

Chapter 10

EXCRETION

Control of Body Temperature and Water Balance

Control of Body Temperature and Water Balance as a part of **homeostasis**

- **Homeostasis means**

- Maintenance of steady internal conditions despite fluctuations in the external environment

- **Examples of homeostasis**

- **Thermoregulation:** the maintenance of internal temperature within narrow limits

- **Osmoregulation:** the control of the gain and loss of water and solutes

- **Excretion:** the disposal of nitrogen-containing wastes

Thermoregulation: An animal's regulation of body temperature helps maintain homeostasis

Thermoregulation

- The process by which animals maintain an internal temperature within a tolerable range
- **Ectothermic animals**
 - Absorb heat from their surroundings
 - Many fish, most amphibians, lizards, most invertebrates
- **Endothermic animals**
 - Derive body heat mainly from their metabolism
 - Birds, mammals, a few reptiles and fish, many insects

Heat is gained or lost in four ways

- Heat exchange with the environment may occur by

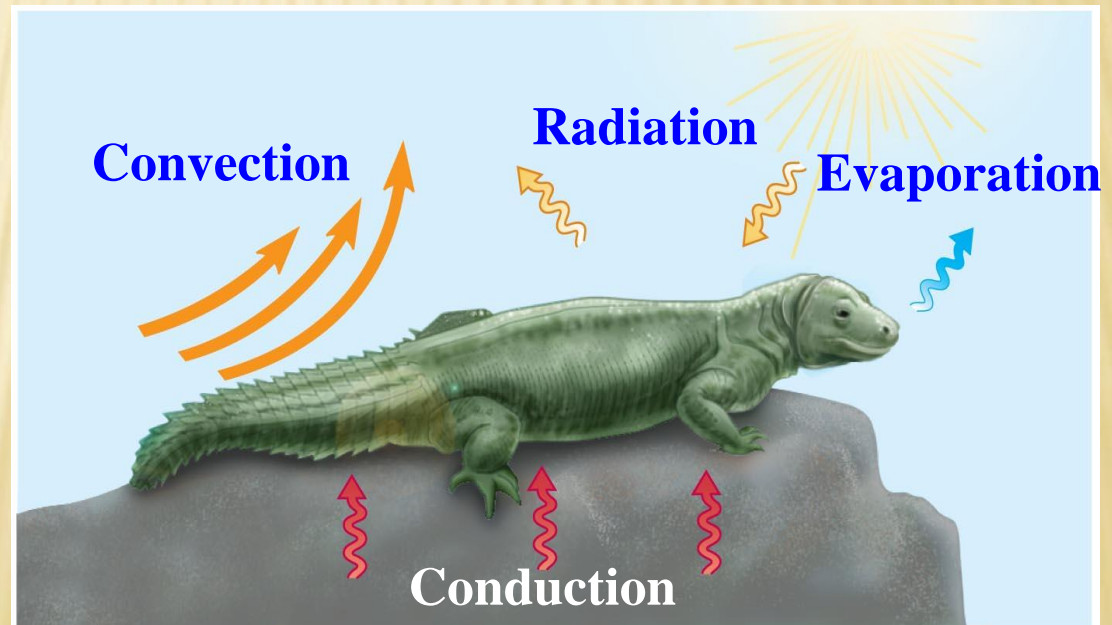
1. Conduction

2. Convection

3. Radiation

4. Evaporation

Mechanisms of
heat exchange



Adaptations that balance heat gain and loss

- **Five** general categories of adaptations promote thermoregulation

1- Increased metabolic heat production

- **Hormonal changes boost metabolic rate in birds and mammals**
- **Shivering**
- **Increased physical activity**
- **Honeybees cluster and shiver**

Thermoregulation involves adaptations that balance heat gain and loss

2- Insulation

- Hair
- Feathers
- Fat layers



3- Circulatory adaptations

- Increased or decreased blood flow to skin by changing diameter of skin blood vessels
- Large ears in elephants
- Countercurrent heat exchange

Thermoregulation involves adaptations that balance heat gain and loss

4- Evaporative cooling

- Sweating
- Panting

5- Behavioral responses

- Used by endotherms and ectotherms
- Examples:
 - Moving to the sun or shade
 - Migrating
 - Bathing

Osmoregulation and Excretion

Osmoregulation is the active regulation of the osmotic pressure of an organism's fluids to maintain the homeostasis of the organism's water content; that is, it keeps the organism's fluids from becoming too diluted or too concentrated.

Animals balance the gain and loss of water and solutes through osmoregulation

- **Osmoconformers**
 - **Have the same internal solute concentration as sea water**
 - **Many marine invertebrates are osmoconformers**
- **Osmoregulators control their solute concentrations**
 - **Freshwater fishes**
 - **Gain water by osmosis**
 - **Excrete excess water**
 - **Uptake salt across their gills**

EXCRETION

- **Excretion** is the process by which waste products of metabolism and other non-useful materials are eliminated from an organism.
- In vertebrates this is primarily carried out by the kidneys and skin

The Mammalian Excretory System

- The mammalian excretory system centers on **paired kidneys**, which are also the principal site of water balance and salt regulation
- Urine exits each kidney through a duct called the **ureter**
- Both ureters drain into a common **urinary bladder**, and urine is expelled through a **urethra**

Anatomy of the human excretory system

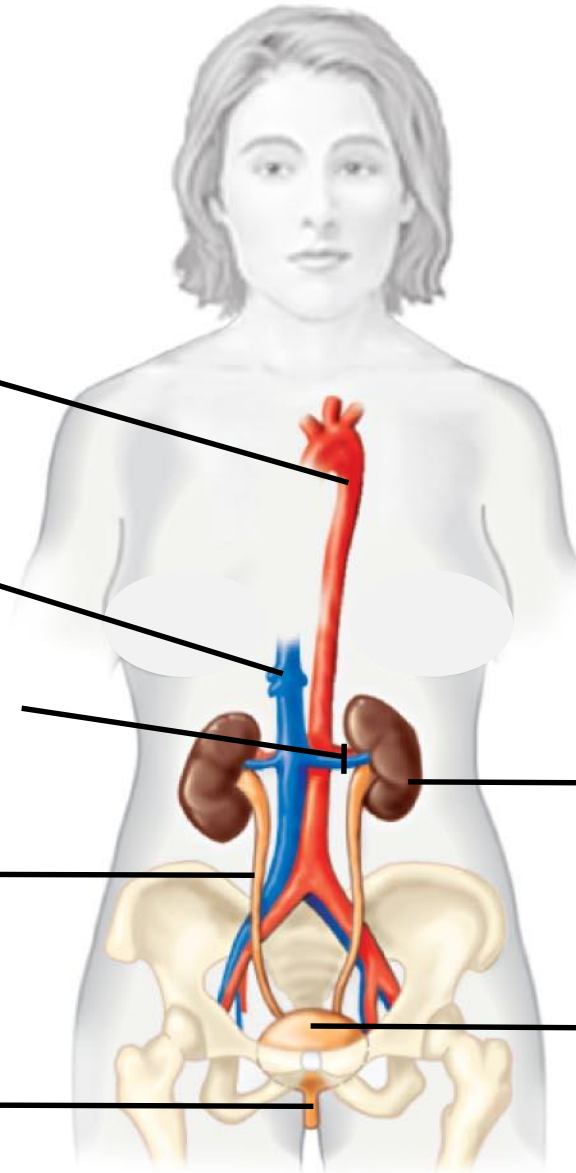
Aorta

**Inferior
vena cava**

Renal artery and vein

Ureter

Urethra

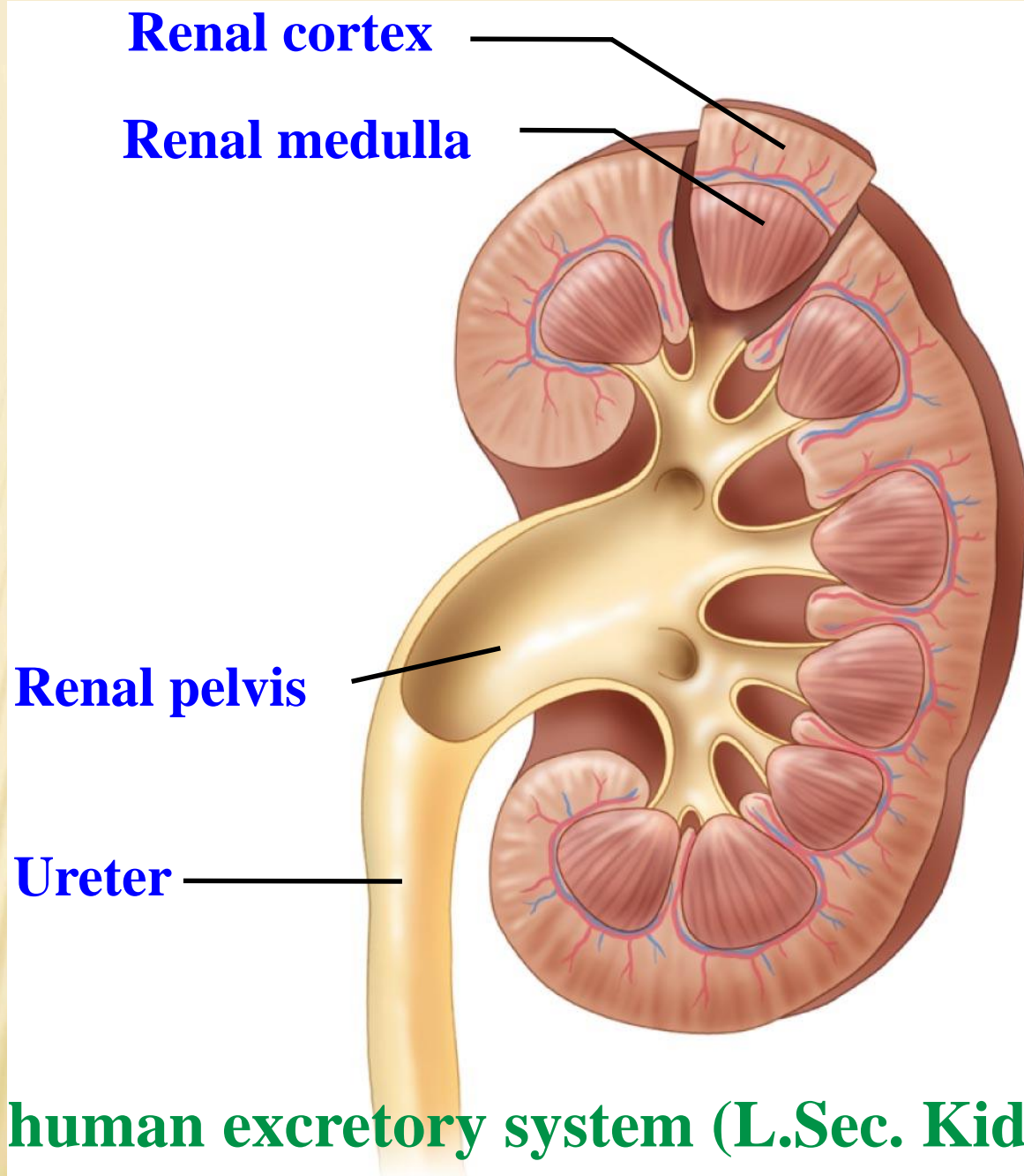


Kidney

Urinary bladder

The urinary system plays several major roles in homeostasis

- **The excretory system**
 - **Expels wastes**
 - **Regulates water balance**
 - **Regulates ion balance**
- **Nephrons**
 - **Functional units of the kidneys**
 - **Extract a filtrate from the blood**
 - **Refine the filtrate to produce urine**



Anatomy of the human excretory system (L.Sec. Kidney)

Bowman's Capsule

Tubule

Renal cortex

Renal artery

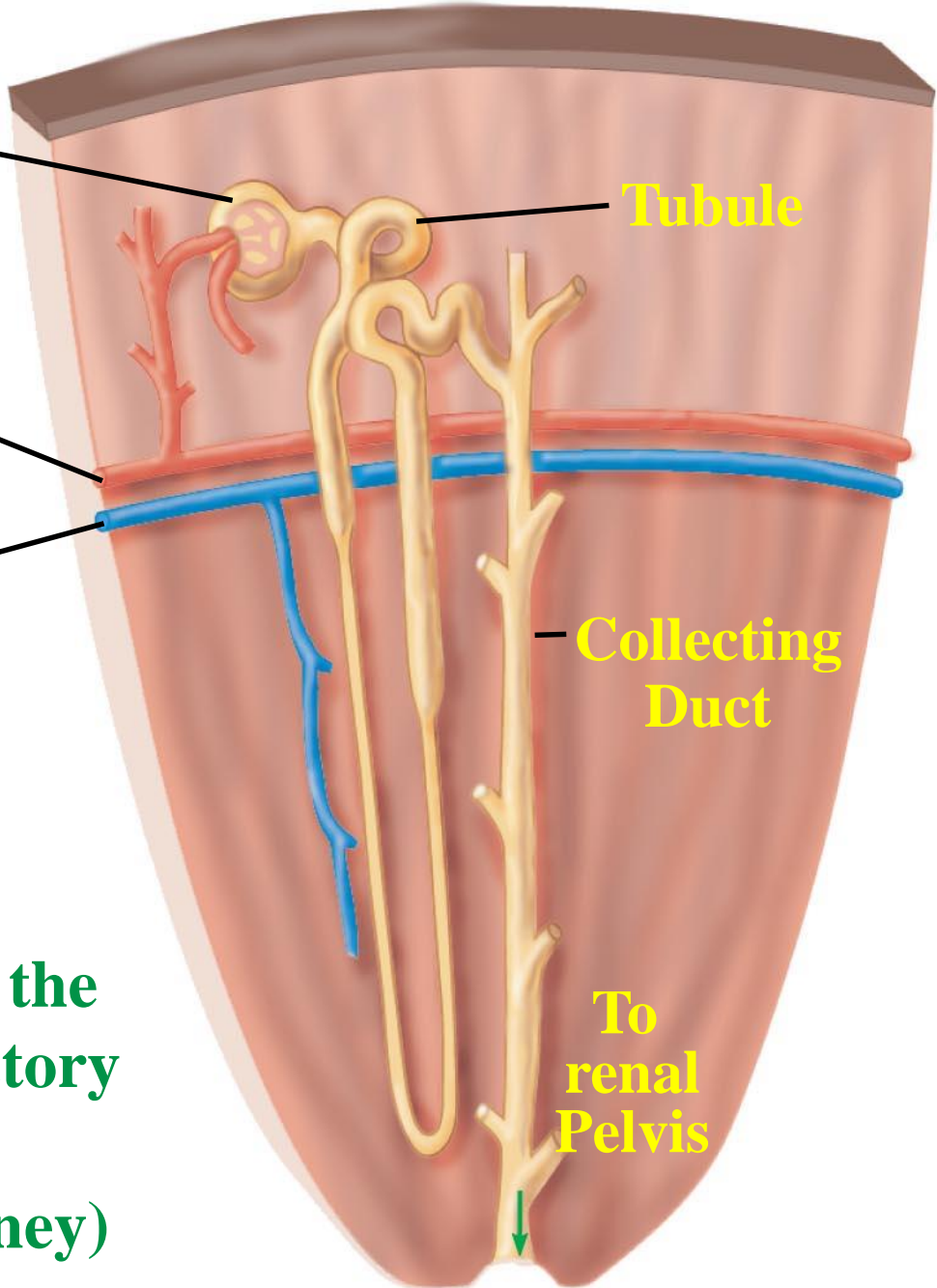
Renal vein

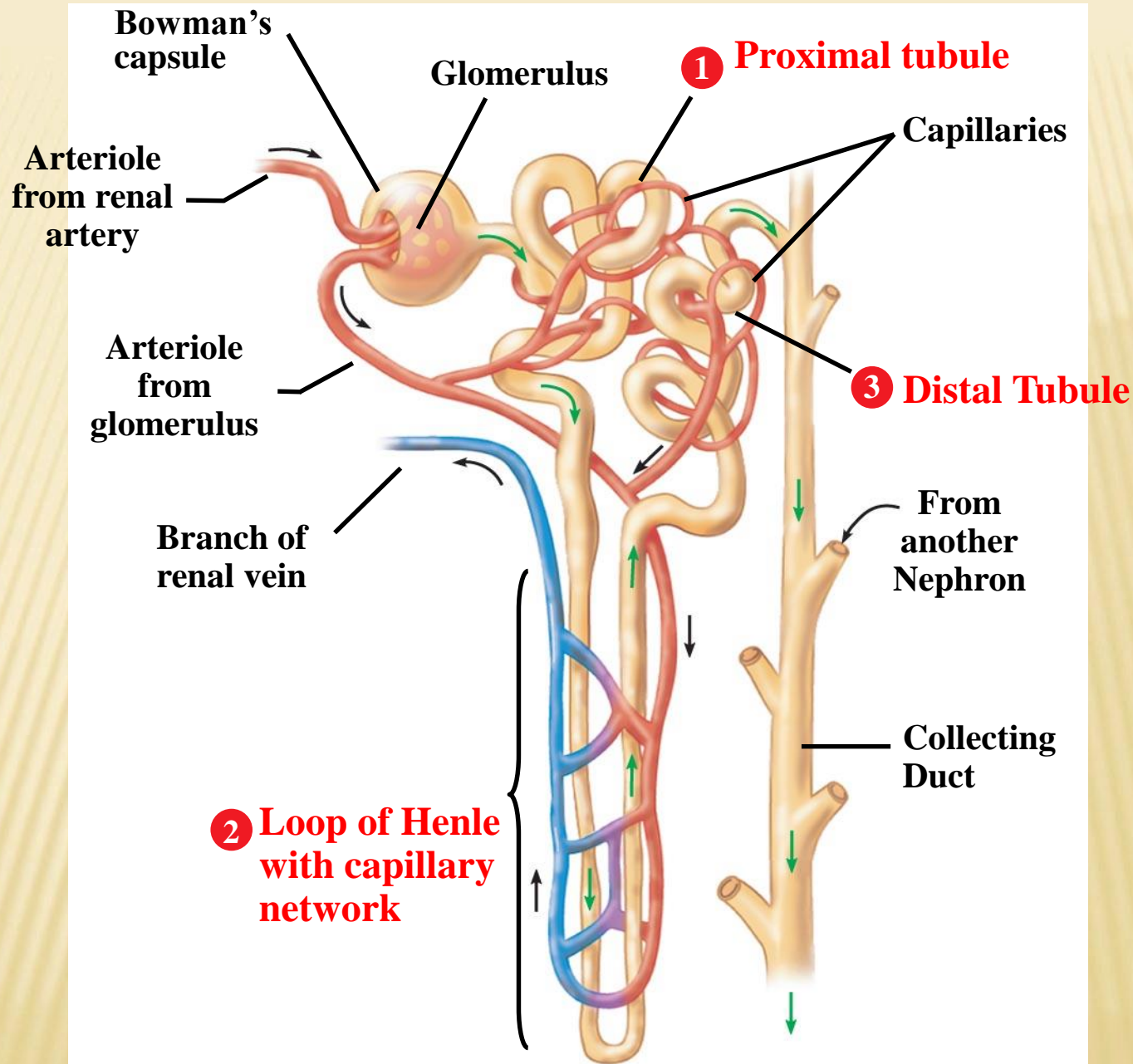
Collecting Duct

Renal medulla

Anatomy of the human excretory system (C. Sec. Kidney)

To renal Pelvis





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Anatomy of the human excretory system (Diagram of a Nephron)

Excretory Processes

The key processes of the urinary system are filtration, reabsorption, secretion and excretion

1) Filtration

Blood pressure forces water and many small solutes into the nephron

2) Reabsorption

Valuable solutes are reclaimed from the filtrate

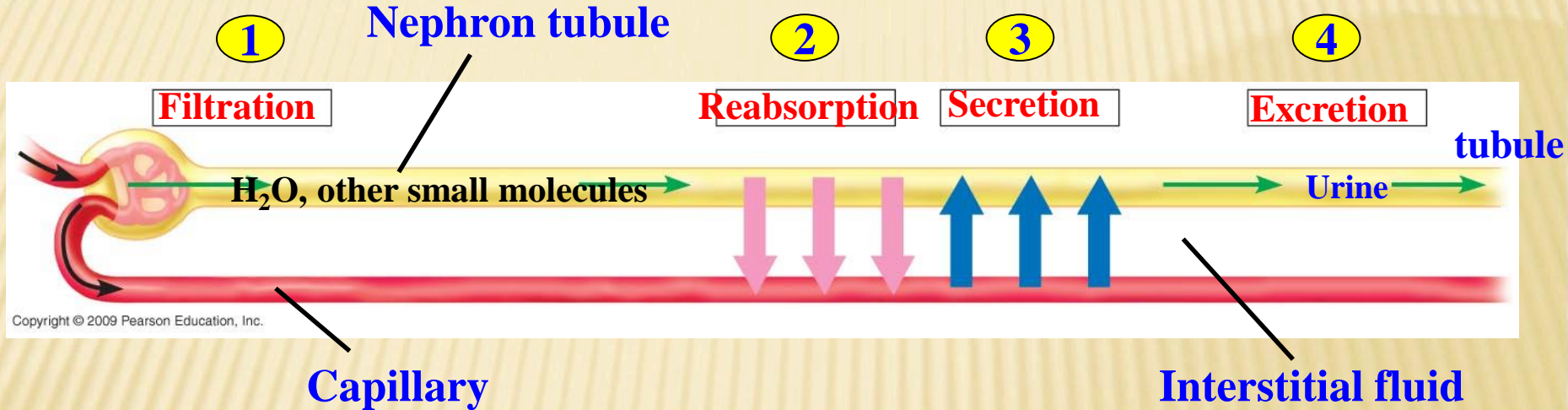
3) Secretion

Excess toxins and other solutes from the body fluids are added to the filtrate

4) Excretion

The final product, urine, is excreted

Major Excretory Processes of the urinary system



Blood filtrate is refined to urine through reabsorption and secretion

- **Reabsorption in the proximal and distal tubules removes Nutrients, Salt, Water**
- **pH is regulated by**
 - **Reabsorption of HCO_3^-**
 - **Secretion of H^+**
- **High NaCl concentration in the medulla promotes reabsorption of water.**
- **Antidiuretic hormone (ADH) regulates the amount of water excreted by the kidneys**

Dispose of nitrogenous wastes in animals

- **Nitrogenous wastes** are toxic breakdown products of protein and nucleic acids (DNA and RNA)

- **Animals dispose of nitrogenous wastes such as**

1) Ammonia (NH₃)

- **Poisonous**
- **Soluble in water**
- **Easily disposed off by aquatic animals**

2) Urea

- **Less toxic**
- **Easier to store**
- **Some land animals save water by excreting uric acid (dry waste)**

3) Urea and uric acid take energy to produce

Proteins

Amino acids

Nitrogenous bases

Nucleic acids

**Nitrogen-containing
metabolic waste
products**

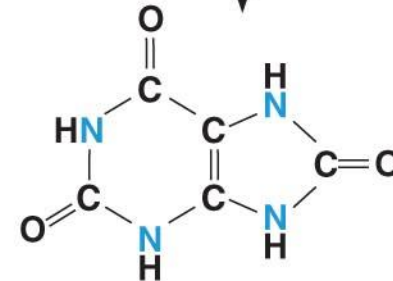
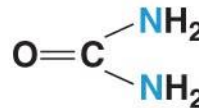
**—NH₂
Amino groups**



**Most aquatic animals,
including most fishes**

**Mammals, amphibians,
sharks, some bony
fishes**

**Birds and many other
reptiles, insects, land
snails**



Ammonia

Urea

Uric acid

Kidney dialysis can be a lifesaver

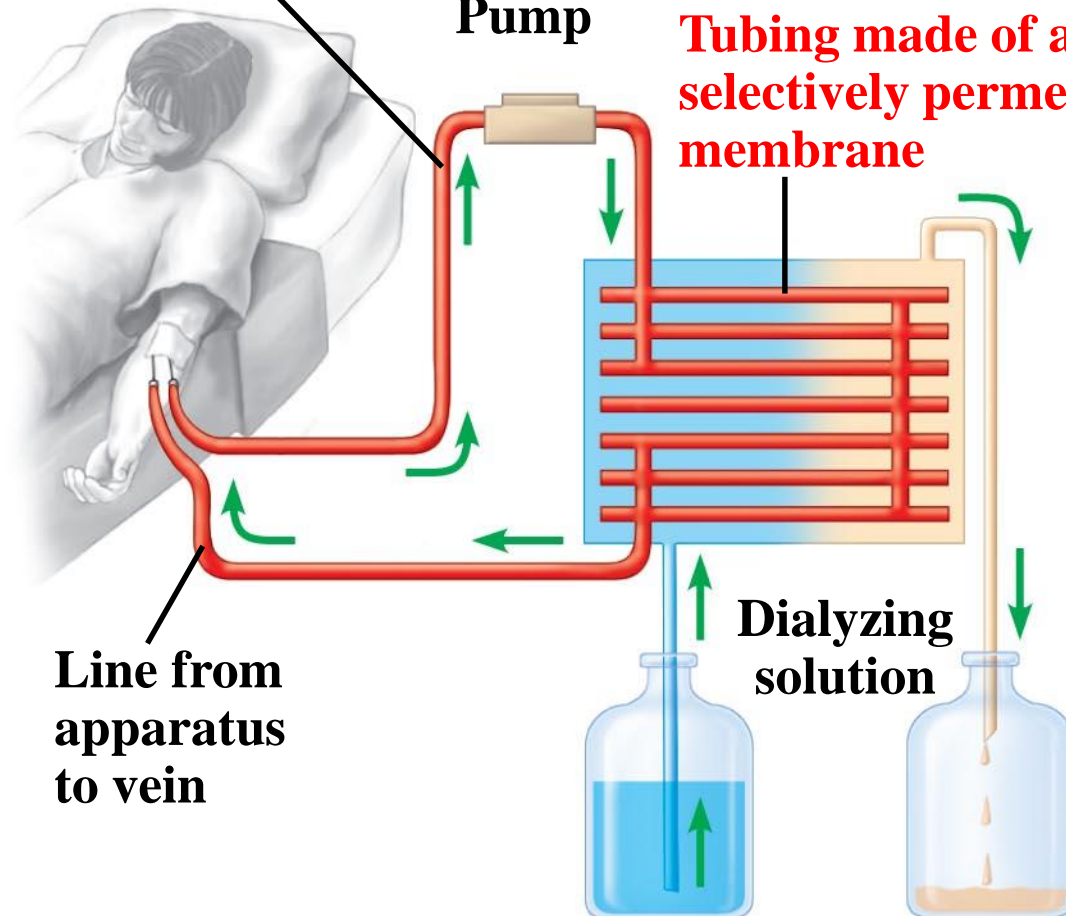
- **Compensating for kidney failure**
- **A dialysis machine**
 - **Removes wastes from the blood**
 - **Maintains its solute concentration**

Line from artery
to apparatus



Pump

Tubing made of a
selectively permeable
membrane



Line from
apparatus
to vein

Dialyzing
solution

Fresh dialyzing
solution

Used dialyzing
solution
(with urea and
excess ions)

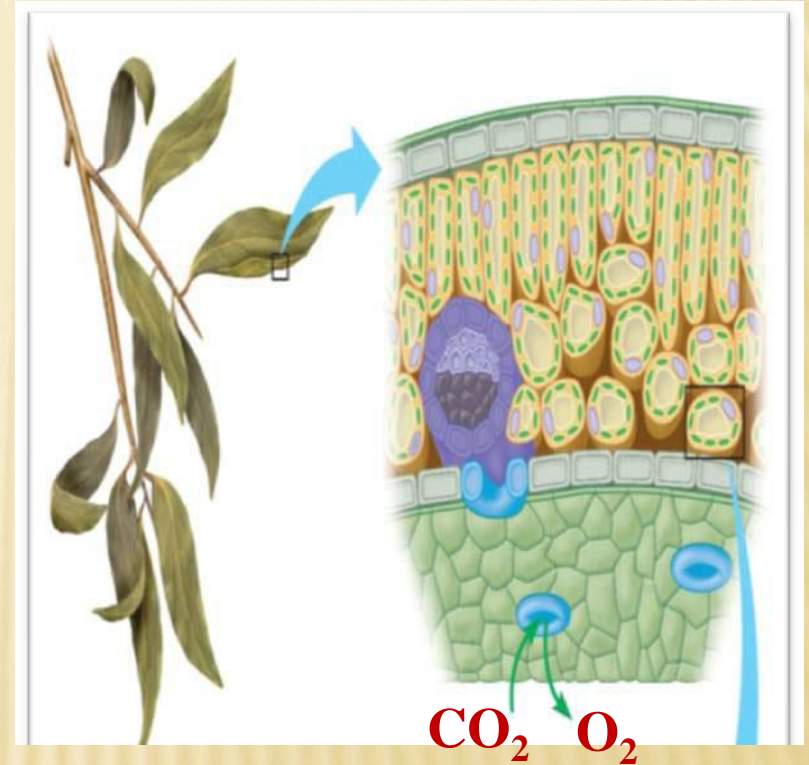
Kidney dialysis.

Excretion in Plants

Excretion in Plants

Excretion of Gases

- **Excess of CO_2 or O_2 in the leaves exit through stomata to the air.**
- **Or they are brought by phloem and xylem from anywhere in the plant body to where there are stomata to exit to the air**
- **They can also penetrate external cell surfaces directly to the air**



Excretion in Plants

Excretion of water

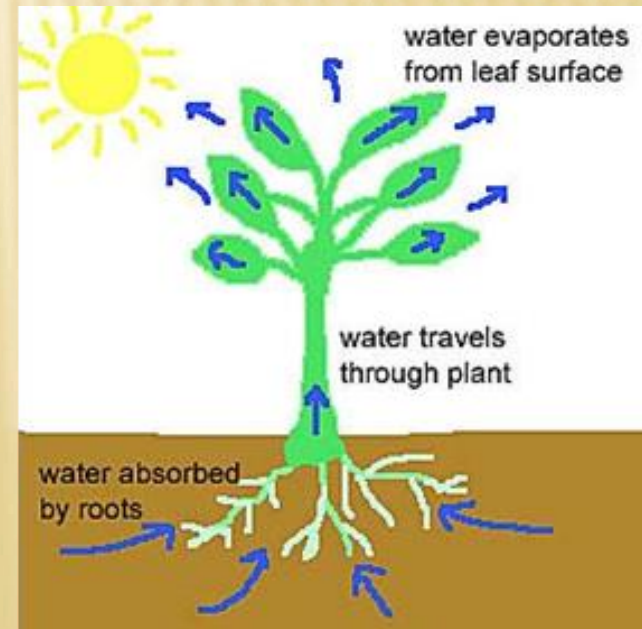
■ Guttation

- Secretion of water and its solutes by **hydathodes** found in the leaf's epidermis of some plants in humid environment.



■ Transpiration

- Water evaporates from the surface of leaves through stomata



Excretion in Plants

Excretion of Nitrogenous Compounds

- Terrestrial plants convert excess **amino acids** into **uric acid** and **Keto acids** by deamination and deposited as crystals in the leaf
- In Aquatic plants the excess of amino acids are converted to **ammonia** and **keto acids**; ammonia exit outside the plant through stomata

Excretion in Plants

Excretion by Salt glands

- Excretion of excess salts outside plant body by special salt glands as in **halophytes** (plants grow in waters of high salinity).

Salt crystals

