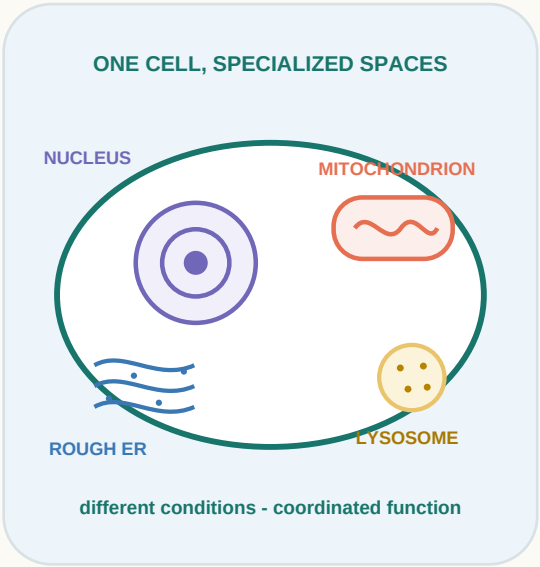
AP BIOLOGY | UNIT 2

TOPIC 2.9

Cell Compartmentalization

Internal membranes create specialized spaces where cellular reactions can run efficiently, safely, and under controlled conditions.



THE CORE CAUSAL CHAIN

MEMBRANES → divide the cell

COMPARTMENTS → set local conditions

ENZYMES → meet substrates

FUNCTION → becomes efficient

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

1. Explain why cells separate reactions into compartments.
2. Link an organelle's structure to its function.
3. Trace materials through the endomembrane system.

BIG IDEA

Compartmentalization lets one cell maintain multiple microenvironments at the same time, so incompatible or specialized processes can occur together.

1 Why compartments improve function

Membranes create controlled microenvironments and organize related molecules, making cellular work more efficient and safer.

FOUR FUNCTIONAL ADVANTAGES

1 LOCAL CONDITIONS

Each compartment can maintain a suitable pH, ion balance, or set of enzymes.

2 EFFICIENCY

Enzymes and substrates stay close, increasing the chance of productive reactions.

3 PROTECTION

Potentially harmful reactions can be isolated from the cytosol.

4 SURFACE AREA

Folded internal membranes provide more space for membrane-based reactions.

ONE CELL, DIFFERENT MICROENVIRONMENTS

LYSOSOME



LOCAL CONDITION

acidic interior

SUPPORTED JOB

Digestive enzymes break down macromolecules without damaging the cytosol.

MITOCHONDRION



LOCAL CONDITION

proton gradient

SUPPORTED JOB

The inner membrane supports ATP production through chemiosmosis.

NUCLEUS



LOCAL CONDITION

DNA enclosed

SUPPORTED JOB

Replication and transcription are organized away from cytoplasmic translation.

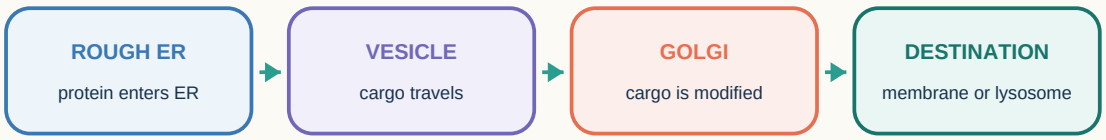
STRUCTURE-FUNCTION LINK

A strong explanation names the compartment's structure, the local condition it creates, and the process that condition supports.

2 Compartments coordinate as a system

Organelles specialize, but materials and information move between them so the whole cell can function as an integrated unit.

THE ENDOMEMBRANE PATHWAY



COORDINATION	The ER builds and folds proteins, transport vesicles carry them, and the Golgi modifies and sorts them for delivery.

STRUCTURE SUPPORTS PROCESS

ORGANELLE	KEY STRUCTURE	SUPPORTED PROCESS
NUCLEUS	double membrane with pores	controls exchange while protecting DNA
ROUGH ER	membrane sheets with ribosomes	synthesizes and begins processing secreted proteins
LYSOSOME	enzyme-filled acidic vesicle	digests and recycles cellular material
MITOCHONDRION	highly folded inner membrane	provides surface area for ATP production

COMMON ERROR

Compartments are not isolated cells within a cell. They exchange materials through pores, vesicles, and transport proteins while maintaining distinct internal conditions.