Urinary System

Khaleel Alyahya, PhD, MEd

www.khaleelalyahya.net
RESOURCES

1. Mastering Medical Technology
   By Sue Walker, Maryann Wood and Jenny Nicol

2. Essential of Human Anatomy and Physiology
   By Elaine Marieb and Suzanne Keller

3. Mosby’s Dictionary
   By Mosby
The urinary system is the system responsible for the production, storage and excretion of urine.

The organs of the urinary system are also responsible for removing metabolic wastes.

They also maintain homeostasis by regulating the proper concentrations and balance of water, salts, nutrients and nitrogenous wastes in the body.

The kidneys work with the lungs, skin and intestines to keep this balance correct.

The urinary system is developmentally and anatomically associated with the male and female reproductive systems.

It is sometimes described as the “genitourinary system”.

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location

- Kidneys lie behind the **peritoneum** (retroperitoneally) in the abdomen, either side of the vertebral column.
- They extend from **T12 to L3**, although the right kidney is often situated slightly lower due to the presence of the **liver**.
- Each kidney is approximately three vertebrae in length.
- This can be used to measure any changes in size when interpreting radiographs.
functions

- The primary functions of the urinary system are the **elimination** of water-soluble waste products from the body's bloodstream and keeping water and chemical levels in the body regulated through metabolic processes.

- It operates through an arrangement of organs, tubes, muscles and nerves which **produce**, **store** and **excrete** urine, **regulate** blood volume and **control** the production of erythrocytes.

- The main organs of the urinary system are:
  - **Kidneys**
  - **Ureters**
  - **Urinary Bladder**
  - **Sphincter Muscles**
  - **Urethra**
# Combining Forms

Check page 309 from the book "Mastering Medical Terminology" for the list of combining form.

<table>
<thead>
<tr>
<th>Combining form</th>
<th>Meaning</th>
<th>Medical term</th>
<th>Meaning of medical term</th>
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<tbody>
<tr>
<td>albumin/o</td>
<td>albumin</td>
<td>pseudoalbuminuria</td>
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<tr>
<td>azot/o</td>
<td>nitrogen, urea</td>
<td>azoturia</td>
<td></td>
</tr>
<tr>
<td>bacteri/o</td>
<td>bacteria</td>
<td>bacteraemia</td>
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<tr>
<td>cali/o</td>
<td>calyx, cup</td>
<td>pyelocalyctasis</td>
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<tr>
<td>cyst/o</td>
<td>bladder, cyst, sac,</td>
<td>cystoscope</td>
<td></td>
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<tr>
<td>dips/o</td>
<td>thirst</td>
<td>polydipsia</td>
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<td>glomerul/o</td>
<td>glomerulus</td>
<td>glomerulonephritis</td>
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<tr>
<td>kal/i</td>
<td>potassium</td>
<td>hypokalaemia</td>
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<tr>
<td>ket/o</td>
<td>ketone bodies</td>
<td>ketosis</td>
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<tr>
<td>keton/o</td>
<td>ketonuria</td>
<td></td>
<td></td>
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<tr>
<td>lith/o</td>
<td>stone, calculus</td>
<td>nephrolithotomy</td>
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<tr>
<td>meat/o</td>
<td>meatus</td>
<td>meatorrhaphy</td>
<td></td>
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<tr>
<td>nephro/o</td>
<td>kidney</td>
<td>hydrenephrosis</td>
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<tr>
<td>noct/i</td>
<td>night</td>
<td>nocturia</td>
<td></td>
</tr>
<tr>
<td>olig/o</td>
<td>scanty, deficiency, few</td>
<td>oliguria</td>
<td></td>
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<tr>
<td>py/o</td>
<td>pus</td>
<td>pyonephrolithiasis</td>
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<tr>
<td>pyel/o</td>
<td>renal pelvis</td>
<td>pyelolithotomy</td>
<td></td>
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<tr>
<td>ren/o</td>
<td>kidney</td>
<td>renal calculus</td>
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<tr>
<td>trigon/o</td>
<td>trigone (base of the bladder)</td>
<td>trigonitis</td>
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<tr>
<td>ur/o</td>
<td>urine, urinary tract, urea</td>
<td>urologist</td>
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<tr>
<td>ureter/o</td>
<td>ureter</td>
<td>ureteroceles</td>
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<tr>
<td>urethr/o</td>
<td>urethra</td>
<td>urethrodynia</td>
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<tr>
<td>urin/o</td>
<td>urine</td>
<td>urinometer</td>
<td></td>
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<tr>
<td>vesic/o</td>
<td>urinary bladder, blister</td>
<td>vesicovaginal</td>
<td></td>
</tr>
<tr>
<td>Prefix</td>
<td>Meaning</td>
<td>Medical term</td>
<td>Meaning of medical term</td>
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<tr>
<td>an-</td>
<td>no, not, without, absence of</td>
<td>anuria</td>
<td></td>
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<tr>
<td>dia-</td>
<td>through, across</td>
<td>dialysis</td>
<td></td>
</tr>
<tr>
<td>dys-</td>
<td>bad, painful, difficult</td>
<td>dysuria</td>
<td></td>
</tr>
<tr>
<td>poly-</td>
<td>many, much</td>
<td>polyuria</td>
<td></td>
</tr>
<tr>
<td>supra-</td>
<td>above, excessive</td>
<td>suprarenal</td>
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</table>

<table>
<thead>
<tr>
<th>Suffix</th>
<th>Meaning</th>
<th>Medical term</th>
<th>Meaning of medical term</th>
</tr>
</thead>
<tbody>
<tr>
<td>-cele</td>
<td>protrusion, hemia</td>
<td>cystocele</td>
<td></td>
</tr>
<tr>
<td>-dlys</td>
<td>irrigating, washing</td>
<td>vesicoclysis</td>
<td></td>
</tr>
<tr>
<td>-gram</td>
<td>record, writing</td>
<td>intravenous pyelogram</td>
<td></td>
</tr>
<tr>
<td>-lysis</td>
<td>separation, destruction, breakdown, dissolution</td>
<td>urinalysis</td>
<td></td>
</tr>
<tr>
<td>-poietin</td>
<td>substance that forms</td>
<td>erythropoietin</td>
<td></td>
</tr>
<tr>
<td>-ptosis</td>
<td>downward displacement, prolapse</td>
<td>nephropotis</td>
<td></td>
</tr>
<tr>
<td>-scope</td>
<td>instrument to view</td>
<td>cystoscope</td>
<td></td>
</tr>
<tr>
<td>-scopy</td>
<td>process of viewing</td>
<td>cystoscopy</td>
<td></td>
</tr>
<tr>
<td>-tripsy</td>
<td>to crush</td>
<td>nephrolithotripsy</td>
<td></td>
</tr>
<tr>
<td>-uresis</td>
<td>excrete in urine, urinate</td>
<td>diuresis</td>
<td></td>
</tr>
<tr>
<td>-uria</td>
<td>urination, urine condition, presence of substance in urine</td>
<td>pyuria</td>
<td></td>
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</tbody>
</table>
pronunciation

Check page 210-211 from the book “Mastering Medical Terminology” for the complete list of pronunciation.

<table>
<thead>
<tr>
<th>Term</th>
<th>Pronunciation</th>
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<tbody>
<tr>
<td>adrenal glands</td>
<td>ad-REE-nal glandz</td>
</tr>
<tr>
<td>atonic bladder</td>
<td>a-TOH-nik BLAD-a</td>
</tr>
<tr>
<td>bladder cancer</td>
<td>BLAD-a KAN-sa</td>
</tr>
<tr>
<td>blood urea nitrogen</td>
<td>BLUD yoo-REE-a NY-tro-jen</td>
</tr>
<tr>
<td>calculi</td>
<td>KAL-kyoo-lye</td>
</tr>
<tr>
<td>calculus</td>
<td>KAL-kyoo-lus</td>
</tr>
<tr>
<td>computed tomography</td>
<td>kom-PYOO-ted to-MOG-ra-fee</td>
</tr>
<tr>
<td>creatinine clearance test</td>
<td>kree-AT-in-in KLEE-rans test</td>
</tr>
<tr>
<td>cystitis</td>
<td>sis-TY-tus</td>
</tr>
<tr>
<td>cystocele</td>
<td>SIS-toh-seel</td>
</tr>
<tr>
<td>cystoscopy</td>
<td>sis-TOS-kop-ee</td>
</tr>
<tr>
<td>dialysis</td>
<td>dy-AL-e-sis</td>
</tr>
<tr>
<td>extracorporeal shock wave</td>
<td>eks-tra-KOR-por-EE-al shok wayv LUTH-oh-trip-see</td>
</tr>
<tr>
<td>lithotripsy</td>
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<tr>
<td>filtration</td>
<td>fil-TRAY-shun</td>
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<tr>
<td>glomerulonephritis</td>
<td>glom-ER-yoo-loh-nef-RY-tus</td>
</tr>
<tr>
<td>hydroureter</td>
<td>HY-droh-YOO-ret-a</td>
</tr>
</tbody>
</table>
## abbreviations

Check page 211 from the book “Mastering Medical Terminology” for the complete list of abbreviations.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tbody>
<tr>
<td>ADH</td>
<td>antidiuretic hormone</td>
</tr>
<tr>
<td>ARF</td>
<td>acute renal failure</td>
</tr>
<tr>
<td>ATN</td>
<td>acute tubular necrosis</td>
</tr>
<tr>
<td>BNO</td>
<td>bladder neck obstruction</td>
</tr>
<tr>
<td>BUN</td>
<td>blood urea nitrogen</td>
</tr>
<tr>
<td>C&amp;S</td>
<td>culture and sensitivity</td>
</tr>
<tr>
<td>CAPD</td>
<td>continuous ambulatory peritoneal dialysis</td>
</tr>
<tr>
<td>CCPD</td>
<td>continuous cycling peritoneal dialysis</td>
</tr>
<tr>
<td>CKD</td>
<td>chronic kidney disease</td>
</tr>
<tr>
<td>CRF</td>
<td>chronic renal failure</td>
</tr>
<tr>
<td>ESKD</td>
<td>end stage kidney disease</td>
</tr>
<tr>
<td>ESRD</td>
<td>end stage renal disease</td>
</tr>
<tr>
<td>ESWL</td>
<td>extracorporeal shock wave lithotripsy</td>
</tr>
<tr>
<td>GFR</td>
<td>glomerular filtration rate</td>
</tr>
<tr>
<td>IVP</td>
<td>intravenous pyelogram</td>
</tr>
<tr>
<td>KUB</td>
<td>kidneys, ureters, bladder</td>
</tr>
<tr>
<td>MSU</td>
<td>midstream urine</td>
</tr>
<tr>
<td>PD</td>
<td>peritoneal dialysis</td>
</tr>
<tr>
<td>pH</td>
<td>a measure of acidity</td>
</tr>
</tbody>
</table>
kidneys

- The human body has two kidneys, each around the size of a fist and located at the back of the abdominal cavity just below the rib cage on each side of the spine.
- The main functions of the kidneys are the removal of toxic waste products from the blood and maintaining homeostasis in the body by controlling pH levels, the concentration of electrolytes, the volume of extracellular fluid and the regulation of blood pressure.
- The main waste products that are managed by the urinary system are urea and uric acid.
- Accumulation of too much of these products in the bloodstream causes serious illness.
- Excretion is the process whereby the blood is cleaned through a process of filtration, reabsorption and secretion, principally carried out by the nephrons within each kidney.
- Each nephron, of which there are many thousands, contains a filtering mechanism, the renal corpuscle, which holds a glomerulus and a Bowman’s capsule.
- Clinicians measure the glomerular filtration rate in assessing the functioning of the kidney.
external structures

- Kidneys are encased in complex layers of fascia and fat.
- The following are the arrangement of kidneys from deep to superficial:
  - **Renal capsule**: tough fibrous capsule.
  - **Perirenal fat**: collection of extraperitoneal fat.
  - **Renal fascia**: encloses the kidneys and the suprarenal glands.
  - **Pararenal fat**: mainly located on the posterolateral aspect of the kidney.
internal structures

- **Cortex**: Dark brown and granular.
- **Medulla**: 6-12 pyramid-shape regions (renal pyramids)
- The base of pyramid is toward the cortex (corticomедullary border).
- The apex of a renal pyramid is called a **renal papilla**.
- Each renal papilla is associated with a structure known as the **minor calyx**, which collects urine from the pyramids.
- Several minor calices merge to form a **major calyx**.
- Urine passes through the major calices into the **renal pelvis**, a flattened and funnel-shaped structure.
- From the renal pelvis, urine drains into the **ureter**, which transports it to the **bladder** for storage.
- The medial margin of each kidney is marked by a deep fissure, known as the **renal hilum**.
- This acts as a gateway to the kidney.
- The renal vessels and ureter enter and exit the kidney via this structure.
operation

- Blood from the renal arteries (which branch off the aorta) moves into the kidneys.
- As it enters each kidney, the blood is filtered by the nephrons and water and other small molecules are reabsorbed through capillaries back into the bloodstream.
- Waste products which are filtered out move into urine.
- The body produces approximately **180 liters** of filtered fluid each day, but only around **2 liters** end up as urine, with the remaining filtrate being reabsorbed.
- The functions of the kidney are fundamental to life and instructions for their operation come from the endocrine system through regulating hormones such as **antidiuretic hormone**, **aldosterone** and **parathyroid hormone**.
- In addition to its vital filtration function, the kidneys work to regulate levels of water and salt in the body.
- Water is absorbed by the **gastrointestinal system** into the bloodstream, effectively diluting the blood.
- The kidneys remove the excess **water** and turn it into urine.
Similarly, excess amounts of salt in the blood are removed by the kidneys and filtered out into urine.

By controlling the amount of waste and salt in the blood, the kidneys manage concentration of these substances.

A third vital function of the kidneys involves the regulation of blood pressure.

Kidneys secrete an enzyme called renin, which triggers the production of hormones that control blood pressure and electrolyte balance.

If the body’s blood pressure drops, the kidneys release renin which operates to turn blood protein into a hormone called angiotensin.

This in turn instructs the adrenal glands, which are located on top of the kidneys, to release another hormone called aldosterone.

Aldosterone causes more salt and water to be reabsorbed into the blood in the kidneys, increasing blood volume and therefore blood pressure.
ureters

- The ureters are the hollow tubes that move urine by peristalsis from the renal pelvis in the kidneys to the bladder.
- In an adult, the ureters are usually approximately 25–30 cm in length and have a width of about 3 mm.
- The ureteric walls are comprised of smooth muscle, which contracts to produce peristaltic waves.
- This propels the urine towards the bladder.
The kidneys work to process water and body wastes into urine which is stored in the urinary bladder (more commonly referred to as the bladder), a hollow muscular organ.

The bladder muscle is called the detrusor muscle and it relaxes to allow the bladder to fill up.

At the same time, sphincter muscles located at the base of the bladder contract to keep the urine within the bladder.

When urinating, the brain instructs these two muscles to change their function, so that muscles at the base of the bladder relax to let the urine flow through the urethra and the detrusor muscle contracts to force the urine out.

The amount of urine that a bladder can hold varies from person to person and decreases with age.

When the bladder is half full, receptors in the wall of the bladder send signals along the pelvic nerves to the spinal cord and on to the brain to alert to the need to go to the toilet to empty the bladder.

This urge can be ignored for a certain amount of time but eventually the need to urinate becomes urgent as the bladder reaches capacity.
bladder functions

- The bladder largely serves two functions:
  - Temporary store of urine
    - The bladder is a hollow organ and walls are very distensible, with a folded internal lining to allow to hold up to 600ml.
  - Assists in the ejection of urine
    - During voiding, the musculature of the bladder contracts, and the sphincters relax.
bladder shape

- The morphological appearance of the bladder varies with filling. When full, it exhibits an oval shape, and when empty it is flattened by the overlying intestines.
- The important external features are:
  - **Apex**: this is located superiorly, pointing towards the pubic symphysis. It is connected to the umbilicus by the median umbilical ligament.
  - **Body**: the main part of the bladder, located between the apex and the fundus.
  - **Fundus**: located posteriorly, and it is triangular-shaped, with the tip of the triangle pointing backwards.
  - **Neck**: formed by the convergence of the fundus and the two inferolateral surfaces. This structure joins the bladder to the urethra.
urethra

- The urethra connects the bladder to the external environment to remove urine from the body.
- In males, the urethra is about 20 cm in length and travels through the penis, carrying semen as well as urine.
- In females, the urethra is shorter than in the male (around 4 cm) and emerges above the vaginal opening.
male urethra

- The male urethra is about 15-20cm long.
- In addition to urine, the male urethra provides an exit for semen.
- Anatomically, the urethra can be divided into four parts:
  - **Pre-prostatic** (intramural): Begins at the internal urethral orifice, located at the neck of the bladder. It passes through the wall of the bladder and ends at the prostate.
  - **Prostatic**: Passes through the prostate gland. The ejaculatory ducts and the prostatic ducts drain into the urethra here.
  - **Membranous**: Passes through the pelvic floor, and the deep perineal pouch. It is surrounded by the external urethral sphincter, which provides voluntary control of micturition.
  - **Spongy**: Passes through the bulb and corpus spongiosum of the penis, ending at the external urethral orifice. In the glans penis, the urethra dilates, forming the navicular fossa. The bulbourethral glands empty into the proximal urethra.
female urethra

- In women, the urethra is relatively short (approximately 4cm).
- This predisposes women to urinary tract infections.
- The urethra begins at the neck of the bladder and passes inferiorly through the perineal membrane and muscular pelvic floor.
- It opens directly onto the perineum, in an area between the labia minora, known as the vestibule.
- Within the vestibule, the urethral orifice is located anteriorly to the vaginal opening, and 2-3cm posteriorly to the clitoris.
- The distal end of the urethra is marked by the presence of two mucous glands that lie either side of the urethra.
- These glands are homologous to the male prostate.
urethra sphincters

- The **external urethral sphincter** is a striated muscle that provides voluntary control over urination.
- The **internal sphincter** is a muscle which compresses the internal urethral orifice at the junction of the urethra and the urinary bladder.
- This is made of smooth muscle, so therefore it is under involuntary control.
Physiology
nephrons

- **Nephrons** (nef’ronz) are the structural and functional units of the kidneys and are responsible for forming urine.
- Each kidney contains over a **million** of these tiny filters.
- In addition, there are thousands of collecting ducts, each of which collects fluid from several nephrons and conveys it to the renal pelvis.
- Each nephron consists of two main structures:
  - **Renal corpuscle.**
  - **Renal tubule.**
- Each **renal corpuscle** consists of a **glomerulus**, which is a knot of capillaries (glom = little ball), and **Bowman’s Capsule**, a cup-shaped hollow structure that completely surrounds the glomerulus like a well-worn baseball glove encloses a ball.
nephrons

- The renal tubule, which makes up the rest of the nephron, is about 3 cm (approximately 1.25 inches) long.
- As it extends from the glomerular capsule, it coils and twists before forming a hairpin loop and then again becomes coiled and twisted before entering a collecting duct.
- These different regions of the tubule have specific names; in order from the glomerular capsule, they are the proximal convoluted tubule (PCT); the nephron loop, (loop of Henle); and the distal convoluted tubule (DCT).
nephrons

- Most nephrons are called **cortical nephrons** because they are located almost entirely within the **cortex**.
- In a few cases, the nephrons are called **juxtamedullary nephrons** because they are situated close to the cortex-medulla junction, and their nephron loops dip deep into the **medulla**.
- The **collecting ducts**, each of which receives urine from many nephrons, run downward through the medullary pyramids, giving the pyramids a striped appearance.
- They deliver the **final urine** product into the calyces and renal pelvis.
glomerular filtration

- As just described, the glomerulus acts as a filter.
- Glomerular filtration is a nonselective, passive process in which fluid passes from the blood into the glomerular capsule part of the renal tubule.
- Once in the capsule, the fluid is called filtrate; it is essentially blood plasma without blood proteins.
- Both proteins and blood cells are normally too large to pass through the filtration membrane, and when either of these appears in the urine, there is usually a problem with the glomerular filters.
- As long as the systemic blood pressure is normal, filtrate will be formed.
- If arterial blood pressure drops too low, glomerular pressure becomes inadequate to force substances out of the blood into the tubules, and filtrate formation stops.
tubular reabsorption

- Besides wastes and excess ions that must be removed from the blood, the filtrate contains many useful substances (including water, glucose, amino acids, and ions), which must be reclaimed from the filtrate and returned to the blood.
- Tubular reabsorption begins as soon as the filtrate enters the proximal convoluted tubule.
- The tubule cells are “transporters,” taking up needed substances from the filtrate and then passing them out their posterior aspect into the extracellular space, from which they are absorbed into peritubular capillary blood.
- Some reabsorption is done passively (for example, water passes by osmosis), but reabsorption of most substances depends on active transport processes, which use membrane carriers, require ATP, and are very selective.
- Needed substances (for example, glucose and amino acids) are usually entirely removed from the filtrate.
- Most reabsorption occurs in the proximal convoluted tubules, but the distal convoluted tubule and the collecting duct are also active.
tubular secretion

- Tubular secretion is essentially tubular reabsorption in reverse.
- Some substances, such as hydrogen and potassium ions (H+ and K+) and creatinine, also move from the blood of the peritubular capillaries through the tubule cells or from the tubule cells themselves into the filtrate to be eliminated in urine.
- This process seems to be important for getting rid of substances not already in the filtrate, such as certain drugs or excess potassium ions, or as an additional means for controlling blood pH.
nitrogenous waste

- **Nitrogenous** waste products are poorly reabsorbed, if at all.
- Tubule cells have few membrane carriers to reabsorb these substances because we do not need them.
- They tend to remain in the filtrate and are found in high concentrations in urine excreted from the body.
- Various ions are reabsorbed or allowed to go out in the urine, according to what is needed at a particular time to maintain the proper pH and electrolyte (solute) composition of the blood.
- Common nitrogenous wastes include the following:
  - **Urea**, formed by the liver as an end product of protein breakdown when amino acids are used to produce energy
  - **Uric acid**, released when nucleic acids are metabolized
  - **Creatinine**, associated with creatine metabolism in muscle tissue.
characteristics of urine

- Freshly voided urine is generally clear and pale to deep yellow.
- The normal yellow color is due to urochrome, a pigment that results from the body’s destruction of hemoglobin.
- The more solutes are in the urine, the deeper yellow its color.
- Dilute urine is a pale, straw color. At times, urine may be a color other than yellow.
- This might be a result of eating certain foods (beets, for example) or the presence of bile or blood in the urine.
- When formed, urine is sterile, and its odor is slightly aromatic.
- If it is allowed to stand, it takes on an ammonia odor caused by the action of bacteria on the urine solutes.
- Some drugs, vegetables (such as asparagus), and various diseases (such as diabetes mellitus) alter the usual odor of urine.
- Urine pH is usually slightly acid (around 6), but changes in body metabolism and certain foods may cause it to be much more acidic or basic.
- For example, a diet with large amounts of protein (eggs and cheese) and whole-wheat products causes urine to become quite acidic.
- Conversely, a vegetarian diet makes urine quite alkaline as the kidneys excrete excess bases.
- Bacterial infection of the urinary tract also may cause the urine to be alkaline.
micturition

- Also called voiding, is the act of emptying the bladder.
- As noted, two sphincters, or valves—the internal urethral sphincter (more superiorly located) and the external urethral sphincter (more inferiorly located)—control the flow of urine from the bladder.
- Ordinarily, the bladder continues to collect urine until about 200 ml have accumulated.
- At this point, stretching of the bladder wall activates stretch receptors.
- Impulses transmitted to the sacral region of the spinal cord and then back to the bladder via the pelvic splanchnic nerves cause the bladder to go into reflex contractions.
- As the contractions become stronger, stored urine is forced past the internal urethral sphincter (the smooth muscle, involuntary sphincter) into the upper part of the urethra.
- The person will then feel the urge to void.
micturition

- Because the **lower external sphincter** is skeletal muscle and is controlled voluntarily, we can choose to keep it closed and postpone bladder emptying temporarily.

- However, if it is convenient, the external sphincter can be relaxed so that urine is flushed from the body.

- When a person chooses not to void, the reflex contractions of the bladder stop within a minute or so, and urine collection continues.

- After 200 to 300 ml more have been collected, the micturition reflex occurs again.

- Eventually, micturition occurs whether the person wills it or not.
Pathology & Diseases
Check page 314-317 from the book “Mastering Medical Terminology” for the complete list of pathology and diseases.
chronic kidney disease

- Chronic kidney disease or **CKD** is the preferred terminology for chronic renal failure.

- **CKD** is diagnosed by blood test for **creatinine** to determine the patient’s glomerular filtration rate.

- High levels of creatinine means the glomerular filtration rate is falling which means that the kidney’s ability to filter and excrete waste products is **inhibited**.

- In the early stages of **CKD**, creatinine levels may be normal, but urinalysis demonstrates a loss of protein or red blood cells into the urine.

- There are five stages of **CKD** categorized according to the level of reduced kidney function and evidence of kidney damage, such as blood or protein in the urine.

- The most severe stage is **end-stage kidney disease (ESKD)**, also called **end-stage renal disease** and **CKD** stage 5, which is diagnosed when kidney function deteriorates to the extent that irreversible kidney failure occurs, requiring kidney dialysis or kidney transplant.
kidney agenesis

- **Kidney** (renal) *agenesis* occurs when the kidneys do not form during fetal development.
- **Renal agenesis** can be unilateral, with one kidney present, or bilateral, with no kidneys or very little kidney tissue present (dysgenesis).
- If the agenesis is unilateral, the other kidney will usually hypertrophy to recover for the missing kidney.
- Unilateral agenesis is often *asymptomatic* and is often discovered later in life.
glomerulonephritis

- **Glomerulonephritis** is a kidney disease in which the glomeruli – the parts of the kidneys responsible for filtering waste and fluids from the blood - become inflamed.

- This causes blood and protein to be lost in the urine.

- **Glomerulonephritis** may be caused by specific problems with the body’s immune system but often the cause is **unknown**.

- **Glomerulonephritis** can be acute (a sudden attack of inflammation) - or chronic (beginning gradually).

- In some patients there is no history of kidney disease and the disorder first manifests as chronic renal failure.
renal failure

- Renal failure refers to inability of the kidneys to maintain proper filtration function, excrete wastes appropriately and to maintain electrolyte balance.
- There are three main stages: acute, chronic (now called chronic kidney disease as discussed above) and end-stage.
- Acute renal failure (ARF) is the sudden loss of the ability of the kidneys to remove waste and concentrate urine.
- It is usually initiated by an underlying cause, such as severe dehydration, infection, trauma to the Kidney or the chronic use of painkillers.
- ARF is often reversible with no lasting damage.
- ARF is also known as acute kidney injury (AKI).
- End-stage renal disease (ESRD) is the complete failure of the kidneys to function, or where chronic kidney disease has worsened to the point at which kidney function is less than 10% of normal.
- See chronic kidney disease above.
- ESRF is also called chronic kidney disease (CKD) stage 5.
bladder calculus

- Bladder calculus is also known as vesical calculus.
- It refers to the presence of calculi (stones) in the bladder.
bladder cancer

- Bladder cancer is the presence of malignant cells in the urinary bladder.
- There are several types of bladder cancers.
- The most common histological type is transitional cell carcinoma that begins in the cells lining the bladder, kidneys, ureters and urethra.
- This accounts for about 90% of cases.
- Squamous cell carcinoma and adenocarcinoma account for the rest.
- The exact causes of bladder cancer are not known but there are well-established risk factors for developing the disease, such as cigarette smoking, occupational exposure to certain chemicals and fumes, chronic bladder infections, family history and gender (male).
- It is treated by electrocautery for superficial tumors, but more invasive tumors may require cystectomy, chemotherapy and/or radiation therapy.
urethritis

- Urethritis is an infection of the urethra.
- It is a specific form of the general condition called **urinary tract infection**.
- It occurs when **bacteria** from the digestive tract enter the urethra and multiply.
ureteric calculus

- Kidney Stone (Ureteric Calculus)
  - The presence of a solid **stone** in the urinary tract, formed from **minerals** within the urine.
  - These can **obstruct** urinary flow, causing **pain** and **haematuria** (blood in the urine).

- There are three locations where a stone is more likely to become stuck:
  - Uretopelvic junction
  - Pelvic brim
  - Where the ureter enters the bladder.

- The gold standard investigation for suspected ureteric calculus is CT scan of the kidneys, ureters and bladder
hypertensive kidney disease

- When high blood pressure causes kidney disease it is called hypertensive kidney disease.
- This occurs most often in persons who have undetected, untreated, or poorly controlled hypertension.
- High blood pressure makes the heart work harder.
- In turn, this can damage blood vessels throughout the body.
- If the blood vessels in the kidneys are damaged, the kidneys can lose their ability to filter blood, allowing a build-up of toxic substances and extra fluid in the body.
- The extra fluid in the blood vessels may then raise blood pressure even more and the cycle continues.
Tests & Procedures
Check page 318-322 from the book “Mastering Medical Terminology” for the complete list of tests and procedures.
blood urea nitrogen

- A BUN is a diagnostic test to determine how well the kidneys are functioning to eliminate waste from the body.
- The test measures the level of nitrogen in urea, with a higher level indicating an issue with kidney function.
computed tomography scan

- A CT is a diagnostic test that can be used to identify disorders of urinary structures.
- Cross-sectional images are taken using a computer in conjunction with x-ray beams.
cystoscopy

- A cystoscopy is a procedure that allows for the visual examination of the bladder using a cystoscope.
- The procedure is performed by inserting the scope into the urethra and passing it up to the bladder.
- Insertion of a catheter into the scope allows for biopsies of the bladder to be taken for microscopic examination.
magnetic resonance imaging

- An MRI is a diagnostic test that creates images of the kidney and associated structures using radiowaves and a magnetic field to identify lesions that cannot be easily noted on x-ray.
renal angiography

- Renal angiography is a process using radio opaque contrast to record x-ray images of the vessels of the kidney to identify disorders such as aneurysms, blood clots, renal stenosis and kidney failure.
renal biopsy

- Renal biopsy involves taking a sample of kidney tissue for laboratory examination.
- It can be performed as an open procedure or percutaneously, using a biopsy needle (generally under ultrasound guidance).
renal transplantation

- Renal transplantation is a surgical procedure that involves the removal of a diseased kidney and replacement with a donor organ (either from a living donor or a cadaver).
- Living donor kidneys can be either from an identical twin (isograft) or another individual (allograft), preferably from a close relative.
voiding cystourethrogram

- A VCUG is a diagnostic test using contrast medium inserted into the bladder to allow for x-ray images to be undertaken while the bladder is emptying (voiding).
- The procedure is performed to identify urethral strictures and urinary reflux.
bilirubin test

- A bilirubin test measures the amount of bilirubin in the urine.
- Bilirubin is a pigmented substance found in bile and removed from the blood by the liver.
- If the liver has difficulty excreting the bilirubin or if there is a blockage of the biliary drainage then bilirubin may appear in urine, giving the urine a darker appearance.
Exercises
EXERCISES

Exercise 14.1: Label the Diagrams

Using the information provided in this chapter, label the anatomical parts in the figures below.

Figure 14.10
(Moody's Dictionary, 2014)

Figure 14.11
(Moody's Dictionary, 2018)
Exercise 14.2: Match Word Elements and Meanings
Match the prefix, suffix or word root in Column A with its meaning from Column B.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Answer</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. trigono</td>
<td>A. urethra</td>
<td></td>
</tr>
<tr>
<td>2. pyelo</td>
<td>B. potassium</td>
<td></td>
</tr>
<tr>
<td>3. nephro</td>
<td>C. thirst</td>
<td></td>
</tr>
<tr>
<td>4. cole</td>
<td>D. substance that forms</td>
<td></td>
</tr>
<tr>
<td>5. crinis</td>
<td>E. trigone (base of the bladder)</td>
<td></td>
</tr>
<tr>
<td>6. calic</td>
<td>E. stone</td>
<td></td>
</tr>
<tr>
<td>7. uriniferous</td>
<td>G. renal pelvis</td>
<td></td>
</tr>
<tr>
<td>8. ilaf</td>
<td>H. keratones</td>
<td></td>
</tr>
<tr>
<td>9. cylindro</td>
<td>I. kidney</td>
<td></td>
</tr>
<tr>
<td>10. digerens</td>
<td>J. nitrogen, urea</td>
<td></td>
</tr>
<tr>
<td>11. unio</td>
<td>K. testis</td>
<td></td>
</tr>
<tr>
<td>12. poodrin</td>
<td>L. protrusion, hernia</td>
<td></td>
</tr>
<tr>
<td>13. kolo</td>
<td>M. pus</td>
<td></td>
</tr>
<tr>
<td>14. nephro</td>
<td>N. irrigation, welling</td>
<td></td>
</tr>
<tr>
<td>15. -quam</td>
<td>O. scanty</td>
<td></td>
</tr>
<tr>
<td>16. -weeaks</td>
<td>P. many, much</td>
<td></td>
</tr>
<tr>
<td>17. perico</td>
<td>Q. cayax</td>
<td></td>
</tr>
<tr>
<td>18. lithio</td>
<td>R. excrete in urine, urinate</td>
<td></td>
</tr>
<tr>
<td>19. poli</td>
<td>S. record, excrete</td>
<td></td>
</tr>
<tr>
<td>20. azotio</td>
<td>T. urine, urinary tract, urea</td>
<td></td>
</tr>
</tbody>
</table>
Exercise 14.3: Word Analysis and Meaning

Break up the medical terms below into their component parts (prefix, root, suffix, word roots, combining vowel).

Provide the meaning for each word element and each term as a whole.

Example:

ama = without
ur = urine, urinary tract, urea
uria = condition of

Meaning = condition of without urine

1. nephrolithotripsy

2. cystectomy

3. glomerulonephritis

4. ureterocystostomy

5. haematuria

6. polydipsia

7. pyelography

8. urology
9. erythropoietin

10. mastopathy

Exercise 14.4: Vocabulary Building
Provide the medical term for each of the definitions below.

1. hernia or protrusion of the uterus
2. condition of blood where there is excessive potassium
3. creation of surgical opening into the uterus and small intestine
4. incision into the urinary bladder
5. downward displacement of the kidney
6. abnormal condition of semen bodies
7. recording of the uterus and urinary bladder
8. expansion or dilation of the uterus
9. pertaining to above the kidneys
10. pain in the urethra
Exercise 14.5: Match the Abbreviations and Meanings

Match each abbreviation in Column A with its meaning in Column B.

<table>
<thead>
<tr>
<th>Column A</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. TFP</td>
<td>A. peritoneal dialysis</td>
</tr>
<tr>
<td>2. CRF</td>
<td>B. chronic kidney disease</td>
</tr>
<tr>
<td>3. PKD</td>
<td>C. voiding cystourethrogram</td>
</tr>
<tr>
<td>4. ESWL</td>
<td>D. end stage renal disease</td>
</tr>
<tr>
<td>5. UTI</td>
<td>E. bladder neck obstruction</td>
</tr>
<tr>
<td>6. BUN</td>
<td>F. acute tubular necrosis</td>
</tr>
<tr>
<td>7. ABS</td>
<td>G. intravenous pyelogram</td>
</tr>
<tr>
<td>8. GFR</td>
<td>H. glomerular filtration rate</td>
</tr>
<tr>
<td>9. BNG</td>
<td>I. chronic renal failure</td>
</tr>
<tr>
<td>10. ESRD</td>
<td>J. urinalysis</td>
</tr>
<tr>
<td>11. VCUG</td>
<td>K. extracorporeal shock wave lithotripsy</td>
</tr>
<tr>
<td>12. ATN</td>
<td>L. polycystic kidney disease</td>
</tr>
<tr>
<td>13. CKD</td>
<td>M. acute renal failure</td>
</tr>
<tr>
<td>14. PAKU</td>
<td>N. glomerular filtration rate</td>
</tr>
<tr>
<td>15. CARD</td>
<td>O. antidiuretic hormone</td>
</tr>
<tr>
<td>16. UA</td>
<td>P. culture and sensitivity</td>
</tr>
<tr>
<td>17. C&amp;B</td>
<td>Q. continuous cycling peritoneal dialysis</td>
</tr>
<tr>
<td>18. PD</td>
<td>R. urinary tract infection</td>
</tr>
<tr>
<td>19. ADH</td>
<td>S. blood urea nitrogen</td>
</tr>
<tr>
<td>20. CCPD</td>
<td>T. continuous ambulatory peritoneal dialysis</td>
</tr>
</tbody>
</table>
Exercise 14.6: Vocabulary Building

Provide the medical term for each of the definitions below.

1. process of passing urine
2. the main nitrogenous constituent of urine
3. sugar in the urine
4. an exces of acetone bodies in the urine
5. abnormal high levels of albumin in the urine
6. doctor who specializes in diseases of the urinary tract
7. x-ray of the ureter and renal pelvis
8. to introduce a catheter into the urinary bladder
9. irrigating the bladder (to cleanse it)
10. excessive urination during the night

New briefly define the following terms.

11. nephroptosis
12. ureteral colic
13. hydronephrosis
14. nephrotic syndrome
15. vesicoureteral reflux
### Exercise 14.7: Applying Medical Terminology

Fill in the blank or select the correct medical term.

1. Urethritis is inflammation of the urethra and
   - a) bladder
   - b) kidney
   - c) renal pelvis
   - d) renal tubule

2. What is the operative term for the fixation of a clasp at kidney?
   - a) nephrectomy
   - b) nephropathy
   - c) nephronectomy
   - d) nephrolithotomy

3. ________ is used for stone retrieval or stone replacement in the urinary tract.
   - a) intracorporeal electrohydraulic lithotripsy
   - b) ureteroscopy
   - c) urologic endoscopic surgery
   - d) pyeloplasty

4. Enuresis refers to
   - a) an involuntary discharge of urine often while asleep
   - b) an inability to urinate
   - c) urinating at night
   - d) excessive urination

5. Oliguria means __________
   - a) scanty production of urine
   - b) excessive production of urine
   - c) presence of bacteria in the urine
   - d) difficulty in urination

6. Cystitis is an inflammation of the __________
   - a) bladder
   - b) kidney
   - c) ureter
   - d) urethra

7. A mast cell in the blood as a result of kidney failure is __________
   - a) uric acid
   - b) urea
   - c) haematuria
   - d) dysuria

8. The inner part of the kidney is called the __________
   - a) cortex
   - b) core
   - c) medulla
   - d) renal tubule

9. Incontinency discharge of urine is known as __________
   - a) incompetence
   - b) impotence
   - c) incontinence
   - d) intussusception

10. Urine passes from the kidney to the bladder via the __________
    - a) urethra
    - b) ureter
    - c) urineter
    - d) urethrer

### Exercise 14.8: Pronunciation and Comprehension

Read the following paragraphs aloud to practice your pronunciation. Using your textbook and a medical dictionary, find the meanings of the underlined medical terms.

A 13-month-old boy was admitted with right vesicoureteric junction obstruction for right ureteric replacement. He was originally admitted in August last year with right vesicoureteric junction obstruction (VUO) at the age of 7 months. A subsequent ultrasound showed mild dilatation of the right ureteric system with the left kidney being normal. An MCU was normal showing no vesicoureteral reflux and a renal scan showed a greatly dilated right pyelocalyceal system (PUC), with significant functional obstruction at the PUC level. In December he was admitted for an emergency procedure, which again showed right vesicoureteric junction and a severe right hydronephrosis. The right ureteric replacement was performed under general anaesthetic (ASA = 3NE) without complication. He was subsequently admitted to ICU for fluid resuscitation and his postoperative recovery was uneventful. This child was discharged on a symptomatic dose of Tenormin and is to be reviewed in Outpatients in 6 weeks with the results of a repeat renal ultrasound scan. Arrangements will then be made to remove the ureteric stent, which was inserted during the operation.
Exercise 14.9: Crossword Puzzle

Complete the puzzle by providing the medical term for each of the clues below.

**ACROSS**

1. a floating kidney (12)
2. occurs when urine in the bladder flows back into the ureters and often back into the kidneys (1, 8)
3. filtering of blood through the nephrons in the kidney (18)
4. a kidney disorder involving the tubular segment of the nephron which becomes damaged or destroyed (17, 2)
5. the inability of the kidneys to maintain proper filtration function, excrete wastes or maintain the electrolyte balance (3, 7)

**DOWN**

2. abnormal distension of the ureter with urine (11)
3. occurs when the kidneys do not form during fetal development (8, 8)
4. infection of the renal pelvis and renal medulla of the kidney (14)
5. herniation or protrusion of the urinary bladder through the anterior vaginal wall (8)
Exercise 14.10: Anagram

Work out each medical term from the jumbled letters below. Then, using the letters in brackets, determine the medical term that matches the description given.

1. lapasy   ___ ___ ___ ___  pos in the urine
2. narnia   ___ ___ ___ ___  the tube that carries urine from the bladder to the exterior
3. diagno   ___ ___ ___ ___  the process of excreting urine
4. sucahbo   ___ ___ ___ ___  an abnormal accumulation of ketones in the body
5. cirwacten  ___ ___ ___ ___ ___ ___ ___  need to pass urine frequently at night
6. prathone  ___ ___ ___ ___ ___  the functional unit of the renal system

Rearrange the letters in brackets to form a word that means a ‘retroperitoneal bean-shaped organ’.

___ ___ ___ ___ ___ ___

Exercise 14.11: Discharge Summary Analysis

Read the Discharge Summary below and answer the questions.

UNIVERSITY HOSPITAL DISCHARGE SUMMARY

<table>
<thead>
<tr>
<th>Field</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>URI number</td>
<td>201801</td>
</tr>
<tr>
<td>Name</td>
<td>Alison Mitchell</td>
</tr>
<tr>
<td>Address</td>
<td>12 Bluebird Street, Mississauga</td>
</tr>
<tr>
<td>Date of birth</td>
<td>2/7/1998</td>
</tr>
<tr>
<td>Sex</td>
<td>F</td>
</tr>
<tr>
<td>Race</td>
<td>White</td>
</tr>
<tr>
<td>Nominated primary healthcare provider</td>
<td>Dr. Joanna Brown</td>
</tr>
<tr>
<td>Consultant</td>
<td>Dr. Felicia</td>
</tr>
<tr>
<td>Registrar</td>
<td>Dr. Hampshire</td>
</tr>
<tr>
<td>Unit</td>
<td>Urology</td>
</tr>
<tr>
<td>Admission source</td>
<td>Elective</td>
</tr>
<tr>
<td>Date of admission</td>
<td>4/9/2016</td>
</tr>
<tr>
<td>Reason for admission/Presenting problems</td>
<td>Five-year history of stress incontinence for which she has had two previous anterior repairs.</td>
</tr>
<tr>
<td>Principal diagnosis</td>
<td>Stress incontinence</td>
</tr>
<tr>
<td>Comorbidities</td>
<td>Mildly elevated BP</td>
</tr>
<tr>
<td>Previous medical history</td>
<td>Two previous anterior repairs for stress incontinence, vaginal deliveries, cholecystectomy, incisional hernial repair, gynecologic surgery due to adhesions, labial and vaginal polyposis excised.</td>
</tr>
</tbody>
</table>

Discharge details

<table>
<thead>
<tr>
<th>Field</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status</td>
<td>Home</td>
</tr>
<tr>
<td>Date of discharge</td>
<td>4/9/2016</td>
</tr>
</tbody>
</table>


Khaleel Alyahya, PhD, MEd
Clinical synopsis:
Booked as an elective admission for a urethral suspension. This was performed on 15/2/2016 under general anaesthetic via a perinealtemplate incision. The procedure was uncomplicated. Following surgery she remained an inpatient for 7 days prior to her discharge. An IDC inserted during surgery was removed on Day 5. She was asked to come back to the Outpatient Clinic about 4 weeks following her surgery.
Prior to discharge, she reported that she could void well and ultrasound of her bladder confirmed that her residual urine was minimal. She was therefore discharged home to continue recovering for a further fortnight prior to a gradual increase in all activities to normal.

Complications:
Clinical interventions:
Urinary suspension

Diagnostics interventions:

Medications at discharge:

Stopped medications:

Allergies:

Alerts:

Arranged services:

Recommendations:
Outpatient Clinic about 4 weeks following her surgery.

Information to patient/related parties:
Continue resting for a further fortnight prior to a gradual increase in all activities to normal.

Authorising doctor: Dr. Thompson

Document recipients:
Patient and LMO: Dr. Joanna Brown

1. Expand the following abbreviations as found in the discharge summary above.
BP
IDC
TAs

2. Ms. Mitchell’s principal diagnosis was stress incontinence. What does this mean?

3. What is a Pfannenstiel incision and why is it preferred?

4. It is stated that post-surgery, Ms. Mitchell’s residual urine was minimal. What does this mean?

5. List all the procedures that Ms. Mitchell had performed during her current admission.
QUESTIONS?

alkhaleel@ksu.edu.sa