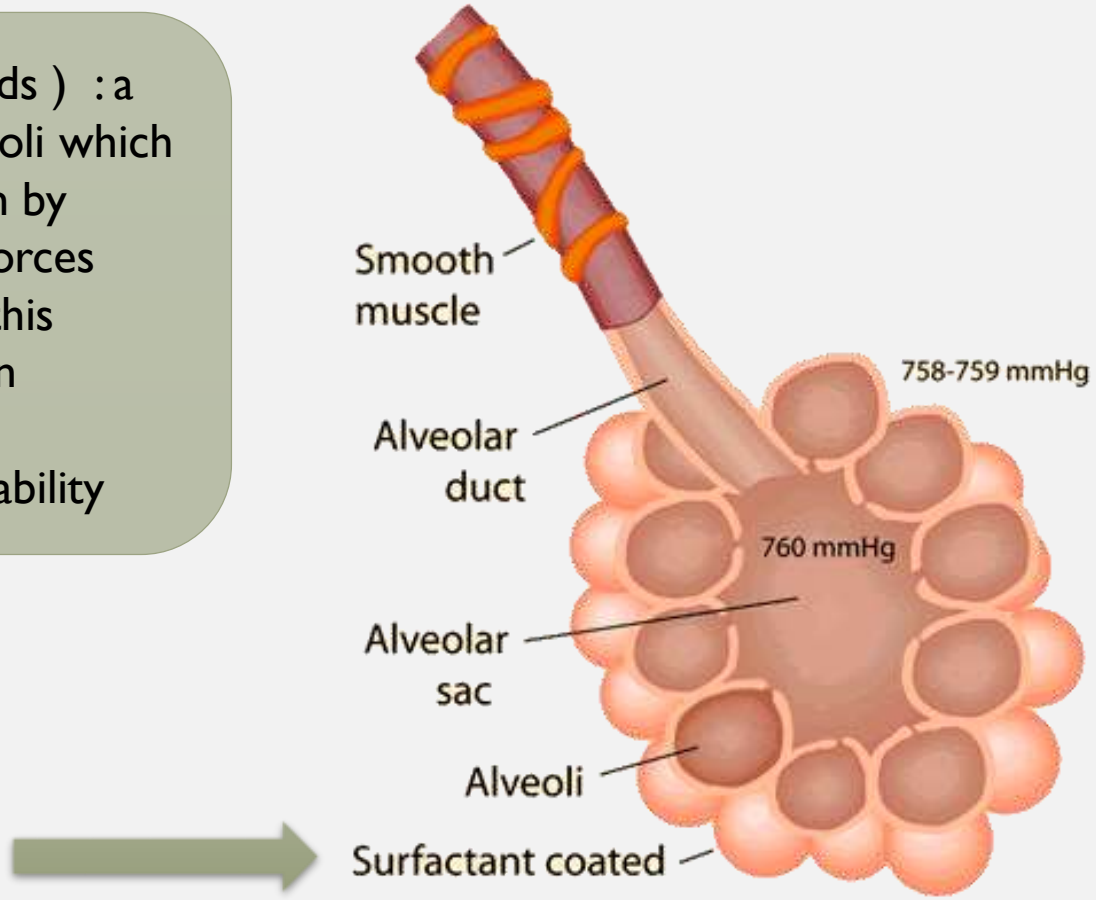
ALVEOLAR SURFACTANT AND OVERVIEW OF THE RENAL SYSTEM

Surface tension of alveoli and surfactant :

Surface tension of alveoli results from attractive forces between liquid molecules lining the alveoli from outside where air and water surface

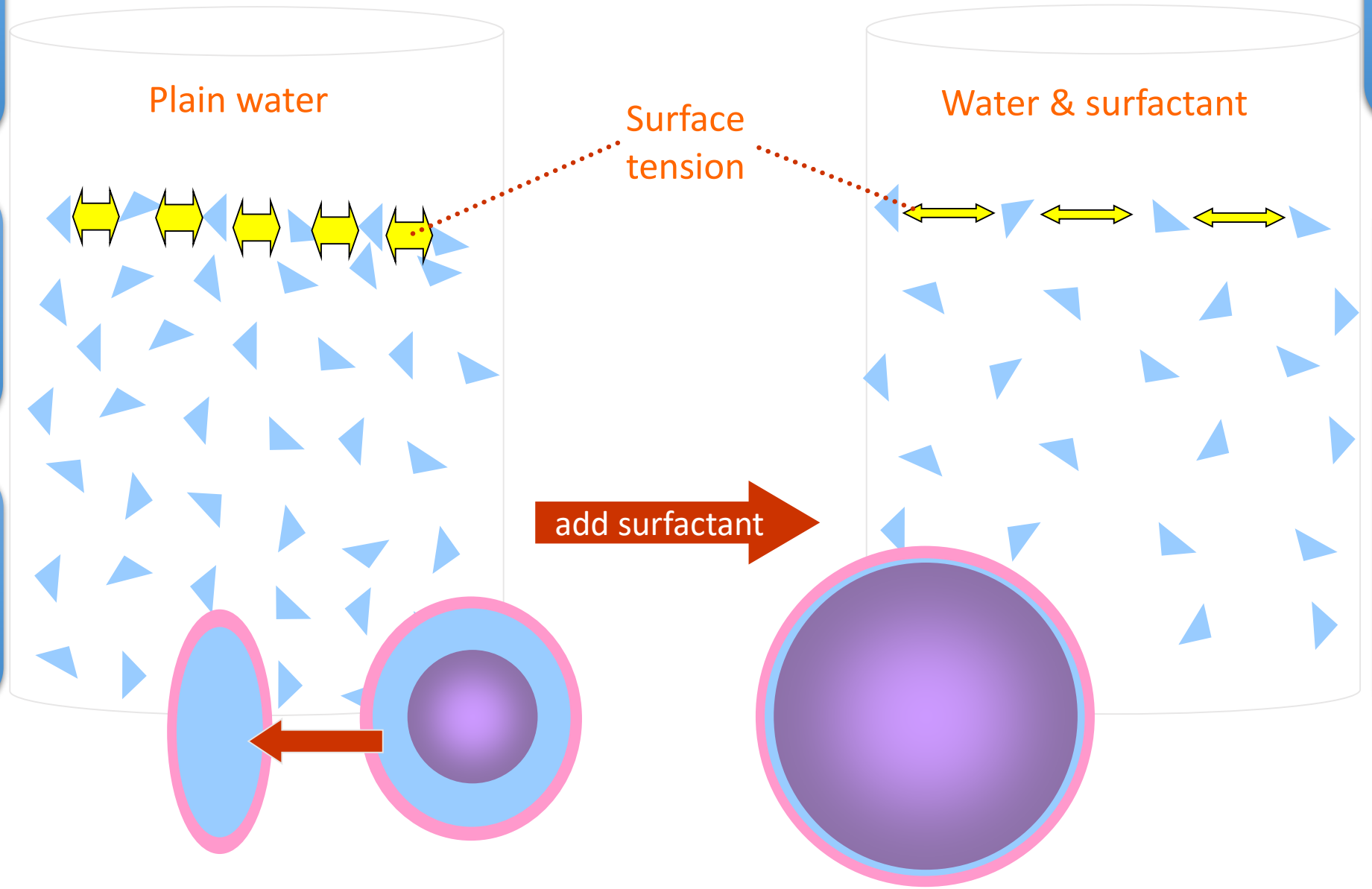
Surfactant(proteins and lipids) : a substance that line the alveoli which reduces the surface tension by disturbing intermolecular forces between liquid molecules. this reduction in surface tension prevents small alveoli from collapsing and increases fixability



1) The droplets of water are close to each other and have a high surface tension

2)The higher surface tension the smaller diameter and smaller space between water molecules

3) Adding a surfactant reduces the surface tension by empowering the hydrogen bonds of water



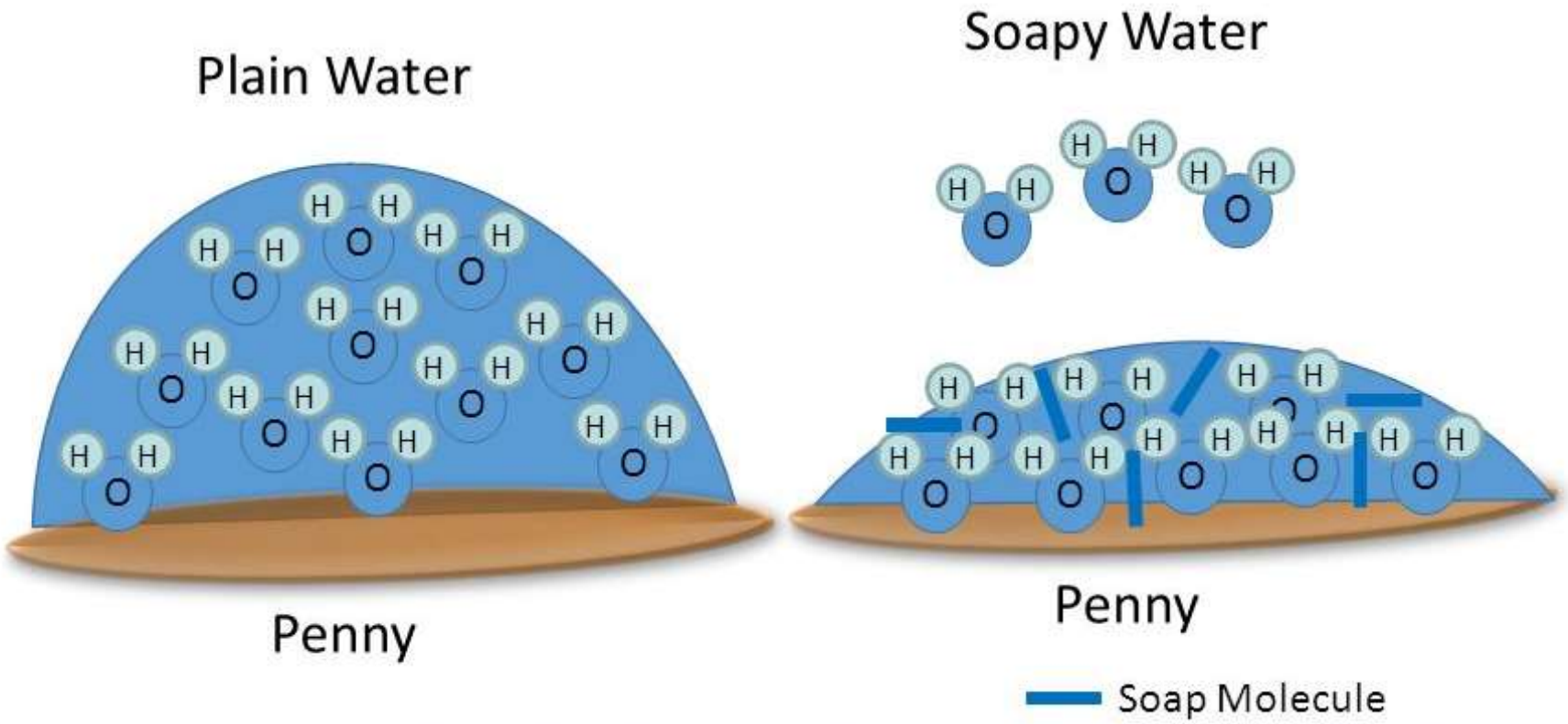
4) The lesser surface tension the longer diameter and longer space between molecules

5) The molecules with high surface tension tend to be spherical due to lesser diameter and lesser surface area

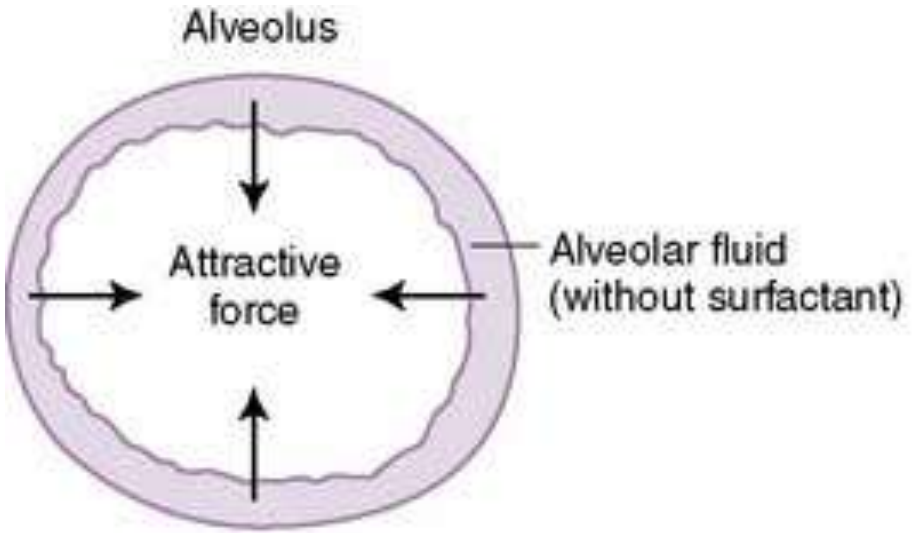
The surfactants usually are detergents like soap : when you wash your hand with out soap the water won't remove the dirt because of the surface tension

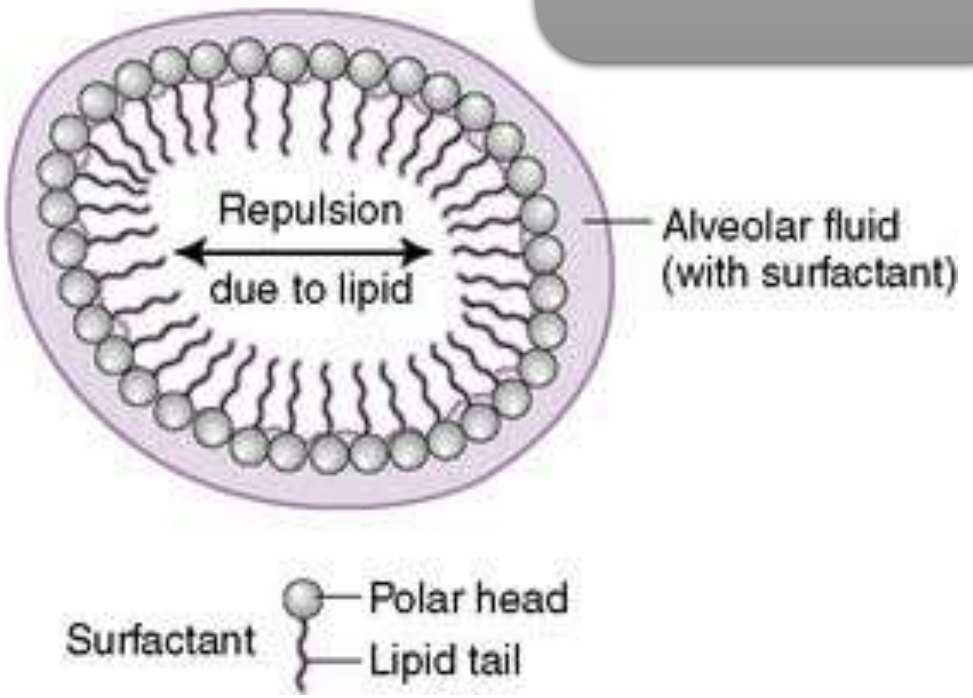
... But if you use the soap the dirt will be removed because the soap destroy the H bond between water molecules and reduce the surface tension

Surface Tension



Large alveoli : has low collapsing pressure and easy to keep open





Small alveoli : has high collapsing pressure and are more difficult to keep open

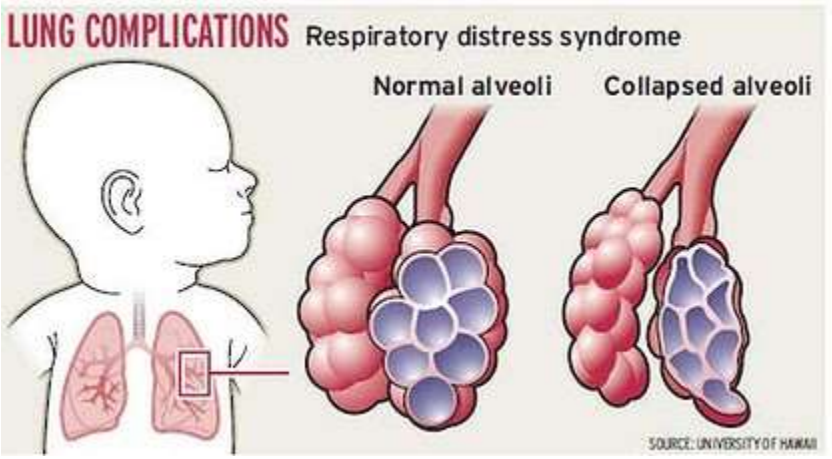
Surfactant

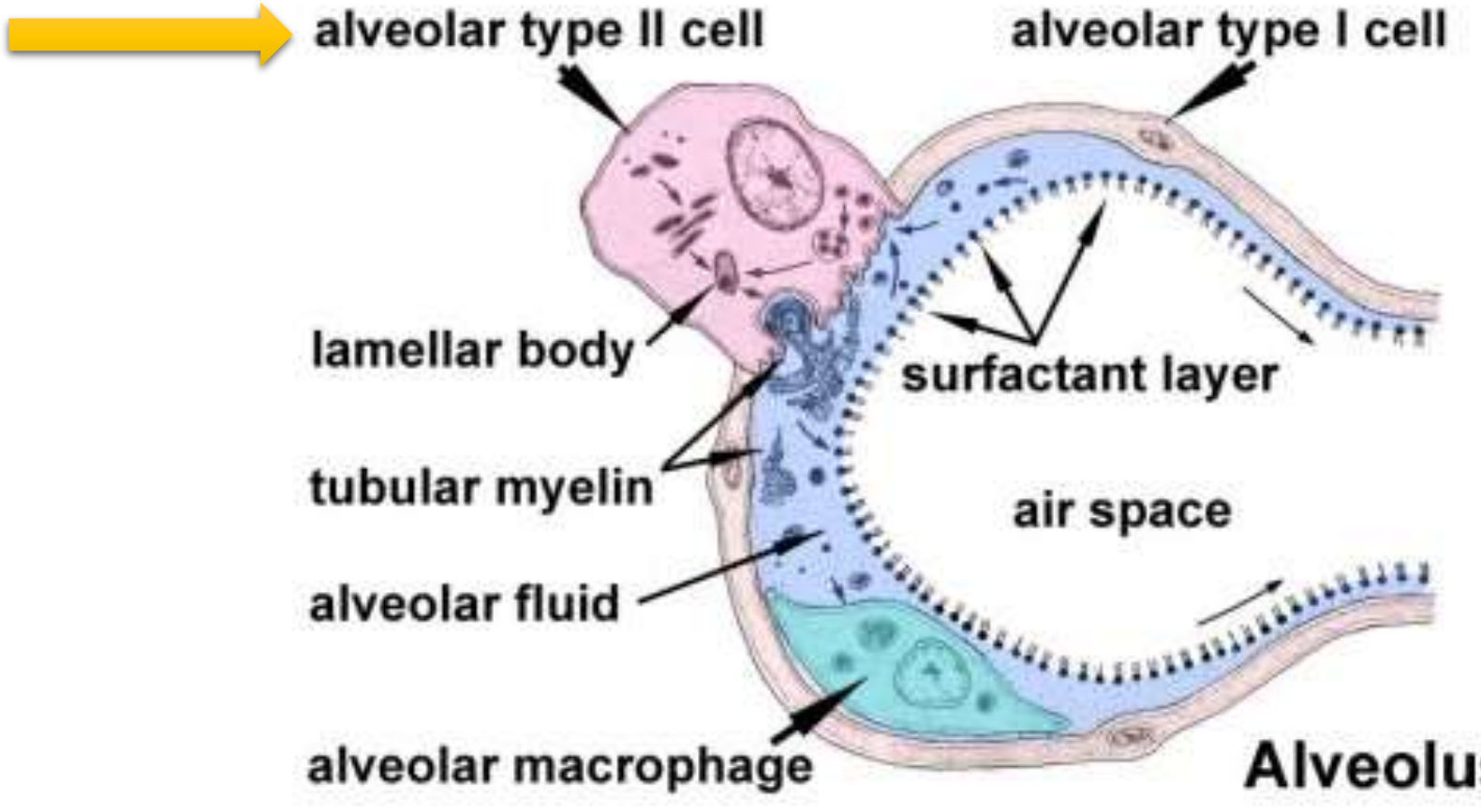
- Type II cuboidal epithelial cells are scattered in alveolar walls
- Surfactant is a detergent-like substance which is secreted in fluid coating alveolar surfaces – it decreases tension
- Without it the walls would stick together during exhalation
- Premature babies – problem breathing is largely because lack surfactant

Type 2 cells : responsible for reducing the surface tension (releasing for surfactant) …… so it increase the diameter of it and the surface area so allow mor transfer of oxygen to the alveoli

Premature infants(preterm) : are those who porn before the end of 37th week

1) Their breathing is difficult because lack of surfactant
2) Breathing is assisted medically by syringe of surfactant until the baby's lungs fully develop





Law of Laplace

Longer radius …. Lesser surface tension and lesser pressure so easier breath and more effort not required

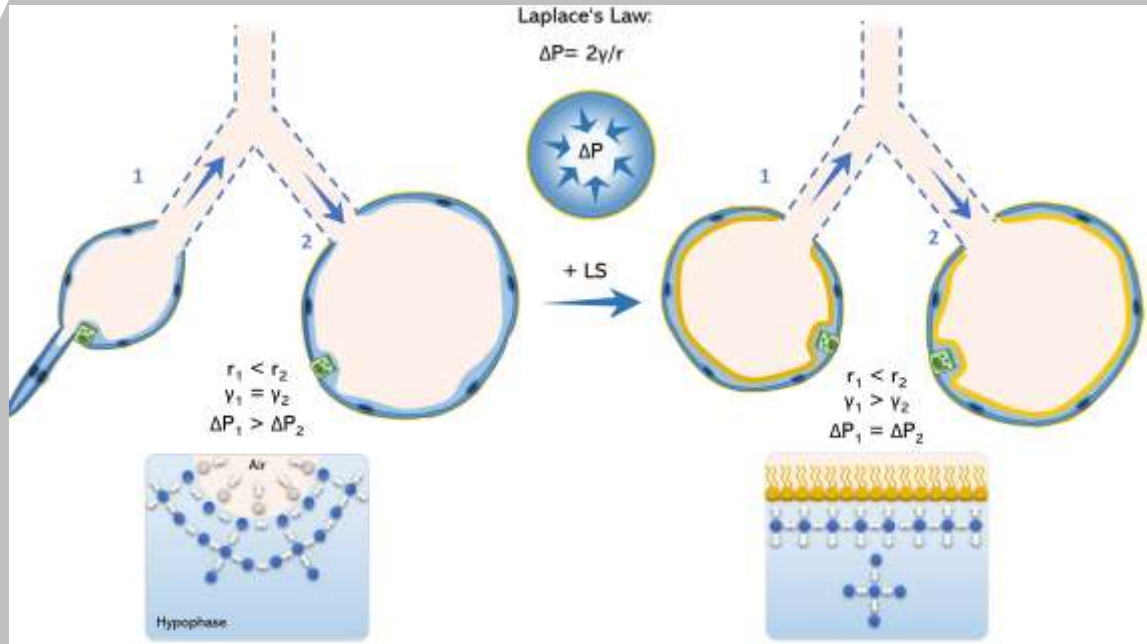
Smaller radius …. Higher surface tension and higher pressure so more difficult breath and more effort required

- For the average-sized alveolus with a radius of about 100 micrometers and lined with *normal surfactant, this* calculates to be about 4 centimeters of water pressure (3 mm Hg).

$$\text{Pressure} = \frac{2 \times \text{Surface tension}}{\text{Radius of alveolus}}$$

- If the alveoli were lined with pure water without any surfactant, the pressure would calculate to be about 18 centimeters of water pressure, 4.5 times as great.

- Thus, one sees how important surfactant is in reducing alveolar surface tension and therefore also reducing the effort required by the respiratory muscles to expand the lungs.



surface tension; this concept that because of the water molecule interaction between the air in the alveoli and the water molecules it causes that tension at the water air interface and the whole thing is the alveoli wants to collapse it wants to assume the small size as possible and the whole purpose again the lung wants to pull the visceral plural away from parietal plural and increase the volume in the chest

Surfactant : during the inhalation and exhalation keeps the lungs inflated and so that's lead to visceral pleura to get closer to the parietal pleura

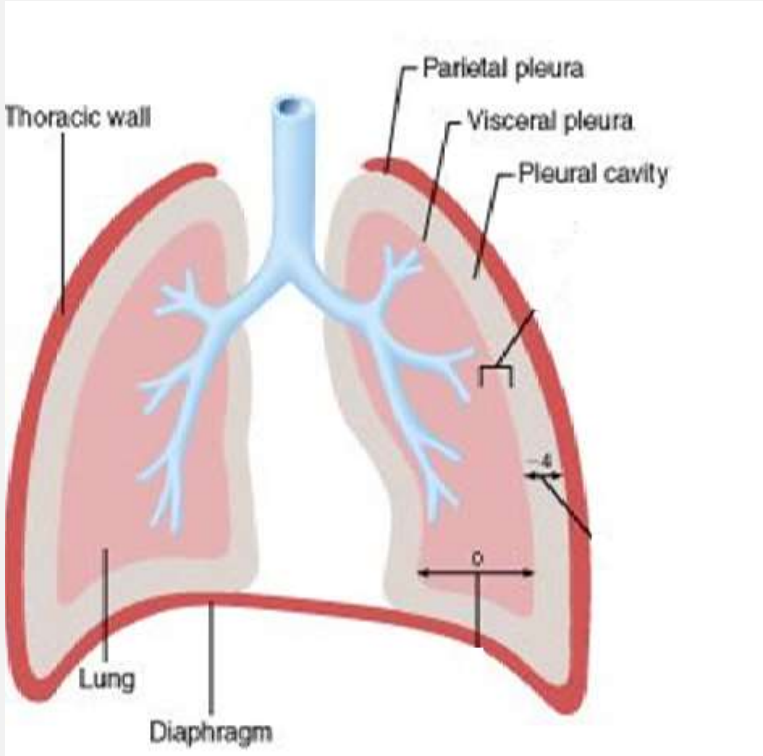
Elasticity : do the opposite action of surfactant by pulling the parietal pleura away from visceral pleura and prevent the lung from getting to the smaller size

Elasticity of the chest wall; when breathing the elasticity is going to pull the chest wall away so increase the volume in the chest wall and pulling the parietal plural away from the visceral plu'

Elasticity : tendency to getting smaller size

Do the opposite action of surfactant

- Both surfactant and elasticity helps the lung keeps inflated and provide flexibility for it



Function of the renal system

Excretion : function of the renal system s formation of urine so :

The removal of organic waste products from body fluids :

Excretion : regulation of the waste product in the body by disposing it within normal range

Homeostasis

- Excretion of metabolic waste products and foreign chemicals
- Regulation of water and electrolyte balances
- Regulation of body fluid osmolarity and electrolyte concentrations

Maintain the net movement

- Regulation of arterial pressure :

Negative feedback role …. Very effective mechanism

- Regulation of acid-base balance
- Secretion, metabolism, and excretion of hormones (erythropoietin, Regulation of 1,25–Dihydroxyvitamin D3 Production) : 1.25 is an important precursor in a long cascade of vitamin D activation
- Gluconeogenesis

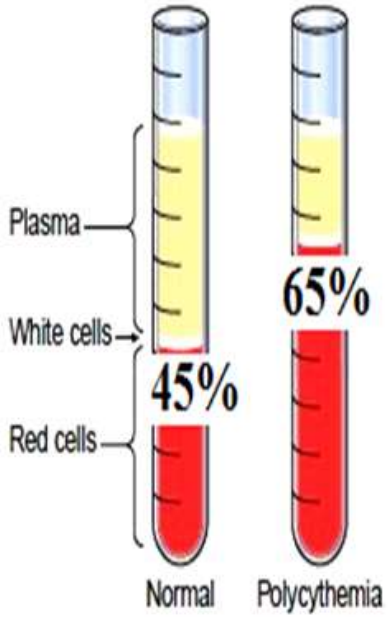
Regulation of arterial pressure : Negative feedback role … very effective mechanism because the Gain = - infinity that meant the new value is almost equal the normal so the denominator will be (0)

Polycythemia and erythropoietin :

1) Erythropoietin : is a protein secreted from the kidney incase of hypoxia(decrease in oxygen and cellular oxygen)and enhance the production of RBCs

2) Stimulus(deficiency of oxygen) ….. Kidney secrets the erythropoietin ….to bone marrow ….increase the production of RBCS to increase oxygen

3)The erythropoietin test of plasma proteins for those who is suffering from secondary polycythemia is showing increase from the normal range

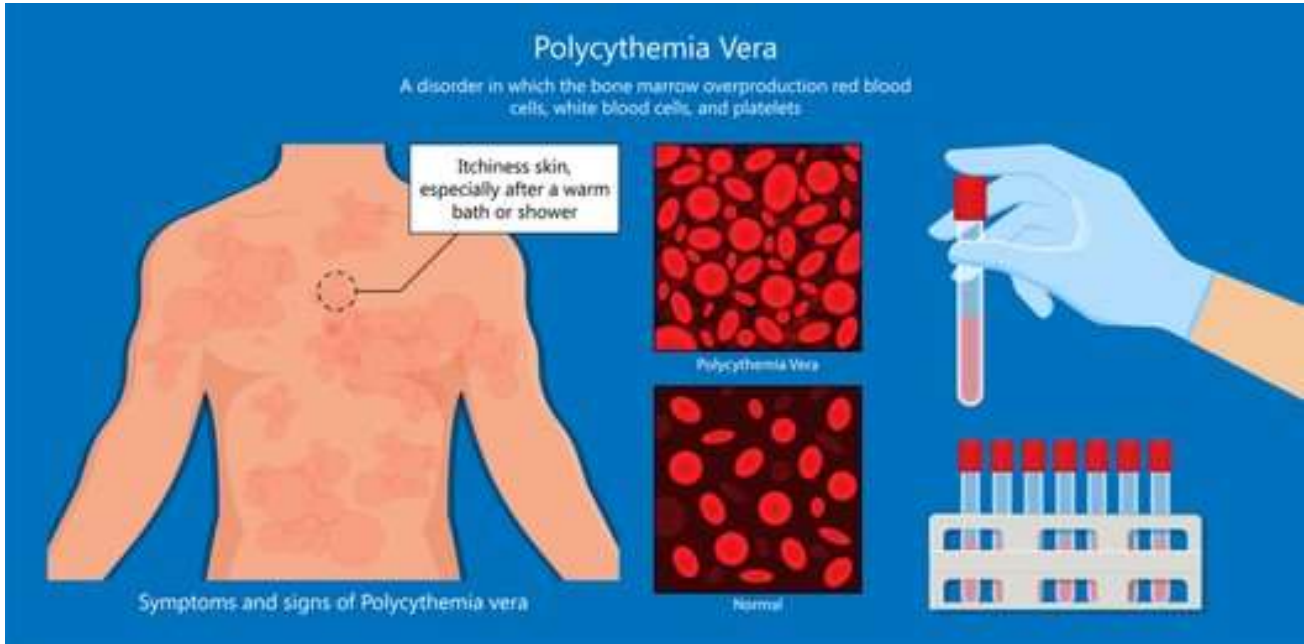


Secondary polycythemia

Exposure to low oxygen

1. living in high attitudes

2. Pulmonary disease



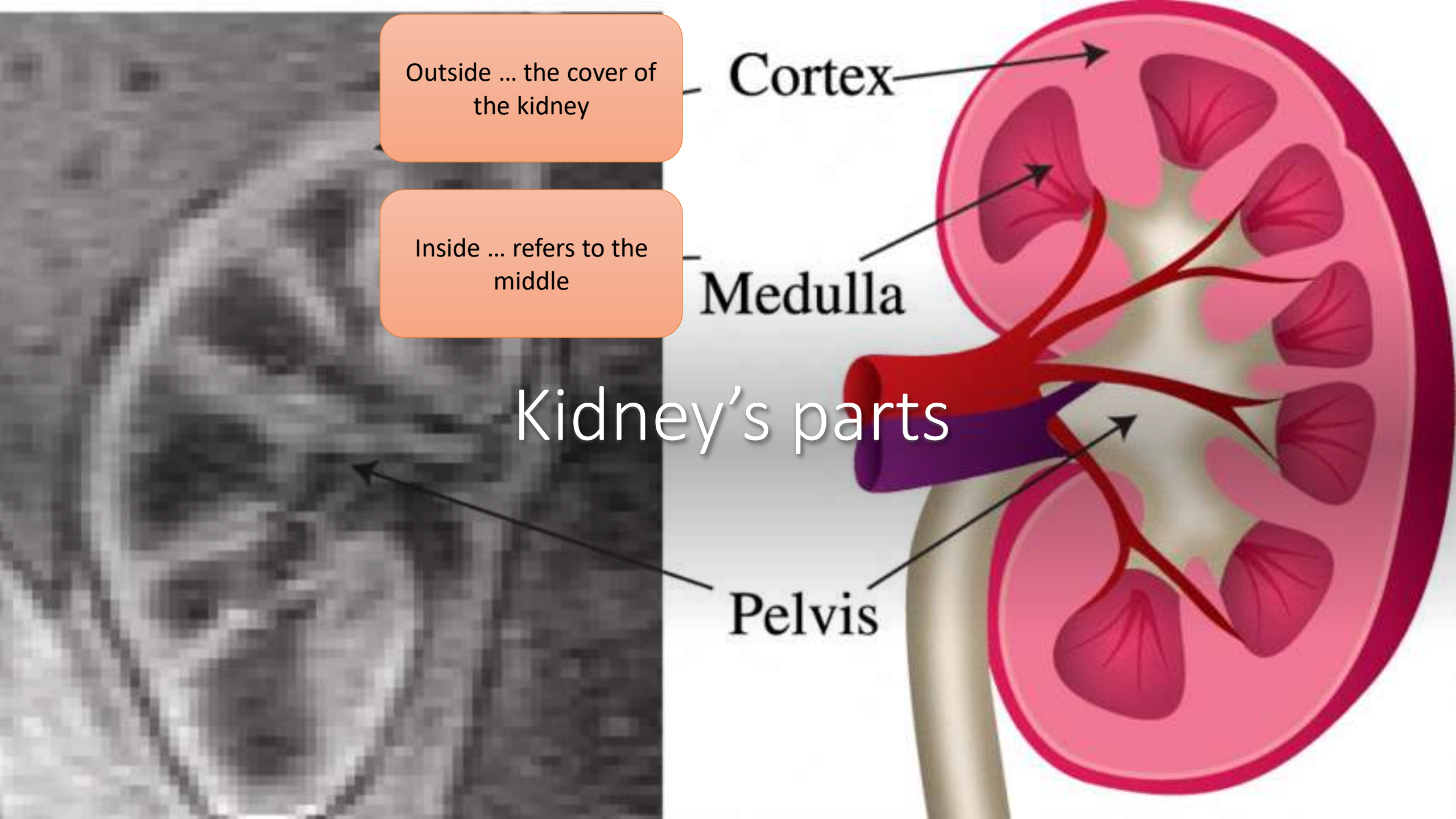
Nephron: formation of the urine and concentration

- The Nephron is the smallest functional unit of the kidney
- Each kidney in the human contains about 1 million Nephrons, each is capable of forming urine (not absolute numbers .. Approximately)
- The kidney cannot regenerate new Nephrons. Therefore, with renal injury, disease, or normal aging, there is a gradual decrease in Nephron number.
- After age 40, the number of functioning Nephrons usually decreases about 10 per cent every 10 years; thus, at age 80, many people have 40 per cent fewer functioning Nephrons than they did at age 40.
- This loss is not life threatening because adaptive changes in the remaining Nephrons allow them to excrete the proper amounts of water

Kidney's parts

Outside … the cover of the kidney

Inside … refers to the middle



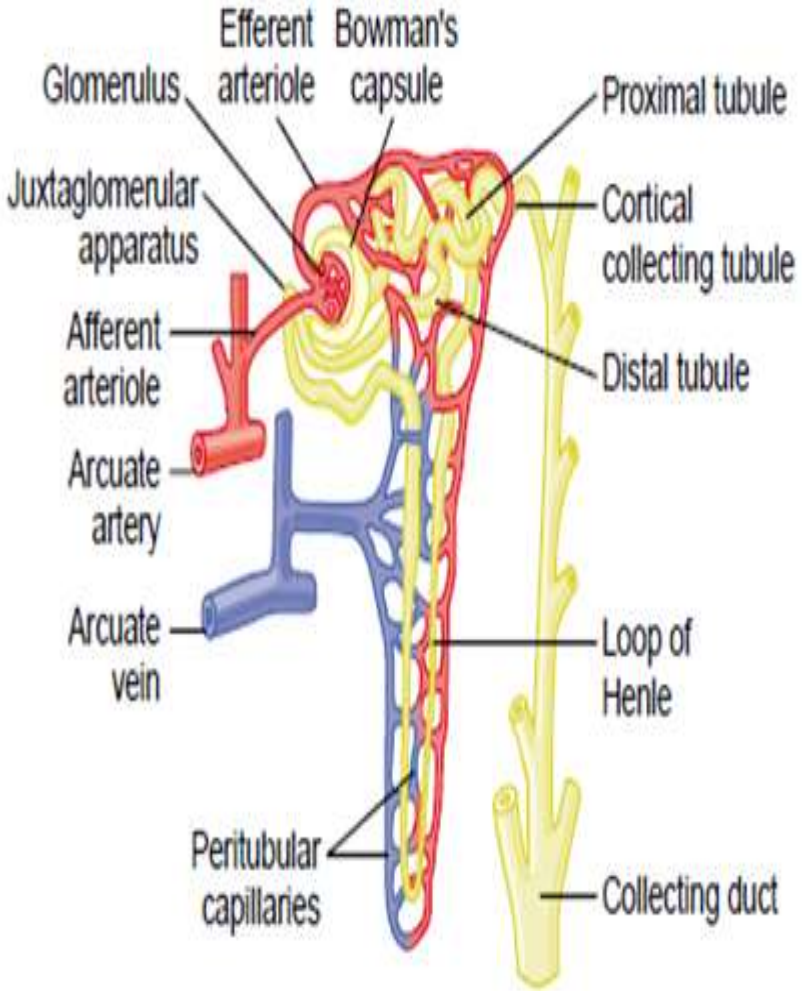
Each nephron begins with a corpuscle that contains a tuft of glomerular capillaries called the glomerulus, through which large amounts of fluid are filtered from the blood

The glomerulus contains capillaries that have high hydrostatic pressure (about 60 mm Hg).

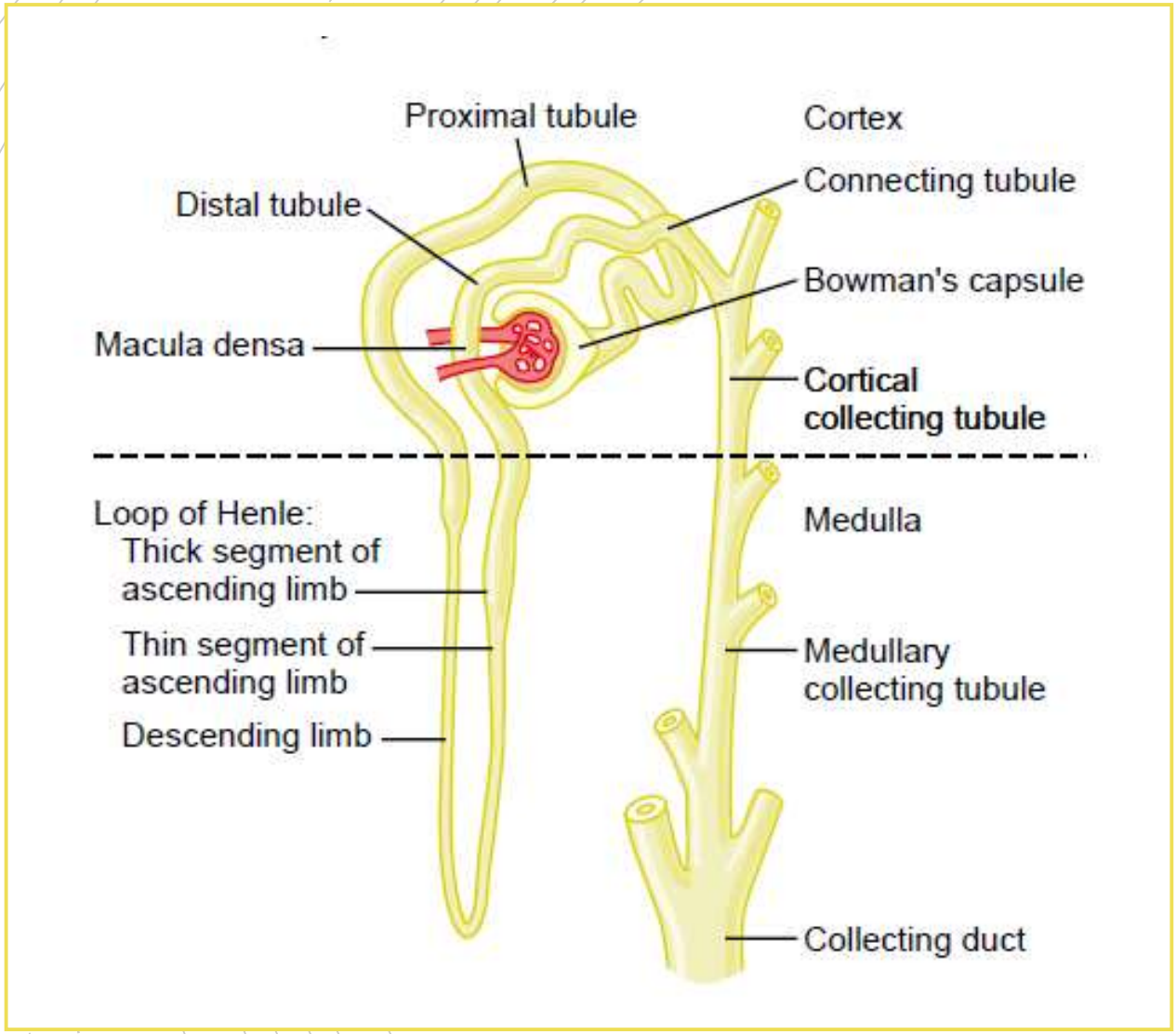
The glomerular capillaries are covered by epithelial cells, and the total glomerulus is encased in Bowman's capsule

Filtrate from the glomerular capillaries flows into Bowman's capsule and then into the proximal tubule, which lies in the cortex of the kidney ….due to the hydrostatic pressure the water moves out of the capillaries to the tubule

From the proximal tubule, filtrate flows into the loop of Henle, which dips into the renal medulla.



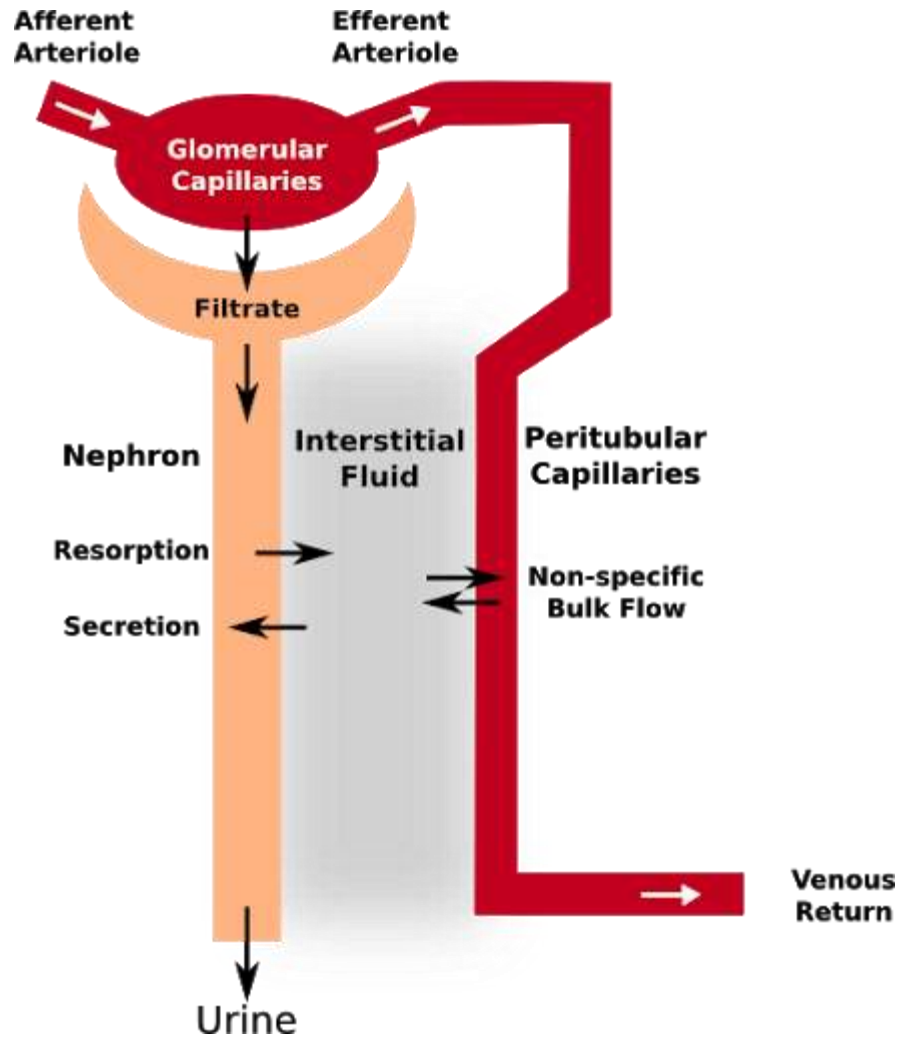
Loop of Henle



- Each loop consists of a descending and an ascending limb. At the end of the thick ascending limb is a short segment, which contains a plaque known as the macula densa
- Beyond the macula densa, fluid enters the distal tubule, which, like the proximal tubule, lies in the renal cortex.
- Distal tubule terminates into the cortical collecting tubule, which leads to the cortical collecting duct.
- The initial parts of 8 to 10 cortical collecting ducts join to form a single larger collecting duct that runs downward into the medulla and becomes the medullary collecting duct.

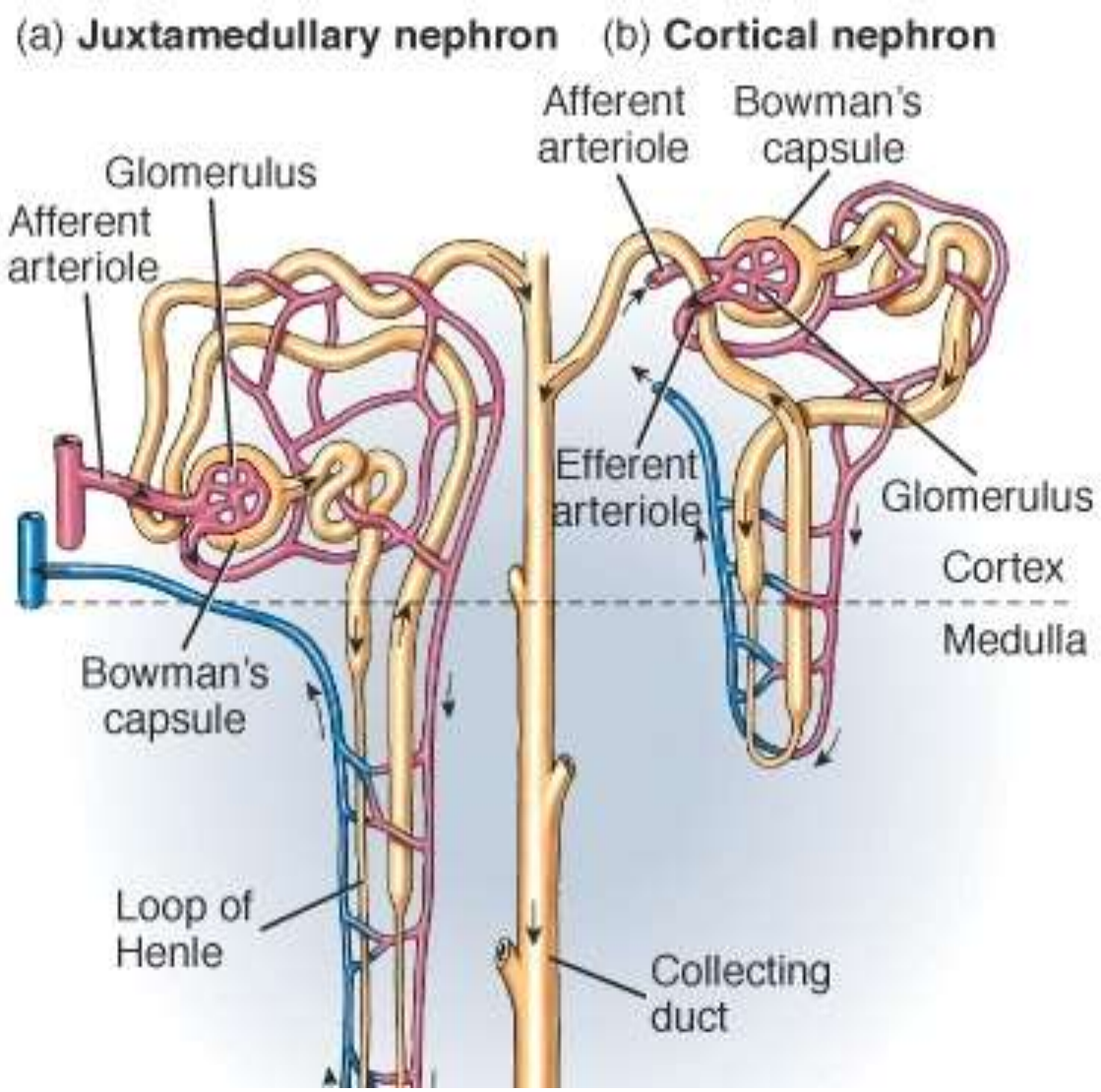
Urine pathway :

Afferent arteriole ..... > Bowman's capsule(here filtration occurs) ..... > proximal tubule ……> Henle loop (Thick descending k - Thin descending - Thin ascending - Thick ascending) ……..> macula densa(very small) …..> distal tubule (behind the macula densa)……> main duct …> urethra ….> bladder



Cortical and Juxtamedullary Nephrons

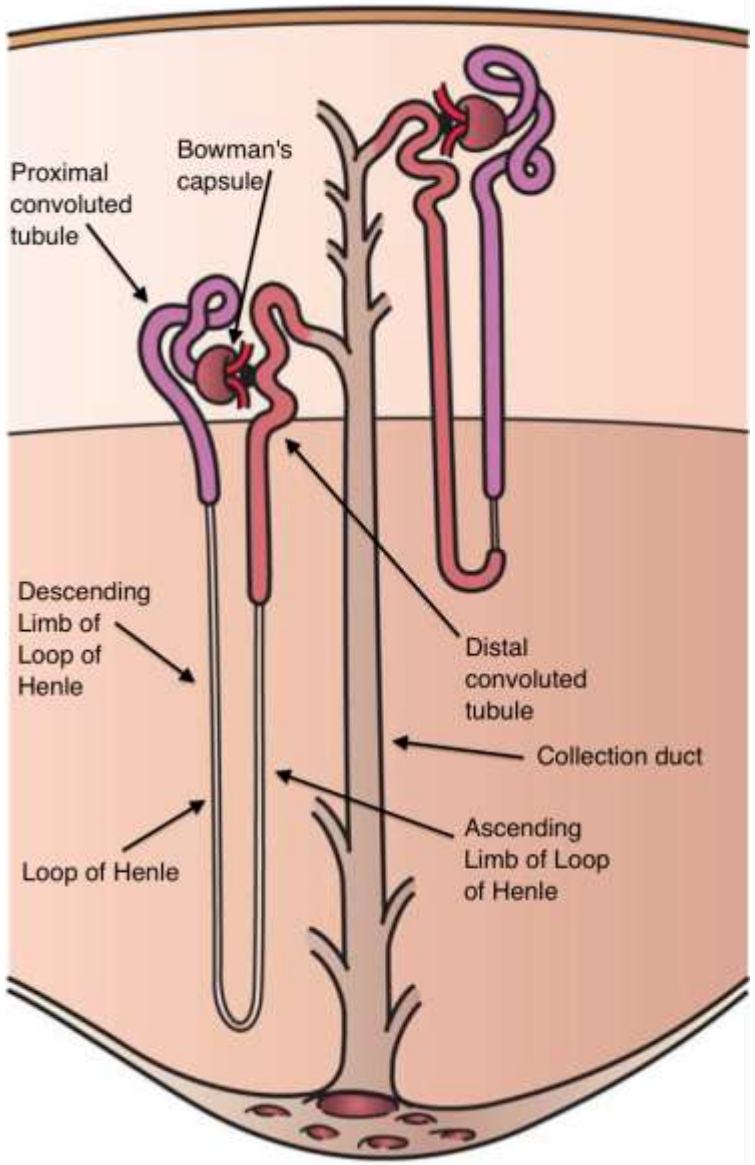
- Those nephrons that have glomeruli located in the outer cortex are called cortical nephrons; they have short loops of Henle that penetrate only a short distance into the medulla
- About 20 to 30 per cent of the nephrons have glomeruli that lie deep in the renal cortex near the medulla and are called juxtamedullary nephrons. These nephrons have long loops of Henle that dip deeply into the medulla, in some cases all the way to the tips of the renal papillae



Types of nephrons :

Juxtamedullary nephron :

1) Most of Whole structure in medulla
2) Very long Henle loop
3) Glomeruli close to the medulla
4) About 20% to 30% of body nephrons



Cortical nephron :

1) Whole structure in the cortical area
2) Very short Henle loop
3) Glomeruli depth away in the cortical
4) More common

urine formation

Afferent arteriole : heading toward the glomeruli

Efferent arteriole : heading away from glomeruli

- Filtration:

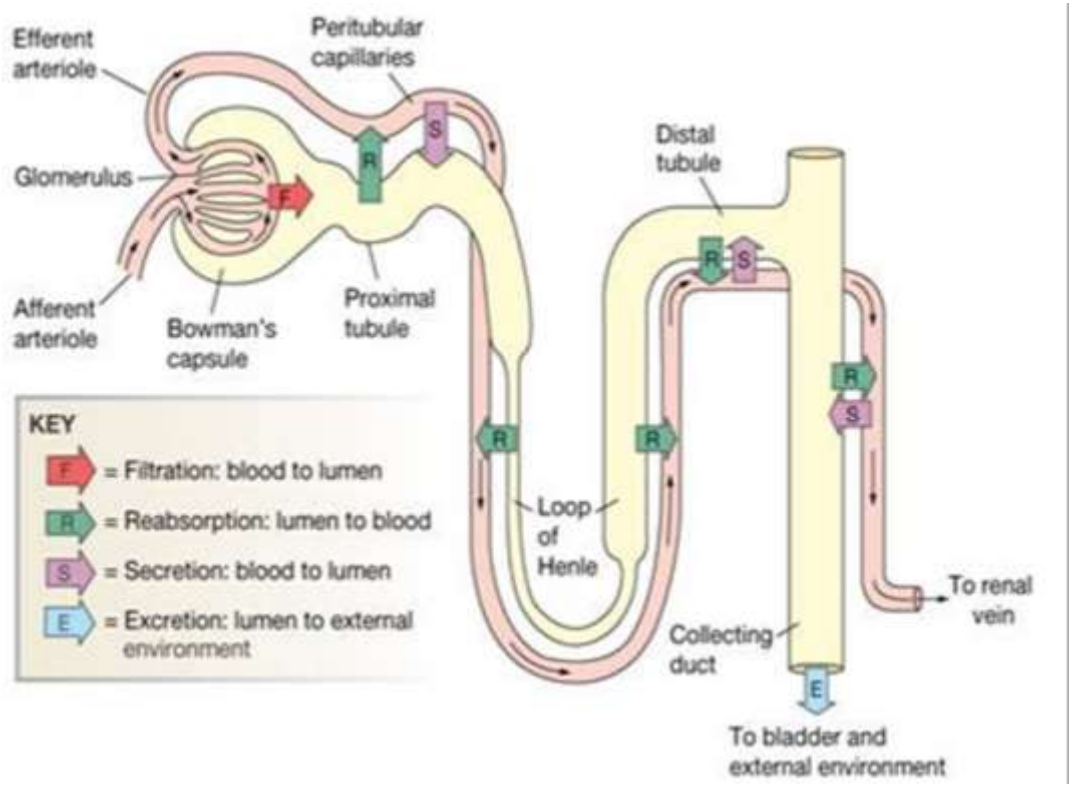
It is directly proportional to renal blood pressure and renal blood flow. Water and solutes is filtered across glomerular capillaries

- Reabsorption: filtrates toward the blood

Is the removal of water and solutes from the renal filtrate

- Secretion: inside the lumen

Transport of solutes from peritubular fluid into the tubular fluid



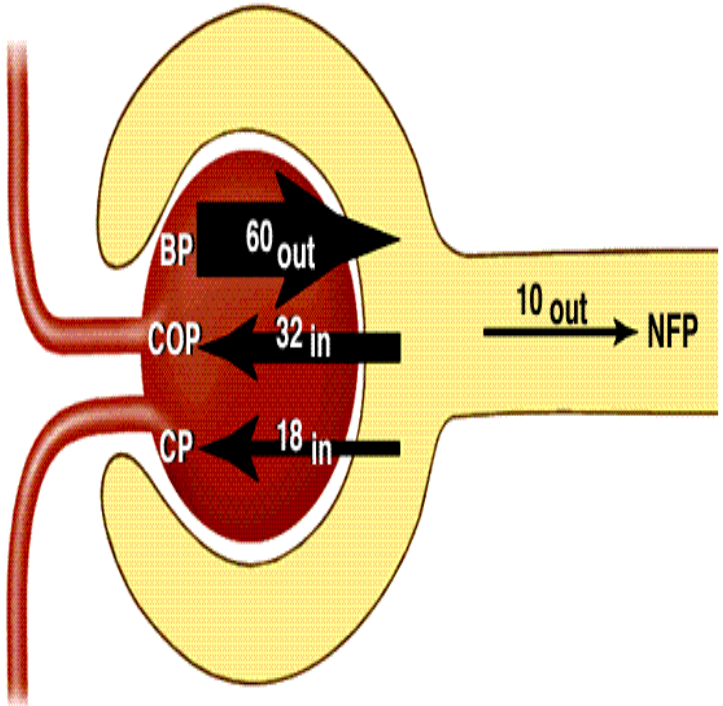
Net filtration

Direction of movement : From glomerular capillaries to capsule space

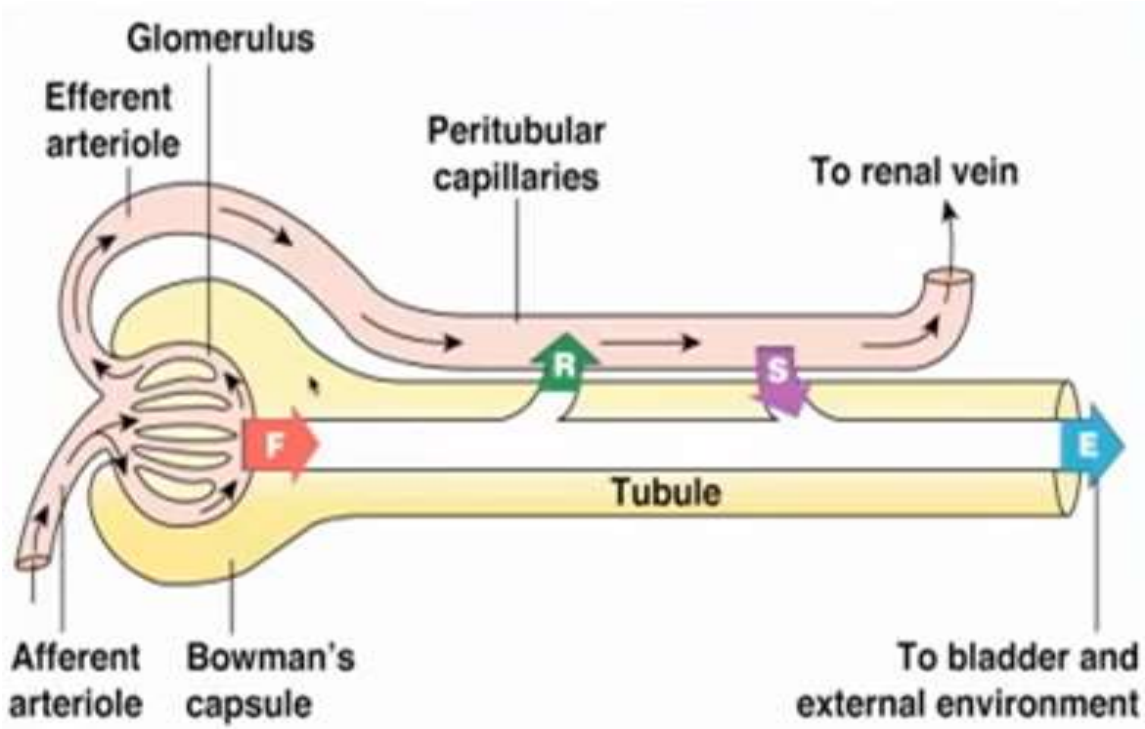
- Driving force: Pressure gradient (net filtration pressure, NFP)
- Types of pressure:

Favoring Force: Capillary Hydrostatic Blood Pressure (BP)

Opposing Force: Plasma colloid osmotic pressure (COP) and Capsular Hydrostatic Pressure (CP)



Capillary blood pressure (BP)	60 mmHg out
Colloid osmotic pressure (COP)	– 32 mmHg in
Capsular pressure (CP)	– 18 mmHg in
Net filtration pressure (NFP)	10 mmHg out



Amount filtered (F) – amount reabsorbed (R) + amount secreted (S) = Amount of solute excreted (E)

Factors that alter filtration pressure change GFR

These factors include:

- Increased renal blood flow → Increased GFR
- Decreased plasma protein → Increased GFR → edema.
- Hemorrhage → Decreased capillary hydrostatic pressure → Decreased GFR