

An anatomical illustration of the human torso, showing the internal organs. The kidneys are highlighted in a bright red color, while the rest of the body is rendered in a semi-transparent blue. The text is overlaid on the center of the image.

CHAPTER 16

EXCRETION IN

HUMANS

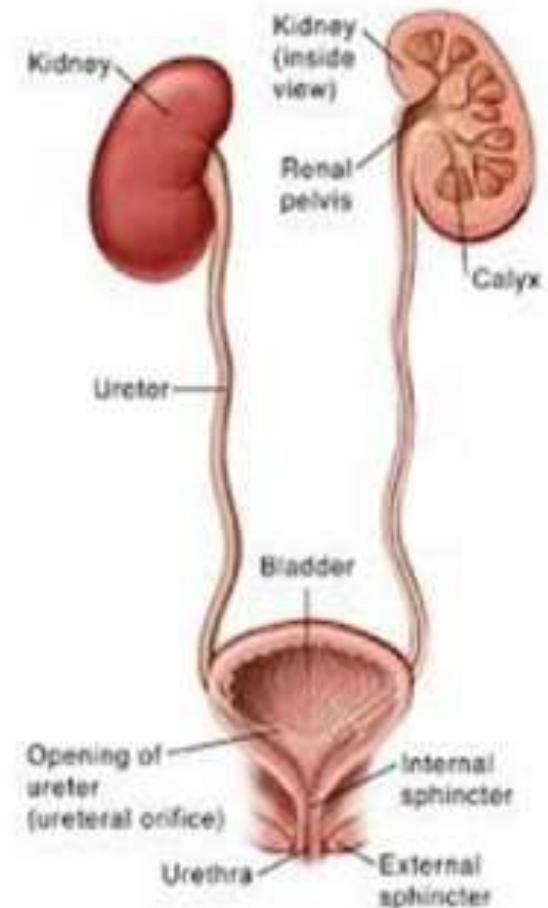
Excretion - DEFINITION

- **Process by which substances formed during body reactions (cellular activity) are removed from the body**
- Excretion may occur via:
 - the kidneys – urination
 - the lungs – removal of CO_2
 - skin – sweating (water & salts)
 - and large intestine – excretion of bile pigments
- NB - normal passing of undigested substances is NOT excretion because they are not products of metabolism, instead = defaecation

Kidneys

- **Morphology**

- It is paired organ (weight about 300 g)
- Compound from two parts cortex (isotonic urine) and medulla (hypertonic urine)
- Cortex: Glomerular apparatus
- Medulla: Divided: Outer and Inner
- Consists of about 1 million filtering units termed **nephrons** (basic structural and functional unit)
- The kidney plays a crucial role in regulating **electrolytes** in the human blood (e.g. Na^+ , K^+ , Ca^{2+}).
- It clears **urea**, a nitrogenous waste product from the metabolism of **amino acids**.



ORGANS OF EXCRETION

✦ Skin and associated glands:

- sweat is removed by skin as a waste product trying to Remove heat and salts

✦ Lungs: Removes carbon dioxide

✦ Liver:

- get rid of unneeded wastes in the body. It changes toxic ammonia, which is a poisonous gas , to urea, a harmless fluid.

✦ Kidneys; removes nitrogenous waste (urea)

Waste products excreted by:



skin

- urea
- excess water
- excess salts

in sweat



lungs

- carbon dioxide
- excess water

in expired air



liver

- bile pigments

**in faeces
through the
intestines**



kidneys

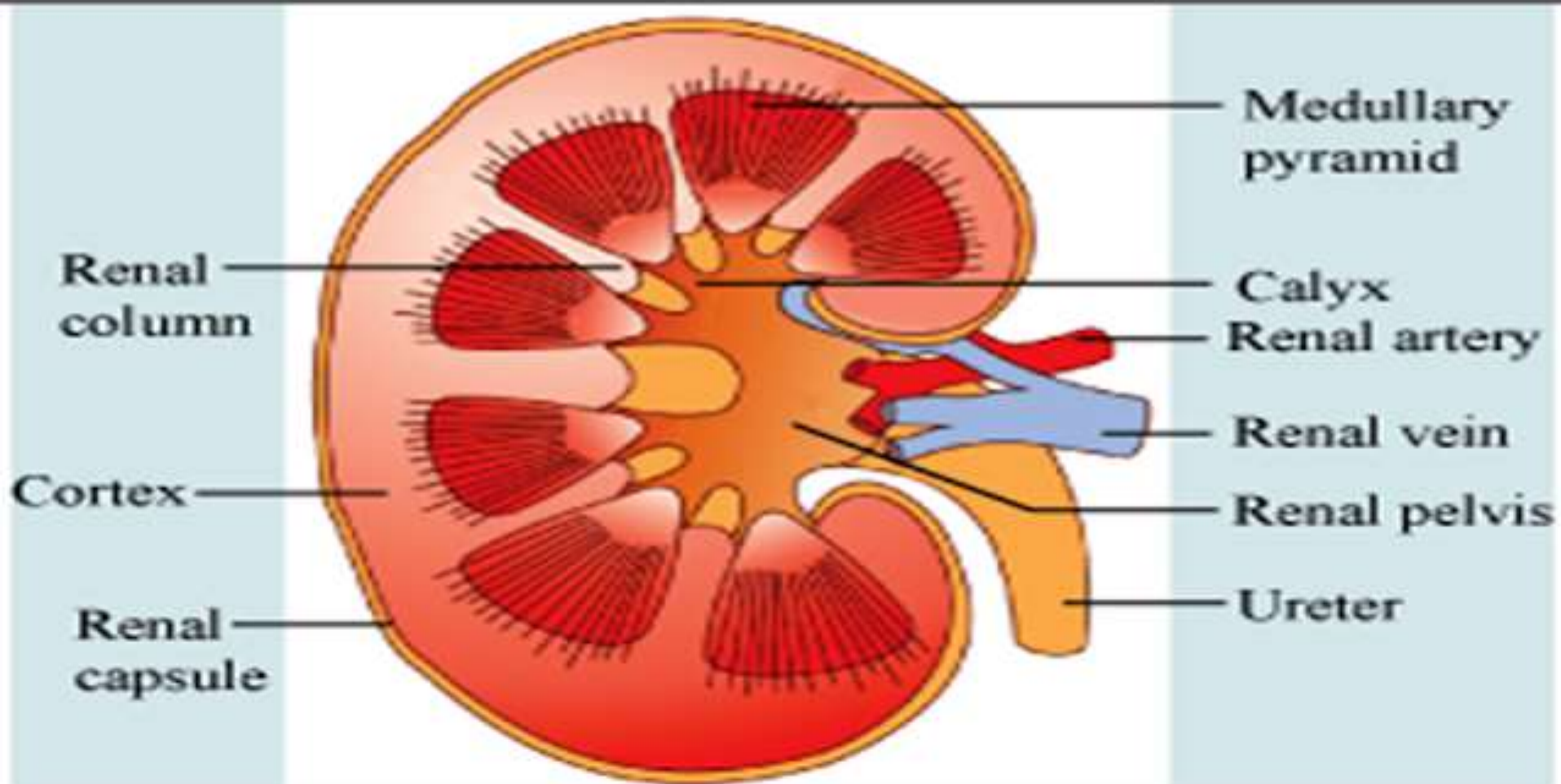
- urea
- excess water
- excess salts

in urine

QUIZ

- 1. Define excretion.**
- 2. Name the organs of excretion.**
- 3. Describe kidney as organ of excretion.**

STRUCTURE AND FUNCTION OF KIDNEY



Urine

The amount and concentration of urine is affected by **water intake**, **temperature** and **exercise**.

The volume of urine is increased, and its concentration is decreased, when:

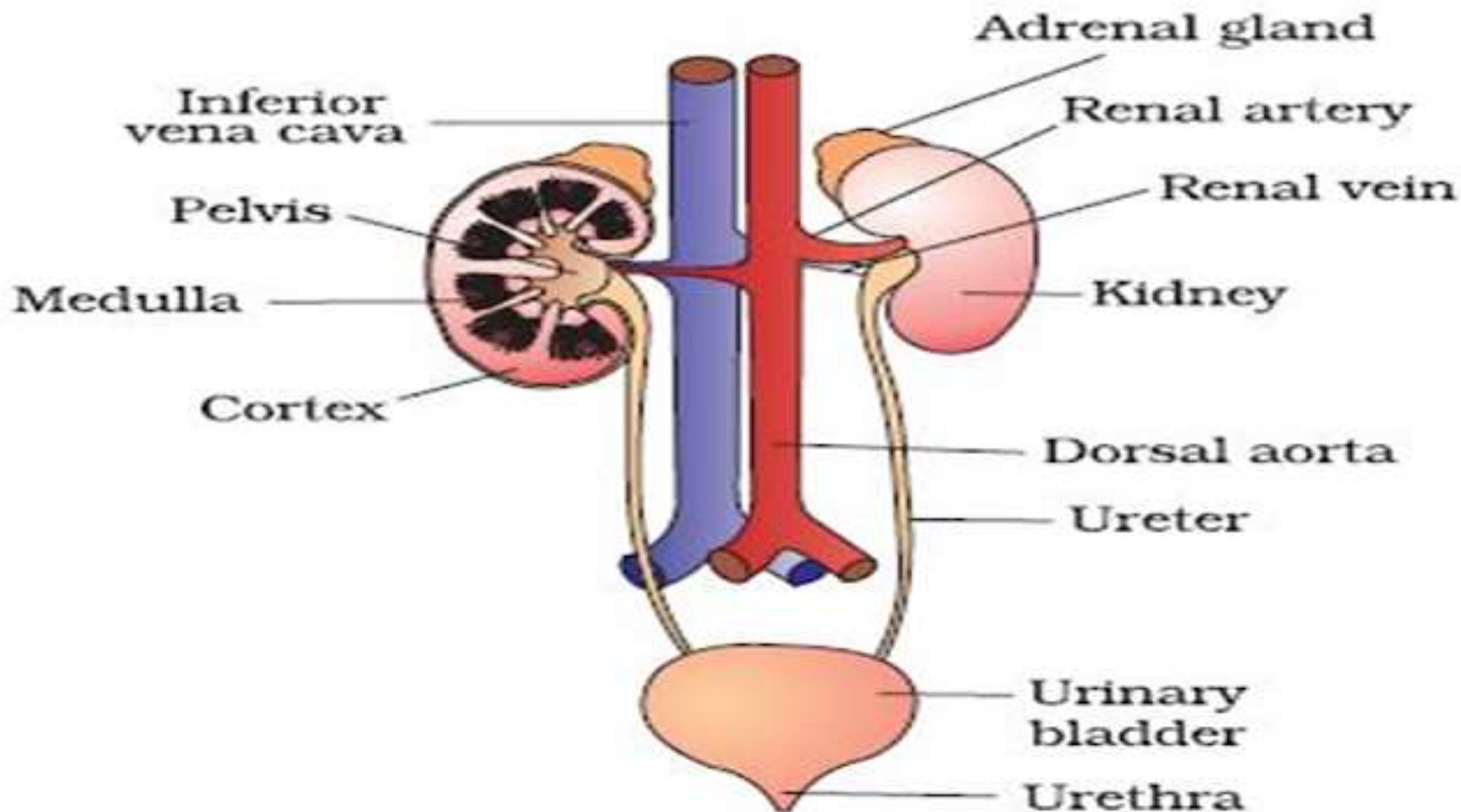
- you drink a lot
- the surrounding temperature is low
- you are not exercising

The volume of urine is decreased, and its concentration is increased, when:

- you do not drink much
- the surrounding temperature is high
- you are exercising

kidneys are paired organs found on each side of the back portion of the abdominal cavity. The larger left kidney is located a bit higher than the right kidney. Unlike other organs found in the abdomen, the kidneys are located behind the lining of the abdominal cavity, thus they are considered retroperitoneal organs. These bean-shaped organs are protected by the back muscles and the ribs, as well as the fat that surrounds them like a protective padding.

URINARY SYSTEM



The urinary system, also known as the renal system, consists of the kidneys, ureters, bladder, and the urethra. Each kidney consists of millions of functional units called nephrons. The purpose of the renal system is to eliminate wastes from the body, regulate blood volume and blood pressure, control levels of electrolytes and metabolites, and regulate blood pH. The kidneys have extensive blood supply via the renal arteries which leave the kidneys via the renal vein

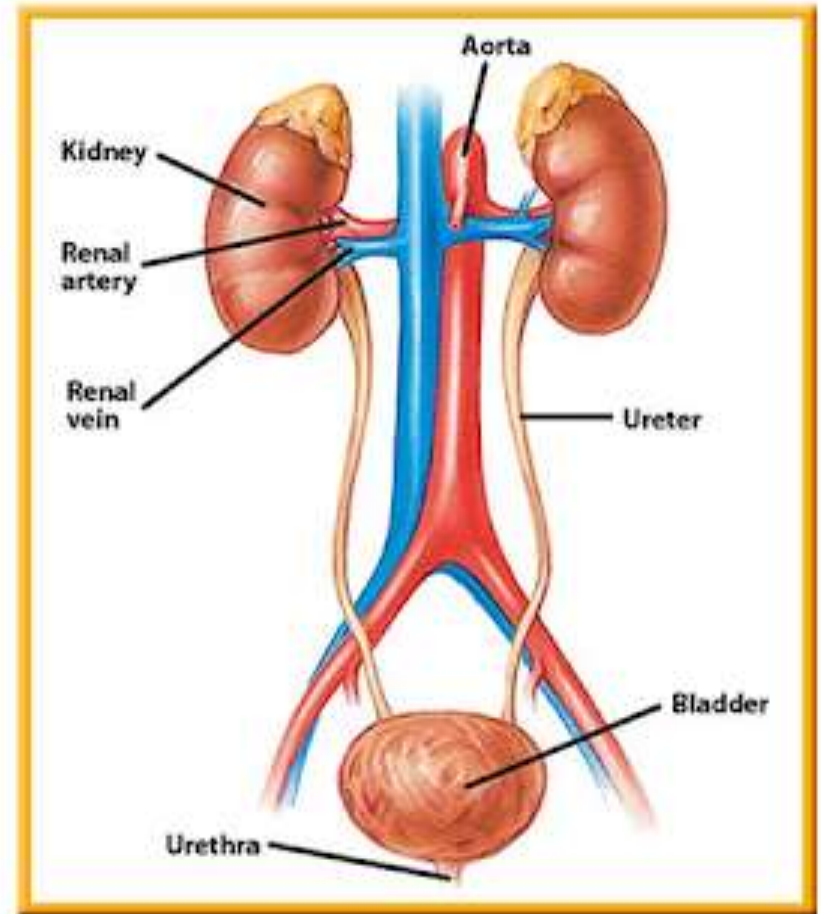
. Following filtration of blood and further processing, wastes exit the kidney via the ureters, tubes made of smooth muscle fibers that propel urine towards the urinary bladder, where it is stored and subsequently expelled from the body by urination. The female and male urinary system are very similar, differing only in the length of the urethra. Urine is formed in the kidneys through a filtration of blood. The urine is then passed through the ureters to the bladder, where it is stored. During urination, the urine is passed from the bladder through the urethra to the outside of the body.

QUIZ

- 1. Describe the structure and function of kidney.**
- 2. Draw and label the parts of kidney.**
- 3. Describe the structure of urinary system.**

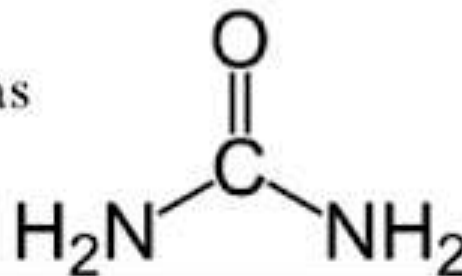
Functions of the Urinary System

- The urinary system (also called the excretory system) is the organ system that produces, stores, and eliminates urine.
- In humans it includes two kidneys, two ureters, the bladder, the urethra, and two sphincter muscles



What is urea?

- Excess amino acids cannot be stored by the body.
- The liver removes the **nitrogen part (Amine)** of the excess amino acids to form the urea molecule, the remainder of the amino acid contains C,H &O and can be used to release energy. This is called **de-amination**.
- Urea leaves the liver in the blood (hepatic vein) it travels with the blood stream till it reaches the kidney.
- Urea molecule, also referred to as nitrogenous waste compound.



QUIZ

- 1. What are the functions of urinary system?**
- 2. State that urea is formed in the liver from excess amino acid.**

Urine Formation

Glomerular filtration

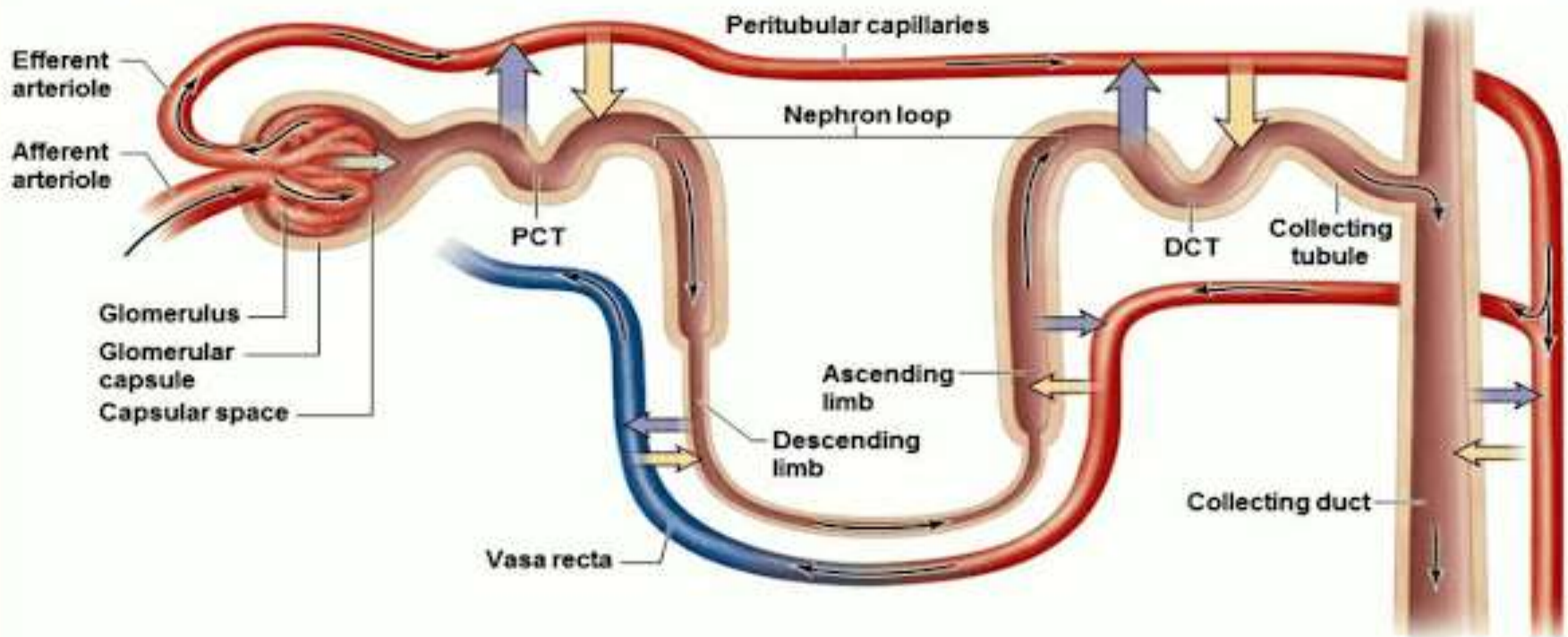
The movement of substances from the blood within the glomerulus into the capsular space

Tubular reabsorption

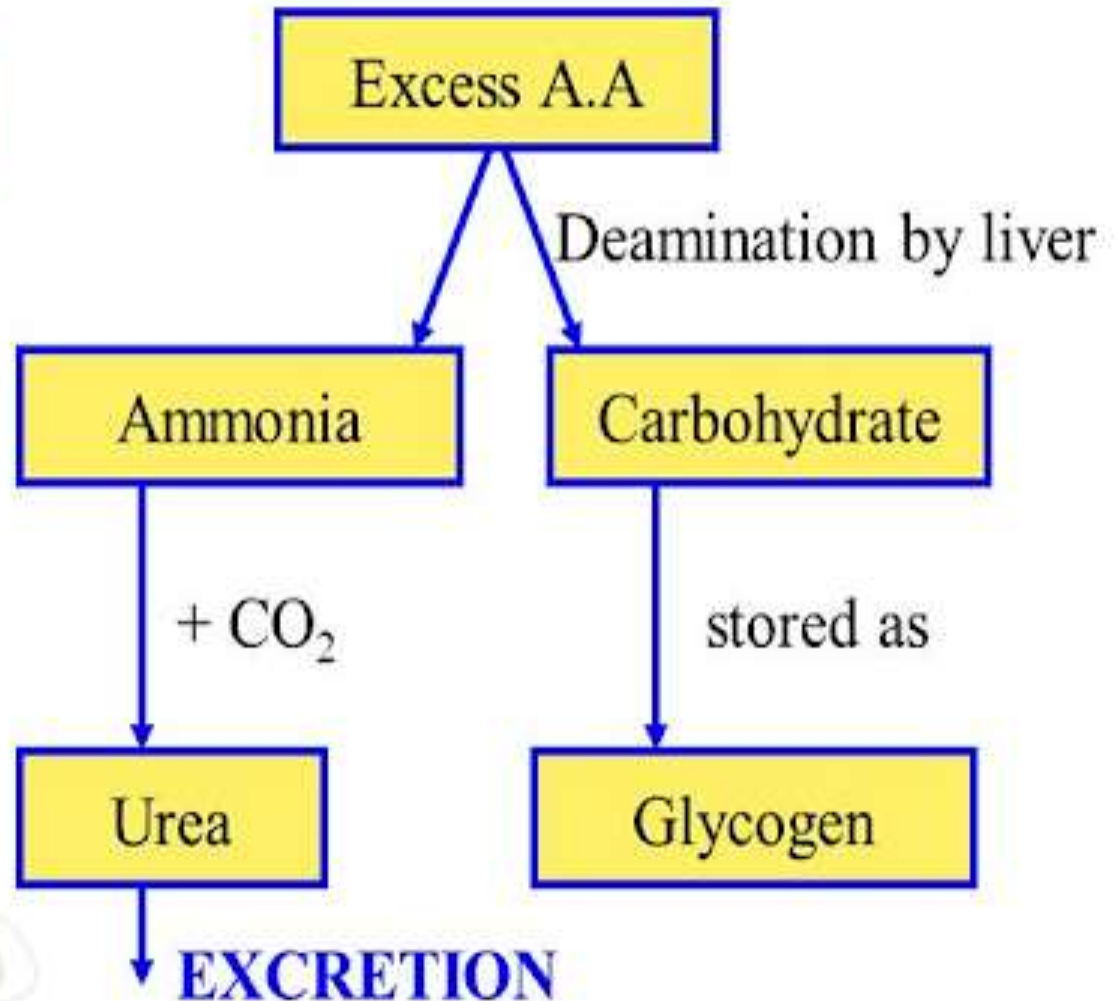
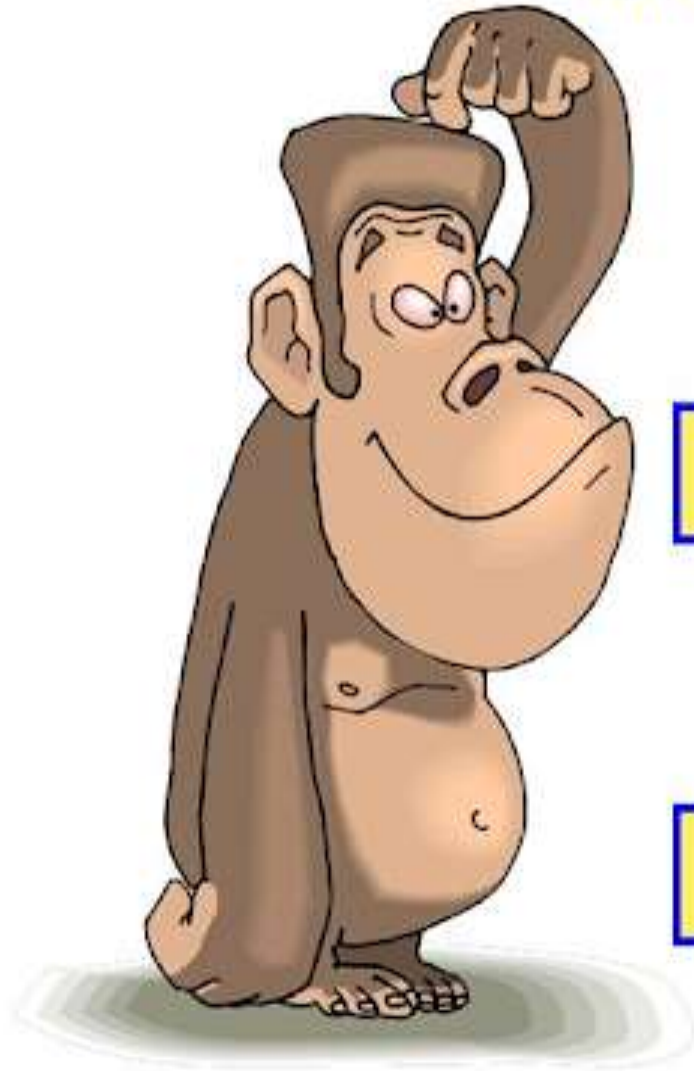
The movement of substances from the tubular fluid back into the blood

Tubular secretion

The movement of substances from the blood into the tubular fluid



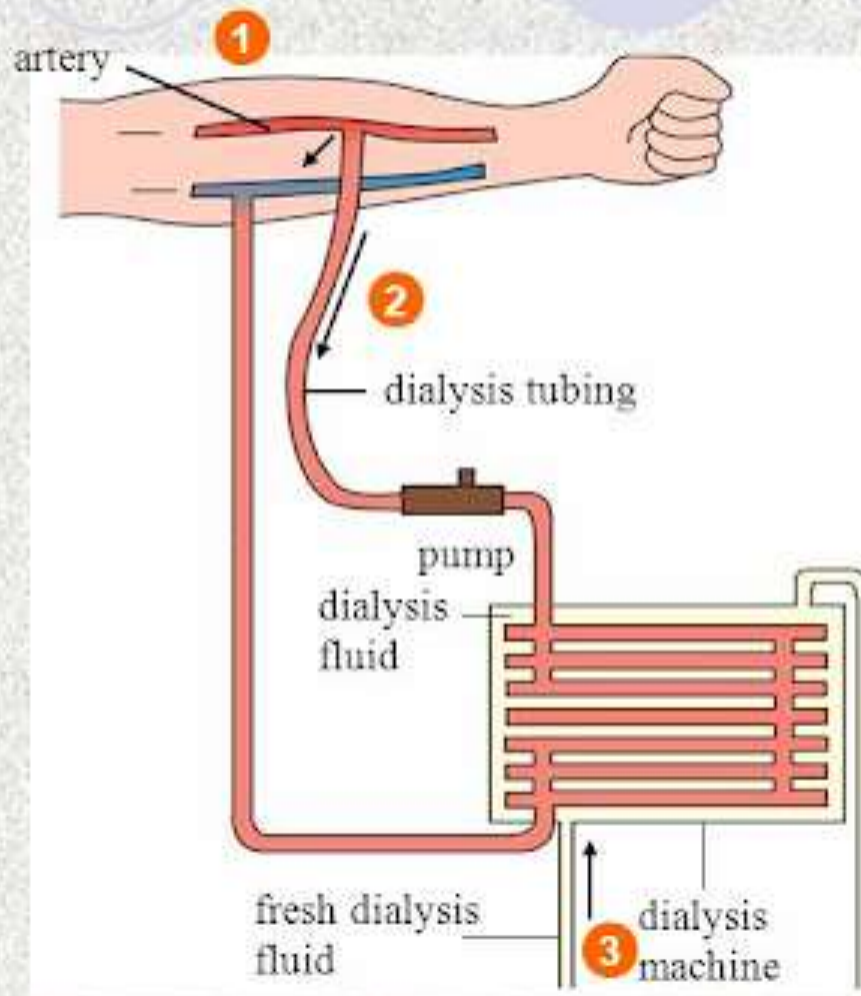
What happened to the excess amino acids in our body?



How Is Blood Cleaned in a Dialysis Machine?

MC Marshall Cavendish

1 Blood is drawn from an artery in the patient's arm



2 Blood is pumped through a tubing to the dialysis machine

3 The tubing is bathed in a special dialysis fluid and the tubing is semi-permeable

How does the kidney dialysis machine work?

1. Patient's blood is drawn from the artery and allow to flow through the tubing in the dialysis machine.
2. **Tubing** which represents the partially permeable membrane is bathed in a specially controlled **dialysis fluid**.
They only allow small molecules, like urea and other waste products, to diffuse out of the tubing.

Purpose of Dialysis

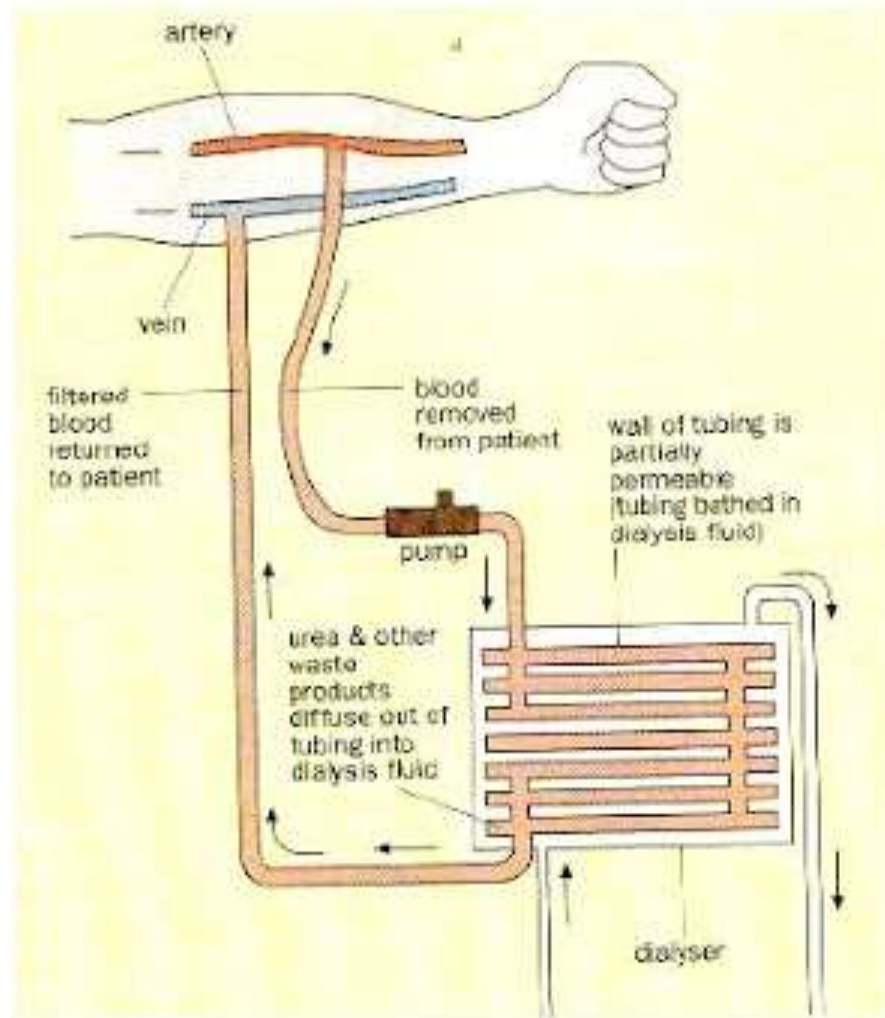
A properly functioning kidney helps prevent salt, extra water, and waste from accumulating in your body. It also helps control blood pressure and regulates important chemicals in the blood, such as sodium (salt) and potassium. When your kidneys don't perform these functions due to disease or injury, dialysis can help purify the blood and remove waste.

PRINCIPLE

- Dialysis works on the principles of the diffusion of solutes and ultrafiltration of fluid across a semi-permeable membrane. Diffusion is a property of substances in water; substances in water tend to move from an area of high concentration to an area of low concentration. Blood flows by one side of a semi-permeable membrane, and a dialysate, or special dialysis fluid, flows by the opposite side.

How a Dialysis Machine Works

(3)



- The temperature of the dialysis fluid is maintained at body temperature.
- The filtered blood is returned to a vein in the patient's arm.
- Patient needs to be treated 2-3 times a week & each treatment takes several hours.

The dialysis fluid has no urea in it, there is a large concentration gradient - meaning that urea moves across the partially permeable membrane, from the blood to the dialysis fluid, by diffusion.

The dialysis fluid contains a glucose concentration equal to a normal blood sugar level, which prevents the net movement of glucose across the membrane as no concentration gradient exists.

And, as the dialysis fluid contains an ion concentration similar to the ideal blood plasma concentration, movement of ions across the membrane only occurs where there is an imbalance.

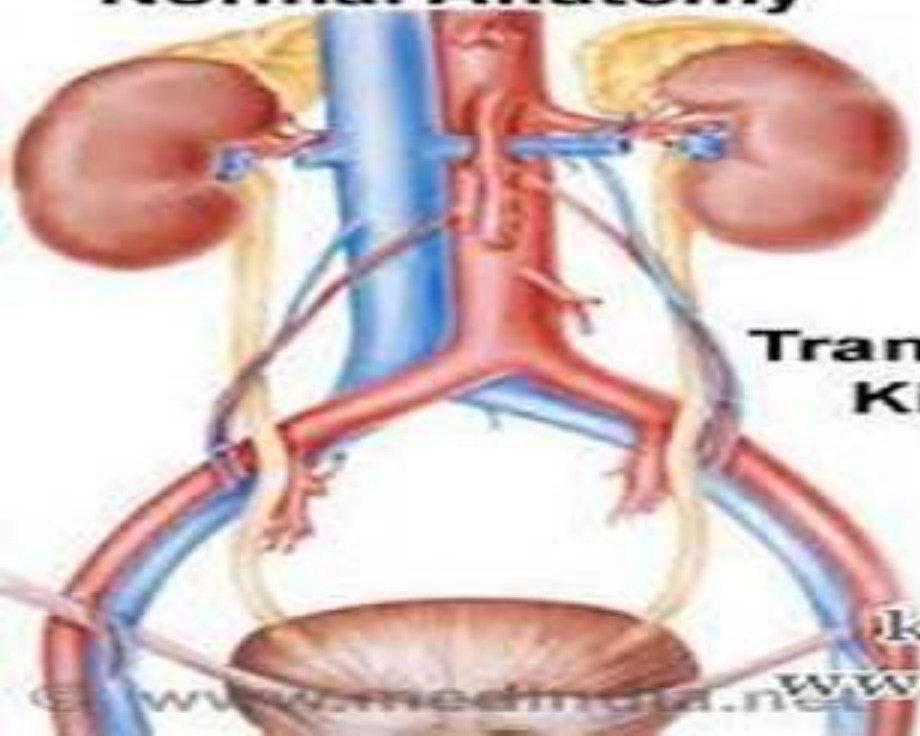
• If the patient's blood is **too low in ions**, they will diffuse from the dialysis fluid into the blood, restoring the ideal level in the blood.

If the patient's blood is **too high in ions**, the excess ions will diffuse from the blood to the dialysis fluid.

KIDNEY TRANSPLANTS

A kidney transplant is a surgical procedure to place a kidney from a live or deceased donor into a person whose kidneys no longer function properly.

Normal Anatomy



Transplanted Kidney




kidney healthy web

www.kidney-healthy.com

www.medindia.net

Kidney Transplant



The second form of treatment is to have a transplant. This has many advantages and disadvantages...

Advantages	Disadvantages
<ul style="list-style-type: none">• No time consuming dialysis• Diet is less limited• Feel better physically• Better quality of life• Don't see yourself as chronically ill	<ul style="list-style-type: none">• Need immuno-suppressants for life and this can cause a susceptibility to anti infection• Major surgery under general anaesthetic• Surgery risks (infection, bleeding etc.)• Frequent checks for signs of rejection

Kidney Transplant and Dialysis

Advantages

- Kidney transplant is completed once and doesn't require weekly hospital treatments.
- Kidney transplant allows patients to lead a normal life.
- Kidney transplant is only expensive initially.

Disadvantages

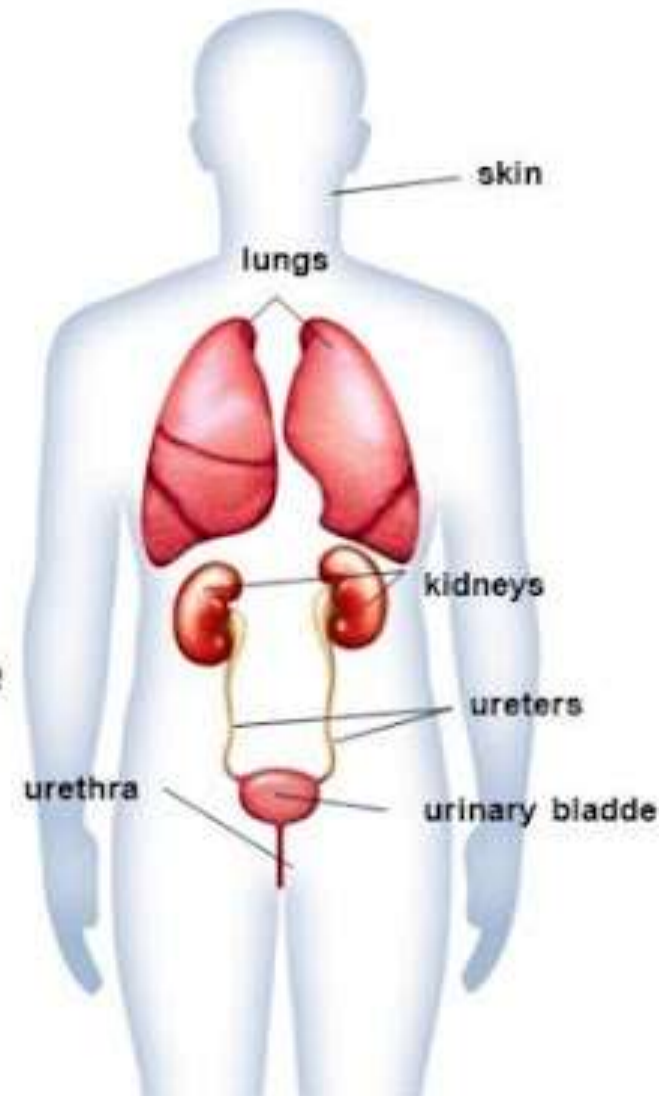
- Shortage of kidneys
- With a kidney transplant patients have to take immunosuppressant drugs for the rest of their life.
- Kidney transplants generally last for around 8 years. The immune system can reject the transplant immediately or slowly after a few years.

QUIZ

- 1. State the role of liver in metabolism.**
- 2. Discuss the application of dialysis in kidney machines.**
- 3. What are kidney transplants. Discuss its advantages and disadvantages.**

Excretory System

- The **ureters** are tubes that carry urine from the pelvis of the kidneys to the urinary bladder.
- The **urinary bladder** temporarily stores urine until it is released from the body.
- The **urethra** is the tube that carries urine from the urinary bladder to the outside of the body.
- The outer end of the urethra is controlled by a circular muscle called a **sphincter**.



RENAL TUBULE

The tubular part of the nephron is known as **renal tubule**.

It has three parts- **Proximal convoluted tubule**, **Loop of Henle** and **distal convoluted tubule**.

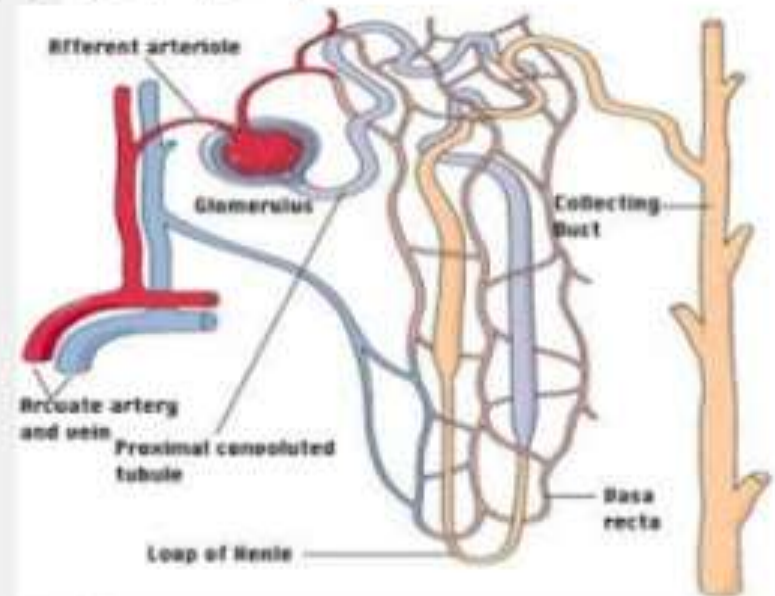
The proximal part of the renal tubule is highly coiled and is present in the renal cortex. This part absorbs water and all the useful salts, amino acids and glucose.

The proximal part extends downwards to form a narrow tubular part- the descending part, a loop and an ascending part. This lies in the medulla and mainly absorbs water from the nephric filtrate.

The ascending limb leads to a convoluted part the which also lies in the cortex. This opens into the collecting tubule. This part excretes some ions and ammonia into the filtrate.

Try this link to lead yourself to a pretty good animation explaining the process.

[Http://www.biologymad.com/resources/kidney.swf](http://www.biologymad.com/resources/kidney.swf)



Urine Formation

- Nephrons form urine in 3 steps
 1. Filtration: Water and small solutes enter the nephron (blood cells and proteins do not enter). Filtrate is similar to blood plasma.
 2. Reabsorption: Useful substances (water, glucose, amino acids, needed ions) are transported out of the filtrate and back into the blood
 3. Secretion: Harmful substances (H^+ , excess K^+ , some drugs and poisons) are removed from the blood and put into the filtrate

1. Glomerular filtration refers to the movement of fluid and solutes from the glomerular capillaries into Bowman's space.

2. Tubular secretion refers to the secretion of solutes from the peritubular capillaries into the tubules.

3. Tubular reabsorption refers to the movement of materials from the filtrate in the tubules into the peritubular capillaries.

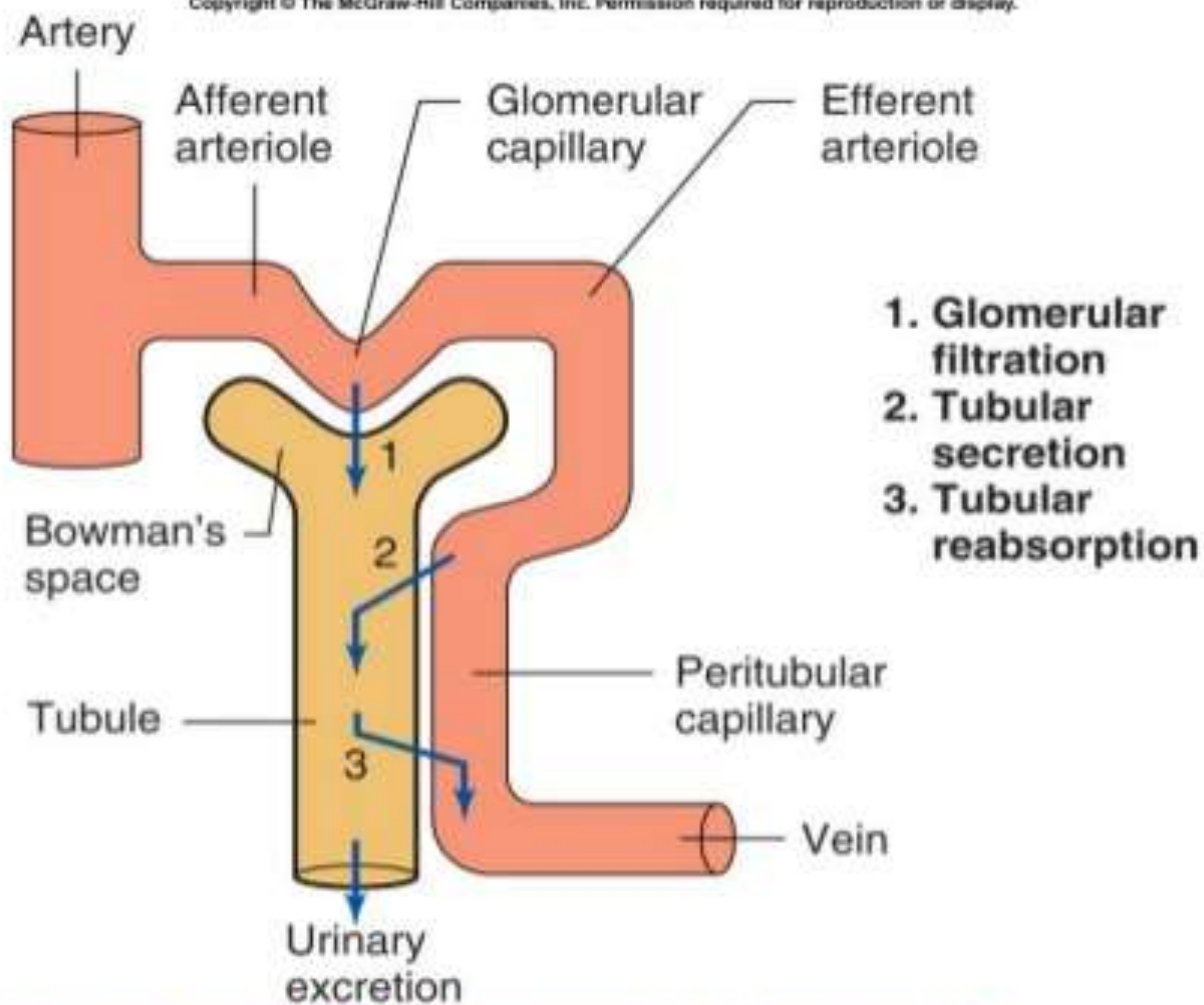
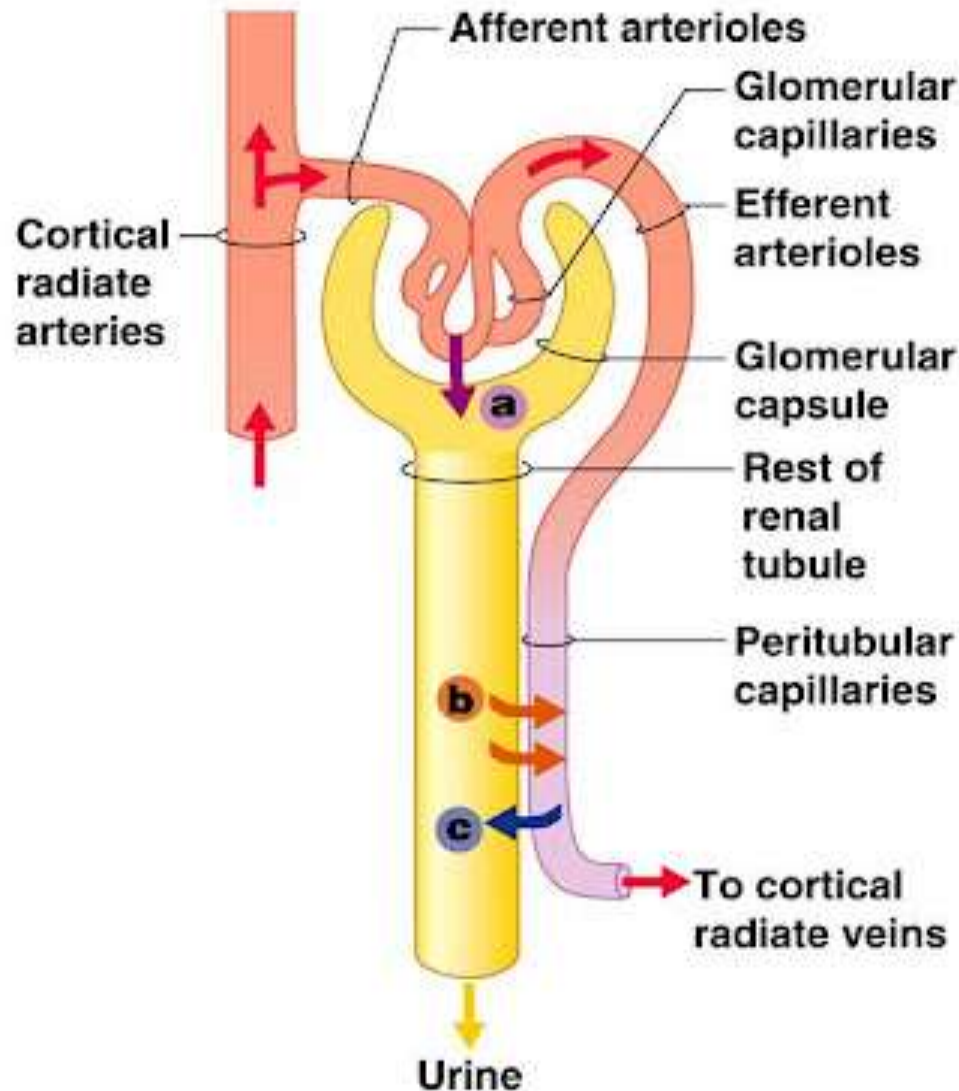





Figure 14-6

Urine Formation



KEY:

- a**  **Glomerular Filtration:** Water and solutes smaller than proteins are forced through the capillary walls and pores of the glomerular capsule into the renal tubule.
- b**  **Tubular Reabsorption:** Water, glucose, amino acids, and needed ions are transported out of the filtrate into the tubule cells and then enter the capillary blood.
- c**  **Tubular Secretion:** H^+ , K^+ , creatinine, and drugs are removed from the peritubular blood and secreted by the tubule cells into the filtrate.

FUNCTION OF THE URINARY SYSTEM

- **KIDNEY** – regulate blood volume and composition, regulate pH, produce 2 hormones and excrete waste
- **URETERS**- transport urine from kidney to urinary bladder
- **URINARY BLADDER**- store urine and expels through urethra
- **URETHRA**- discharge urine from the body

