

UNIT 4

LESSON 46

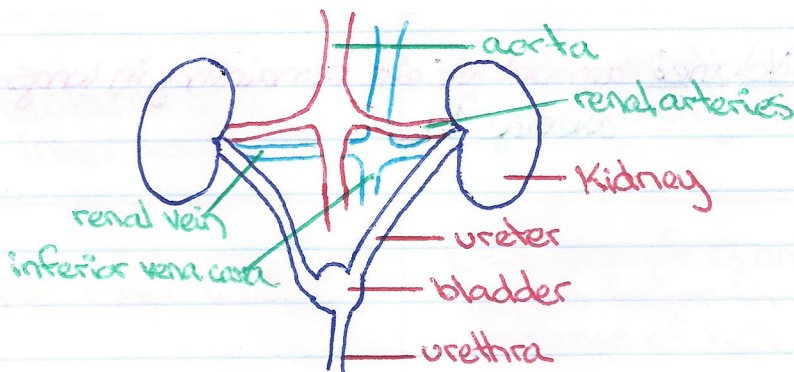
The Urinary System

Function: to create urine and move it outside the body.

Renal: Latin for kidney. The term renal is making a reference to the kidneys.

The major organs of the urinary system are:

- 1) Kidneys - produce urine
- 2) ureter - carries urine from kidneys to the bladder.
- 3) bladder - muscular sac, stores urine.
- 4) urethra - moves urine out of the body.



- the renal artery is connected directly to the aorta.
- the body's entire blood volume is filtered 2-3 times per min.
- this produces 1-2ml of urine.

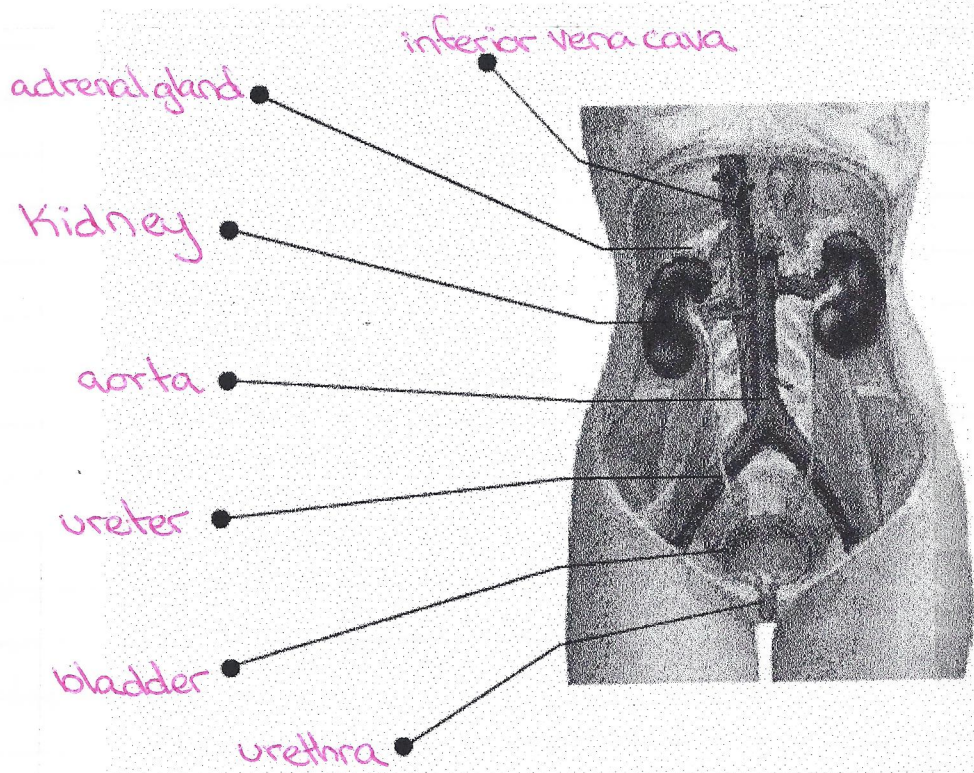
How much urine is produced per day? (average)

$$\begin{aligned} 24 \text{ hr} \times 60 \text{ min/hr} \times 1 \text{ mL} &= 1440 \text{ mL} - 2880 \text{ mL} \\ &= 1.4 \text{ L to } 2.9 \text{ L per day} \end{aligned}$$

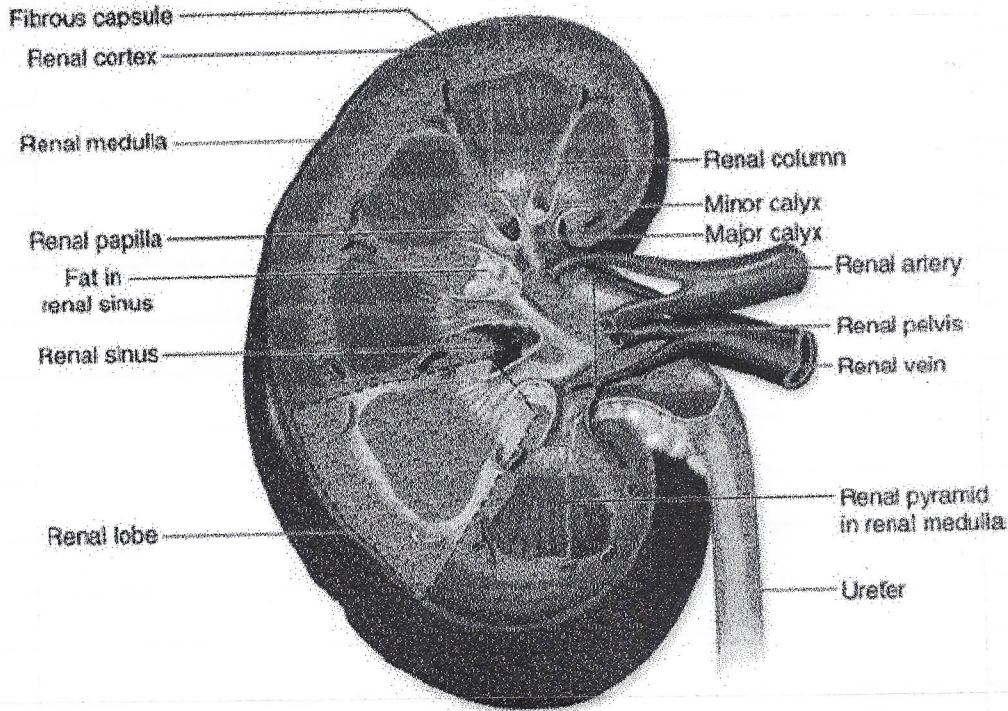
Waste products in urine:

- 1) Urea - formed by metabolism of proteins
 - breakdown of polypeptides into amino acids produces toxic ammonia (NH_3)
 - the body combines NH_3 with CO_2 to form urea.

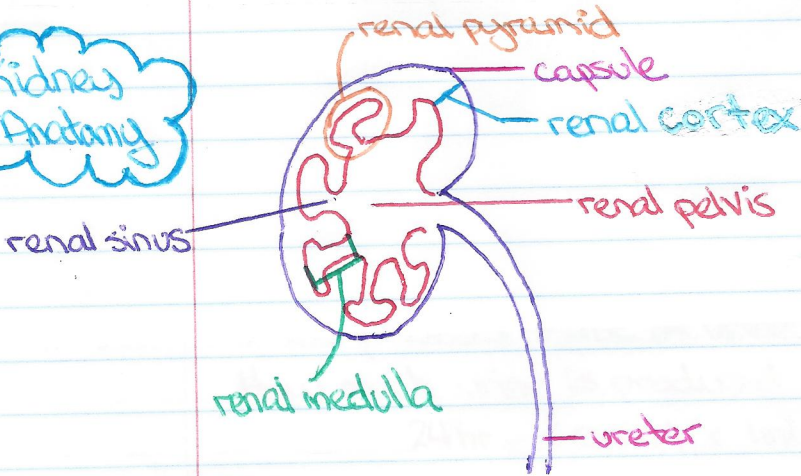
- 2) Creatinine - produced by the breakdown of creatine-phosphate
(a backup energy molecule to ATP) - used in muscle cells.
- 3) Uric Acid - produced by the metabolism of nucleic acids. ^{DNA} RNA
gout → buildup of uric acid RNA crystals in joints,
causes joint pain and swelling.



LESSON 47



Kidney Anatomy



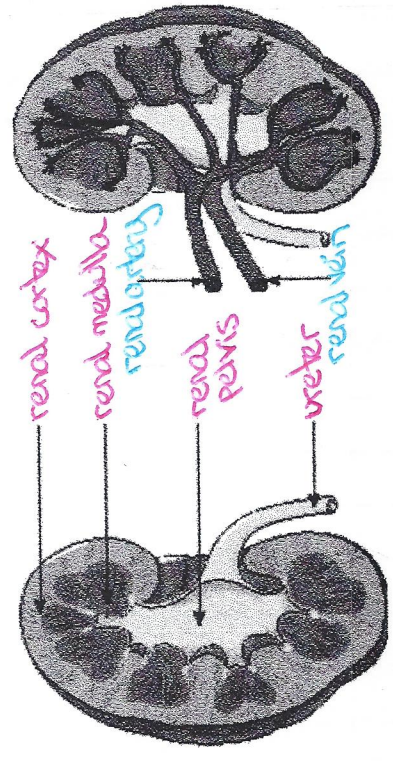
Note: renal pyramid + renal cortex = renal lobe

Kidney Structure Functions

Structure	Function
kidneys	main organ of excretion, water balance and Na ⁺ ion regulation; also involved in secretion of the hormones renin and erythropoietin
renal pyramid	region of the kidney which contains nephrons, the urine-forming structures of the kidney
renal cortex	outer region of the kidney that contains most of nephrons, excluding the collecting ducts
renal medulla	central region of the kidney that contains the collecting ducts
renal pelvis	receives urine from the collecting ducts
renal artery	carries arterial blood to kidney
renal vein	carries venous blood away from kidney
ureter	carries urine to bladder from each kidney
urinary bladder	stores urine until released in urination
urethra	carries urine from bladder, out of the body

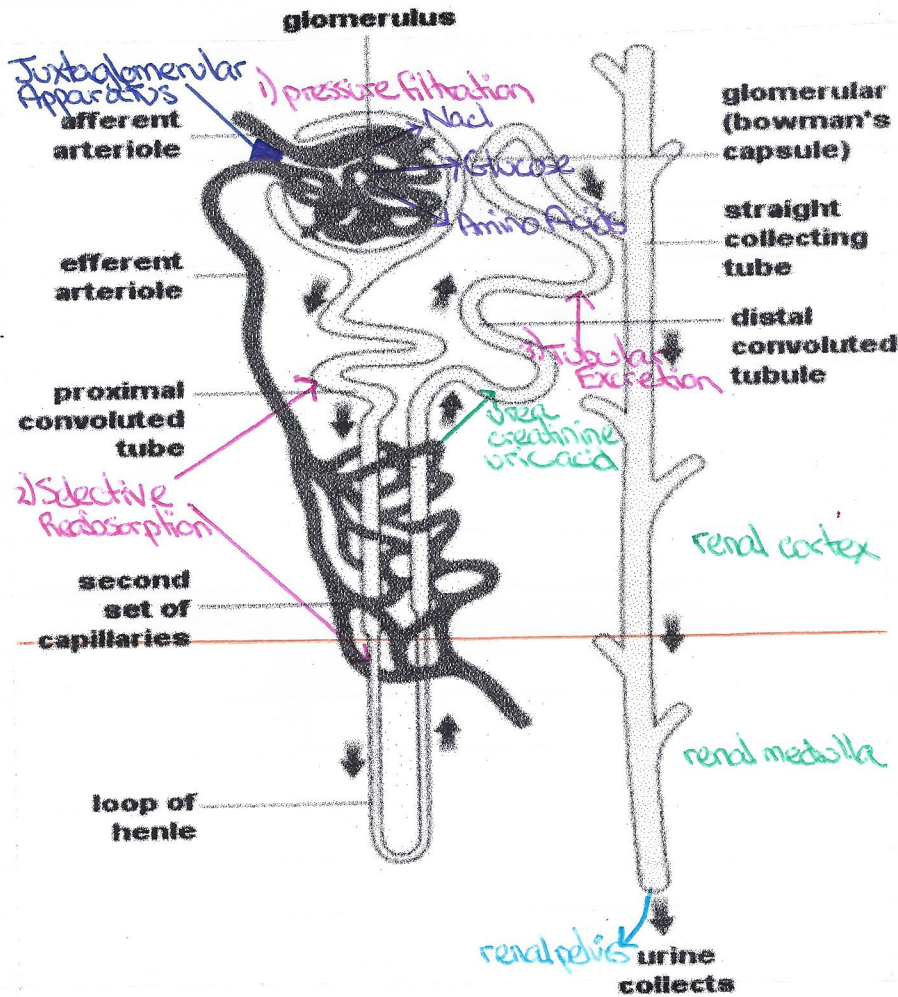
Use the terms from the following list to label the diagram of the kidney.

- renal cortex
- renal medulla
- ureter
- renal vein
- renal artery
- renal pelvis



Urine Formation

- urine formation occurs in the kidneys
- the kidney contains millions of individual filtration units called nephrons.



Urine Formation 3 steps:

1) **Pressure Filtration** - blood flowing into the glomerulus is under high pressure.

* all small molecules (H_2O , salt, nutrients & waste) are filtered through the capillaries and into the Bowman's capsule.
→ at this point, the collected fluid is called **Glomerular Filtrate**.

LESSON 48 2) **Selective Reabsorption** - some components of glomerular filtrate are needed by the body.

ex. $NaCl$ is reabsorbed by diffusion in **Proximal Convoluted Tubule**,
* nutrients (glucose, amino acids) are reabsorbed by active transport, not diffusion. along with H_2O

3) **Tubular Excretion** - large molecules not filtered by the glomerulus are actively transported out of the blood and into the distal convoluted tubule.
(urea, creatinine, uric acid)

Final Product: Urine should contain:
1) mostly water
2) excess salts
3) metabolic wastes (urea, creatinine, uric acid)

Urine should NOT contain:

- 1) **nutrients:** selective reabsorption is not happening.
* bacterial infections which originate in the urethra can travel up to the kidney.
water is needed to remove glucose, so urine output is increased.
* all are symptoms of Diabetes ↓
- 2) **protein:** high blood pressure, large proteins are pushed out during pressure filtration.
2) **blood:** bruised kidneys, cause capillaries and tubules to break in the nephron, blood then enters the collecting duct.
- 3) **glucose:** normally all glucose is reabsorbed. If blood glucose causes some to remain in urine

*** NO URINE OUTPUT** → indicates kidney failure
blood would contain high levels of urea, creatinine, uric acid.

Case Studies in Renal Functions

Instructions

Here's your chance to exercise your knowledge! Imagine you are an intern doctor doing a rotation in the emergency ward of a hospital. What would you say is the cause of each patient's condition, based on the information provided? Use the *Inquiry Into Life* textbook and the Internet to research your answers.

Case 1

Young adolescent boy dressed in soccer uniform. Complaining of pain in lower back. When examined he has a large bruise in the painful region of his back. His urine sample is tinged red. He has no fever, no other pain, and is otherwise quite healthy and normal. (3 marks)

Case 2

Older female patient dressed in nightclothes. Urine sample indicates abnormal levels of nutrients, salts, and urea. Patient is lethargic (seems tired and has difficulty moving) and complains of feeling unwell. Blood work indicates elevated levels of white blood cells. (5 marks)

Case 3

Middle aged overweight man. Complains of being thirsty and urinating frequently. Patient complains of being extremely weak and tired. Blood work shows elevated levels of glucose. Urine contains glucose and is very dilute. (5 marks)

Case 4

Patient has extremely low blood pressure caused by congestive heart failure; unable to provide a urine sample. Patient reports that they have not urinated for two days. Patient is extremely weak and feels terrible. Blood work shows elevated levels of urea and imbalance of electrolytes (ions in blood). (4 marks)

LESSON 49

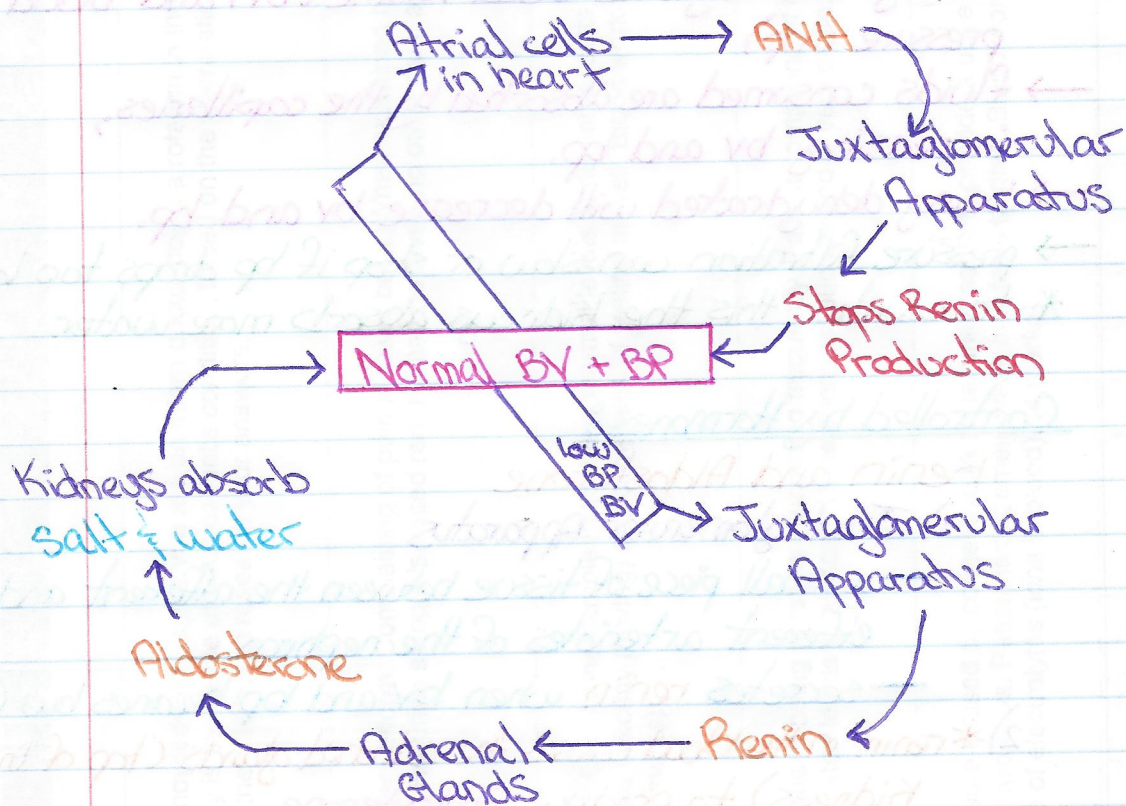
Regulation of Water Balance

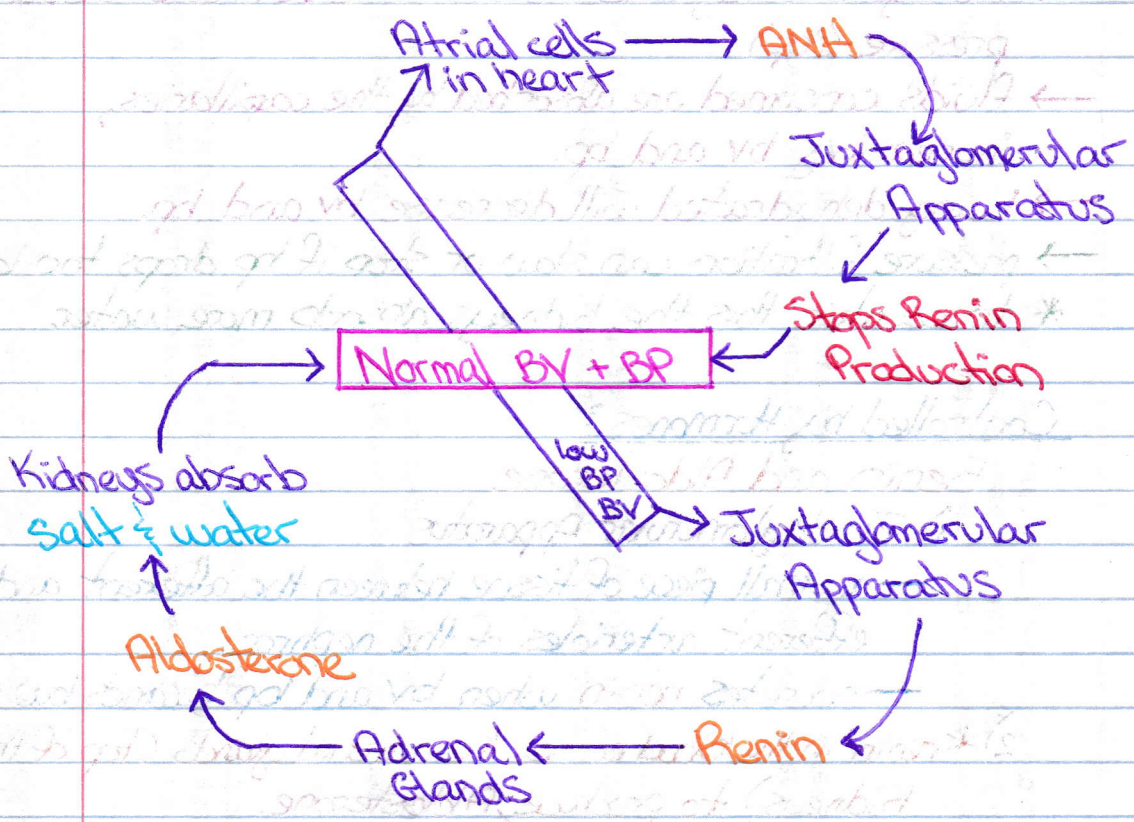
- the kidney's have a role in homeostasis,
- they maintain the water/salt balance of the body,
- Kidneys also regulate blood volume (bv) and blood pressure (bp)
- fluids consumed are absorbed by the capillaries, increasing bv and bp.
- being dehydrated will decrease bv and bp.
- pressure filtration can slow or stop if bp drops too low.
- * to counter this the kidneys absorb more water.

Controlled by Hormones

Renin and Aldosterone

- 1) Juxtaglomerular Apparatus
 - a small piece of tissue between the afferent and efferent arterioles of the nephron.
 - secretes renin when bv and bp becomes low (dehydrated)
- 2) *renin in the blood causes the adrenal glands (top of the kidneys) to produce Aldosterone.
 - ↳ causes more Na^+ ions to move out of the loop of Henle and into the blood
 - water moves with the Na^+ ions, so more water is absorbed
 - water moves out of the nephron tubule and into the blood.
 - urine becomes more concentrated
 - if blood volume becomes too high...
- 3) Heart atria cells stretch
 - causes them to secrete Atrial Natriuretic Hormone (ANH)
 - ANH in the blood stops the juxtaglomerular apparatus from producing renin.





LESSON 50

→ Another hormone produced in the hypothalamus (an area of the brain) is **Anti-Diuretic Hormone (ADH)** causes kidneys to absorb more water.

* ADH production STOPS as blood volume ↑s.

- Blood enters the kidney through the Renal Artery.
- Blood leaves the kidney through the Renal Vein.

* IF levels are other than shown, that indicates illness.

Renal Artery	Renal Vein
- high O ₂ levels	- low O ₂ levels
- normal glucose	- normal glucose
- high metabolic wastes	- low metabolic wastes
- normal levels of renin, aldosterone, ANH, ADH	- normal levels of renin, aldosterone, ANH, ADH

First Nations • BI12 • Resources • Urinary System Written Response

Please answer the following questions as completely as you can.

This assignment is to handed in for marks.

/15

1. Draw a diagram of the urinary system the show the location of the following structures.(4 marks)
a) kidneys b) ureters c) urinary bladder d) urethra
2. List the names of the three tubes connected to the kidneys and describe the composition of the fluid contained within each one.(3 marks)
3. In what part of the kidney are the nephrons located? (1 mark)
4. What methods of transport does the kidney use to move molecules into or out of the blood?(1 mark)
5. Describe the compositions of the filtrate at the two opposite ends of the nephron. What is the glomerular filtrate composed of vs. what is the final urine product composed of?(2 marks)
6. What are the three steps in urine formation? Describe each one briefly.(2 marks)
7. List the hormones involved in regulating water levels in the body. For each hormone include where it is produced, when it is produced and what effect it has on water reabsorption.(2 marks)