

The Urinary System

Anatomy ,physiology and embryology

The Functions of Kidneys

A) ☐ Excretion & Elimination:

removal of organic wastes products from body fluids
(urea, creatinine, uric acid)

B) ☐ Homeostatic regulation:

Water -Salt Balance

Acid - base Balance

C) ☐ Endocrine function:

Productions of some hormones

B) Homeostatic Functions

1) Water –electrolytes balance

Regulate blood volume and blood pressure:

by adjusting volume of water lost in urine
releasing renin from the juxtaglomerular apparatus

- **Regulate plasma ion concentrations:**
 - sodium, potassium, and chloride ions (by controlling quantities lost in urine)
 - calcium ion levels

2) Acid-Base Balance (Help stabilize blood pH)

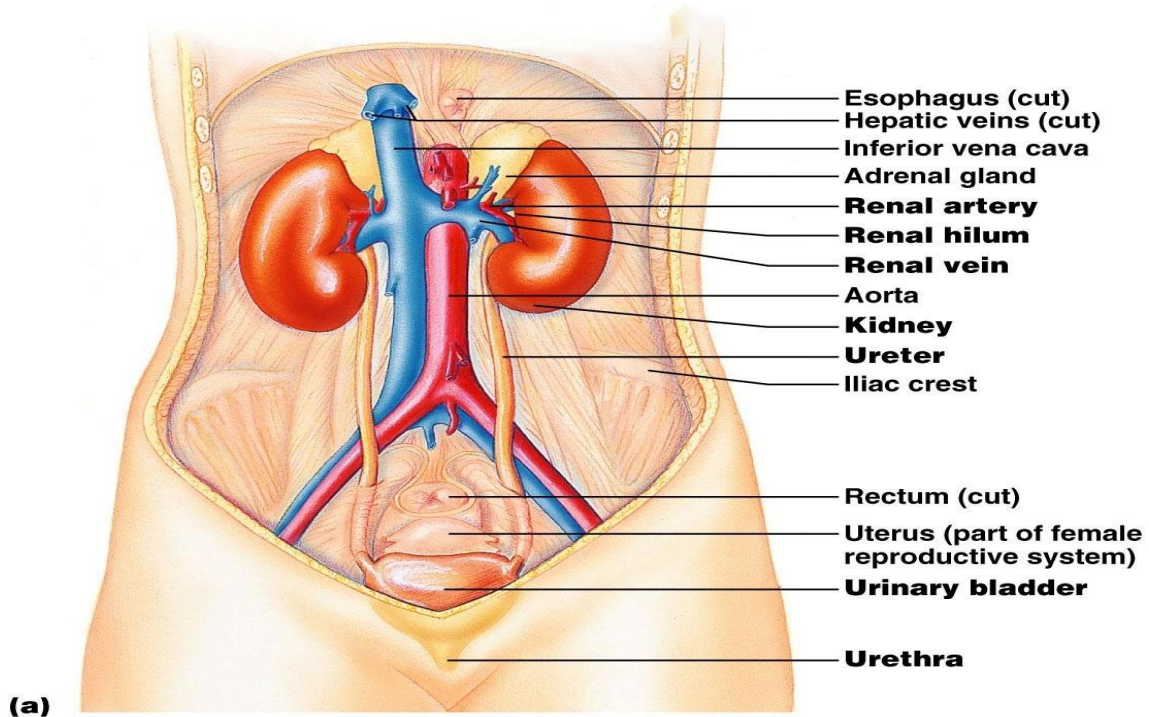
The kidneys control this by **excreting H^+ ions and reabsorbing HCO_3 (bicarbonate).**

C) The endocrine function

- Kidneys have primary endocrine function since they **produce hormones** (erythropoietin, renin and prostaglandin).
- ✓ **Erythropoietin** is secreted in response to a lowered oxygen content in the blood. It acts on bone marrow, stimulating the production of red blood cells.
- ✓ **Renin** the primary stimuli for renin release include reduction of renal perfusion pressure and hyponatremia.
Renin release is also influenced by angiotension II and ADH.
- The kidneys are primarily responsible for **producing vitamin D3**

Organs of the Urinary System

Kidneys ■
Ureters ■
Urinary bladder ■
Urethra ■



Location and External Anatomy of Kidneys

- Located **retroperitoneally**
- Lateral to T₁₂–L₃ vertebrae
- Average kidney
 - 12 cm tall, 6 cm wide, 3 cm thick
- **Hilus**
 - On concave surface
 - Vessels and nerves enter and exit
- Renal capsule surrounds the kidney

Relationship of the Kidneys to Vertebra and Ribs

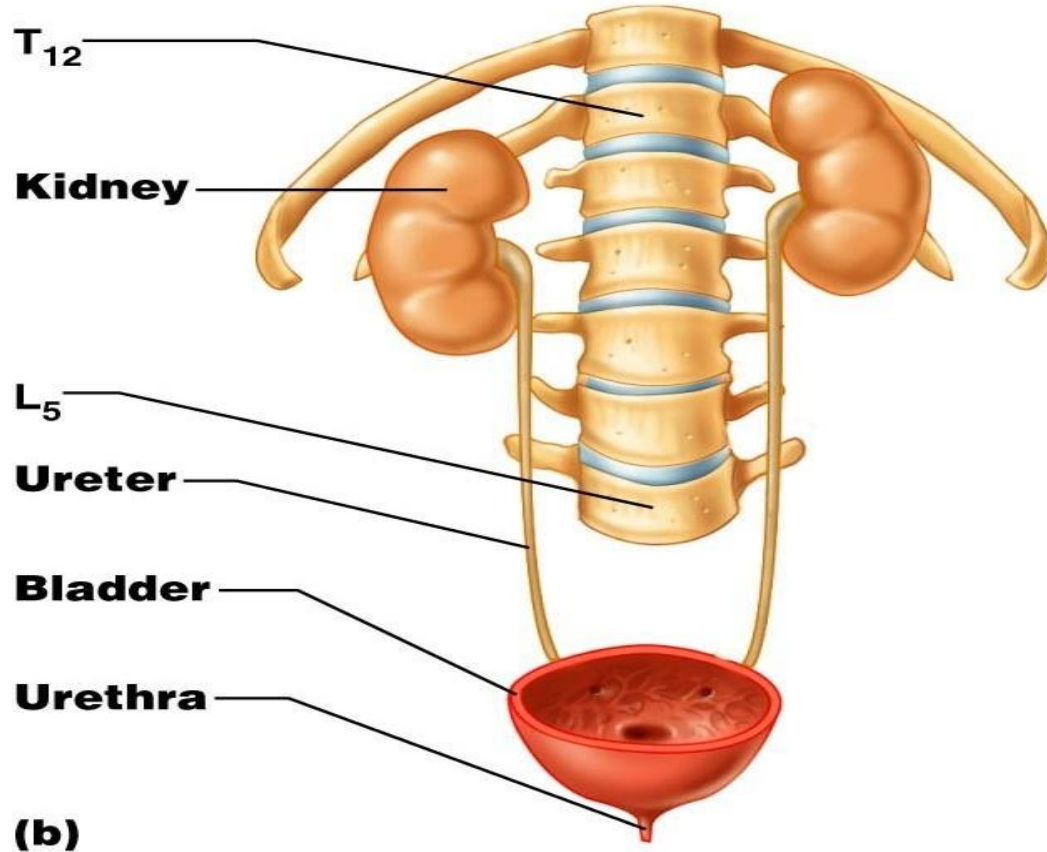


Figure 23.1b

Position of the Kidneys within the Posterior Abdominal Wall

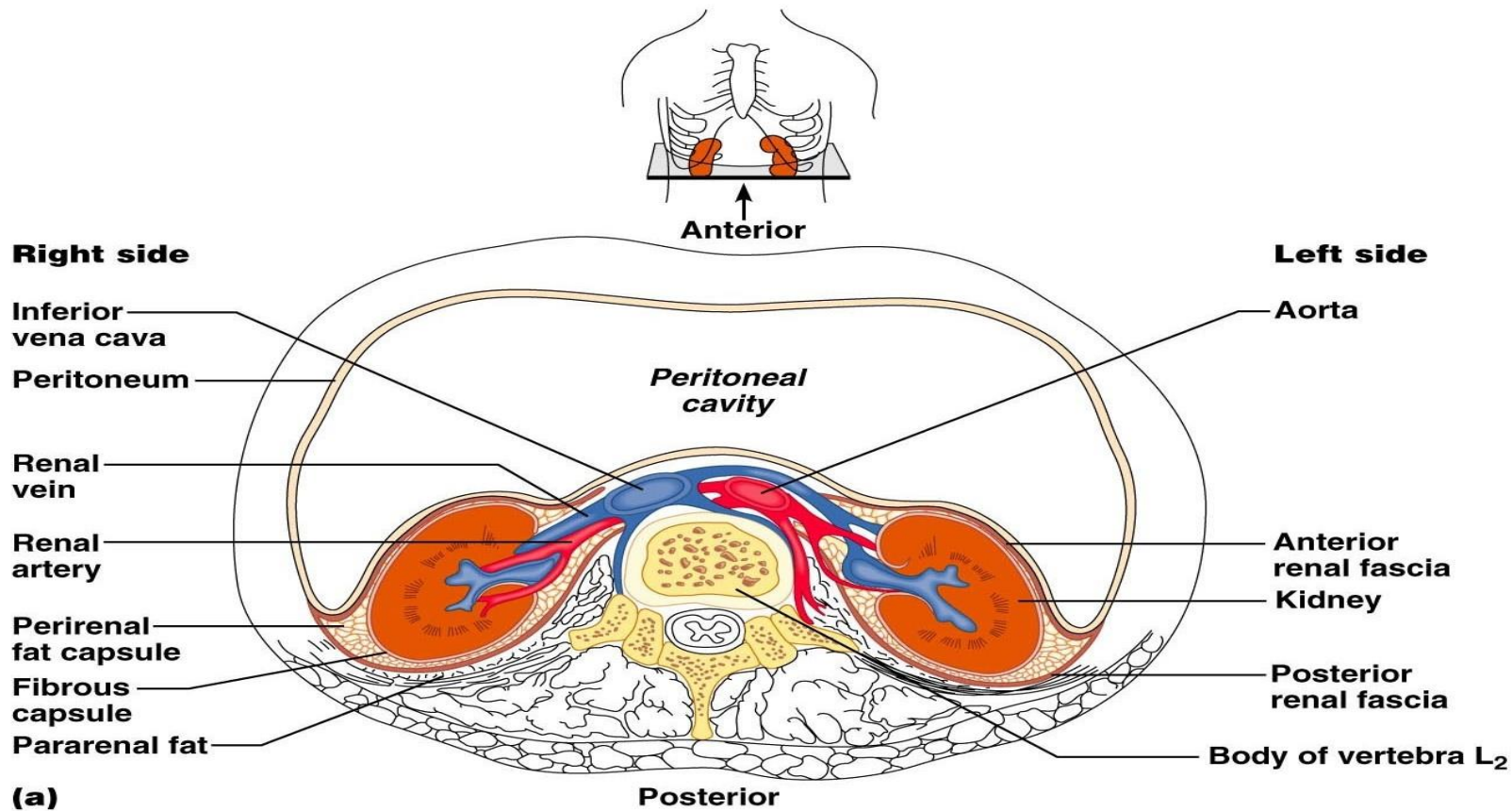
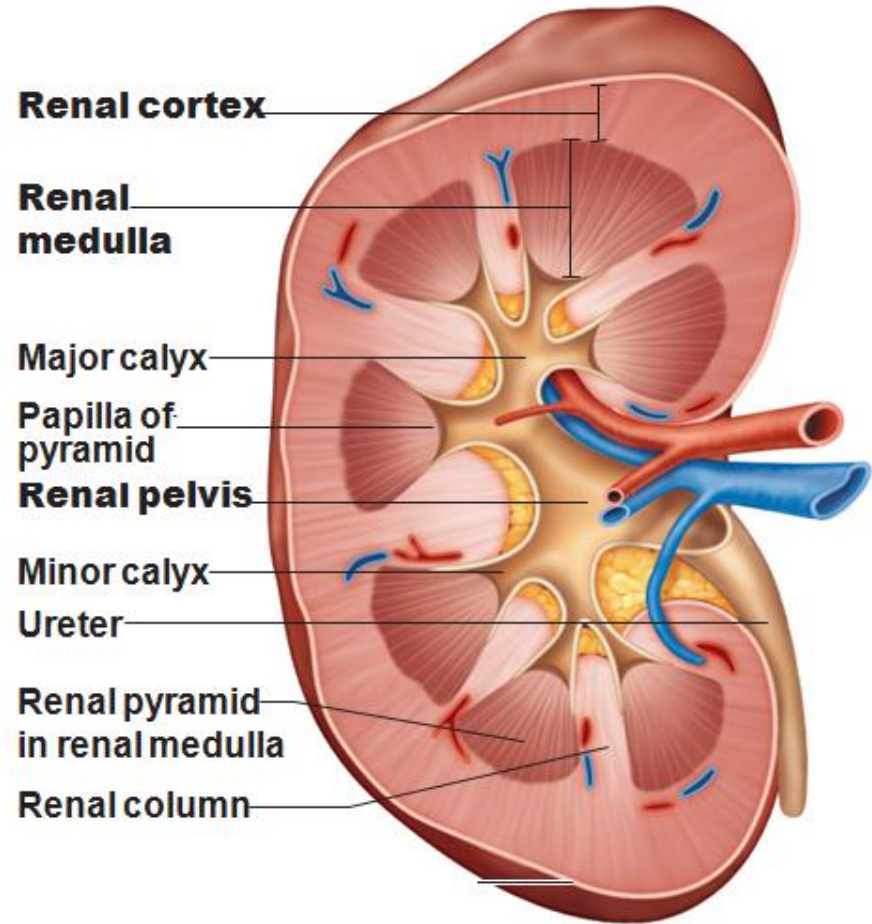


Figure 23.2a

Internal Gross Anatomy of the Kidneys

- Renal cortex
- Renal pyramids
- Renal pelvis
 - Major calices
 - Minor calices
- Gross vasculature
 - Renal arteries
 - Branch into segmental arteries



Internal Anatomy of the Kidneys

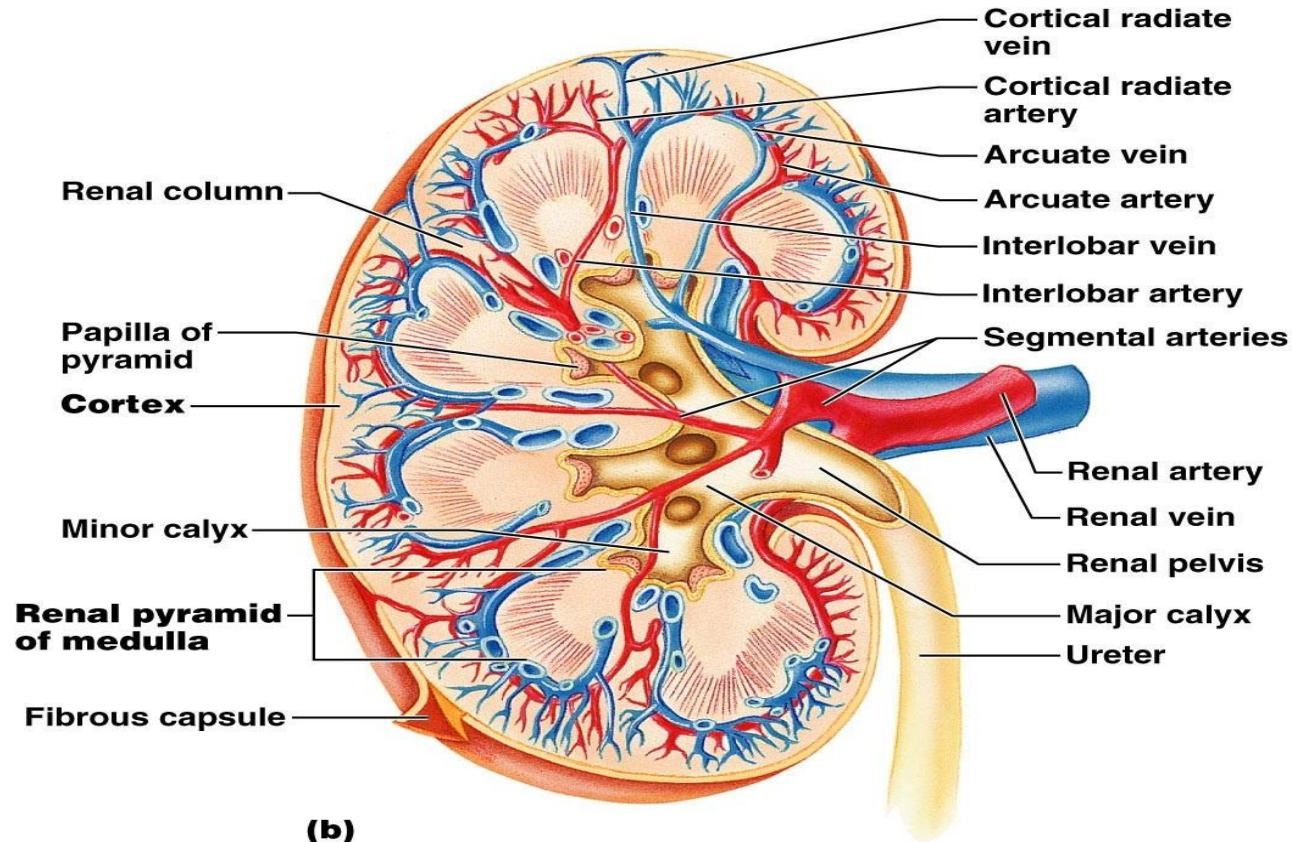


Figure 23.3b

Summary of Blood Vessels Supplying the Kidney

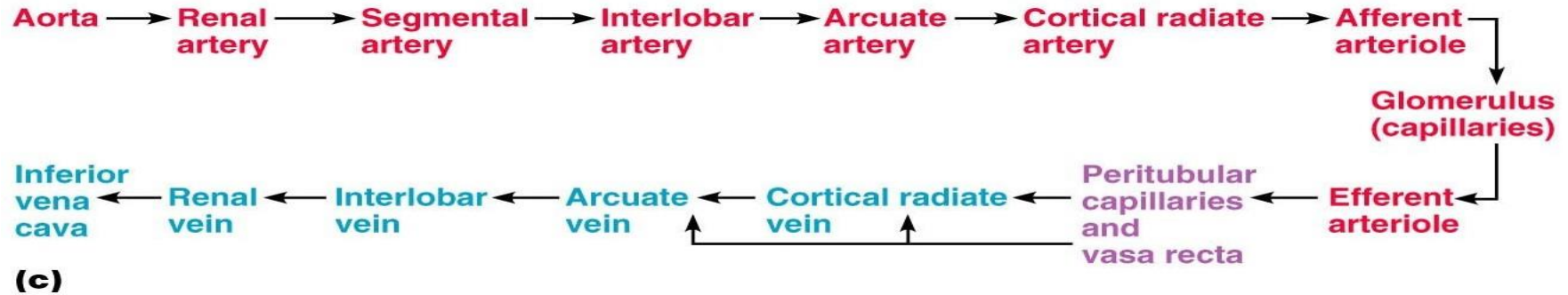


Figure 23.3c



Mechanisms of Urine Production

- **Filtration**

- Filtrate of blood leaves kidney capillaries

- **Reabsorption**

- Most nutrients, water, and essential ions reclaimed

- **Secretion**

- Active process of removing undesirable molecules

Basic Kidney Functions

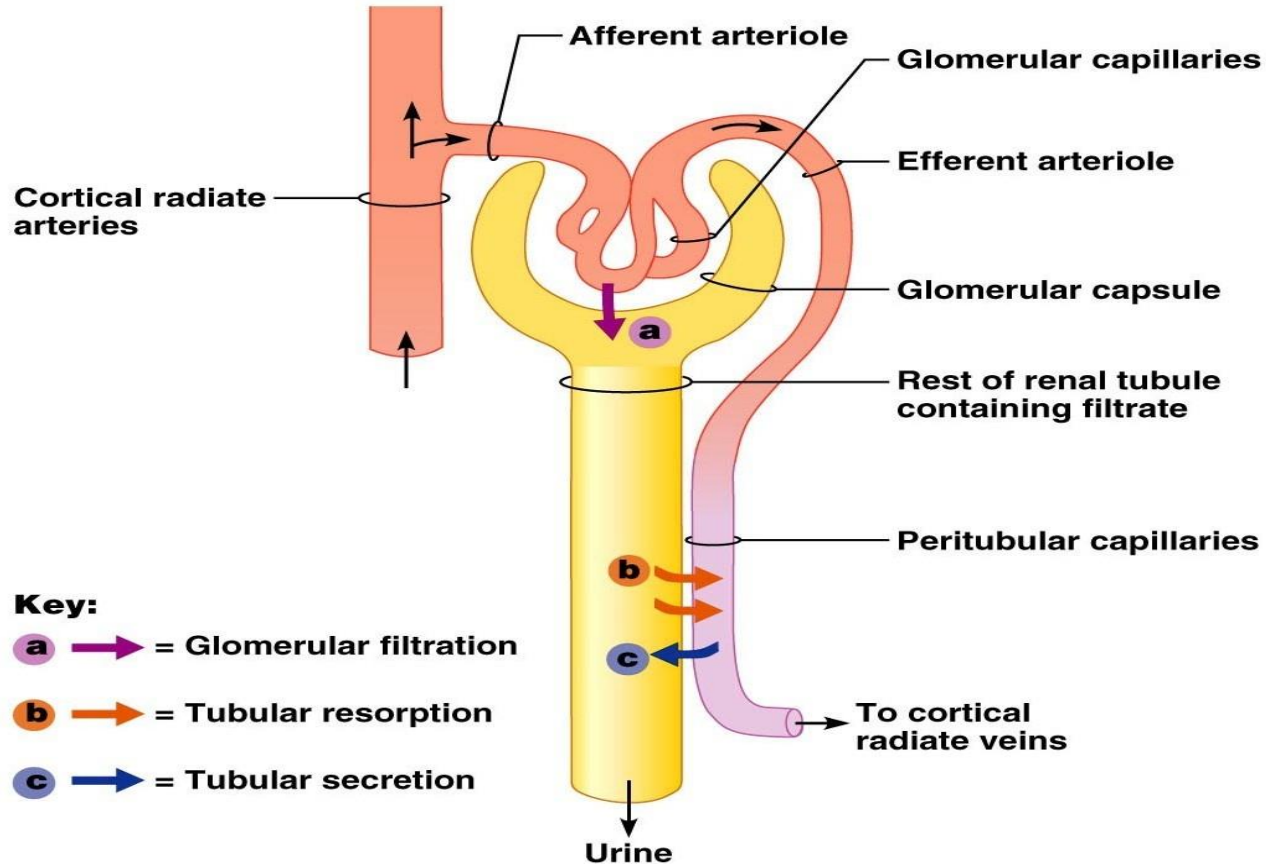


Figure 23.4



The Nephron

- **Renal corpuscle**
 - Glomerulus and glomerular capsule
 - **Glomerulus** – tuft of capillaries
 - Capillaries of glomerulus are *fenestrated*
 - **Glomerular (Bowman's) capsule**
 - Parietal layer – simple squamous epithelium
 - Visceral layer – consists of podocytes



Tubular Section of Nephron

- Filtrate proceeds to renal tubules from glomerulus
 - Proximal convoluted tubule
 - Loop of Henle
 - Descending limb
 - Thin segment
 - Thick segment
 - Distal convoluted tubule
 - Collecting tubules



Ureters

- Carry urine from the kidneys to the urinary bladder
- Oblique entry into bladder prevents backflow of urine
- Histology of **ureter**
 - Mucosa – **transitional epithelium**
 - **Muscularis** – two layers
 - Inner longitudinal layer
 - Outer circular layer
 - **Adventitia** – typical connective tissue

Microscopic Structure of the Ureter

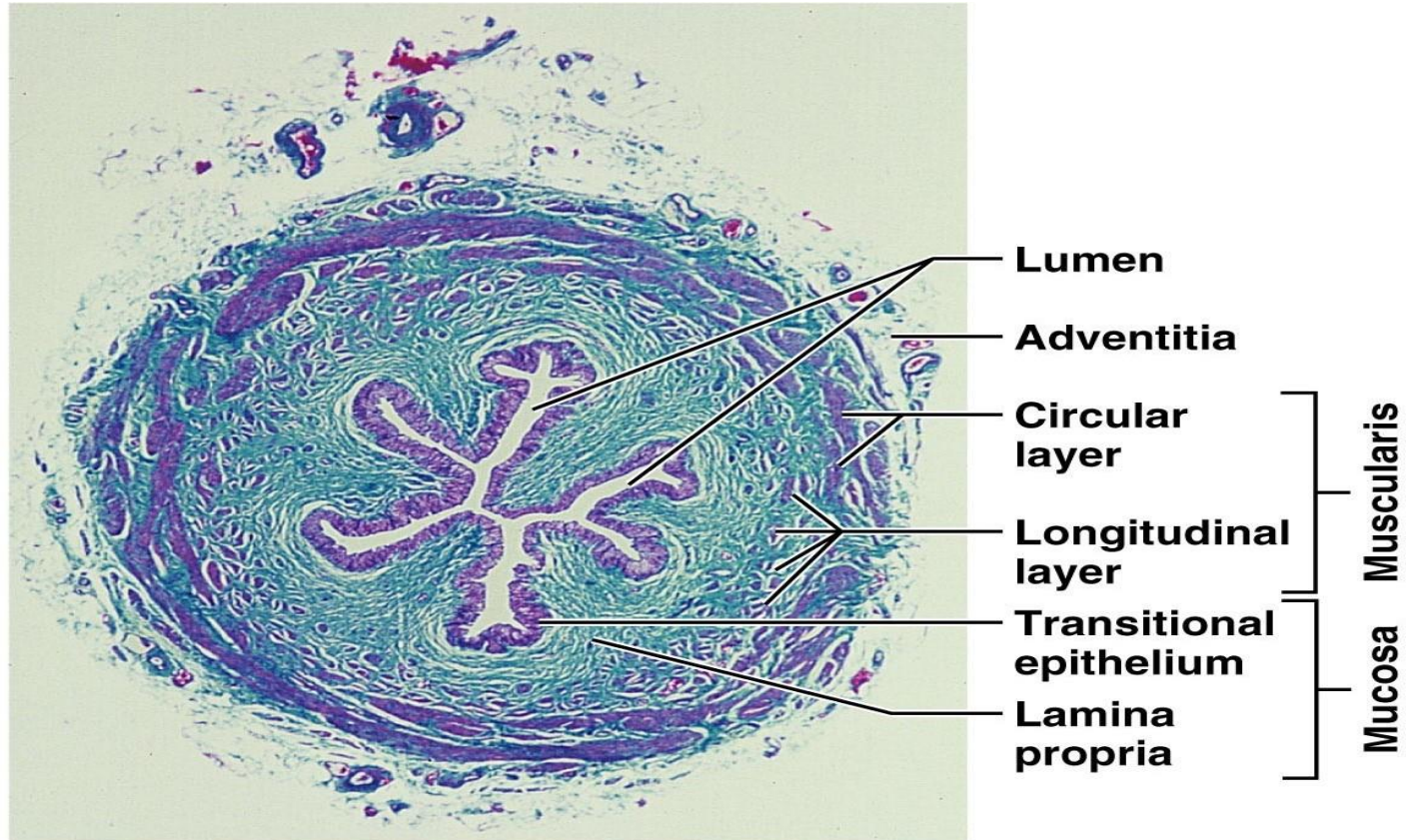


Figure 23.12

Urinary Bladder

- A collapsible muscular sac
- Stores and expels urine
 - Full bladder – spherical
 - Expands into the abdominal cavity
 - Empty bladder – lies entirely within the pelvis

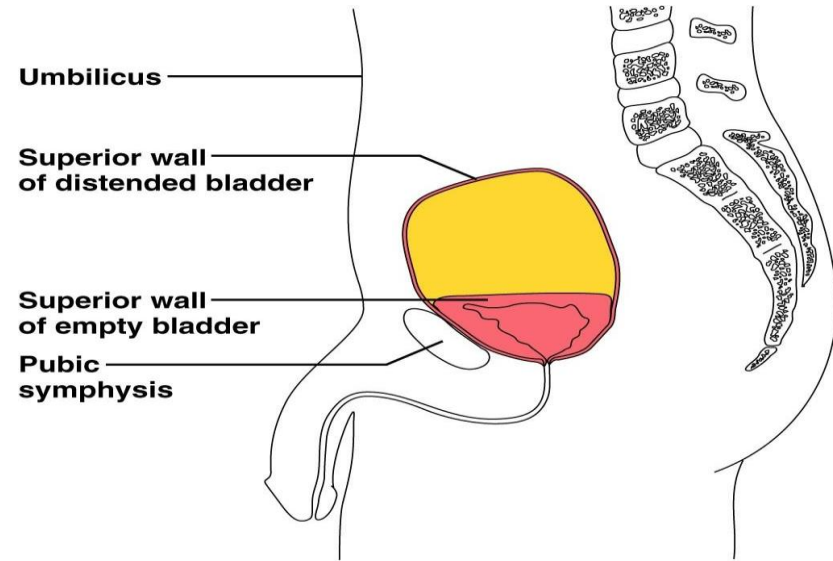


Figure 23.13

Urinary Bladder

- **Urachus** – closed remnant of the allantois
- **Prostate gland**
 - Lies directly inferior to the bladder
 - Surrounds the urethra

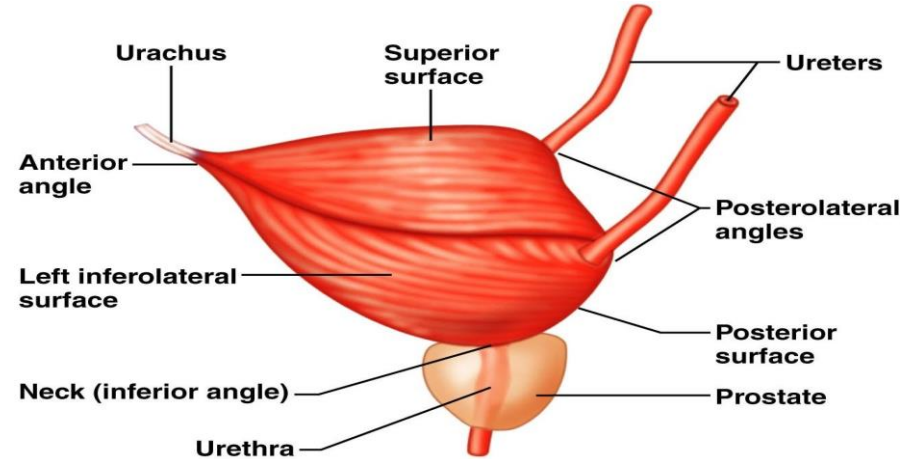


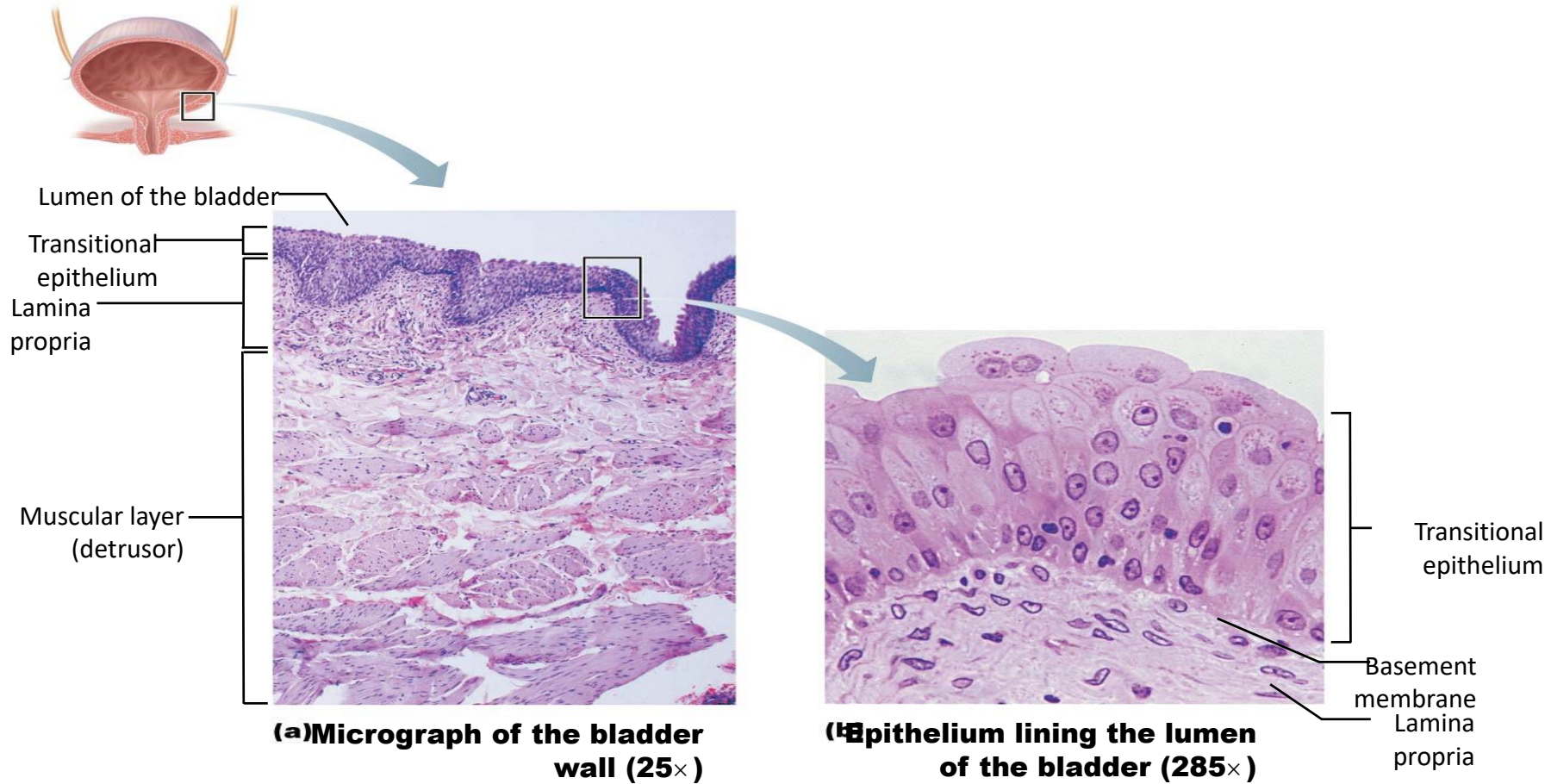
Figure 23.14



Urinary Bladder

- Wall of bladder
 - Mucosa
 - Transitional epithelium
 - Muscular layer
 - Detrusor muscle
 - Adventitia

Histology of the Urinary Bladder



Structure of the Urinary Bladder and Urethra

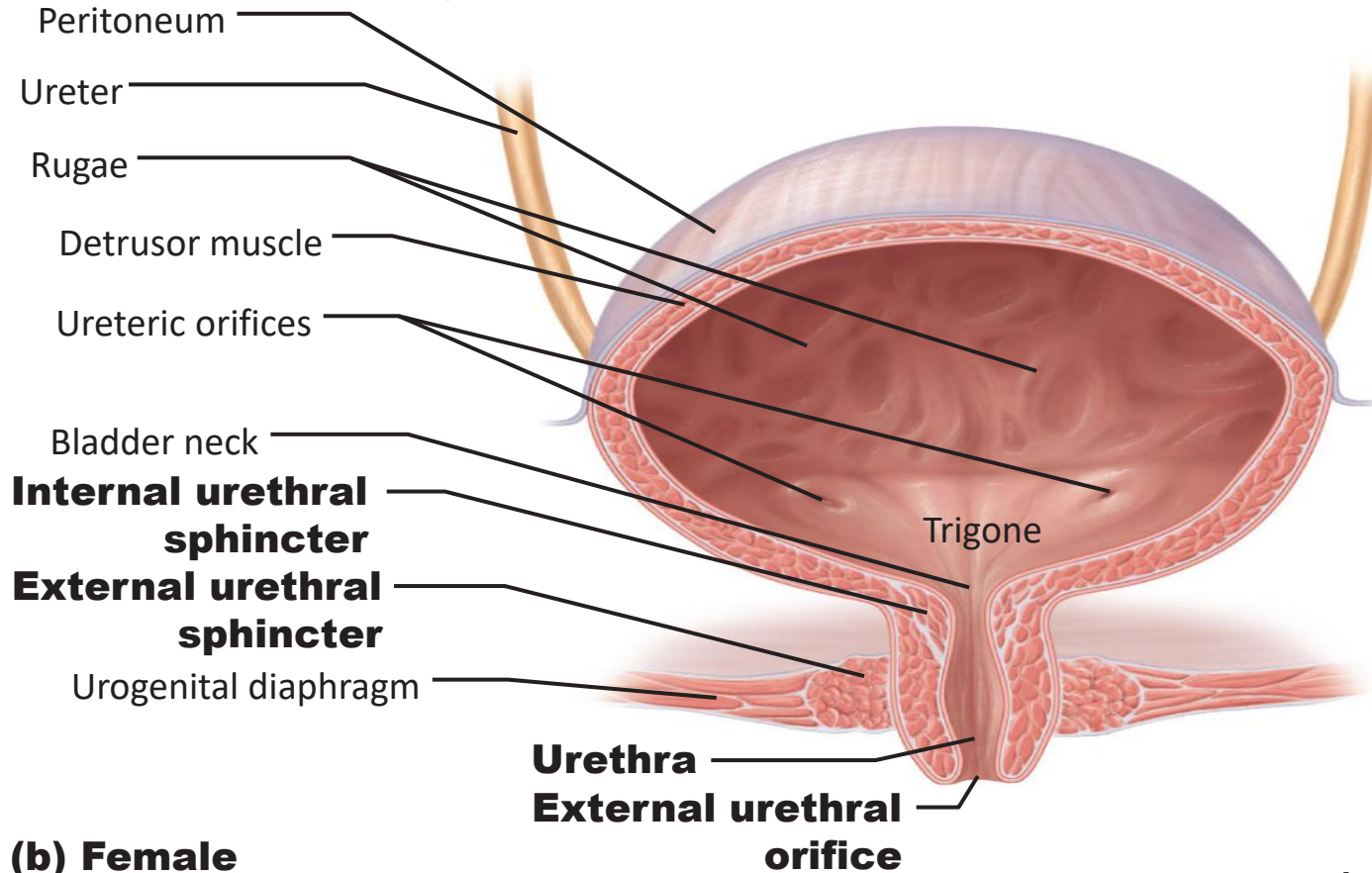


Figure 23.16b



Urethra

- **Internal urethral sphincter**
 - Involuntary smooth muscle
- **External urethral sphincter**
 - Voluntarily inhibits urination
 - Relaxes when one urinates



Urethra

- In females
 - Length of 3–4 cm
- In males – 16-20 cm in length – three named regions
 - **Prostatic urethra**
 - Passes through the prostate gland
 - **Membranous urethra**
 - Through the urogenital diaphragm
 - **Spongy (penile) urethra**
 - Passes through the length of the penis

Embryology of The Urinary System

- Embryo develops three pairs of kidneys
 - Pronephros
 - Mesonephros
 - Metanephros
 - Only **metanephros** persists to become the adult kidneys
 - Metanephric kidney produces urine by fetal third month
 - Contributes to the volume of **amniotic fluid**

The urinary tract develops from the 3rd week of the embryonic period from the **intermediate mesoderm** as well as from the **urogenital sinus**. The kidneys develop from the 4th week in **three steps**:

As a first one, the **pronephros**, forms that then later atrophies in the 8th week and is never active functionally.

It is followed by the **mesonephros**, that is formed between the 6th and 10th weeks, but is only transitory.

The definitive kidneys develop from a metanephros (mesodermal origin) and the ureter bud (that has its origin in the caudal part of the wolffian duct)

The **urine-excreting part** of the kidneys, the nephron, mainly arises from the **metanephrones** (glomerulus, proximal, intermediate and distal tubules), **while** the rest of the upper urinary tract (collecting ducts, calices, renal pelvis and ureter) develop from the **ureteric bud**.

The numerous induction mechanisms between ureter bud and metanephric mesenchyma during the development of the renal system, as well as the **ascent of the kidneys**, originating at the level of the sacrum and moving up to the diaphragm at the end of the development, make it possible for a large number of abnormalities to arise.

Many remain asymptomatic whereas others are not compatible with survival.

In **males** the internal sex organs come from the **mesonephric duct (Wolff)** that differentiates itself into the **epididymis, deferent duct, seminal vesicle and the ejaculatory duct.**

The **paramesonephric duct (Müller)** atrophies. It leaves behind embryonic remnants such as the **testicular appendage** and parts of the **prostatic utricle.**

In **females** the **paramesonephric duct (Müller)** remains in existence and differentiates itself into the fallopian tube with its ampullae and, following its fusion at the caudal end, into the **uterus** and the **upper part of the vagina**.

The mesonephric duct (Wolff) with its tubules atrophies and leaves embryonic remnants such as the ductus longitudinalis epoöphori (Gartner), epoöphoron and paroöphoron.

Development of the Urinary Organs

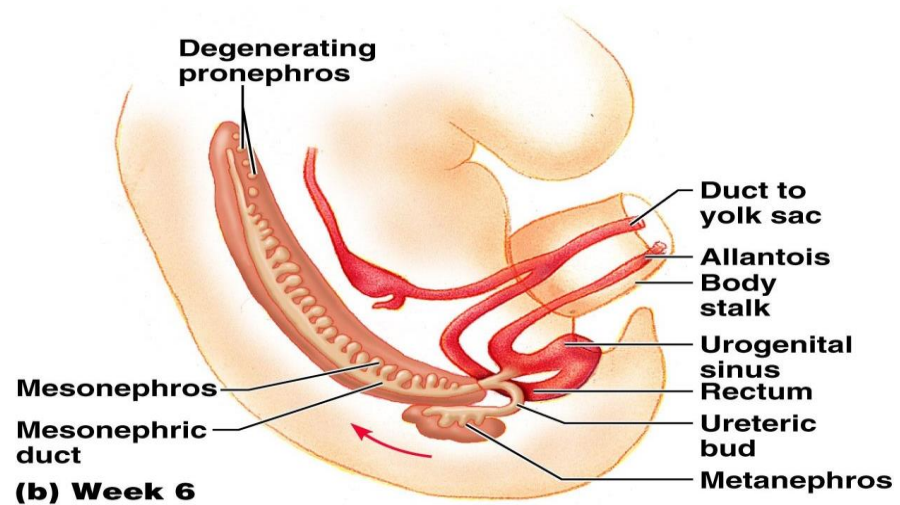
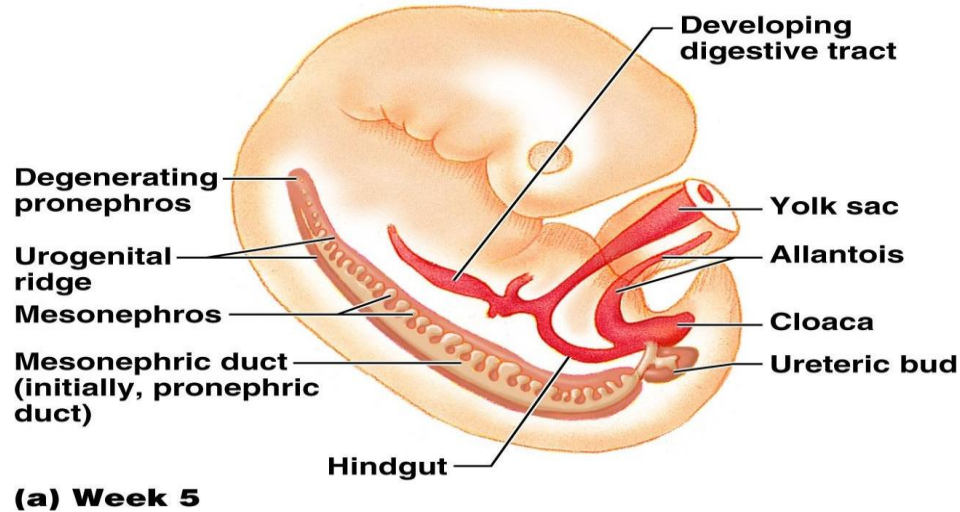


Figure 23.18a,b

Development of the Urinary Organs

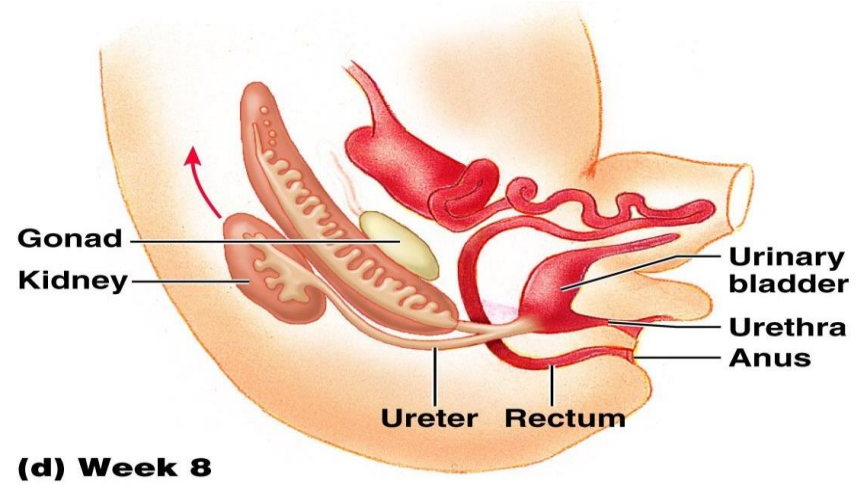
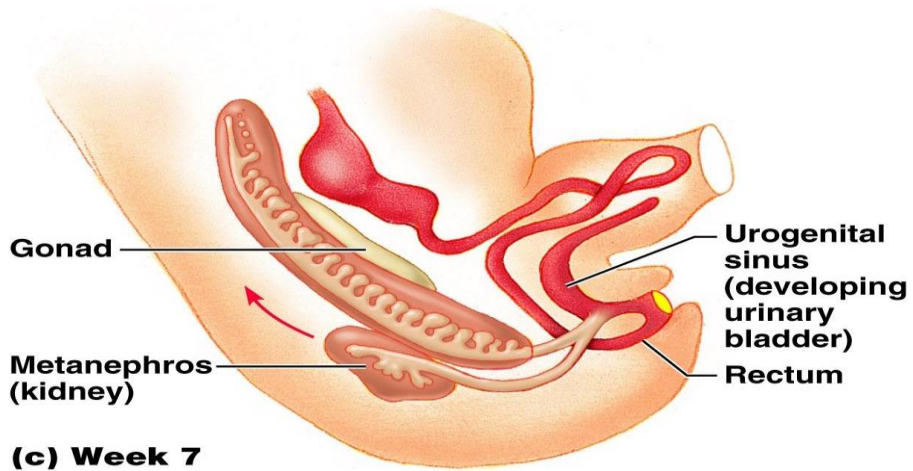


Figure 23.18c, d

Good

Luck