

# Life Processes

## Comprehensive Study Notes for RBSE Class 10 Science Chapter 5

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### 1. WHAT ARE LIFE PROCESSES?

#### Definition

**Life processes** are the maintenance functions of living organisms that must continue even when they are not doing any particular activity. These are essential for preventing damage and breakdown of organized structures.

#### Key Characteristics

- Occur continuously to maintain organized structure
- Require energy from outside the body
- Essential for growth, repair, and maintaining order
- Occur at molecular level (invisible to naked eye)
- Present in all living organisms

#### Molecular Movement and Life

- Living organisms are well-organized structures with tissues, cells, and smaller components
- Environmental effects continuously break down this organization
- Molecular movements prevent complete breakdown by maintaining and repairing structures
- **Without molecular movement, organisms cannot be considered alive**
- Viruses lack molecular movement until they infect cells (controversy about whether they're truly alive)

#### Main Life Processes

- **Nutrition:** Intake of food (energy and raw materials)
- **Respiration:** Breaking down food to release energy
- **Transportation:** Movement of materials within the body
- **Excretion:** Removal of waste products

#### Why are Life Processes Necessary?

##### Energy Requirements:

- Needed to maintain cellular organization
- Required for growth and development
- Essential for all metabolic activities
- Source: External food material (carbon-based molecules)

### In Multi-cellular Organisms:

- Cells not in direct contact with environment
- Simple diffusion insufficient for oxygen and nutrient distribution
- Specialized tissues required for nutrient uptake and waste removal
- Transportation system needed to carry materials between body parts
- Waste by-products harmful and must be removed

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## 2. NUTRITION

### 2.1 Definition and Types

**Nutrition:** Process of obtaining food, which provides energy and raw materials for growth, development, and synthesis of required body substances.

#### Two Main Types of Nutrition

Feature	Autotrophic Nutrition	Heterotrophic Nutrition
Food Source	Simple inorganic substances (CO <sub>2</sub> , H <sub>2</sub> O)	Complex organic substances
Organisms	Green plants, some bacteria	Animals, fungi
Process	Photosynthesis	Ingestion & digestion
Energy Source	Sunlight	Organic compounds
Food Preparation	Make their own food	Depend on autotrophs
Independence	Independent (self-feeders)	Dependent (feeders)

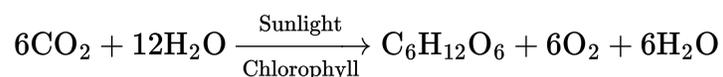
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### 2.2 AUTOTROPHIC NUTRITION

#### Definition

Process by which autotrophs take in simple inorganic substances from outside and convert them into stored forms of energy using sunlight and chlorophyll.

#### Photosynthesis: Overview



**Glucose is formed as carbohydrate**

## Three Main Stages of Photosynthesis

### 1. Light Energy Absorption

- Chlorophyll absorbs light energy
- Occurs in chloroplast (green dots in leaf cells)
- Energy converted from light to chemical form

### 2. Water Splitting and Energy Conversion

- Water molecules split:  $\text{H}_2\text{O} \rightarrow 2\text{H} + \frac{1}{2}\text{O}_2$
- Light energy converts to chemical energy (ATP)
- Oxygen released as by-product

### 3. Carbon Dioxide Reduction

- $\text{CO}_2$  converted to carbohydrates (glucose)
- Uses energy and hydrogen from water splitting
- Does not require light directly (dark reaction)

## Chloroplast Structure and Function

**Location:** Green dots visible in leaf cells

### Essential Components:

- Chlorophyll: Pigment that absorbs light
- Thylakoids: Site of light reactions
- Stroma: Site of dark reactions

## Leaf Structure for Photosynthesis

Part	Function in Photosynthesis
Upper Epidermis	Protective layer, allows light penetration
Chloroplast	Contains chlorophyll, absorbs light
Stomata	Pores for $\text{CO}_2$ entry and gas exchange
Guard Cells	Control opening/closing of stomata
Vascular Bundles (Xylem/Phloem)	Transport water and nutrients
Air Spaces	Allow gas diffusion within leaf

## Stomata: The Gateway for Gases

**Function:** Tiny pores on leaf surface for massive gaseous exchange

### Guard Cells:

- Control stomatal opening and closing

- Swell with water entry → pore opens
- Shrink when water exits → pore closes

#### **When Stomata Close:**

- Plant doesn't need CO<sub>2</sub> for photosynthesis
- Prevents water loss through transpiration
- Night time and dry conditions

#### **When Stomata Open:**

- Day time when photosynthesis occurs
- Adequate water supply available
- Gas exchange maximum

### **Raw Materials for Photosynthesis**

#### **Carbon Dioxide:**

- Obtained from air through stomata
- Atmospheric concentration: ~0.04%
- Essential for carbohydrate formation

#### **Water:**

- Taken from soil by roots
- Transported through xylem
- Also provides hydrogen for glucose

#### **Sunlight:**

- Provides energy for photosynthesis
- Intensity affects rate of photosynthesis
- Quality (wavelength) affects efficiency

#### **Chlorophyll:**

- Green pigment in chloroplasts
- Absorbs light energy (mainly red and blue light)
- Present in leaves and green parts of plant

#### **Minerals from Soil:**

- Nitrogen (N): For protein synthesis
- Phosphorus (P): For energy compounds
- Iron (Fe): Component of chlorophyll
- Magnesium (Mg): Center of chlorophyll molecule

### **Energy Storage in Plants**

#### **Carbohydrates Used Immediately:**

- Provide energy for plant metabolism
- Support growth and development

### **Carbohydrates Stored as Starch:**

- Internal energy reserve
- Used when immediate photosynthesis insufficient
- Used at night and in winter
- **Similar to glycogen storage in animals**

### **Key Experimental Concept: Proof of Starch Formation**

#### **Variegated Leaf Experiment:**

- Darkened plant placed in sunlight
- Only green areas show starch (iodine test turns blue-black)
- Non-green areas show no starch
- **Conclusion:** Chlorophyll essential for photosynthesis

### **Exam-Important Points**

#### **Where Photosynthesis Occurs:**

- Primary: Green leaves (maximum chlorophyll)
- Also in: Green stems, green fruits, algae
- Chloroplasts contain chlorophyll

#### **Conditions Required:**

- CO<sub>2</sub> availability
- Water availability
- Light (direct sunlight or bright light)
- Suitable temperature (25-35°C optimal)
- Chlorophyll presence

#### **Evidence of Photosynthesis:**

- Oxygen release (gas evolution)
- Starch formation (iodine test)
- Leaf color (chlorophyll presence)
- Plant growth and biomass increase

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## **2.3 HETEROTROPHIC NUTRITION**

### **Definition**

Mode of nutrition in organisms that cannot synthesize their own food and depend on complex organic substances produced by other organisms.

### **Types of Heterotrophs**

#### **1. Holozoic (Ingestion) Nutrition**

- Takes in whole food material
- Breaks it down inside body
- Most animals use this

- Examples: Humans, cows, cats, dogs

## 2. Saprophytic Nutrition

- Organisms break down dead organic material
- Secretes enzymes outside body
- Absorbs digested products
- Examples: Fungi (bread mold, yeast, mushrooms)

## 3. Parasitic Nutrition

- Derives nutrition from living organisms without killing them
- Lives in/on host body
- Harms the host
- Examples: Cuscuta (amar-bel), ticks, lice, tape-worms, blood-feeding insects

## Dependency Chain

Autotrophs → Herbivores → Carnivores

**Key Fact:** Heterotrophs depend directly or indirectly on autotrophs for survival

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## 2.4 NUTRITION IN SINGLE-CELLED ORGANISMS

### Amoeba (Holozoic Nutrition)

#### Process:

1. Extends temporary finger-like projections (pseudopodia)
2. Projects fuse over food particle
3. Forms food vacuole
4. Enzymes break down complex substances into simpler ones
5. Digested products diffuse into cytoplasm
6. Undigested material moved to surface and expelled

**Advantage:** Can engulf large food particles

### Paramecium

#### Characteristics:

- Fixed cell shape (covered by cilia)
- Food taken at specific spot
- Cilia movement brings food to mouth area
- Cilia beat create current that draws food

#### Process:

1. Cilia create water current
  2. Food particles drawn into oral groove
  3. Food enters gullet
  4. Forms food vacuole
  5. Digestion occurs, absorption into cytoplasm
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## 2.5 NUTRITION IN HUMAN BEINGS

### Alimentary Canal (Digestive Tract)

**Structure:** Long tube extending from mouth to anus

#### Specialized Regions:

Region	Secretion	Function
Mouth	Saliva (salivary amylase)	Mechanical grinding, starch digestion
Esophagus	Mucus	Food transport (peristalsis)
Stomach	Gastric juice (HCl, pepsin, mucus)	Protein digestion, food mixing
Small Intestine	Pancreatic juice, bile, intestinal juice	Complete digestion, absorption
Large Intestine	Mucus	Water reabsorption
Rectum	—	Feces storage
Anus	—	Waste elimination

### Detailed Process of Digestion

#### Stage 1: Ingestion (Mouth)

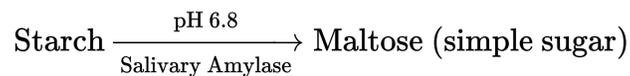
##### Food Entry:

- Teeth crush food into small pieces (mechanical digestion)
- Saliva mixes with food (chemical digestion begins)

##### Saliva Composition:

- Water (solvent and lubrication)
- Salivary amylase (enzyme)
- Mucus (protection and lubrication)
- Salts and other substances

##### Salivary Amylase Action:



##### Activity 5.3 Observation:

- Test tube A (saliva + starch): Iodine test shows NO color change (starch degraded)
- Test tube B (no saliva + starch): Iodine test shows blue-black color (starch remains)

##### Food Movement:

- Tongue mixes food with saliva
- Tongue pushes food into esophagus
- Swallowing reflex initiated

### Stage 2: Transport (Esophagus)

#### Process:

- Peristalsis: Rhythmic muscular contractions
- Wave-like motion pushes food downward
- Occurs involuntarily (automatic)

**Duration:** Food reaches stomach in ~10 seconds

**Mucus Function:** Protects esophagus lining, provides lubrication

### Stage 3: Stomach Digestion

#### Structure:

- Large muscular organ
- Expands when food enters
- Wall contains gastric glands

#### Gastric Juice Composition:

- **Hydrochloric Acid (HCl):**
  - Creates acidic medium (pH 1.5-2)
  - Activates pepsin
  - Kills some bacteria
  - Denatures proteins
- **Pepsin (Protease):**
  - Enzyme for protein digestion
  - Breaks proteins into smaller fragments (peptides)
  - Works only in acidic medium
- **Mucus:**
  - Protects stomach lining from HCl
  - Prevents self-digestion of stomach
  - Provides lubrication

#### Functions of Stomach:

- Protein digestion begins
- Food thoroughly mixed
- Forms semi-liquid mass called chyme
- Regulated release into small intestine through sphincter muscle

#### Acidity and Health:

- Normal HCl production maintains digestive function
- Excess acidity causes "acidity" complaints
- Mucus protects against acid damage

## Stage 4: Small Intestine Digestion and Absorption

### Structure:

- Longest part of alimentary canal
- Extensively coiled to fit in compact space
- Divided into: Duodenum, Jejunum, Ileum

### Why Length Varies:

- **Herbivores:** Longer small intestine
  - Need more time to digest cellulose (plant fiber)
  - Example: Cows, rabbits, horses
- **Carnivores:** Shorter small intestine
  - Meat easier to digest
  - Example: Lions, tigers, cats
- **Omnivores:** Medium length
  - Example: Humans

### Secretions Entering Small Intestine:

#### From Pancreas (Pancreatic Juice):

- Trypsin: Breaks proteins into amino acids
- Lipase: Breaks fats into fatty acids and glycerol
- Amylase: Breaks carbohydrates into glucose

#### From Liver (Bile Juice):

- Bile salts: Emulsify fats (break into smaller droplets)
- Increases surface area for enzyme action
- **Similar to soap action on dirt** (Chapter 4 concept)
- Makes alkaline medium

#### From Intestinal Glands (Intestinal Juice):

- Multiple enzymes for final digestion
- Protease: Amino acids formation
- Carbohydrase: Glucose formation
- Lipase: Completes fat breakdown

### Complete Digestion Summary:

Nutrient	Product	Enzyme/Substance	Location
Carbohydrates	Glucose	Amylase	Mouth, small intestine
Proteins	Amino acids	Pepsin, Trypsin	Stomach, small intestine
Fats	Fatty acids + Glycerol	Lipase + Bile salts	Small intestine

## **Absorption in Small Intestine:**

### **Villi Structure:**

- Finger-like projections on inner lining
- Increase surface area enormously
- Each villus contains blood capillaries
- Single epithelial cell layer for rapid absorption

### **Why Villi Important:**

- Dramatically increase absorption surface
- Direct contact with digested nutrients
- Rich blood supply for transport

### **Nutrient Transport:**

- Glucose and amino acids: Absorbed into blood
- Fatty acids and glycerol: Absorbed, recombined into fats, enter lymph
- Vitamins and minerals: Absorbed into blood
- Transported to all cells for energy and growth

## **Stage 5: Large Intestine (Colon)**

### **Function:**

- Reabsorption of water
- Absorption of minerals and vitamins
- Formation of feces

### **Process:**

- Unabsorbed material enters as liquid
- Water reabsorbed into blood
- Minerals and vitamins absorbed
- Remaining material becomes feces

### **Exit Regulation:**

- Anal sphincter muscle controls feces release
- Voluntary control possible
- Unabsorbed material (cellulose, other fiber) helps bowel movement

**Material Exit:** Via anus (defecation)

## **Role of Different Organs**

### **Teeth:**

- Incisors: Cut and bite
- Canines: Tear
- Premolars and molars: Grind
- **Mechanical digestion:** Increases surface area for enzyme action

### **Tongue:**

- Mixing food with saliva
- Positioning food for chewing
- Swallowing reflex
- Taste perception

**Liver:**

- Bile production and storage
- Bile salts emulsify fats
- Produces alkaline medium for pancreatic enzymes
- Many metabolic functions

**Pancreas:**

- Pancreatic juice production
- Contains multiple digestive enzymes
- Also produces insulin (not digestive)

**Stomach:**

- Temporary food storage (capacity ~1-1.5 L)
- Protein digestion
- Mixing and churning
- Controlled release through pyloric sphincter

## Dental Health

**Dental Caries (Tooth Decay):**

**Cause:**

- Bacteria act on sugars
- Produce acids that demineralize enamel
- Plaque (bacteria + food particles) forms on teeth

**Prevention:**

- Brush teeth after eating
- Remove plaque before acid formation
- Avoid excessive sugar intake
- Regular dental checkups

**If Untreated:**

- Microorganisms invade pulp
  - Inflammation and infection develop
  - Loss of tooth possible
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### 3. RESPIRATION

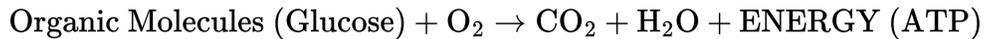
#### 3.1 Definition and Overview

**Respiration:** Biochemical process of breaking down organic food molecules to release energy in the form of ATP for cellular activities.

**NOT the same as breathing:** Breathing = physical process; Respiration = chemical process in cells

#### Overall Process

##### Energy Release:



**ATP:** Adenosine Triphosphate - universal energy currency of cells

#### Two Types of Cellular Respiration

Feature	Aerobic Respiration	Anaerobic Respiration
Oxygen Required	Yes	No
Location	Mitochondria	Cytoplasm
Products	CO <sub>2</sub> , H <sub>2</sub> O, Energy	Ethanol/Lactate, CO <sub>2</sub> , Energy
Energy Yield	30-32 ATP per glucose	2 ATP per glucose
Efficiency	High (40% efficient)	Low (2-3% efficient)
Organisms	Most organisms	Some bacteria, yeast, muscle cells

#### 3.2 Aerobic Respiration (Respiration with Oxygen)

##### Complete Equation:



##### Stages:

##### Stage 1: Glycolysis (in Cytoplasm)

- Glucose (6-carbon) → Pyruvate (3-carbon)
- Produces: 2 ATP, 2 NADH
- No oxygen required yet

##### Stage 2: Pyruvate Oxidation (in Mitochondria)

- Pyruvate → Acetyl-CoA
- Releases CO<sub>2</sub>
- Produces: NADH

### **Stage 3: Krebs Cycle (in Mitochondrial Matrix)**

- Acetyl-CoA → CO<sub>2</sub>
- Produces: ATP, NADH, FADH<sub>2</sub>
- Complete oxidation of carbon

### **Stage 4: Electron Transport Chain (in Inner Mitochondrial Membrane)**

- Uses NADH and FADH<sub>2</sub>
- Produces: ~28-30 ATP
- Combines with O<sub>2</sub> to form H<sub>2</sub>O
- Final CO<sub>2</sub> and H<sub>2</sub>O release

**Total Energy Yield:** 30-32 ATP per glucose molecule

## **3.3 Anaerobic Respiration (Respiration without Oxygen)**

**Definition:** Breaking down glucose without oxygen to release limited energy

### **Stage 1: Glycolysis (in Cytoplasm)**

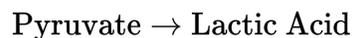
- Glucose → Pyruvate
- Produces: 2 ATP (all energy available)

### **Stage 2: Pyruvate Conversion (in Cytoplasm)**

#### **Path 1: Alcoholic Fermentation (in Yeast)**



#### **Path 2: Lactic Acid Fermentation (in Muscle Cells)**



### **Organisms Using Anaerobic Respiration:**

- Bacteria (many types)
- Yeast and fungi
- Muscle cells during intense activity
- Organisms in oxygen-poor environments (mud, deep water)

**Energy Yield:** Only 2 ATP per glucose (1% efficient)

## **3.4 Lactic Acid Fermentation in Muscles**

**Situation:** During sudden intense activity or oxygen shortage

### **Process:**

1. Oxygen depleted in muscle cells
2. Normal aerobic respiration cannot continue
3. Pyruvate converted to lactic acid

4. Limited ATP produced (2 per glucose)

**Consequence:**

- Lactic acid accumulation in muscles
- Causes muscle cramps and fatigue
- Recovered after rest and oxygen restoration

**Recovery:**

- Rest increases blood flow
- Oxygen reaches muscles
- Lactic acid oxidized or converted back to glucose
- Cramps disappear

### 3.5 Gas Exchange in Plants

**During the Day (Photosynthesis occurs):**

- Photosynthesis produces  $O_2$  and uses  $CO_2$
- Respiration produces  $CO_2$  and uses  $O_2$
- Net effect: More  $O_2$  released than used
- **Major gas exchange:  $O_2$  release**

**During the Night (No photosynthesis):**

- Only respiration occurs
- $CO_2$  produced and released
- $O_2$  consumed
- **Major gas exchange:  $CO_2$  release**

**Mechanism:**

- Stomata open/close based on plant needs
- Diffusion through intercellular spaces
- All cells have direct access to gases
- No special respiratory organs needed

### 3.6 Respiration in Aquatic Animals

**Challenge:** Oxygen concentration in water is low (~5-10 mg/L) compared to air (~210 mg/L)

**Adaptation:** Gills with large surface area

**Process in Fish:**

1. Water enters through mouth
2. Forced over gill filaments
3. Dissolved oxygen taken up by blood
4. Deoxygenated blood returns water
5. Coordinated mouth and gill opening

**Breathing Rate:** Much faster than terrestrial animals

**Example:** Fish may open/close mouth 20-40 times per minute vs. humans ~15 times per minute

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## 3.7 RESPIRATION IN HUMAN BEINGS

### Respiratory System Structure

#### Path of Air:

Nostrils → Throat → Larynx → Trachea → Bronchi → Bronchioles → Alveoli

### Components

#### Nasal Passage

##### Function:

- Air intake
- Filtering (fine hairs trap dust)
- Warming (blood vessels)
- Moistening (mucus layer)

**Advantages:** Clean, warm, moist air reaches lungs

#### Throat (Pharynx)

**Function:** Air passage from nose to larynx

#### Larynx (Voice Box)

##### Features:

- Rings of cartilage
- Prevents air-passage collapse
- Contains vocal cords (sound production)

#### Trachea (Windpipe)

##### Features:

- C-shaped cartilage rings
- Flexibility and protection
- Lines with mucus and cilia
- Cilia trap and remove particles

##### Ciliary Function:

- Beat rhythmically upward
- Remove germs, dust, harmful particles
- Protect lung tissues
- **Smoking destroys cilia** → harmful particles reach lungs

## Lungs

### Structure:

- Left lung: 2 lobes (heart space)
- Right lung: 3 lobes

### Bronchi Division:

- Trachea branches into left and right bronchi
- Further divide into bronchioles
- Finally terminate in alveoli

### Alveoli (Plural of Alveolus):

- Balloon-like structures
- Site of gas exchange
- Walls: One cell thick
- Surrounded by extensive capillary network
- **Enormous surface area** if spread:  $\sim 80 \text{ m}^2$

## Gas Exchange in Alveoli

### Process:

#### 1. Oxygen Transfer:

- $\text{O}_2$  from air in alveolus
- Diffuses across thin alveolar wall
- Enters capillary blood
- Binds to hemoglobin in RBCs

#### 2. Carbon Dioxide Transfer:

- $\text{CO}_2$  from capillary blood
- Dissolves in blood plasma
- Diffuses across alveolar wall
- Exhaled through air

### Why Efficient:

- Large surface area (alveoli)
- Very thin walls (single cell layer)
- Rich blood supply
- Concentration gradients maintained

## Breathing Mechanism

### Inspiration (Inhalation):

1. Diaphragm contracts and flattens
2. Rib muscles lift ribs up and out
3. Chest cavity expands
4. Pressure inside lungs decreases
5. Air sucked into lungs

### Expiration (Exhalation):

1. Diaphragm relaxes and curves up
2. Rib muscles relax, ribs move down
3. Chest cavity contracts
4. Pressure inside lungs increases
5. Air pushed out of lungs

**Residual Volume:**

- Small amount of air always remains in lungs
- Ensures continuous O<sub>2</sub> availability
- Allows continued gas exchange between breaths

**Respiratory Pigment: Hemoglobin**

**Function:** Transport oxygen from lungs to tissues

**Properties:**

- Protein with iron center
- Very high affinity for oxygen
- Located in red blood corpuscles
- Binds O<sub>2</sub> in lungs (high O<sub>2</sub>), releases in tissues (low O<sub>2</sub>)

**Structure:** Heme (iron-containing) + Globin (protein)

**Oxygen Capacity:** One hemoglobin binds 4 O<sub>2</sub> molecules

**CO<sub>2</sub> Transport**

**Methods:**

- **Dissolved in blood plasma:** ~7-10% (CO<sub>2</sub> highly soluble in water)
- **As bicarbonate ions:** ~70% (most common)
  - $\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3 \rightarrow \text{H}^+ + \text{HCO}_3^-$
- **Bound to hemoglobin:** ~23% (as carbaminohemoglobin)

**Breathing Rate and Efficiency**

**Normal Breathing Rate:** 12-20 breaths per minute (at rest)

**Without Hemoglobin:**

- Oxygen diffusion alone insufficient
- Would take **3 years** for O<sub>2</sub> molecule to reach toes from lungs
- Tissues would be oxygen-starved

**With Hemoglobin:**

- Rapid oxygen delivery (minutes)
- Efficient distribution to all tissues
- Supports metabolism in all cells

## Health and Respiration

### Smoking Effects

#### Damage:

- Destroys cilia in trachea and bronchi
- Germs, dust, smoke reach lungs
- Accumulation of harmful substances

#### Consequences:

- Chronic cough
- Infections and inflammation
- Lung cancer risk
- Heart and liver damage
- Reduced oxygen absorption

### Pollution and Respiratory Health

- Air pollutants damage respiratory system
  - Reduce oxygen absorption capacity
  - Increase risk of respiratory diseases
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## 4. TRANSPORTATION

### 4.1 Overview

#### Need for Transportation:

- Digested food absorbed in small intestine
- Oxygen taken by lungs
- Waste products produced in cells
- All cells need nutrients and oxygen
- All cells produce waste to be removed

#### In Single-cell Organisms:

- Entire surface in contact with environment
- Simple diffusion sufficient
- No transportation system needed

#### In Multi-cellular Organisms:

- Cells not in direct contact with environment
  - Diffusion too slow and insufficient
  - **Specialized transportation system essential**
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## 4.2 TRANSPORTATION IN HUMAN BEINGS

### 4.2.1 The Circulatory System

#### Components:

- **Heart:** Pumping organ
- **Blood:** Fluid connective tissue
- **Blood Vessels:** Arteries, veins, capillaries
- **Lymph:** Tissue fluid (secondary transport system)

#### The Heart

##### Structure:

- Muscular organ, size of closed fist
- Four chambers: 2 atria (upper), 2 ventricles (lower)
- Septum: Wall dividing left and right sides

##### Chamber Functions:

Chamber	Receives Blood From	Sends Blood To
Right Atrium	Vena cava (body)	Right ventricle
Right Ventricle	Right atrium	Lungs (pulmonary artery)
Left Atrium	Lungs (pulmonary vein)	Left ventricle
Left Ventricle	Left atrium	Body (aorta)

##### Separation of Oxygenated and Deoxygenated Blood:

- **Right side:** Deoxygenated blood (from body to lungs)
- **Left side:** Oxygenated blood (from lungs to body)
- **Septum:** Prevents mixing
- **Valves:** Ensure one-way flow

##### Why Separation Important:

- High energy demand in mammals and birds
- Constant energy needed for body temperature maintenance
- Highly oxygenated blood delivered to tissues
- Maximized oxygen availability
- Increased metabolic efficiency

##### Contraction Cycle (Cardiac Cycle):

###### Phase 1: Atrial Contraction

- Atria contract, ventricles relax
- Blood pushed into ventricles
- Atrial valves open, ventricular valves closed

## **Phase 2: Ventricular Contraction**

- Ventricles contract, atria relax
- Blood pushed out of heart
- Ventricular valves open, atrial valves closed
- Left ventricle pumps to body (aorta)
- Right ventricle pumps to lungs (pulmonary artery)

### **Valve Function:**

- Prevent backflow of blood
- Ensure one-direction circulation
- Mitral and tricuspid: Atrial-ventricular
- Aortic and pulmonary: Ventricular-arterial

### **Wall Thickness:**

- Atria: Thin walls (low pressure movement)
- Ventricles: Thick muscular walls (high pressure pumping)

## **Circulation Patterns**

### **Single vs Double Circulation**

#### **Fish (Single Circulation):**

- Blood passes through heart once per cycle
- Heart: Body → Gills → Body
- Deoxygenated blood oxygenated in gills
- Less efficient, low body temperature

#### **Mammals and Birds (Double Circulation):**

- Blood passes through heart twice per cycle
- **Pulmonary Circuit:** Heart → Lungs → Heart
- **Systemic Circuit:** Heart → Body → Heart
- Highly efficient oxygen distribution
- Maintains high body temperature

#### **Amphibians and Reptiles (Intermediate):**

- Three-chambered heart (one ventricle)
- Some mixing of oxygenated and deoxygenated blood
- Lower metabolic rate than mammals/birds

## **Blood Vessels**

### **Arteries**

#### **Structure:**

- Thick, elastic muscular walls
- Narrow lumen (central channel)
- Smooth muscle layer (tunica media)

**Function:**

- Carry blood away from heart
- Withstand high pressure
- Elasticity maintains pressure between beats

**Distribution:**

- Aorta: Main artery from heart
- Branch into smaller arteries
- Further branch to arterioles
- End in capillaries

**Capillaries****Structure:**

- Microscopically small
- Walls: One cell thick (endothelial cells)
- Narrow lumen

**Function:**

- Exchange materials with tissues
- Oxygen and nutrients to tissues
- CO<sub>2</sub> and wastes from tissues
- Only blood vessel type allowing exchange

**Distribution:**

- Network in every organ and tissue
- Surround all cells

**Veins****Structure:**

- Thin walls (less elastic muscle)
- Large lumen
- Valves present

**Function:**

- Carry blood back to heart
- Low pressure circulation
- Valves prevent backflow
- Muscle contractions help blood movement

**Distribution:**

- Venules: Small veins from capillaries
- Larger veins converge toward heart
- Vena cava: Main vein to heart

## Comparative Table

<b>Feature</b>	<b>Arteries</b>	<b>Capillaries</b>	<b>Veins</b>
Wall Thickness	Thick	Very thin (1 cell)	Thin
Lumen Size	Small	Microscopic	Large
Pressure	High	Medium	Low
Elasticity	Very elastic	None	Minimal
Valves	No	No	Yes
Function	Carry away	Exchange	Return to heart

## Blood Composition and Function

**Blood = Plasma + Cells**

Plasma (55% of blood)

### Composition:

- Water: 90%
- Proteins: 7-8% (albumin, globulins, fibrinogen)
- Salts, glucose, other nutrients: 1-2%

### Functions:

- **Transport:** Food, CO<sub>2</sub>, urea, hormones
- **Buffering:** Maintains pH
- **Clotting:** Fibrinogen and other factors
- **Defense:** Antibodies (globulins)
- **Osmotic regulation:** Proteins maintain blood pressure

Red Blood Corpuscles (RBCs)

### Structure:

- Disc-shaped, biconcave
- No nucleus (mature mammalian RBCs)
- Contain hemoglobin

### Function:

- Oxygen transport (primary function)
- Hemoglobin binds O<sub>2</sub> and carries to tissues

**Production:** Bone marrow (lifespan ~120 days)

### Hemoglobin Content:

- Normal: Men ~14-15 g/dL, Women ~12-13 g/dL
- Children: Age-dependent, typically ~11-14 g/dL
- Animals: Varies by species (buffalo/cow: ~11-14 g/dL)

### **Low Hemoglobin (Anemia):**

- Reduces oxygen carrying capacity
- Fatigue and weakness
- Shortness of breath
- Pale appearance

### **White Blood Corpuscles (WBCs)**

#### **Function:**

- Defense against pathogens
- Immune response
- Remove dead cells and debris

#### **Types:**

- Neutrophils: Most abundant
- Lymphocytes: Produce antibodies
- Macrophages: Engulf pathogens
- Others: Support immune function

### **Platelets**

#### **Structure:**

- Cell fragments
- No nucleus
- Granules with clotting substances

#### **Function:**

- Blood clotting at injury sites
- Plug leaks in blood vessels
- Prevent excessive bleeding

#### **Process:**

1. Vessel damage
2. Platelets aggregate at site
3. Form clot (thrombus)
4. Prevent blood loss

### **Blood Pressure**

**Definition:** Force blood exerts against blood vessel walls

#### **Measurement:**

- Systolic (contraction): ~120 mm Hg
- Diastolic (relaxation): ~80 mm Hg
- Written as: 120/80 mmHg

#### **Gradient:**

- **Arteries:** Highest pressure

- **Capillaries:** Medium pressure
- **Veins:** Lowest pressure

### **Hypertension (High Blood Pressure):**

- 140/90 mmHg
- Caused by arteriole constriction
- Increased resistance to blood flow
- Risk: Artery rupture, internal bleeding

**Measurement:** Sphygmomanometer with stethoscope

## **Lymph and Lymphatic System**

### **Formation:**

- Some plasma escapes from capillary pores
- Forms tissue fluid (lymph)
- In intercellular spaces surrounding cells
- Similar to plasma but colorless and lower protein

### **Composition:**

- Water (main component)
- Proteins (less than plasma)
- Blood cells (lymphocytes)
- Digested materials

### **Functions:**

1. **Nutrient delivery:** To cells
2. **Waste removal:** From cells
3. **Fat transport:** Absorbed fat from intestine
4. **Immune function:** Lymphocytes provide defense

### **Circulation:**

- Tissue fluid → Lymphatic capillaries
- Lymphatic capillaries → Lymph vessels
- Lymph vessels → Lymph nodes
- Lymph nodes → Large veins (return to blood)

### **Return to Blood:**

- Lymph eventually enters larger veins
  - Thoracic duct: Main lymphatic vessel
  - Merges with superior vena cava
  - Re-enters blood circulation
-

## 4.3 TRANSPORTATION IN PLANTS

### Plant vs Animal Transport

#### Differences:

- **Plants:** No circulatory pump (no heart)
- **Plants:** Passive and semi-active mechanisms
- **Plants:** Two separate transport systems (xylem and phloem)
- **Plants:** Slower transport (suited to stationary lifestyle)

### Xylem Transport (Water and Minerals)

**Function:** Transport water and mineral ions from roots to leaves

#### Structure:

- Vessels and tracheids (tube-like cells)
- Interconnected system throughout plant
- Forms continuous water-conducting channels

#### Path:

Soil → Root Hairs → Root Xylem → Stem Xylem → Leaf Xylem

### Mechanism of Water Transport

#### Root Absorption

#### Process:

1. Root cells actively uptake mineral ions from soil
2. Creates concentration difference (osmotic gradient)
3. Water enters root by osmosis
4. Builds root pressure

#### Root Pressure:

- Water pushed upward into xylem
- Creates positive pressure
- Evident when plant "bleeds" sap
- More important at night (no transpiration)

### Transpiration Pull (Major Mechanism)

#### Process:

1. Water evaporates from leaf cells into intercellular spaces
2. Water vapor escapes through stomata
3. Water column in xylem pulled upward
4. Creates suction from leaves to roots

#### Why Effective:

- Water molecules cohesive (stick together)

- Adhesive to xylem walls
- Creates unbroken water column
- Pulls water upward against gravity

**Advantages:**

- Operates even at heights (tall trees)
- No energy cost to plant (passive process)
- Continuous upward movement
- More important during day (stomata open, transpiration high)

**Two Mechanisms Working Together**

**Day (Photosynthesis, Stomata Open):**

- Transpiration pull: Primary mechanism
- Root pressure: Supplementary
- Maximum water movement
- High transpiration rate

**Night (No Photosynthesis, Stomata Closed):**

- Root pressure: Primary mechanism
- Transpiration pull: Absent
- Slower water movement
- Lower transpiration rate

**Transpiration: Water Loss and Regulation**

**Definition:** Loss of water vapor from aerial parts of plant (leaves, stems)

**Purposes:**

1. Pulls water and minerals from roots
2. Cools plant (evaporation releases heat)
3. Supports photosynthesis (open stomata)

**Factors Affecting Transpiration:**

- Temperature: Higher → more transpiration
- Humidity: Lower → more transpiration
- Light: Open stomata → more transpiration
- Wind: Removes humid air → more transpiration

**Plant Adaptation:**

- Stomata close at night (reduce water loss)
- Stomata close in drought (emergency response)
- Waxy cuticle on leaves (reduces direct evaporation)
- Some plants: Leaf hairs reduce air movement

## Phloem Transport (Food and Other Substances)

**Function:** Transport products of photosynthesis from leaves to other parts

**Process Name:** Translocation

### Materials Transported:

- Sucrose (main transport sugar)
- Amino acids
- Minerals
- Hormones
- Vitamins

### Path:

Leaves (source) → Phloem → Roots/Seeds/Growing Tips (sink)

## Mechanism of Phloem Transport

### Active Process:

#### Step 1: Loading (in Leaf)

1. Sucrose produced in photosynthesis
2. ATP energy used to transfer sucrose into phloem
3. Increases osmotic pressure in phloem tissue

#### Step 2: Water Entry

1. Water enters phloem by osmosis
2. Increases turgor pressure
3. Creates positive pressure

#### Step 3: Transport

1. Material moves from high pressure (leaves) to low pressure (roots/seeds)
2. Sieve tubes transport material
3. Companion cells assist with energy

#### Step 4: Unloading (in Root/Seed)

1. Material leaves phloem
2. Pressure decreases
3. Water exits by osmosis

### Why Energy Needed:

- Material moves against concentration gradient (low to high in root)
- Active transport mechanism
- ATP provides energy
- Bidirectional (up or down depending on plant needs)

### Flexibility:

- Spring: Sugar stored in roots moves to growing buds
- Summer: Sugar from leaves to developing fruits
- Fall: Sugar from leaves to root storage

### Comparison: Xylem vs Phloem

Feature	Xylem	Phloem
Material Transported	Water, minerals	Sugars, amino acids
Direction	Upward (roots to leaves)	Bidirectional (both ways)
Mechanism	Passive (transpiration pull)	Active (ATP energy)
Energy Requirement	No	Yes
Cell Type	Dead (vessels, tracheids)	Living (sieve tubes)
Companion Cells	None	Present (assist)

## 5. EXCRETION

### 5.1 Definition and Overview

**Excretion:** Biological process of removing harmful metabolic waste products from the body

#### Difference from Digestion:

- **Digestion:** Breaking down food into absorbable nutrients
- **Excretion:** Removing metabolic waste (byproducts of cellular activity)

#### Waste Types:

##### 1. Gaseous Wastes:

- CO<sub>2</sub> from respiration
- O<sub>2</sub> from photosynthesis (plants)
- Removed by respiratory system

##### 2. Nitrogenous Wastes:

- Urea, uric acid (protein breakdown)
- Removed by excretory system (kidneys)

##### 3. Other Wastes:

- Water excess
- Minerals excess
- Byproducts of metabolic reactions

## 5.2 EXCRETION IN HUMAN BEINGS

### Excretory System Components

#### Organs:

- **Kidneys:** 2 (one on each side of backbone)
- **Ureters:** 2 (tubes from kidneys to bladder)
- **Urinary Bladder:** Storage organ
- **Urethra:** Tube for urine release

#### Accessory Organs:

- Skin: Sweat glands (minor excretion)
- Lungs: CO<sub>2</sub> and water vapor (respiratory excretion)

### Kidney Function

**Location:** Abdomen, on either side of vertebral column

**Function:** Filtration of blood to remove nitrogenous wastes

#### Process:

1. Blood enters kidney through renal artery
2. Filtration in nephrons
3. Urine formation
4. Urine passes through ureter
5. Storage in bladder
6. Release through urethra

### Nephron Structure and Function

**Nephron:** Basic functional unit of kidney (thousand of nephrons per kidney)

#### Components:

1. Bowman's Capsule (Cup-shaped)

#### Structure:

- Double-walled cup
- Surrounds glomerulus
- Epithelial cells form filtration barrier

#### Function:

- Collects filtrate from blood
- Initial filtration site

## 2. Glomerulus

### Structure:

- Network of capillaries from renal artery
- Thin-walled vessels
- High filtration pressure

### Function:

- First site of filtration
- Small molecules filtered out
- Blood cells and large proteins retained

## 3. Proximal Convoluted Tubule

### Structure:

- Coiled tube connected to Bowman's capsule
- Cuboidal epithelium with microvilli
- Many mitochondria (energy-requiring)

### Function:

- Selective reabsorption
- Glucose, amino acids, salts, water reabsorbed
- Back into blood capillaries

## 4. Loop of Henle

### Structure:

- Hairpin-shaped loop
- Descending limb: Thin walls
- Ascending limb: Thick walls

### Function:

- Water reabsorption (descending)
- Salt reabsorption (ascending)
- Concentration of urine

## 5. Distal Convoluted Tubule

### Structure:

- Coiled tube
- Cuboidal epithelium

### Function:

- Fine-tuning of reabsorption
- Adjusts water and salt based on body needs
- Hormonal control (ADH, aldosterone)

## 6. Collecting Duct

### Structure:

- Straight tubular structure
- Collects urine from many tubules

### Function:

- Final urine concentration
- Water reabsorption (ADH-controlled)
- Conducts urine to ureter

## Urine Formation Process

### Step 1: Glomerular Filtration (in Bowman's Capsule)

#### Process:

- Blood enters glomerulus under high pressure
- Small molecules forced through capillary wall
- Water, glucose, amino acids, salts, urea filtered
- Blood cells and large proteins remain in blood

**Filtrate Composition:** Similar to blood plasma but lacks proteins and blood cells

**Filtration Rate:** ~180 L daily

**Important:** All useful substances filtered at this stage

### Step 2: Selective Reabsorption (in Tubule)

**Location:** Proximal convoluted tubule mainly

#### Process:

- Useful substances actively reabsorbed
- Glucose: 100% reabsorbed (needed for energy)
- Amino acids: 100% reabsorbed (needed for proteins)
- Salts: Selectively reabsorbed (body needs regulated)
- Water: Amount depends on body water status

#### Mechanism:

- Active transport (uses ATP, mitochondria abundant)
- Selective, not all filtered substances reabsorbed
- Urea: Some reabsorbed, most remains

#### Reabsorption Sites:

- Proximal convoluted tubule: Glucose, amino acids, water, salts
- Loop of Henle: Water, salt
- Distal convoluted tubule: Water, salt (hormonal control)
- Collecting duct: Water (hormonal control)

### Step 3: Urine Composition

### **Final Urine:**

- Urea: Main waste product
- Uric acid: Purine metabolism waste
- Water: Excess water
- Salts: Excess salts
- Other metabolic wastes

**Volume:** 1-2 L daily (not 180 L filtered)

**Remaining Filtrate:** ~178 L reabsorbed (99% efficient recovery)

### **Urine Storage and Release**

#### **Urinary Bladder:**

- Muscular storage organ
- Capacity: ~400-600 mL
- Under nervous control

#### **Urethra:**

- Tube for urine release
- Sphincter muscle (anal sphincter)
- **Voluntary control possible** (unlike most animals)

#### **Micturition (Urination):**

- Bladder fills to pressure threshold
- Sensory signals to brain
- Voluntary relaxation of sphincter
- Urine released

### **Hormonal Control of Urine Production**

#### **ADH (Antidiuretic Hormone):**

- Released by pituitary gland
- Response to water deficit
- Increases water reabsorption
- Produces concentrated urine (less volume)

#### **Aldosterone:**

- Released by adrenal gland
- Controls salt reabsorption
- Affects water reabsorption (secondary)
- Maintains blood pressure and osmotic balance

#### **Effect of Dehydration:**

1. Blood osmotic pressure increases
2. ADH release increases
3. Water reabsorption increases
4. Urine becomes concentrated (dark color)

5. Water retention in body

**Effect of Excess Water Intake:**

1. Blood osmotic pressure decreases
2. ADH release decreases
3. Water reabsorption decreases
4. Urine becomes dilute (pale color)
5. Excess water excreted

**Artificial Kidney (Hemodialysis)**

**Need:** Kidney failure, disease, or injury

**Device:** Tubes with semi-permeable membranes

**Process:**

1. Blood from artery enters tubing
2. Dialysing fluid surrounds tubes
3. Wastes diffuse from blood to fluid
4. Purified blood returned to vein
5. Repeat 3-4 times weekly, 4 hours per session

**Difference from Natural Kidney:**

- No selective reabsorption
- Cannot concentrate urine as effectively
- Cannot regulate electrolytes as precisely
- Requires frequent treatment

**Success Rate:** Extends life significantly, though quality less than natural kidney

**Organ Donation and Transplantation**

**Benefits:**

- Can save life
- Better quality of life than dialysis
- More natural kidney function restoration

**Sources:**

- Deceased donor (most common)
- Living donor (related or unrelated)
- Some organs viable: Kidneys, partial liver, parts of lung

**Success Factors:**

- Tissue type matching
  - Immunosuppressive drugs prevent rejection
  - Early post-transplant care crucial
-

## 5.3 EXCRETION IN PLANTS

### Plant Excretion Strategies

#### Differences from Animals:

- No specialized excretory organs
- No kidney-like structures
- Multiple strategies for waste removal

### Methods of Plant Excretion

#### 1. Gaseous Waste Removal

##### Oxygen (from Photosynthesis):

- Released through stomata
- Diffuses out of leaves

##### Carbon Dioxide (from Respiration):

- Released through stomata
- Also used in photosynthesis

**Process:** Simple diffusion through stomata and intercellular spaces

#### 2. Water Removal: Transpiration

##### Mechanism:

- Excess water evaporated from leaves
- Released as water vapor through stomata
- Cooling effect for plant
- Cannot control as precisely as kidneys

#### 3. Storage in Vacuoles

##### Process:

- Waste products stored in cell vacuoles
- Prevents interference with cellular activities
- Isolates harmful substances

#### 4. Storage as Resins and Gums

**Location:** Old xylem tissue

##### Function:

- Accumulate toxic substances
- Prevent movement to active parts
- Eventually dead tissue discarded

#### 5. Leaf Abscission (Leaf Fall)

**Mechanism:**

- Waste products accumulate in leaves
- Leaves become less efficient
- Plant drops leaves seasonally
- Waste removed with leaves

**Advantages:**

- Removes accumulated waste
- Reduces water loss in winter
- Prepares for dormancy

**6. Root Excretion into Soil****Process:**

- Some waste substances excreted into surrounding soil
- Diffusion from root cells
- Organic acids and other compounds

**Ecological Effect:**

- Can acidify soil
- Affects soil microorganisms
- Influences plant-soil interactions

**Why Plants Don't Need Kidneys**

1. **Sessile Lifestyle:** Don't move, lower metabolic demands
2. **Asynchronous Metabolism:** Can store and process at own pace
3. **Dead Cell Tissues:** Can afford to lose tissues containing wastes
4. **Diffusion System:** All cells in contact with environment or vascular system
5. **Continuous Growth:** New tissues replace old ones

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**6. INTEGRATED LIFE PROCESSES****How Life Processes Work Together**

**Nutrition** → **Respiration** → **Energy Production** ↓

↓ (Use for)

**Transportation** (of nutrients, O<sub>2</sub>, CO<sub>2</sub>) → **Cellular Activities**

↓ (Produce)

**Excretion** (of CO<sub>2</sub>, urea, water, excess salts)

## Energy Flow in Organisms

1. **Intake:** Nutrition brings food (chemical energy)
2. **Conversion:** Respiration breaks down food, releases energy
3. **Utilization:** Energy used for:
  - Growth
  - Movement
  - Maintenance
  - Reproduction
  - Defense
4. **Transport:** Circulatory system distributes nutrients and oxygen
5. **Waste Management:** Excretory system removes byproducts

## Homeostasis Maintenance

**Definition:** Maintaining stable internal environment despite external changes

### Role of Each Process:

- **Nutrition:** Provides raw materials
- **Respiration:** Provides energy
- **Transportation:** Delivers needed materials, removes wastes
- **Excretion:** Removes harmful byproducts
- **Together:** Maintain optimal conditions for life

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## 7. KEY TERMS AND DEFINITIONS

### Nutrition Terms

- **Autotrophs:** Organisms making their own food (plants, some bacteria)
- **Heterotrophs:** Organisms depending on other organisms for food (animals, fungi)
- **Photosynthesis:** Process of making food using sunlight
- **Chlorophyll:** Green pigment absorbing light energy
- **Stomata:** Pores on leaves for gas exchange
- **Guard Cells:** Control stomatal opening and closing
- **Carbohydrates:** Sugars and starches made in photosynthesis
- **Glycogen:** Storage carbohydrate in animals

### Digestion Terms

- **Enzyme:** Biological catalyst speeding chemical reactions
- **Saliva:** Fluid containing salivary amylase
- **Salivary Amylase:** Enzyme breaking starch to maltose
- **Pepsin:** Enzyme digesting proteins in stomach
- **Trypsin:** Enzyme digesting proteins in small intestine
- **Lipase:** Enzyme digesting fats
- **Bile:** Liquid emulsifying fats
- **Villi:** Finger-like projections in small intestine for absorption

- **Peristalsis:** Rhythmic muscular contractions moving food

## Respiration Terms

- **Respiration:** Breakdown of glucose releasing energy
- **Aerobic Respiration:** Using oxygen for energy production
- **Anaerobic Respiration:** Energy production without oxygen
- **Pyruvate:** Three-carbon molecule from glucose breakdown
- **ATP:** Adenosine triphosphate (energy currency)
- **Fermentation:** Anaerobic respiration producing ethanol or lactic acid
- **Glycolysis:** Breaking glucose into pyruvate
- **Krebs Cycle:** Series of reactions oxidizing pyruvate

## Respiratory System Terms

- **Alveoli:** Tiny air sacs in lungs where gas exchange occurs
- **Diaphragm:** Muscle controlling breathing
- **Hemoglobin:** Protein carrying oxygen in RBCs
- **Inspiration:** Breathing in
- **Expiration:** Breathing out
- **Trachea:** Windpipe
- **Bronchi:** Main air passages in lungs
- **Cilia:** Hair-like structures in respiratory tract

## Circulation Terms

- **Atrium:** Upper heart chamber
- **Ventricle:** Lower heart chamber
- **Artery:** Vessel carrying blood away from heart
- **Vein:** Vessel carrying blood to heart
- **Capillary:** Tiny vessel where exchange occurs
- **Plasma:** Liquid part of blood
- **RBC:** Red blood corpuscle (oxygen carrier)
- **Hemoglobin:** Iron-protein in RBCs
- **Platelet:** Cell fragment for clotting
- **Lymph:** Tissue fluid in lymphatic system
- **Double Circulation:** Blood passing through heart twice per cycle

## Plant Transport Terms

- **Xylem:** Tissue transporting water and minerals
- **Phloem:** Tissue transporting food (sucrose)
- **Transpiration:** Water loss from leaves
- **Root Pressure:** Pressure from root absorption
- **Translocation:** Movement of food in phloem
- **Sieve Tubes:** Phloem transport cells
- **Companion Cells:** Support cells in phloem

## Excretion Terms

- **Excretion:** Removal of metabolic waste
  - **Urea:** Nitrogenous waste from protein breakdown
  - **Uric Acid:** Nitrogenous waste from nucleic acid breakdown
  - **Nephron:** Functional unit of kidney
  - **Glomerulus:** Capillary network in kidney
  - **Bowman's Capsule:** Cup collecting filtrate
  - **Reabsorption:** Returning useful substances to blood
  - **ADH:** Antidiuretic hormone controlling water reabsorption
  - **Dialysis:** Artificial kidney filtration process
- 

## 8. EXAM-ORIENTED QUESTION PATTERNS

### Definition Questions (2-3 marks)

**Example 1:** "Define photosynthesis and write the equation."

**Example 2:** "What is respiration? Distinguish between aerobic and anaerobic."

**Example 3:** "Define transpiration and explain its importance."

### Process/Mechanism Questions (3-5 marks)

**Example 1:** "Describe the process of digestion in the small intestine."

**Example 2:** "Explain how oxygen is transported from lungs to tissues."

**Example 3:** "How does water move from roots to leaves in plants?"

### Structure-Function Questions (3-4 marks)

**Example 1:** "How is the small intestine designed for absorption?"

**Example 2:** "Explain how alveoli are adapted for gas exchange."

**Example 3:** "Describe the structure of a nephron and its functions."

### Comparison Questions (3-4 marks)

**Example 1:** "Compare autotrophic and heterotrophic nutrition."

**Example 2:** "Distinguish between xylem and phloem transport."

**Example 3:** "Compare arteries and veins."

### Application Questions (4-5 marks)

**Example 1:** "How do life processes work together to maintain life?"

**Example 2:** "Explain why transportation systems are necessary in multicellular organisms."

**Example 3:** "How is blood pressure related to cardiovascular health?"

### Diagram-Based Questions (2-3 marks)

**Example 1:** "Label the parts of a nephron and explain their functions."

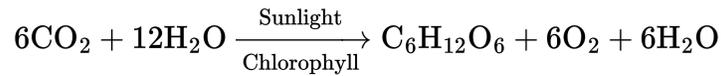
**Example 2:** "Draw and label a cross-section of a leaf showing photosynthesis."

**Example 3:** "Diagram the path of blood through the heart."

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## 9. IMPORTANT CHEMICAL EQUATIONS

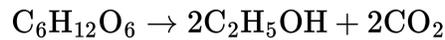
### Photosynthesis



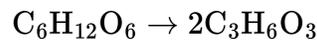
### Aerobic Respiration



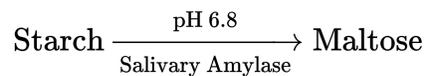
### Anaerobic Respiration (Alcoholic Fermentation)



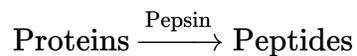
### Anaerobic Respiration (Lactic Acid)



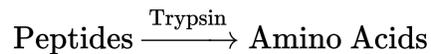
### Starch Digestion



### Protein Digestion (Stomach)



### Protein Digestion (Small Intestine)



### Fat Digestion



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## 10. SUMMARY OF KEY CONCEPTS

### Life Processes Checklist

- ✓ **Nutrition:** Intake of food for energy and growth
  - Autotrophic: Plants using photosynthesis
  - Heterotrophic: Animals using ingestion
- ✓ **Digestion:** Breaking food into absorbable nutrients
  - Mechanical: Teeth and muscular action
  - Chemical: Enzymes breaking bonds
- ✓ **Respiration:** Breaking down food for energy

- Aerobic: Using oxygen, high energy yield
  - Anaerobic: Without oxygen, low energy yield
- ✓ **Transportation:** Moving materials within body
- Animals: Circulatory system with heart
  - Plants: Xylem (water) and phloem (food)
- ✓ **Excretion:** Removing metabolic waste
- Gases: Through lungs and stomata
  - Liquid: Through kidneys and skin
- ✓ **Growth:** Building new tissues using nutrients
- ✓ **Movement:** Using energy from respiration
- ✓ **Reproduction:** Creating new individuals

## Organ-Specific Summary

### Heart:

- Pumping organ
- Four chambers: 2 atria, 2 ventricles
- Separates oxygenated and deoxygenated blood
- Rate: 60-100 beats per minute

### Lungs:

- Site of gas exchange
- 300 million alveoli
- Surface area: ~80 m<sup>2</sup>
- Exchange: O<sub>2</sub> in, CO<sub>2</sub> out

### Kidneys:

- Filter blood
- 1-2 million nephrons per kidney
- Produce 1-2 L urine daily
- Filter 180 L daily

### Small Intestine:

- Absorption site
  - Length: 6-7 meters
  - Surface area: Villi increase absorption
  - Complete digestion occurs
-

# 11. PRACTICE QUESTIONS

## Very Short Answer (1-2 marks)

1. Name the process by which plants prepare their own food.
2. What is the main function of saliva?
3. Which enzyme digests proteins in the stomach?
4. What is the normal blood pressure range?
5. Name the basic functional unit of kidney.
6. What is transpiration?
7. Define excretion.
8. How many chambers does a human heart have?
9. What is hemoglobin?
10. Name two nitrogenous wastes in human body.

## Short Answer (2-3 marks)

1. Explain why nutrition is essential for living organisms.
2. Describe the path of food from mouth to anus.
3. Compare aerobic and anaerobic respiration.
4. How are alveoli adapted for gas exchange?
5. Explain the role of transpiration in plants.
6. Why is separation of oxygenated and deoxygenated blood important?
7. Describe the filtration process in nephrons.
8. How do guard cells control stomatal opening?
9. Explain the role of bile in fat digestion.
10. Why is blood pressure important?

## Long Answer (4-5 marks)

1. Describe the complete process of nutrition in human beings. (Include all stages of digestion)
2. Explain how water is transported from roots to leaves in plants.
3. Describe the structure and function of the circulatory system in human beings.
4. How is urine formed? Explain the role of each part of the nephron.
5. Compare transportation in plants and animals.
6. Describe how oxygen is absorbed and utilized in human body.
7. Explain the relationship between respiration and photosynthesis.
8. How do life processes work together to maintain life?

## Diagram-Based Questions

1. Draw and label a cross-section of a leaf showing photosynthesis.
2. Draw the structure of a human heart and label its parts. Explain blood flow through it.
3. Draw a nephron and explain each part's function.
4. Show the path of food through the alimentary canal with labels.
5. Diagram the gas exchange process in alveoli.

## **Exam-Oriented Comprehensive Study Notes**