

Exercise walk-through

Origins of Cell Compartmentalization ■ 2.10

eXercise

You must be able to

- state the **endosymbiotic theory** 内共生学说
- give the evidence (own DNA, double membrane, own ribosomes, binary fission)
- identify which organelles it explains

Method — The endosymbiotic theory

Mitochondria and **chloroplasts** are thought to have originated when a larger cell **engulfed** a free-living prokaryote, which then lived inside it (**endosymbiosis**) rather than being digested.

Method — The evidence

- they have their **own DNA** (circular, like bacteria);
- they have their **own ribosomes**;
- they are surrounded by a **double membrane**;
- they reproduce by **binary fission**, like bacteria.

Method — Which organelles

The theory explains **mitochondria** (from an aerobic bacterium) and **chloroplasts** (from a photosynthetic bacterium) — both double-membraned, DNA-containing organelles.

Method — A worked reasoning

A mitochondrion's own circular DNA and ability to divide independently are strong signs it descended from a once free-living bacterium.

Practice 2.1 ■ 2 marks

Which two organelles does the endosymbiotic theory explain?

Solution 2.1

Worked steps

Mitochondria and chloroplasts **B1** **B1**.

Practice 2.2 ■ 1 mark

State one piece of evidence for the theory.

Solution 2.2

Worked steps

Any one: own (circular) DNA, own ribosomes, double membrane, reproduce by binary fission **B1**.

Practice 2.3 ■ 1 mark

How do mitochondria reproduce?

Solution 2.3

Worked steps

By binary fission (dividing like bacteria) **B1**.

Exam-style 3.1 ■ 1 mark

Evidence that mitochondria were once free-living bacteria includes that they have

- A** no DNA
- B** their own circular DNA and ribosomes
- C** a single membrane only
- D** the same DNA as the nucleus

Solution 3.1

- A** no DNA
- B** their own circular DNA and ribosomes 
- C** a single membrane only
- D** the same DNA as the nucleus

Worked steps

B — their own circular DNA and ribosomes.

Exam-style 3.2 ■ 2 marks

A student examines a chloroplast.

- (a) State two features that support the endosymbiotic theory.
- (b) Explain what the theory proposes about the chloroplast's origin.

Solution 3.2

Method: The endosymbiotic theory

Worked steps

- (a) Any two: own DNA, own ribosomes, double membrane, binary fission **B1 B1**.
- (b) It proposes the chloroplast arose when a cell engulfed a photosynthetic bacterium that survived and lived inside it **M1 A1**.

Exam-style 3.3 ■ 2 marks

Explain why having its own DNA and dividing by binary fission suggests a mitochondrion had a bacterial ancestor.

Solution 3.3

Method: The evidence

Worked steps

These are bacterial traits — free-living bacteria have their own DNA and reproduce by binary fission — so their presence in mitochondria points to a bacterial ancestor

M1 **A1**.