

Levels of Organization



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التواصل الاجتماعي بحسب الصف السابع



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Workbook Unit 2: How do you get energy from movement?

1

How do you get energy from movement?

2

What jobs do robots do? - Workbook Unit 2

3

What jobs do robots do?

4

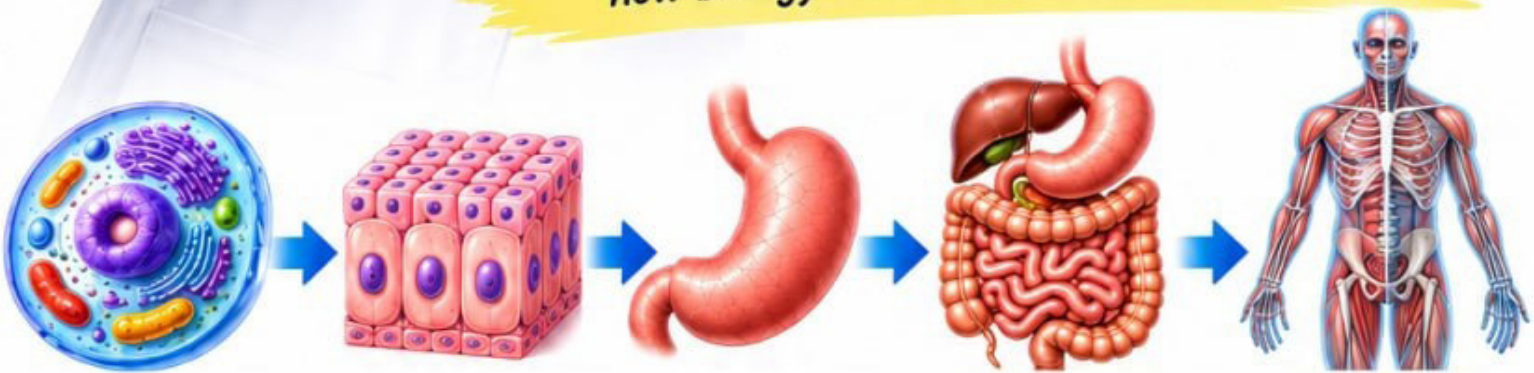
How do robots work?

5

LESSON 1

LEVELS OF ORGANIZATION

*From single cells to a complete, living organism —
how biology is built, one level at a time.*



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Key Concepts

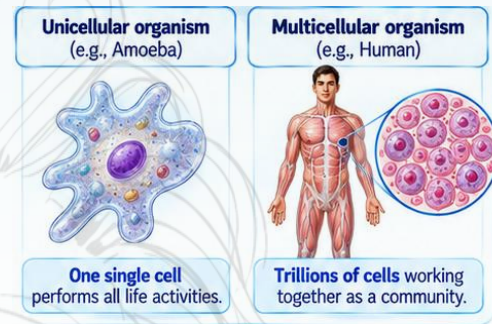
1.1 The Cellular Foundation of Life

All living things are composed of **cells**.

Unicellular organisms carry out all life activities inside one single cell.

Multicellular organisms are made of trillions of cells working as a coordinated community.

The human body is estimated to contain approximately **37.2 trillion cells**.

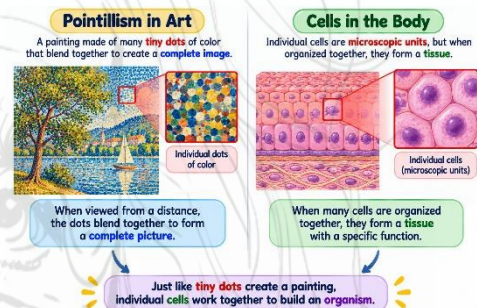


Unicellular vs. multicellular organisms

1.2 The Pointillism Phenomenon & Analogy

In art, **pointillism** is a painting technique in which distinct, tiny dots of color blend together when viewed as a whole to create an image.

In biology, individual **cells** act like those tiny dots:



A pointillism painting, up close and from a distance

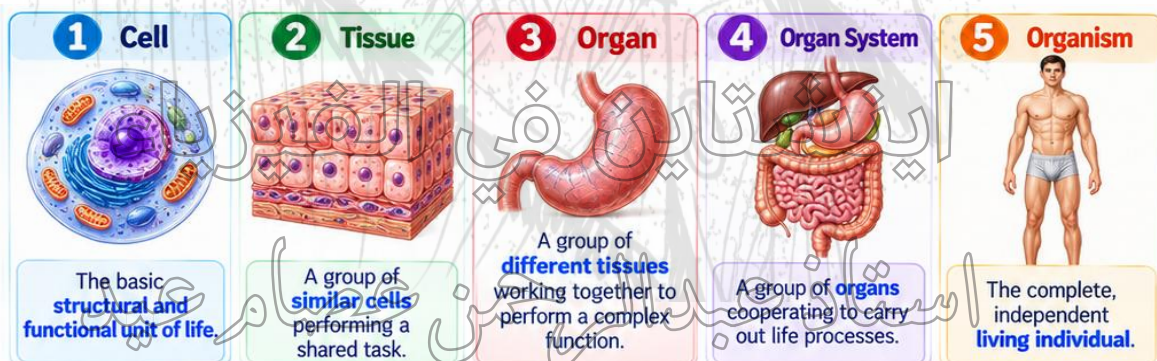
Cells → Tissues → Organs → Organ Systems → Organism

Individually, cells are microscopic units. When organized together, they form **tissues**, **organs**, and **organ systems**, eventually producing a complete, functioning **organism**.

1.3 The Five Levels of Organization

Living things are structured in an organized hierarchy:

Level	Description
1. Cell	The basic structural and functional unit of life.
2. Tissue	A group of similar cells performing a shared task.
3. Organ	A group of different tissues working together to perform a complex function.
4. Organ System	A group of organs cooperating to carry out life processes.
5. Organism	The complete, independent living individual.



The five levels of organization, illustrated with the human skeletal example

LESSON 1 Levels of Organization

Explanation

2.1 How Cells Are Organized in the Body

An organism can be:

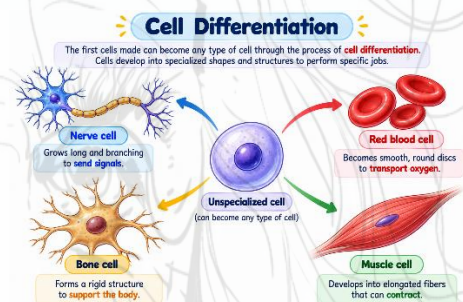
- **Unicellular** → made of one cell.
- **Multicellular** → made of many cells.

In a multicellular organism, growth occurs because cells divide to produce new cells.

The earliest cells produced are identical and unspecialized. Through **cell differentiation**, these cells transform into specialized forms that perform distinct tasks.

Examples of Cell Specialization

- **Nerve cells** → grow long extensions to transmit signals.
- **Red blood cells** → become smooth, round discs to transport oxygen through blood vessels.
- **Bone cells** → form a rigid framework to support the body.
- **Muscle cells** → develop into fibers capable of shortening and contracting.



Cell differentiation: unspecialized cells become specialized

As the cell population increases, similar specialized cells join together to form functional groups called **tissues**.

Key Idea — Structure reflects function. The shape and structure of a specialized cell allow it to perform its specific function.

2.2 How Tissues Are Organized in Animals and Plants

A. Animal Tissues — 4 Main Types

Tissue	Main Function	Example
Muscle Tissue	Generates force and enables movement.	Stomach wall, heart, skeletal muscles
Connective Tissue	Provides structural support and holds internal parts together.	Bone, fat, blood
Nervous Tissue	Transmits nerve impulses and information.	Brain, spinal cord
Epithelial Tissue	Provides protection and forms inner linings.	Skin, stomach lining

Muscle tissue — in the stomach, layers of muscle tissue contract to churn and break down food mechanically.

Connective tissue examples: **bone tissue** forms the skeleton, **fat tissue** stores energy and provides cushioning, and **blood** functions as a connective tissue.

Nervous tissue transmits information through nerve impulses, helping the body sense conditions such as fullness, pain, and temperature.

Epithelial tissue forms a protective barrier: it forms the outer surface of the skin, lines internal organs such as the stomach, and lines major body cavities.

B. Plant Tissues — 3 Main Types

Tissue	Location	Primary Function
Dermal Tissue	Outer surface of leaves, stems, roots	Protection and prevention of water loss
Vascular Tissue	Veins, stems, roots	Transport of water, minerals, and food
Ground Tissue	Interior of leaves, stems, roots	Storage, support, photosynthesis

Dermal tissue acts like the plant's skin: it covers the outer surfaces of stems, roots, and leaves, protecting against injury and preventing water loss.

Vascular tissue functions like a plumbing network, containing internal tubes (xylem and phloem) that transport water, minerals, and dissolved sugars throughout the plant.

Ground tissue forms much of the functional bulk of the plant, providing internal support, storage of starches and water, and — through its chloroplasts — photosynthesis.

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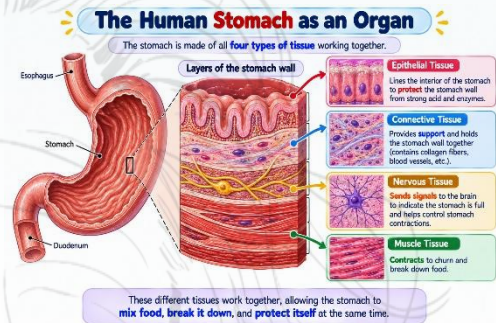
2.3 How Tissues Form Organs

Complex biological tasks require more than one type of tissue. **Different tissues** combine their functions to form an **organ**.

Example 1: The Human Stomach

The stomach is an organ because several different tissues work together:

- **Muscle tissue** contracts rhythmically to churn and grind food.
- **Epithelial tissue** lines the interior and secretes protective fluids.
- **Nervous tissue** detects stomach stretching and signals the brain that the stomach is full.
- **Connective tissue** binds the layers and provides structural strength.



The stomach: four tissues working as one organ

Why is the stomach an organ? Because **different tissues work together** to perform the complex function of digestion.

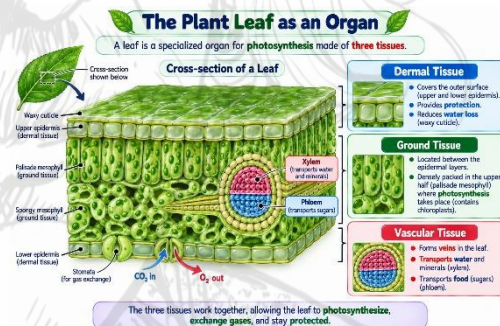
Example 2: The Plant Leaf

A leaf is a specialized plant organ dedicated to **photosynthesis**.

Dermal tissue forms the upper and lower protective surfaces.

Ground tissue captures sunlight and manufactures glucose.

Vascular tissue delivers water and transports manufactured food.



Leaf cross-section: three tissues, one organ

Key Idea — A leaf is an **organ**, not simply a tissue, because it contains different tissue types working together.

2.4 How Organs Form Organ Systems

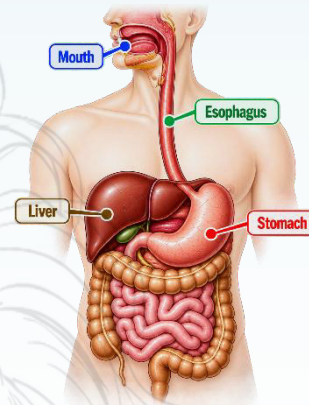
Individual organs cannot keep an organism alive on their own. Different organs combine to form **organ systems** that perform extensive tasks.

A. Human Organ Systems

The **digestive system** includes:

Mouth → Esophagus → Stomach → Small Intestine → Large Intestine

along with organs such as the **liver**. Main functions: ingestion, digestion, absorption, and waste elimination.



The human digestive system

Other essential human systems include the **circulatory system** (transports oxygen, nutrients, and waste products), **respiratory system** (supplies oxygen, removes carbon dioxide), **skeletal system** (structure and support), **muscular system** (movement), and **nervous system** (controls body functions and responds to the environment).

B. Plant Organ Systems



*The shoot system (above ground)
and root system (underground)*

Plants operate through two major organ systems:

- **Shoot System** (leaves, stems, flowers) — captures sunlight, performs photosynthesis, transports water and food, and participates in reproduction.
- **Root System** (located mainly underground) — anchors the plant in the soil, absorbs water, and absorbs dissolved minerals.

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LESSON 1 Levels of Organization

2.5 How Organ Systems Interact in an Organism

The organism is the highest level of biological organization. In multicellular organisms, **organ systems are interdependent** — each system depends on other systems to survive and function properly.

Plant Interdependence

Leaf cells require water for photosynthesis, but leaves cannot absorb ground water directly. The process:

Root System → Vascular Tissue → Shoot System → Leaf

Root System **absorbs water from the soil** → Vascular Tissue **transports water upward** → Shoot System **delivers water to the leaves** → Leaf **performs photosynthesis**. Manufactured food is then transported to other parts of the plant.

Animal Interdependence

Stomach muscle cells require continuous oxygen to produce energy and contract, but the stomach cannot obtain oxygen from the air by itself. Therefore:

Respiratory System → Circulatory System → Stomach Tissues

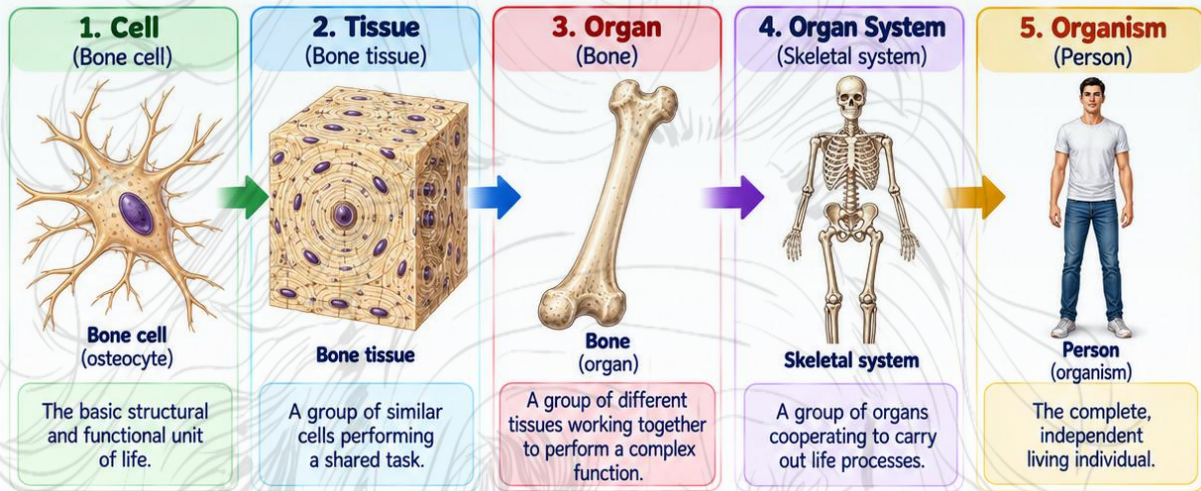
Respiratory System **takes in oxygen** → Circulatory System **transports oxygen through the blood** → Stomach Tissues **receive oxygen** for cellular activities.

Key Idea — Organ systems work together to sustain the entire organism.

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Processes & Mechanisms

Five Levels of Biological Organization — Human Skeletal Example



Bone cell → bone tissue → bone (organ) → skeletal system → person (organism)

Level	Skeletal Example	Description
Cell	Bone cell	Specialized cell
Tissue	Bone tissue	Group of similar cells
Organ	Bone	Different tissues (e.g. bone, connective) working together
Organ System	Skeletal system	Many bones working together
Organism	Human body	Complete human body

Modeling Lab Process

Students model biological organization using everyday materials.

Model	Represents
Macaroni	Individual cells
Dot on macaroni	Nucleus
Glued macaroni group	Tissue
Joining cards A + B (stomach + liver)	Organ (digestive system's organ)
Joining cards E + F	Organ System
Final connected model G	Complete Organism

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LESSON 1 Levels of Organization

Bone Marrow Transplantation Mechanism

A real-life example of how tissues can be replaced to save lives:

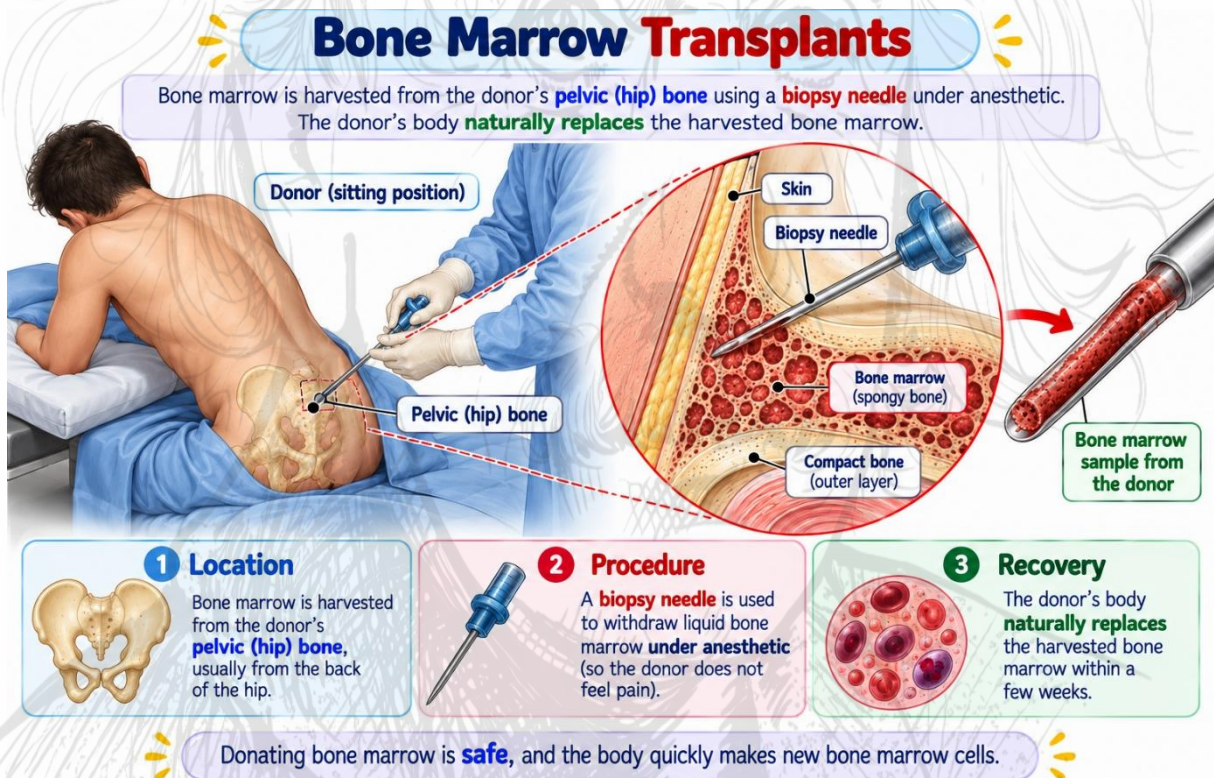
Step 1 — Conditioning: The patient receives medical treatment to destroy unhealthy or defective bone marrow.

Step 2 — Harvesting: Healthy bone marrow is extracted from a donor's pelvic (hip) bone.

Step 3 — Compatibility Matching: The donor's marrow is tested for genetic compatibility to reduce the risk of rejection.

Step 4 — Transfusion: The donated marrow is infused into the recipient's bloodstream.

Step 5 — Engraftment & Differentiation: The new marrow migrates to the bone cavities, settles, and begins producing healthy red blood cells, white blood cells, and platelets.



Bone marrow is harvested from the donor's pelvic (hip) bone and naturally regenerates

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Comparison Tables

Table 1: Four Animal Tissues

Tissue Type	Key Structure / Characteristics	Primary Function	Example
Muscle Tissue	Elongated, contractile cells	Movement through contraction	Stomach wall, heart
Connective Tissue	Cells surrounded by an extracellular matrix	Support and structure	Bone, fat, blood
Nervous Tissue	Branching neurons and supporting cells	Transmits electrical messages	Brain, spinal cord
Epithelial Tissue	Sheets of tightly packed cells	Protection and lining	Skin, stomach lining

Table 2: Three Plant Tissues

Tissue Type	Location	Primary Function	Functional Equivalent
Dermal Tissue	Outer surface of leaves, stems, roots	Protection and prevention of water loss	Epithelial tissue
Vascular Tissue	Veins, stems, roots	Transport of water, minerals, and food	Blood vessels
Ground Tissue	Interior of leaves, stems, roots	Storage, support, photosynthesis	Connective / organ tissues

Table 3: Plant Organ Systems

System	Main Organs	Primary Functions
Shoot System	Leaves, stems, flowers	Photosynthesis, reproduction, transport
Root System	Taproots, lateral roots, root hairs	Anchoring, water absorption, mineral absorption

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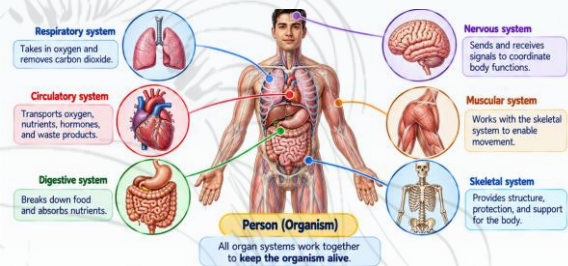
LESSON 1 Levels of Organization

Important Notes

1. Scale & Quantity — The human body contains an estimated **37.2 trillion cells**, demonstrating the enormous division of labor required for complex life.

2. Strict Hierarchy — The correct order is: **Cell → Tissue → Organ → Organ System → Organism**

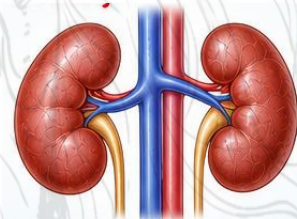
3. Functional Unity — No individual organ or organ system works in complete isolation — all systems work together to keep the organism alive.



All organ systems work together

4. Multi-Tissue Rule — An **organ** is formed when different tissue types work together to perform a complex function.

5. Living Donation — Humans possess **two kidneys**, and a living donor can donate **one kidney**. A person can live a healthy life with one kidney.



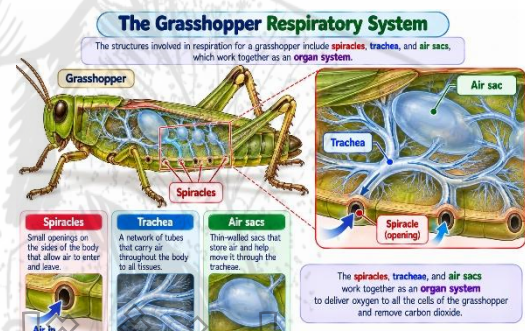
A person can live a healthy life with one kidney

6. Dialysis — **Dialysis** artificially removes wastes and toxins from the blood when the kidneys fail, helping maintain the body's internal balance.



Dialysis removes wastes when kidneys cannot function

7. Invertebrate Systems — Organ systems are not exclusive to humans or mammals. A **grasshopper's respiratory system** contains: **Spiracles → Tracheae → Air sacs**



The grasshopper respiratory system

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Scientific Case Studies

Case Study 1: Multi-Tissue Architecture of the Stomach

Context: Digestion requires both chemical and mechanical actions.

- **Epithelial tissue** → forms a protective barrier against acidic gastric juices.
- **Muscle tissue** → contracts to churn food.
- **Nervous tissue** → monitors stomach expansion and signals the brain.
- **Connective tissue** → provides the structural framework.

Conclusion — The stomach is an **organ** because four different tissues collaborate to perform digestion.

Case Study 2: System Interdependence in Plant Survival

Observation: Green leaves produce sugar through photosynthesis, but photosynthesis requires water (H_2O). **The Problem:** the leaf's dermal tissue is water-resistant and cannot absorb soil moisture.

Cooperative Solution

Root System: absorbs water from the soil.

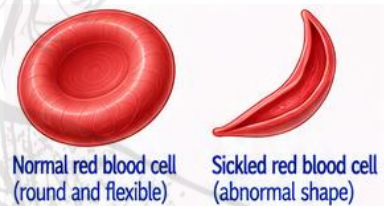
Vascular Tissue: transports water upward through the stem.

Ground Tissue of Leaf: performs photosynthesis.

Result: manufactured food is distributed to other parts of the plant.

Case Study 3: Blood Disorders and Whole-Body Impact

Observation: diseases such as leukemia or sickle cell anemia can damage blood cells.



Normal (round, flexible) vs. sickled (abnormal shape) red blood cell

Cascading Effect

Step 1: Abnormal / deficient red blood cells.

Step 2: Reduced oxygen transport.

Step 3: Body tissues become oxygen-deprived.

Step 4: Organs such as the heart, brain, and kidneys may be affected.

Step 5: The entire organism can be endangered.

Key Idea — A problem at the **cellular level** can affect the entire **organism**.

LESSON 1 Levels of Organization

Graphs & Diagrams Explained

1. Cellular Differentiation Tree

The diagram shows an early unspecialized cell developing into different specialized cells: nerve cell, red blood cell, bone cell, and muscle cell.

Key Takeaway — Structure reflects function

2. Stomach Wall Cutaway

The stomach diagram shows epithelial tissue on the inside surface, connective and nervous tissue in the middle layers, and muscle tissue as the outer thick layer.

Key Takeaway — The stomach is an **organ** because it contains different tissues working together.

3. Leaf Cross-Section

Dermal tissue forms the top and bottom protective surfaces, ground tissue is the central green region, and vascular tissue forms the internal veins.

Key Takeaway — Dermal → **Protection**, Ground → **Photosynthesis**, Vascular → **Transport**.

4. Human Organism Diagram

Multiple organ systems combine and coordinate to form an organism.

Key Takeaway — **Multiple organ systems** combine and coordinate to form an organism.

5. Grasshopper Respiratory Anatomy

The respiratory system contains: **Spiracles** → **Tracheae** → **Air sacs**

Key Takeaway — Different structures work together as an **organ system**.

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Exam Focus & Revision Tips

1. Memorize the Order

Direction	Order
Simplest → Most Complex	Cell → Tissue → Organ → Organ System → Organism
Most Complex → Simplest	Organism → Organ System → Organ → Tissue → Cell

2. Tissue Pairing Shortcuts

Animal Tissue	Plant Equivalent
Epithelial Tissue (protection)	Dermal Tissue (protection)
Connective Tissue (support / transport in blood)	Vascular Tissue (transport)
Muscle / Nervous Tissue (movement / signaling)	Ground Tissue (storage, support, photosynthesis)

3. Plant Tissue Pairing

Plant Tissue	Role
Dermal Tissue	Protection and reduction of water loss
Vascular Tissue	Transport of water, minerals, and food
Ground Tissue	Storage, support, photosynthesis

4. Explaining System Interactions

When explaining why an organ cannot function independently, connect its function to the resources it needs. **Example:**

Stomach muscle cells → need oxygen → respiratory system → circulatory system → stomach tissues receive oxygen

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Check Your Understanding

Part 1 — Multiple Choice Questions

Q1. What is the fundamental difference between a tissue and an organ?

- Ⓐ A tissue is made of organs; an organ is made of cells.
- Ⓑ **A tissue is made of similar cells; an organ is made of different tissues.**
- Ⓒ A tissue is found only in plants; an organ is found only in animals.
- Ⓓ A tissue and an organ are the same structure at different sizes.

✓ *Explanation: A tissue is a group of similar cells performing a shared task, while an organ is a group of different tissues working together for a complex function.*

Q2. Which change would fix an incorrect flowchart displaying: Organs → Tissues → Cells → Organ Systems → Organisms

- Ⓐ Add cell membranes at the start.
- Ⓑ Move organ systems to the beginning.
- Ⓒ Remove tissues and cells.
- Ⓓ **Switch organs and cells.**

✓ *Explanation: Switching 'Organs' and 'Cells' restores the correct order: Cells → Tissues → Organs → Organ Systems → Organisms.*

Q3. Which human tissue provides the exact same primary function as plant dermal tissue?

- Ⓐ Connective tissue
- Ⓑ Nervous tissue
- Ⓒ **Epithelial tissue**
- Ⓓ Muscle tissue

✓ *Explanation: Both epithelial tissue and dermal tissue serve a protective, barrier-forming function.*

Q4. An unspecialized cell transforming into a muscle cell, nerve cell, or blood cell is an example of:

- Ⓐ **Cell differentiation**
- Ⓑ Photosynthesis
- Ⓒ Pointillism
- Ⓓ Organ transplantation

✓ *Explanation: Cell differentiation is the process by which unspecialized cells develop into specialized cell types.*

Q5. The spiracles, tracheae, and air sacs of a grasshopper work together to exchange gases. This collection of structures represents a:

- Ⓐ Organelle
- Ⓑ Specialized single cell
- Ⓒ Tissue
- Ⓓ **Organ system**

✓ *Explanation: Several different structures cooperating to carry out a complete life process (gas exchange) constitutes an organ system.*

Q6. Bone marrow is classified as a tissue that produces:

- Ⓐ Gastric acid and enzymes
- Ⓑ **Blood cells — red, white, and platelets**
- Ⓒ Dermal and ground cells
- Ⓓ Nerve impulses to the brain

✓ *Explanation: Bone marrow produces red blood cells, white blood cells, and platelets.*

Q7. Why is a living donor able to donate a kidney to a recipient?

- Ⓐ Kidneys can regenerate completely within 24 hours.
- Ⓑ **A healthy human has two kidneys and can survive normally with one.**
- Ⓒ The donor no longer requires kidney function afterward.
- Ⓓ Kidneys are not essential organs.

✓ *Explanation: Humans possess two kidneys and a person can live a healthy life with only one.*

Part 2 — True / False

T/F 1. A unicellular organism contains complex tissues and organ systems.

✗ FALSE — A unicellular organism is made of only one cell and carries out all life activities within that single cell — it has no tissues or organ systems.

T/F 2. In plants, ground tissue is the primary location where photosynthesis occurs.

✓ **TRUE** — Ground tissue contains chloroplasts, which are the site of photosynthesis.

T/F 3. Adipose (fat) tissue is an example of connective tissue.

✓ **TRUE** — Fat tissue is classified as a connective tissue, storing energy and providing cushioning.

LESSON 1 Levels of Organization

T/F 4. The stomach is made exclusively of muscle tissue.

✗ FALSE — *The stomach is an organ made of four tissue types: muscle, epithelial, nervous, and connective tissue.*

T/F 5. The shoot system of a plant includes leaves, stems, and flowers.

✓ TRUE — *The shoot system is the above-ground part of the plant, including leaves, stems, and flowers.*

T/F 6. Bone marrow donors suffer permanent, irreversible loss because bone marrow never regenerates.

✗ FALSE — *The donor's body naturally replaces the harvested bone marrow within a few weeks.*

Part 3 — Complete the Sentence

1. An organism composed of only one cell is called a _____ organism, whereas an organism made of trillions of cells is called a _____ organism.

✓ Answer: unicellular ... multicellular

2. Groups of similar cells working together to carry out a specific task are known as _____.

✓ Answer: tissues

3. The art technique that uses tiny dots to form an entire image, serving as a model for biological organization, is called _____.

✓ Answer: pointillism

4. The two main organ systems found in plants are the _____ system and the _____ system.

✓ Answer: shoot ... root

5. When kidneys fail, patients often undergo a medical procedure called _____ to remove toxins and wastes from their blood artificially.

✓ Answer: dialysis

Part 4 — Explain Why & Short Answer

Q: Why is a plant leaf classified as an organ rather than simply a tissue?

Answer: A leaf contains several different tissue types — dermal, ground, and vascular — all working together to perform the complex function of photosynthesis. Because it combines different tissues (not just one kind of similar cell), it meets the definition of an organ, not a tissue.

Q: Why cannot the human stomach function independently without the help of the respiratory and circulatory systems?

Answer: Stomach muscle cells need a continuous supply of oxygen to produce energy and contract. The stomach cannot obtain oxygen from the air itself; the respiratory system takes in oxygen, and the circulatory system transports it through the blood to the stomach tissues. Without these systems, the stomach would be deprived of oxygen and could not function.

Q: Identify the four types of tissues found in the human stomach and state the exact role of each.

Answer: **Epithelial tissue** lines the interior and secretes protective fluid against acidic gastric juices. **Muscle tissue** contracts to churn and grind food. **Nervous tissue** detects stomach stretching and signals the brain when full. **Connective tissue** binds the layers together and provides structural strength.

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Important Definitions

Term	Definition
Unicellular Organism	An organism made of only one cell.
Multicellular Organism	An organism made of more than one cell.
Cell Differentiation	The process by which unspecialized cells develop into specialized cell types with distinct structures and jobs.
Tissue	A group of similar types of cells working together to carry out a specific task.
Muscle Tissue	Animal tissue that contracts and relaxes to cause movement.
Connective Tissue	Animal tissue that provides structure and support and connects other tissues together.
Nervous Tissue	Animal tissue that carries electrical messages to and from the brain.
Epithelial Tissue	Animal tissue that forms the protective outer layer of the skin and lines major organs and body cavities.
Dermal Tissue	Plant tissue that covers the exterior of a plant to provide protection and reduce water loss.
Vascular Tissue	Plant tissue that transports water and nutrients throughout the plant.
Ground Tissue	Plant tissue that provides storage and support and serves as the site of photosynthesis.
Organ	A group of different tissues working together to perform a specific, complex job.
Organ System	A group of different organs that work together to complete a series of related tasks.
Organism	An individual living thing that possesses all the systems needed for survival.
Bone Marrow	A specialized tissue inside certain bones containing cells that develop into red blood cells, white blood cells, and platelets.
Dialysis	A medical procedure that artificially filters and removes waste products from the blood when the kidneys fail.
Organ Donor	A person who donates an organ while living or upon death to a patient in medical need.

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