Life Processes

How do we know if something is alive?

- **Movement:** Living things often move, whether it's a dog running or a plant growing. But movement alone isn't enough.
- **Molecular movement:** Even when things seem still, living things have constant movement at the molecular level. This is essential for life processes.

Why is molecular movement necessary?

- **Maintenance:** Living things are organized structures that constantly need repair. Molecular movement allows for the transport of molecules needed for these repairs.
- **Energy:** Life processes require energy. Molecular movement facilitates the breakdown of food and the transfer of energy within the organism.

What are life processes?

- **Essential functions:** Life processes are the ongoing activities that maintain life, even when an organism is at rest.
- **Energy and nutrition:** Organisms need to take in energy from outside sources (food) and convert it into a usable form.
- **Respiration:** Many organisms use oxygen to break down food for energy.
- **Transportation:** Multicellular organisms need systems to transport food, oxygen, and waste products throughout their bodies.
- **Excretion:** Waste products from energy generation need to be removed from the body.

Specialization in multicellular organisms:

- **Tissues and organs:** Multicellular organisms have specialized tissues and organs for different functions, including nutrition, respiration, transportation, and excretion.
- **Complexity:** Larger and more complex organisms require more sophisticated systems for these life processes.

Why do we need food?

- **Energy:** We need energy for activities like walking and cycling, but also for essential bodily functions even when resting.
- **Growth and Maintenance:** Food provides the building blocks for growth, development, and the creation of important substances like proteins.

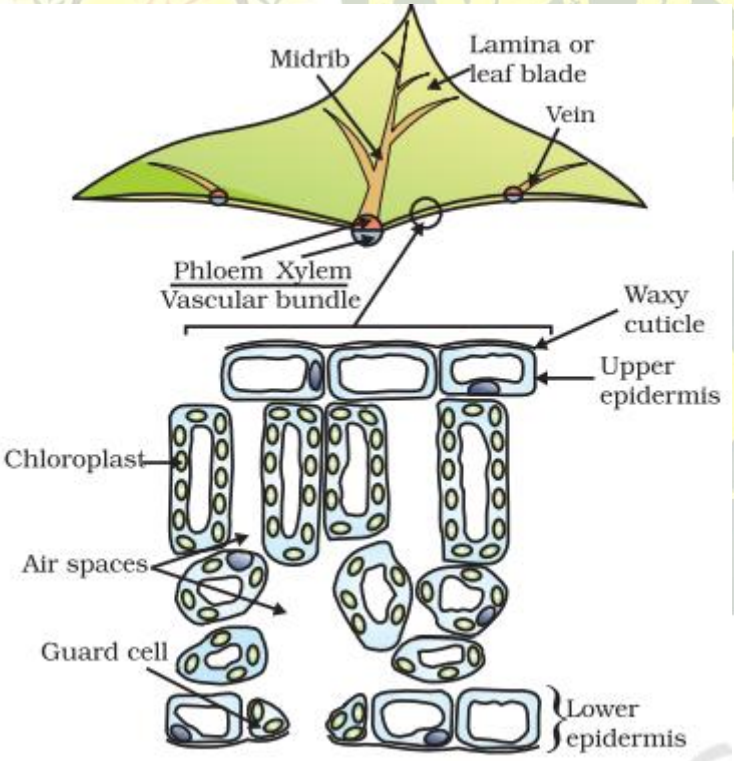
How do organisms get their food?

$$6CO_2 + 12H_2O \xrightarrow[\text{Sunlight}]{\text{Chlorophyll}} \underset{\text{(Glucose)}}{C_6H_{12}O_6} + 6O_2 + 6H_2O$$

- **Autotrophs:**
  - Produce their own food using simple inorganic materials like carbon dioxide and water.
  - Examples: Green plants and some bacteria.
  - Photosynthesis: The process where autotrophs use sunlight, chlorophyll, carbon dioxide, and water to produce carbohydrates (energy).
  - Store extra energy as starch.
- **Heterotrophs:**
  - Consume complex substances and break them down into usable forms with enzymes.
  - Depend on autotrophs directly or indirectly for food.
  - Examples: Animals and fungi.

Photosynthesis:

- **Process:**
  1. Chlorophyll absorbs light energy.
  2. Light energy is converted to chemical energy, and water is split into hydrogen and oxygen.
  3. Carbon dioxide is reduced to carbohydrates.
- **Chlorophyll:** The green pigment in chloroplasts that absorbs light energy.
- **Stomata:** Tiny pores on leaves that allow for gas exchange (carbon dioxide in, oxygen out).
- **Guard cells:** Control the opening and closing of stomata to regulate water loss.



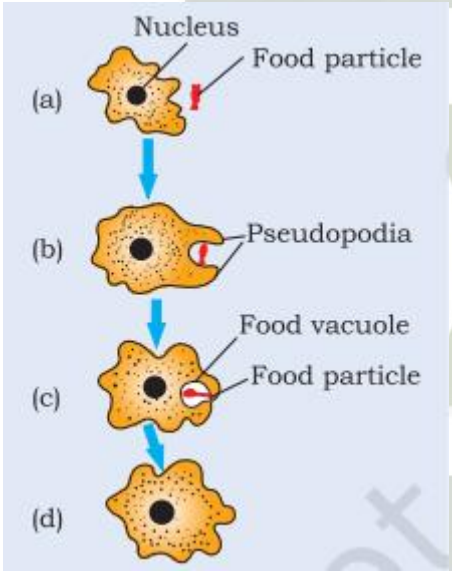
Plant Nutrition:

- **Water:** Absorbed from the soil by roots.
- **Essential nutrients:** Plants also need nitrogen, phosphorus, iron, and magnesium from the soil for growth and development.
- **Nitrogen:** Used for protein synthesis; obtained from the soil as nitrates, nitrites, or organic compounds.

Heterotrophic Nutrition

- **Adaptation:** Organisms have different ways of getting nutrition based on their environment and the type of food they eat.
- **Strategies:**
  - **External digestion:** Some organisms (like fungi) break down food outside their bodies and then absorb it.
  - **Internal digestion:** Others (like animals) consume food and break it down inside their bodies.
  - **Parasitic:** Some organisms get their nutrition from other living organisms without killing them (e.g., cuscuta, ticks, tapeworms).

How Organisms Obtain Nutrition



Nutrition in Amoeba

- **Single-celled organisms:** May absorb food through their entire surface.
- **Multicellular organisms:** Have specialized digestive systems.
  - **Amoeba:** Uses temporary finger-like extensions (pseudopods) to engulf food.
  - **Paramecium:** Has a defined shape and uses cilia to move food to a specific spot for ingestion.

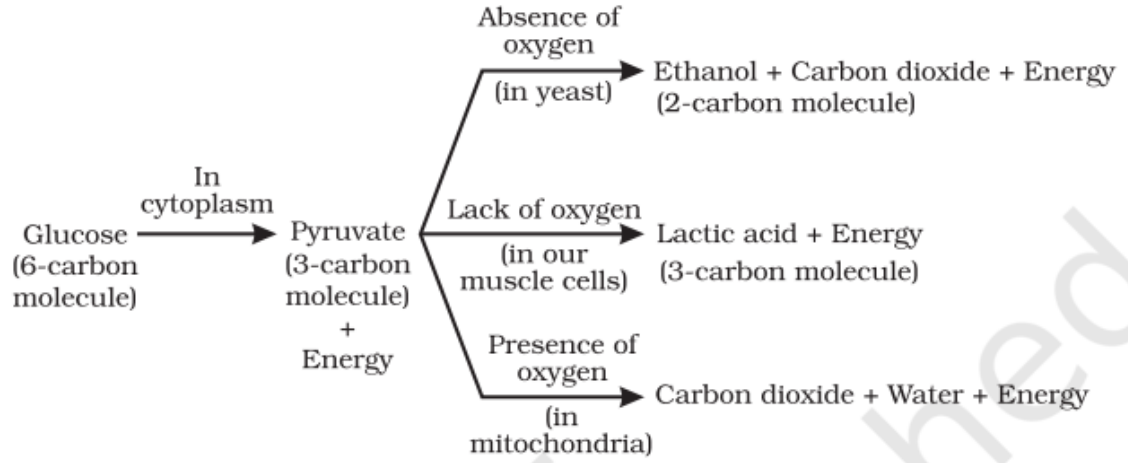
Nutrition in Human Beings

- **Alimentary canal:** A long tube from mouth to anus with different regions for various digestive functions.
- **Mouth:**
  - Teeth: Crush food.
  - Saliva: Wets food and contains salivary amylase to break down starch.
  - Tongue: Helps mix food with saliva.
- **Oesophagus:** Food pipe that moves food from mouth to stomach using peristaltic movements (muscular contractions).
- **Stomach:**
  - Muscular walls: Mix food with digestive juices.
  - Gastric glands: Secrete hydrochloric acid, pepsin (protein-digesting enzyme), and mucus.
    - Hydrochloric acid: Creates an acidic environment for pepsin to work.
    - Mucus: Protects the stomach lining from the acid.
- **Small intestine:**
  - Longest part of the alimentary canal.
  - Receives secretions from the liver (bile) and pancreas (pancreatic juice).
  - Bile: Neutralizes stomach acid and breaks down fats.
  - Pancreatic juice: Contains enzymes like trypsin (digests proteins) and lipase (digests fats).
  - Intestinal juice: Completes the digestion of proteins, carbohydrates, and fats.
  - Villi: Finger-like projections that increase the surface area for absorption of digested food.
- **Large intestine:**
  - Absorbs water from undigested food.
- **Anus:** Eliminates waste products from the body.

Dental Caries (Tooth Decay)

- **Cause:** Bacteria acting on sugars produce acids that soften tooth enamel.
- **Prevention:** Good oral hygiene (brushing after meals) to remove plaque and neutralize acids.

Respiration



Break-down of glucose by various pathways

- **Purpose:** To break down food and release energy for life processes.
- **Types of Respiration:**
  - **Aerobic respiration:** Uses oxygen to break down glucose completely into carbon dioxide and water, releasing a lot of energy.
  - **Anaerobic respiration:** Breaks down glucose without oxygen.
    - In yeast: Produces ethanol and carbon dioxide (fermentation).
    - In muscle cells (during intense activity): Produces lactic acid, which can cause cramps.
- **Energy Transfer:**
  - Energy released during respiration is used to create ATP (adenosine triphosphate).
  - ATP acts as an energy currency for the cell, powering various activities.

Gas Exchange in Plants

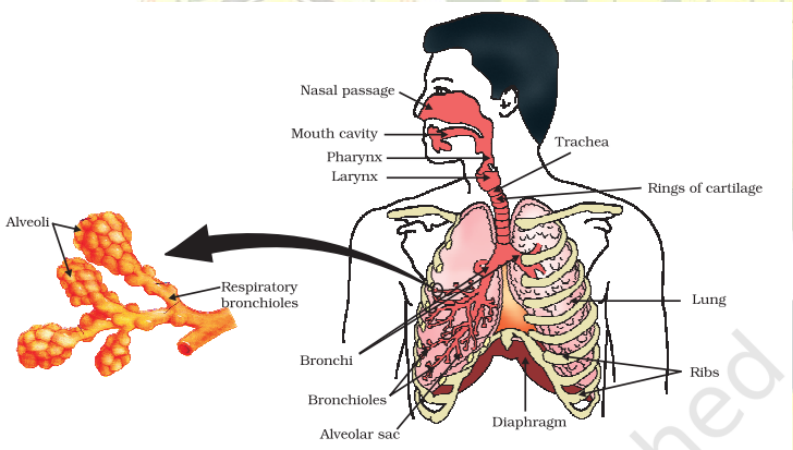
- **Stomata:** Tiny pores on leaves used for gas exchange (carbon dioxide, oxygen, and water vapor).
- **Diffusion:** Gases move in and out of leaves based on concentration differences.
- **Daytime:** Carbon dioxide produced during respiration is used for photosynthesis, so oxygen release is the main event.
- **Nighttime:** Photosynthesis stops, and carbon dioxide elimination becomes the major exchange activity.

Gas Exchange in Animals

- **Aquatic animals:**
  - Extract dissolved oxygen from water using gills.
  - Breathe faster than terrestrial animals due to lower oxygen levels in water.
- **Terrestrial animals:**
  - Use oxygen from the atmosphere.

- Have specialized respiratory organs (e.g., lungs) with large surface areas for efficient gas exchange.

Respiration in Humans



- **Air pathway:** Nostrils → throat (with cartilage rings to prevent collapse) → lungs → alveoli (tiny air sacs).
- **Alveoli:**
  - Sites of gas exchange.
  - Surrounded by blood vessels for efficient oxygen uptake and carbon dioxide removal.
- **Breathing mechanism:**
  - Inhalation: Ribs lift, diaphragm flattens, chest cavity expands, air is sucked into lungs.
  - Exhalation: Ribs lower, diaphragm relaxes, chest cavity contracts, air is expelled.
- **Residual volume:** Lungs always retain some air to ensure continuous gas exchange.

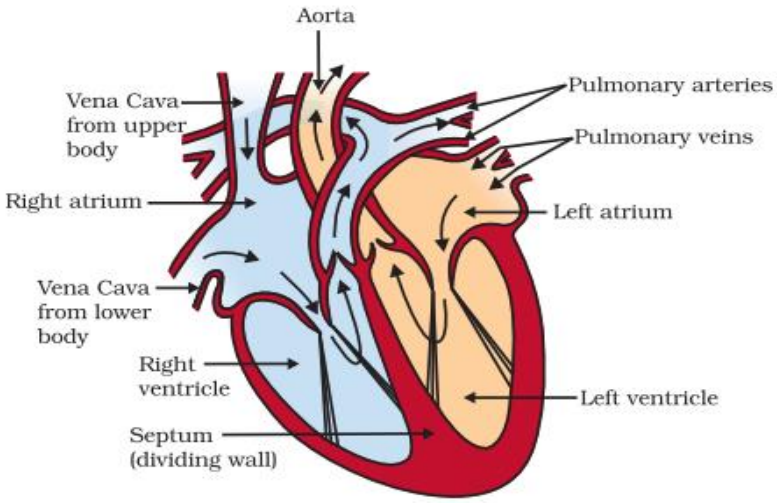
Oxygen Transport in Humans

- **Hemoglobin:** A respiratory pigment in red blood cells that has a high affinity for oxygen.
- **Transportation:** Hemoglobin carries oxygen from the lungs to the body tissues.
- **Carbon dioxide transport:** Mostly transported in dissolved form in the blood.

Transportation in Human Beings

- **Blood:**
  - A fluid connective tissue that transports food, oxygen, waste materials, salts, etc.
  - Components:
    - Plasma: Fluid medium that carries food, carbon dioxide, and nitrogenous wastes.
    - Red blood cells: Carry oxygen.

- **Heart:**



  - Muscular organ that pumps blood throughout the body.
  - Four chambers:
    - Left atrium: Receives oxygen-rich blood from the lungs.
    - Left ventricle: Pumps oxygen-rich blood to the body.
    - Right atrium: Receives deoxygenated blood from the body.
    - Right ventricle: Pumps deoxygenated blood to the lungs.
  - Valves: Prevent backflow of blood.
  - Double circulation: Blood passes through the heart twice in one complete cycle.

Blood Vessels

- **Arteries:**
  - Carry blood away from the heart.
  - Thick, elastic walls to withstand high pressure.
- **Veins:**
  - Carry blood towards the heart.
  - Thinner walls with valves to prevent backflow.
- **Capillaries:**
  - Tiny, thin-walled vessels that connect arteries and veins.
  - Allow for exchange of materials between blood and cells.

Maintenance and Repair

- **Platelets:**
  - Cell fragments that help in blood clotting to prevent blood loss and maintain pressure.

Lymph (Tissue Fluid)

- **Formation:** Plasma, proteins, and blood cells escape from capillaries into intercellular spaces.

- **Function:**
  - Transports digested fats from the intestines.
  - Drains excess fluid from tissues back into the blood.
  - Part of the lymphatic system, which also plays a role in immunity.

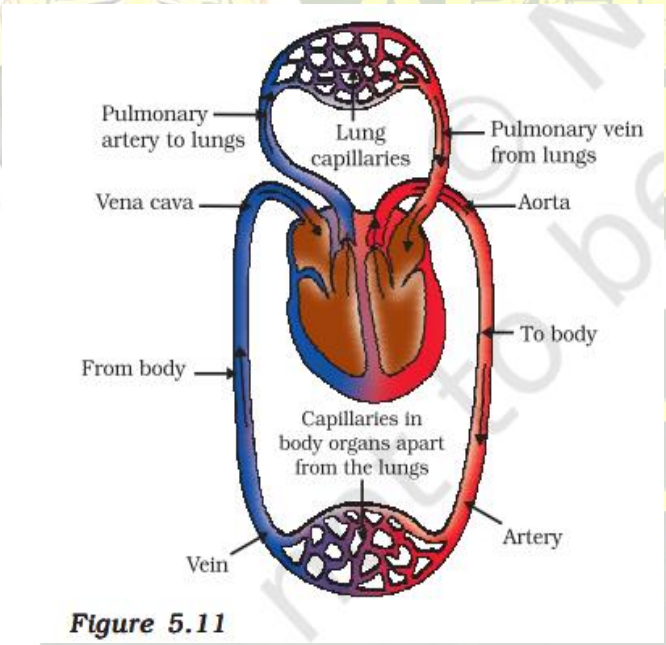
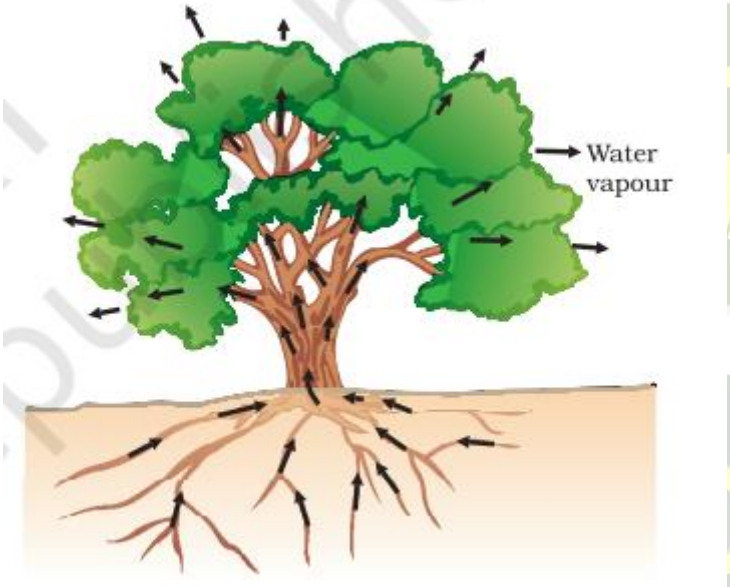


Figure 5.11

Transportation in Plants



- **Why is transportation necessary?**
  - Plants need to move water and minerals from the soil (absorbed by roots) to the leaves for photosynthesis.
  - They also need to transport the products of photosynthesis (sugars) from the leaves to other parts of the plant for growth and storage.
  - Diffusion is sufficient for small plants, but larger plants need a dedicated transport system.

- **Energy needs:**
  - Plants have lower energy needs than animals because they don't move and have many dead cells.
  - This means they can use slower transport systems.
  - However, these systems must be able to transport substances over long distances in tall trees.
- **Transport systems:**
  - **Xylem:** Transports water and minerals from roots to leaves.
    - Unidirectional flow.
  - **Phloem:** Transports products of photosynthesis (sugars) from leaves to other parts of the plant.
    - Bidirectional flow.
  - These two pathways are separate and independently organized.

Transport of Water

- **Xylem:** A continuous system of interconnected vessels and tracheids that transport water and minerals throughout the plant.
- **Absorption by roots:**
  - Root cells actively take up ions from the soil.
  - This creates a concentration difference, causing water to move into the roots by osmosis.
- **Root pressure:**
  - The force that pushes water upwards from the roots into the xylem.
  - More important at night.
- **Transpiration:**
  - Evaporation of water from leaves through stomata.
  - Creates a suction force that pulls water up the xylem.
  - Main driving force for water movement during the day.
- **Benefits of transpiration:**
  - Helps in absorption and upward movement of water and minerals.
  - Regulates temperature.

Transport of Food and Other Substances

- **Phloem:** The vascular tissue responsible for translocation (transporting food and other substances).
- **Translocation:**
  - Movement of soluble products of photosynthesis (sugars), amino acids, and other substances.
  - Occurs in sieve tubes with the help of companion cells.
  - Bidirectional (both upward and downward).
- **Mechanism:**

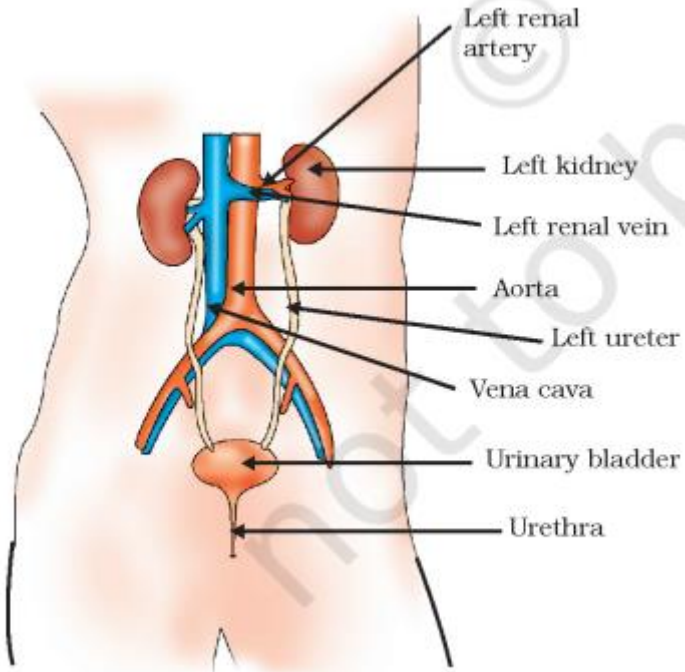
- Uses energy (ATP) to move materials like sucrose into phloem.
- This increases osmotic pressure, drawing water into the phloem.
- Creates pressure that moves materials to areas of lower pressure, according to the plant's needs.

- **Examples:**
  - Sugar stored in roots or stems is transported to growing buds in spring.

Excretion

- **Purpose:** To remove harmful metabolic waste products from the body.
- **Waste products:** Include nitrogenous wastes (urea, uric acid) generated from metabolic activities.
- **Excretion in different organisms:**
  - **Unicellular organisms:** Remove wastes by simple diffusion through the cell membrane.
  - **Multicellular organisms:** Have specialized organs for excretion.

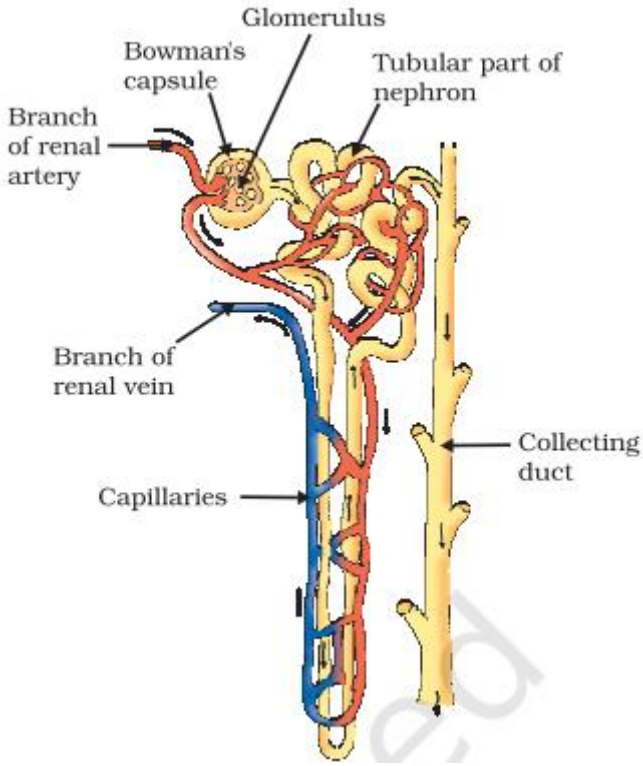
Excretion in Human Beings



- **Excretory system:**
  - Kidneys: Filter waste products from the blood.
  - Ureters: Tubes that carry urine from the kidneys to the bladder.
  - Urinary bladder: Stores urine.
  - Urethra: Tube that carries urine from the bladder out of the body.

Urine Production in the Kidneys

- **Nephrons:** The functional units of the kidneys responsible for filtering blood.
  - Each nephron consists of a cluster of capillaries (glomerulus) and a Bowman's capsule.
- **Filtration:**
  - Blood is filtered in the glomerulus.
  - The filtrate (water, glucose, amino acids, salts, and wastes) is collected in the Bowman's capsule.
- **Reabsorption:**
  - Useful substances (glucose, amino acids, salts, and some water) are reabsorbed back into the blood.
- **Secretion:**
  - Additional waste products are secreted into the filtrate.
- **Urine formation:**
  - The remaining fluid, containing waste products, forms urine.
- **Urine flow:**
  - Urine flows from the kidneys through the ureters to the bladder.
- **Storage and elimination:**
  - Urine is stored in the bladder.
  - When the bladder is full, the urge to urinate occurs.
  - Urine is passed out of the body through the urethra.



Structure of a nephron

Excretion in Plants

- **Different strategies:** Plants have different ways of getting rid of waste compared to animals.
- **Gaseous wastes:**
    - Oxygen (a byproduct of photosynthesis) and carbon dioxide are released through stomata.
- **Excess water:** Removed through transpiration (evaporation from leaves).
- **Other waste products:**
    - Stored in cellular vacuoles.
    - Stored in leaves that fall off.
    - Stored as resins and gums in old xylem (non-functional wood tissue).
    - Excreted into the soil.
- **Dead cells:** Plants can shed waste-containing dead cells and tissues.