



جامعة المستقبل
AL MUSTAQBAL UNIVERSITY
كلية العلوم

قسم الأنظمة الطبية الذكية

General Anatomy and Physiology

(L6) Body Fluids & Kidneys

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Body Fluids Definition

Body is formed of solids & fluids, The fluid part is more than 2/3 of the whole body.

What is body fluid? body fluid is the fluid of the body. The adult human body is ~60% composed of water, which is distributed *inside* the cells (intracellular) and *outside* the cells (extracellular). A total of intracellular and extracellular water forms the total body fluid.

Apart from **water**, the body fluid is also composed of other molecules, such as **electrolytes** (sodium, potassium, etc), **metabolites** (urea, glucose, carbon dioxide, oxygen), and **proteins** (albumin, hormones, amino acids, antibodies). Depending on the location of the body fluid, the composition and amounts vary.

The body fluid or the physiologic fluid is essential for various physiological processes and the maintenance of body **homeostasis**. **The functions** of water in the body include temperature regulation, moistening of tissues, transportation of essential nutrients, elimination of waste from the body, and lubricating different joints and tissues. Some example of body fluid includes blood plasma, tears, synovial fluid, sweat, and urine.

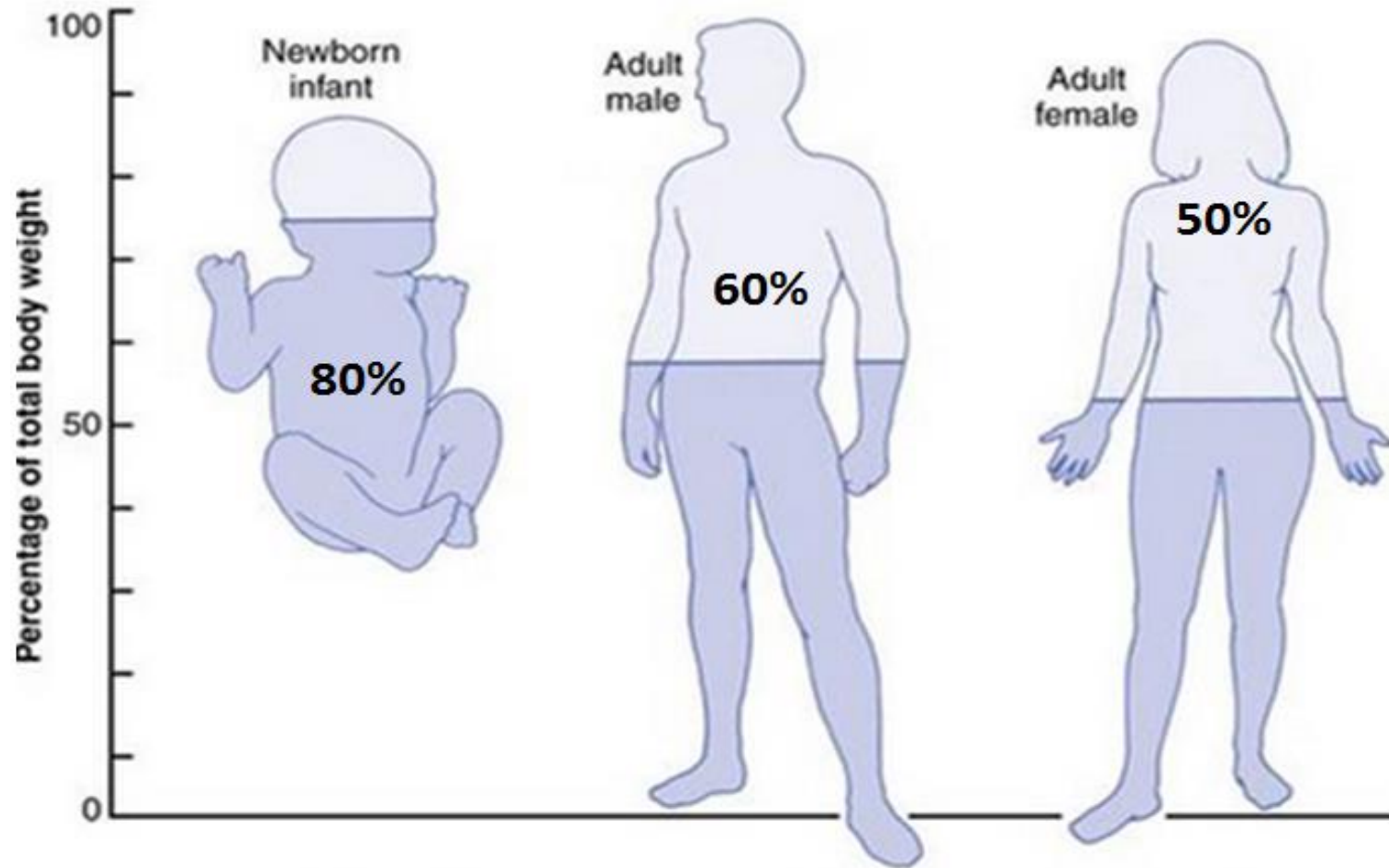
What percent of your body is water? or what percentage of water is the human body?

The human body is primarily made up of water and the water distributed in different parts of the body organs and tissues is what defines the **body fluid**. The body fluid content of the body changes with the body's development.

The maximum body fluid is present at the **fetal development stage** (~95%), which goes down to ~75% for **an infant** and eventually to ~50-60% in the **adult stage** (Figure).



BODY FLUID PERCENTS

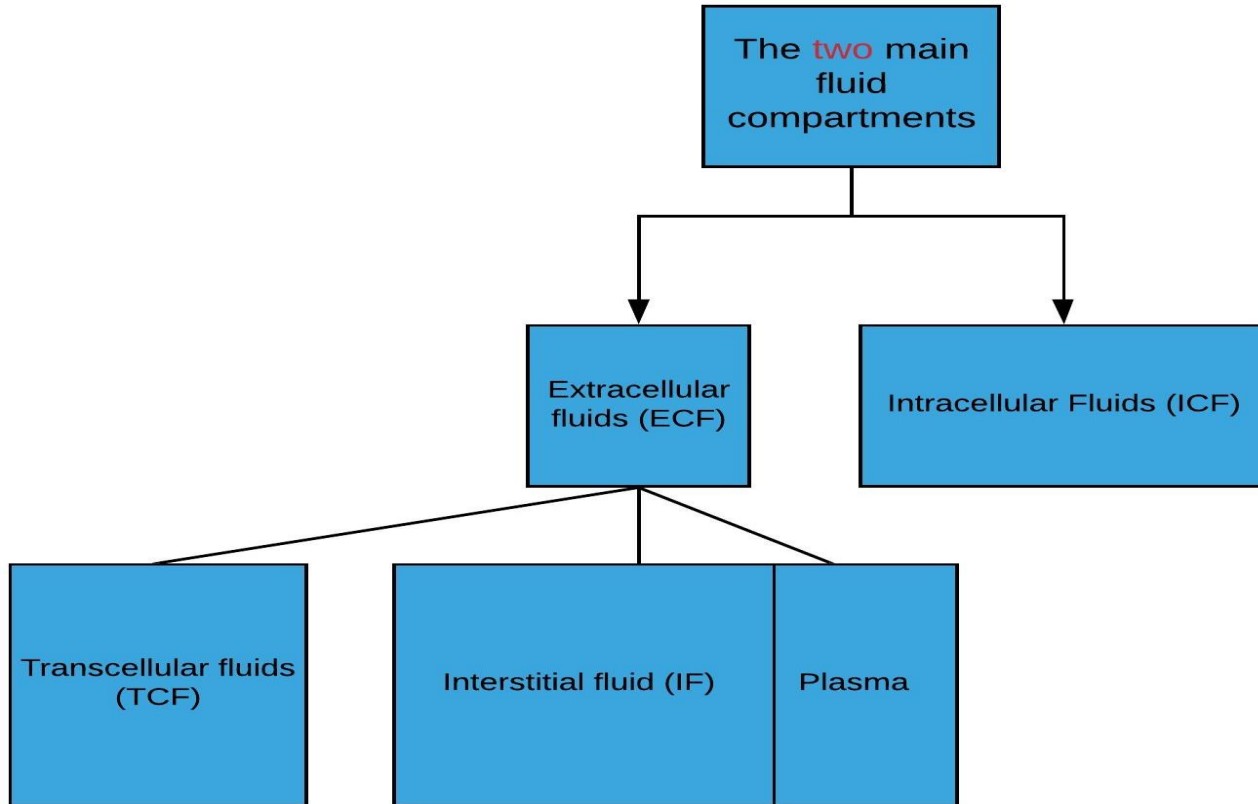


- The percentage of fluid depends on:
 1. Age.
 2. Gender
 3. Degree of obesity.

- The females has **adipose tissue** so the fat cells doesn't absorb water less than muscle.
- Dehydration is common and rapid in children because the **regulatory mechanisms for maintaining ECF volume** are not well developed in infants and children.

| | Percentage of body water | clarification |
|-----------------------|-------------------------------------|---|
| Infants (fleshy) | 70%* or more | Low body fat, low bone mass |
| Healthy males adult | 60% | larger amount of skeletal muscle, lower body fat |
| Healthy females adult | 50%** | Smaller amount of skeletal muscle , Higher body fat |
| obesity | 45%*** | Higher amount of fats |
| Older age | 45% | TBW declines throughout life |

Fluid Compartments



| Intracellular Fluids | Interstitial Fluids = internal environment | Plasma | Transcellular fluids (specialized type of ECF) |
|-------------------------------|---|--|--|
| Inside the cell | Outside the cell | Outside the cell | Outside the cell |
| HIGH concentration of protein | Fluid bathing the cell | Fluid circulating in the blood vessels | Small amount |

-Fluids distribution :

Intracellular fluids (ICF): $\frac{2}{3}$ of TBW

Extracellular fluids (ECF): $\frac{1}{3}$ of TBW

Interstitial fluids (IF): $\frac{3}{4}$ of ECF

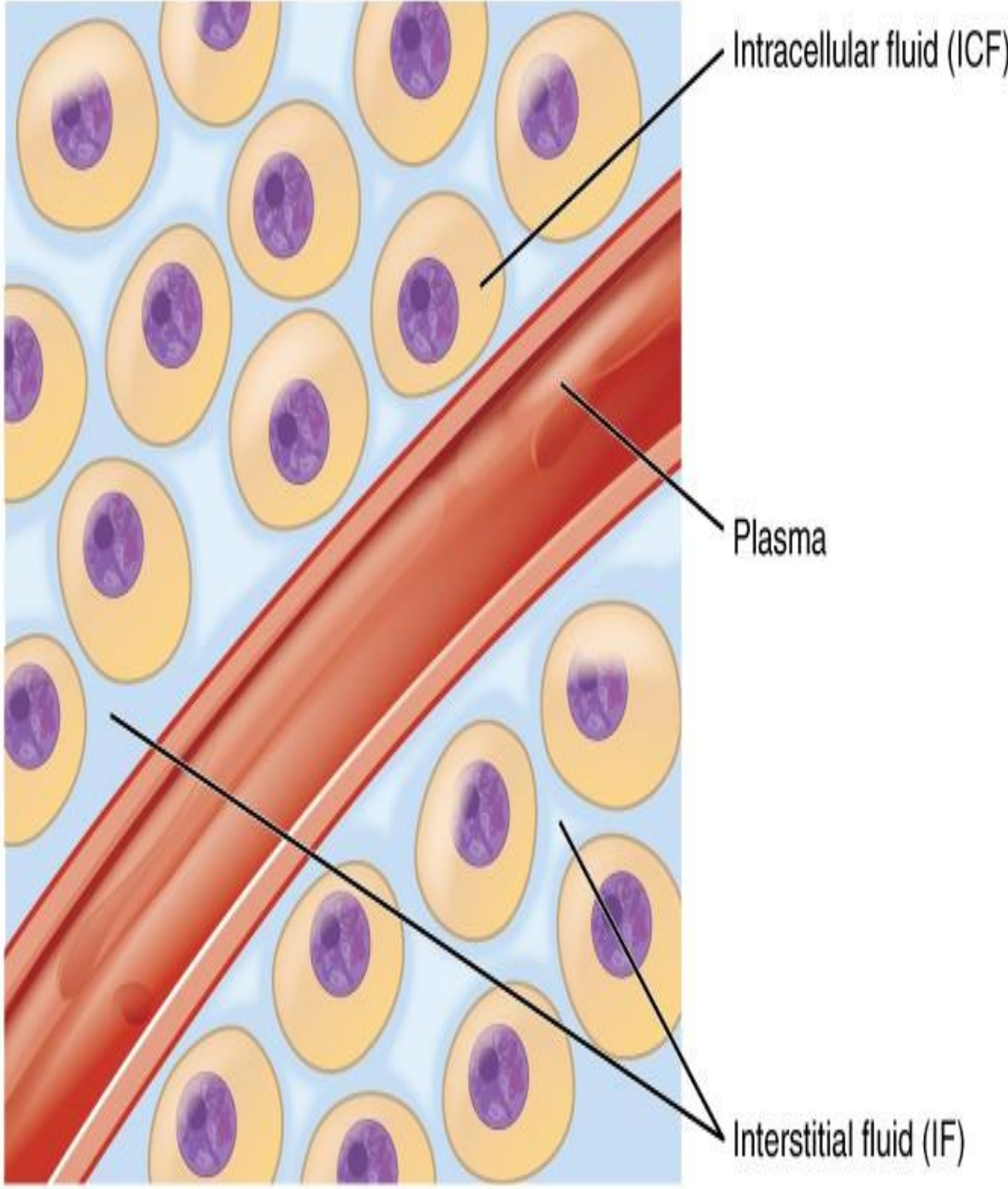
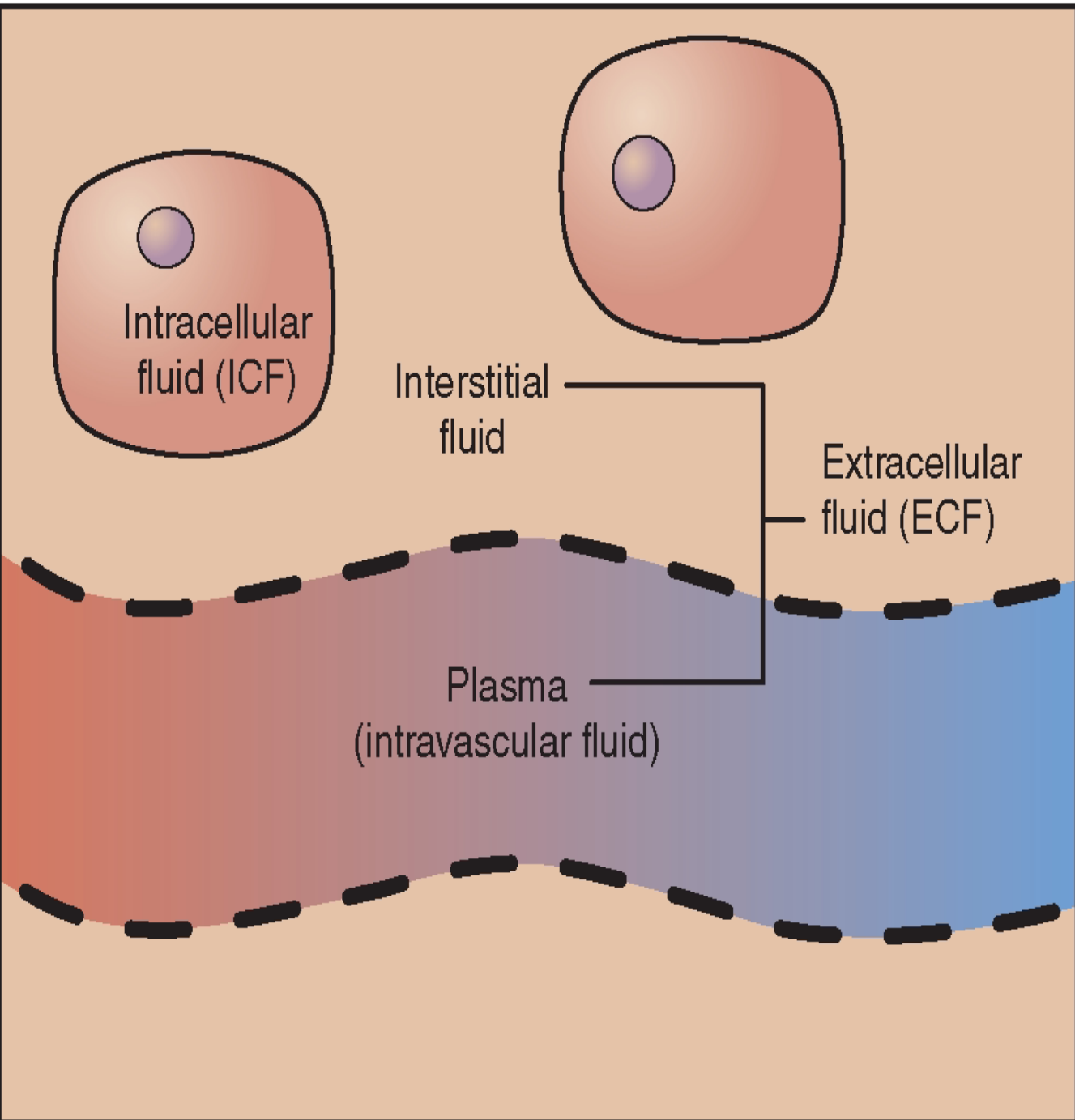
Plasma: $\frac{1}{4}$ of ECF

Transcellular fluids:

- found in small amounts (CSF, Intraocular, Pleural, Peritoneal, Synovial, Digestive Secretions).
- Equal to 1-2 L

-Plasma and interstitial fluid are almost having the same composition except for **high protein concentration in plasma.**

-Interstitial fluids are composed from **ultrafiltration of plasma in capillary walls.**



Differences between ECF & ICF

- The extracellular fluid contains large amounts:

1. Sodium, chloride, and bicarbonate ions plus nutrients (oxygen, glucose, fatty acids, and amino acids).
2. Cellular waste product carbon dioxide & ammonia.

- Intracellular fluid contains large amounts:

potassium, magnesium, and phosphate ions.

| ECF | |
|---|---|
| <u>Cations:</u> Na ⁺ (142 _{mmol/L}) K ⁺ (4.2) Mg ²⁺ (0.8) | <u>Anions:</u> Cl ⁻ (108) HCO ₃ ⁻ (24) |
| <u>Nutrients:</u> O ₂ , glucose, fatty acids, & amino acids. | |
| <u>Wastes:</u> CO ₂ , Urea, uric acid, excess water, & ions. | |

| ICF | |
|--|---|
| <u>Cations:</u> Na ⁺ (14) K ⁺ (140) Mg ²⁺ (20) | <u>Anions:</u> Cl ⁻ (4) HCO ₃ ⁻ (10) Phosphate ions |
| <u>Nutrients:</u> High concentrations of proteins. | |
| | |

ECF constitutes of:

- A. Interstitial fluid including lymph
- B. Plasma
- C. Transcellular fluids

Transcellular fluids:

- CSF
- Intraocular fluid
- Gastrointestinal secretions
- Pleural fluid
- Pericardial fluid
- Peritoneal fluid
- Synovial fluid
- Fluid in urinary tract

More the amount of fat, lesser the ECF volume

Elderly – lesser ECF volume

Infants & children – greater ECF volume

Blood volume = 7% body weight = 5 L in a 70 kg adult male

- Fluid intake and output are balanced during steady-state conditions.

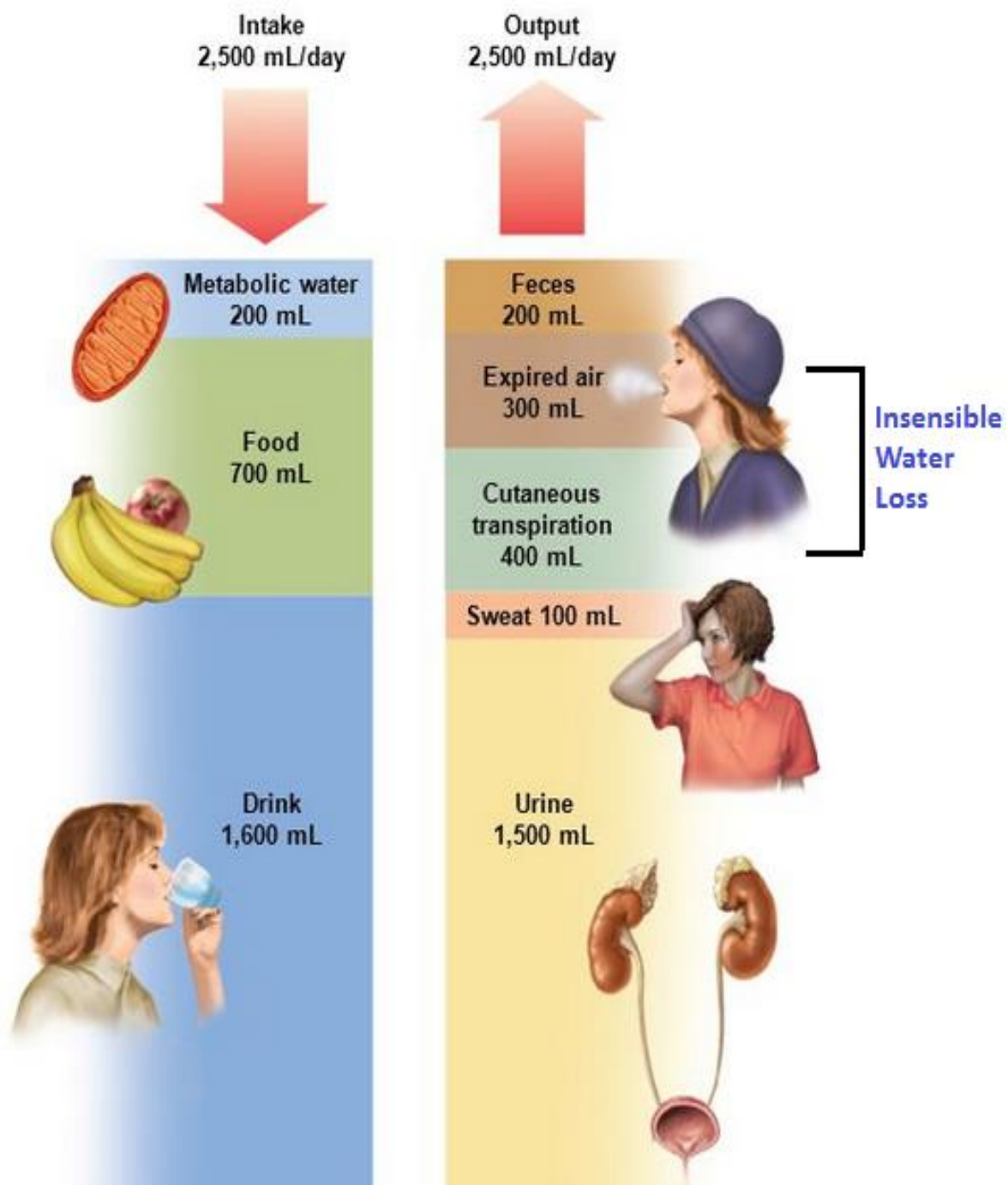
Balance b/w Fluid Intake & Fluid Loss:

DAILY INTAKE OF WATER:

1. It is ingested in the **form of liquids or water in food (2L).**
2. It is synthesized in the **body by oxidation of carbohydrates**, adding about 200 ml/day.

DAILY LOSS OF BODY WATER:

1. **Insensible Water Loss (Skin, Lungs).**
2. **Fluid Loss in Sweat.**
3. **Water Loss in Feces.**
4. **Water Loss by the Kidneys (urine).**



| | Normal | Prolonged, Heavy Exercise |
|-------------------|--------|---------------------------|
| Intake | | |
| Fluids ingested | 2100 | ? |
| From metabolism | 200 | 200 |
| Total intake | 2300 | ? |
| Output | | |
| Insensible: skin | 350 | 350 |
| Insensible: lungs | 350 | 650 |
| Sweat | 100 | 5000 |
| Feces | 100 | 100 |
| Urine | 1400 | 500 |
| Total output | 2300 | 6600 |

Kidneys & Fluids : Urinary System

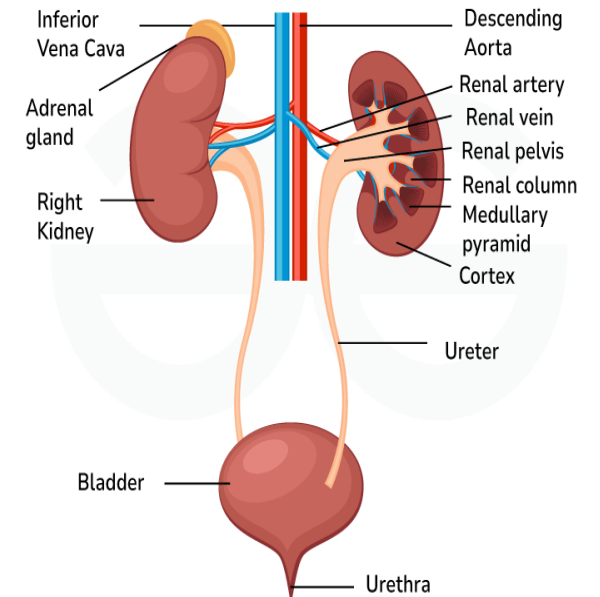
The purpose of the urinary system is to regulate extracellular fluids (plasma, tissue fluid, and lymph) of the body by removing a variety of harmful substances from plasma while retaining useful products.

Harmful substances, including nitrogenous wastes and excess electrolytes (sodium, potassium, and calcium), are excreted from the body as urine, while useful products are returned to the blood. **Nitrogenous wastes** are toxic to the body, and must be continuously eliminated or death will occur.

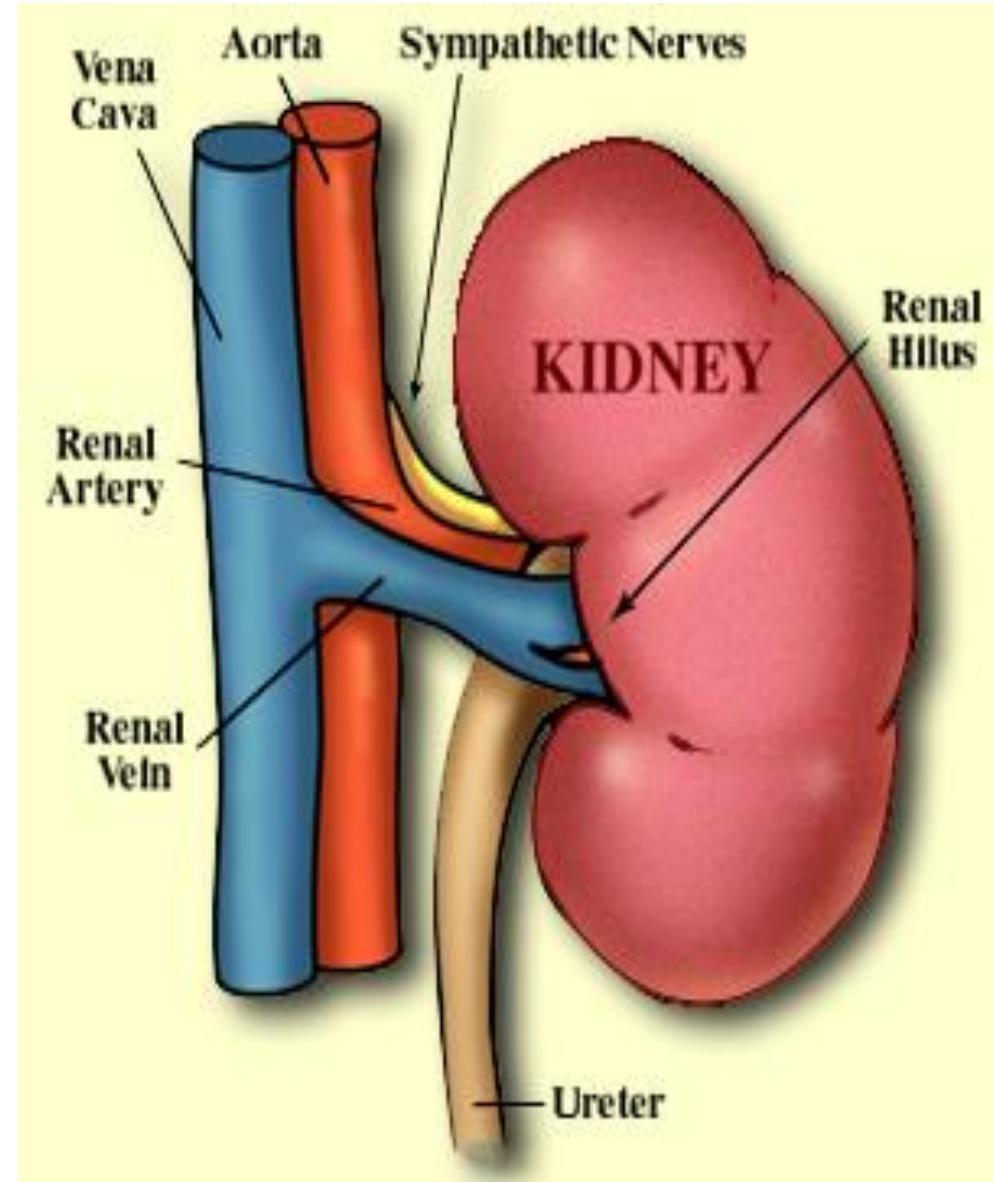
The structures make up the urinary system:

- **two kidneys**
- **two ureters**
- **bladder**
- **urethra**

Diagram of Urinary System



- Each kidney has a concave surface containing a slit called the hilus, allowing access to the renal sinus.
- Kidneys are normally supplied by a single renal artery branching from the abdominal aorta, and entering the kidney through the hilus.
- Also entering the kidney through the hilus are the renal sympathetic nerves which arise from the celiac ganglia.
- The ureter, the renal vein and renal lymphatics exit through the renal hilus.



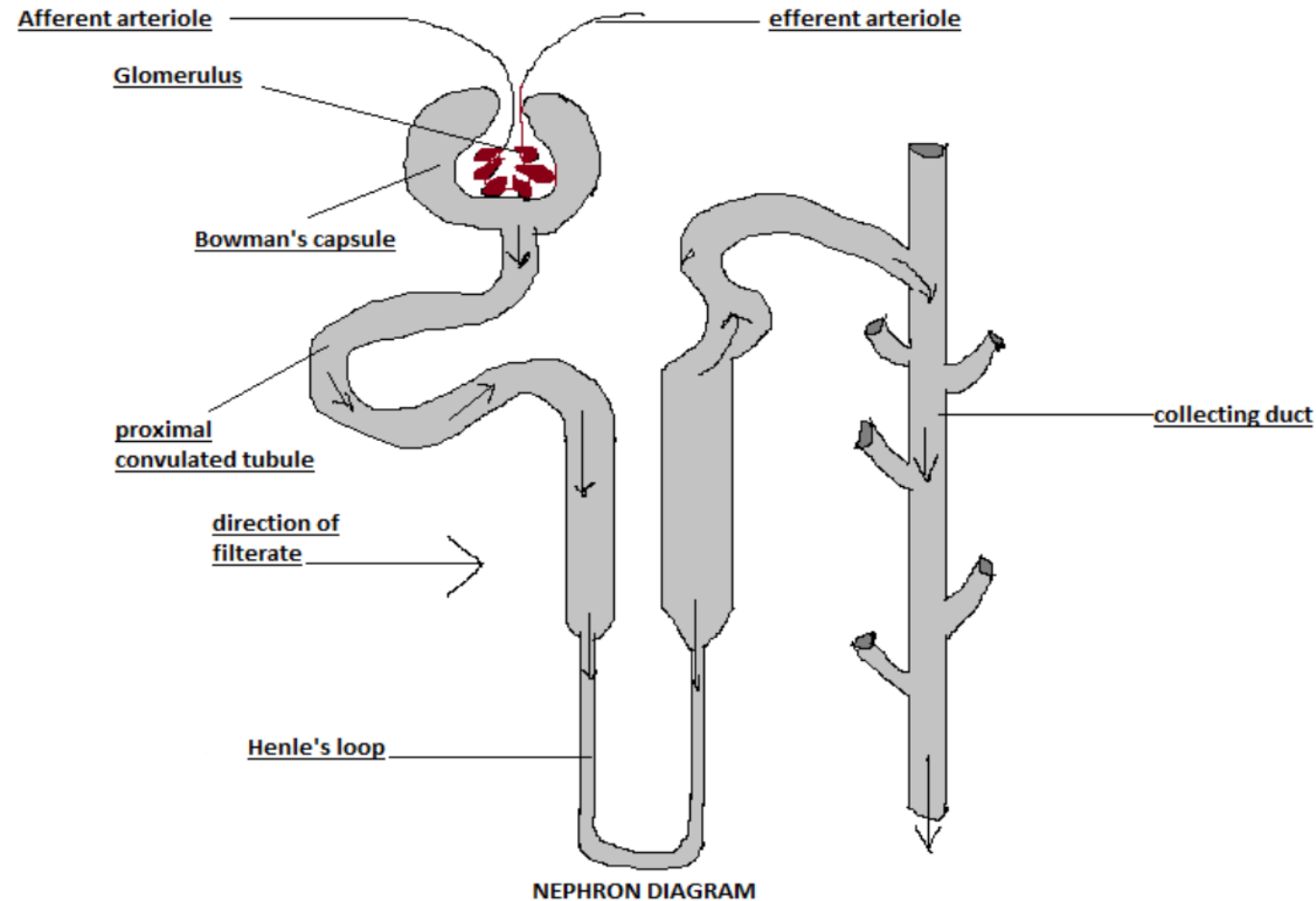
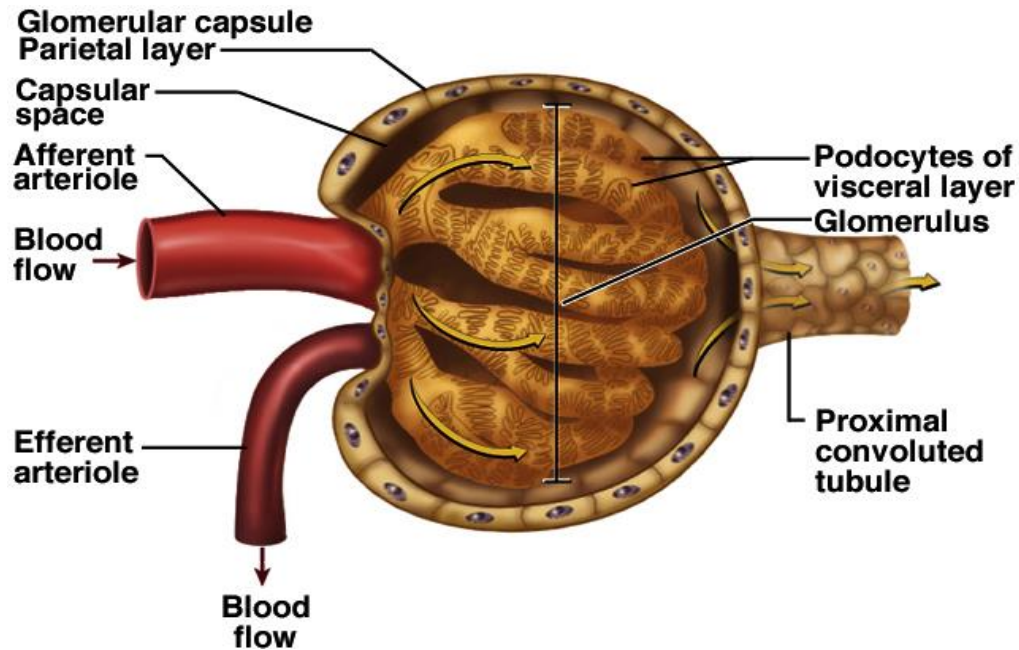
The Nephron

- Structural and Functional unit of kidney is called *nephron*. It's composed of:

1. a. GLOMERULUS

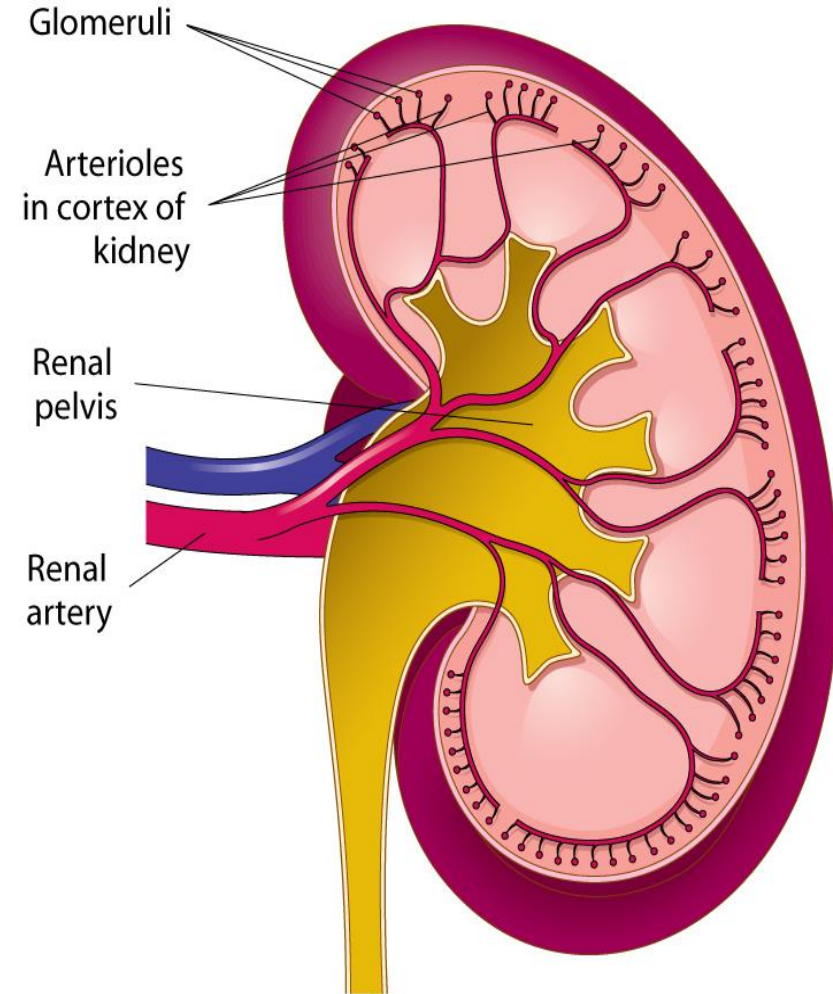
2. RENAL TUBULES

b. BOWMAN'S CAPSULE



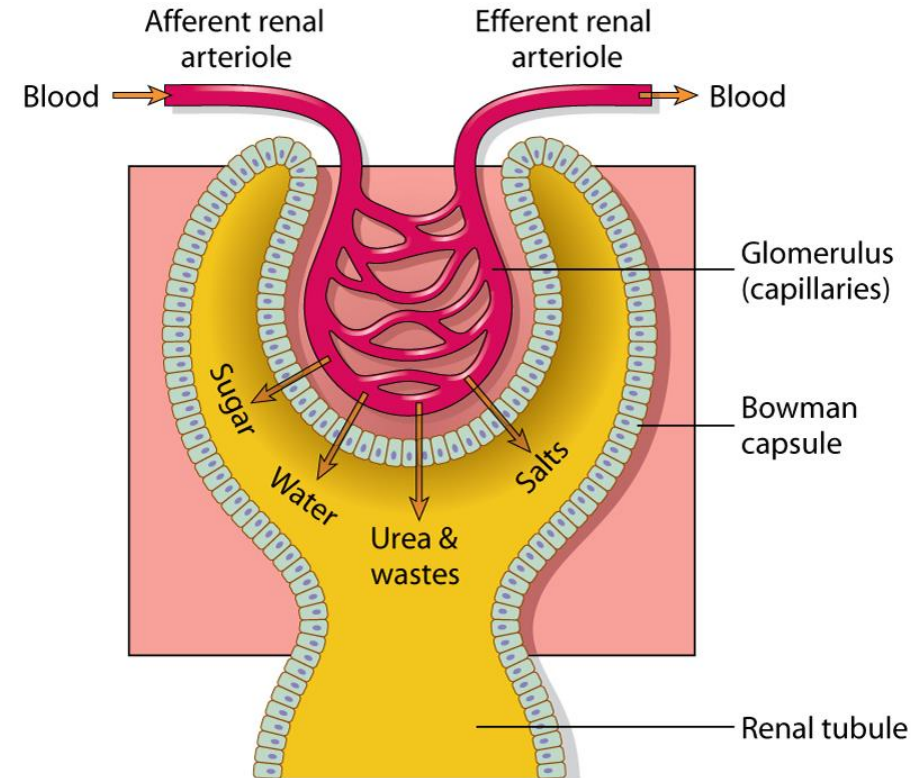
How Kidneys Produce Urine

- Blood enters the kidneys through the right and left **renal arteries**
- **Arterioles** carry blood to the **capillaries**
- **Glomeruli** filter the blood



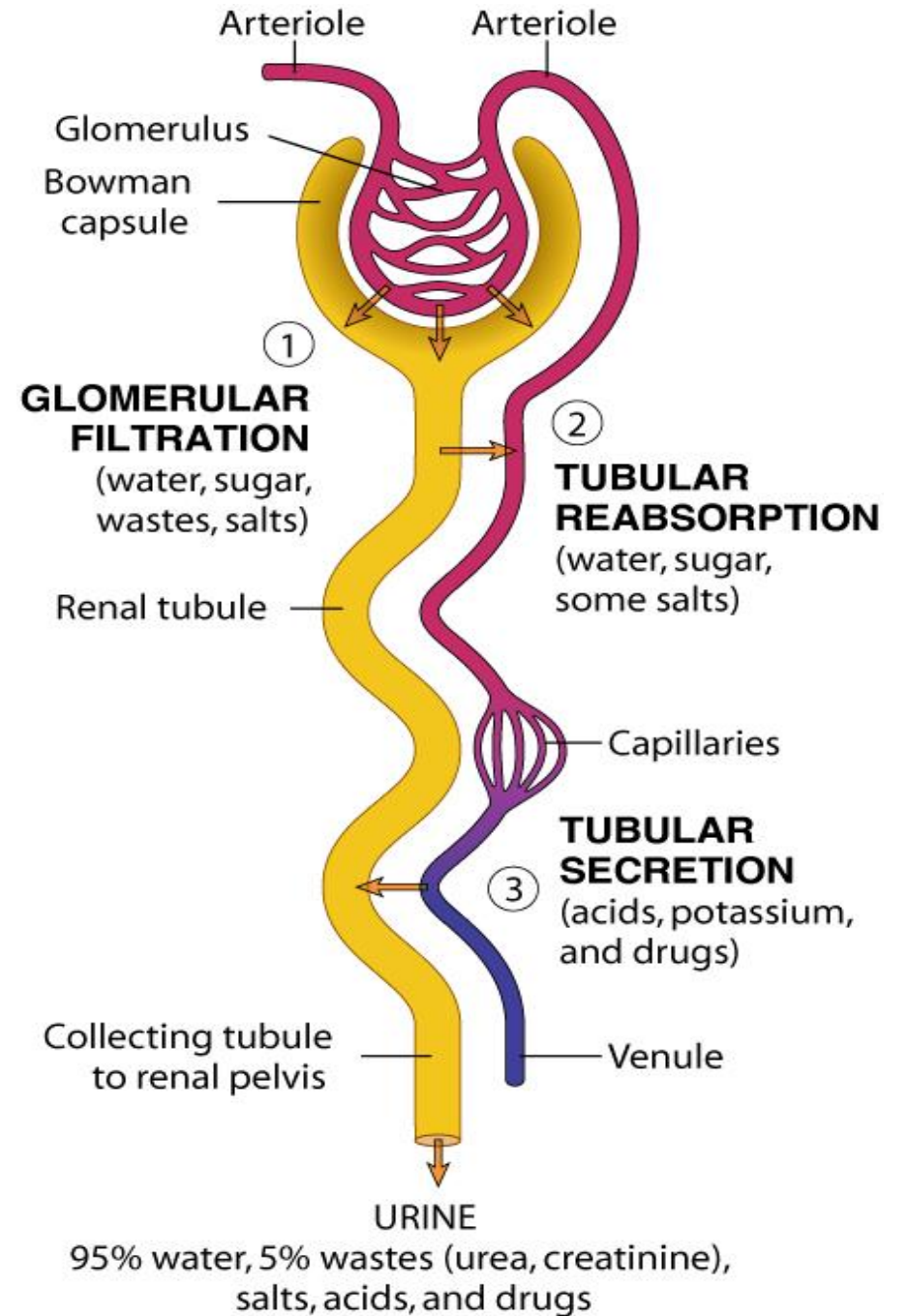
Glomerulus and glomerular/Bowman capsule

- Blood passes through the glomeruli
- Glomerular (**Bowman**) capsule surrounds each glomerulus
- **Renal tubule** is attached to each Bowman capsule



Three steps in the formation of urine:

- Glomerular filtration
- Tubular reabsorption
- Tubular secretion
- The glomerulus and a renal tubule combine to form a unit called a **nephron**.



THANK YOU!

