HKU Med LKS Faculty of Medicine
School of Biomedical Sciences
香港大學生物醫學學院

BMSC1101/BMSN1601

Anatomy of Urinary System

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Learning Outcomes

By the end of this lecture, you should be able to:

1. Understand the general organization of the urinary system
2. Describe the structure and function of the kidneys, ureters, urinary bladder and urethra
3. Relate the anatomy of the urinary system to relevant developmental, functional and clinical features

Main references:

- Saladin K. *Human Anatomy*
- Drake R. *Gray's Anatomy for Students*

For any questions:

- gfonseca@hku.hk with subject Nurse / TCM

1. Overview of the Urinary System

1. Overview of the Urinary System

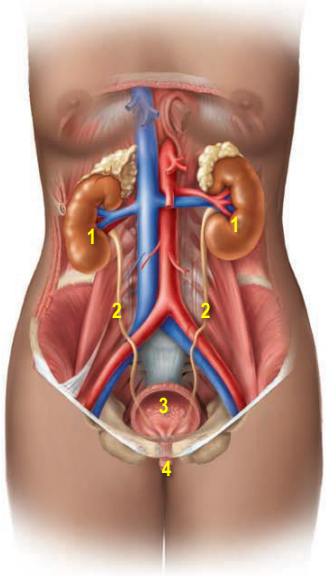
A) Structures and functions

1. Kidney
   - Excretion of metabolic wastes, drugs and toxic substances
   - Regulation of blood volume, pressure and ionic composition
   - Synthesis of hormones (erythropoietin, calcitriol, renin) and glucose (via gluconeogenesis)

2. Ureter
   - Transportation of urine

3. Bladder
   - Storage of urine

4. Urethra
   - Excretion of urine



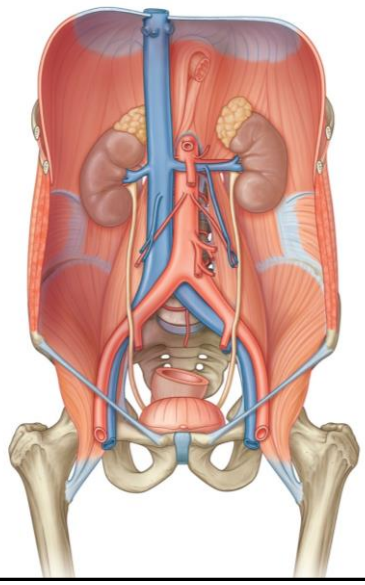
2. Kidney

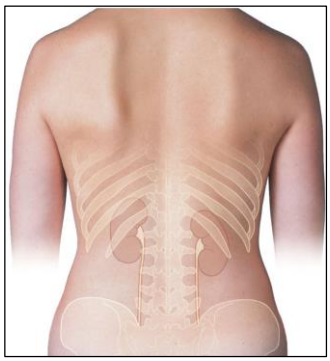
2. Kidney

A) Description of kidney: bean-shaped blood-filtering solid organ of the urinary system

B) Position and relationships of kidney

- Retroperitoneal organs in abdominal cavity
- Levels of vertebrae T12-L3
- Superior pole of left kidney at level of 11th rib
- Superior pole of right kidney at level of 12th rib

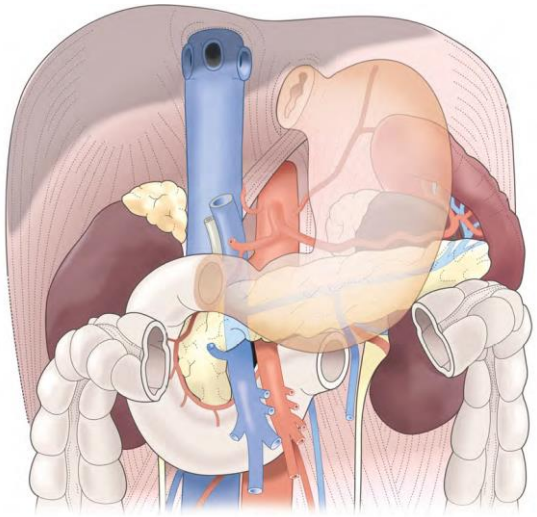




2. Kidney

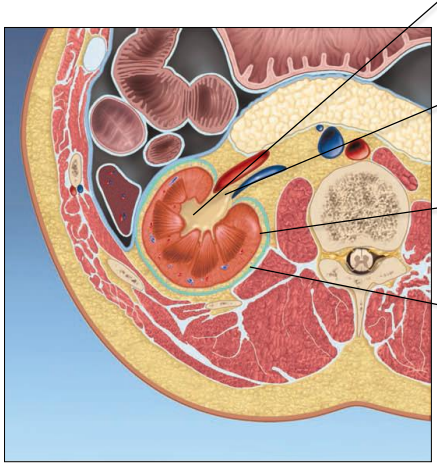
B) Position and relationships of kidney

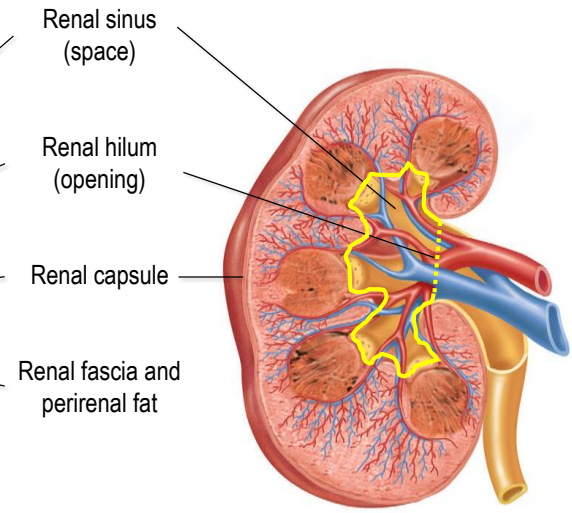
- Both kidneys are anterior to diaphragm, muscles of posterior abdominal wall and inferior to adrenal glands
- Right kidney is posterior to hepatic colic flexure, liver, duodenum, coils of small intestine and is lateral to inferior vena cava
- Left kidney is posterior to splenic colic flexure, stomach, tail of pancreas, spleen, coils of small intestine and is lateral to aorta



2. Kidney

C) External anatomy of kidney





2. Kidney

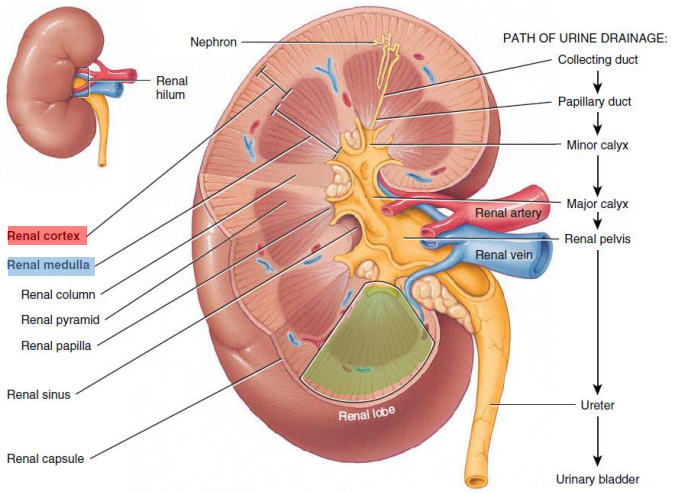
D) Internal anatomy of kidney

i. Renal cortex = outer layer of renal parenchyma

ii. Renal medulla = inner layer of renal parenchyma

- Renal column
- Renal pyramid
- Renal papilla

iii. Renal lobe = pyramid + adjacent cortex

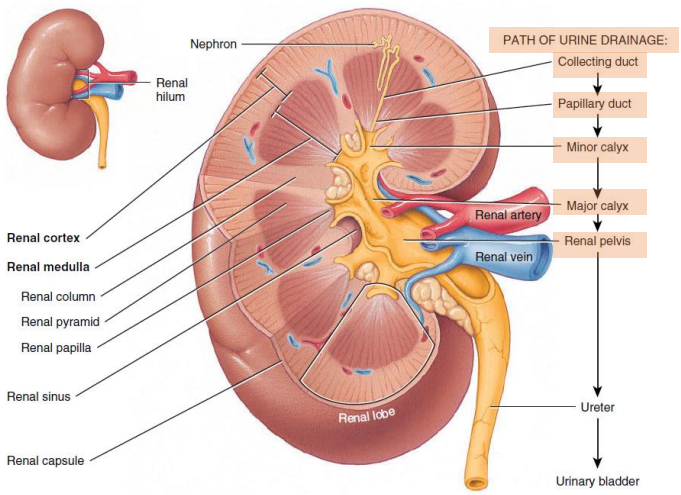


2. Kidney

D) Internal anatomy of kidney

iv. Urine drainage system = ducts that drain urine from nephrons to ureter

- Collecting duct
- Papillary duct
- Minor calyx
- Major calyx
- Renal pelvis



2. Kidney

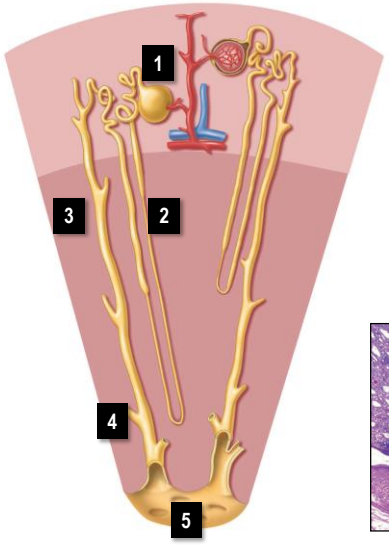
E) Microstructure of kidney

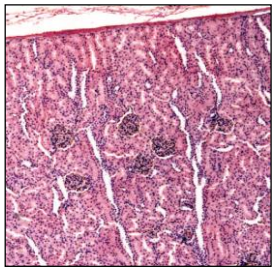
i. Nephron = basic microscopic and multicellular functional unit of the kidney (~1 million per kidney)

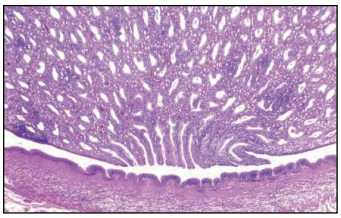
1. Renal corpuscle
2. Renal tubule

ii. Duct system

3. Collecting duct
4. Papillary duct
5. Minor calyx





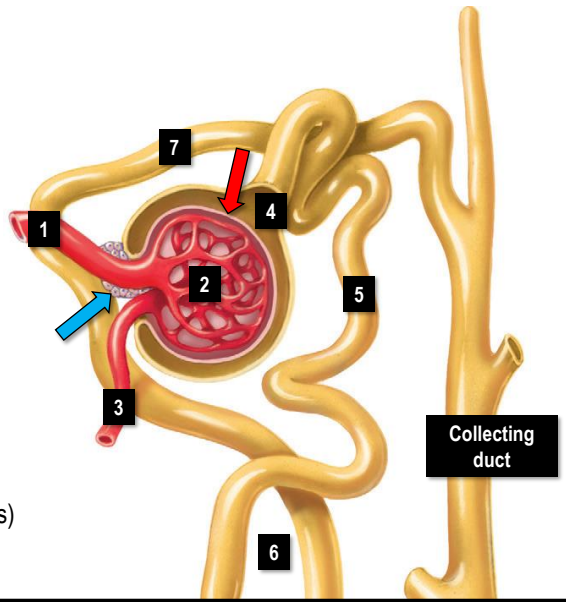


2. Kidney

E) Microstructure of kidney

iii. Parts of nephron
1. Afferent arteriole (c)
2. Glomerulus (c)
3. Efferent arteriole (c)
4. Bowman's capsule (c)
5. Proximal convoluted tubule (t)
6. Limbs of loop of Henle (t)
7. Distal convoluted tubule (t)

- Juxtaglomerular apparatus → group of cells that monitor and adjust the activity of the nephron
- Filtration membrane → transmits most blood components (exceptions: blood cells and large proteins)



2. Kidney

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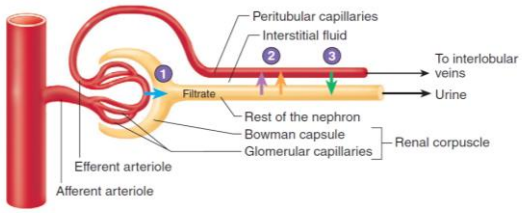
E) Microstructure of kidney

iv. Functions of nephron

1. Glomerular filtration
2. Tubular reabsorption
3. Tubular secretion

Urinalysis



Concentrations of Major Solutes in Urine

Substance	Plasma	Daily volume Filtrate	Urine	Urine Concentration/ Plasma Concentration*
Water (L)	180	180	1.4	——
Organic molecules (mg/100 mL)				
Protein	3900–5000	6–11	0†	0
Glucose	100	100	0	0
Urea	26	26	1820	70
Uric acid	3	3	42	14
Creatinine	1.1	1.1	196	180
Ions (mEq/L)				
Na^+	142	142	128	0.9
K^+	5	5	60	12.0
Cl^-	103	103	134	1.3
HCO_3^-	28	28	14	0.5

2. Kidney

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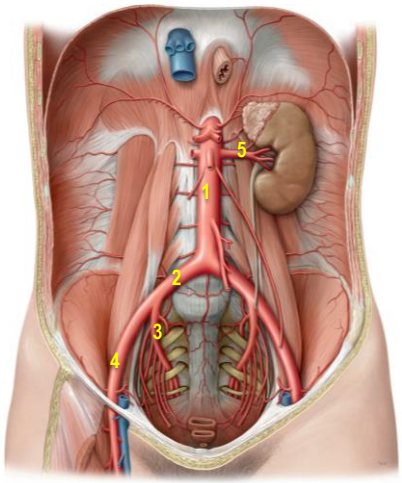
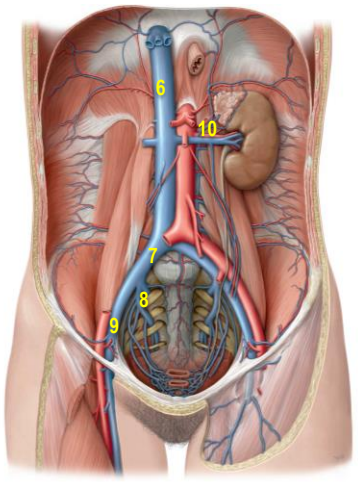
F) Vasculature

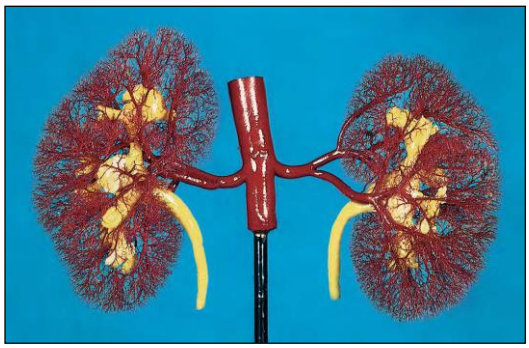
1. Abdominal aorta
2. Common iliac a
3. Internal iliac a
4. External iliac a
5. Renal a
6. Inferior vena cava
7. Common iliac v
8. Internal iliac v
9. External iliac v
10. Renal v



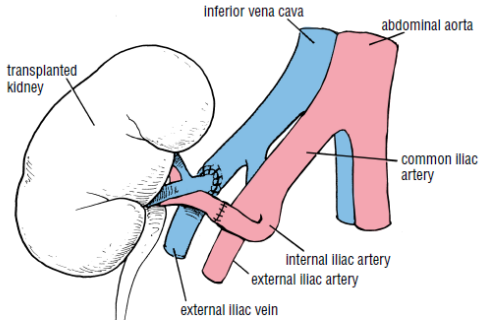


2. Kidney

F) Vasculature



Arterial supply of kidney



Kidney transplant

3. Ureters, Bladder and Urethra

3. Ureters, Bladder and Urethra

A) Description of ureters: tube-shaped mucosal-lined organ of the urinary system with thick walls of smooth muscle

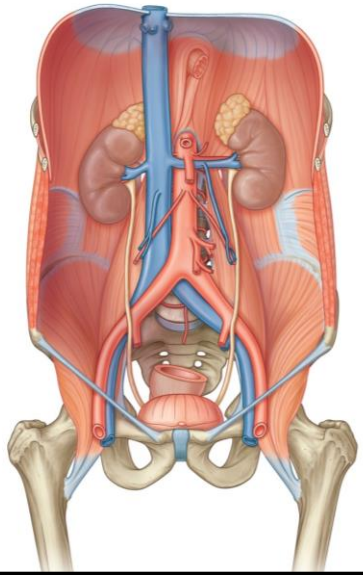
B) Position and relationships of ureters

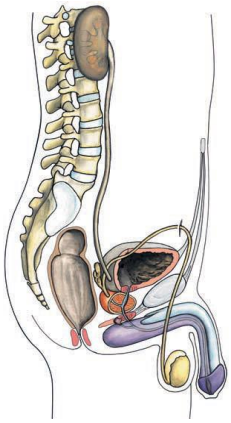
i) Emerge from renal pelvis

ii) Retroperitoneal descent in posterior abdominal wall

iii) Cross pelvic inlet and iliac vessels to enter pelvic cavity

iv) Open onto posterior bladder





Oblique entry of ureter to bladder forms a physiologic valve

3. Ureters, Bladder and Urethra

C) Description of bladder: mucosal-lined and distensible reservoir of urine with walls of smooth muscle (detrusor). Pyramid-shaped when empty. Oval when full

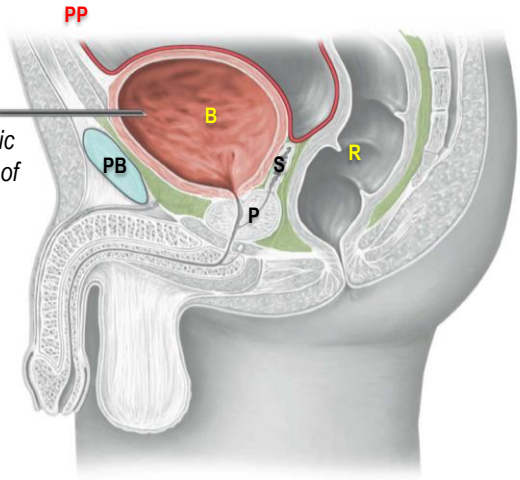
D) Position and relationships of bladder

i. Infraperitoneal organ in pelvic cavity

ii. Female bladder is posterior to pubis, anterior to vagina, inferior to uterus, superior to pelvic diaphragm

iii. Male bladder is posterior to pubis, anterior to rectum and seminal vesicles, superior to prostate

Suprapubic aspiration of urine



3. Ureters, Bladder and Urethra

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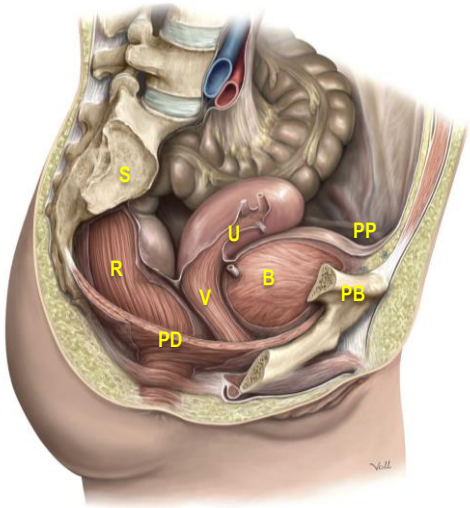
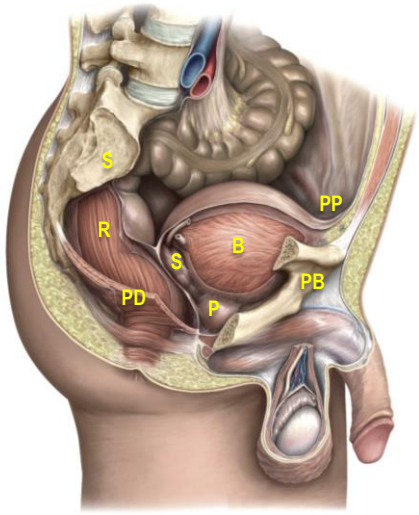
D) Position and relationships of bladder





3. Ureters, Bladder and Urethra

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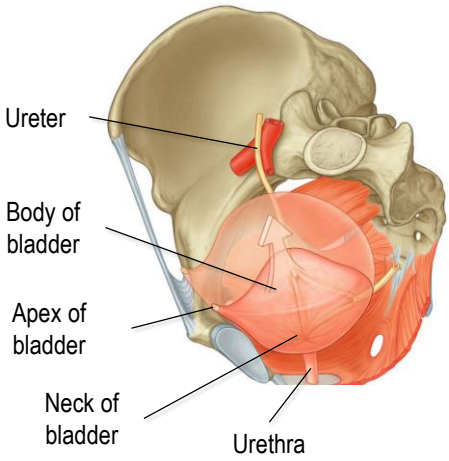
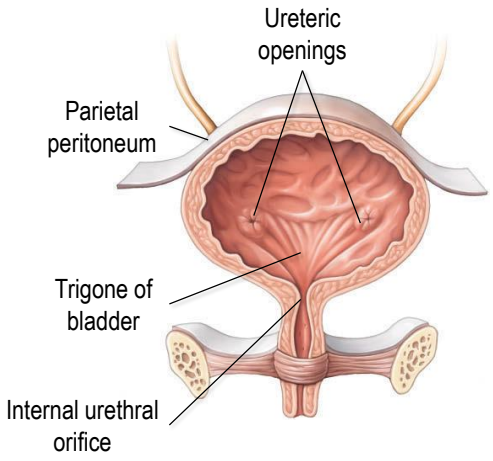
E) Anatomy of bladder

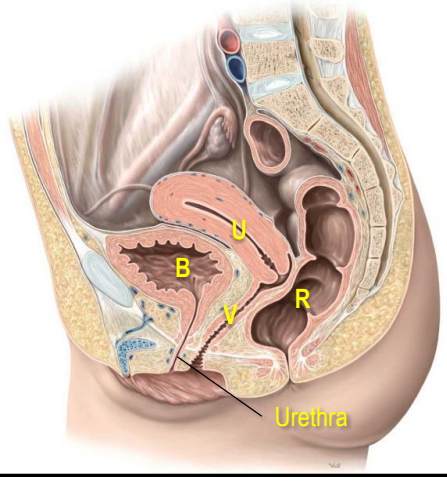


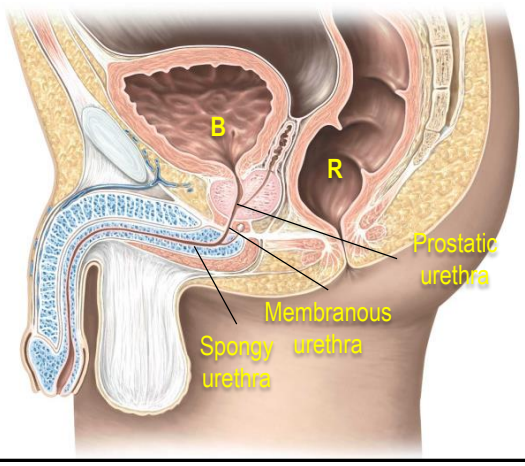


3. Ureters, Bladder and Urethra

F) Description of urethra: mucosal-lined tube with walls of smooth muscle that propel urine (and semen) to the exterior

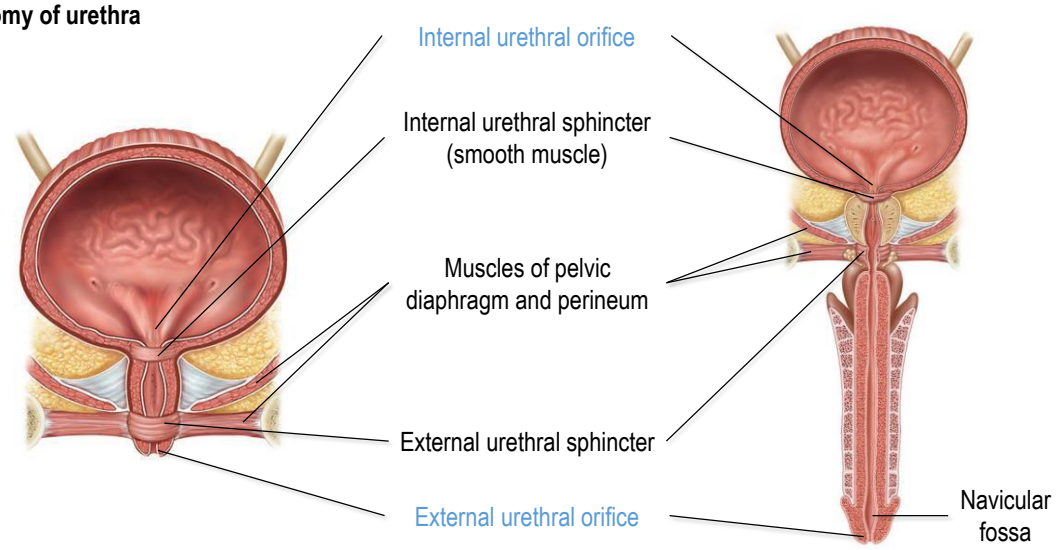
G) Position and relationships of urethra: female urethra is shorter whereas the longer male urethra is divided into 3 parts





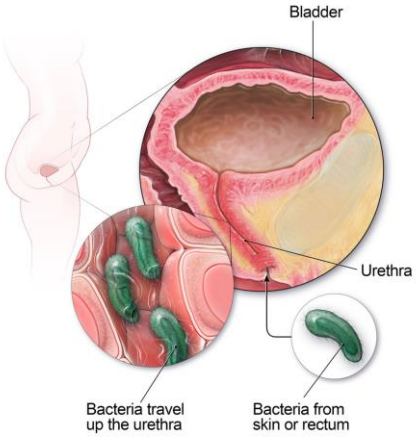
3. Ureters, Bladder and Urethra

H) Anatomy of urethra

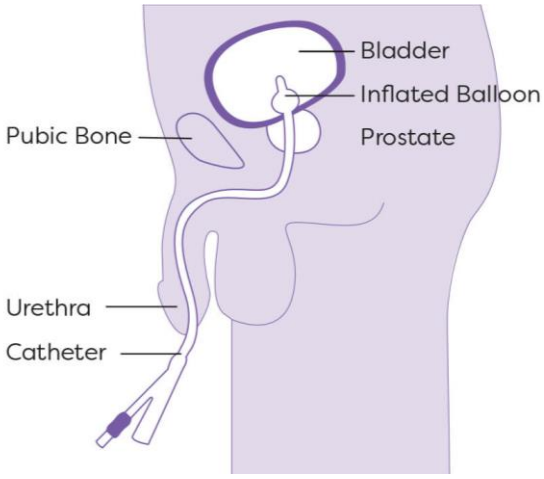


3. Ureters, Bladder and Urethra

H) Anatomy of urethra



Urinary tract infections



Urinary catheterization

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Some problems…

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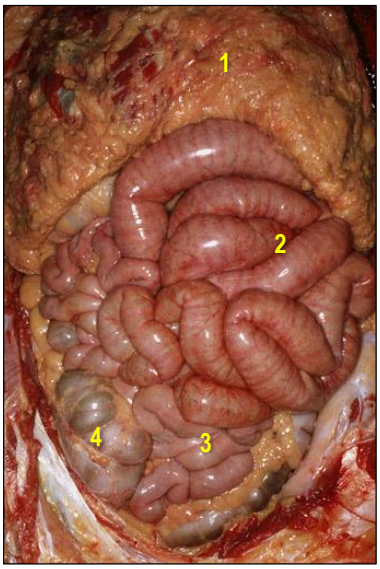
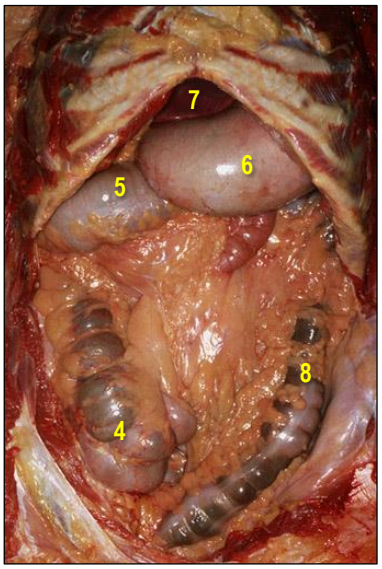
Label the images





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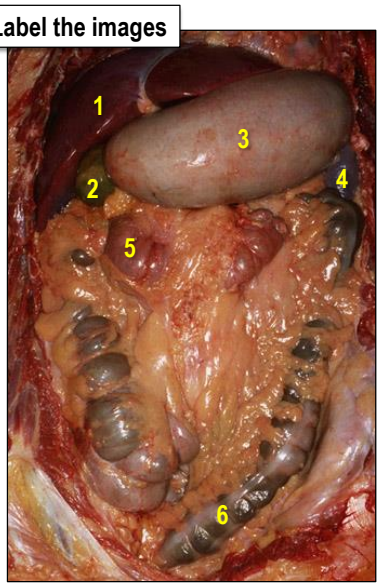

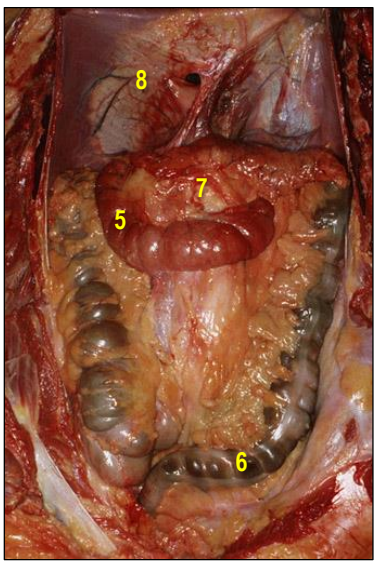

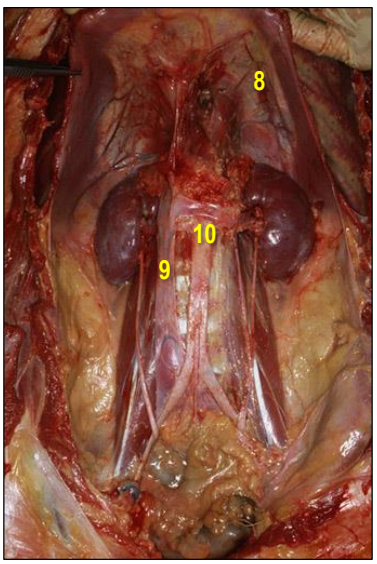

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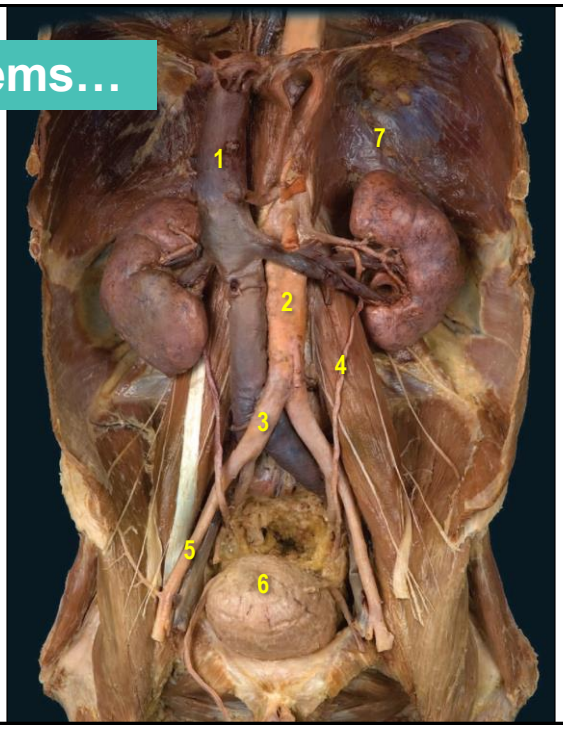

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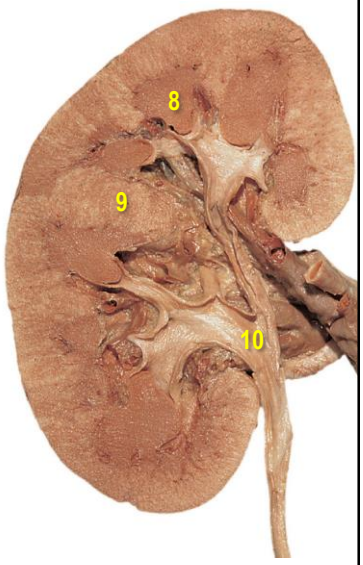

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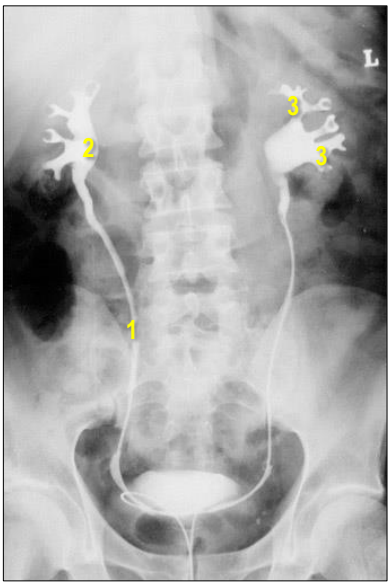

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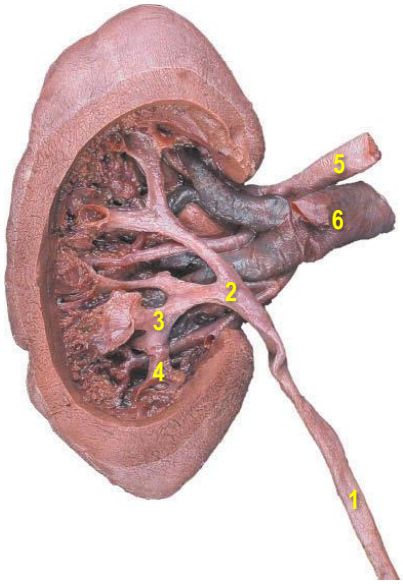

Some problems…

1. A 19-year-old man was examined in the emergency department and found to have a bleeding stab wound in his left flank. A urine specimen revealed blood. Of the organs listed, which one is least likely to be damaged in this patient?

A. Stomach
B. Spleen
C. Inferior vena cava
D. Left suprarenal gland
E. Coils of jejunum
F. Pancreas

2. A reflex is an automatic motor response by the nervous system to a specific stimulus. The micturition reflex (voiding) is triggered when urine fills the bladder and stretches its walls. Which response occurs in this reflex?

A. Contraction of muscles of pelvic diaphragm and perineum
B. Contraction of external urethral sphincter
C. Inhibition of detrusor muscle
D. Inhibition of internal urethral sphincter

3. A 42-year-old man was suffering from postoperative retention of urine after an appendectomy. Because the patient was in considerable discomfort, a catheter was placed. Which statement is incorrect?

A. Because the external urethral orifice is the narrowest part of the urethra, once the tip of the catheter has passed this point, further passage should be easy.
B. The membranous part of the urethra is the widest part of the urethra and should cause no resistance.
C. The prostatic part of the urethra is wide enough to allow the catheter to pass without major difficulty.
D. Near the posterior end of the navicular fossa, a mucosal fold may catch the end of the catheter.

Some solutions…

Label the images (slide 25)
1 Greater omentum (peritoneal fold)
2 coils of jejunum
3 coils of ileum
4 cecum / ascending colon
5 transverse colon
6 stomach
7 liver
8 descending colon

Label the images (slide 26)
1 Liver
2 gallbladder
3 stomach
4 spleen
5 duodenum
6 sigmoid colon
7 pancreas
8 diaphragm
9 inferior vena cava
10 aorta

Label the images (slide 27)
1 Inferior vena cava
2 aorta
3 common iliac artery
4 ureter
5 external iliac artery
6 bladder
7 diaphragm
8 renal pyramid
9 renal column
10 renal pelvis

Label the images (slide 28)
1 Ureter
2 renal pelvis
3 major calyx
4 minor calyx
5 renal artery
6 renal vein

MCQ
1. C
2. D
3. B