Principles of organisation

4.2.1 · Biology · revision notes

How living things are built up from cells into tissues, organs, organ systems and whole organisms. It is usually tested with short recall questions (defining a tissue or an organ, putting the levels in order, classifying a structure) and as the opening part of longer questions on digestion, the heart or plants.

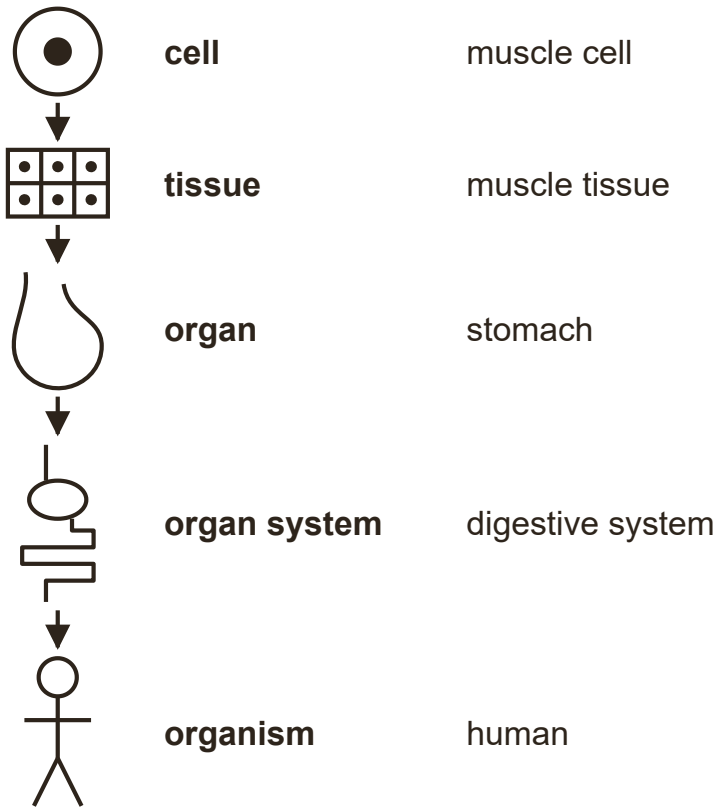
Key facts

- Order: cell → tissue → organ → organ system → organism
- Organ = a group of different tissues working together to perform a specific function
- Stomach tissues: muscular (churns), glandular (makes digestive juice), epithelial (covers)
- Leaf = a plant organ; roots + stem + leaves = the plant transport organ system
- Tissue = a group of cells with a similar structure and function
- Organ system = a group of organs working together to perform a function
- Blood = a tissue; heart = an organ; circulatory system = an organ system

Notes

The levels of organisation

- **Cells** are the basic building blocks of all living organisms. In a multicellular organism most cells are specialised for one job.
- A **tissue** is a group of cells with a similar structure and function, e.g. muscular tissue contracts to move things.
- An **organ** is a group of different tissues that work together to perform a specific function, e.g. the stomach, the heart or a leaf.
- An **organ system** is a group of organs that work together to perform a function, e.g. the digestive system digests and absorbs food.
- Organ systems work together to form an **organism**.
- Size and scale: most cells are about 10 to 100 μm (0.01 to 0.1 mm) across, tissues and organs are millimetres to centimetres, and an organ system can run through the whole body.



Levels of organisation, smallest to largest

Examples to learn

- The stomach contains **muscular tissue** (contracts to churn the food), **glandular tissue** (makes digestive juices containing enzymes and acid) and **epithelial tissue** (covers the inside and outside of the stomach).
- Blood is a tissue. The heart is an organ. The heart, blood vessels and blood together make up the circulatory system, an organ system.
- In plants, a leaf is an organ. It contains epidermal tissue, palisade and spongy mesophyll, xylem and phloem.
- The roots, stem and leaves together form a plant organ system that transports substances around the plant.

Why large organisms need organ systems Grade 7+ only

- A single-celled organism can get everything it needs by diffusion across its surface, because it has a large surface area to volume ratio.
- A large multicellular organism has a small surface area to volume ratio, and many of its cells are far from the surface, so diffusion across the body surface alone is too slow.
- It needs specialised exchange organs (such as the lungs and small intestine) and a transport system (heart, blood vessels and blood) to carry substances to and from every cell.
- Specialisation lets each tissue or organ carry out one job efficiently, but the parts then depend on each other.

How to answer each type of question

Recall: define a level or put the levels in order

1 mark each | Grade 3

1. Learn the exact definitions: 'similar structure and function' for a tissue, 'different tissues working together' for an organ.
2. For ordering questions, always start with the cell and finish with the organism.

Example. (a) What is a tissue?
(b) Put these in order from smallest to largest: organ, cell, organ system, tissue.

Model answer.

(a) A group of cells with a similar structure and function (1)
(b) cell → tissue → organ → organ system (1)

Classify structures by level of organisation

1 mark each | Grade 5

1. Ask yourself: is it one cell, a group of similar cells, several different tissues, or several organs?
2. Watch for the traps: blood is a tissue, xylem is a tissue, a leaf is an organ.

Example. Give the level of organisation of each structure. Choose from: cell, tissue, organ, organ system.
(a) the heart
(b) xylem
(c) a root hair cell
(d) the stomach, liver, pancreas and intestines working together

Model answer.

(a) organ (1)
(b) tissue (1)
(c) cell (1)
(d) organ system (1)

Explain why a structure is an organ

2 marks | Grade 5

1. Point 1: it is made of several different tissues (use the tissues named in the question).
2. Point 2: the tissues work together to carry out a specific function (say what the function is).

Example. The small intestine contains muscular tissue, glandular tissue and epithelial tissue. Explain why the small intestine is described as an organ.

Model answer. It is made of several different tissues (1) that work together to carry out a specific function, digesting and absorbing food (1).

Explain why large organisms need organ systems

3 marks | Grade 7

1. Start with size: a large organism has a small surface area to volume ratio.
2. Say that diffusion across the body surface is too slow to supply cells deep inside the body.
3. Link to organ systems: exchange organs take substances in and a transport system carries them to every cell.

Example. An amoeba is a single-celled organism. A human is a large multicellular organism. Explain why a human needs a circulatory system but an amoeba does not.

Model answer. An amoeba has a large surface area to volume ratio, so diffusion across its membrane supplies the whole cell (1). A human has a small surface area to volume ratio / many cells are far from the body surface, so diffusion alone would be too slow (1). The circulatory system transports substances such as oxygen and glucose from the exchange organs to every cell (1).

Don’t lose marks

- Defining a tissue as 'a group of cells' without 'with a similar structure and function'.
- Saying an organ is 'a group of cells'. It is a group of different tissues.
- Calling blood an organ or a cell. Blood is a tissue.
- Calling a leaf a tissue. A leaf is an organ; palisade mesophyll and xylem are tissues.
- Writing 'they work together' without saying what function they carry out.

More tips

Memory tricks

- Order mnemonic: 'Clever Tigers Often Sleep Outside' = Cell, Tissue, Organ, organ System, Organism.
- Each level is made of several of the level below: similar cells make a tissue, different tissues make an organ, different organs make a system.
- Quick test: if it is a single named body part (heart, stomach, leaf, root), it is an organ.

Exam technique

- In 'explain why X is an organ' questions, name the tissues given in the question to show you have applied your knowledge.
- This subtopic is often the first part of a longer question, so learn which organs belong to which organ system.
- Use the key phrases examiners look for: similar structure and function, work together, specific function.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

Put the levels of organisation in order

From smallest to largest: cell → tissue → organ → organ system → organism.

Grade 4

Define tissue, organ and organ system

A tissue is a group of cells with a similar structure and function, an organ is a group of tissues working together, and an organ system is a group of organs working together.

Grade 4

Explain why a structure is an organ

Say that it is made of several different tissues that work together to carry out a specific function.

Grade 5

Classify a structure by its level

For example, a red blood cell is a cell, blood is a tissue, the heart is an organ and the circulatory system is an organ system.

Grade 7

Explain why large organisms need organ systems

Large organisms have a small surface area to volume ratio, so they need specialised exchange organs and a transport system to supply every cell.

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