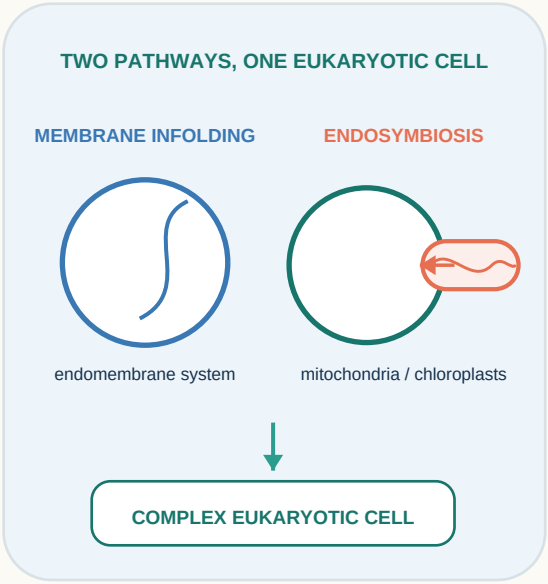
AP BIOLOGY | UNIT 2

TOPIC 2.10

Origins of Cell Compartmentalization

Membrane infolding and ancient endosymbiotic partnerships help explain how eukaryotic cells acquired internal compartments.



THE CORE CAUSAL CHAIN

VARIATION
new cell arrangement

→

PARTNERSHIP
host retains bacterium

→

BENEFIT
energy or photosynthesis

→

DESCENT
organelle inherited

BY THE END, YOU SHOULD BE ABLE TO...

1. Describe how membrane infolding creates internal spaces.
2. Outline the endosymbiotic origin of mitochondria and chloroplasts.
3. Use multiple lines of evidence to support endosymbiosis.

BIG IDEA

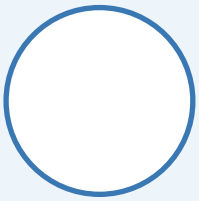
Evolutionary explanations are strongest when a proposed process is matched with several independent structural and molecular observations.

1 Membrane infolding builds internal spaces

Inward folds of an ancestral plasma membrane could enlarge, connect, and specialize into parts of the endomembrane system.

A PLAUSIBLE SEQUENCE

1 SURFACE MEMBRANE



The ancestral cell begins with a plasma membrane surrounding its cytoplasm.

2 FOLDS INWARD



Invaginations create extra membrane surface and internal pockets.

3 COMPARTMENTS FORM



Connected membranes can surround DNA and organize reactions.

WHAT THIS MODEL HELPS EXPLAIN

CONTINUITY

The nuclear envelope is continuous with the endoplasmic reticulum.

SAME MATERIAL

Internal membranes and the plasma membrane share a phospholipid-bilayer structure.

MORE SURFACE

Membrane folds provide additional area for organized cellular reactions.

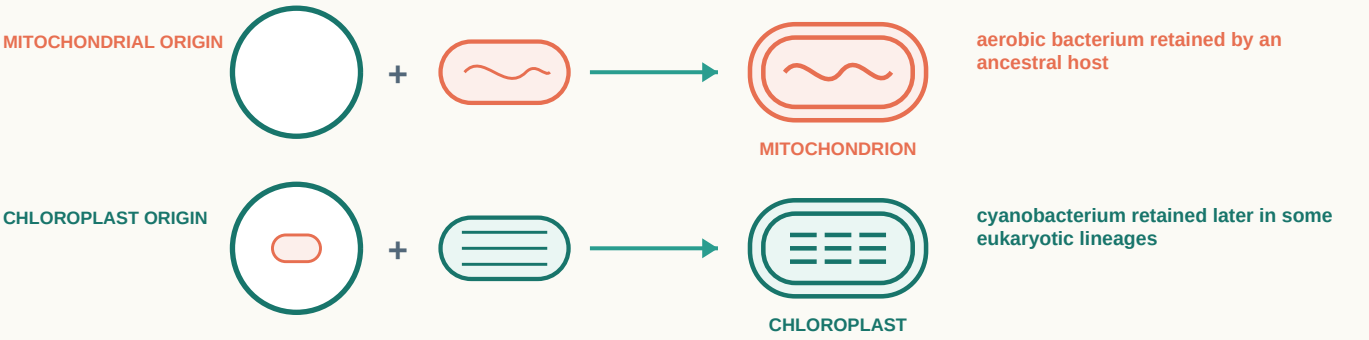
MODEL BOUNDARY

Membrane infolding helps explain the nucleus and endomembrane system. Mitochondria and chloroplasts require a different explanation: endosymbiosis.

2 Endosymbiosis explains two organelles

An ancestral host retained engulfed bacteria that supplied useful metabolism; over generations, the partners became integrated organelles.

THE EVOLUTIONARY SEQUENCE



FOUR INDEPENDENT LINES OF EVIDENCE

DOUBLE MEMBRANES

An outer membrane is consistent with engulfment; the inner membrane resembles the bacterial ancestor.

CIRCULAR DNA

Mitochondria and chloroplasts contain their own small, bacterial-like DNA molecules.

BACTERIAL RIBOSOMES

Their ribosomes are more similar in size and features to bacterial ribosomes than to cytosolic ones.

DIVISION PATTERN

Each organelle grows and divides by a process resembling bacterial binary fission.

COMMON ERROR

Mitochondria and chloroplasts are not part of the endomembrane system. Their bacterial ancestry is supported by several converging observations, not by one feature alone.