Dandii Boru School

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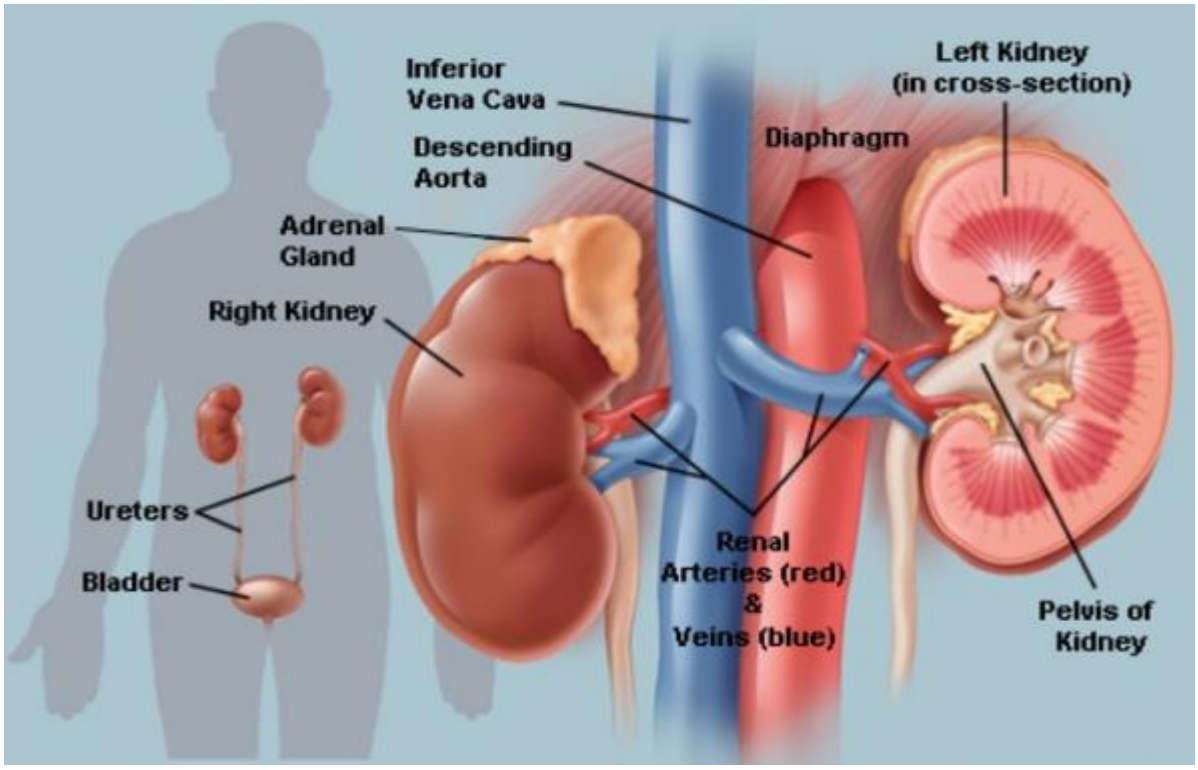
**2012E.C. (2019/2020) ACADEMIC YEAR**

Name _____ section_____

Grade 10 biology lecture notes on Homeostasis- part II.

- The kidneys



# THE KIDNEYS

The kidneys are a pair of bean-shaped organs on either side of your spine, below your ribs and behind your belly. Each kidney is about 4 or 5 inches long, roughly the size of a large fist.

The kidneys' job is to filter your blood. They remove wastes, control the body's fluid balance, and keep the right levels of electrolytes. All of the blood in your body passes through them several times a day

Blood comes into the kidney, waste gets removed, and salt, water, and minerals are adjusted, if needed. The filtered blood goes back into the body. Waste gets turned into urine, which collects in the kidney's pelvis -- a funnel-shaped structure that drains down a tube called the ureter to the bladder.

Each kidney has around a million tiny filters called nephrons. You could have only 10% of your kidneys working, and you may not notice any symptoms or problems

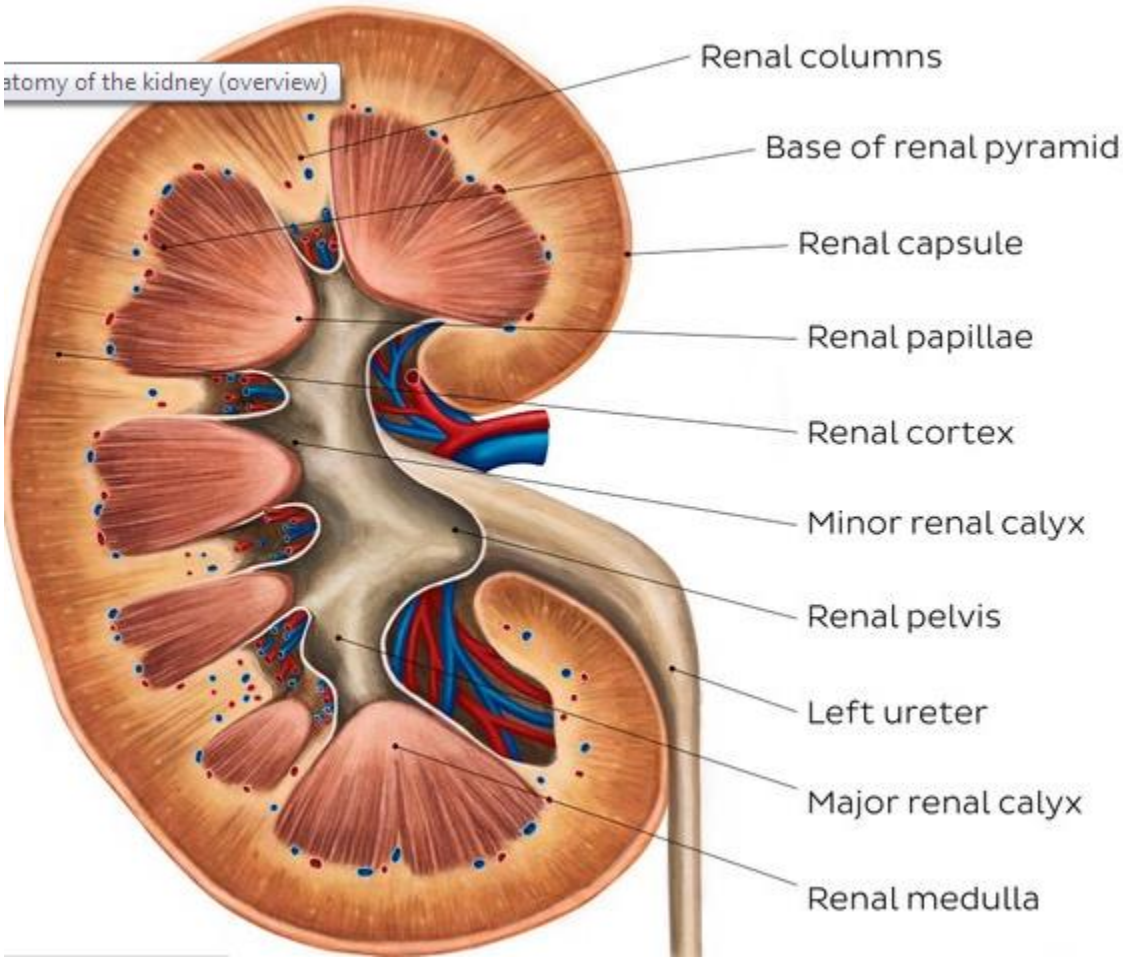



Figure 1. STRUCTURES OF THE HUMAN KIDNEY

**How do the kidneys remove urea and control the levels of water and ions in your body?**

Blood flows into the kidney along the renal artery. The blood is filtered, so fluid containing water, salt, urea, glucose and many other substances is forced out into the kidney tubules. Then everything the body needs is taken back (reabsorbed), including all of the sugar and the mineral ions needed by the body.
The amount of water reabsorbed depends on the needs of the body. The waste product urea and excess ions and water not needed by the body are released as urine.
Each kidney has a very rich blood supply and is made up of millions of tiny microscopic tubules (nephrons) which are where all the filtering and reabsorption takes place.

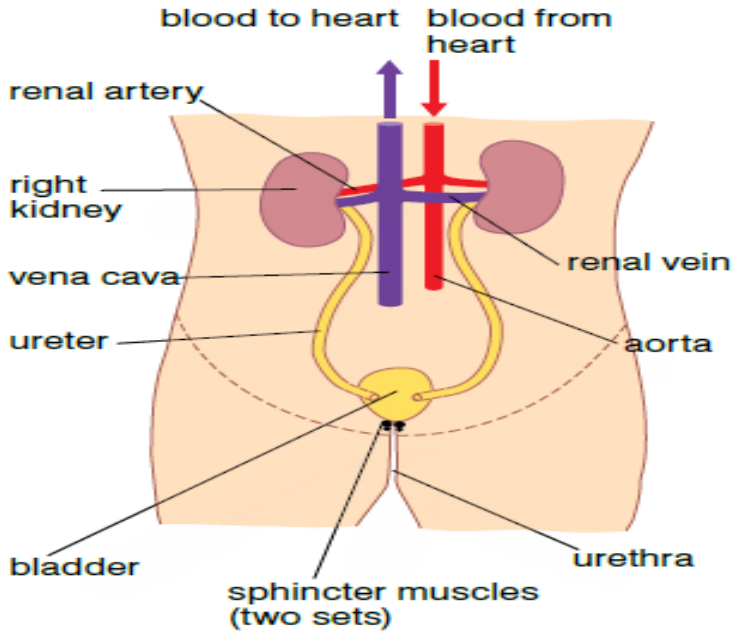



Figure 2. Our kidneys are very important organs of homeostasis ,involved in controlling the loss of water and mineral ions from the body as well as getting rid off urea

## The roles of the different areas of a single kidney tubule in the production of urine:

- Nephron is defined as the structural and functional unit of kidney. Each kidney consists of 1 to 1.3 millions of nephrons, each capable of forming urine

- Each nephron is formed by two parts: renal **corpuscle** and tubular portion called **renal tubule.**.

Renal corpuscle is formed by two portions:
1. Glomerulus
2. Bowman capsule

Function of the renal corpuscle is the filtration of blood which forms the first phase of urine formation..
***Bowman Capsule***

Bowman capsule is a capsular structure, which encloses the glomerulus.

• **Bowman's capsule**: the site of the **ultra filtration** of the blood. The blood vessel feeding into the capsule is wider than the vessel leaving the capsule, which means the blood in the capillaries is under a lot of pressure.

- Several layers of cells – the wall of the blood capillaries and the wall of the capsule – act as a filter and the blood cells and the large blood proteins cannot leave the blood vessels as they are too big to fit through the gaps. However, water, salt, glucose, urea and many other substances are forced out into the start of the tubule – in fact the concentration of substances in the liquid in the capsule is the same as that in the blood itself. This process is known as **ultra filtration** – filtration on a very small scale.

• **Glomerulus**: the knot of blood vessels in the Bowman's capsule where the pressure builds up so that ultrafiltration occurs. The volume of blood leaving the glomerulus is about 15% less than the blood coming in – which is a measure of the liquid which has moved into the capsule as a result of ultra filtration.

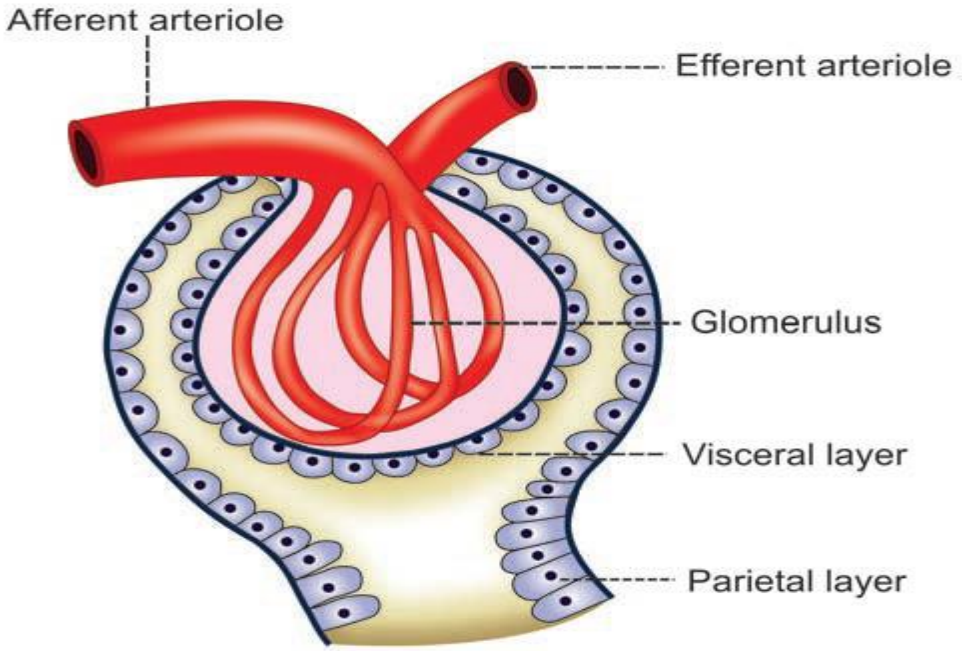



Fig 3.Renal corpuscle

**TUBULAR PORTION OF NEPHRON**

Tubular portion of nephron is the continuation of Bowman capsule.
It is made up of three parts:

1. Proximal convoluted tubule/**First coiled (convoluted) tubule**
2. Loop of Henle
3. Distal convoluted tubule/**Second coiled (convoluted) tubule**

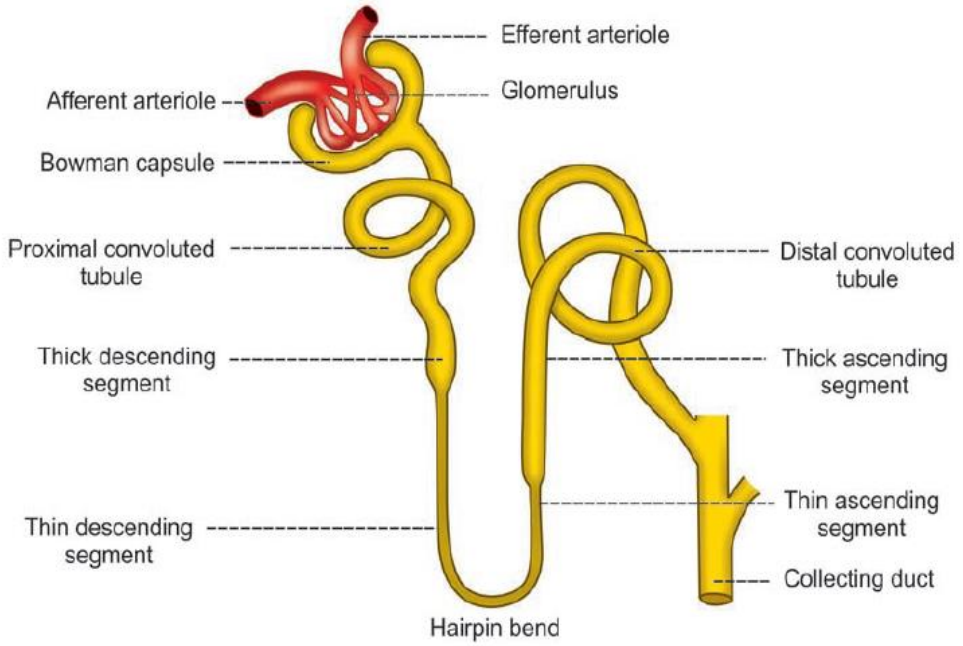



**FIGURE 49.1:** Structure of nephron

1. **First coiled (convoluted) tubule**: the liquid which enters this first tubule is known as the **glomerular filtrate**. The first tubule is where much of the reabsorption takes place. All of the glucose is actively taken back into the blood along with around 67% of the sodium ions and around 80% of the water. It has many microvillus to increase the surface area for absorption.
2. **Loop of Henlé**: where the urine is concentrated and more water is conserved.
3. **Second coiled (convoluted) tubule**: where the main water balancing is done. If the body is short of water, more is

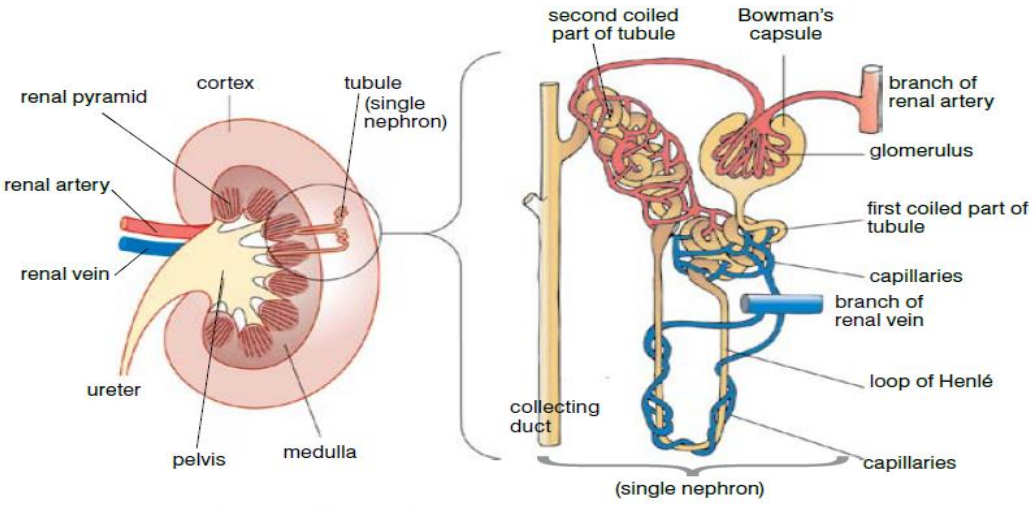



Figure The kidney filters

- reabsorbed into the blood in this tubule under the influence of the **anti-diuretic hormone** or **ADH**. (Diuresis means passing urine, so anti-diuresis means preventing or reducing urine flow.)
- Also ammonium ions and some drugs (if they have been taken into the body) are secreted from the blood into this tubule to get rid of them.
- By the end of this second coiled tubule all of the salt which is needed by your body has been reabsorbed, leaving the excess in the filtrate along with most of the urea.

**Collecting duct**: where the liquid (essentially urine) is collected. It contains about 1% of the original water, with no glucose at all. The level of salt in the urine will depend on the amount of salt in your diet and the water content of the urine. There is also a much higher concentration of urea in the urine than in the blood – about 60 times more, in fact.

- if your body badly needs more water, more may be reabsorbed along the collecting duct – again under the influence of ADH – until the urine passes into the pyramid of the kidney and on into your bladder.
- Urine is formed constantly in your kidneys, and it drips down to collect in your bladder. The bladder is a muscular sac which can hold between 600 and 800 $cm^3$ urine, although we usually empty it when it contains only 150–300 $cm^3$.
- We can control the opening of the bladder thanks to a strong ring of muscle known as a **sphincter**at the entrance to our **urethra**, the tube that leads from the bladder to the outside world. We can open and close this sphincter voluntarily, although it also opens as a reflex action if the bladder is too full – or if we are very frightened! When we are young, we have to learn to control our bladder sphincter voluntarily.
- The amount of water lost from the kidney in the urine is controlled by a sensitive feedback mechanism involving the hormone ADH.

If the water content of the blood is too low (so the salt concentration of blood increases) special sense organs known as **osmoreceptors** in your brain detect this.

- They stimulate the pituitary gland in the brain to release ADH into the blood. This hormone affects the second coiled tubules of the kidneys, making them more permeable so more water is reabsorbed back into the blood. This means lesswater is left in the kidney tubules and so a more concentratedurine is formed. At the same time the amount of water in the bloodincreases and so the concentration of salts in the blood returns to normal.
- If the water content of the blood is too high, the pituitary gland releases much less ADH into the blood. The kidney then reabsorbs less water back into the blood, producing a large volume of dilute urine. Water is effectively lost from the blood and concentration of salts returns to normal.
- This system of osmoregulation is an example of negative feedback. As the water concentration of the blood falls, the level of ADH produced rises. Then as the water concentration of the blood rises again, the level of ADH released falls.

- On an average day your kidneys will produce around 180 l (that's about 50 gallons) of liquid filtered out of your blood in the

glomerulus (**glomerular filtrate**) – but only about 1.5 l (just over 2.5 pints) of urine.

- So more than 99% of the liquid filtered out of your blood is eventually returned to it. You can observe the way in which your kidney works to maintain water balance in your own body.
- If you drink a lot of water, you will quickly notice that you need to urinate more often, and that you produce large quantities of very pale coloured, dilute urine.

If, on the other hand, you are ina situation where you cannot get enough to drink, you will urinate much less frequently and produce a small volume of dark coloured,concentrated urine.

- skin also plays a part in the salt and water balance of the body.

It forms a waterproof layer around the body tissues which protects us from the uncontrolled loss of water from our body tissues by evaporation.

- It also prevents you from gaining water by osmosis every time you go swimming in the river! The skin also loses salt and water through the process of sweating. This can affect the ion and water balance of your body when you sweat a lot. But this is a relatively uncontrolled loss.

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**Bowman's capsule** *the expanded end of a kidney tubule or nephron that acts as a filter to produce urine*
**Ultra filtration** *the removal of excess water and other substances from the blood*
**Glomerular filtrate** *the liquid resulting from filtration in the Bowman's capsule*

## The liver and homeostasis

- The plays a large role in maintaining a constant internal environment. It is the largest individual organ in your body – Your liver cells are very active – they carry out a wide range of functions, many of which help to maintain a constant internal environment.
- The liver has a very special blood supply. As well as the usual artery and vein (thehepatic artery and vein) there is another blood vessel which comesto the liver directly from the gut. This is the hepatic portal vein andit brings the products of digestion to the liver to be dealt with.
- A large number of reactions take place in the liver. Many of them are involved in homeostasis in one way or another.

## It plays a part in all of the following functions:

- **Control of the sugar levels** in the body (through stored glycogen in the liver itself).

• **Controlling and balancing the fats** that you eat and the cholesterol levels in your blood.

• **Protein metabolism** – your liver breaks down excess amino acids and forms urea. If you eat more carbohydrate or fat than you need in your diet your body simply stores the excess energy as fat. If you eat too much protein, it isn't so easy. Your body cannot store the excess amino acids or simply convert protein to fat.

Instead the amino acids which make up the protein are broken down in your liver. The amino (nitrogen containing) part of the amino acid molecule is removed and converted into ammonia and then urea in the liver. The rest of the amino acid can be used in cellular respiration or converted to fat for storage. The process of removing the amino group from excess amino acids is known as **deamination** and it is a very important function of the liver.

• **The breakdown of worn-out red blood cells** – in particular the red pigment hemoglobin.
• The **formation of bile** which is made in the liver and stored in the gall bladder before it is released into your gut to emulsify fats and help in their digestion.

- **Control of toxins –** your liver breaks down most of the poisons you take into your body, including alcohol. This is why the liver is so often damaged when people drink heavily.

• **Temperature control**. Around 500 different reactions take place in the liver at any time. For many years it has been believed that as a result of all these reactions the liver generates a lot of heat which is then spread around the body by the bloodstream.

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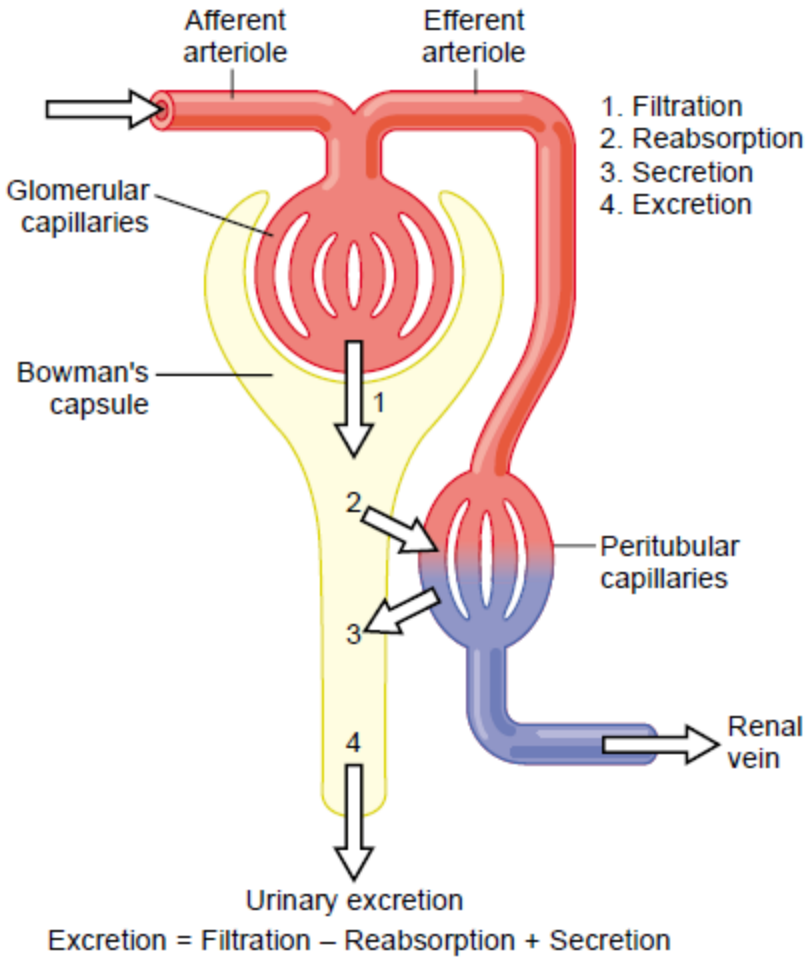
The liver is a very important organ and we need to look after the health of our livers. The best way to do this is to avoid drinking too much alcohol, which can cause cirrhosis of the liver. The liver tissue is destroyed which can eventually kill you. Heavy drinkers also often develop liver cancer which spreads quickly and can be fatal.


Afferent arteriole
Efferent arteriole
1. Filtration
2. Reabsorption
3. Secretion
4. Excretion
Glomerular capillaries
Bowman's capsule
1
2
Peritubular capillaries
3
4
Renal vein
Urinary excretion
Excretion = Filtration – Reabsorption + Secretion