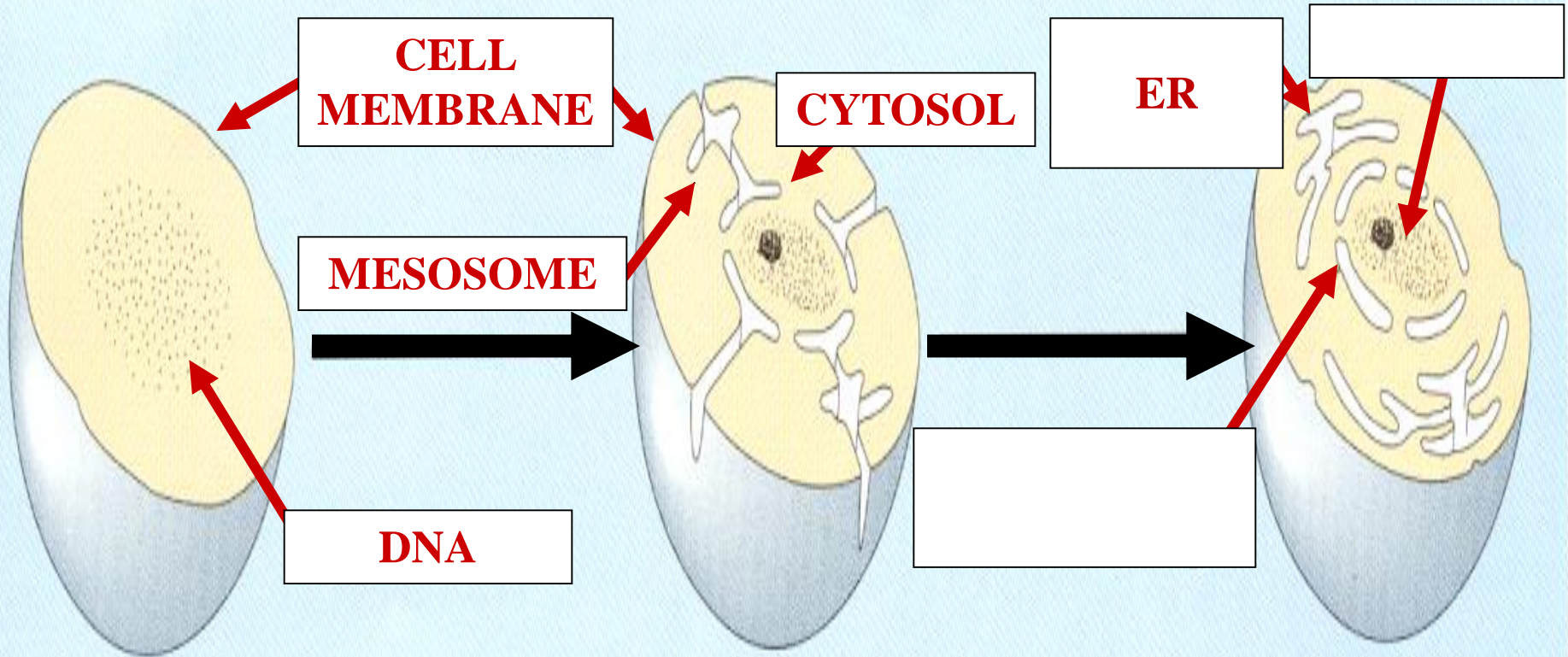


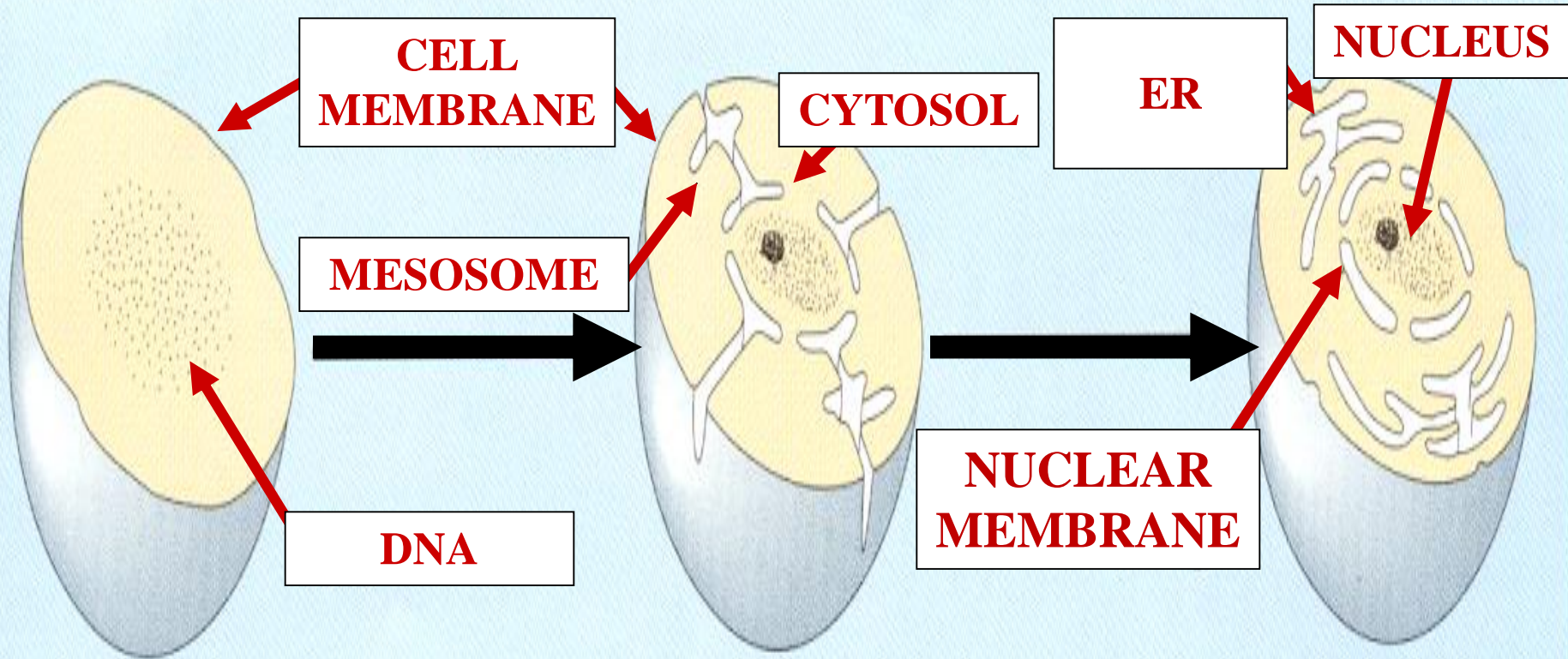
AUTOGENOUS THEORY



**ANCESTRAL
PROKARYOTE**

**NUCLEATED
EUKARYOTE**

AUTOGENOUS THEORY



**ANCESTRAL
PROKARYOTE**

**NUCLEATED
EUKARYOTE**



EUKARYOTE CELL

\$

**PHOSPHOLIPID
BILAYER**

**EVIDENCE SUPPORTS
AUTOGENOUS
THEORY**

EUKARYOTE CELL

A transmission electron micrograph (TEM) of a eukaryotic cell. The image shows a large, roughly spherical nucleus in the center, surrounded by a nuclear envelope. The cytoplasm is filled with various organelles, including several large, dark, elongated mitochondria with visible internal folds (cristae). There are also smaller, circular vesicles and other membrane-bound structures scattered throughout the cell. The overall appearance is that of a complex, multi-organellar cell.

NUCLEUS

**AUTOGENOUS
THEORY**

ENDOSYMBIOTIC THEORY

ENDOSYMBIOTIC THEORY



**ENDOSYMBIOTIC
THEORY**

PLASTID

&

MITOCHONDRION

EVOLUTION

**ENDOSYMBIOTIC
THEORY**

ENDOSYMBIOTIC THEORY



VIA PROKARYOTE SYMBIOSIS

ENDOSYMBIOTIC THEORY

EUKARYOTE CELL

A transmission electron micrograph (TEM) of a eukaryotic cell. The image shows various organelles including a large nucleus with a prominent nucleolus, several mitochondria with visible internal folds (cristae), and a large, multi-layered plastid. The cytoplasm is filled with various smaller organelles and vesicles. The cell is bounded by a plasma membrane and a cell wall.

MITOCHONDRION

PLASTID

**ENDOSYMBIOTIC
THEORY**

SYMBIOSIS

SYMBIOSIS

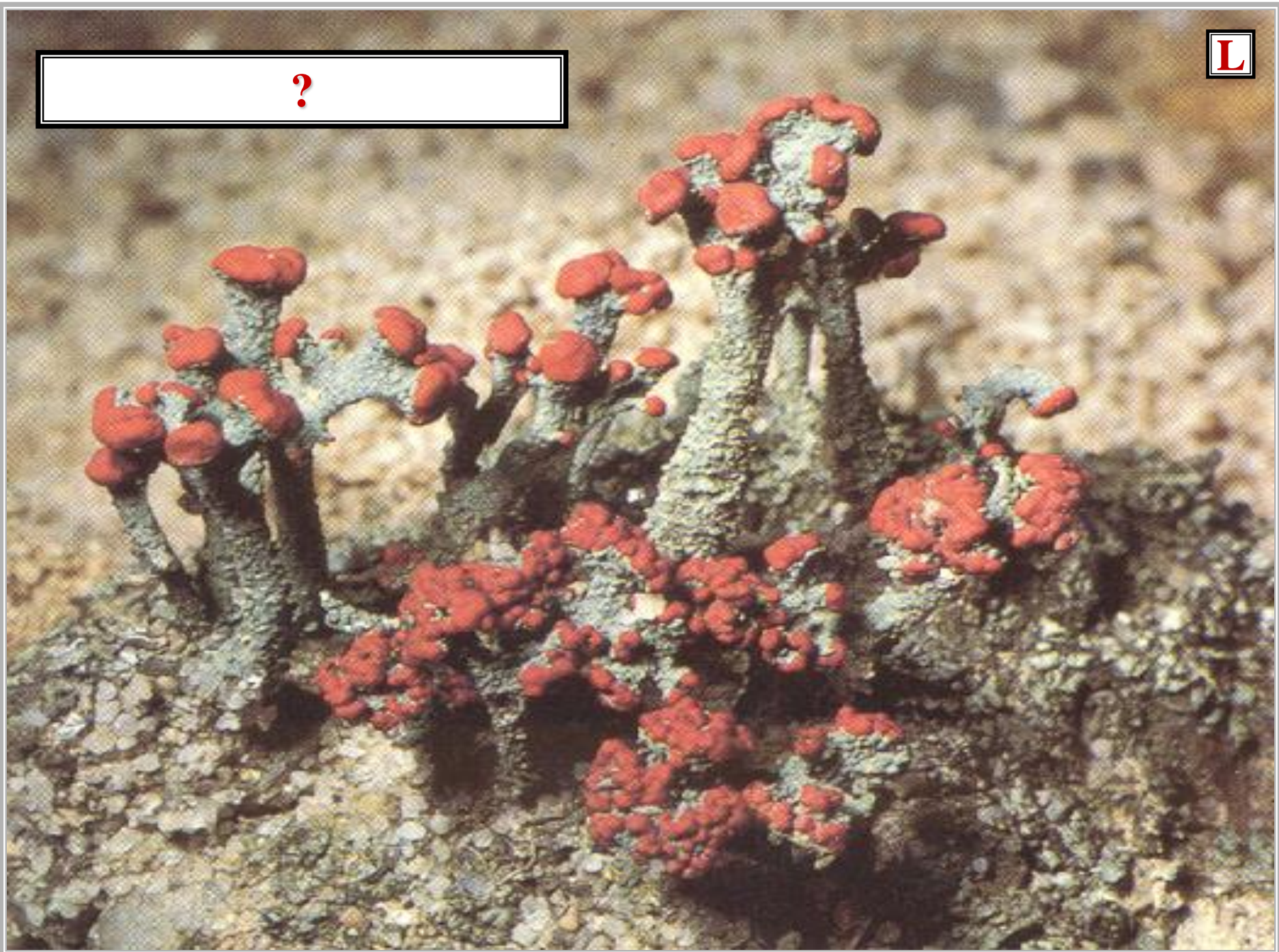


SYMBIOSIS

**TWO DIFFERENT SPECIES
EXIST IN AN
INTRICATE ASSOCIATION**

SYMBIOSIS

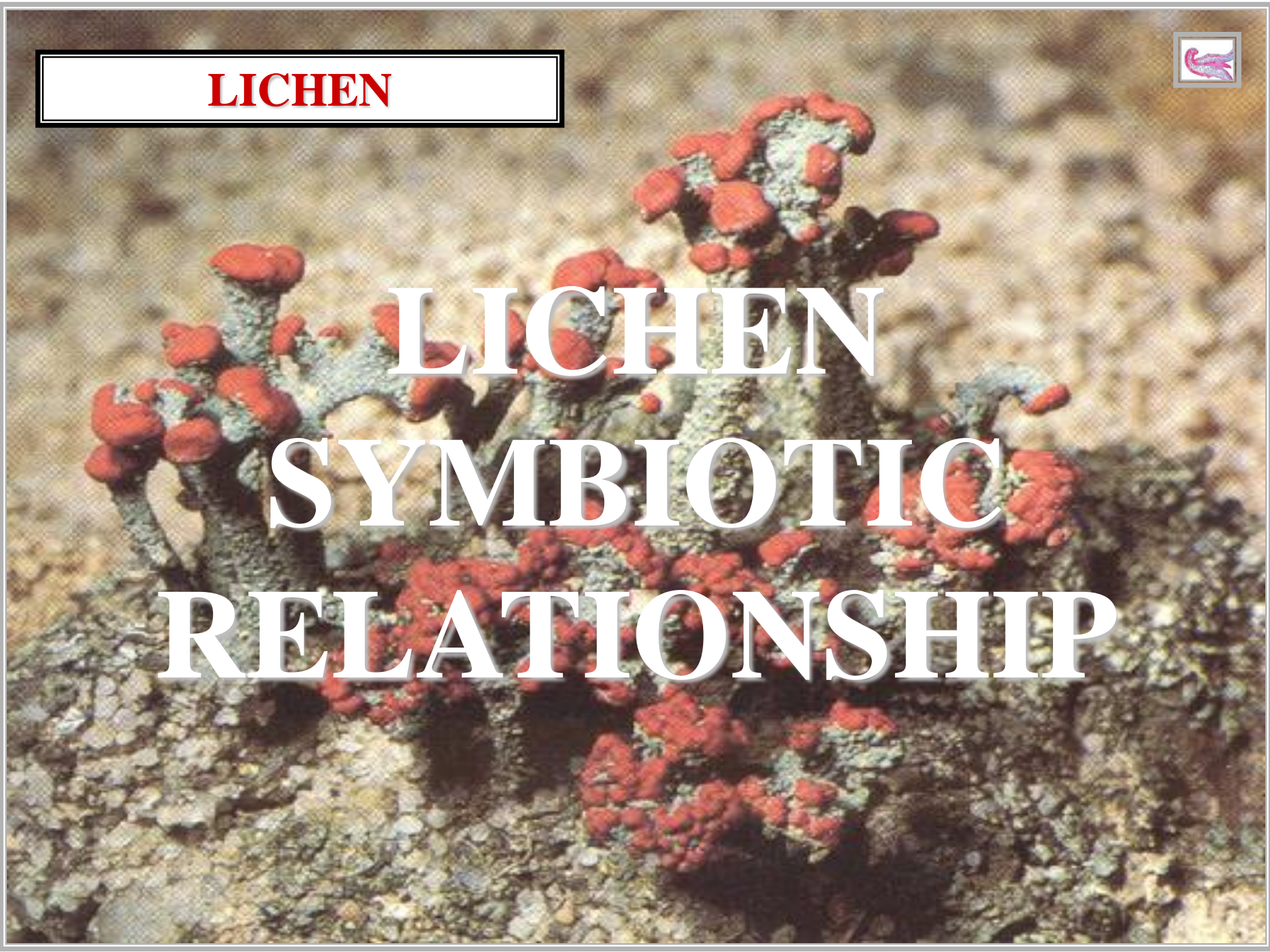
?



LICHEN



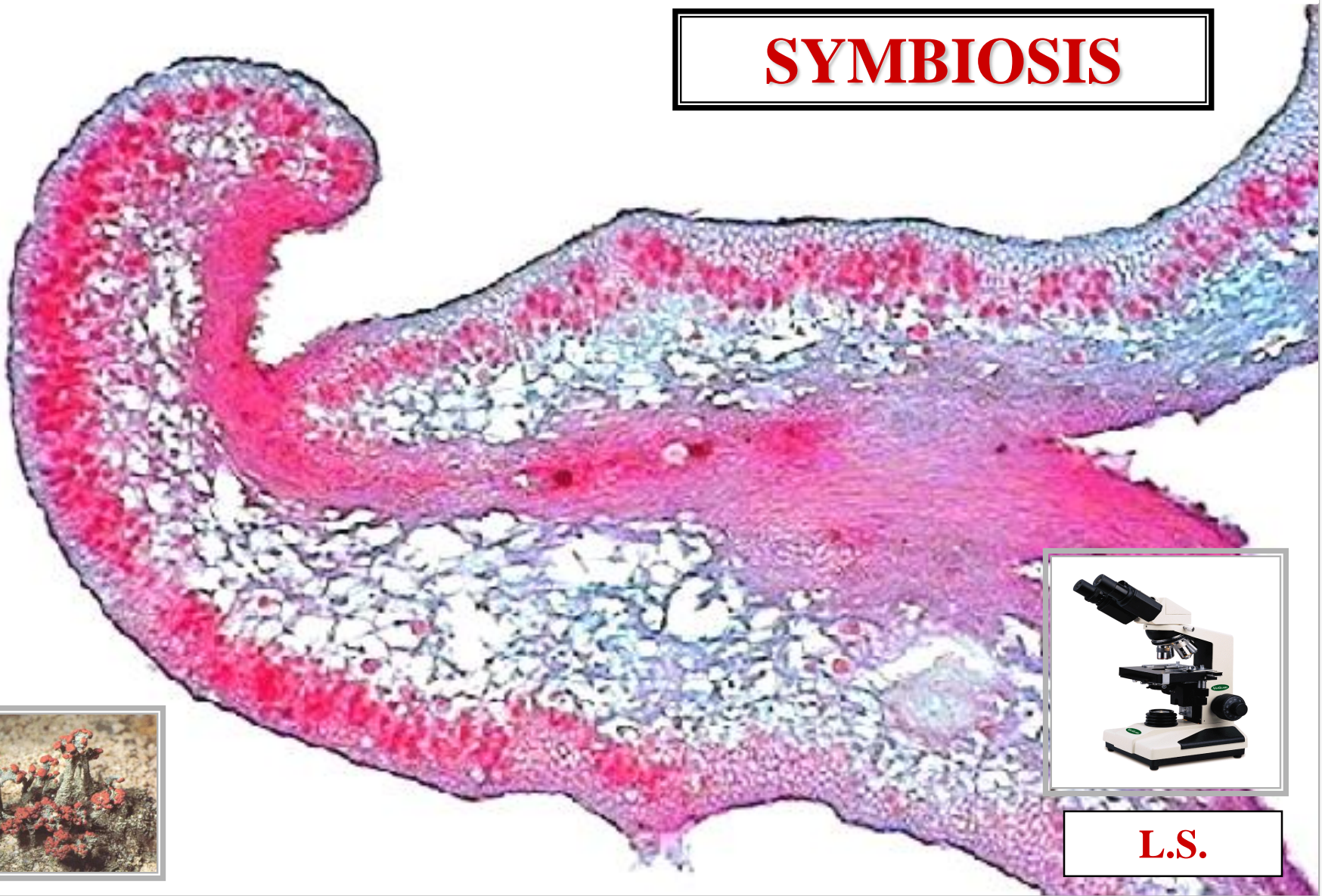
**LICHEN
SYMBIOTIC
RELATIONSHIP**



LICHEN THALLUS



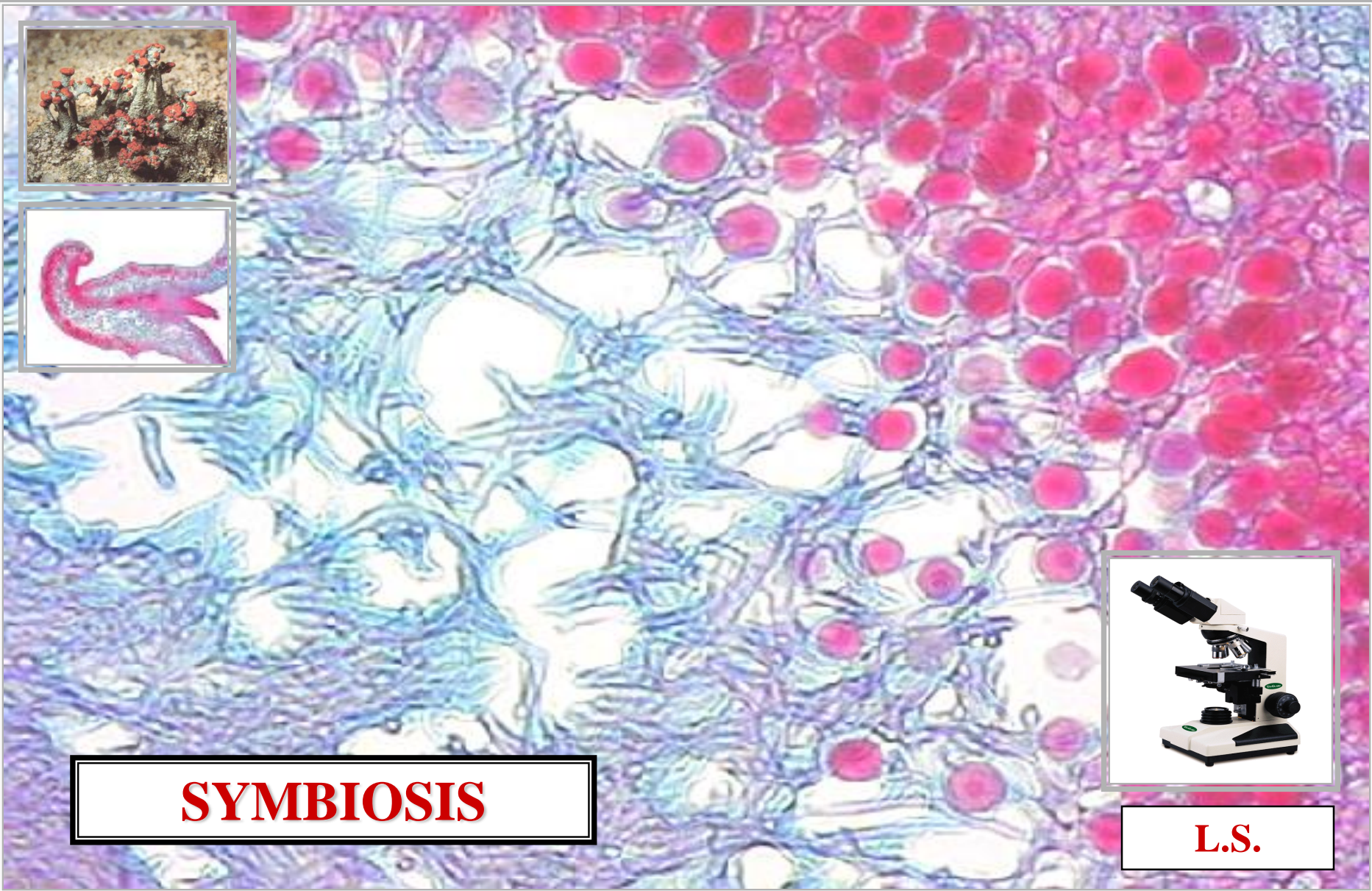
SYMBIOSIS



L.S.

LICHEN THALLUS

FS

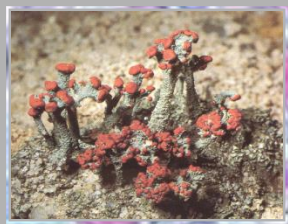


SYMBIOSIS



L.S.

LICHEN THALLUS

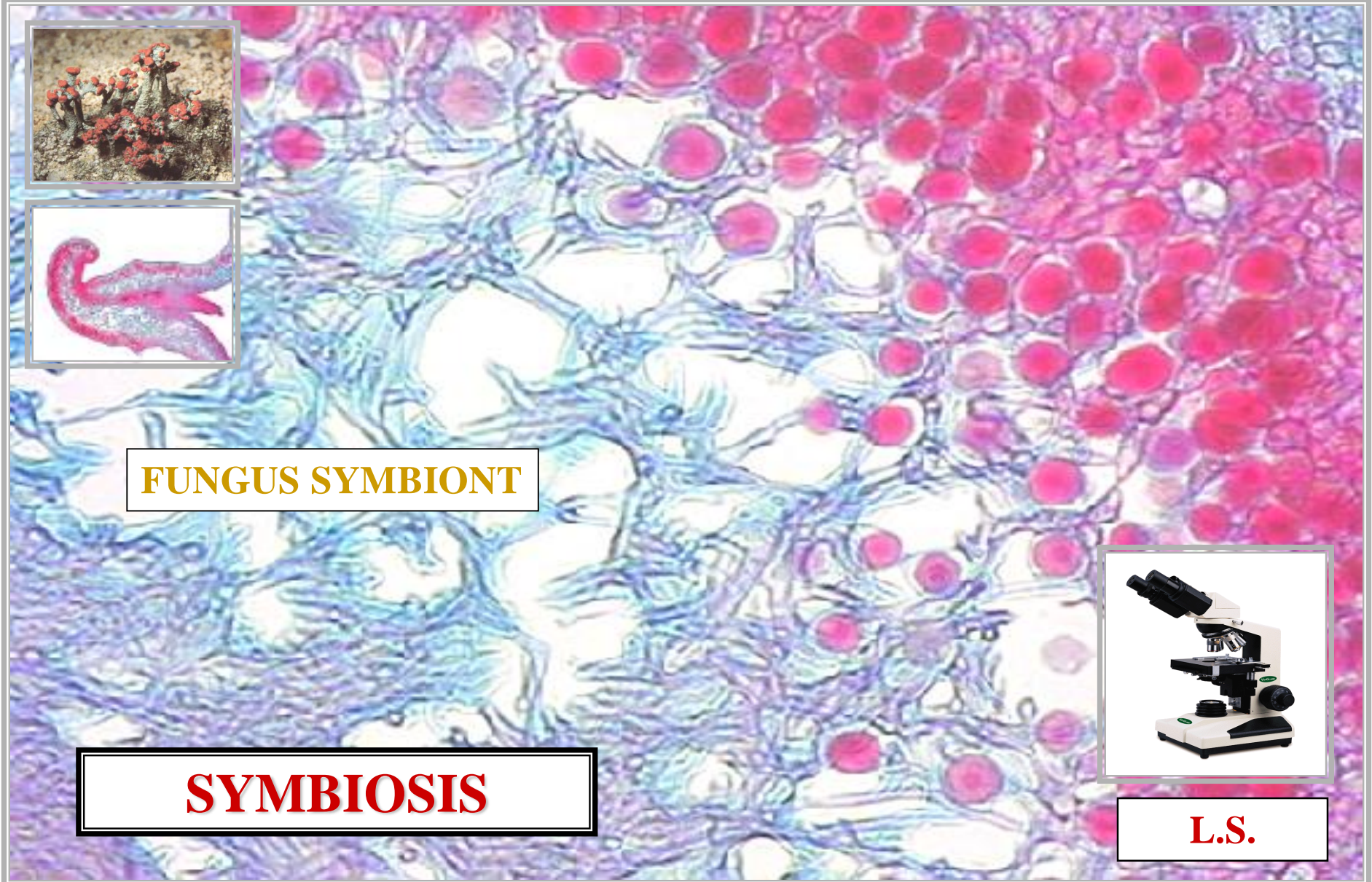


FUNGUS SYMBIONT

SYMBIOSIS



L.S.



LICHEN THALLUS



**CYANOBACTERIUM
SYMBIONT**

FUNGUS SYMBIONT

SYMBIOSIS

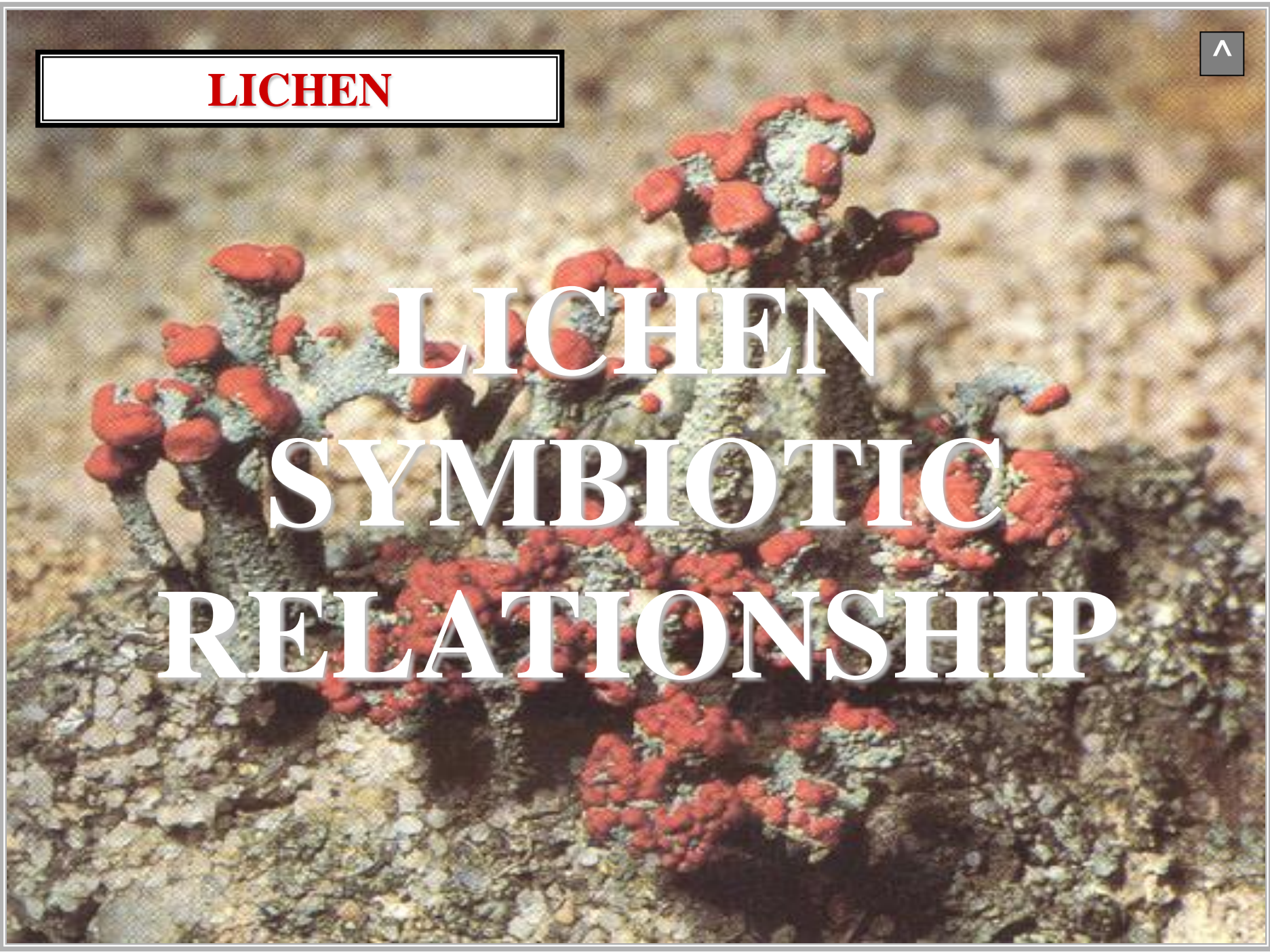


L.S.

LICHEN



**LICHEN
SYMBIOTIC
RELATIONSHIP**



SYMBIOSIS TYPES

SYMBIOSIS TYPES

PARASITISM

SYMBIOSIS TYPES

SYMBIOSIS TYPES

PARASITISM

COMMENSALISM

SYMBIOSIS TYPES

SYMBIOSIS TYPES

PARASITISM

COMMENSALISM

MUTUALISM

SYMBIOSIS TYPES

PARASITISM



SYMBIOSIS
PARASITISM

ONE SPECIES BENEFITS
ONE SPECIES ADVERSELY
AFFECTED

SYMBIOSIS
PARASITISM

A photograph of an Indian Pipe (Monotropa hypopitys) plant in a forest. The plant is a pale, translucent white color with several upright stems and clusters of small, bell-shaped flowers. It is growing on a forest floor covered with brown, fallen leaves. To the left of the plant, there is a small, green, needle-leaved sapling. The background is a soft-focus forest floor with more leaves and branches.

INDIAN PIPE

FL

SYMBIOSIS

A photograph of an Indian Pipe (Monotropa hypopitys) plant in a forest. The plant is white and lacks chlorophyll, growing from a forest floor covered in brown leaves and twigs. It has several upright stems with clusters of small, bell-shaped flowers. A red arrow points from a label 'FLOWER' to one of the flowers. Other labels include 'INDIAN PIPE', 'ANGIOSPERM', 'CL', 'AB', and 'SYMBIOSIS'.

INDIAN PIPE

ANGIOSPERM

CL

AB

FLOWER

SYMBIOSIS

INDIAN PIPE

ANGIOSPERM

N



CHLOROPLASTS: ABSENT

SYMBIOSIS

A photograph of an Indian Pipe (Monotropa hypopitys) plant in a forest. The plant is a pale, translucent white color with several bell-shaped flowers on thin, upright stems. It is growing in a forest floor covered with brown leaves and pine needles. A small green pine sapling is visible to the left of the plant. The background is a blurred forest floor with various green leaves and brown debris.

INDIAN PIPE

ANGIOSPERM

P

NON-PSYN PLANT

SYMBIOSIS

A photograph of an Indian Pipe (Monotropa hypopitys) plant. The plant is a pale, translucent white color with several upright stems and clusters of small, bell-shaped flowers. It is growing in a forest setting with a ground covered in brown, fallen leaves and some green foliage. The plant is positioned in the center-left of the frame.

INDIAN PIPE

ANGIOSPERM

^

C

PARASITISM

SYMBIOSIS

COMMENSALISM



SYMBIOSIS

COMMENSALISM

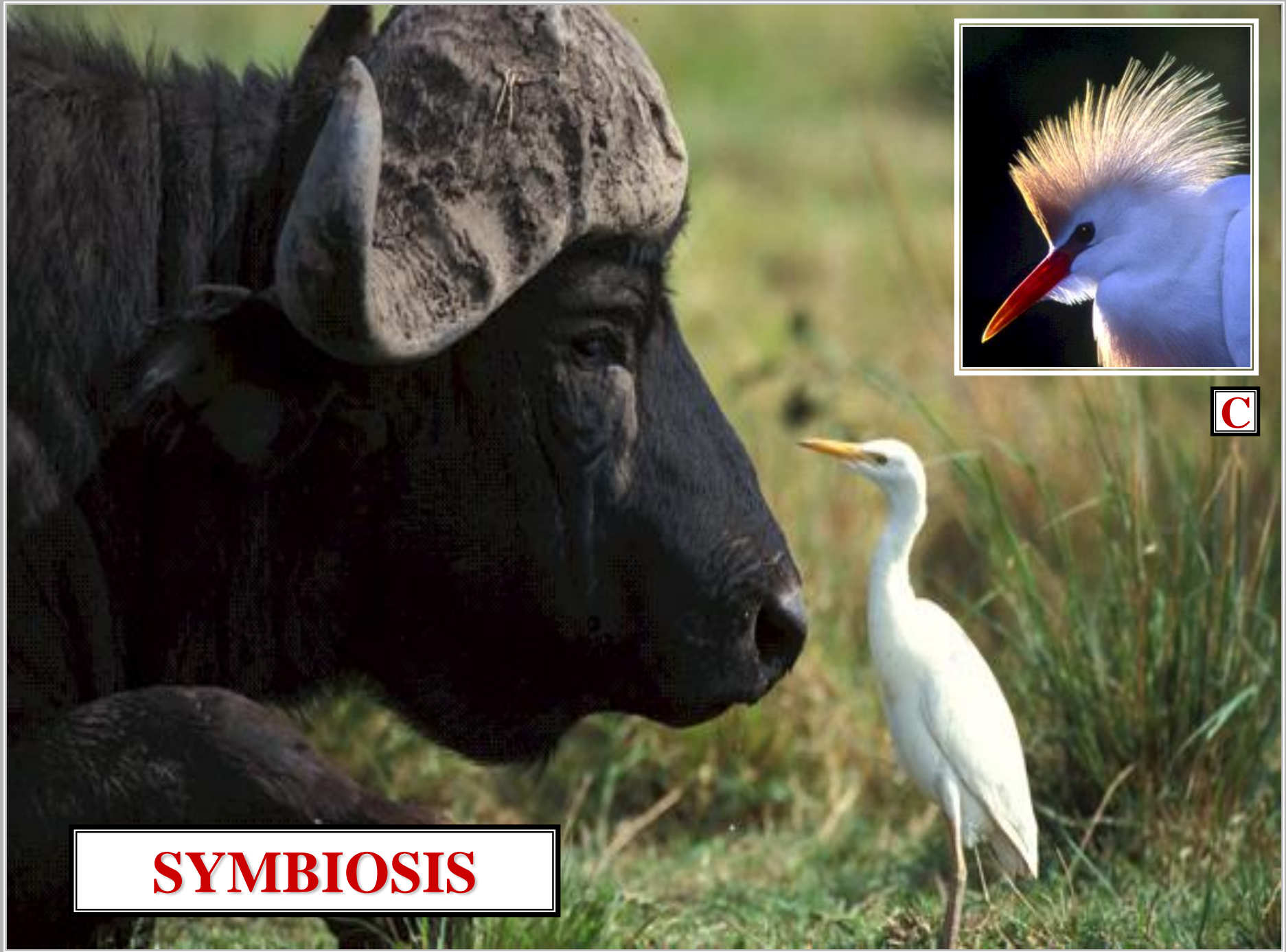
ONE SPECIES BENEFITS
ONE SPECIES UNAFFECTED

SYMBIOSIS

COMMENSALISM

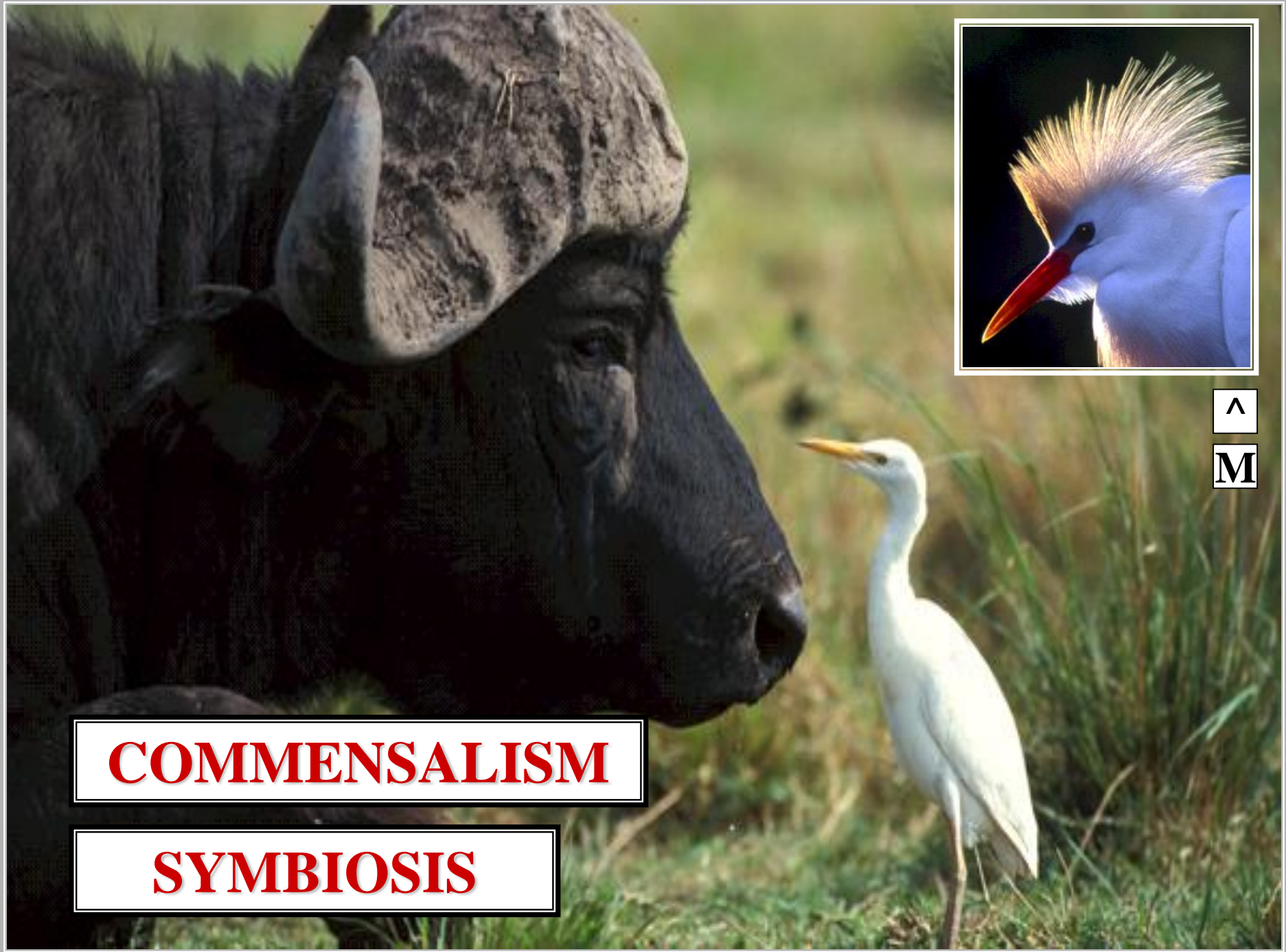
AFRICAN SAVANNA





C

SYMBIOSIS



^
M

COMMENSALISM

SYMBIOSIS

MUTUALISM

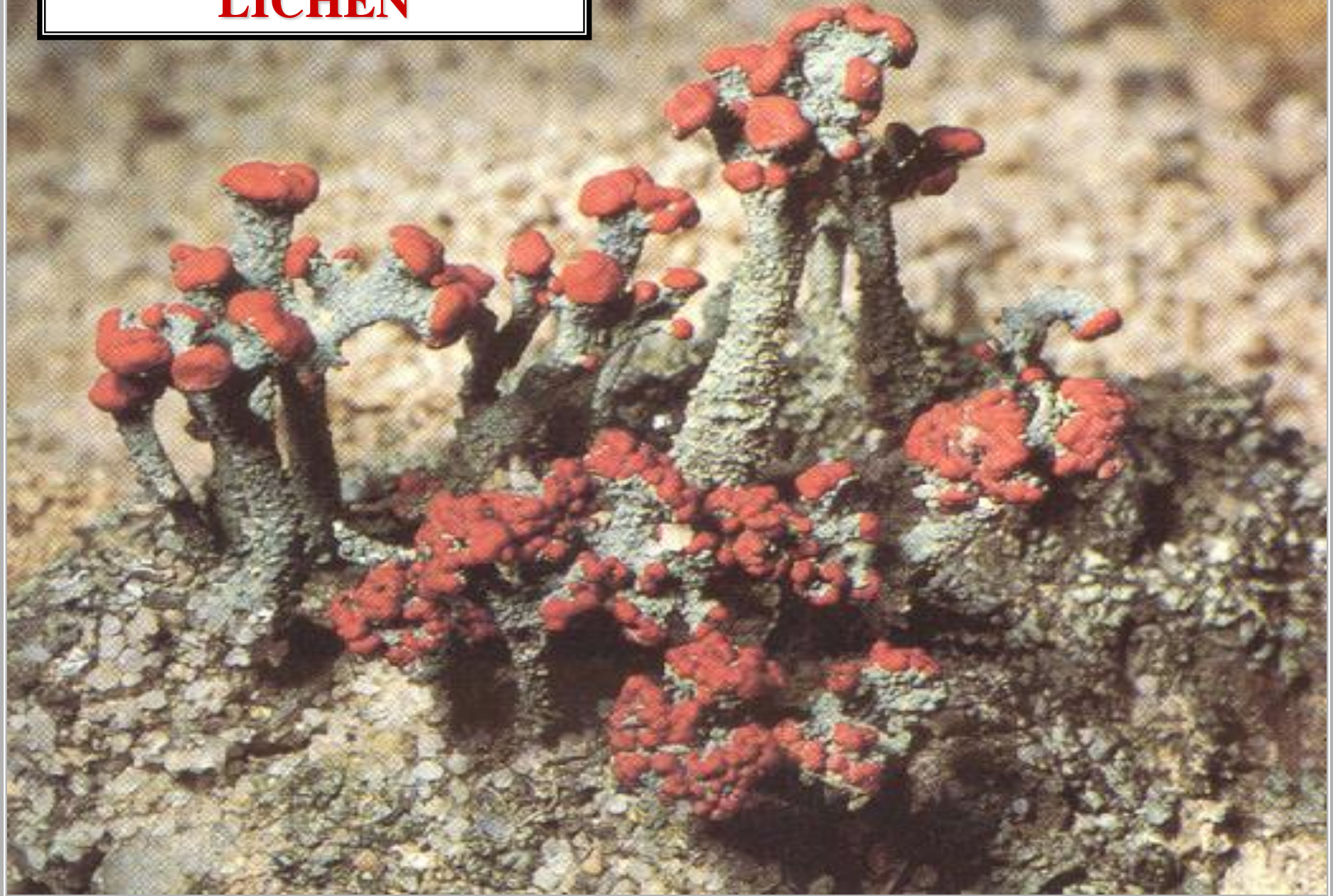


**SYMBIOSIS
MUTUALISM**

**BOTH SPECIES
BENEFIT**

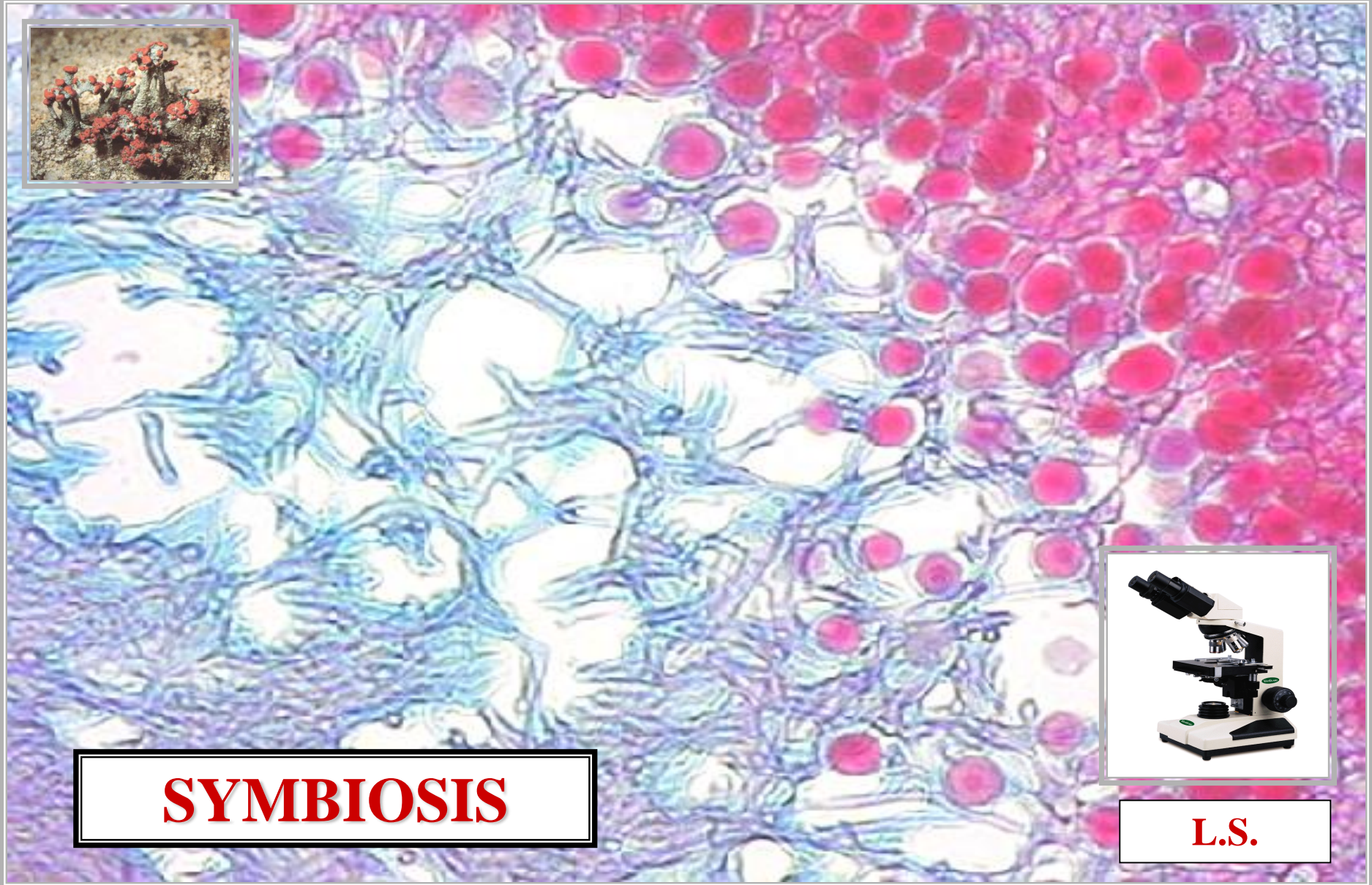
**SYMBIOSIS
MUTUALISM**

LICHEN



LICHEN THALLUS

FS

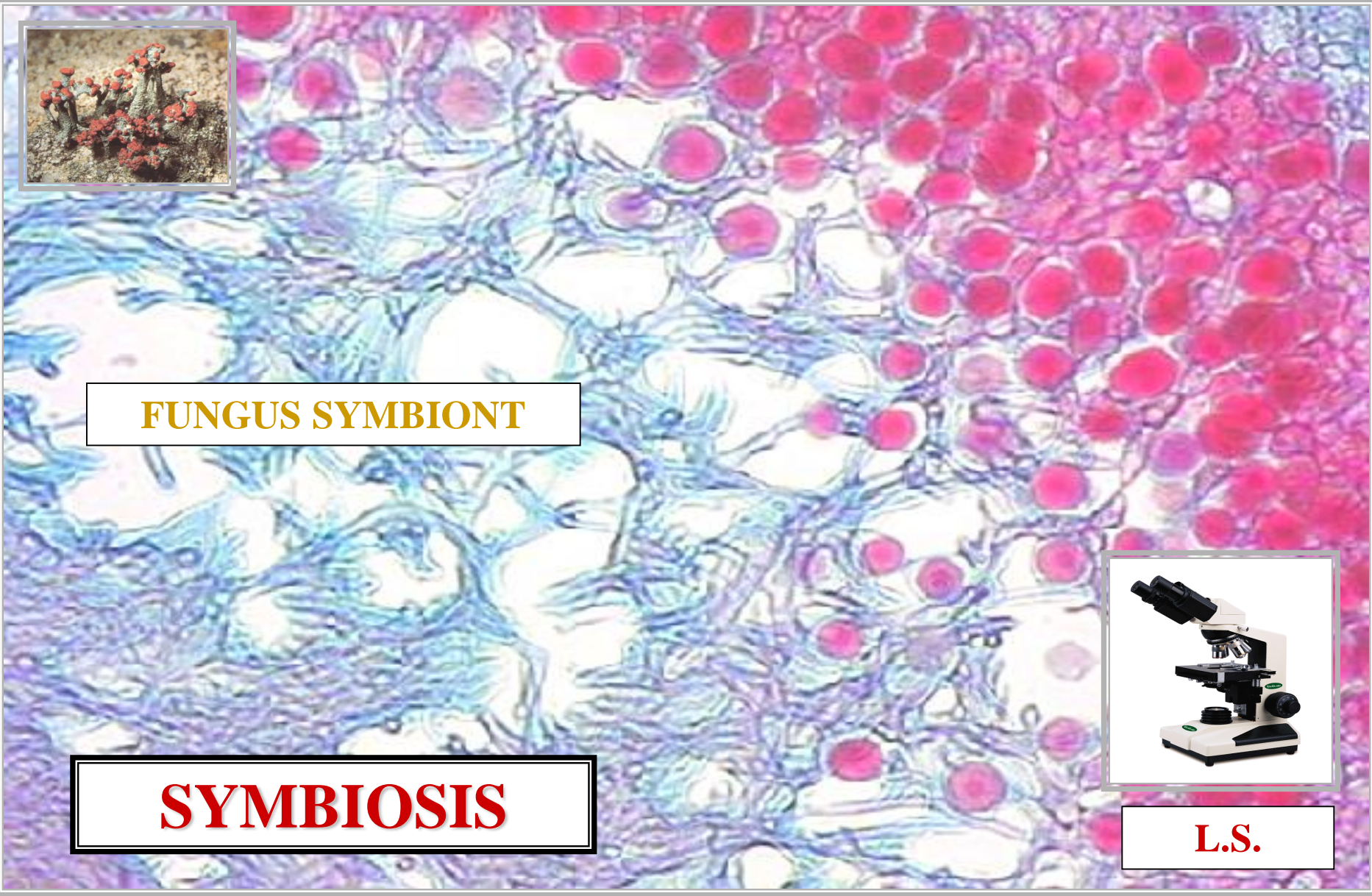
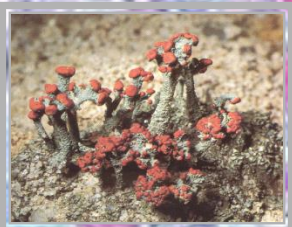


SYMBIOSIS



L.S.

LICHEN THALLUS



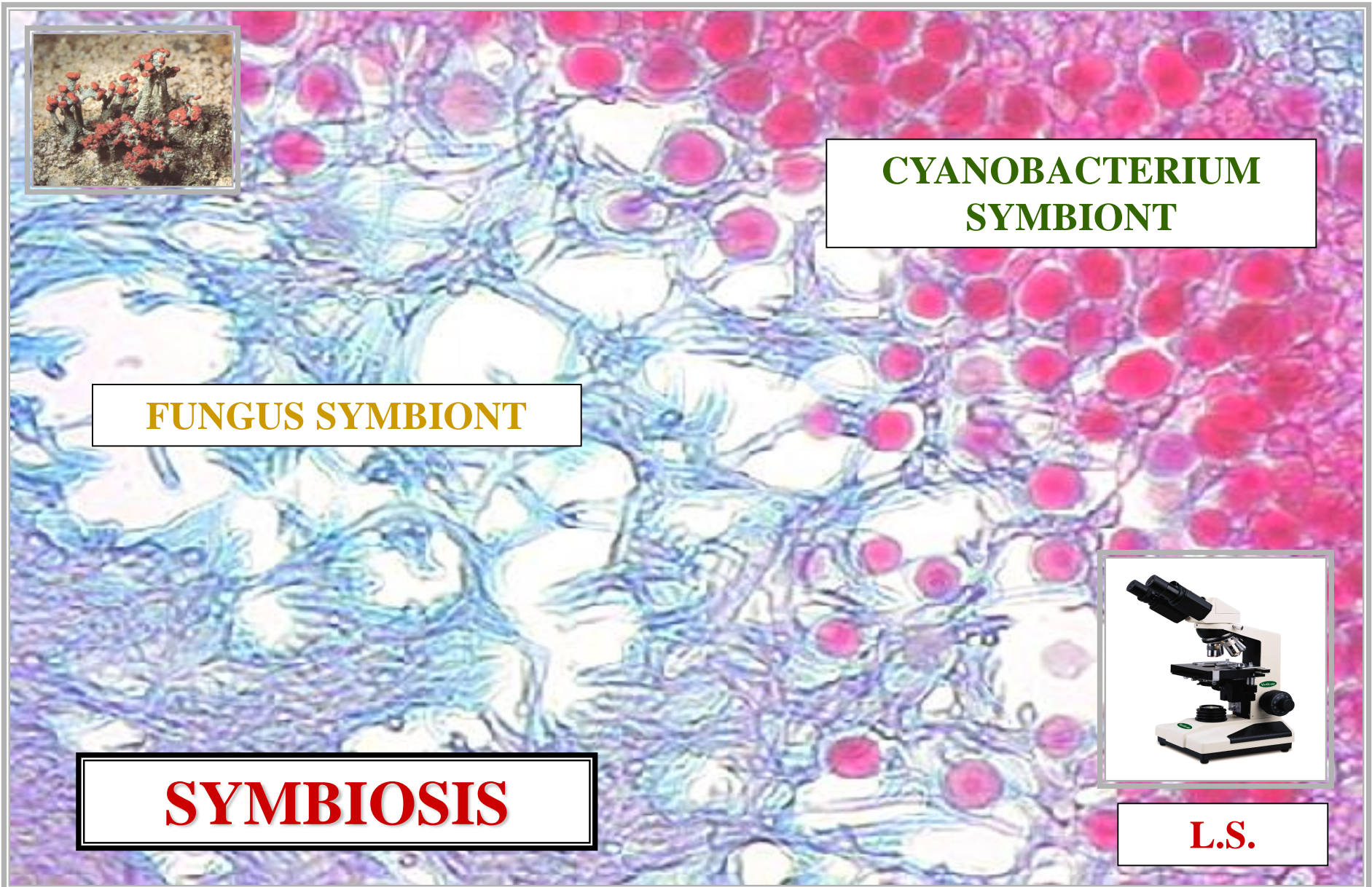
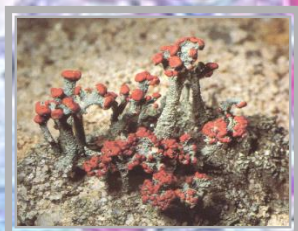
FUNGUS SYMBIONT

SYMBIOSIS



L.S.

LICHEN THALLUS



**CYANOBACTERIUM
SYMBIONT**

FUNGUS SYMBIONT

SYMBIOSIS



L.S.

LICHEN THALLUS



**CYANOBACTERIUM
SYMBIONT
PHOTOSYNTHESIS**

FUNGUS SYMBIONT

SYMBIOSIS



L.S.

LICHEN THALLUS



**CYANOBACTERIUM
SYMBIONT
PHOTOSYNTHESIS
PROVIDES: GLUCOSE**

FUNGUS SYMBIONT

SYMBIOSIS



L.S.

LICHEN THALLUS



**CYANOBACTERIUM
SYMBIONT
PHOTOSYNTHESIS
PROVIDES: GLUCOSE**

**FUNGUS SYMBIONT
GLUCOSE**

SYMBIOSIS



L.S.

LICHEN THALLUS



**CYANOBACTERIUM
SYMBIONT
PHOTOSYNTHESIS
PROVIDES: GLUCOSE**

**FUNGUS SYMBIONT
PROVIDES: SECURITY**

SYMBIOSIS



L.S.

LICHEN THALLUS



**CYANOBACTERIUM
SYMBIONT
PHOTOSYNTHESIS
PROVIDES: GLUCOSE**

**FUNGUS SYMBIONT
PROVIDES: SECURITY**

MUTUALISM

SYMBIOSIS



L.S.

ENDOSYMBIOSIS

ENDOSYMBIOSIS

ENDOSYMBIOSIS



ONE SPECIES
EXISTS WITHIN A
SECOND HOST SPECIES

ENDOSYMBIOSIS

PLANT CELL

P

CHLOROPLASTS

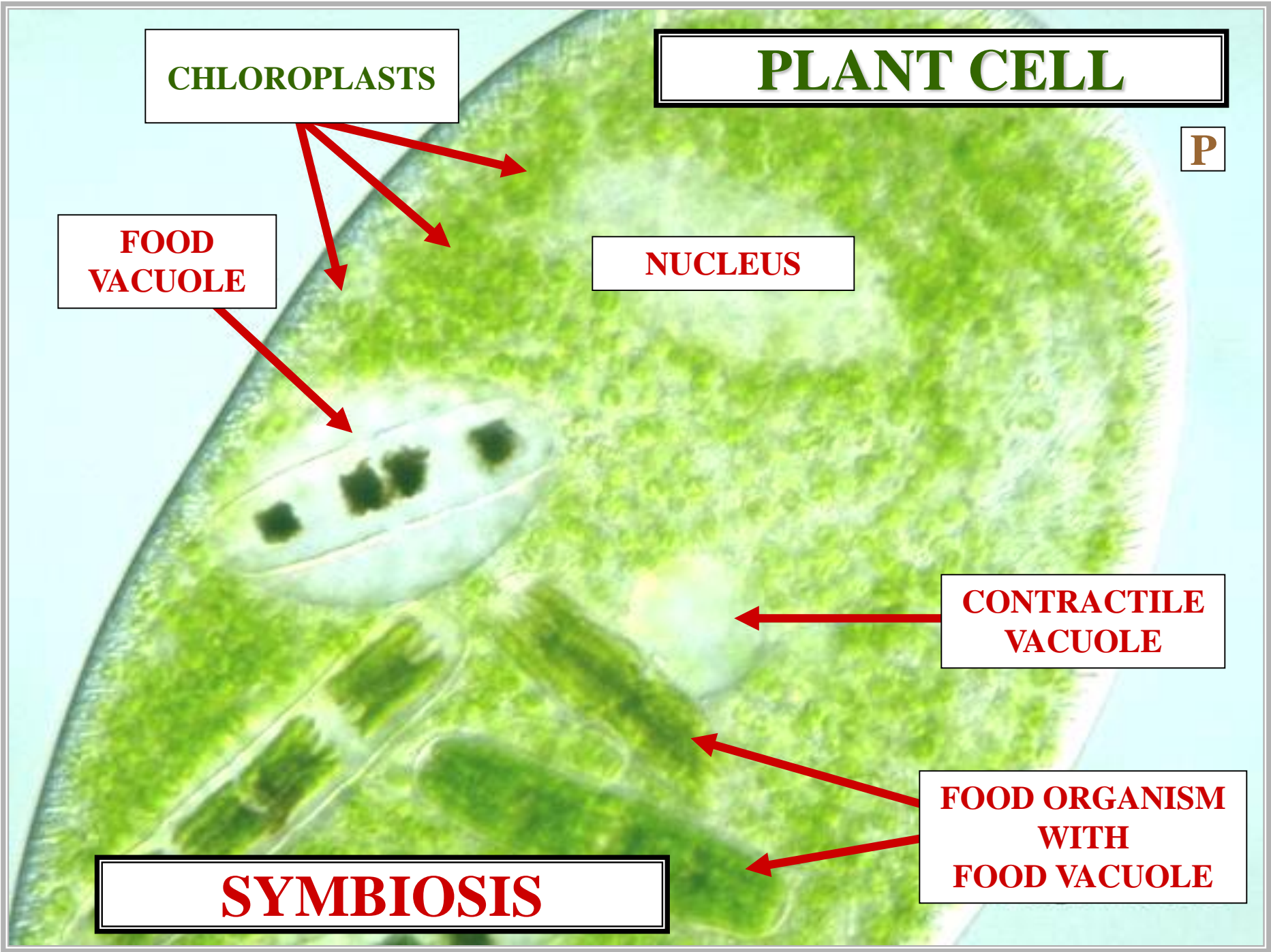
FOOD
VACUOLE

NUCLEUS

CONTRACTILE
VACUOLE

FOOD ORGANISM
WITH
FOOD VACUOLE

SYMBIOSIS



PROTOZOAN

G

CHLOROPLASTS

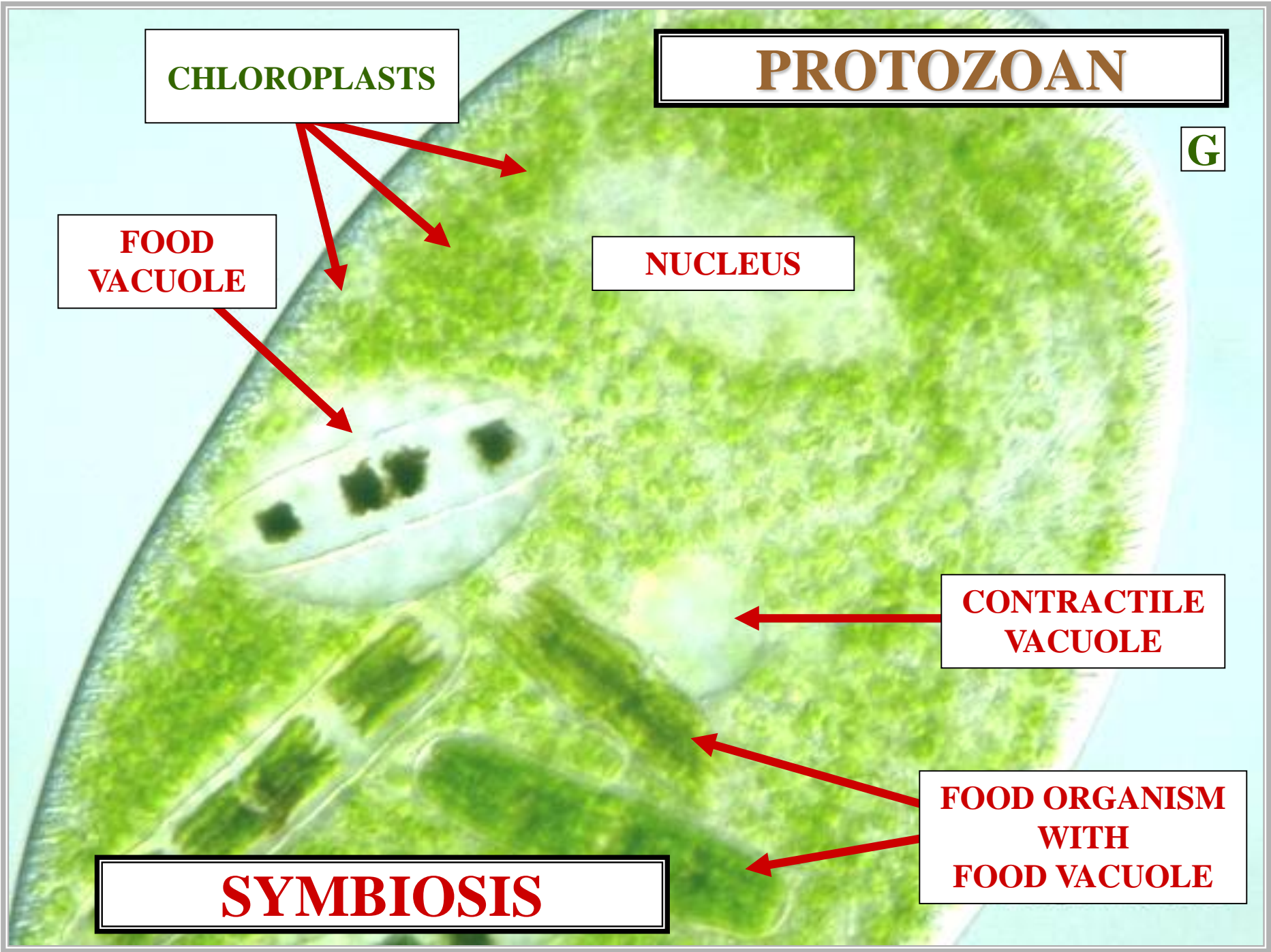
FOOD
VACUOLE

NUCLEUS

CONTRACTILE
VACUOLE

FOOD ORGANISM
WITH
FOOD VACUOLE

SYMBIOSIS



PROTOZOAN

E

**SYMBIOTIC
GREEN ALGAE**

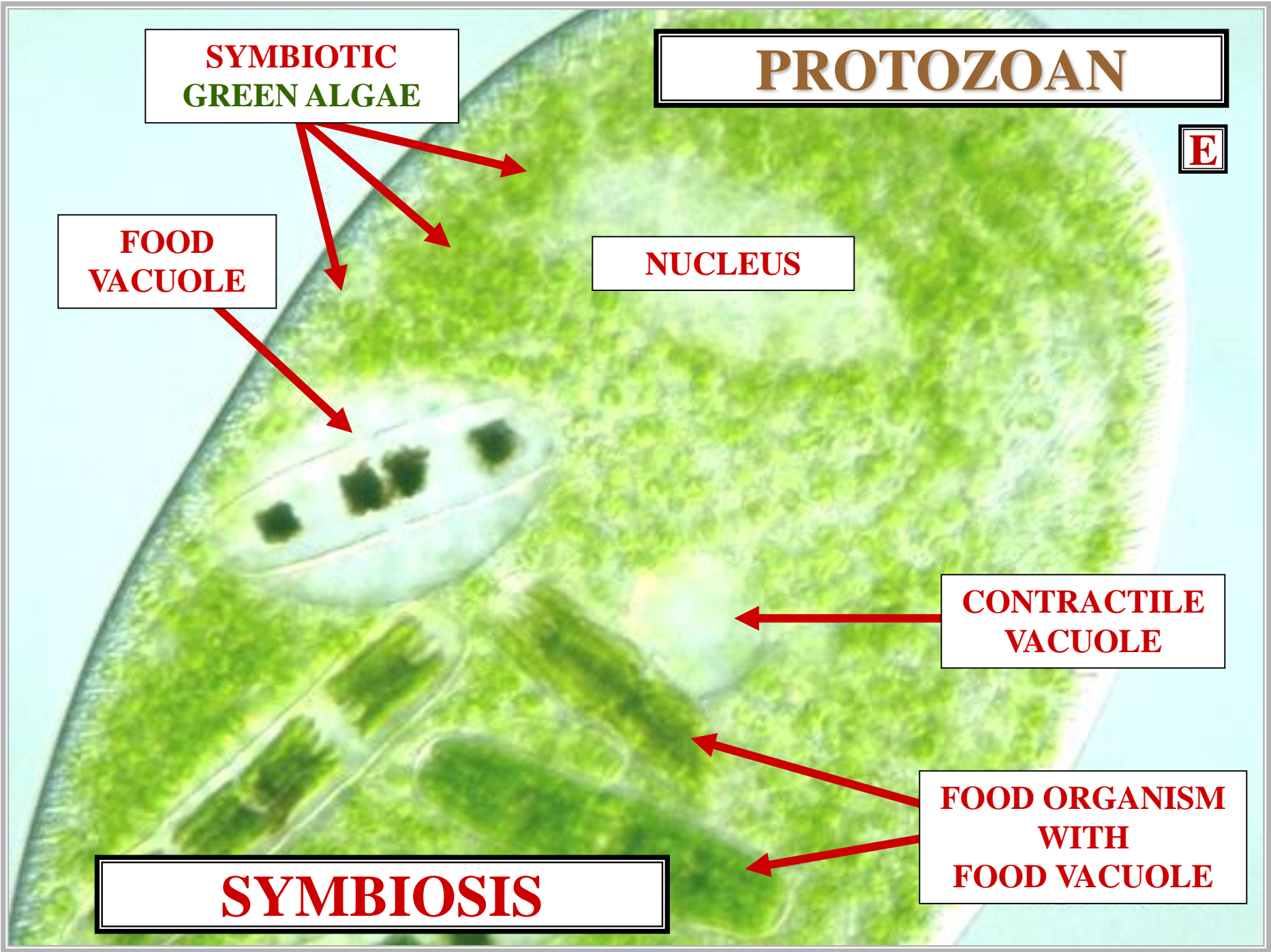
**FOOD
VACUOLE**

NUCLEUS

**CONTRACTILE
VACUOLE**

**FOOD ORGANISM
WITH
FOOD VACUOLE**

SYMBIOSIS



PROTOZOAN

**ENDOSYMBIOTIC
GREEN ALGAE**

**FOOD
VACUOLE**

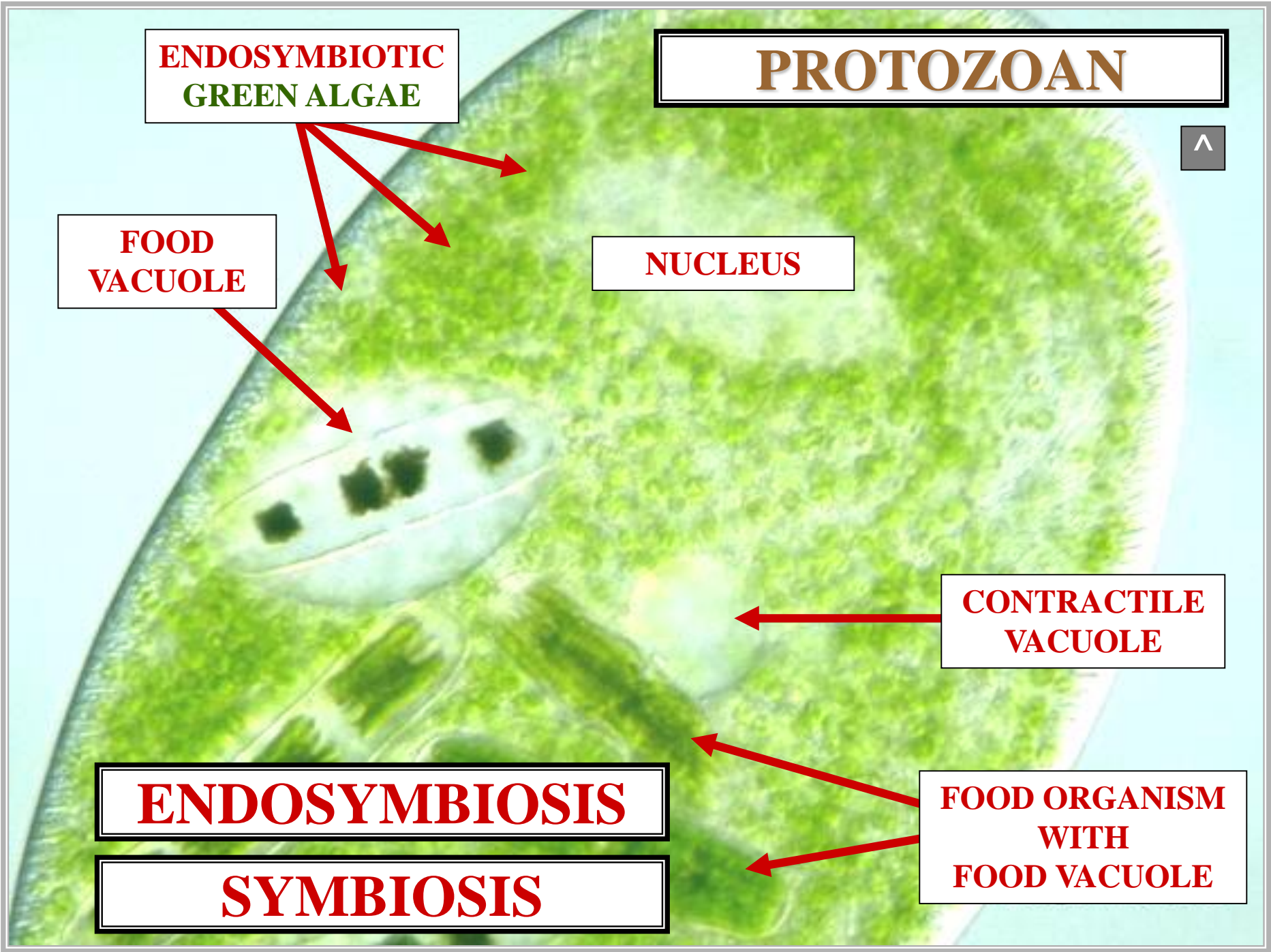
NUCLEUS

**CONTRACTILE
VACUOLE**

ENDOSYMBIOSIS

SYMBIOSIS

**FOOD ORGANISM
WITH
FOOD VACUOLE**





PLASTID EVOLUTION

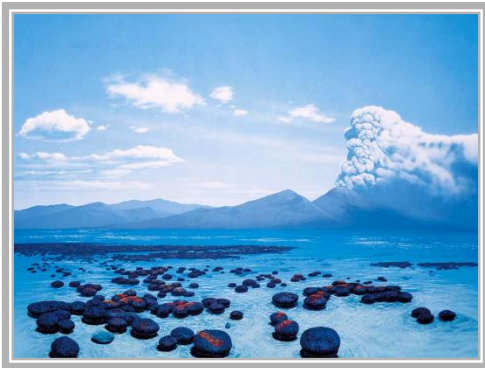


**PLASTID
EVOLUTION
HYPOTHETICAL
SCENARIO**

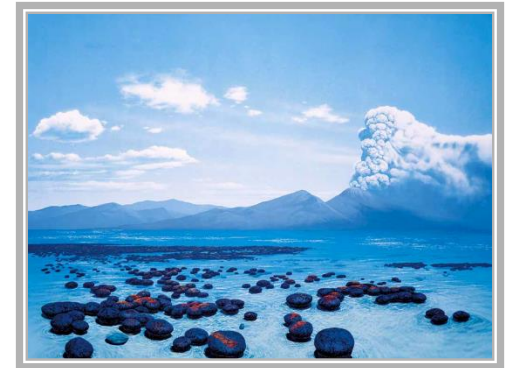
**HETEROTROPHIC
HOST CELL**
DNA W\ HISTONE PROTEINS
LARGE RIBOSOMES

**AUTOTROPHIC
PROKARYOTE**
DNA W\OUT HISTONE PROTEINS
SMALL RIBOSOMES

**HETEROTROPHIC
HOST CELL
DNA W\ HISTONE PROTEINS
LARGE RIBOSOMES**



**AUTOTROPHIC
PROKARYOTE
DNA W\OUT HISTONE PROTEINS
SMALL RIBOSOMES**



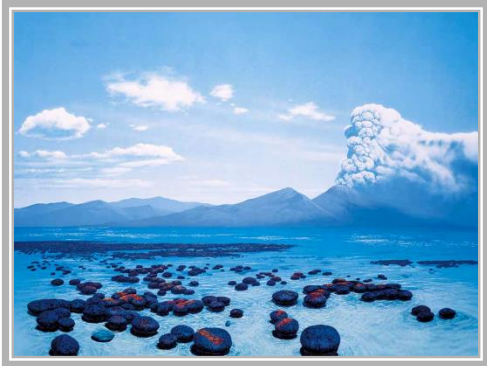
HETEROTROPH & AUTOTROPH: SAME HABITAT

**HETEROTROPHIC
HOST CELL**

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES

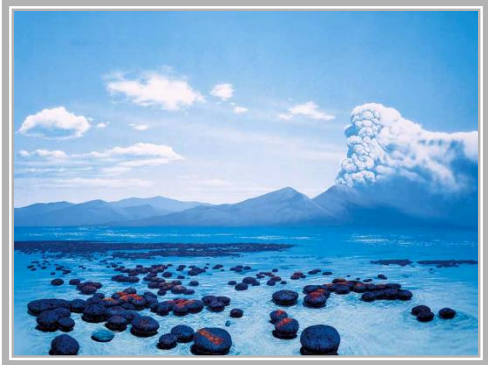
***CANNOT DERIVED* GLUCOSE**



**AUTOTROPHIC
PROKARYOTE**

PHOTOSYNTHESIS

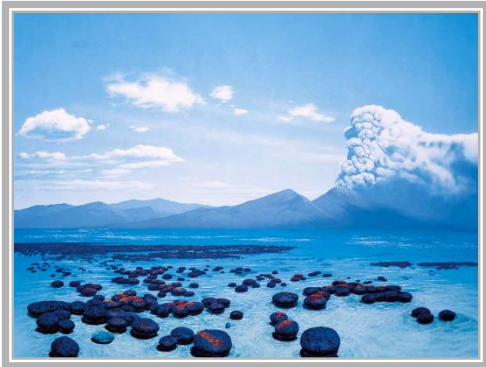
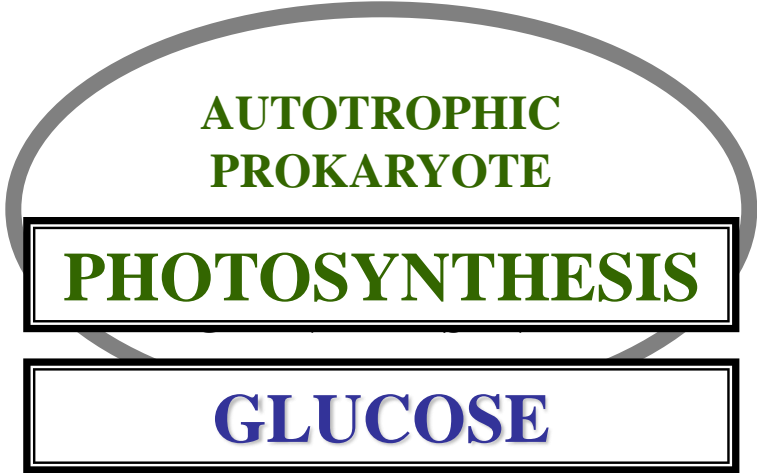
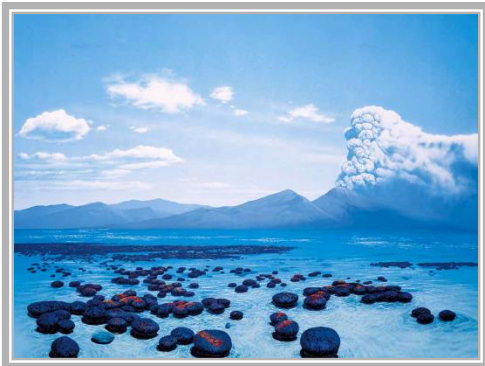
GLUCOSE



**HETEROTROPHIC
HOST CELL**

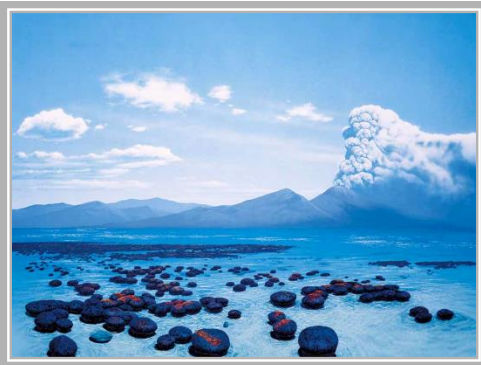
CONSUMES OTHER ORGANISMS

CONSUMES AUTOTROPH



**HETEROTROPHIC
HOST CELL**

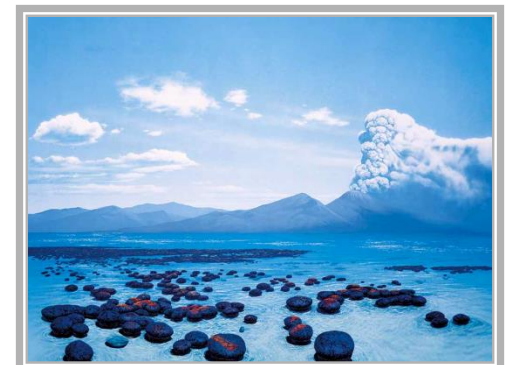
**CONSUMES OTHER ORGANISMS
CONSUMES AUTOTROPH
VIA ENDOCYTOSIS**



**AUTOTROPHIC
PROKARYOTE**

PHOTOSYNTHESIS

GLUCOSE



HETEROTROPH CONSUMES AUTOTROPH

**HETEROTROPHIC
HOST CELL**

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES

**AUTOTROPHIC
PROKARYOTE**

CHL A&B + CAROTENOIDS

GRANA PRESENT

ENDOCYTOSIS



ENDOCYTOSIS



ENDOCYTOSIS

**CELL MEMBRANE
ENGULFMENT
INTO HOST CELL**

ENDOCYTOSIS

**HETEROTROPHIC
HOST CELL**

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES

**CELL MEMBRANE
ENGULFMENT**

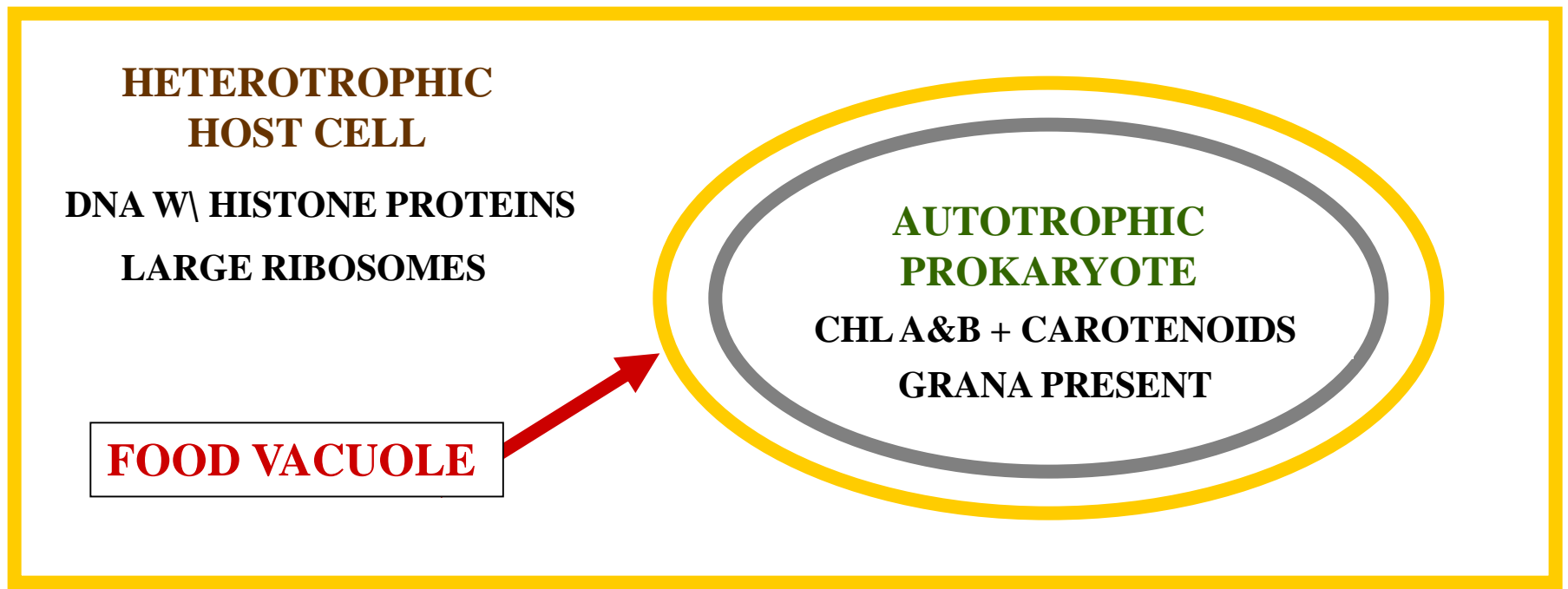
ENDOCYTOSIS

**AUTOTROPHIC
PROKARYOTE**

CHL A&B + CAROTENOIDS

GRANA PRESENT

AUTOTROPH WITHIN HETEROTROPH FOOD VACUOLE



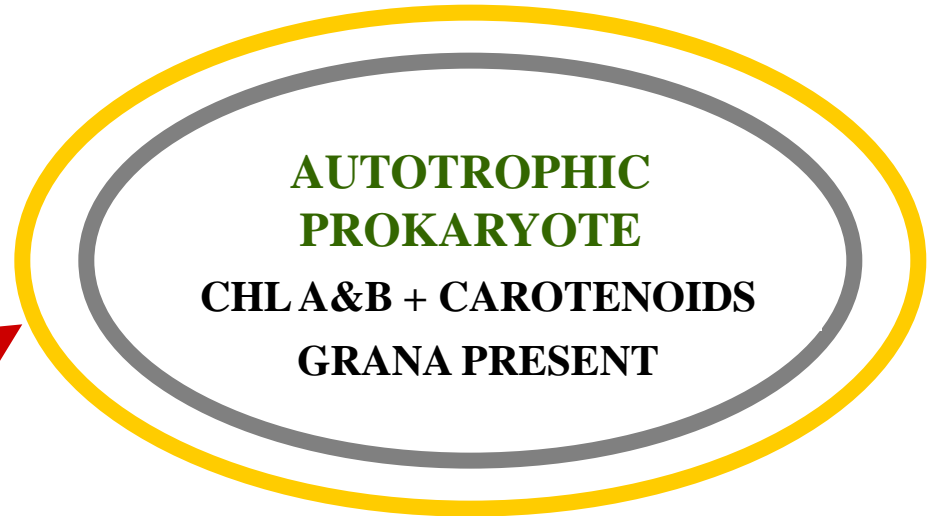


INITIALLY HETEROTROPH DIGESTS AUTOTROPH

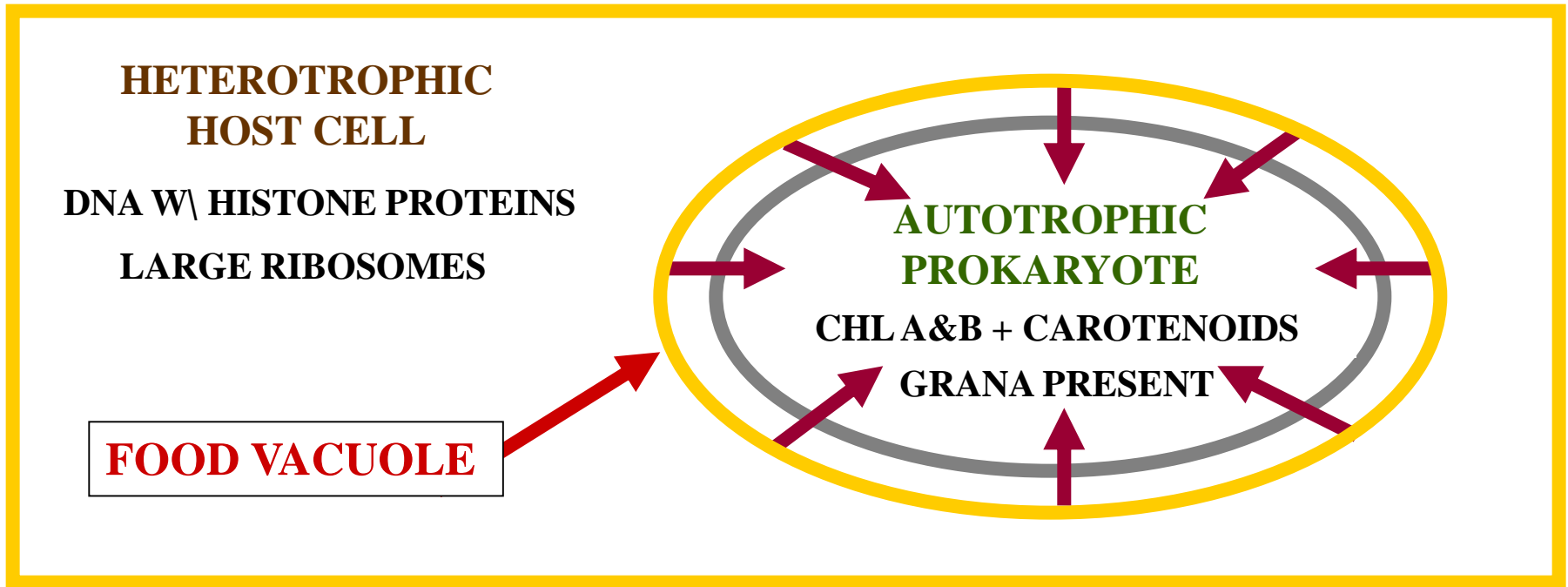
**HETEROTROPHIC
HOST CELL**

**DNA W\ HISTONE PROTEINS
LARGE RIBOSOMES**

FOOD VACUOLE

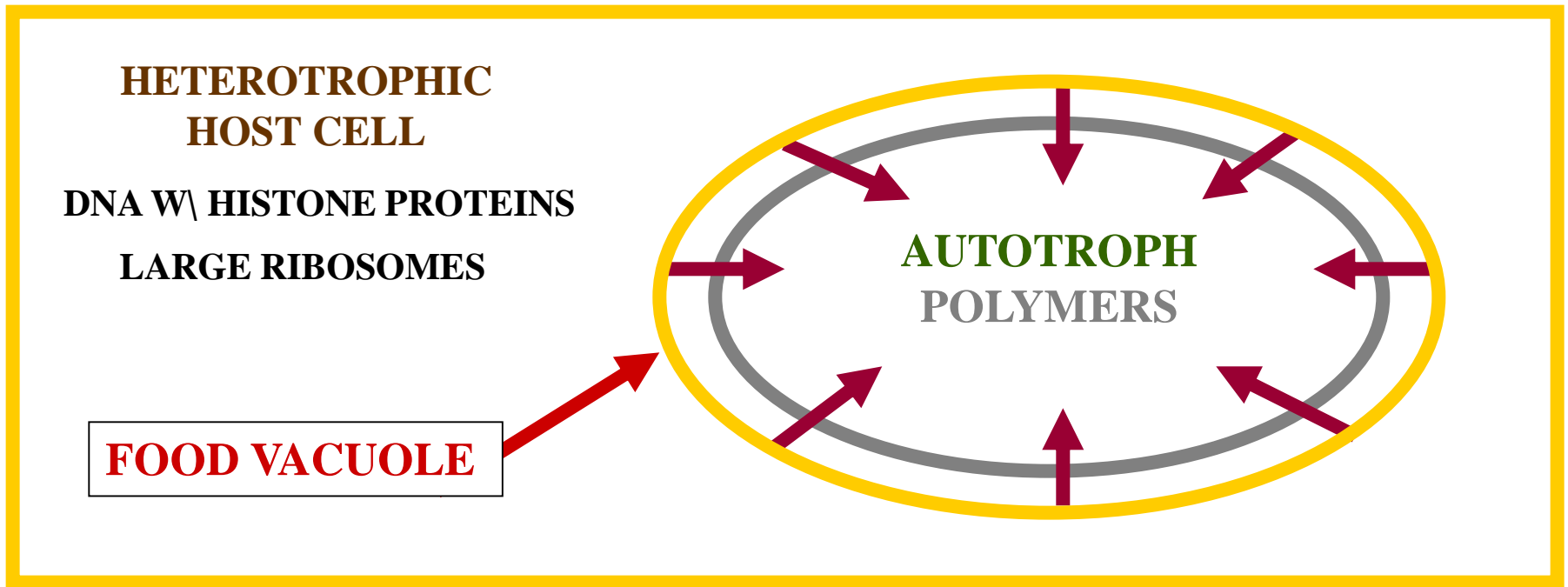


INITIALLY HETEROTROPH DIGESTS AUTOTROPH



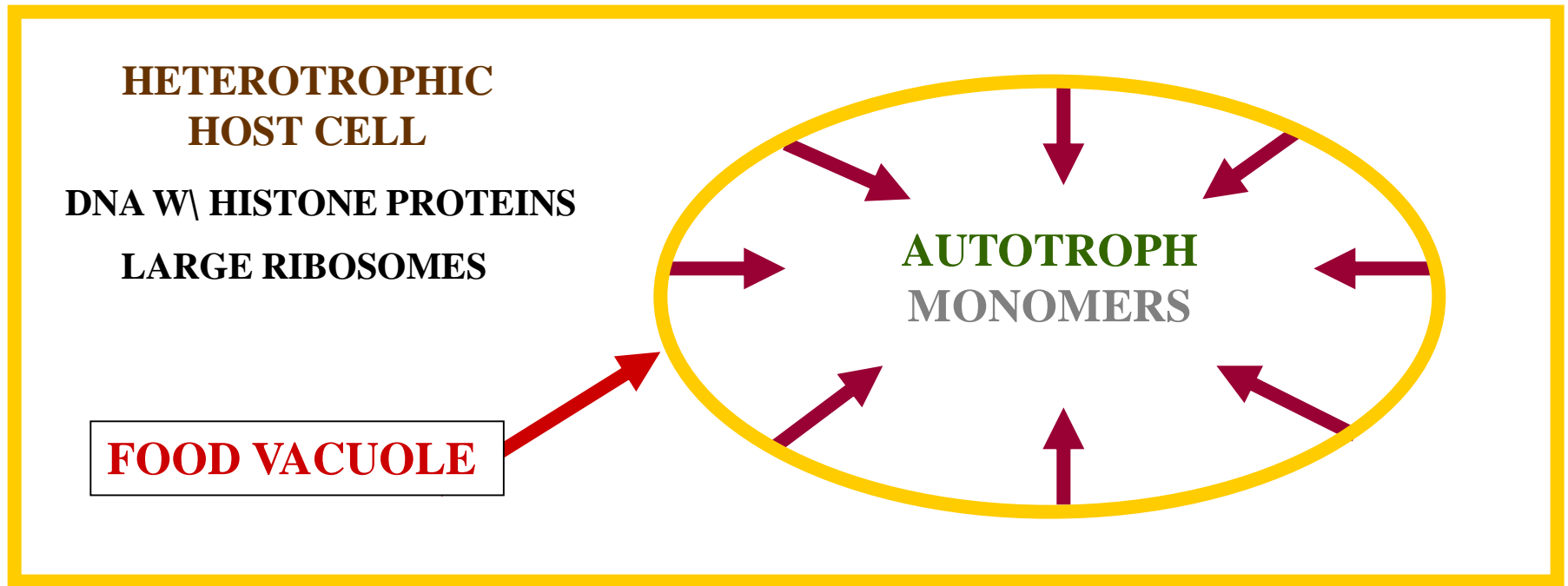
➔ = ENZYMES

INITIALLY HETEROTROPH DIGESTS AUTOTROPH



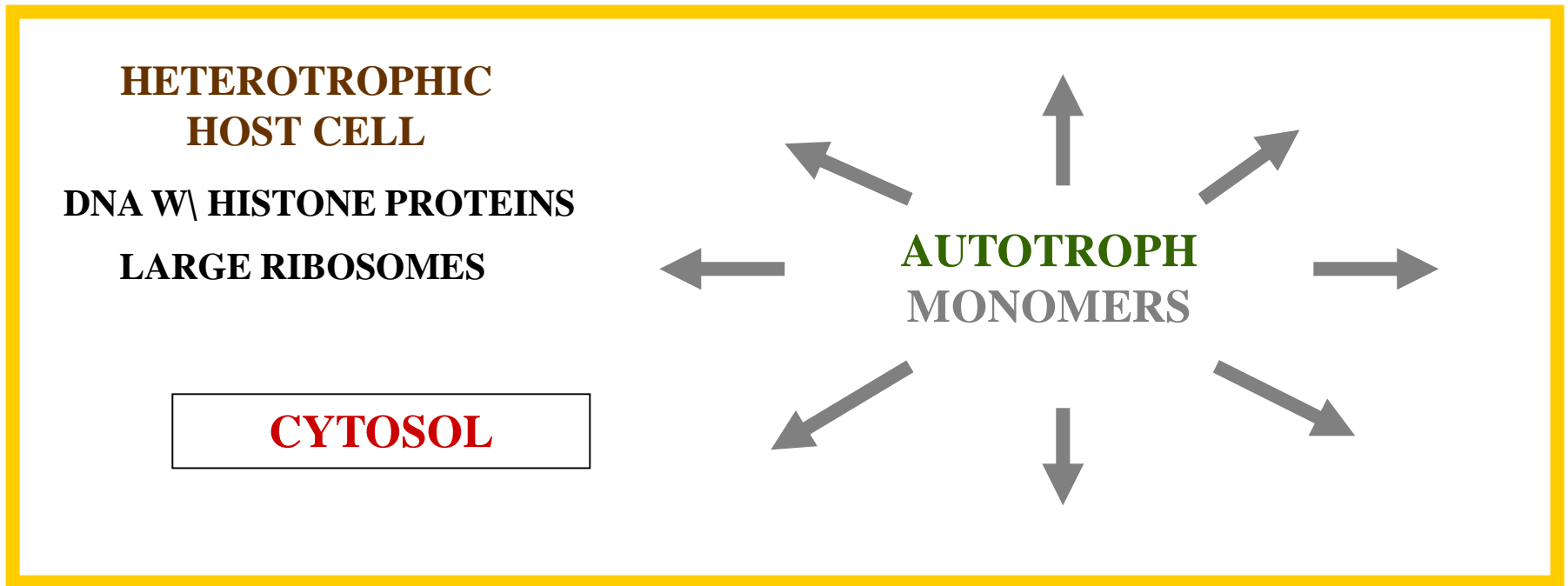
➔ = ENZYMES

INITIALLY HETEROTROPH DIGESTS AUTOTROPH

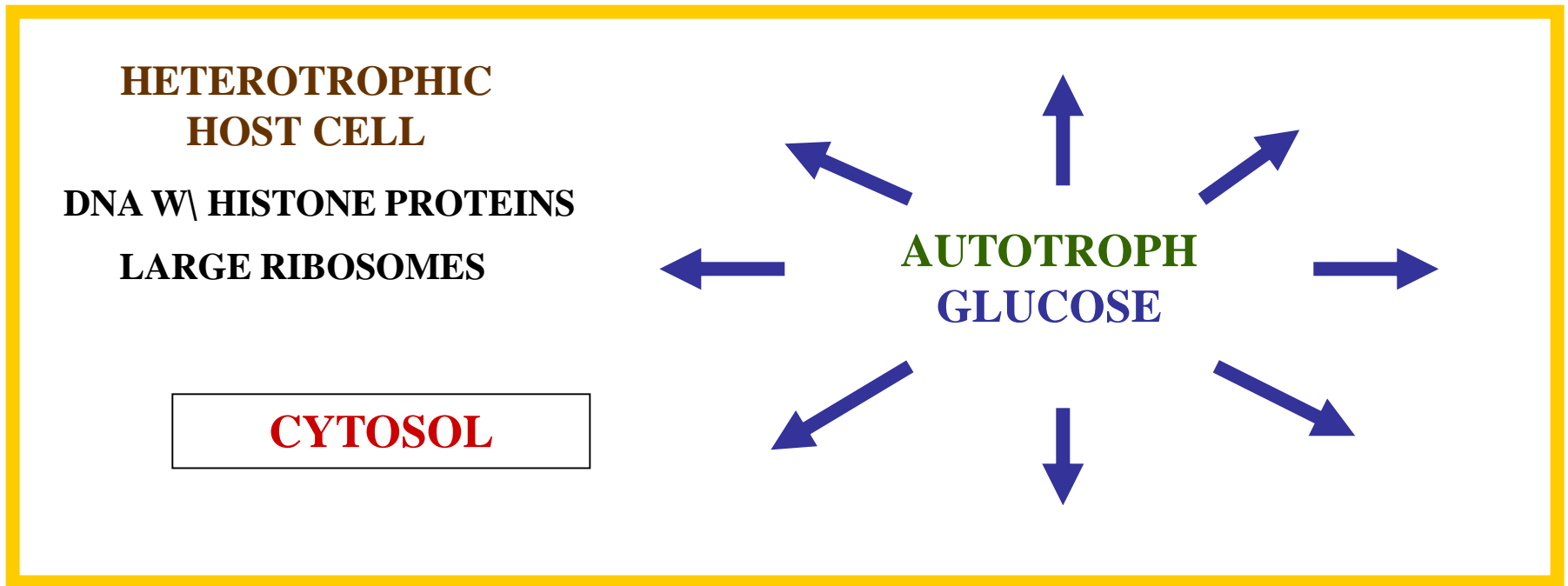


→ = ENZYMES

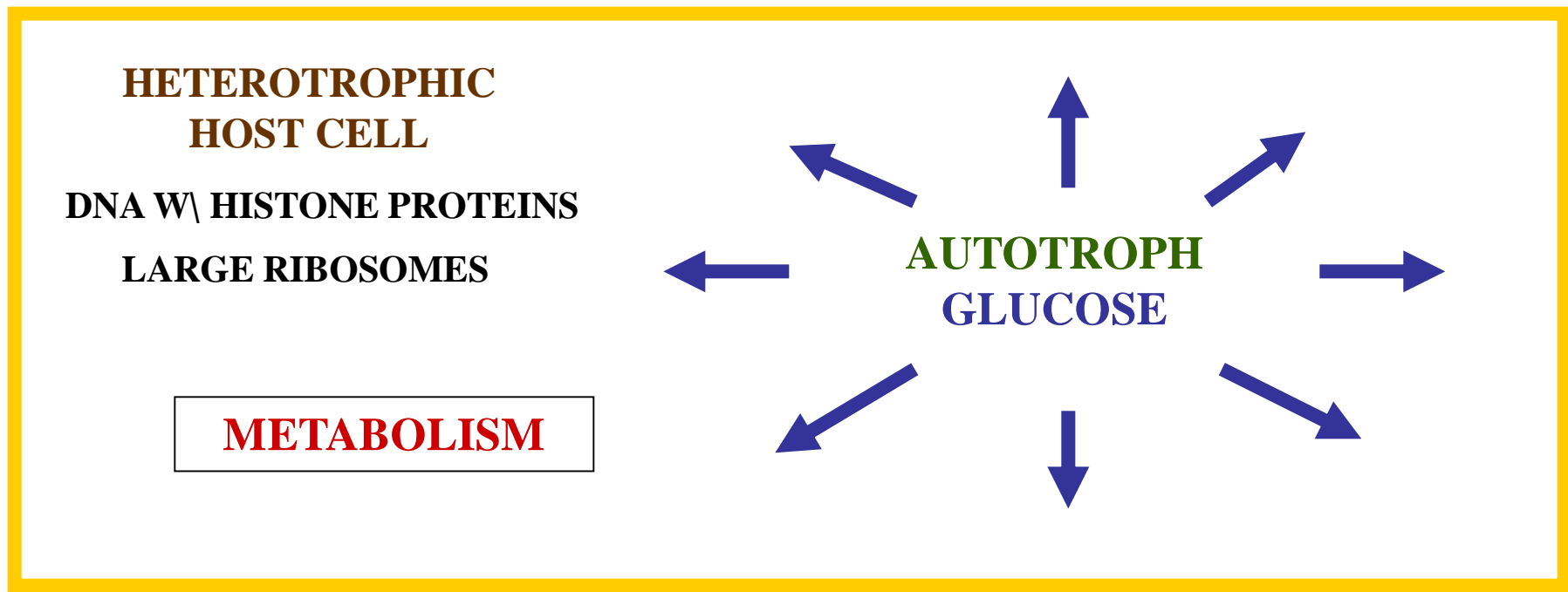
INITIALLY HETEROTROPH DIGESTS AUTOTROPH



INITIALLY HETEROTROPH DIGESTS AUTOTROPH



INITIALLY HETEROTROPH DIGESTS AUTOTROPH



EVENTUALLY

“DAWNS ON HETEROTROPH”

**HETEROTROPHIC
HOST CELL**

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES

**AUTOTROPHIC
PROKARYOTE**

CHL A&B + CAROTENOIDS

GRANA PRESENT

EVENTUALLY

“DAWNS ON HETEROTROPH”

**HETEROTROPHIC
HOST CELL**

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES

**AUTOTROPHIC
PROKARYOTE**

PHOTOSYNTHESIS

EVENTUALLY

“DAWNS ON HETEROTROPH”

**HETEROTROPHIC
HOST CELL**

DNA W\ HISTONE PROTEINS

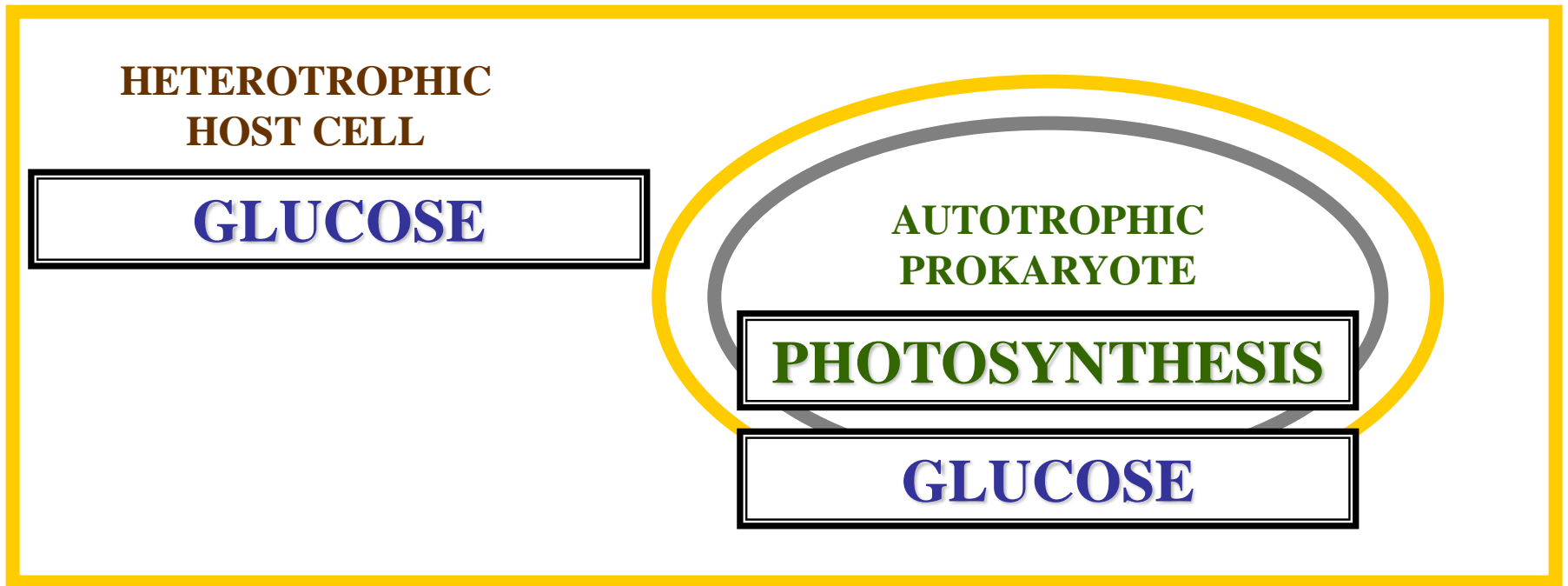
LARGE RIBOSOMES

**AUTOTROPHIC
PROKARYOTE**

PHOTOSYNTHESIS

GLUCOSE

EVENTUALLY “DAWNS ON HETEROTROPH”



AUTOTROPH LIVING WITHIN HETEROTROPH



**2 SPECIES LIVING
INTRICATE ASSOCIATION**

SYMBIOSIS



EN

**HETEROTROPHIC
HOST CELL**

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES

**AUTOTROPHIC
PROKARYOTE**

CHL A&B + CAROTENOIDS

GRANA PRESENT



SYMBIOSIS

ENDOSYMBIOSIS

**HETEROTROPHIC
HOST CELL**

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES

**AUTOTROPHIC
PROKARYOTE**

CHL A&B + CAROTENOIDS

GRANA PRESENT

SYMBIOSIS

ENDOSYMBIOSIS

**HETEROTROPHIC
HOST CELL**

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES

**AUTOTROPHIC
PROKARYOTE**

CHL A&B + CAROTENOIDS

GRANA PRESENT

**AUTOTROPH PROVIDES
HETEROTROPH WITH?**

SYMBIOSIS

ENDOSYMBIOSIS

**HETEROTROPHIC
HOST CELL**

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES

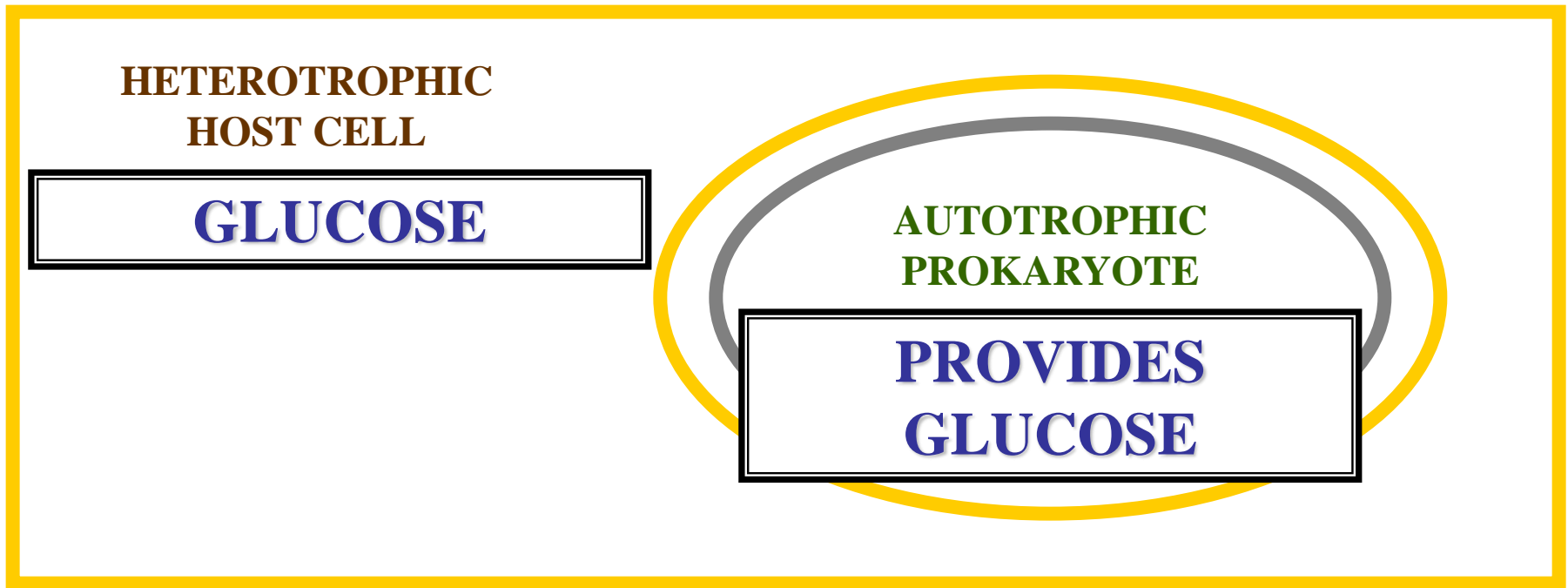
**AUTOTROPHIC
PROKARYOTE**

PHOTOSYNTHESIS

**AUTOTROPH PROVIDES
HETEROTROPH WITH?**

SYMBIOSIS

ENDOSYMBIOSIS



**AUTOTROPH PROVIDES
GLUCOSE**

SYMBIOSIS

ENDOSYMBIOSIS

**HETEROTROPHIC
HOST CELL**

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES

**AUTOTROPHIC
PROKARYOTE**

CHL A&B + CAROTENOIDS

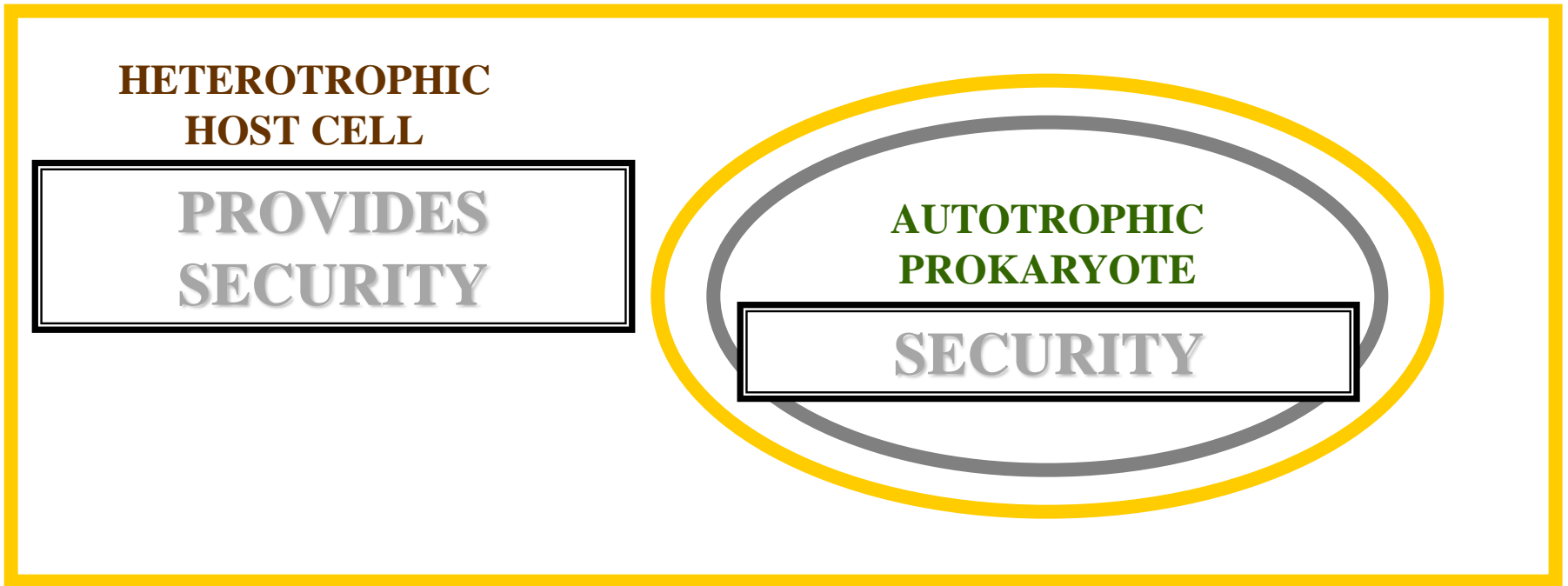
GRANA PRESENT

**HETEROTROPH PROVIDES
AUTOTROPH WITH?**



SYMBIOSIS

ENDOSYMBIOSIS



**HETEROTROPH PROVIDES
SECURITY**

SYMBIOSIS

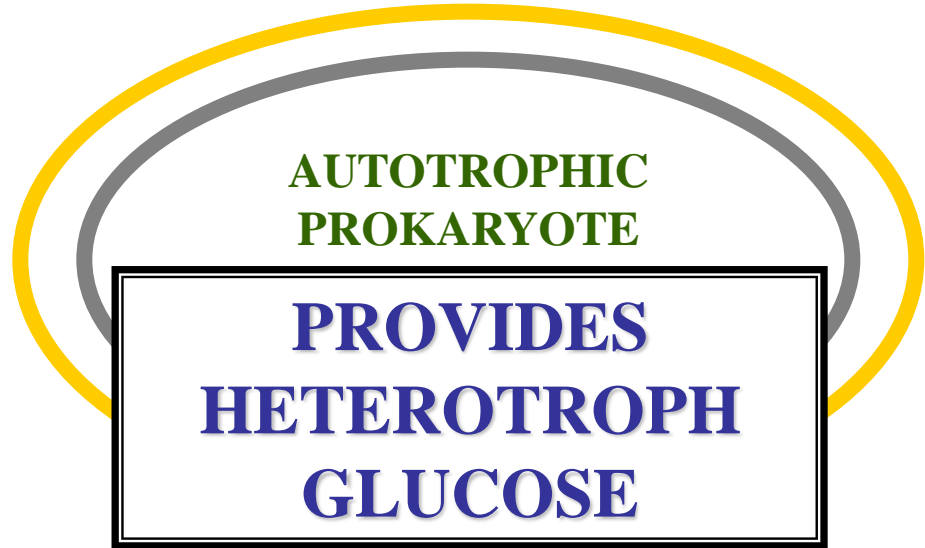
ENDOSYMBIOSIS

**HETEROTROPHIC
HOST CELL**

**PROVIDES
AUTOTROPH
SECURITY**

**AUTOTROPHIC
PROKARYOTE**

**PROVIDES
HETEROTROPH
GLUCOSE**



SYMBIOSIS

ENDOSYMBIOSIS

**HETEROTROPHIC
HOST CELL**

**PROVIDES
AUTOTROPH
SECURITY**

**AUTOTROPHIC
PROKARYOTE**

**PROVIDES
HETEROTROPH
GLUCOSE**

MUTUALISTIC ENDOSYMBIOSIS

MUTUALISTIC ENDOSYMBIOSIS

**HETEROTROPHIC
HOST CELL**

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES

**AUTOTROPHIC
PROKARYOTE**

CHL A&B + CAROTENOIDS

GRANA PRESENT

GIVEN LONG TIME PERIOD

OBLIGATE DEPENDENT RELATIONSHIP EVOLVES

**HETEROTROPHIC
HOST CELL**

**DNA W\ HISTONE PROTEINS
LARGE RIBOSOMES**

**AUTOTROPHIC
PROKARYOTE**

**CHL A&B + CAROTENOIDS
GRANA PRESENT**

**SYMBIONTS CANNOT
EXIST INDEPENDENTLY**

AUTOTROPHIC PROKARYOTE

**HETEROTROPHIC
HOST CELL**

DNA W\ HISTONE PROTEINS

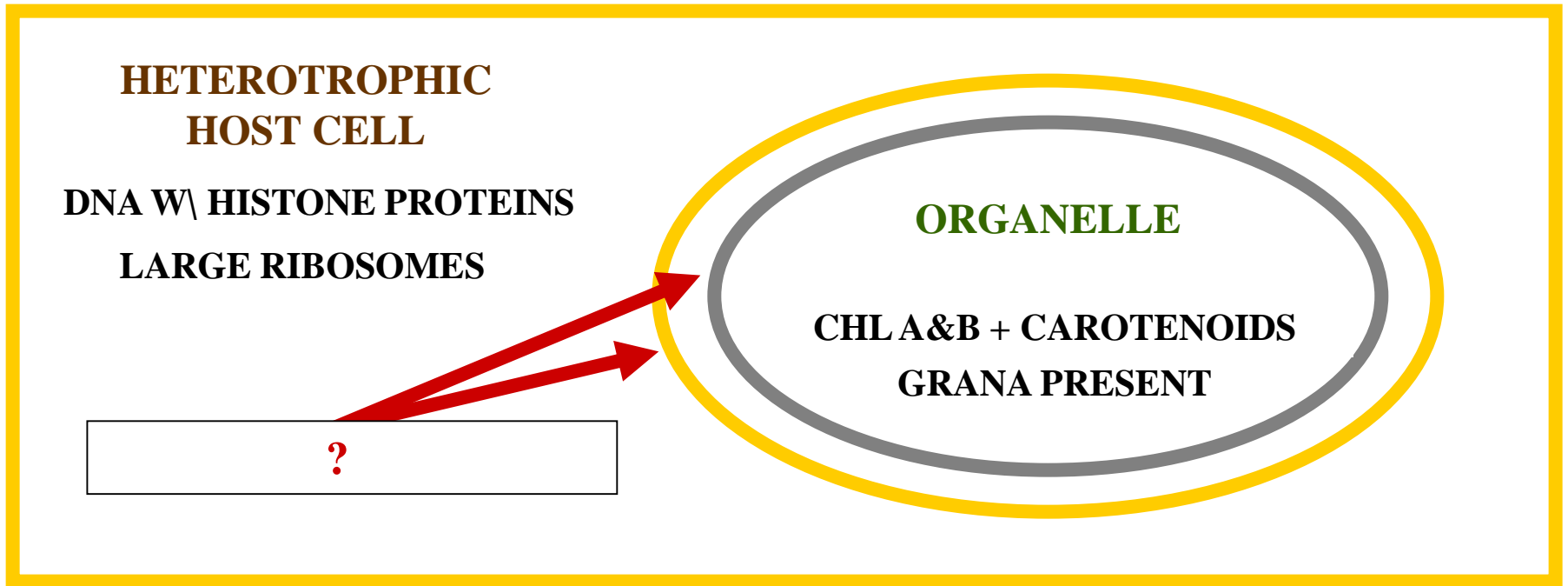
LARGE RIBOSOMES

**AUTOTROPHIC
BECOMES?**

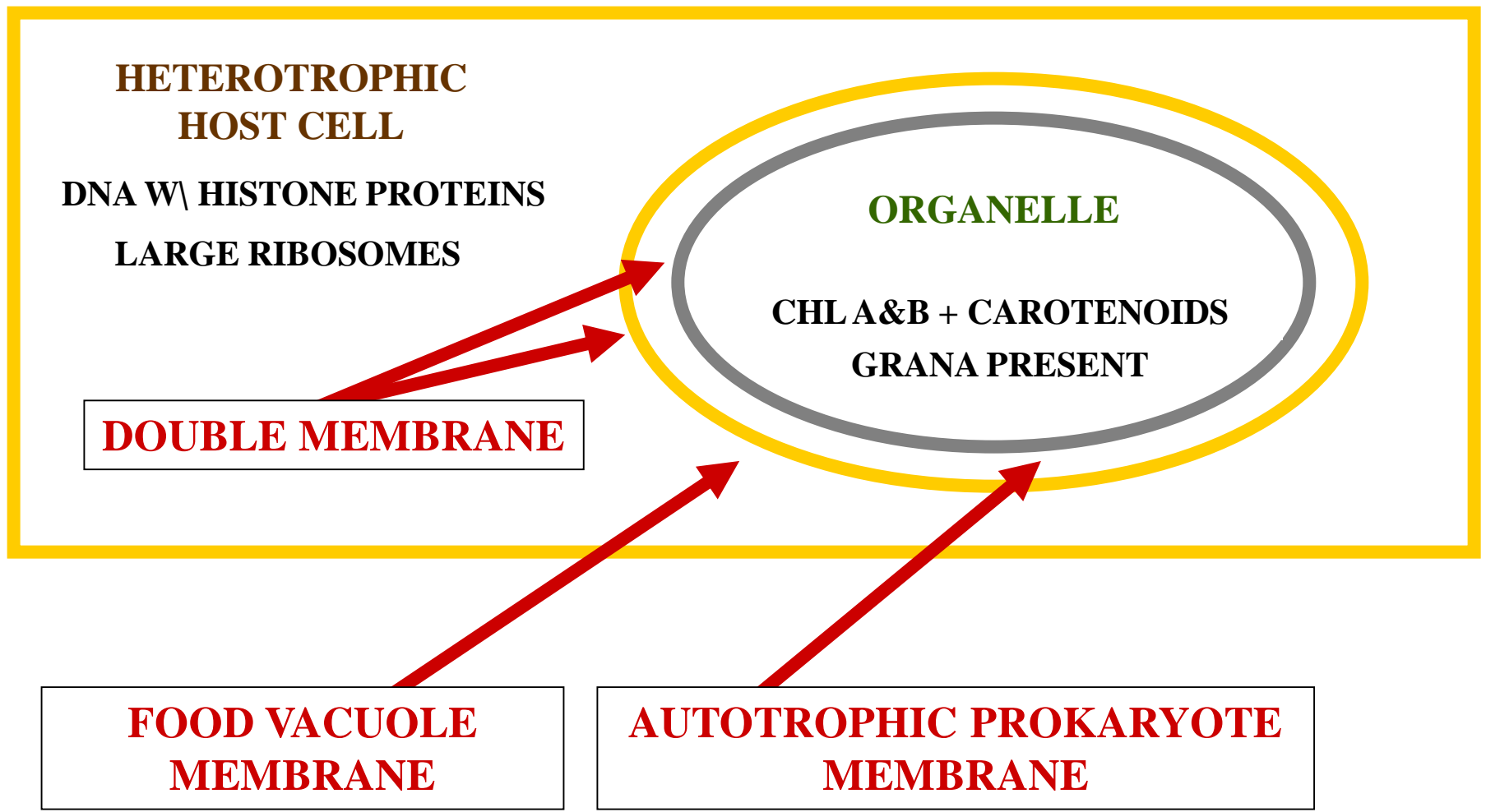
CHL A&B + CAROTENOIDS

GRANA PRESENT

AUTOTROPHIC ORGANELLE



AUTOTROPHIC ORGANELLE



AUTOTROPHIC ORGANELLE

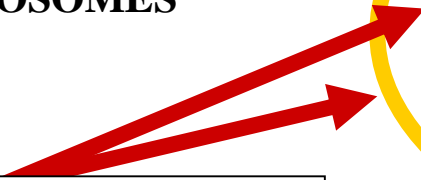
**HETEROTROPHIC
HOST CELL**

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES

DOUBLE MEMBRANE

ORGANELLE
PHOTOSYNTHESIS
CHL A&B + CAROTENOIDS
GRANA PRESENT



AUTOTROPHIC ORGANELLE



CL

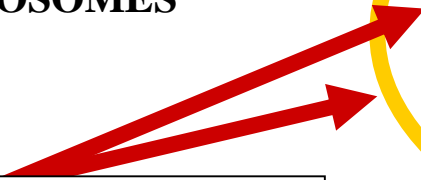
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**PLASTID
CHLOROPLAST**

CHL A&B + CAROTENOIDS

GRANA PRESENT

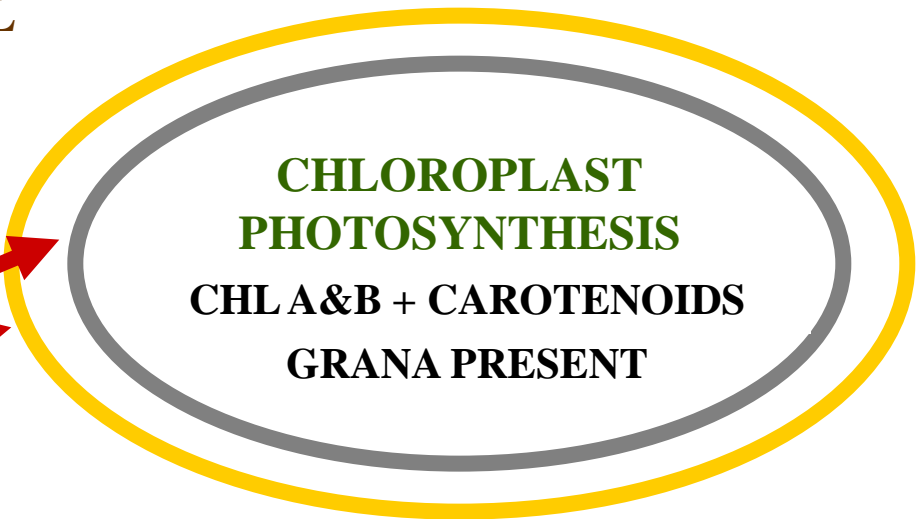


HETEROTROPHIC HOST CELL

**HETEROTROPHIC HOST CELL
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PHOTOSYNTHESIS
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AUTOTROPHIC ORGANISM

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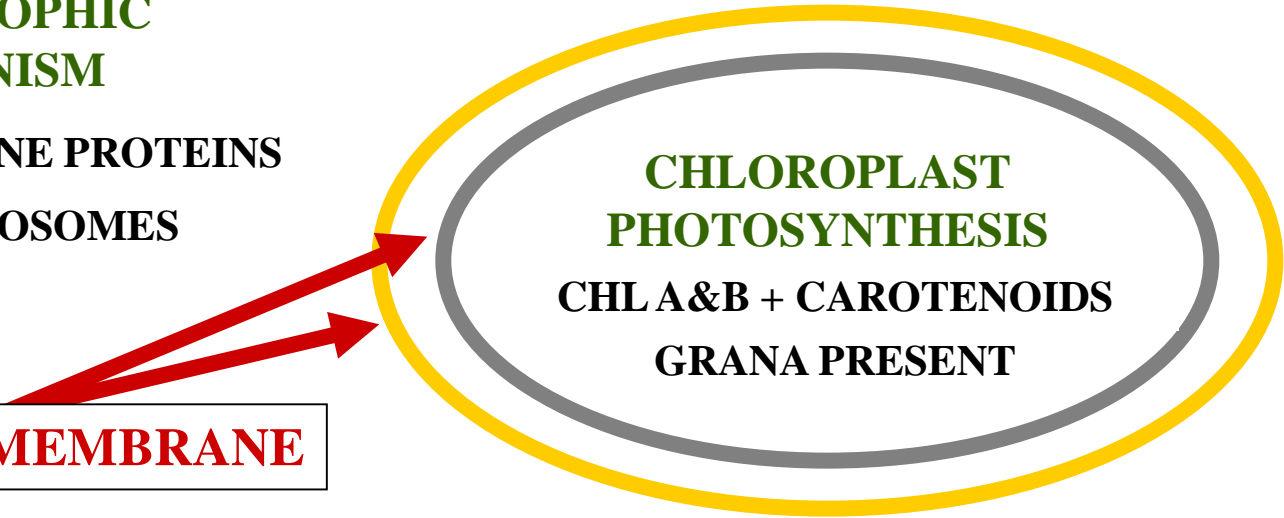
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PLANT CELL

EUKARYOTE CELL

A transmission electron micrograph (TEM) of a eukaryotic cell, likely a plant cell, showing a chloroplast. The chloroplast is a large, oval-shaped organelle with a double membrane and internal stacks of thylakoids (grana) connected by stroma lamellae. The thylakoids are dark, elongated structures. The surrounding cytoplasm contains various organelles, including a nucleus with a prominent nucleolus and other smaller organelles. The cell wall is visible on the left side.

PLASTID
CHLOROPLAST

A red arrow originates from the text box and points to a specific chloroplast within the cell, highlighting its structure.

ENDOSYMBIOTIC THEORY



MITOCHONDRION EVOLUTION