Homeostasis

What is Homeostasis?

- Body cells work best if they have the correct
  - Temperature
  - Water levels
  - Glucose concentration
- Your body has mechanisms to keep the cells in a constant environment.

What is Homeostasis?

The maintenance of a constant environment in the body is called **Homeostasis**

Controlling Body Temperature

Controlling body temperature

- All mammals maintain a constant body temperature.
- Known as homeothermic

Controlling body temperature

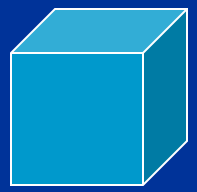
- Human beings have a body temperature of about 37ºC.
  - E.g. If your body is in a hot environment your body temperature is 37ºC
  - If your body is in a cold environment your body temperature is still 37ºC

Controlling body temperature

- Use physiological changes for generating or losing heat
- Also called endotherms

Controlling body temperature

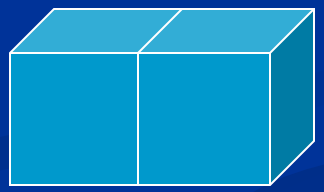
- Animals with a large surface area compared to their volume will lose heat faster than animals with a small surface area.



Volume = _____

Surface area = _____

Volume : Surface area ratio = _____

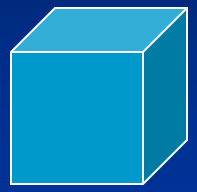


Volume = _____

Surface area = _____

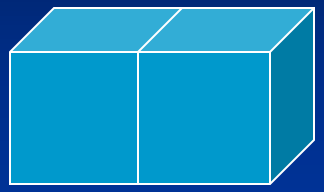
Volume : Surface area ratio = _____

Controlling body temperature



Volume : Surface area ratio = 1:6

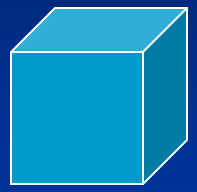
For every 1 unit of heat made, heat is lost out of 6 sides



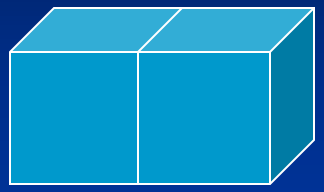
Volume : Surface area ratio = 1:5

For every 1 unit of heat made, heat is lost out of 5 sides

Controlling body temperature



Volume : Surface area ratio = 1:6



Volume : Surface area ratio = 1:5

The bigger the Volume : Surface Area ratio, the faster heat will be lost.

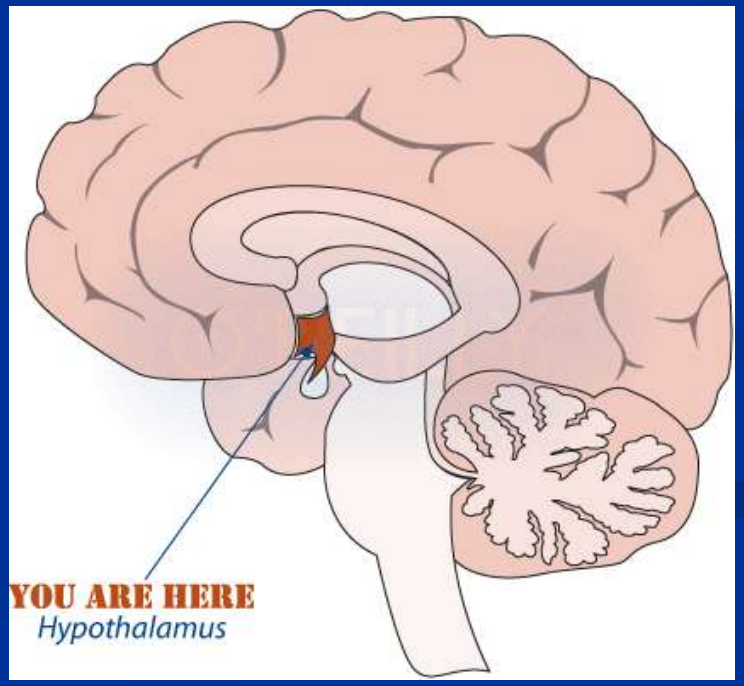
Penguins huddling to keep warm

Controlling body temperature

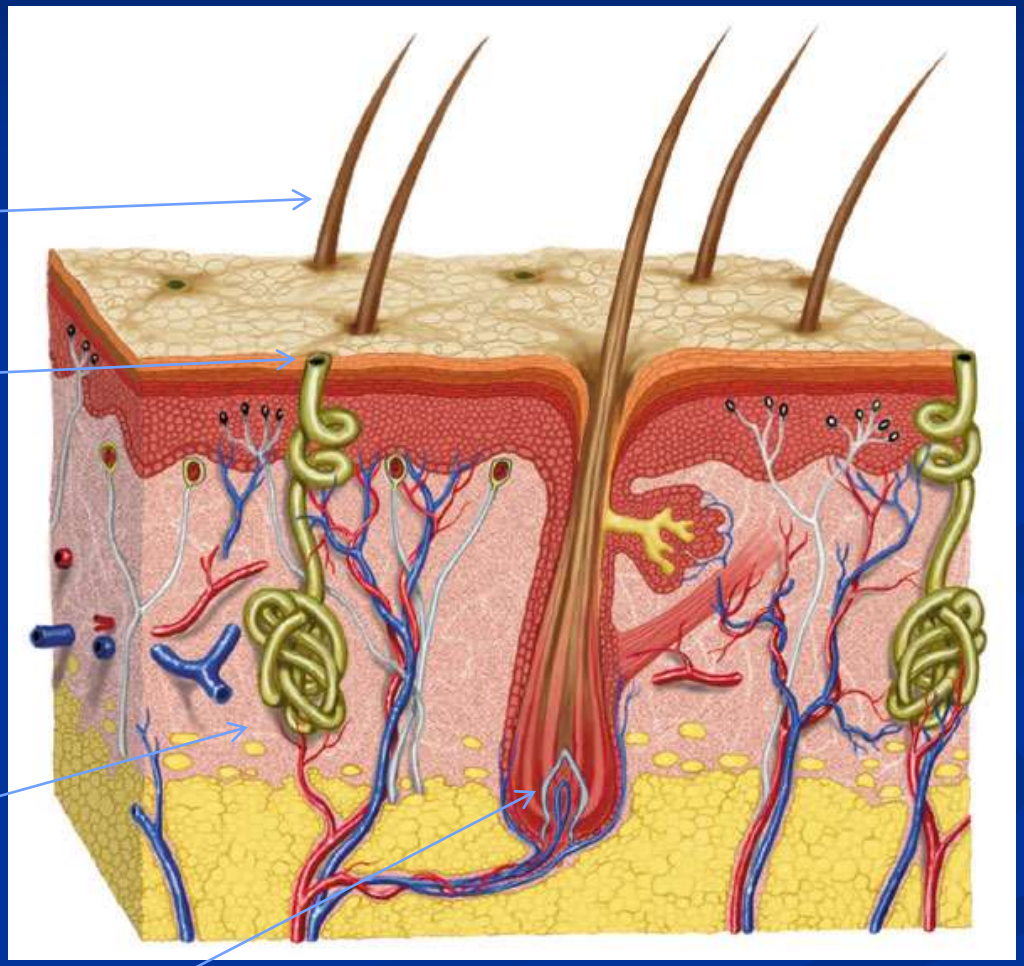
- Important in the control of enzymes

Controlling body temperature

- Core body temperature monitored by the thermoregulatory centre in the brain.
- Located in the hypothalamus
- Acts like a thermostat



Human Skin


Hair
Sweat pore
Sweat gland
Follicle
Epidermis
Dermis
Hypodermis

Human Skin

- Resists mechanical damage
- Barrier to the entry of disease organisms
- Prevents loss of water
- Sense organ touch and temperature
- Controls loss of heat

Human Skin

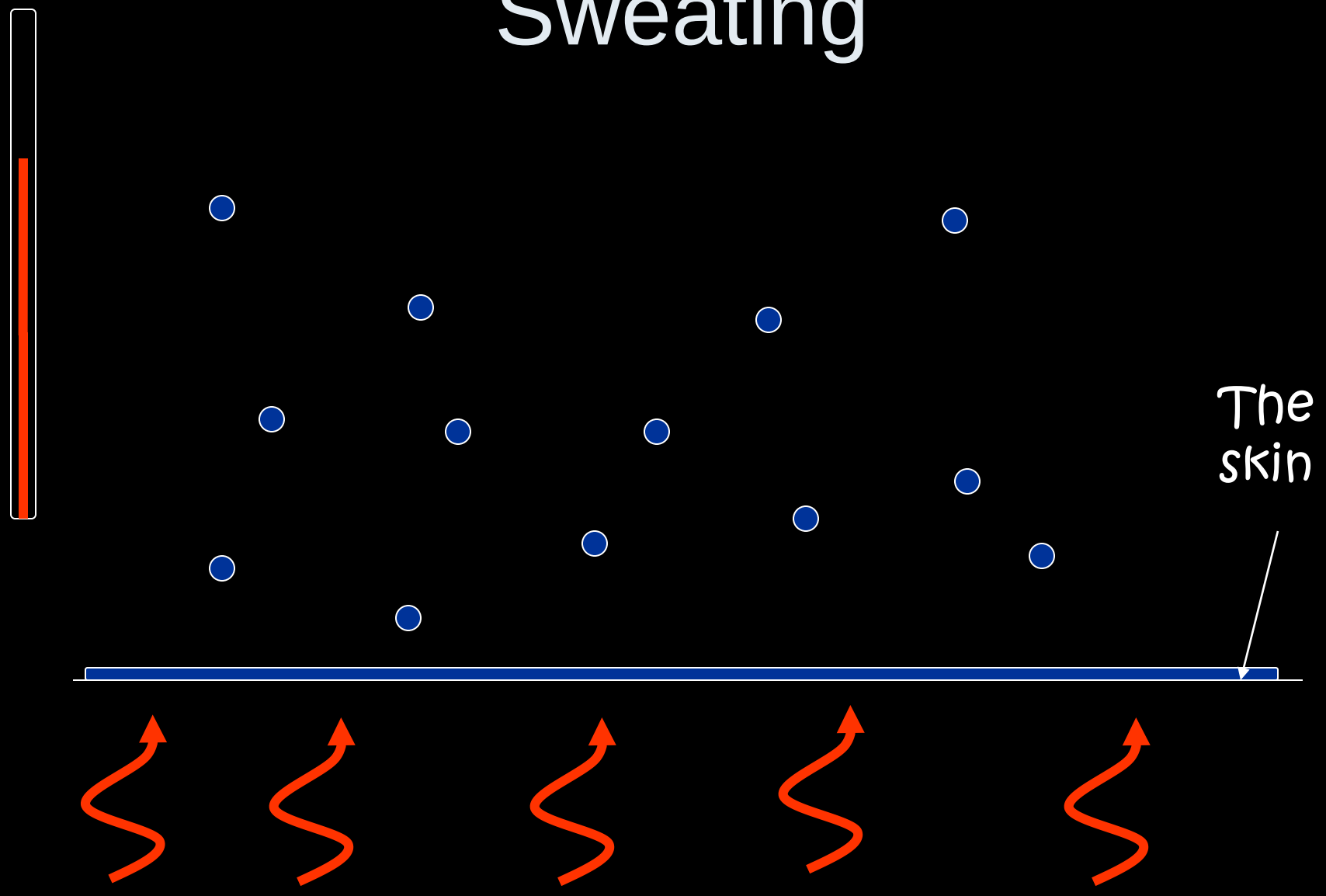
- Two ways of cooling down
  - Sweating
  - Vasodilation

What mechanisms are there to cool the body down?

1. <u>Sweating</u>

- When your body is hot, sweat glands are stimulated to release sweat.
- The liquid sweat turns into a gas (latent heat of vaporisation)
- To do this, it needs heat.
- It gets that heat from your skin.
- As your skin loses heat, it cools down.

Sweating

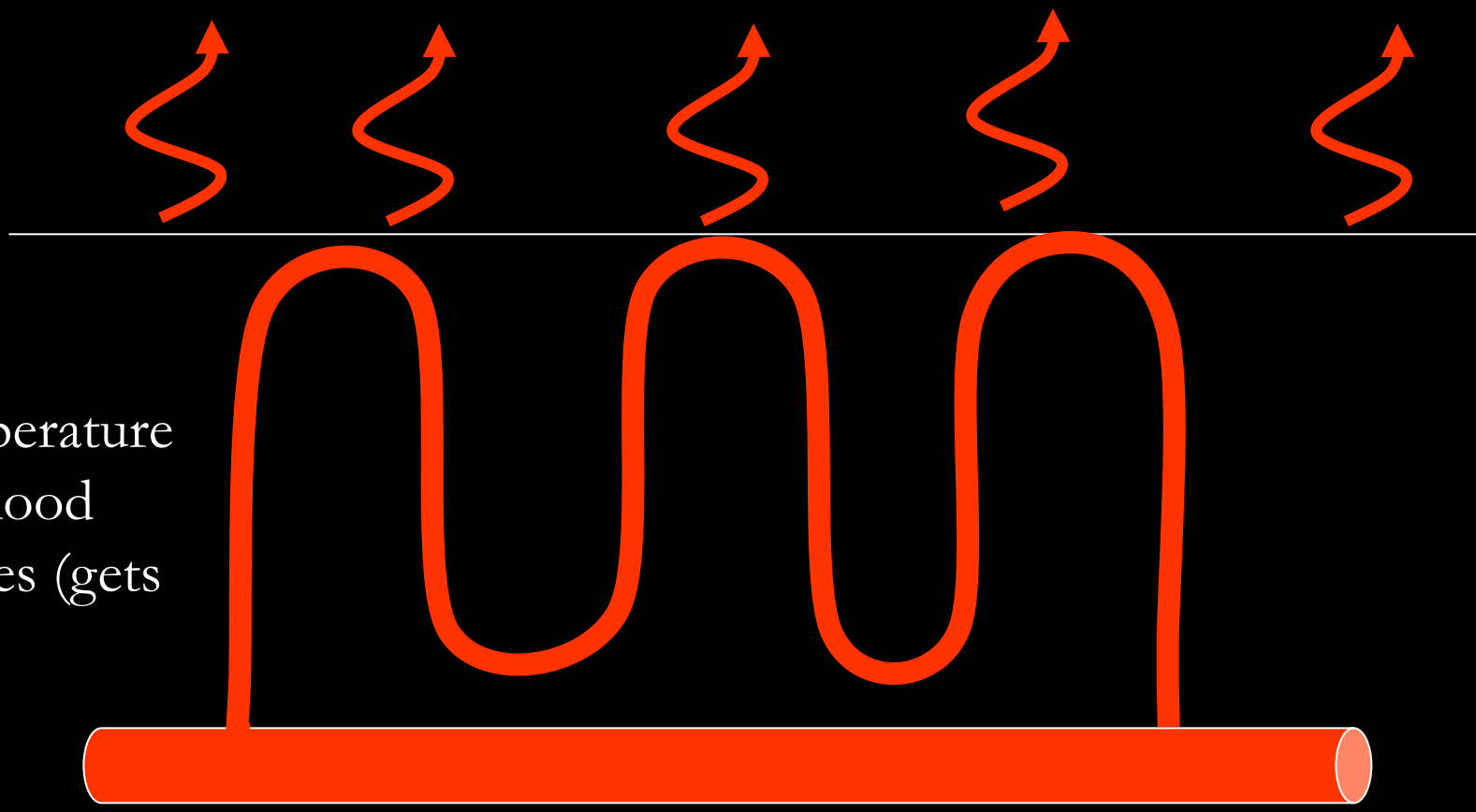


What mechanisms are there to cool the body down?

2. <u>Vasodilation</u>

- Your blood carries most of the heat energy around your body.
- There are capillaries underneath your skin that can be filled with blood if you get too hot.
- This brings the blood closer to the surface of the skin so more heat can be lost.
  - This is why you look red when you are hot!

This means more heat is lost from the surface of the skin



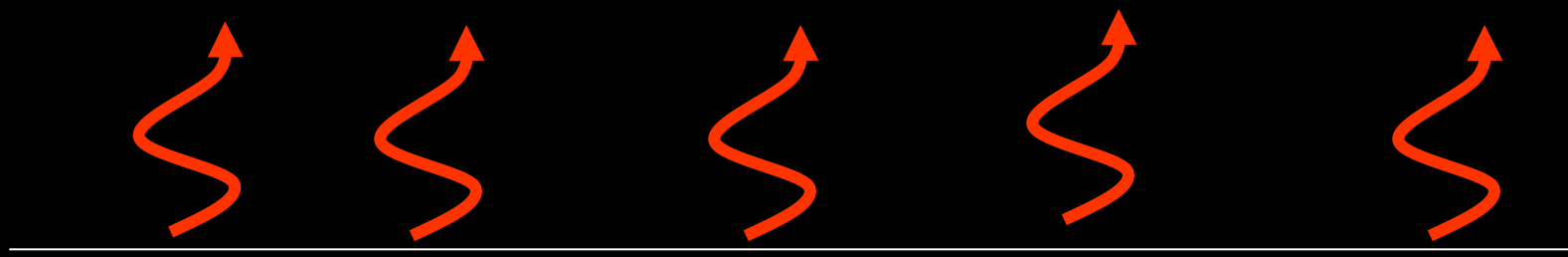
If the temperature rises, the blood vessel dilates (gets bigger).

What mechanisms are there to warm the body up?

1. <u>Vasoconstriction</u>

- This is the opposite of vasodilation
- The capillaries underneath your skin get constricted (shut off).
- This takes the blood away from the surface of the skin so less heat can be lost.

This means less heat is lost from the surface of the skin

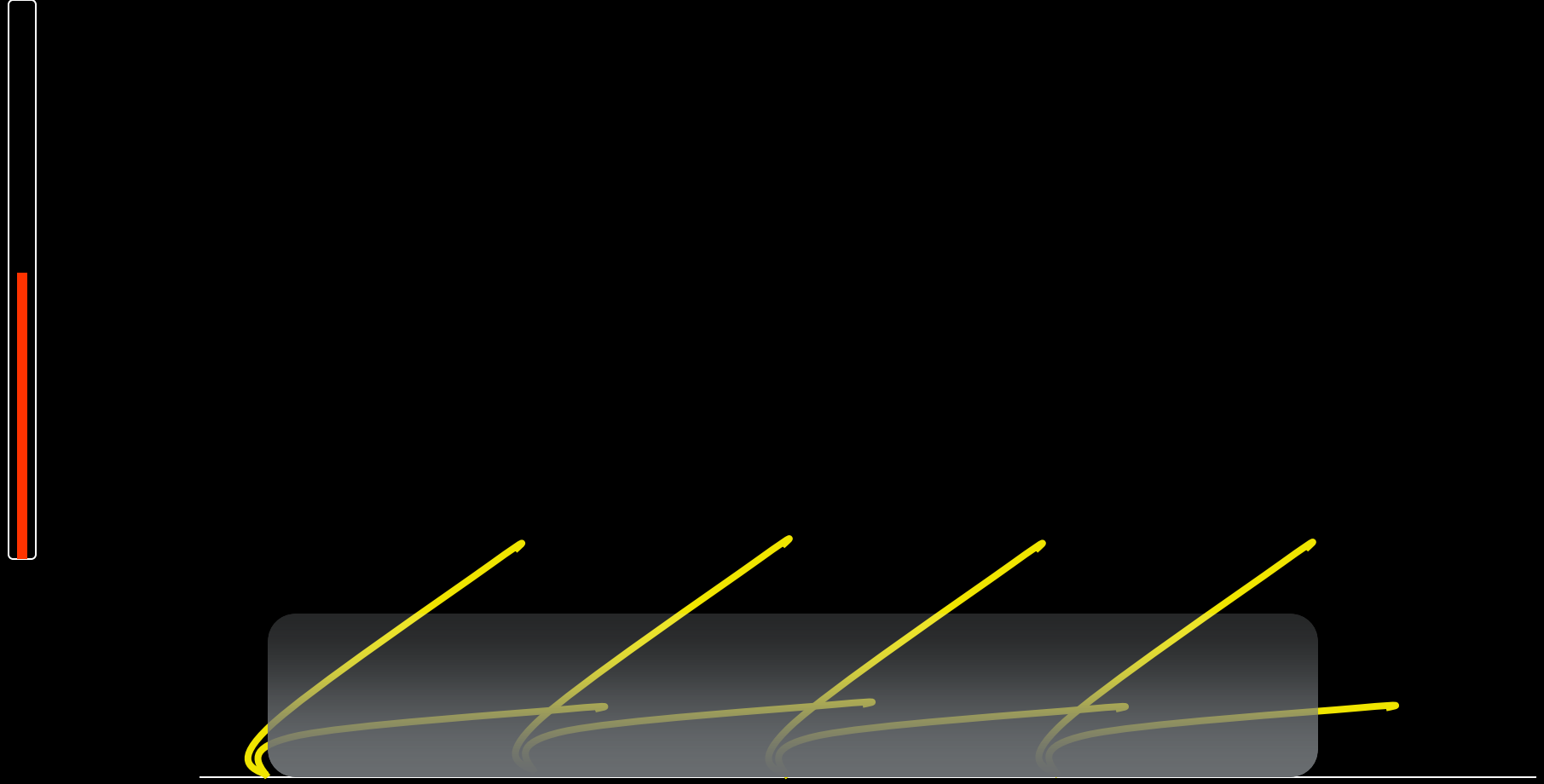


If the temperature falls, the blood vessel constricts (gets shut off).

What mechanisms are there to warm the body up?

2. <u>Piloerection</u>

- This is when the hairs on your skin "stand up" .
- It is sometimes called "goose bumps" or "chicken skin"!
- The hairs trap a layer of air next to the skin which is then warmed by the body heat
- The air becomes an insulating layer.



What mechanisms are there to warm the body up?

- Shivering generates a large amount of heat
- Adrenaline stimulates the increase in metabolism

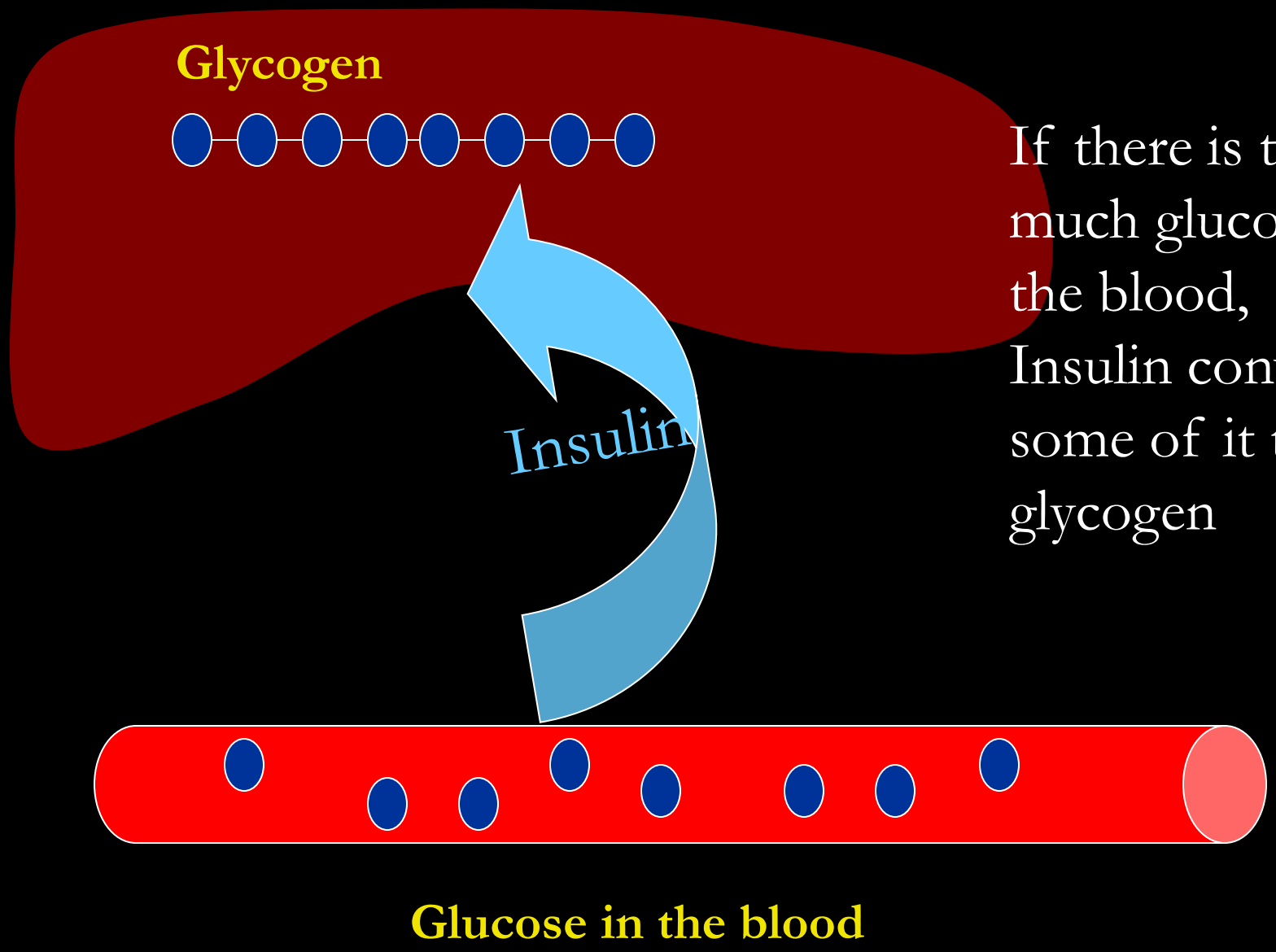
Controlling Glucose

Controlling Glucose levels

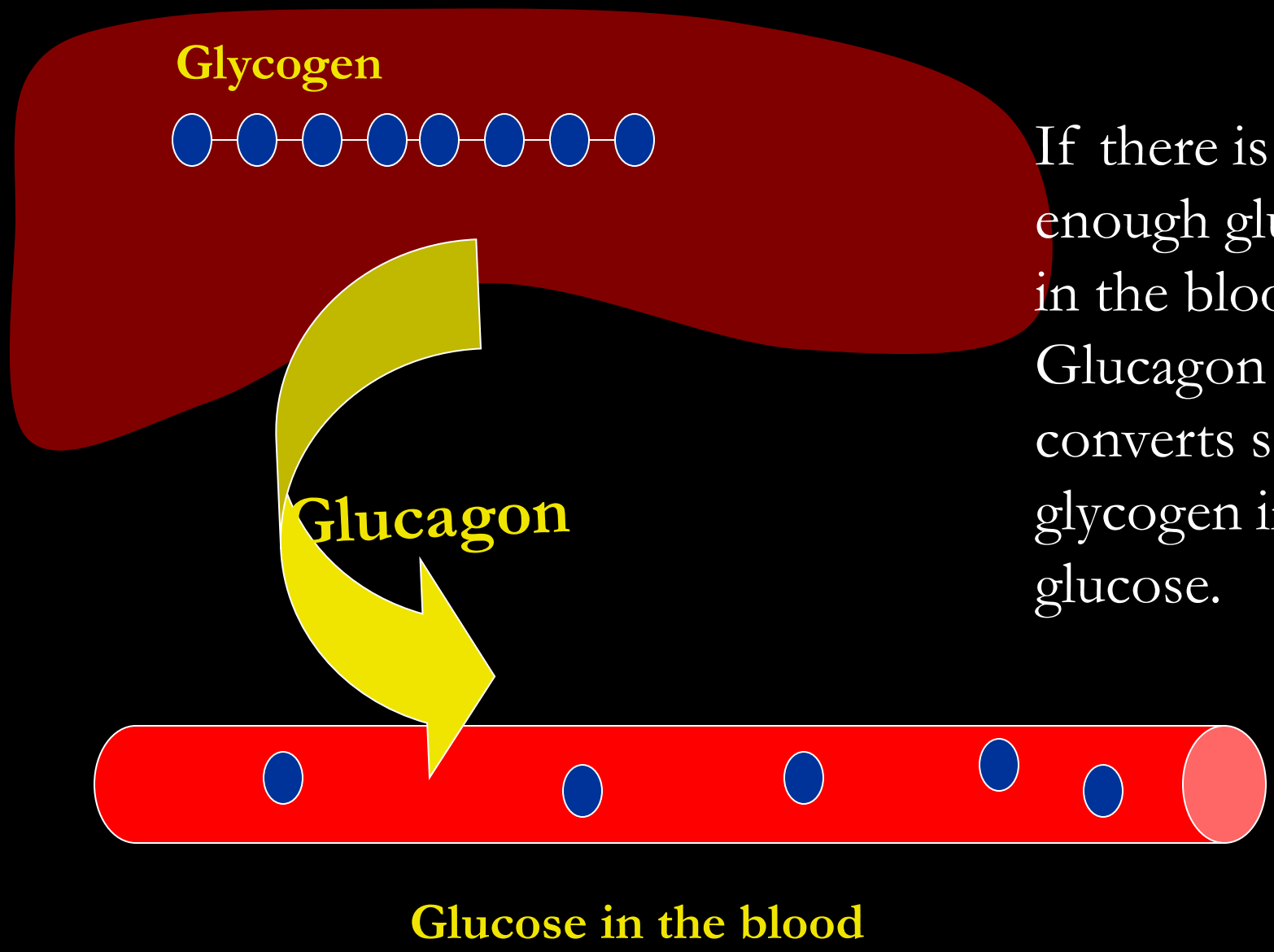
- Your cells also need an exact level of glucose in the blood.
- Excess glucose gets turned into glycogen in the liver
- This is regulated by 2 hormones (chemicals) from the **pancreas** called:

Insulin

Glucagon



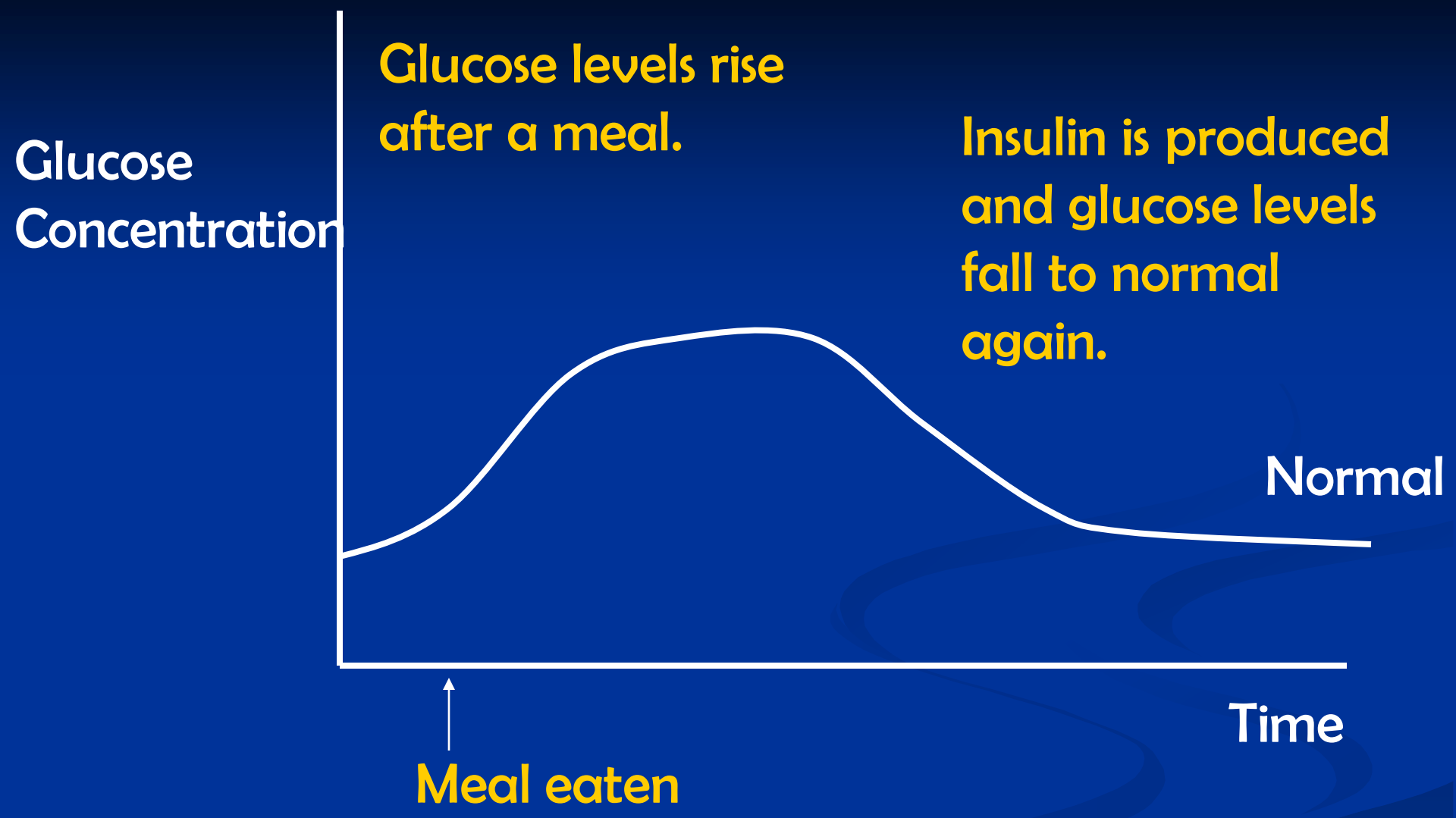
If there is too much glucose in the blood, Insulin converts some of it to glycogen

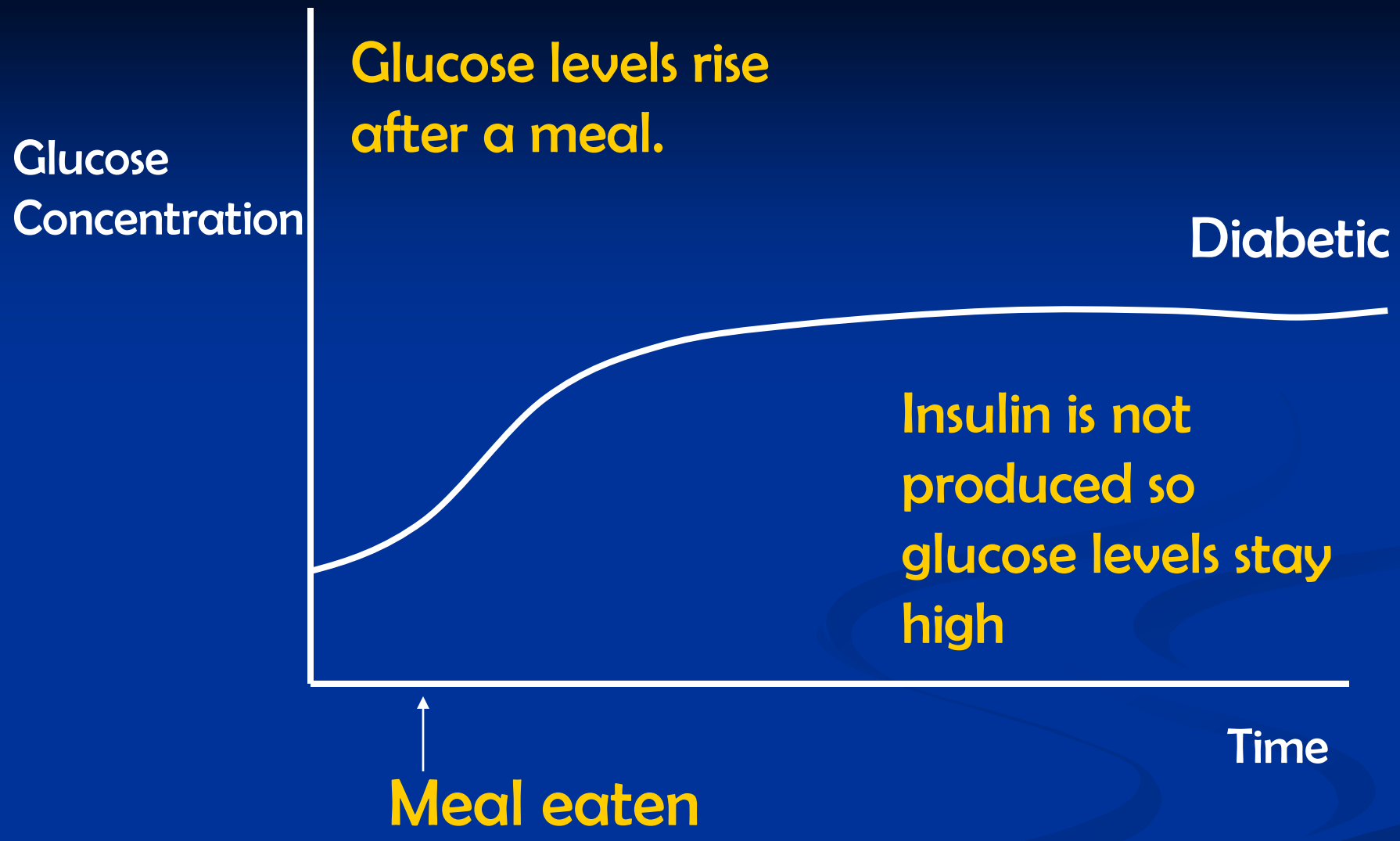


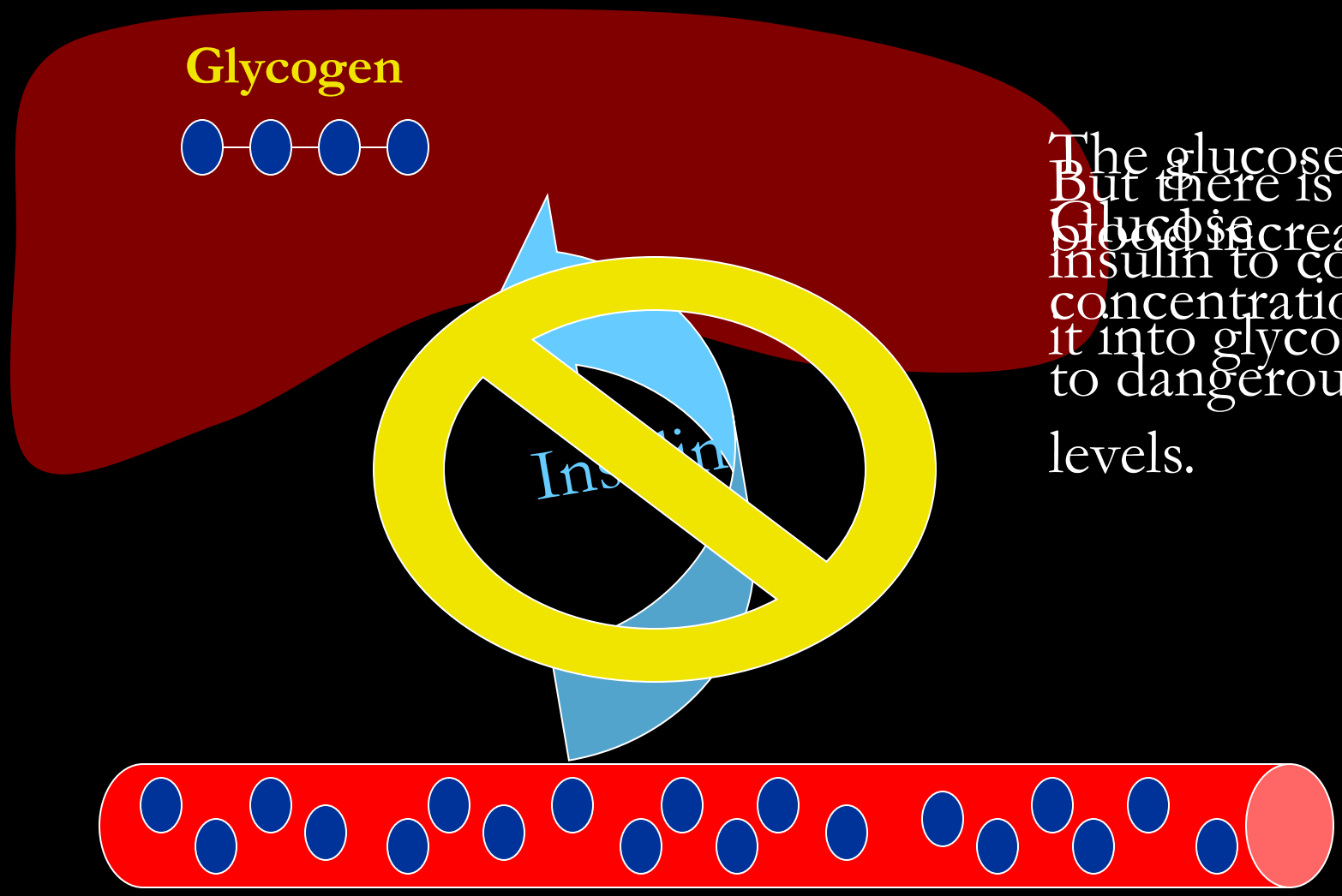
If there is not enough glucose in the blood, Glucagon converts some glycogen into glucose.

Diabetes

- Some people do not produce enough insulin.
- When they eat food, the glucose levels in their blood cannot be reduced.
- This condition is known as DIABETES.
- Diabetics sometimes have to inject insulin into their blood. They have to be careful of their diet.


Glucose levels rise after a meal.
Insulin is produced and glucose levels fall to normal again.
Glucose Concentration
Normal
Time
Meal eaten


Glucose levels rise after a meal.
Glucose Concentration
Diabetic
Insulin is not produced so glucose levels stay high
Time
Meal eaten



The glucose in the blood increases. But there is no insulin to convert it into glycogen. Glucose concentration rises to dangerous levels.

Glucose in the blood

The Kidneys

The kidneys

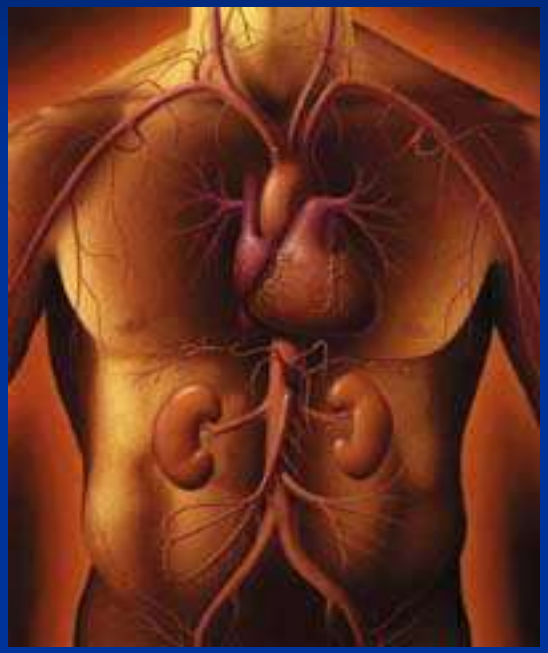
The kidneys "clean" the blood of waste products and control how much water is kept in the body. The waste products and water make up urine which is excreted via the ureter.

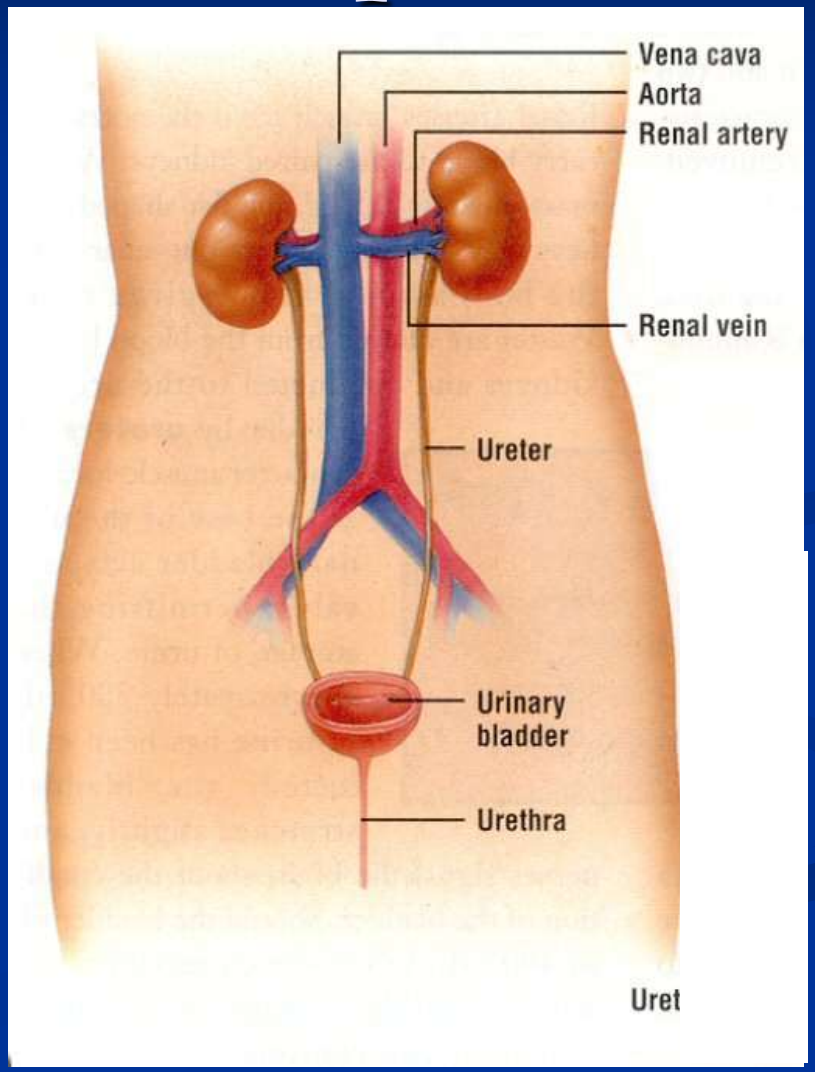
"Dirty" blood enters the kidney through the renal artery. Then, several things happen to clean the blood...

The kidneys

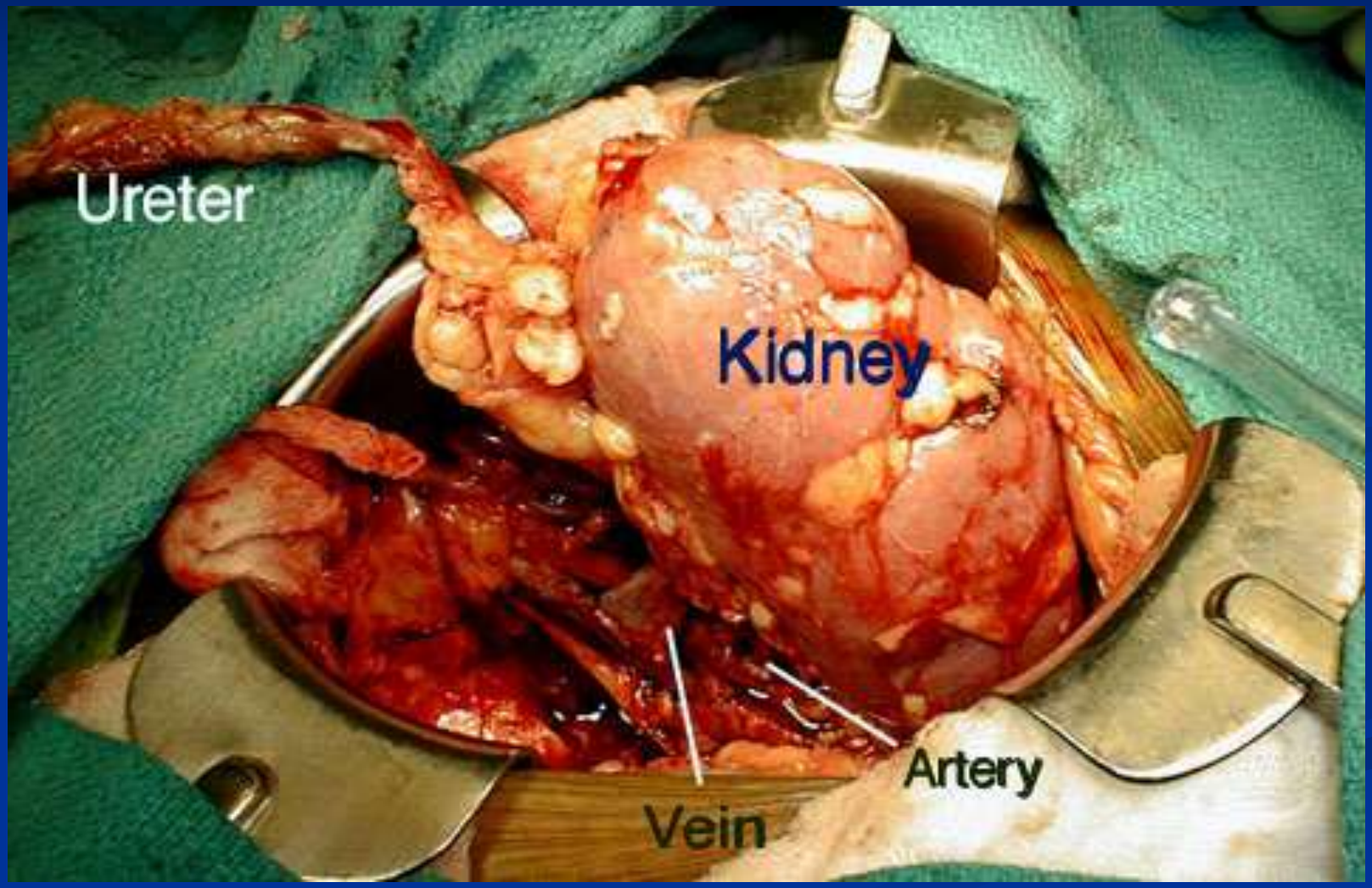
Excretion is the process by which waste products of metabolism and other non-useful materials are eliminated from an organism

Kidney and bladder position





Kidney transplant



The kidneys

- Urea is a waste product that is made when the LIVER breaks down proteins that are not needed by the body.
- Urea contains the element Nitrogen and Ammonia.

The kidneys

- Excess proteins can't be stored in the body
- They are broken down in the liver and converted into glycogen

The kidneys

- The urea passes into the blood, to be filtered out by the kidneys

Key Words!!

Nephron: structure in the kidney that acts as a microscopic filtration unit

Glomerulus: dense mass of very fine blood capillaries at the nephron that act as a filter

Key Words!!

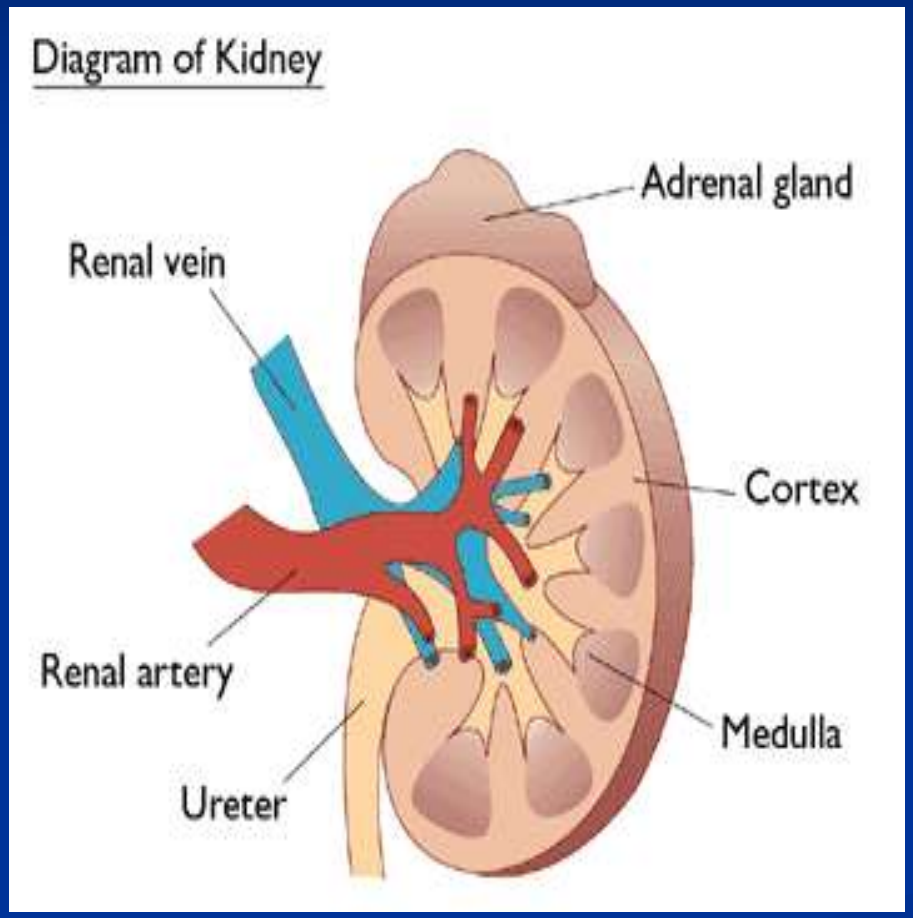
Bowman's capusle: cup-shaped part of the nephron that holds a glomerulus and collects the products of filtration from it

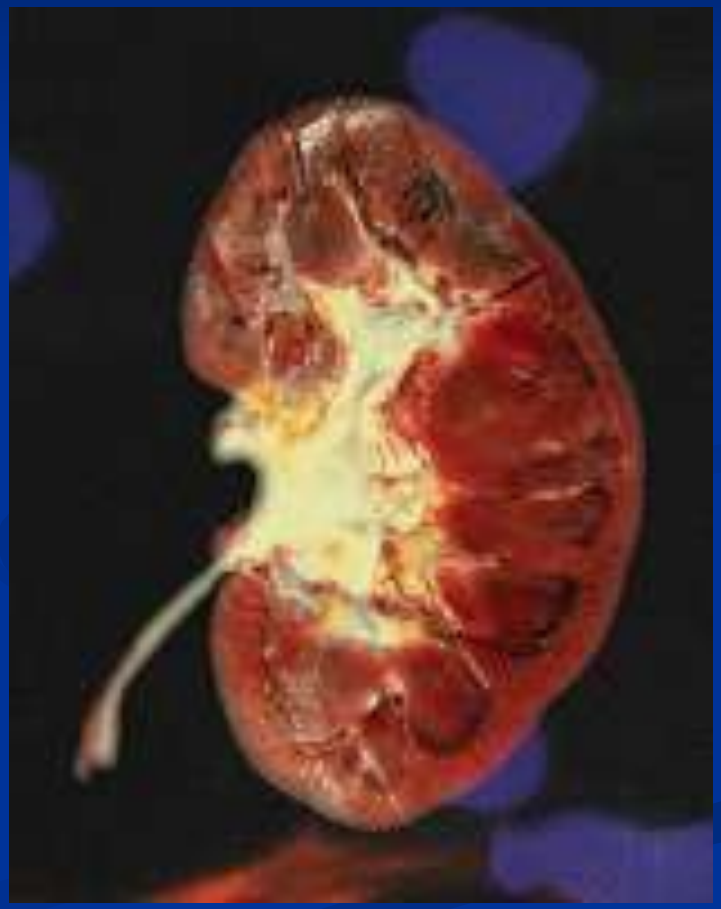
Glomerular filtrate: liquid removed from the blood by filtration in the kidney

Key Words!!

Loop of Henle: portion of the nephron that leads from the proximal tubule to the distal tubule. The main function of this structure is to create a concentration gradient in the medulla of the kidney

Cross section

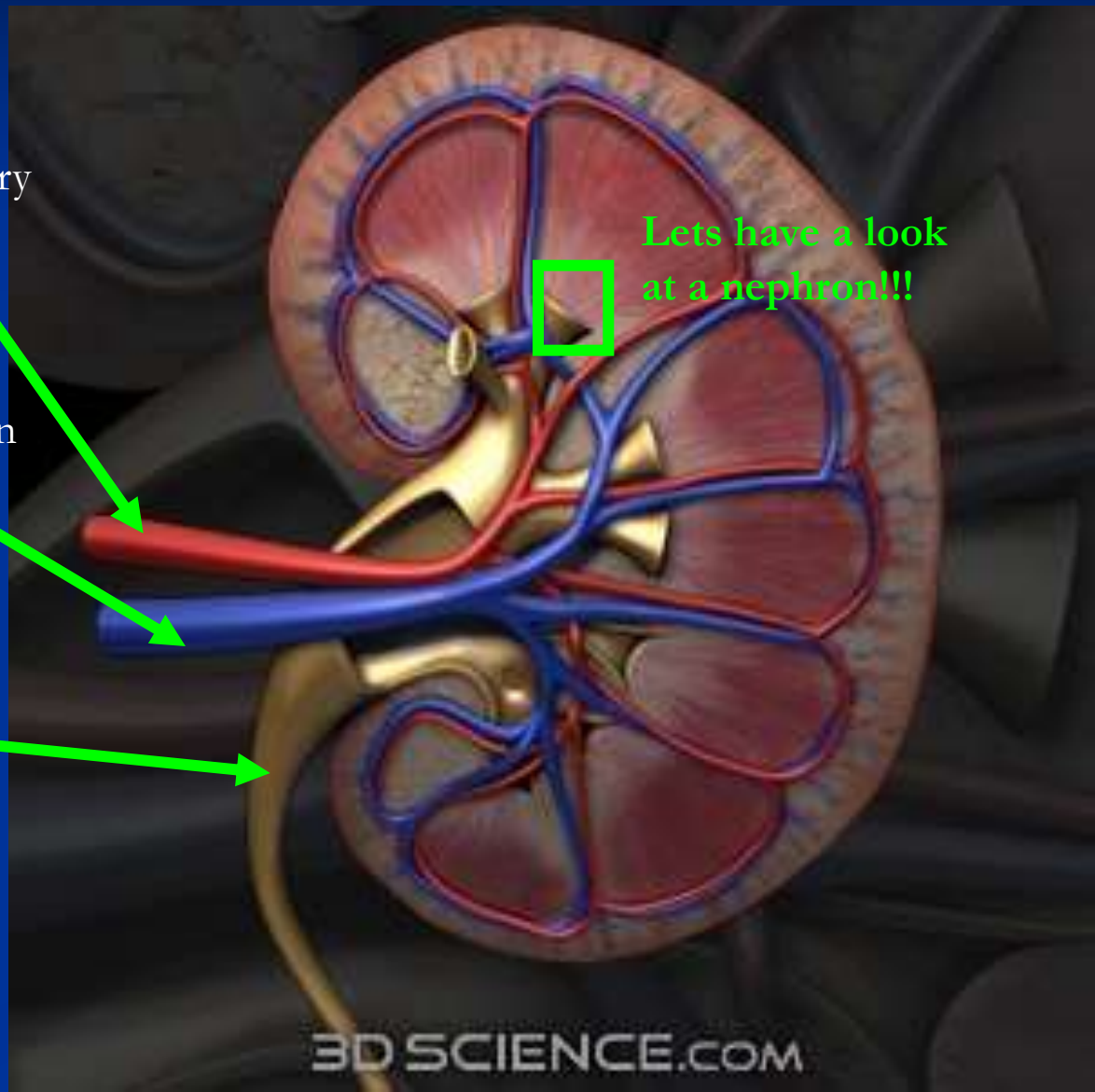


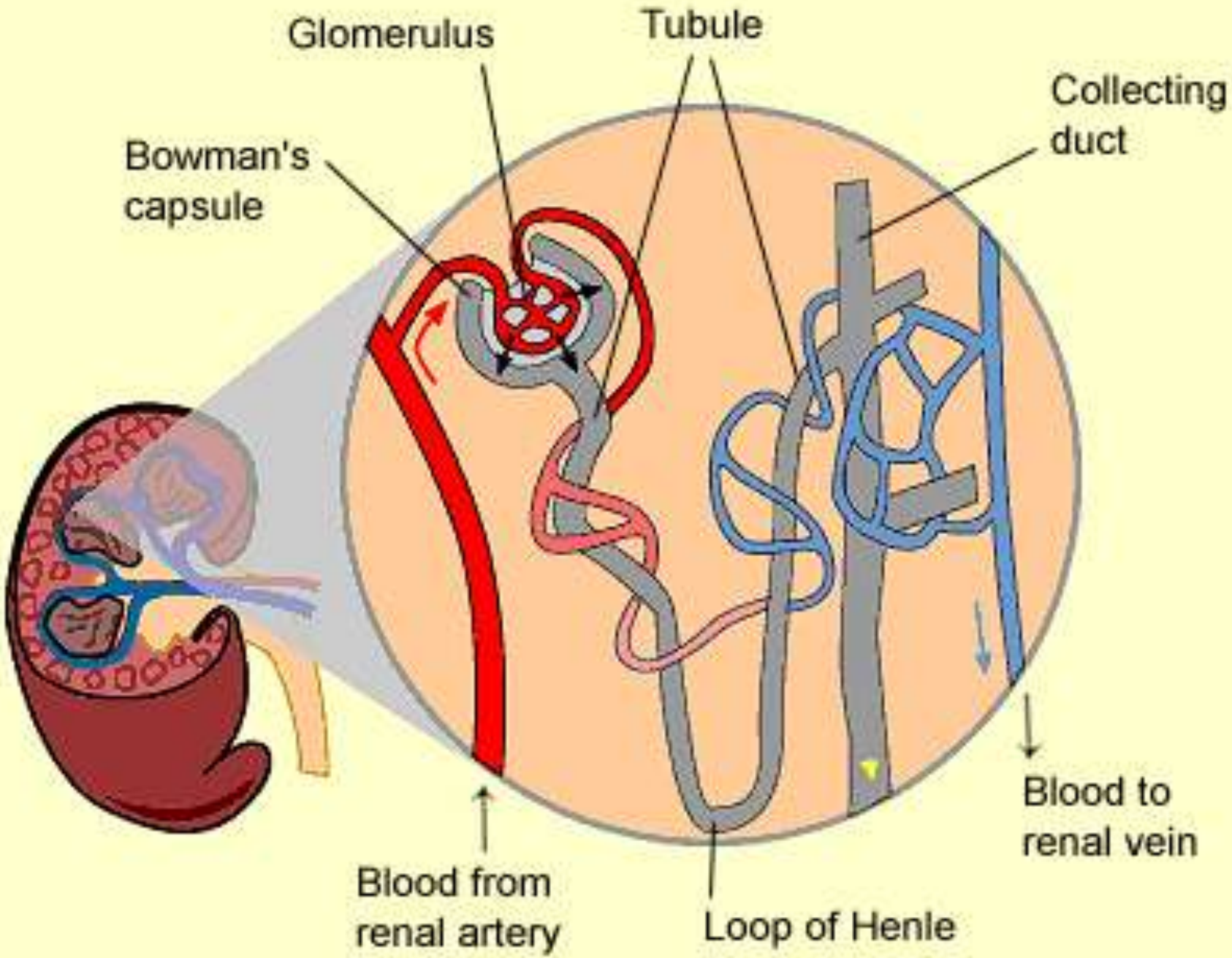


•Supplied with blood from **renal artery**

•Inside it splits into many fine **capillaries**

•Each capillary supplies blood to hundreds of thousands of tiny filtration units called **nephrons**




Glomerulus
Tubule
Collecting duct
Bowman's capsule
Blood to renal vein
Blood from renal artery
Loop of Henle

Process of the Nephron

- Filtration
- Secretion
- Reabsorption

Filtration in the Bowmans Capsule

Glomerular filtrate produced containing:

-water

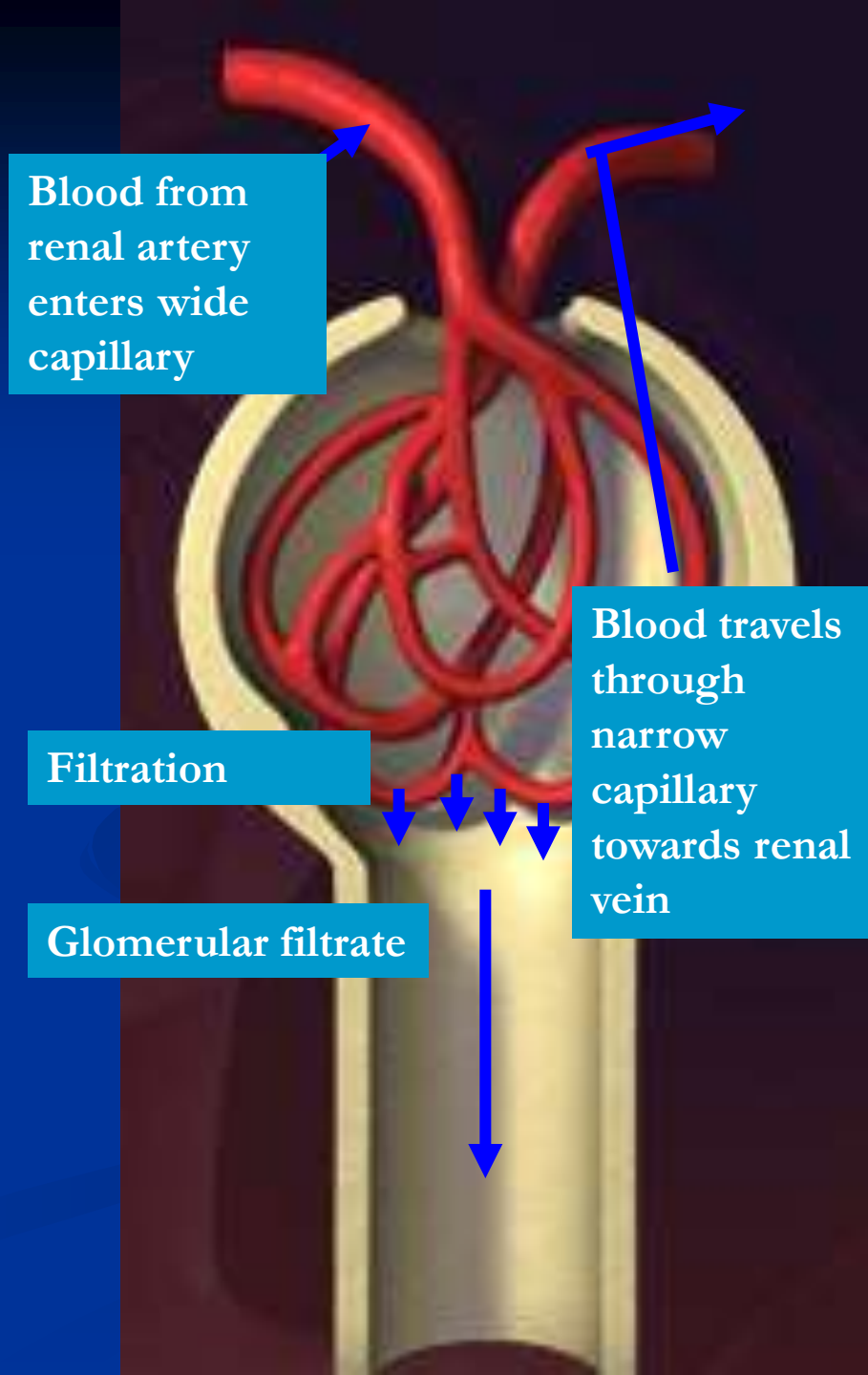
-glucose

-salts

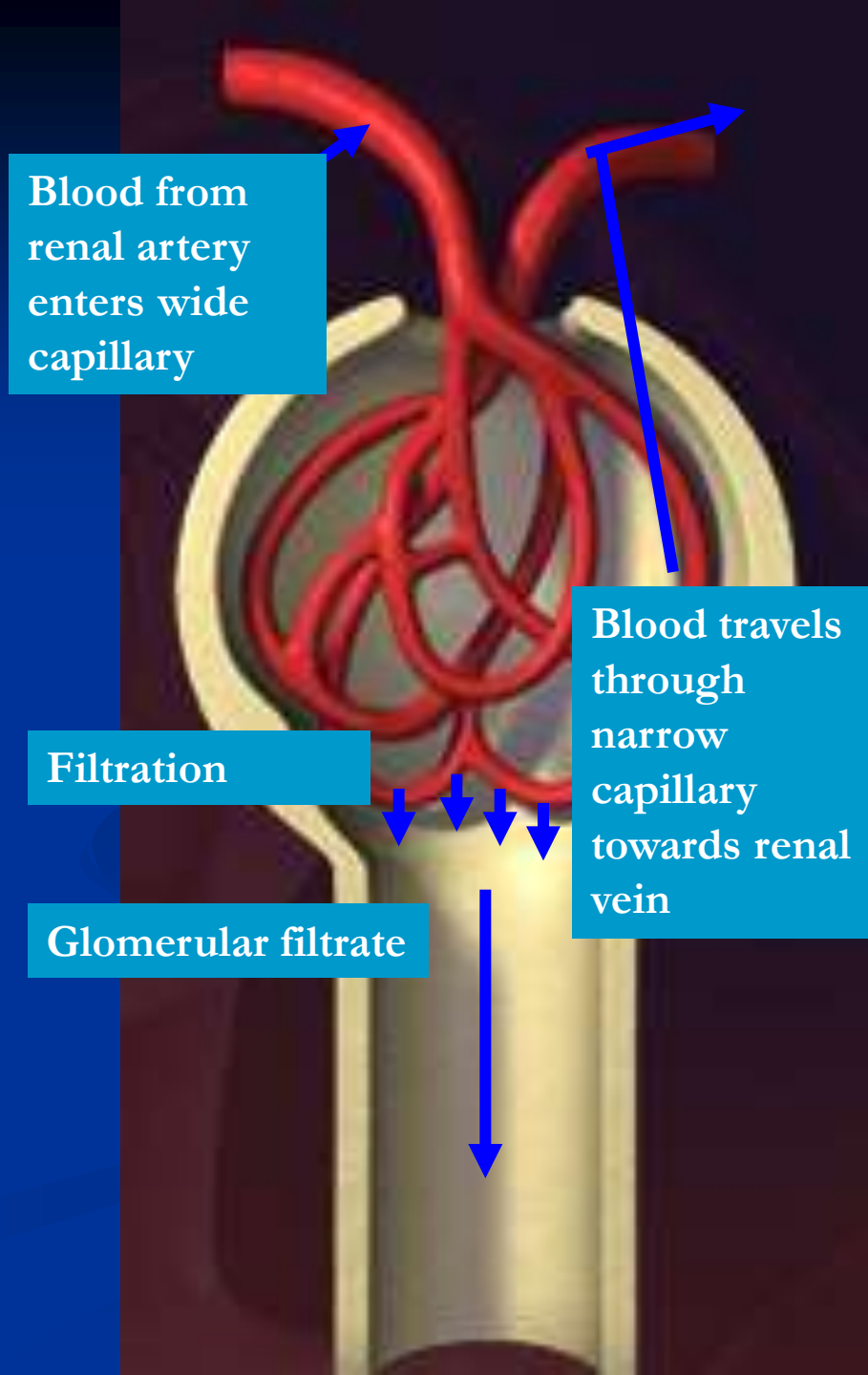
-urea

Filter separates different sized molecules under pressure. This process is known as ultrafiltration

Cells in the glomerulus and Bowman's capsule do not fit together very tightly



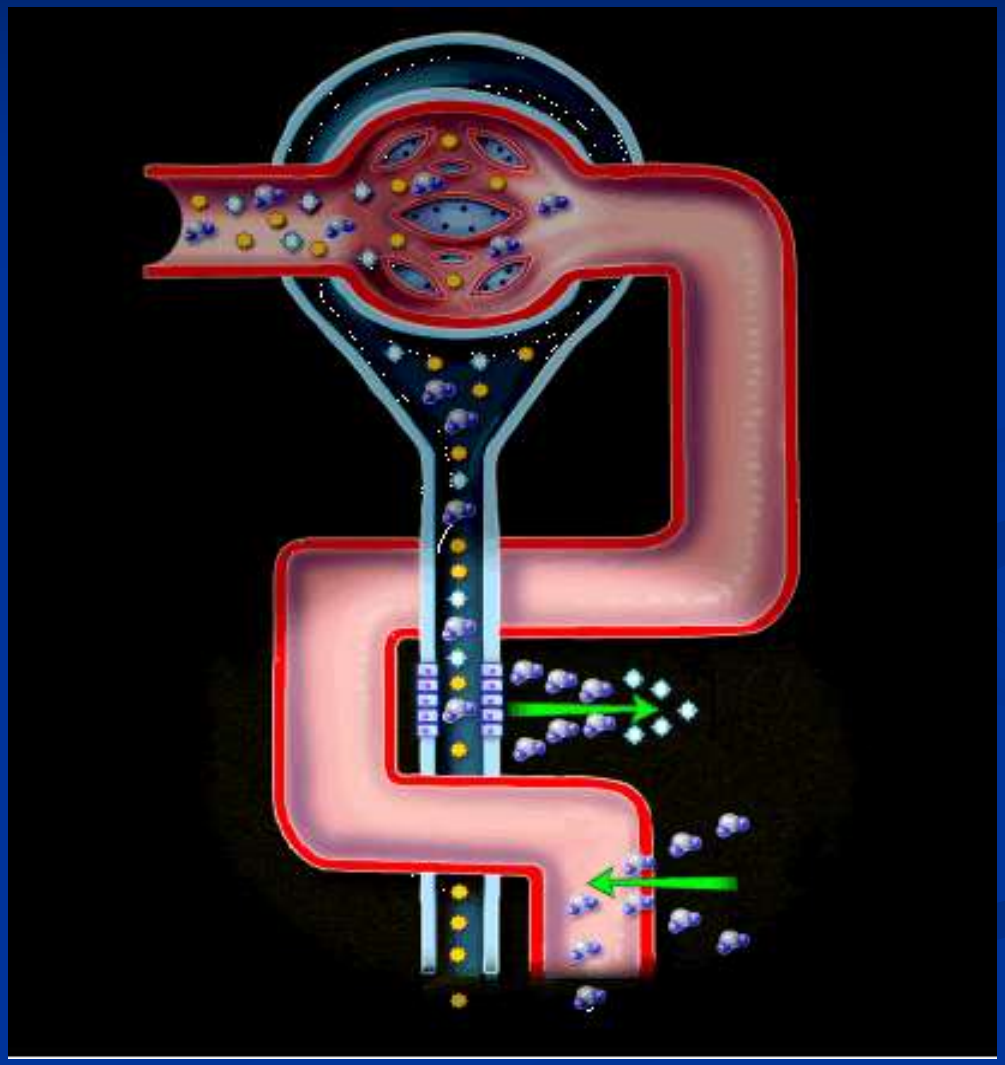
(Protein molecules and red blood cells do not pass into tubule as they are TOO BIG!!!!)

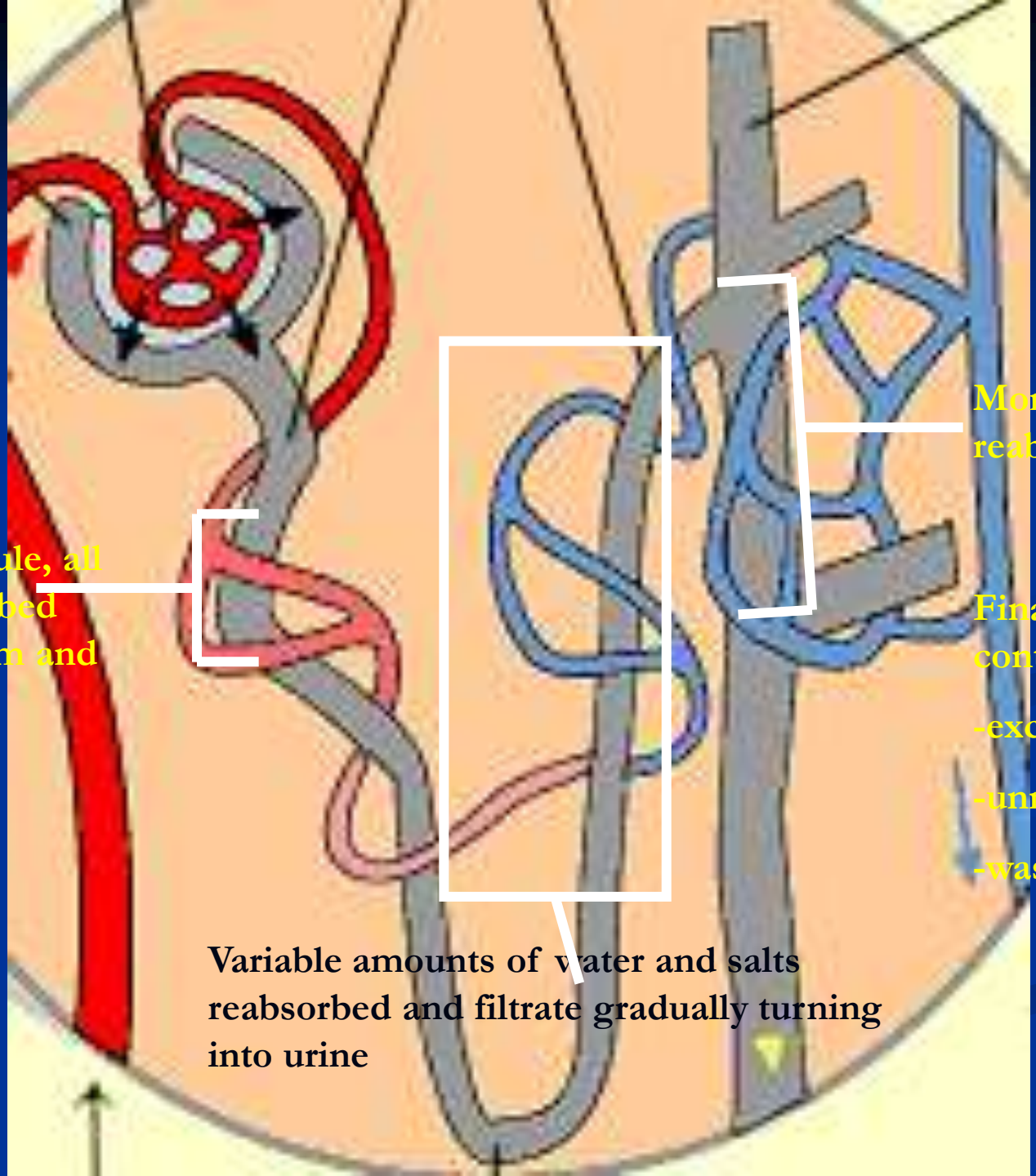


Secretion

- Additional materials such as antibiotics, vitamins, and other large molecules are selectively secreted into the convoluted tubule by passive and active transport

Reabsorption




Convoluted tubule, all glucose reabsorbed and most sodium and chloride ions
More water reabsorbed
Final urine containing:
-excess water
-unneeded salts
-waste urea
Variable amounts of water and salts reabsorbed and filtrate gradually turning into urine

Reabsorbing water

If you have too little water in your blood, you will produce very concentrated urine.

(very little water in it)

If you have too much water in your blood, you will produce very dilute urine.

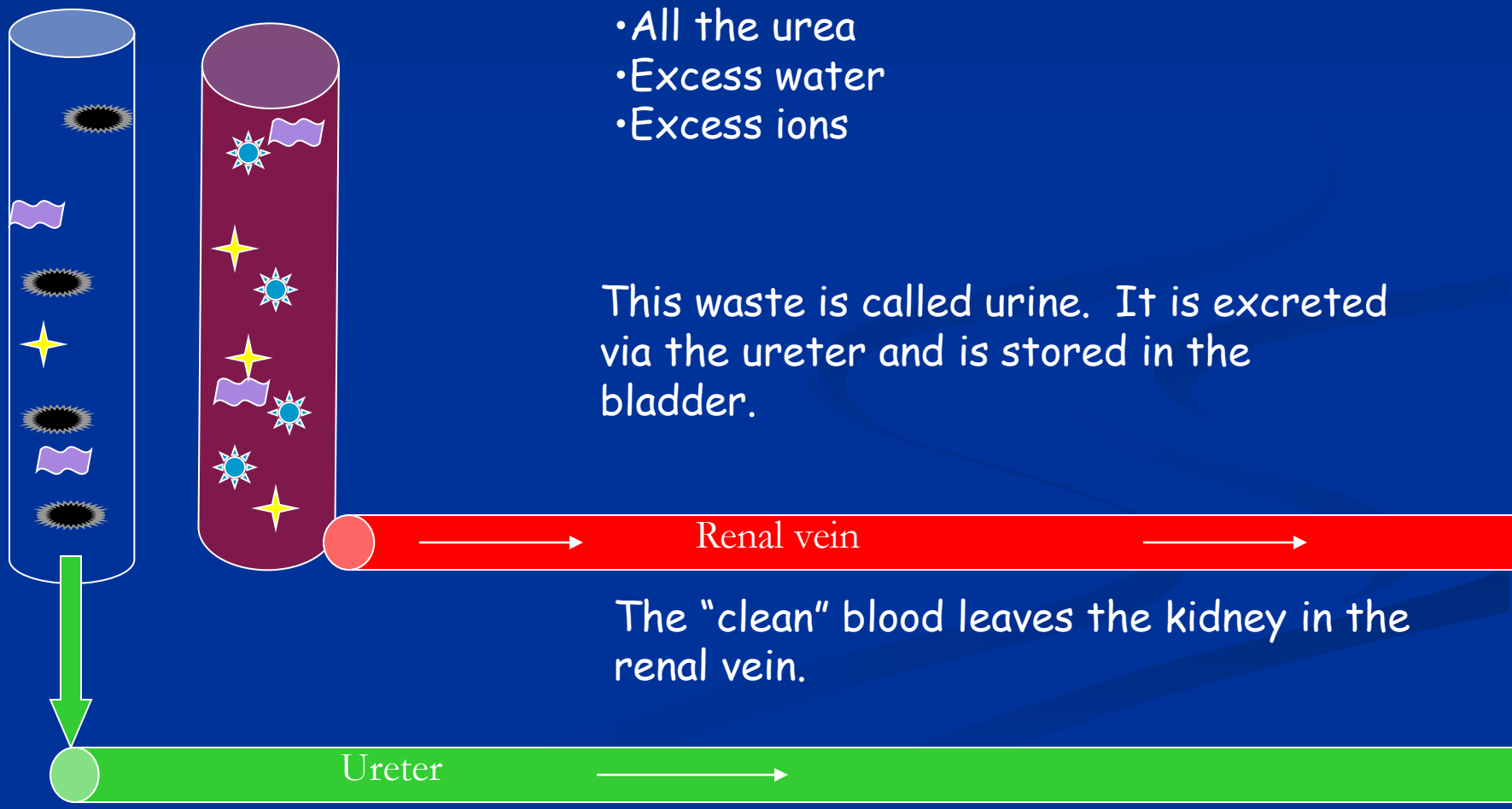
(lots of water in it)

Excrete the waste

Everything that is left in the kidney tubule is waste:

- All the urea
- Excess water
- Excess ions

This waste is called urine. It is excreted via the ureter and is stored in the bladder.



The "clean" blood leaves the kidney in the renal vein.

Controlling Water Concentration

- Blood
  -important part of internal environment
  -constantly changing water concentration
  -e.g. exercising
  drinking lots of water

- The body uses negative feedback control to regulate water content of the blood

Controlling Water Concentration

- ADH
  - Anti diuretic hormone
  - Hormone used to control water
  - Produced in the pituitary gland

Controlling Water Concentration

- Diuresis is the flow of urine from the body
- Anti diuresis means the production of less urine
  - ADH is released when your body loses too much water

How does it work?

too little water in blood

↓

detected by hypothalamus

↓

more ADH secreted into blood by pituitary gland

↓

kidneys absorb less water from blood

↓

less urine produced

↓

blood water level back to normal

too much water in blood

↓

detected by hypothalamus

↓

less ADH secreted into blood by pituitary gland

↓

kidneys absorb more water from blood

↓

lots of dilute urine produced

↓

blood water level back to normal

Summary of urine production

- Complete the summary questions

Summary of urine production

- Urea is a waste product made in the **LIVER**
- Water content of the body is controlled in the **KIDNEYS**
- Urea, water and other waste makes up **URINE**.
- Urine travels down the **URETER** and is stored in the **BLADDER**
- Urine is excreted through the **URETHRA**.

Review

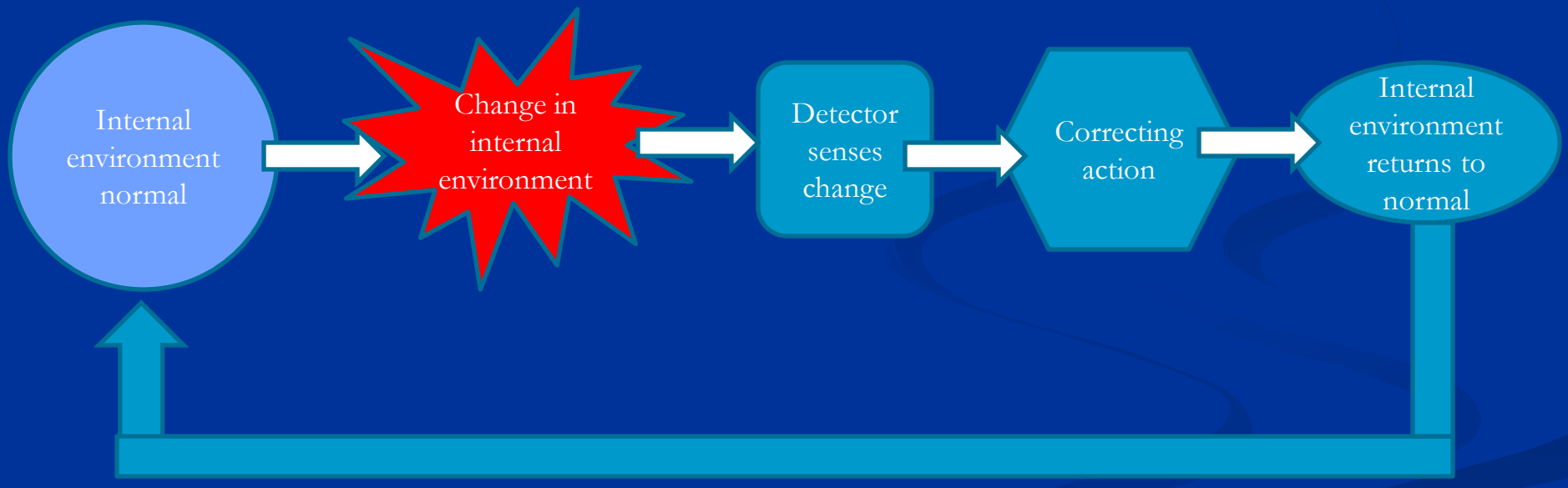
- Complete the kidney review questions

Negative Feedback

- A change in conditions in the body is detected, and starts a process which works to return conditions to normal.
- Negative feedback loops require a receptor, a control centre, and an effector.

Negative Feedback

- The action of ADH is an example of negative feedback.



Negative feedback switches off

COMPLETE THE DIAGRAM