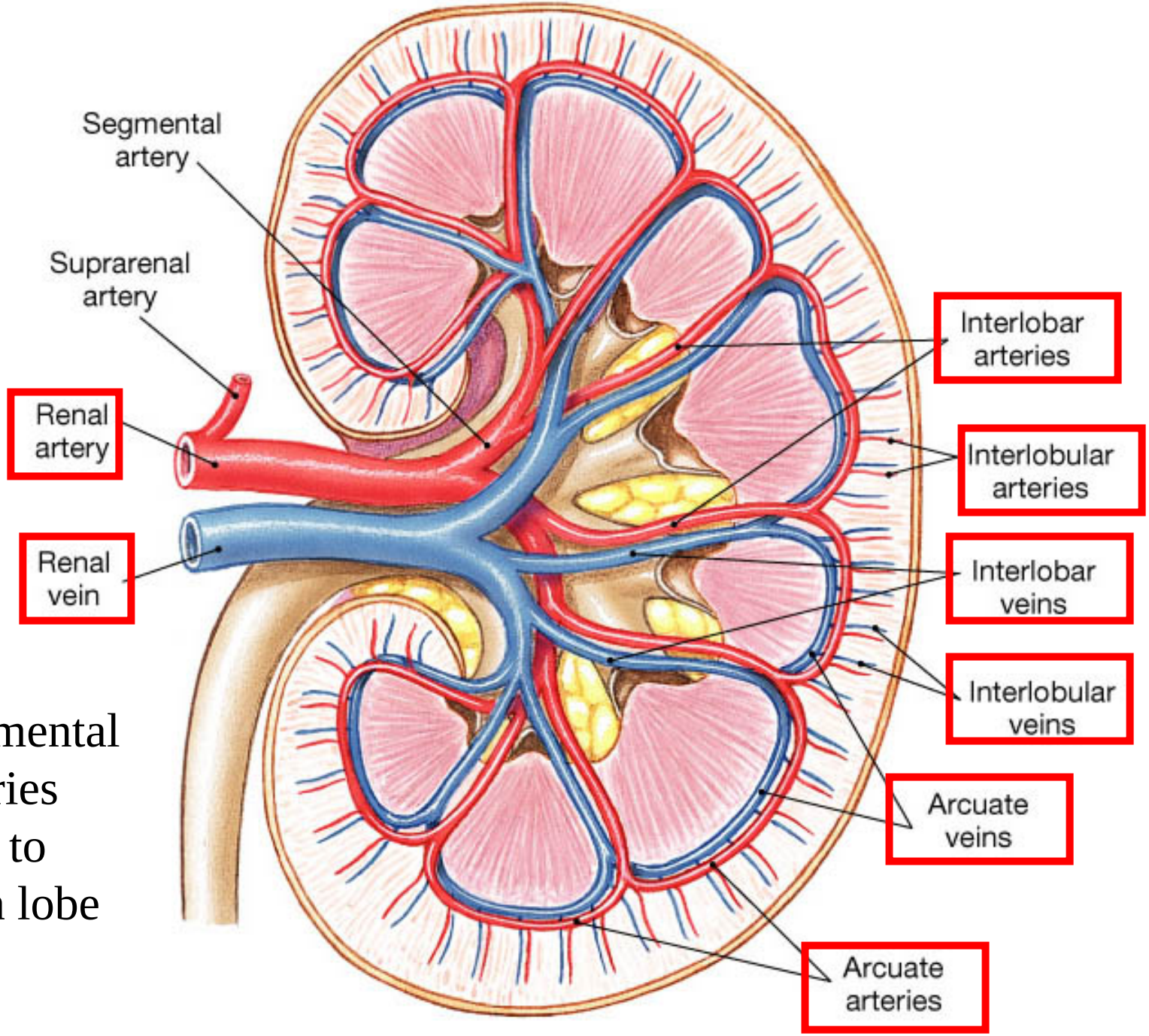
(b) Posterior view

Fig 26.3



(a) Frontal section of left kidney, anterior view

Fig 26.4

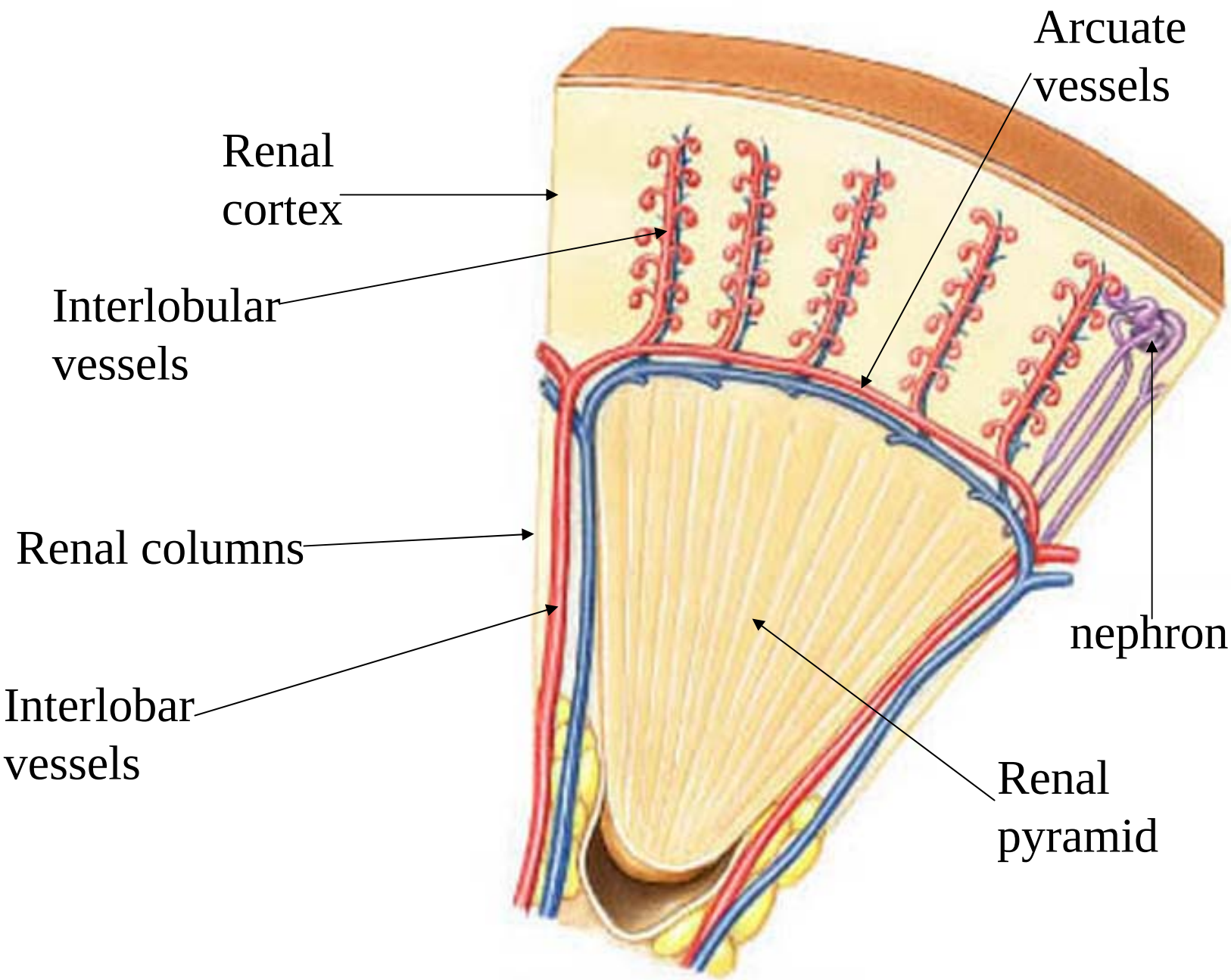


(a) Frontal section

Segmental arteries lead to each lobe

Fig

26.4


Arcuate vessels
Renal cortex
Interlobular vessels
Renal columns
Interlobar vessels
nephron
Renal pyramid
(b) Cortical circulation

- Kidney slide