?

ANSWER

NO

PLASTIDS

ABSENT

ANSWER

QUESTION

WHY ARE WE STUDYING CYANOBACTERIA GREEN BACTERIA?

QUESTION

?

ANSWER

SOME UNKNOWN
CYANOBACTRIUM
WITH POSSIBLE
GREEN BACTERIA
CHARACTERS
EVOLVED TRUE PLANT
CHLOROPLASTS

ANSWER

QUESTION

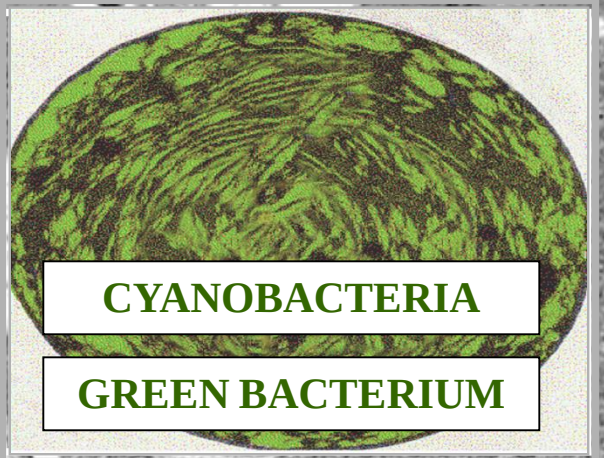
WHAT THEORY GAVE RISE TO TRUE PLANT CHLOROPLAST?

QUESTION

ANSWER

ENDOSYMBIOTIC THEORY

ANSWER



CYANOBACTERIA

GREEN BACTERIUM

SE

+

CHLOROPLAST

ENDOSYMBIOTIC THEORY

TRUE PLANT CELL

ENDOSYMBIOTIC THEORY

CYANOBACTERIUM

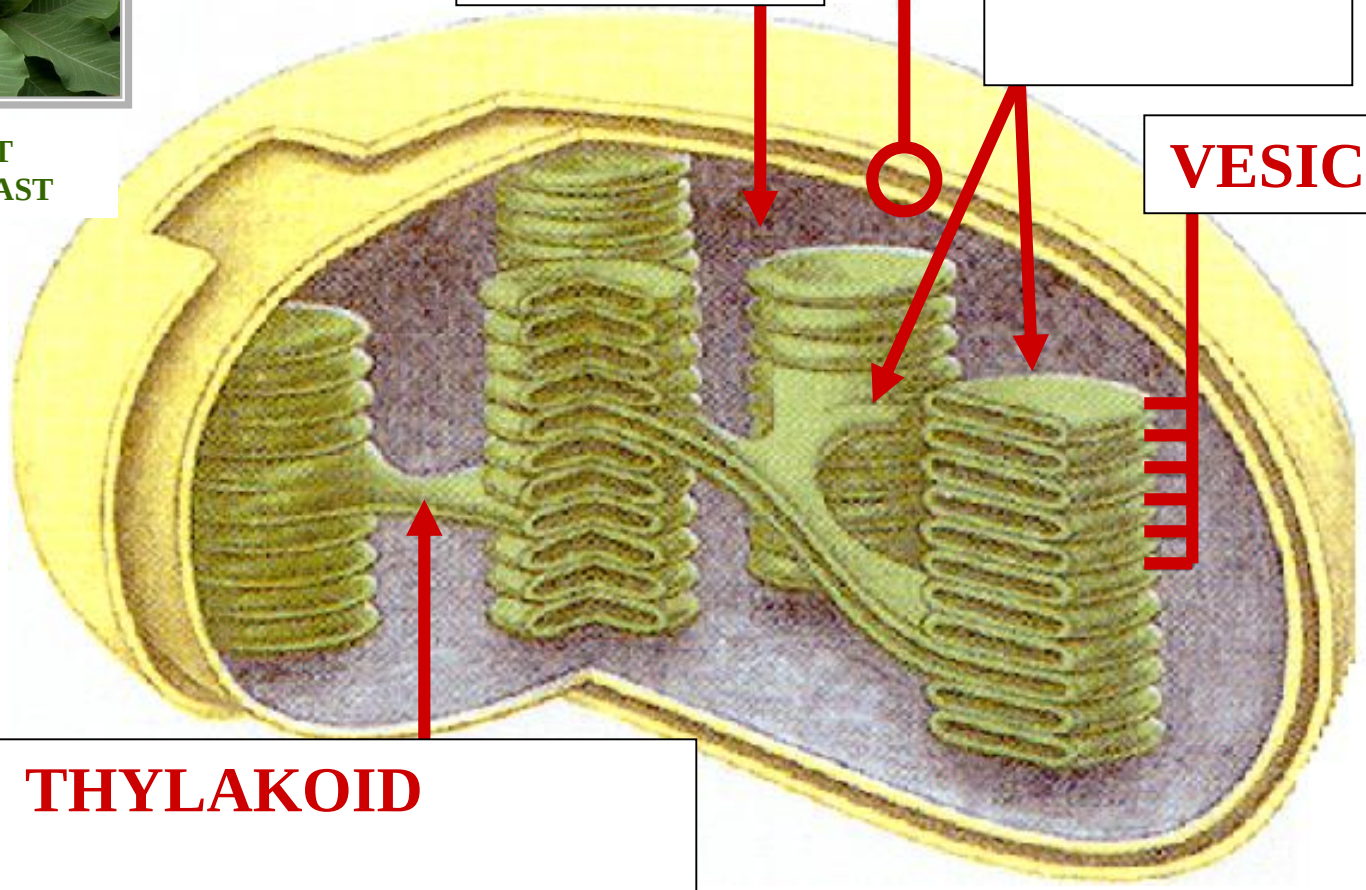
SUPPORTING EVIDENCE

CYANOBACTERIUM
GREEN BACTERIUM

TRUE PLANT
CHLOROPLAST

TRUE PLANT CHLOROPLAST ULTRASTRUCTURE

G



CYANOBACTERIUM
GREEN BACTERIUM

TRUE PLANT
CHLOROPLAST

TRUE PLANT CHLOROPLAST ULTRASTRUCTURE

A

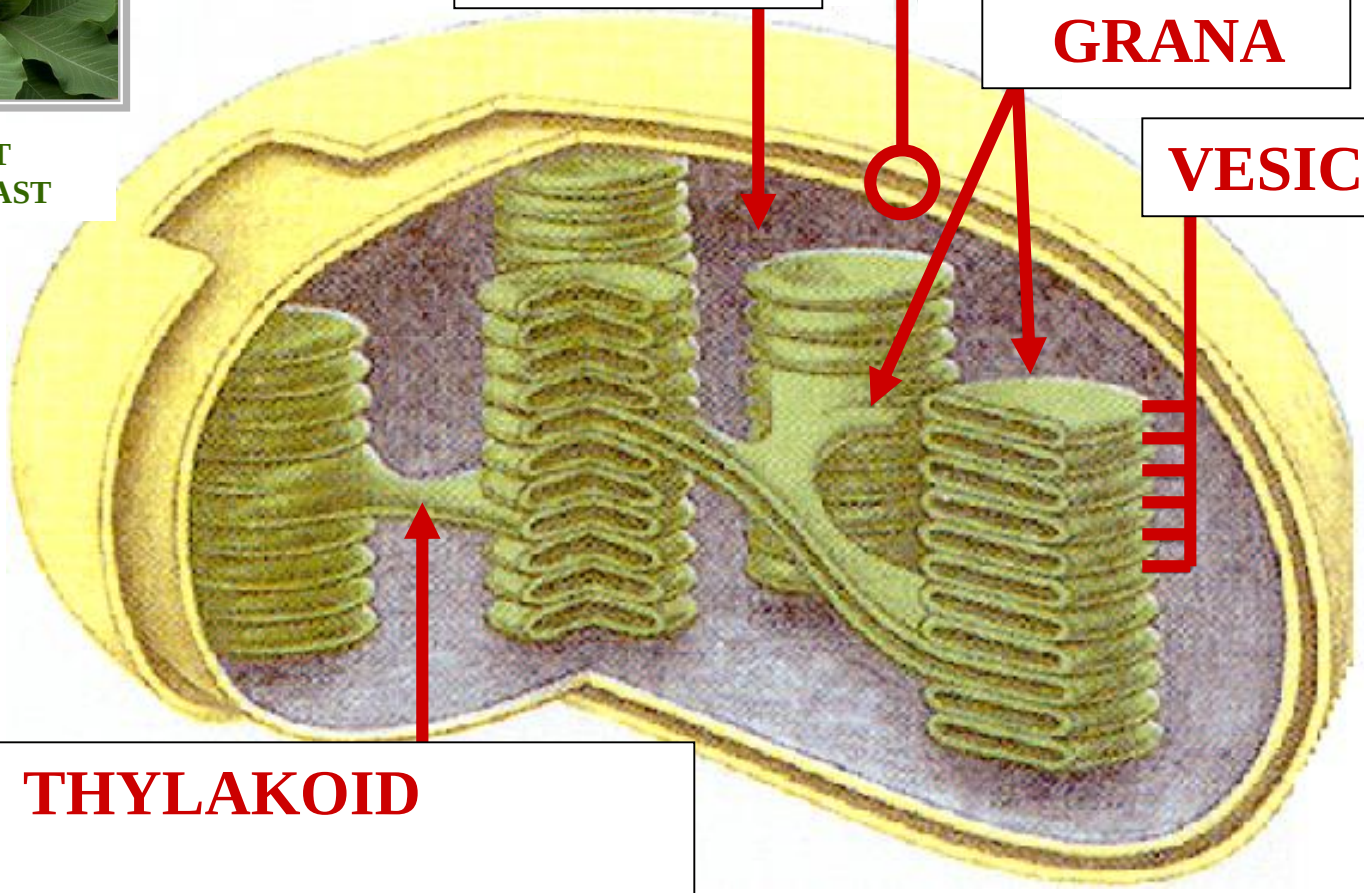
B

STROMA

DOUBLE MEMBRANE

GRANA

VESICLES



THYLAKOID

CYANOBACTERIUM
GREEN BACTERIUM

TRUE PLANT
CHLOROPLAST

C

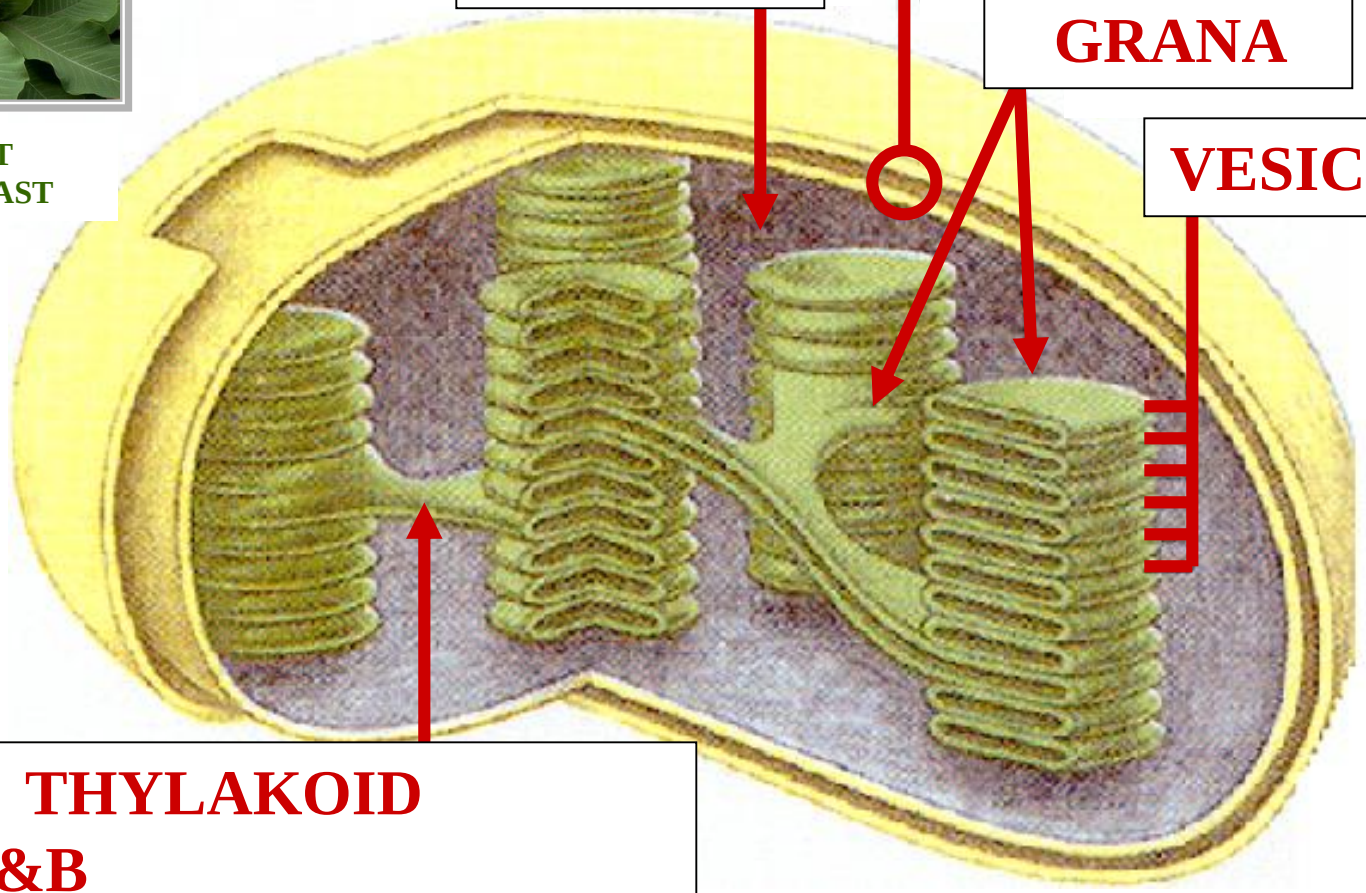
TRUE PLANT CHLOROPLAST ULTRASTRUCTURE

STROMA

DOUBLE MEMBRANE

GRANA

VESICLES



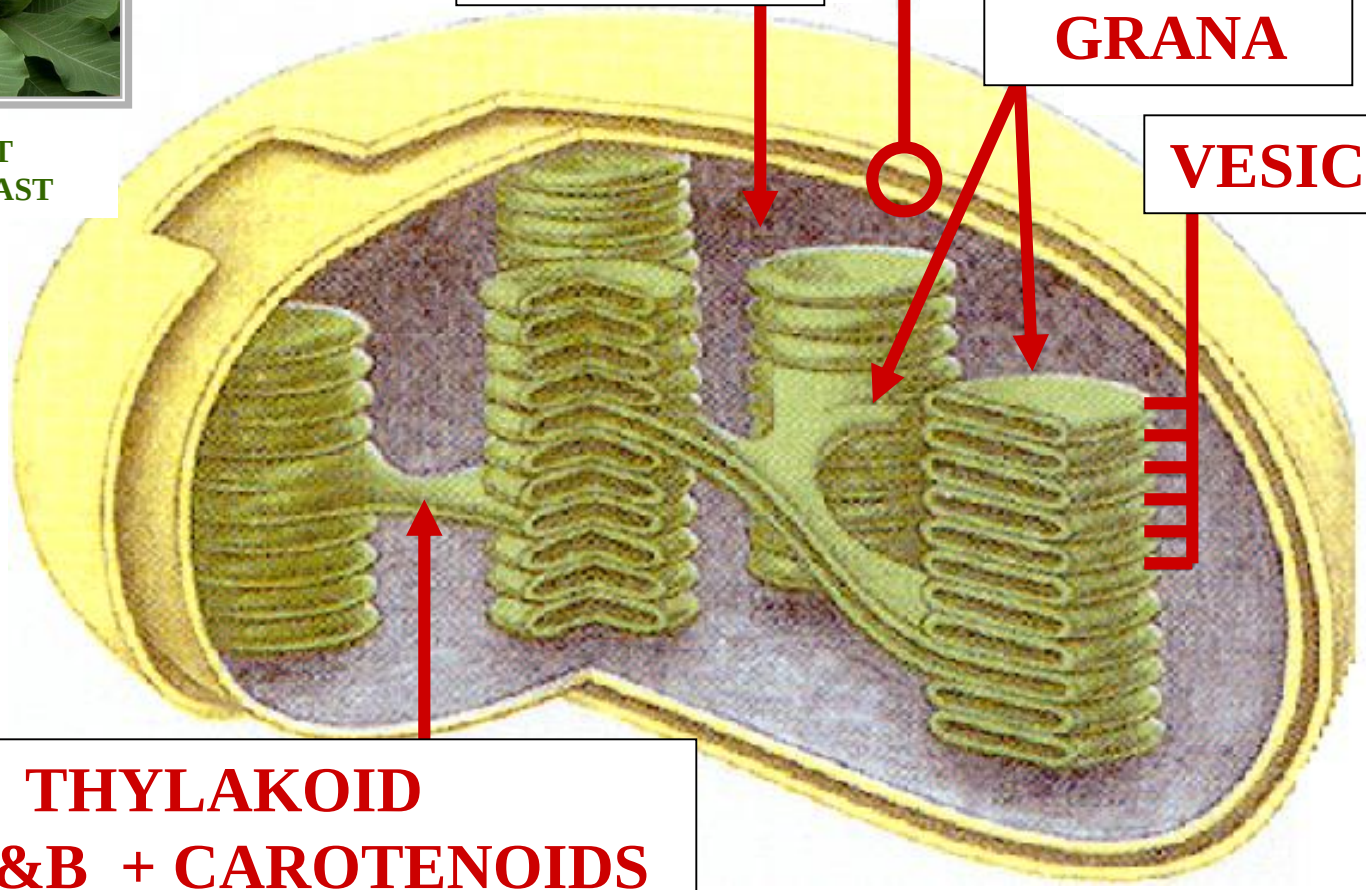
THYLAKOID

CHL A&B

CYANOBACTERIUM
GREEN BACTERIUM

TRUE PLANT
CHLOROPLAST

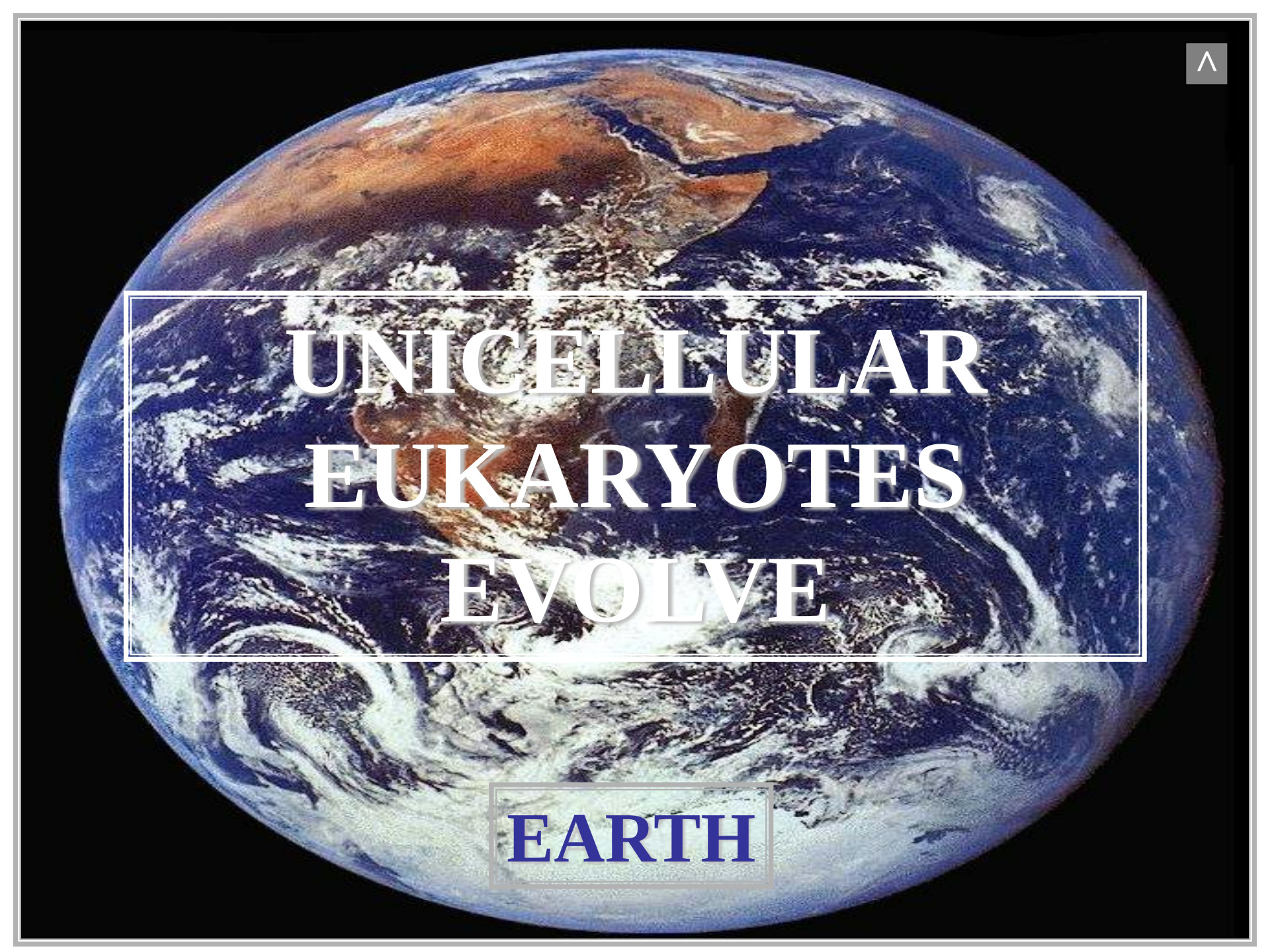
TRUE PLANT CHLOROPLAST ULTRASTRUCTURE



THYLAKOID
CHL A&B + CAROTENOIDS

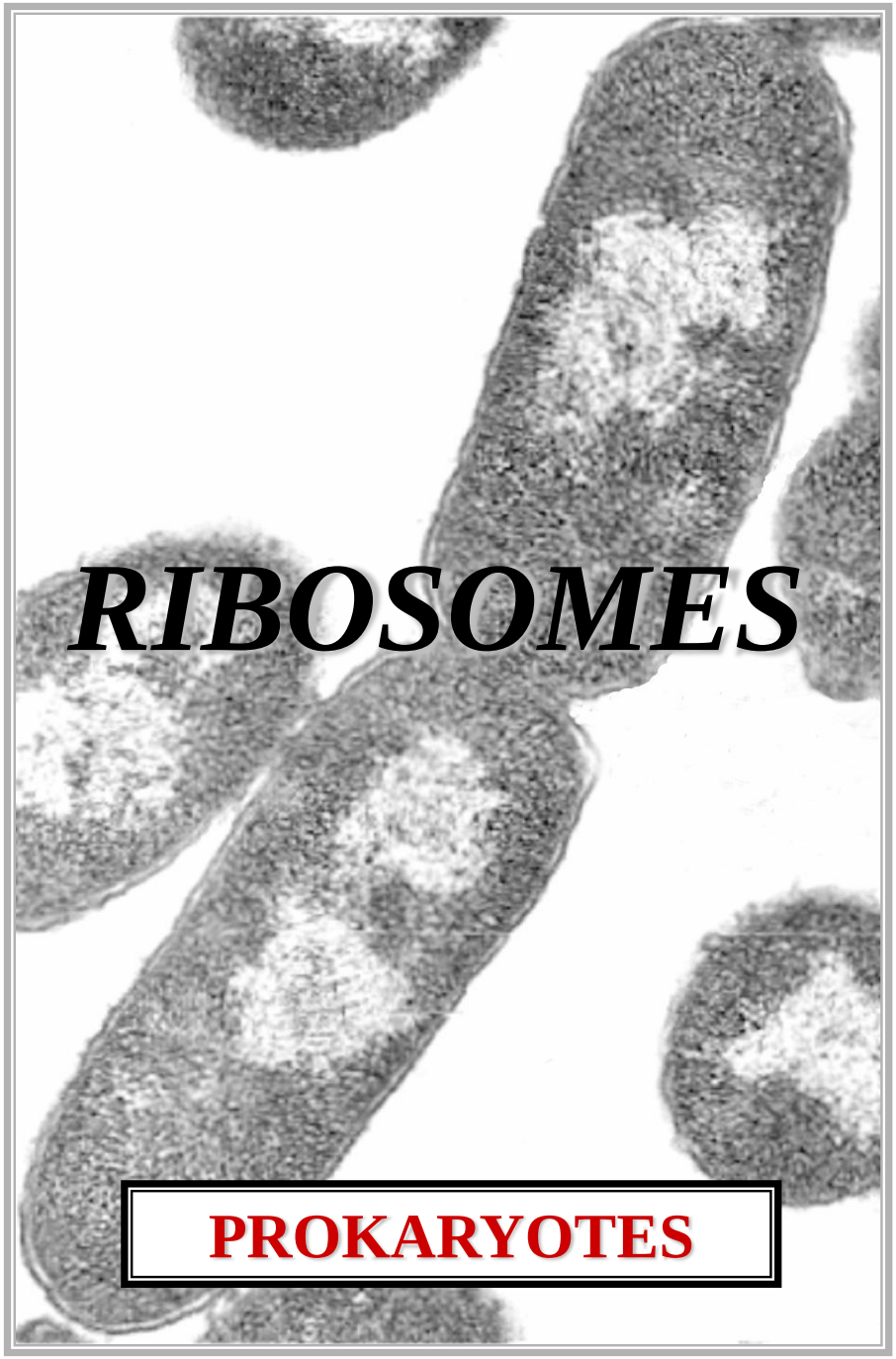
VASCULAR PLANT EVOLUTION

2.1 – 1.8
BILLION YEARS


UNICELLULAR
EUKARYOTES
EVOLVE
EARTH

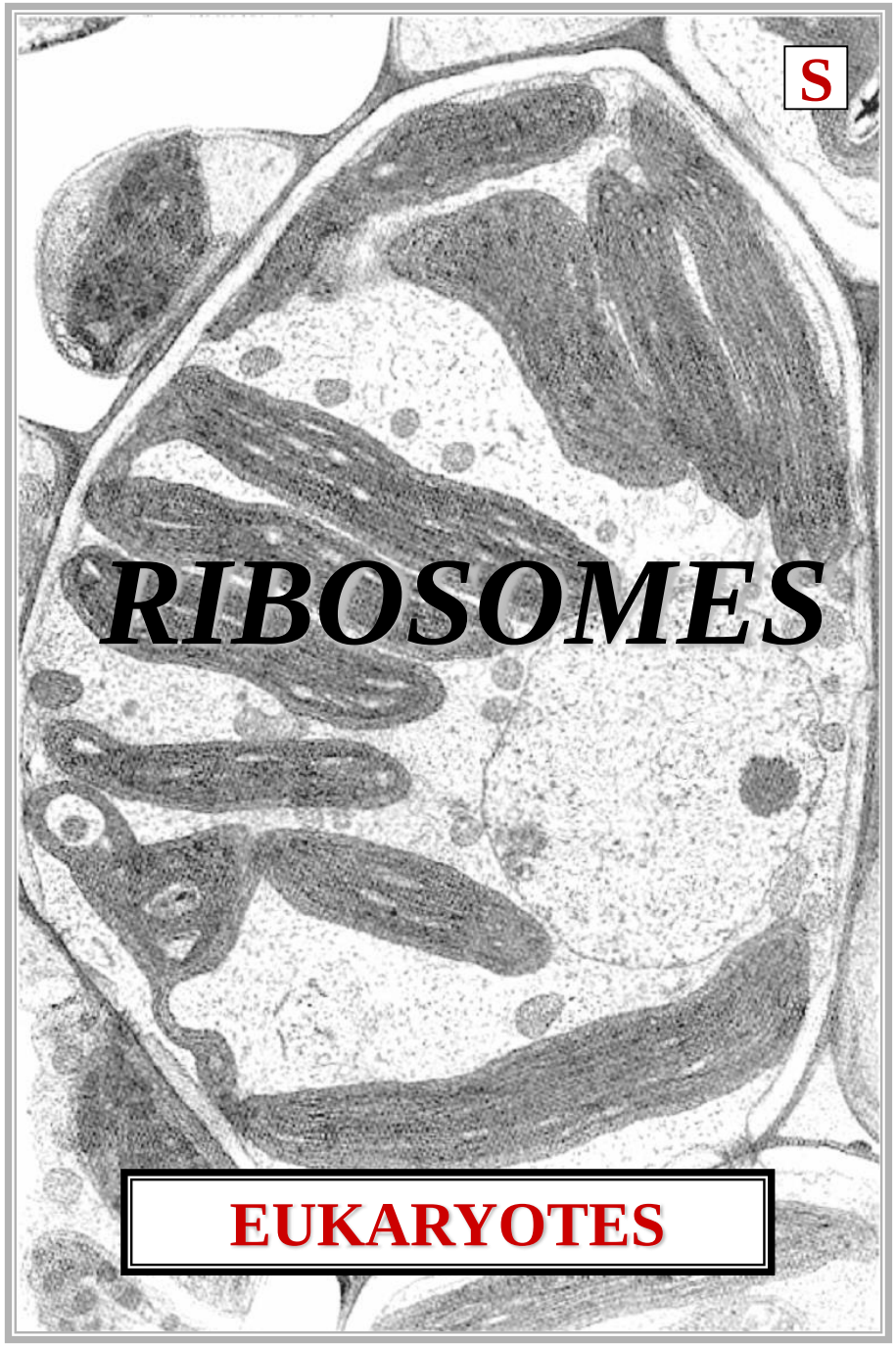
INTRODUCTION EUKARYOTES

EUKARYOTE CHARACTERS



RIBOSOMES

PROKARYOTES



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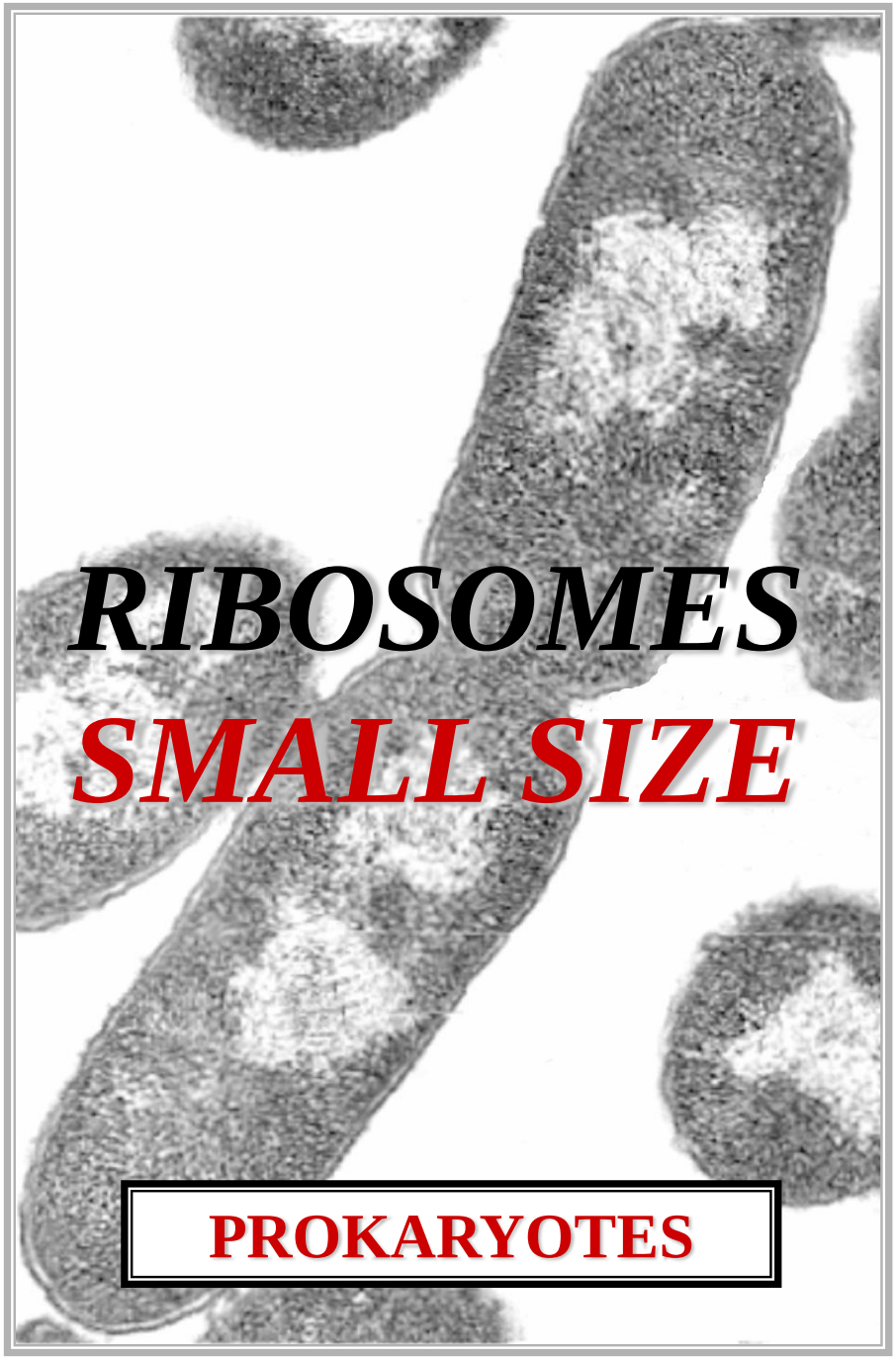
RIBOSOMES

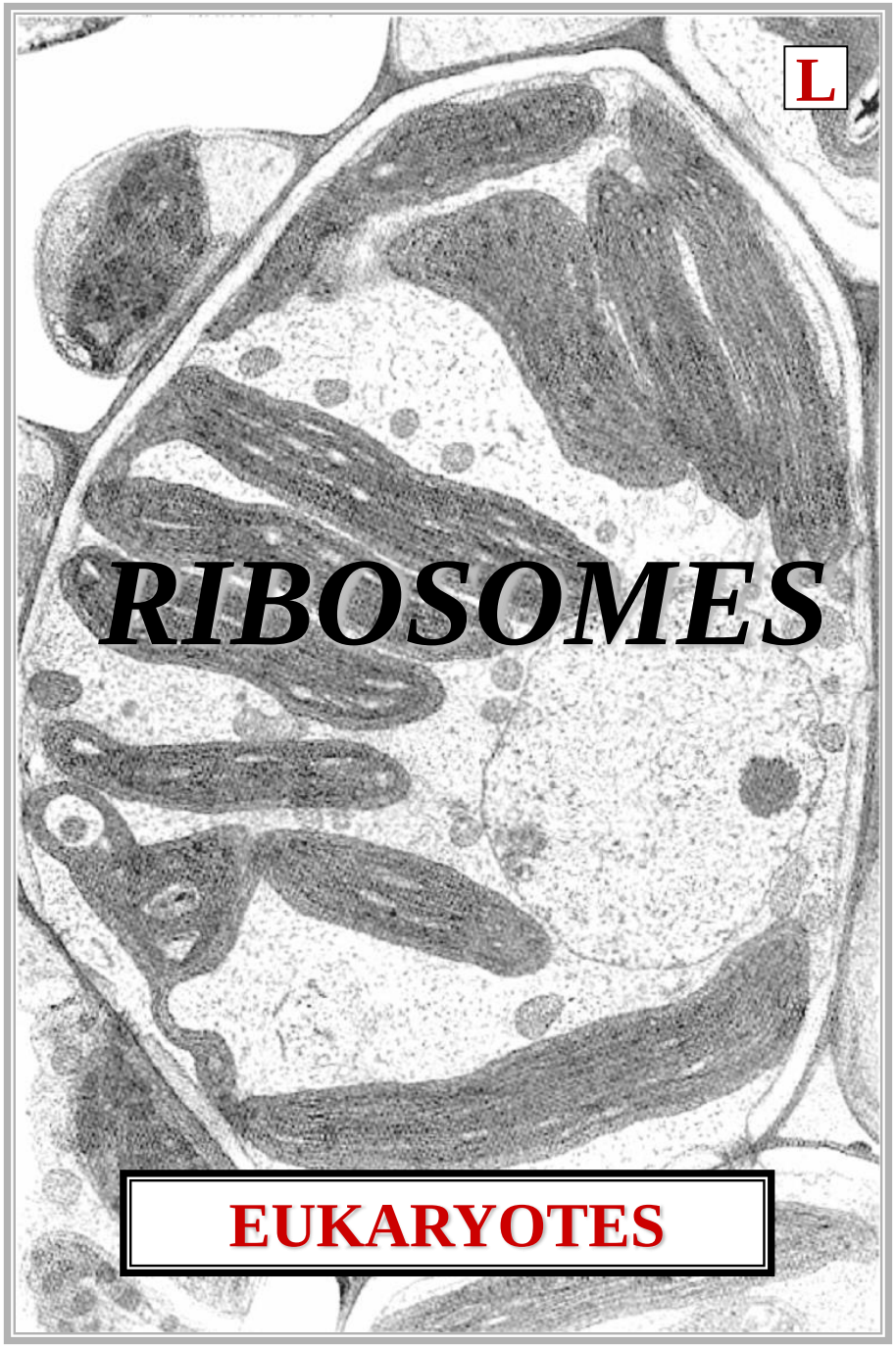
EUKARYOTES



RIBOSOMES

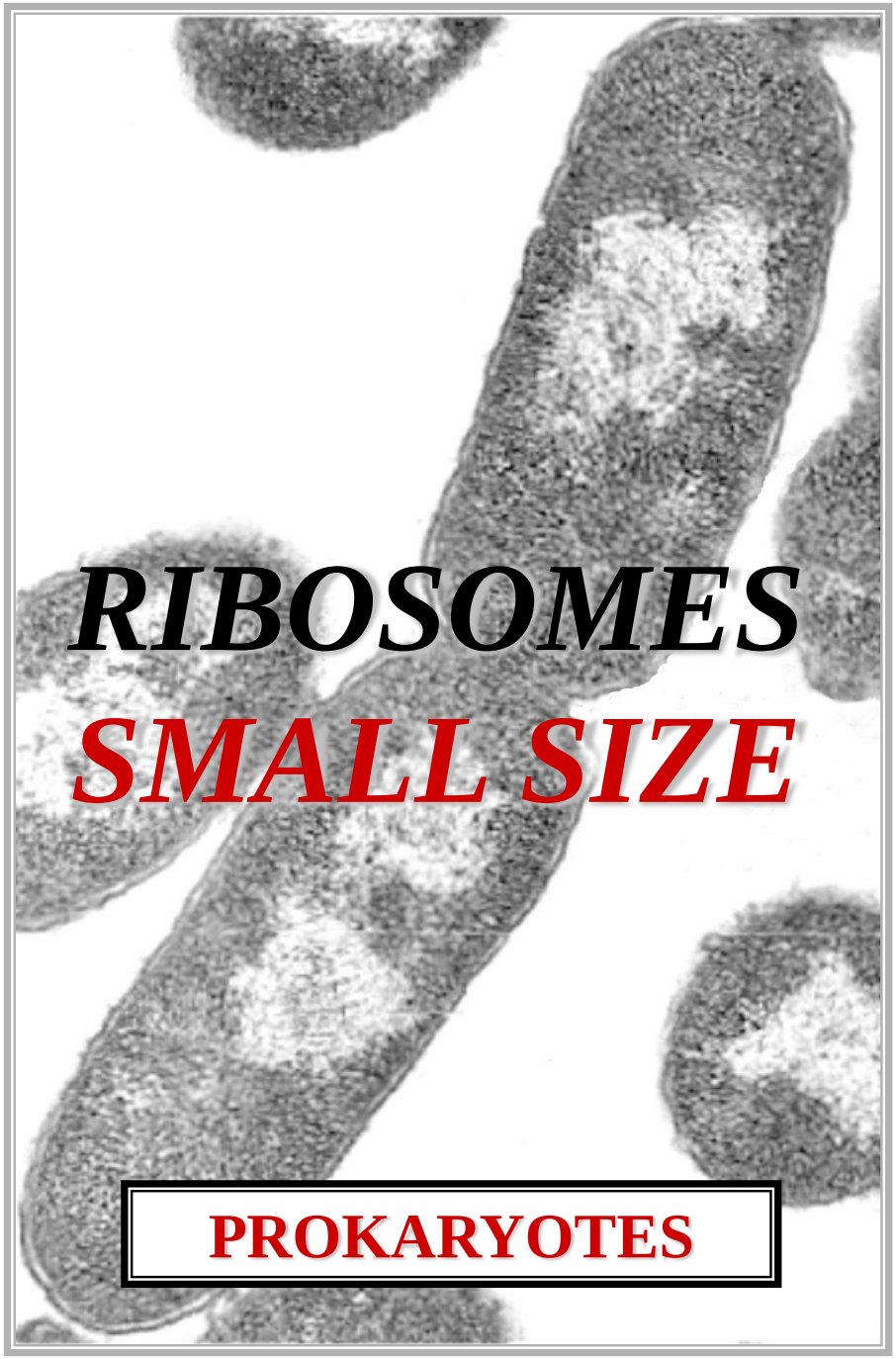
SMALL SIZE

PROKARYOTES



RIBOSOMES

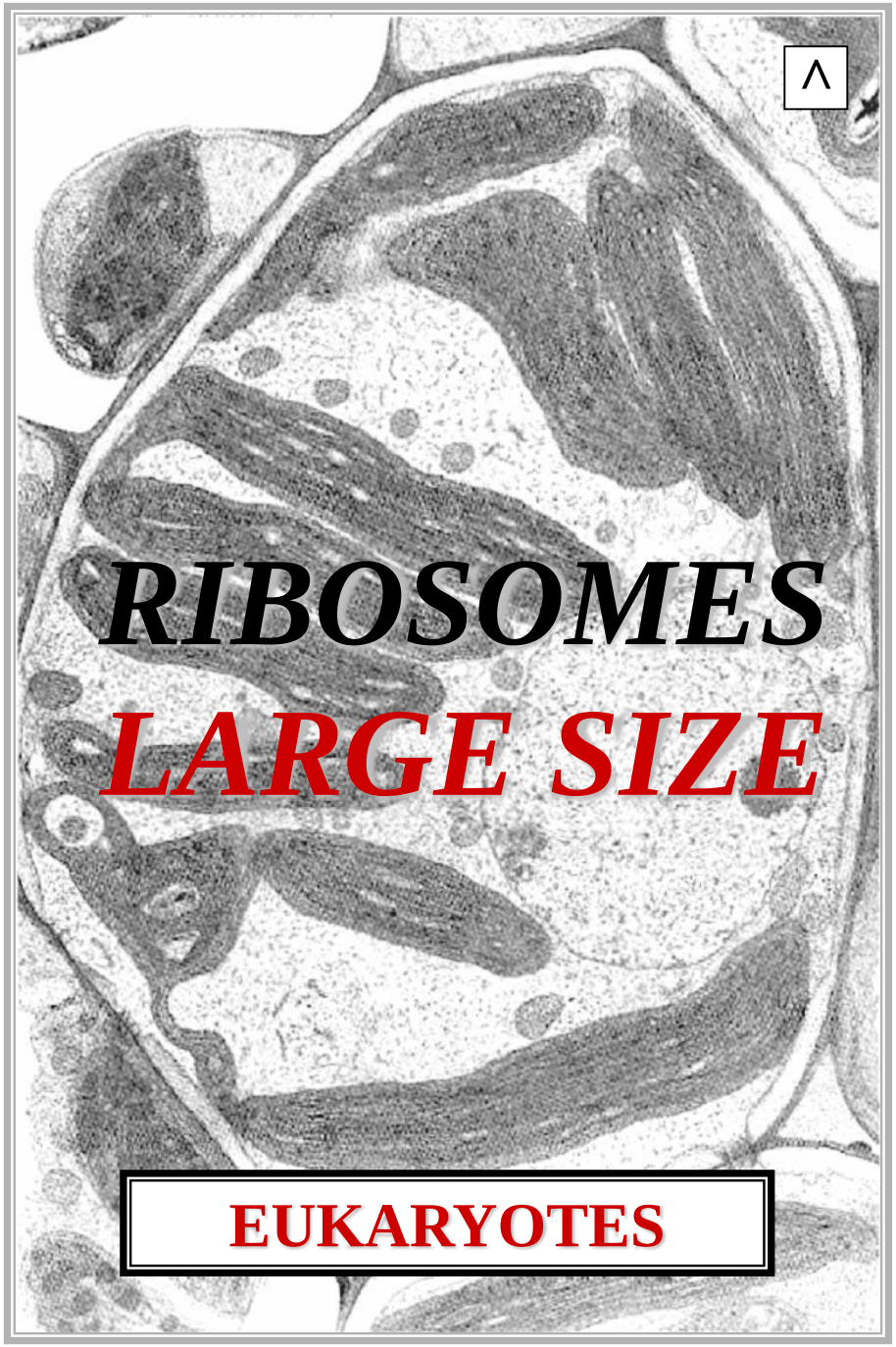
EUKARYOTES



RIBOSOMES

SMALL SIZE

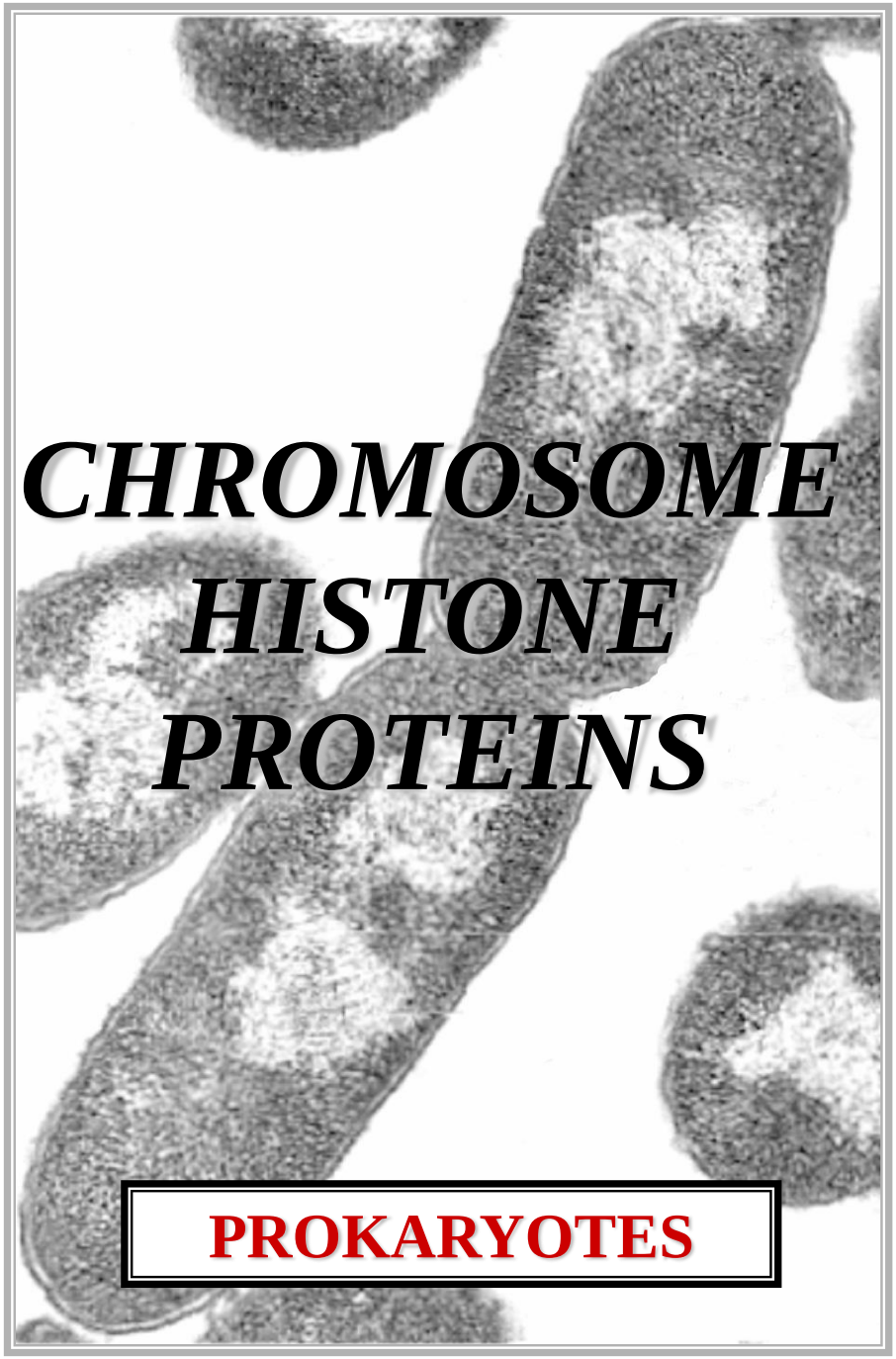
PROKARYOTES



RIBOSOMES

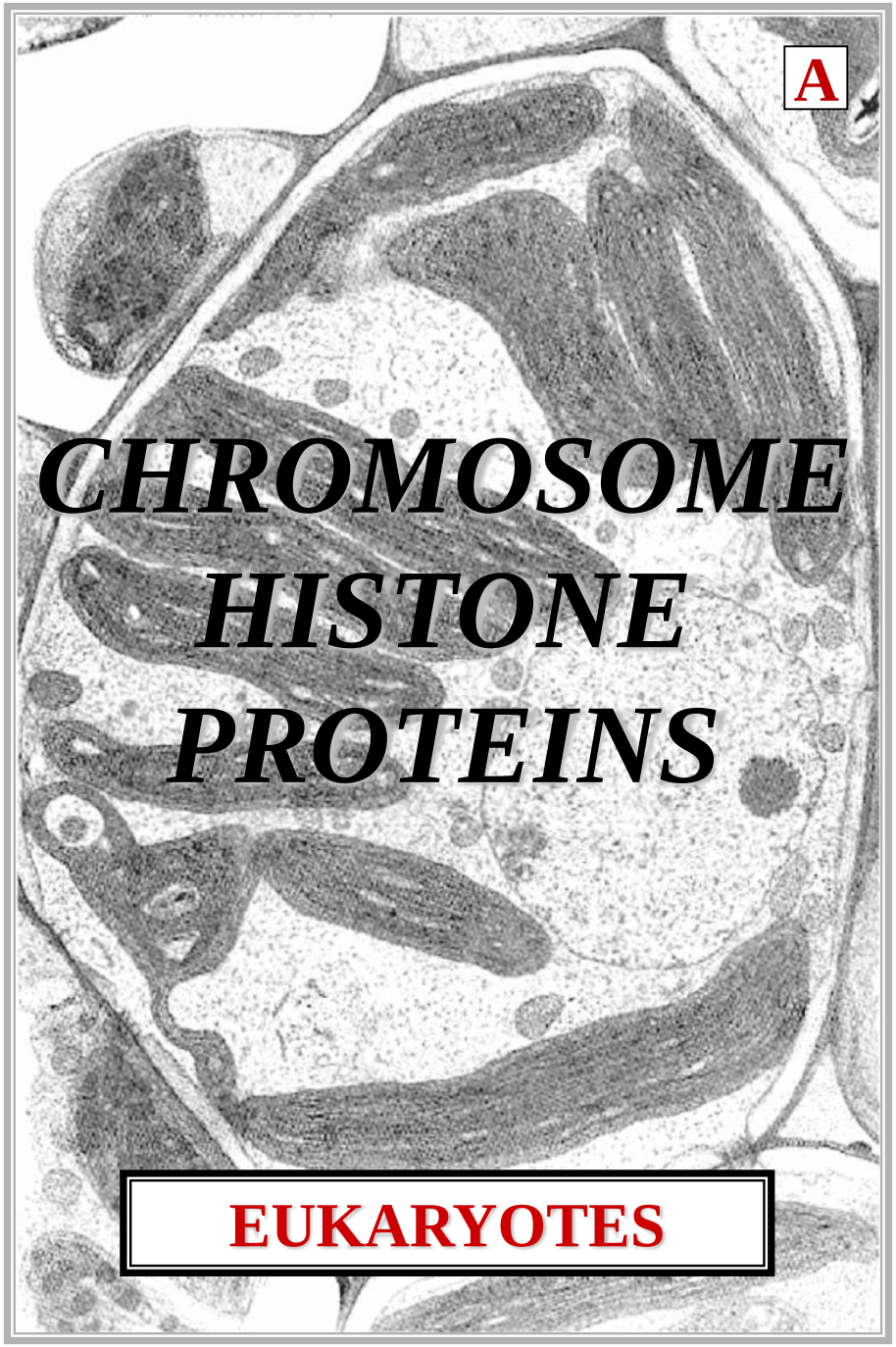
LARGE SIZE

EUKARYOTES



CHROMOSOME
HISTONE
PROTEINS

PROKARYOTES



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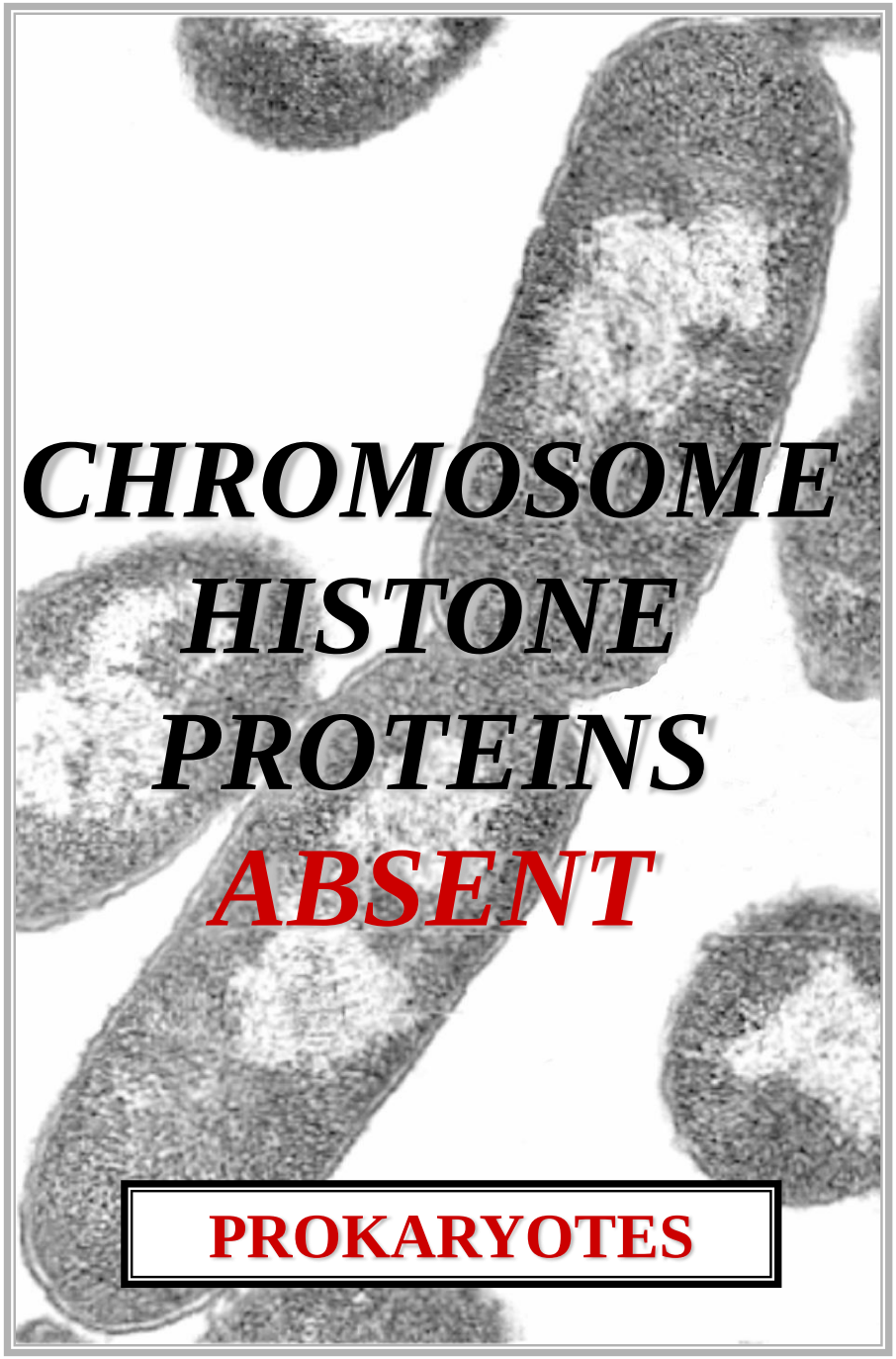
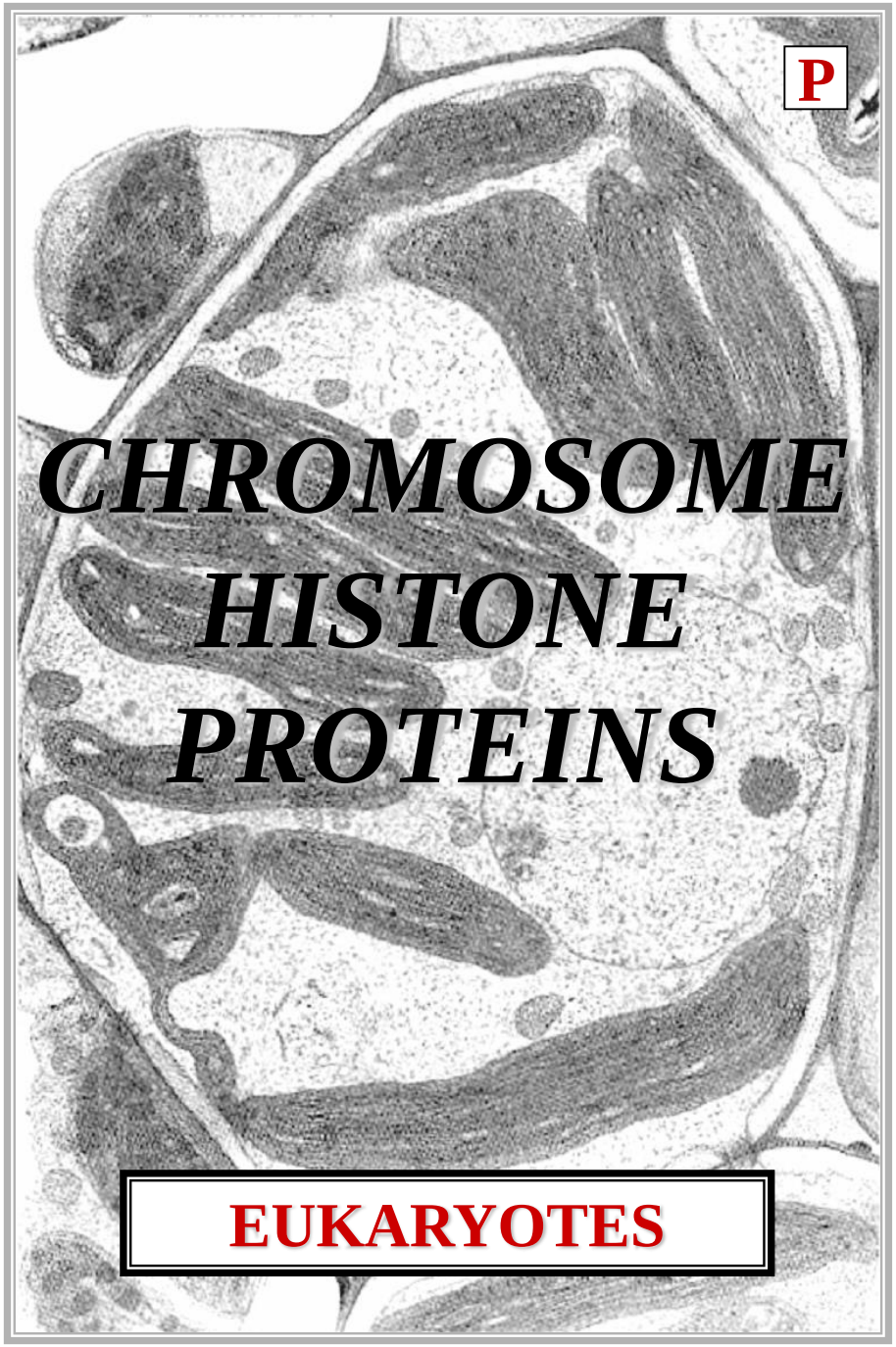
CHROMOSOME
HISTONE
PROTEINS

EUKARYOTES



CHROMOSOME
HISTONE
PROTEINS
ABSENT

PROKARYOTES



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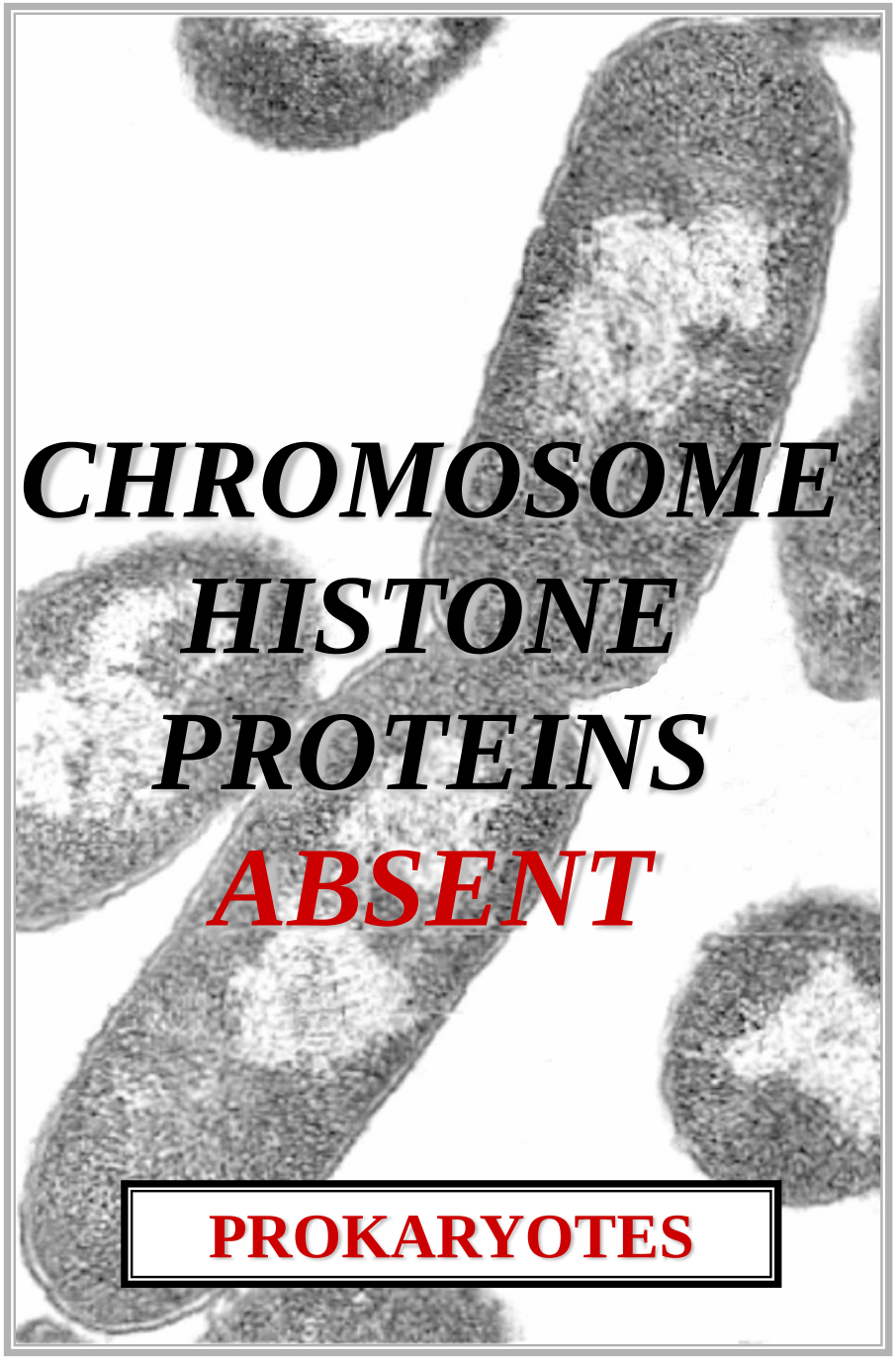
CHROMOSOME
HISTONE
PROTEINS

EUKARYOTES



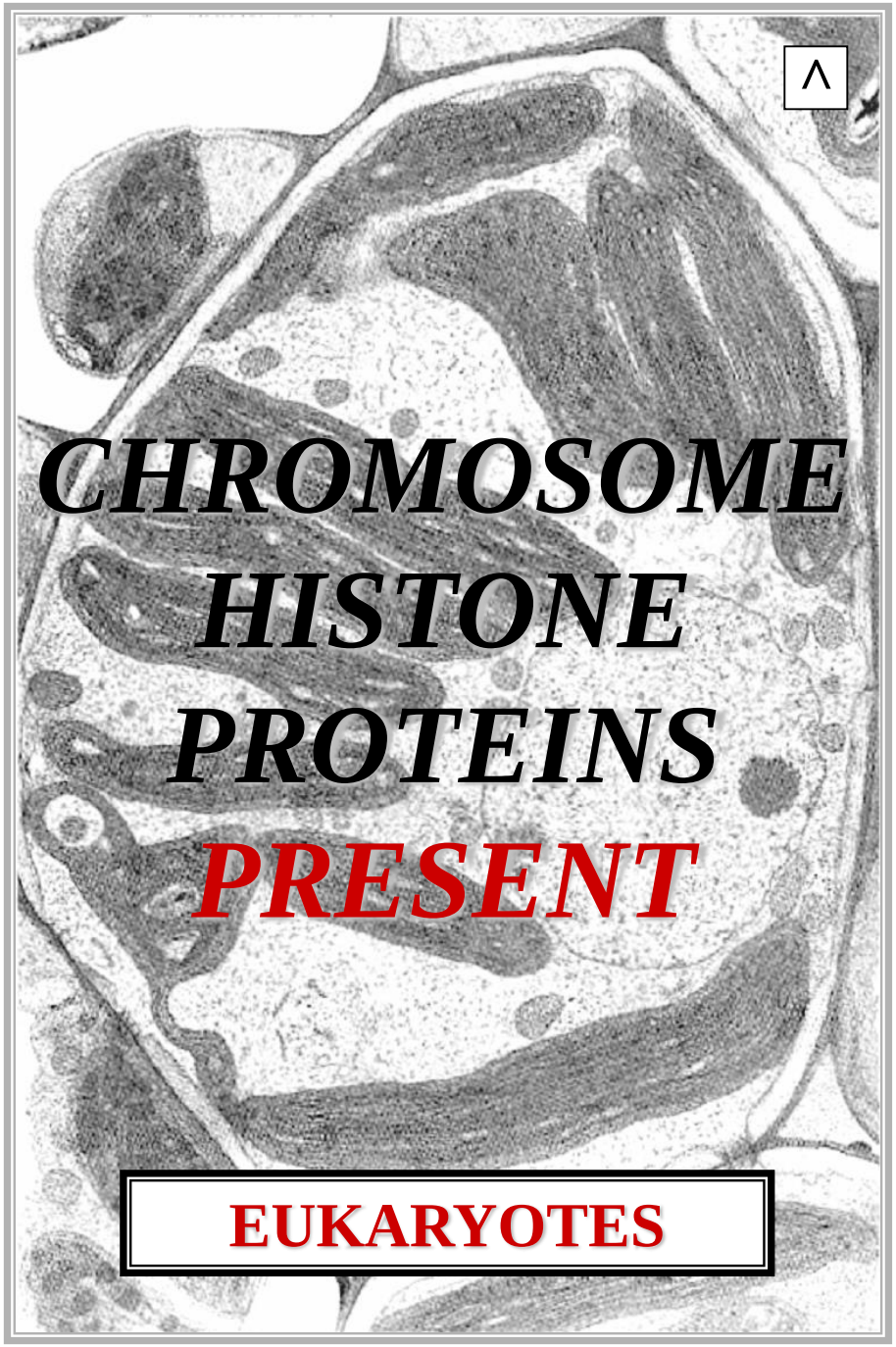
CHROMOSOME

HISTONE

PROTEINS

ABSENT

PROKARYOTES



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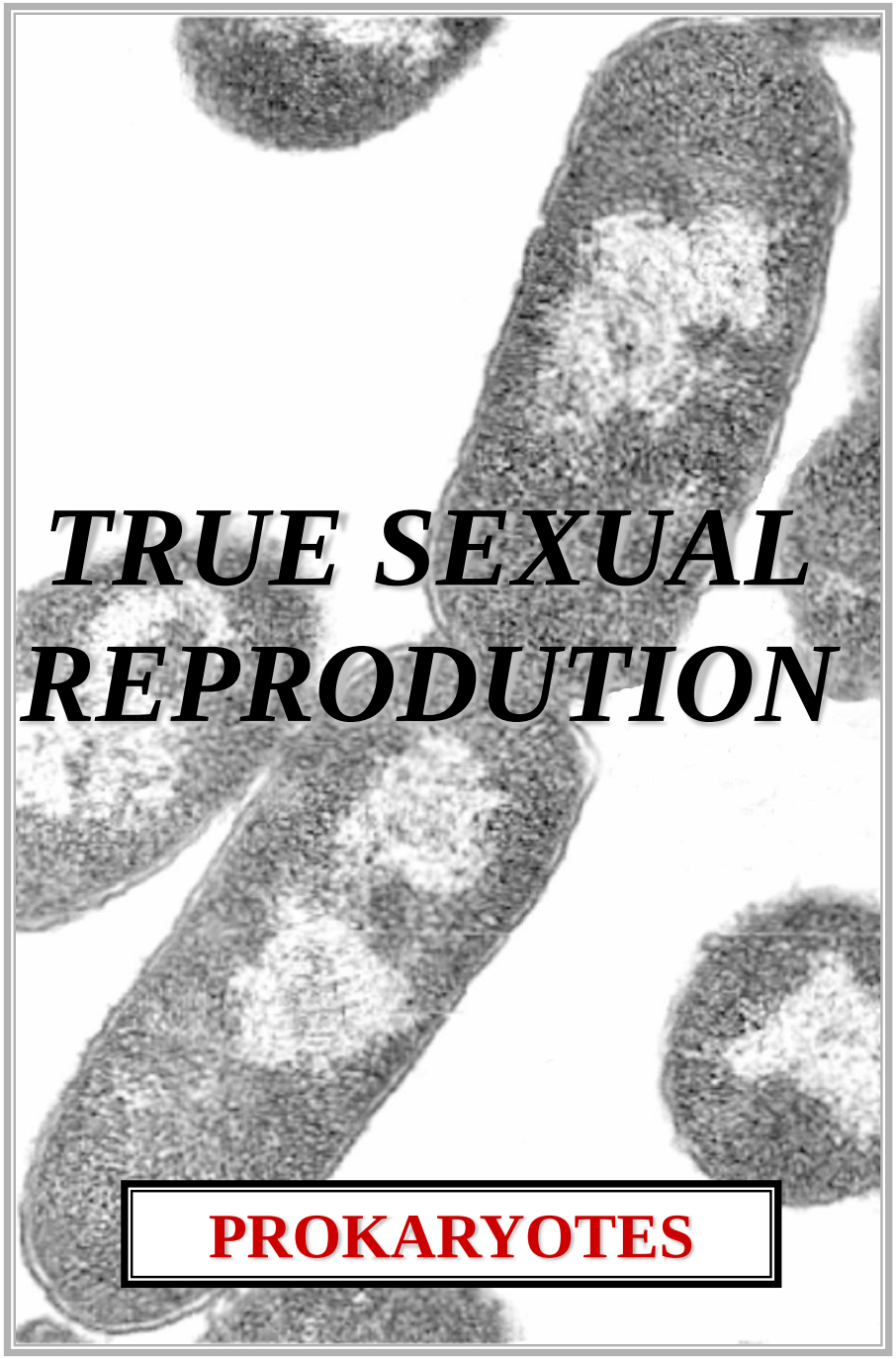
CHROMOSOME

HISTONE

PROTEINS

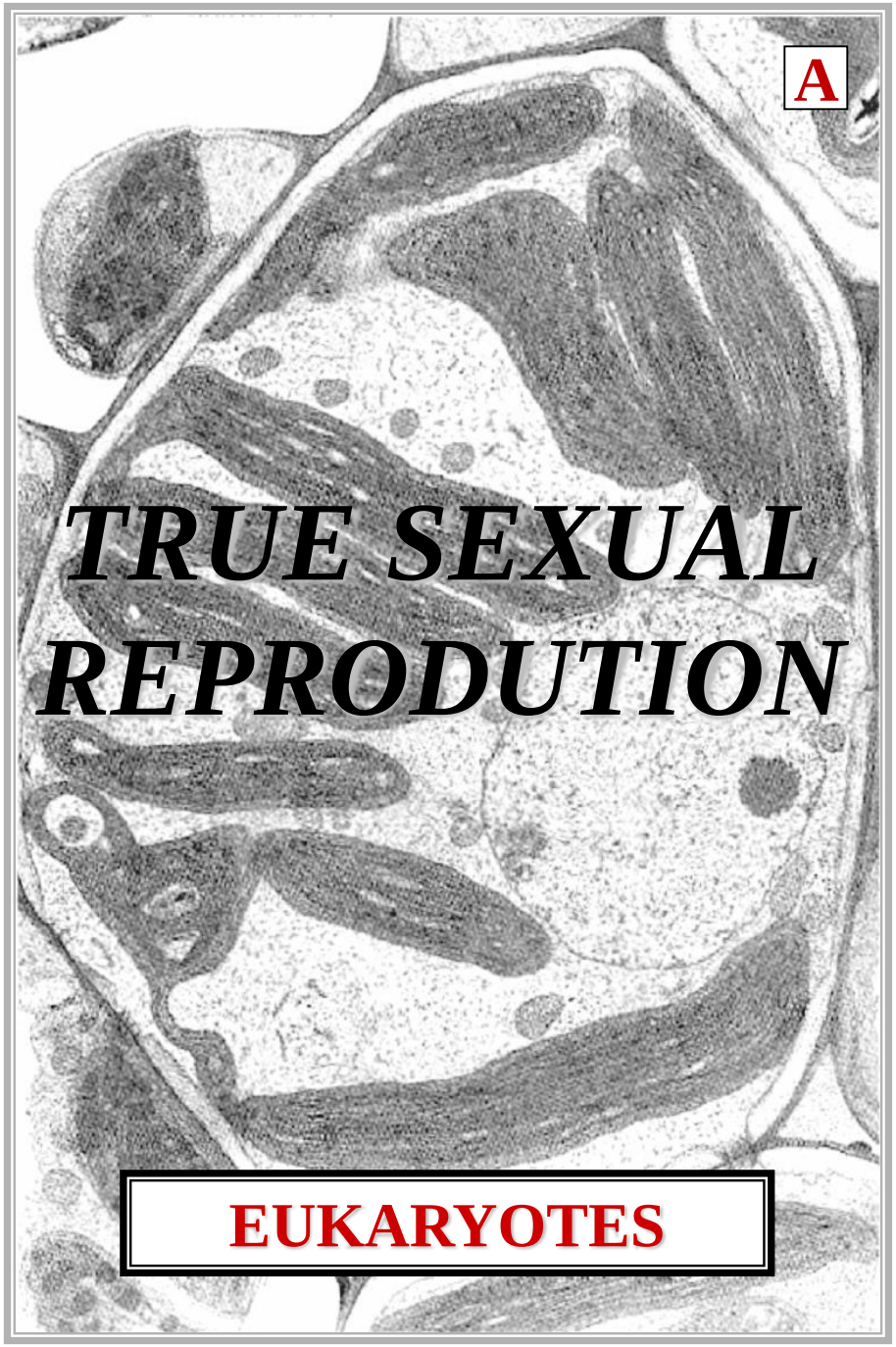
PRESENT

EUKARYOTES



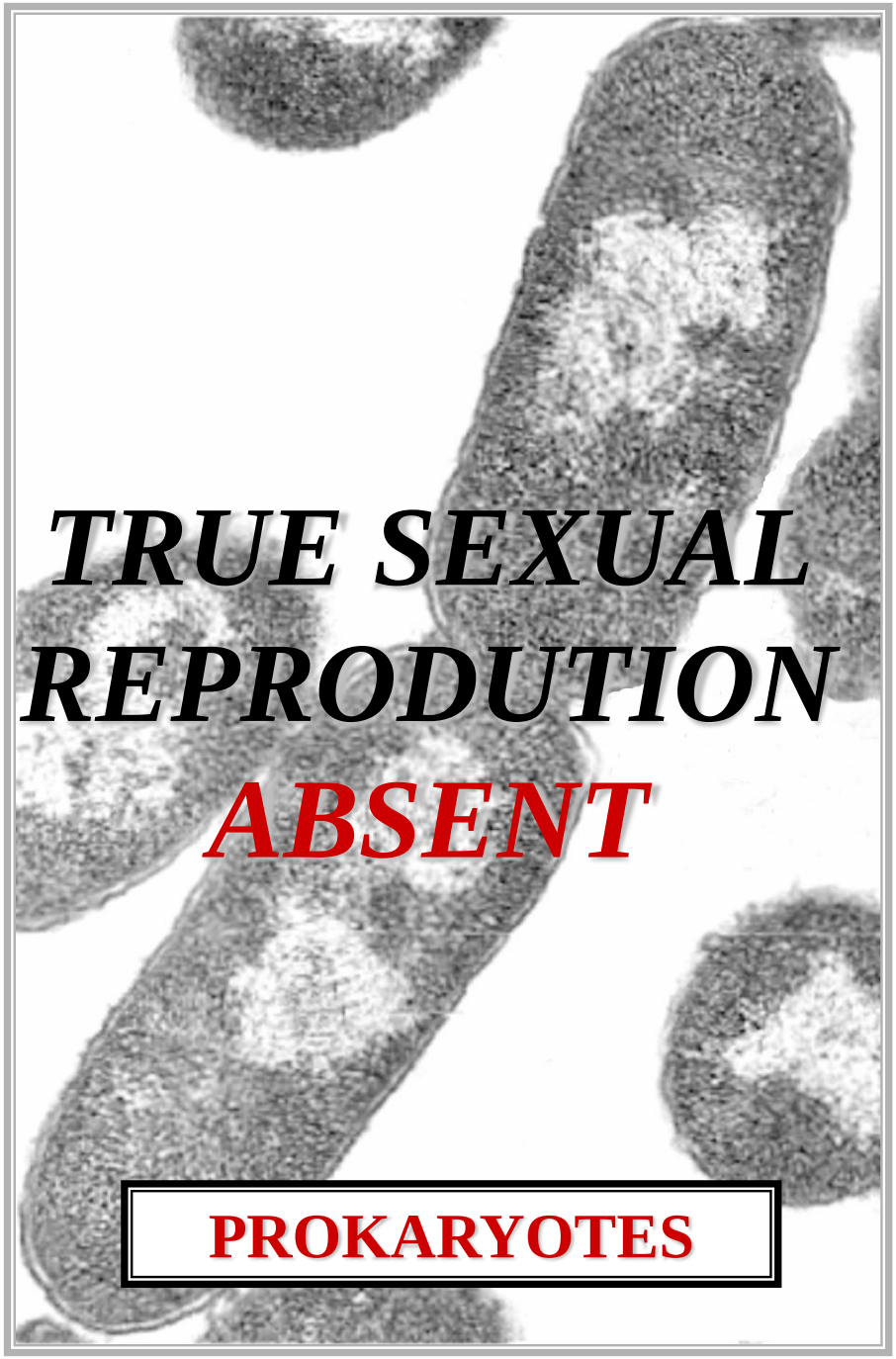
TRUE SEXUAL REPRODUTION

PROKARYOTES



TRUE SEXUAL REPRODUTION

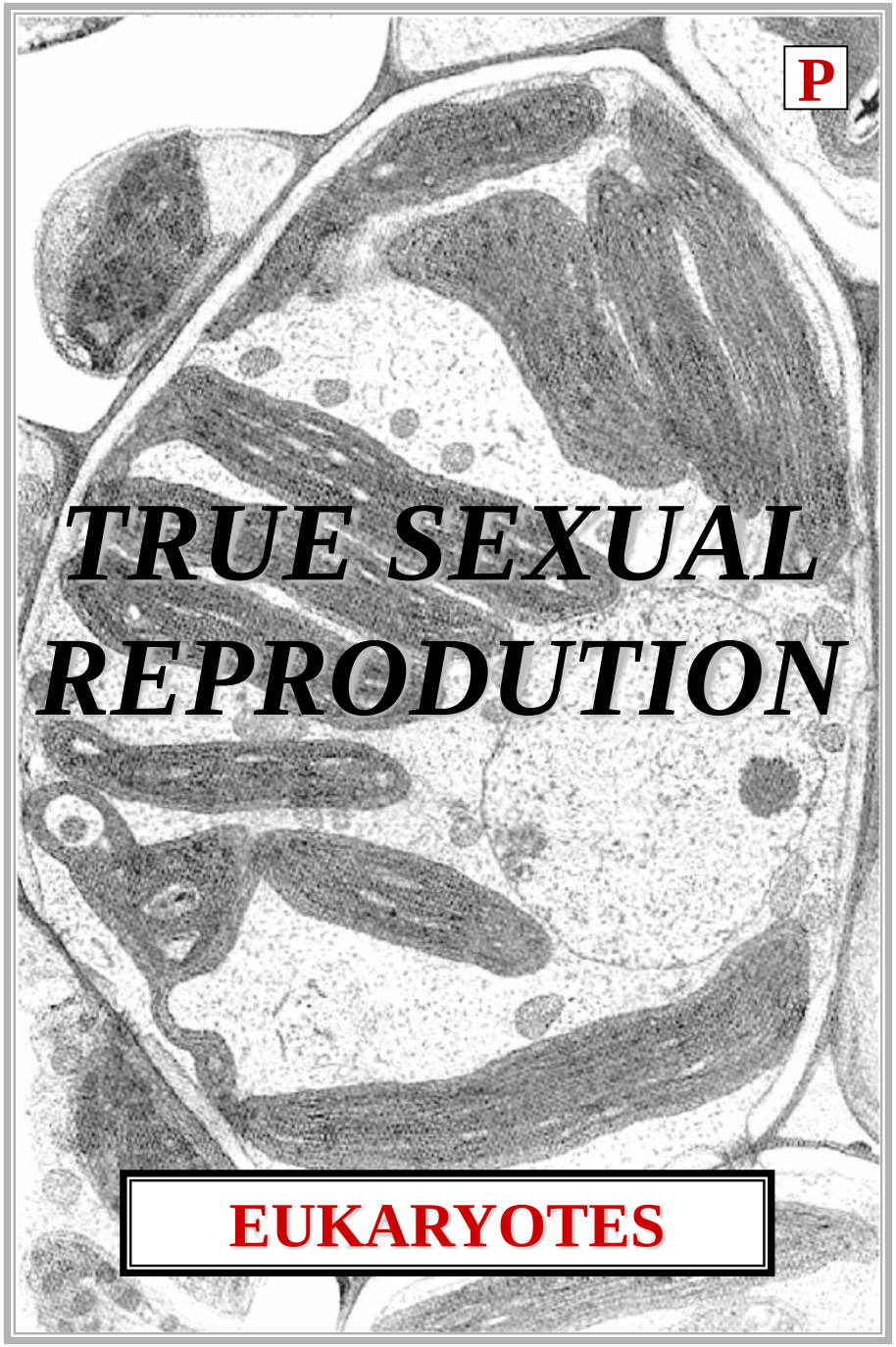
EUKARYOTES



TRUE SEXUAL REPRODUTION

ABSENT

PROKARYOTES



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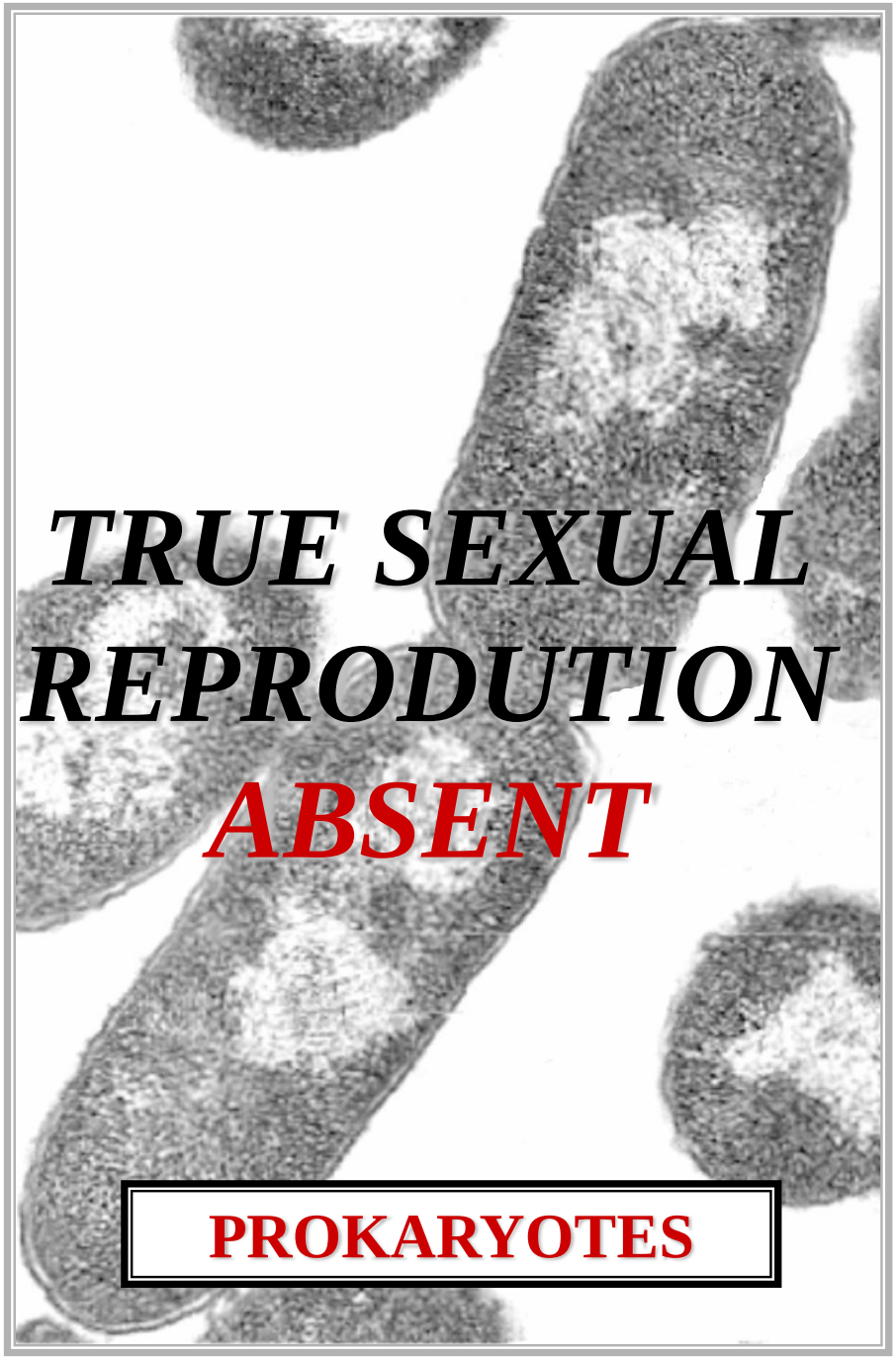
TRUE SEXUAL REPRODUTION

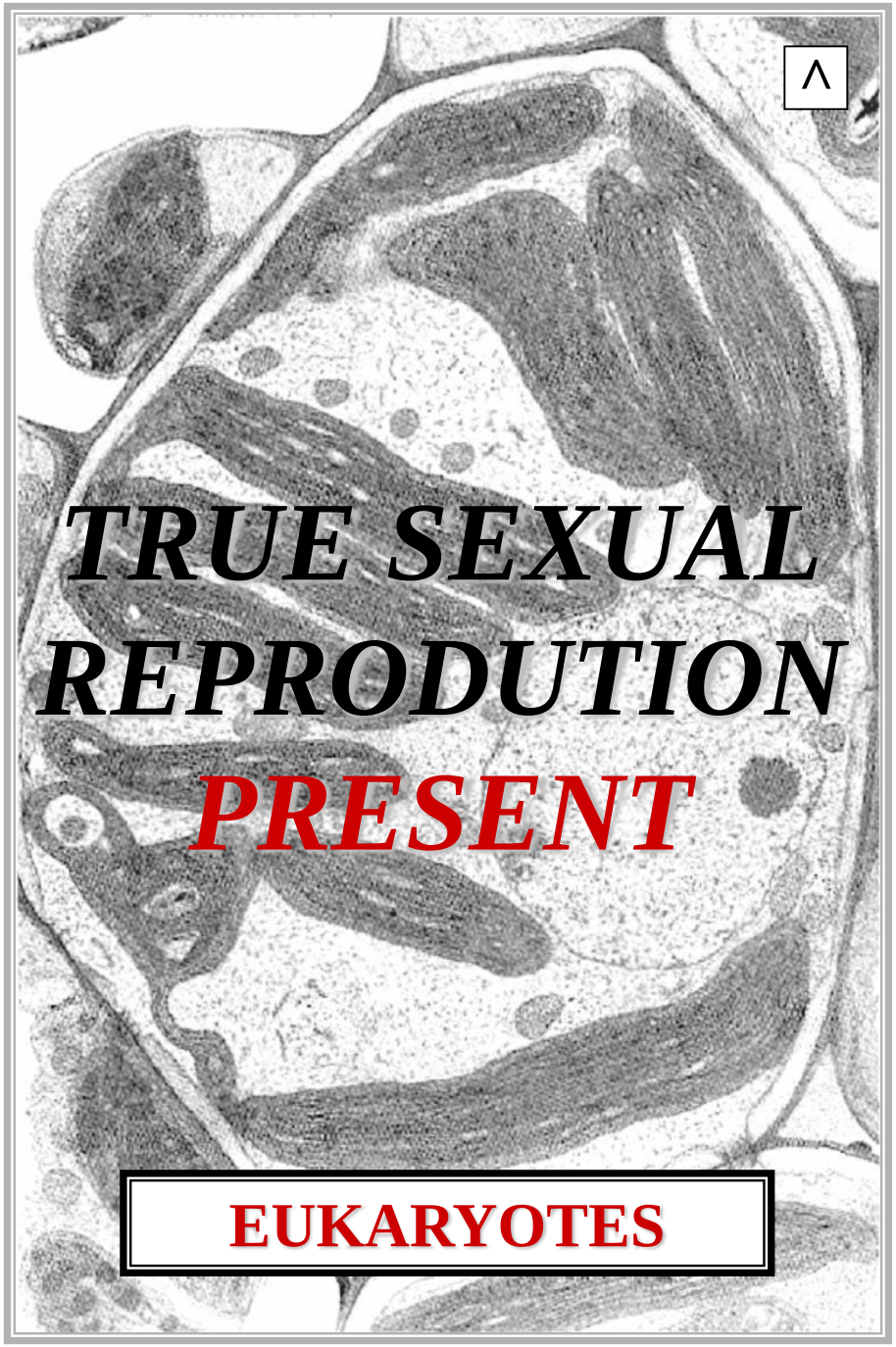
EUKARYOTES



TRUE SEXUAL REPRODUTION

ABSENT

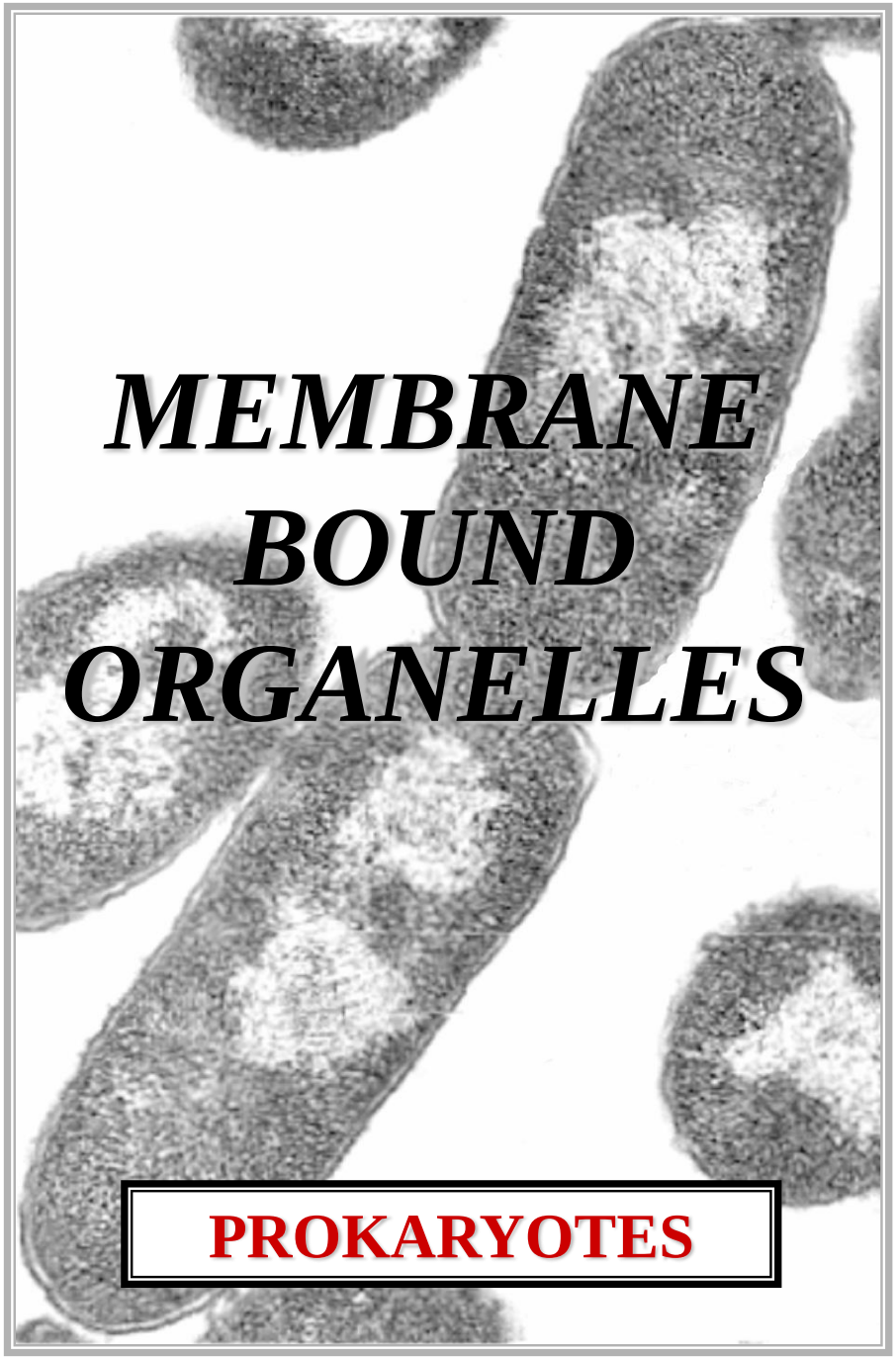
PROKARYOTES



TRUE SEXUAL REPRODUTION

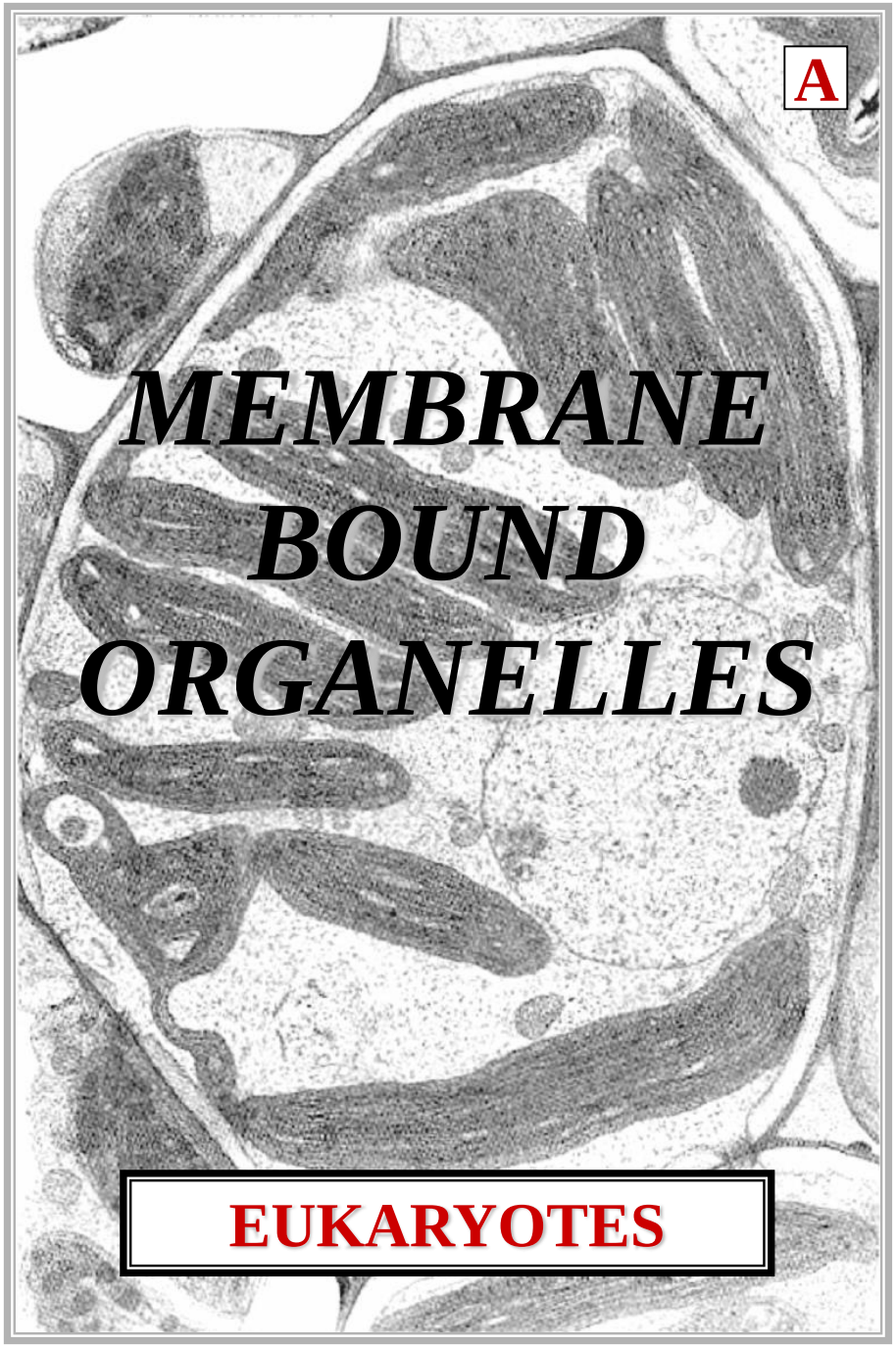
PRESENT

EUKARYOTES



MEMBRANE BOUND ORGANELLES

PROKARYOTES



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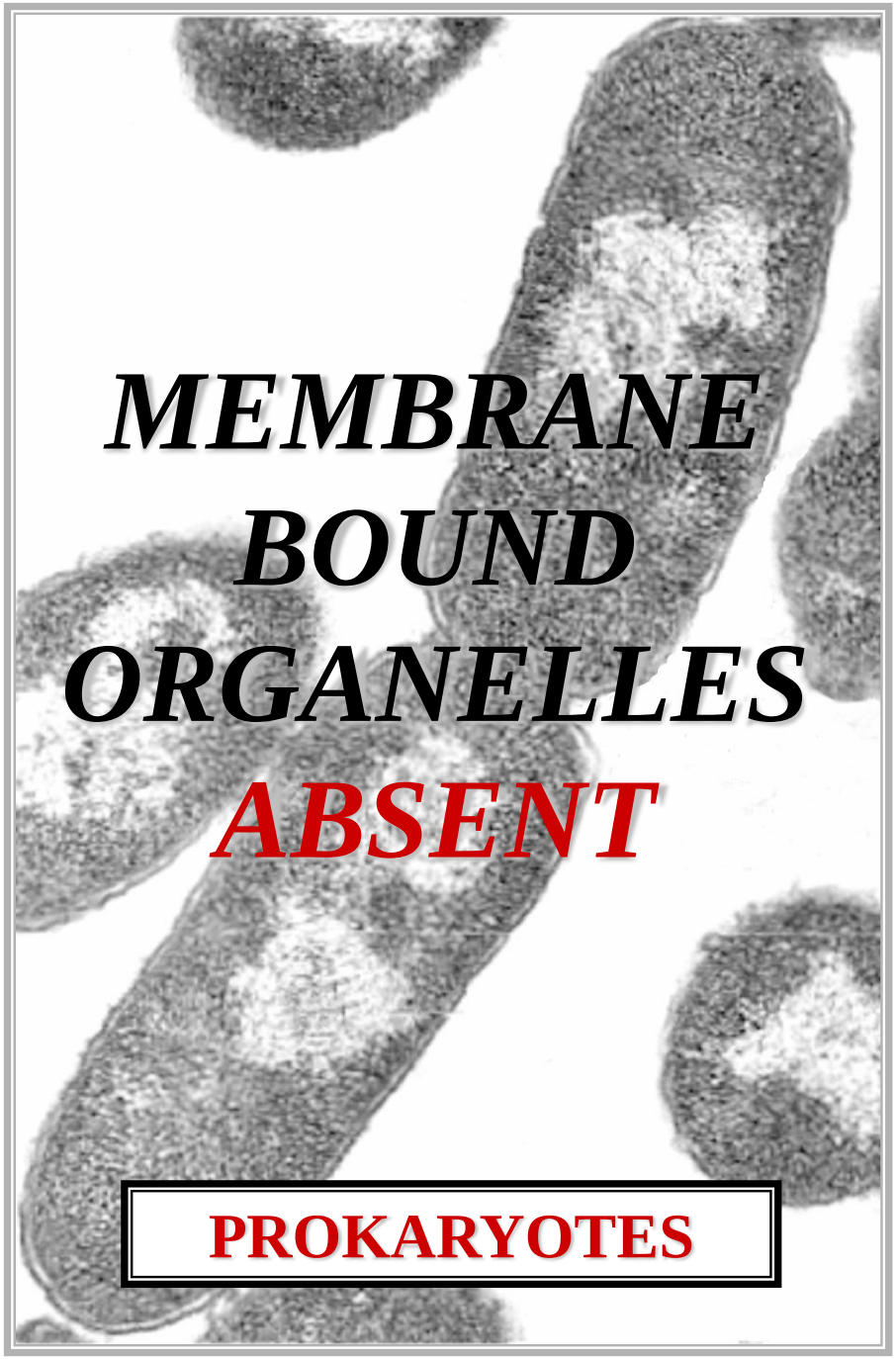
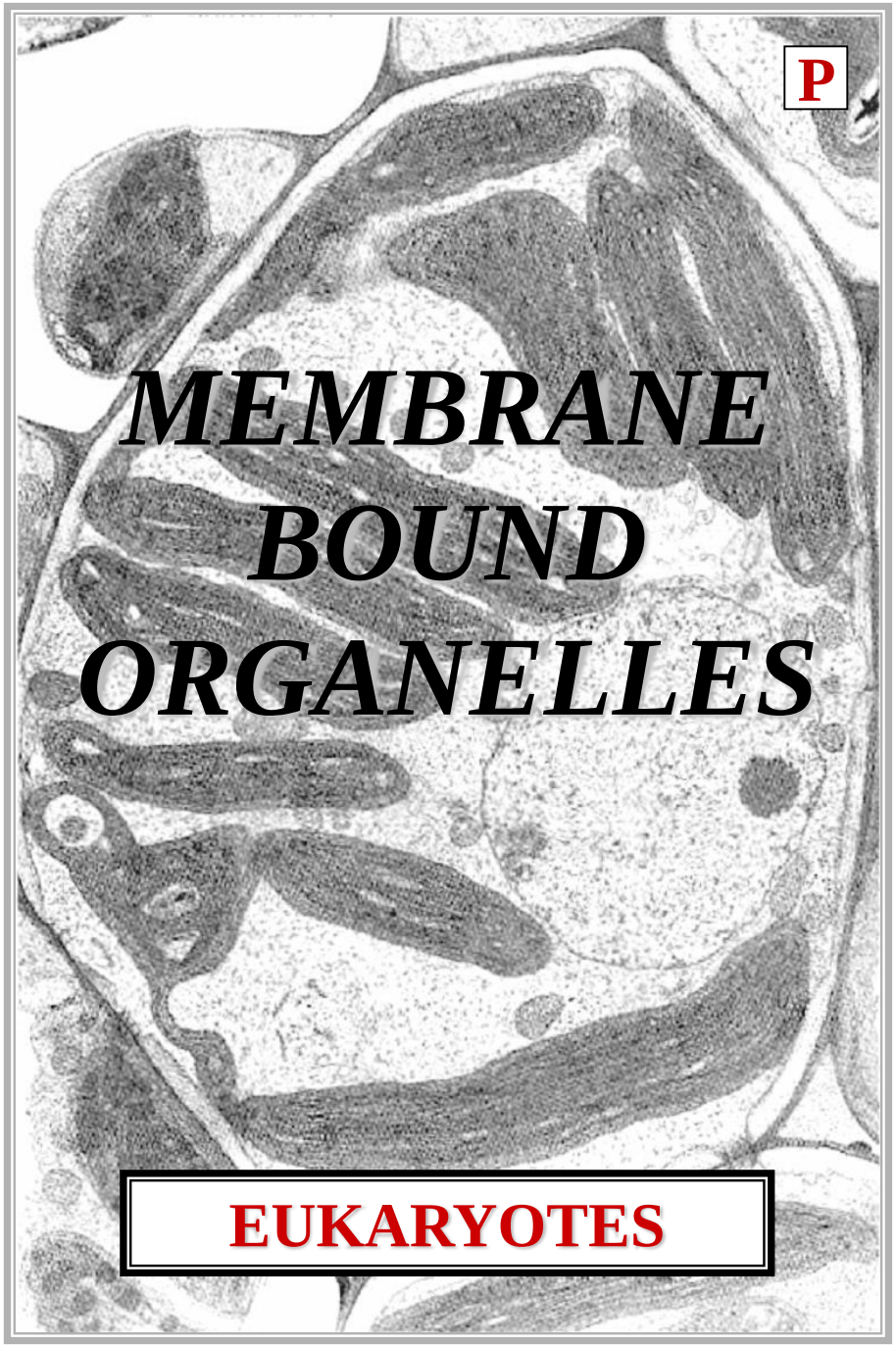
MEMBRANE BOUND ORGANELLES

EUKARYOTES



MEMBRANE BOUND ORGANELLES ABSENT

PROKARYOTES



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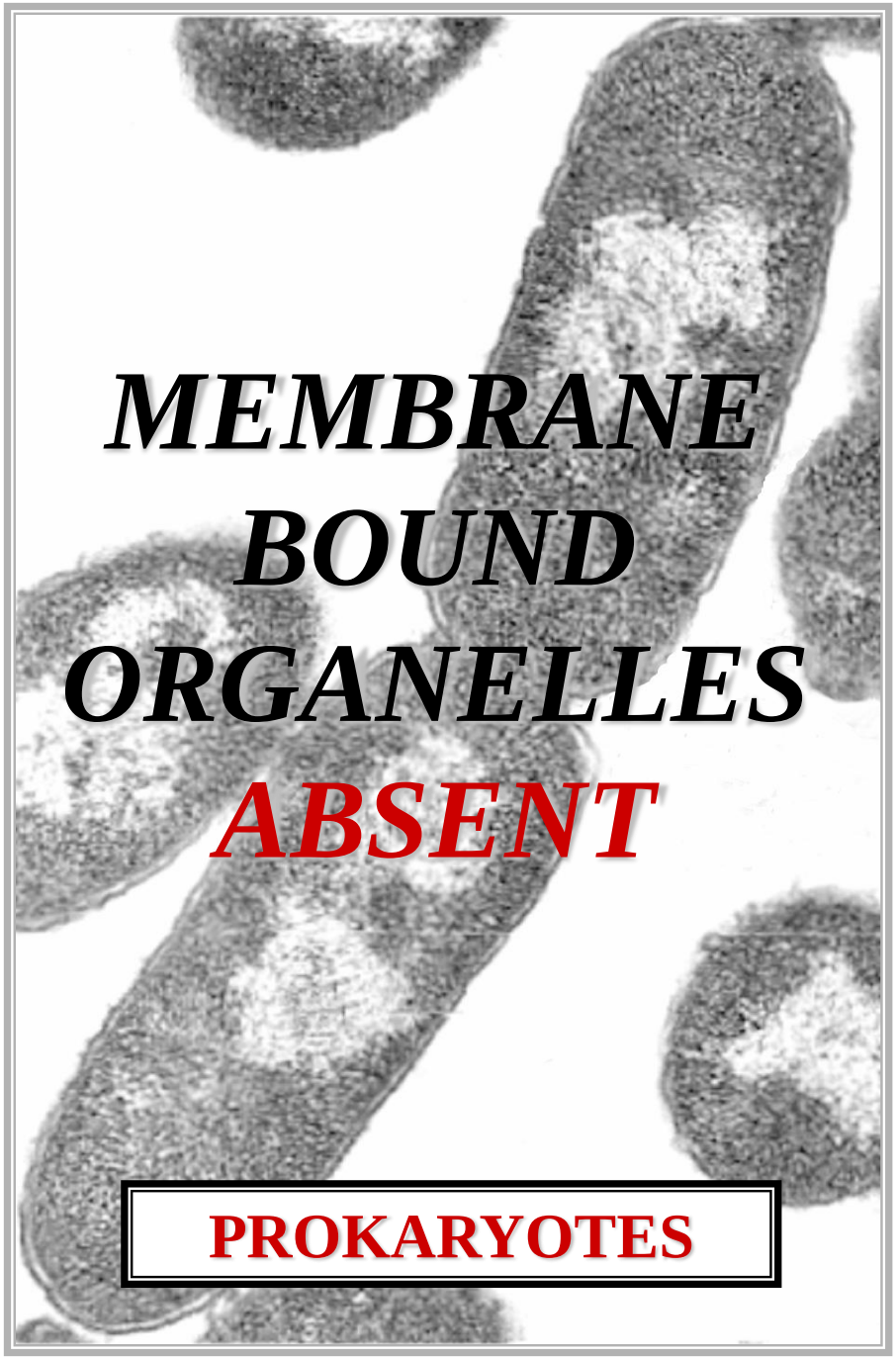
MEMBRANE BOUND ORGANELLES

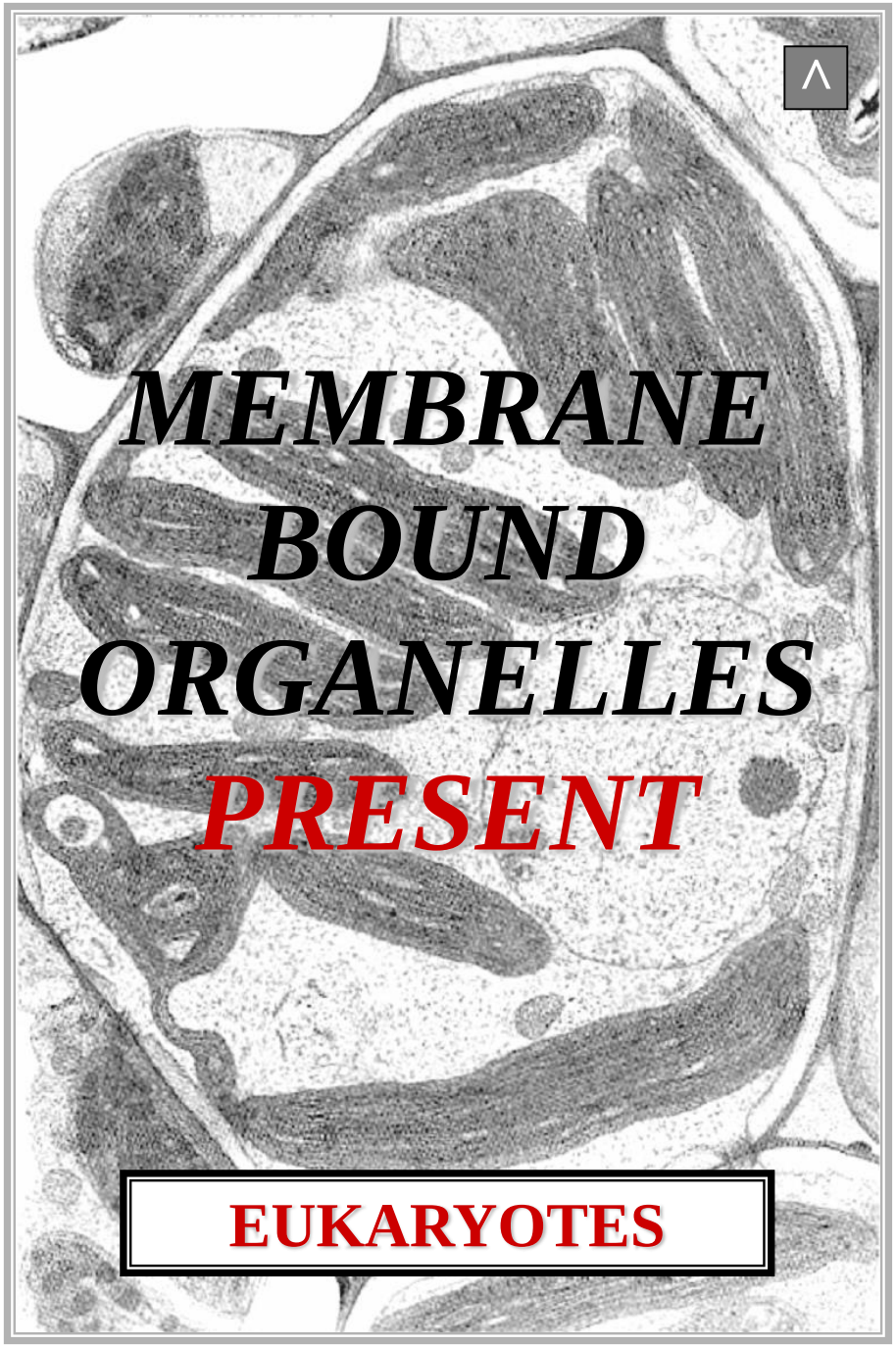
EUKARYOTES



MEMBRANE BOUND ORGANELLES

ABSENT

PROKARYOTES



MEMBRANE BOUND ORGANELLES

PRESENT

EUKARYOTES

D

DOUBLE MEMBRANE BOUND ORGANELLES

DOUBLE MEMBRANE BOUND ORGANELLES

DOUBLE MEMBRANE BOUND ORGANELLES

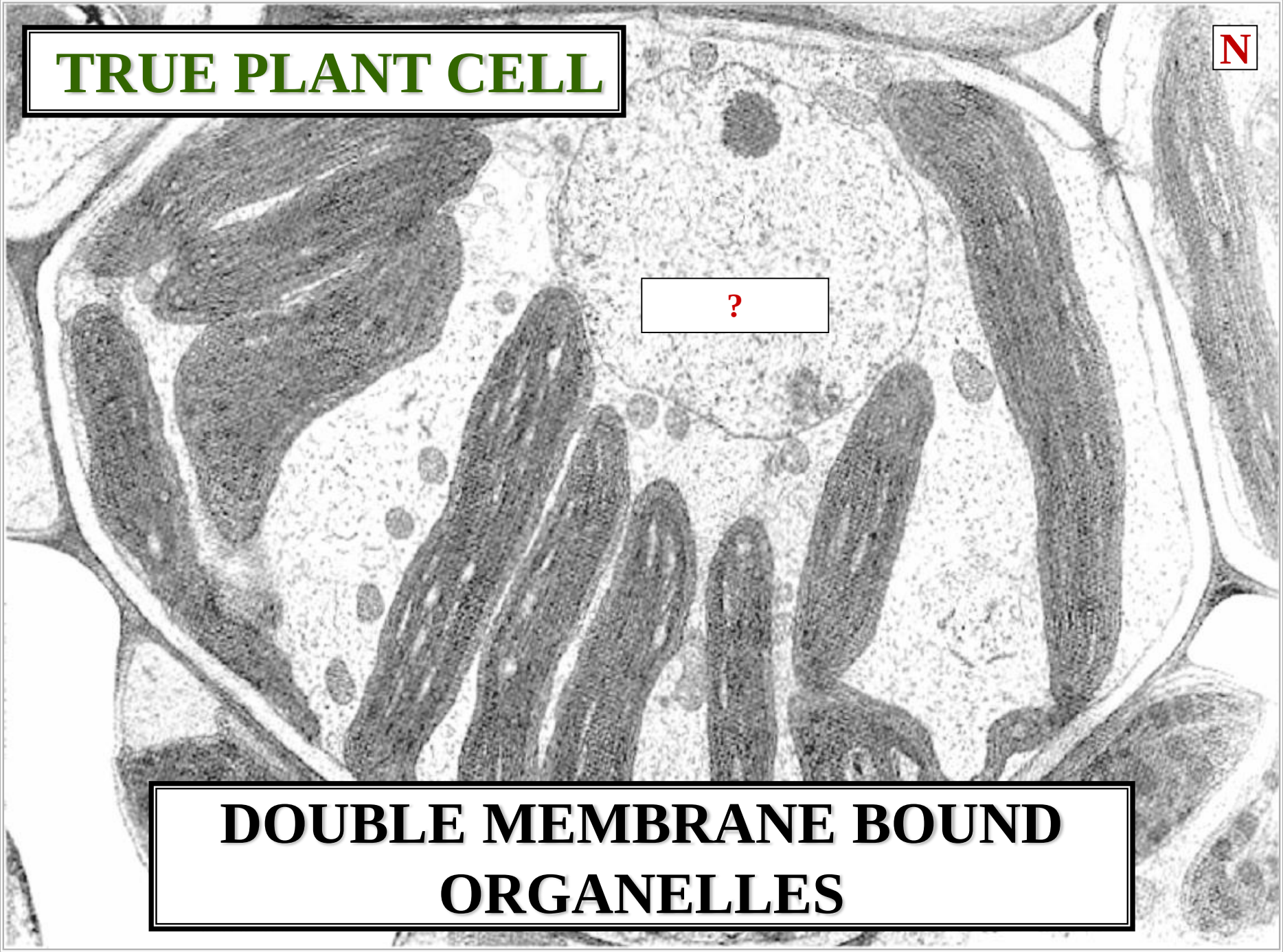
POSSESS

OUTER & INNER PERIPHERAL MEMBRANE

DOUBLE MEMBRANE BOUND ORGANELLES

TRUE PLANT CELL

N



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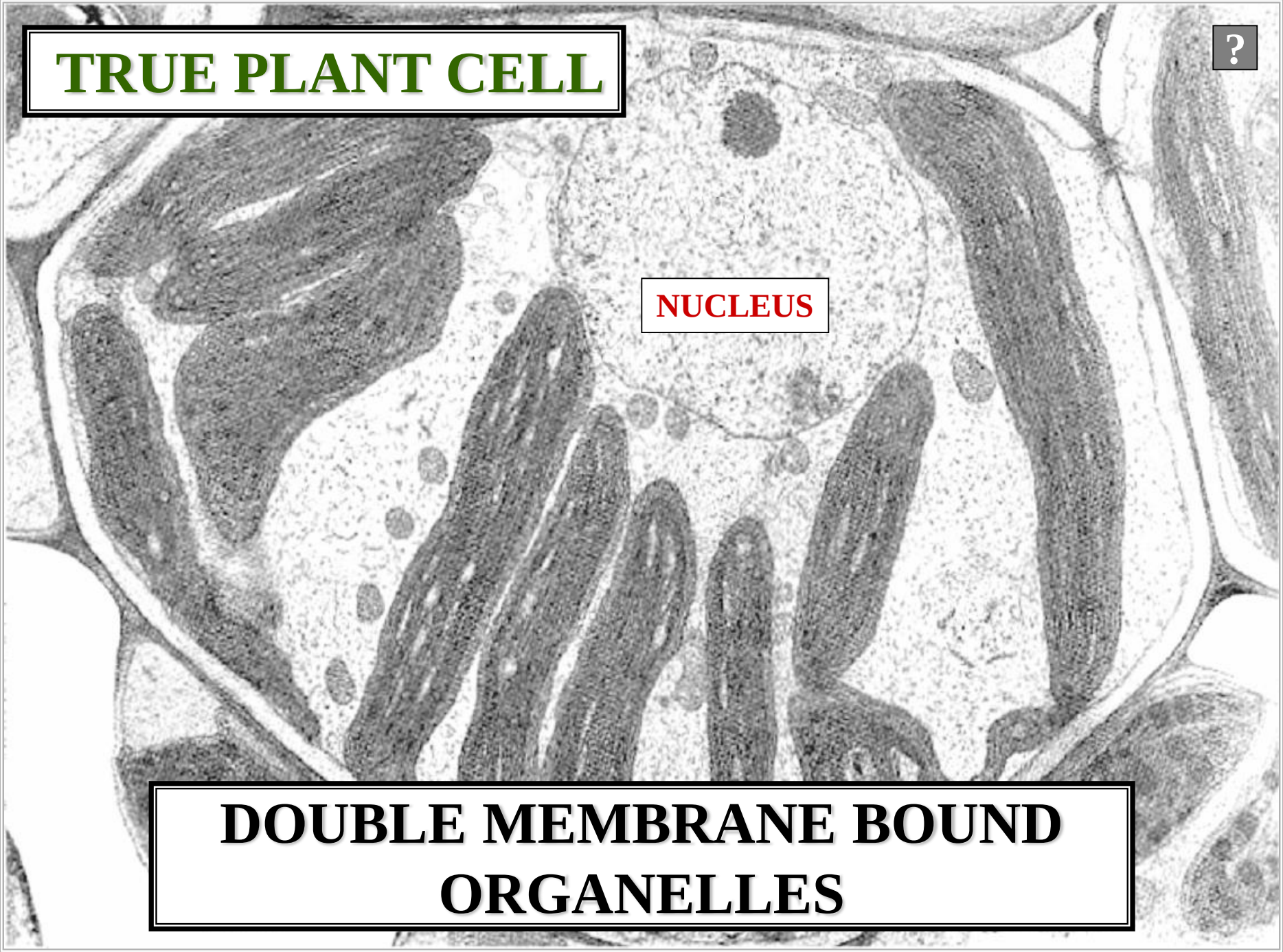
DOUBLE MEMBRANE BOUND ORGANELLES

TRUE PLANT CELL

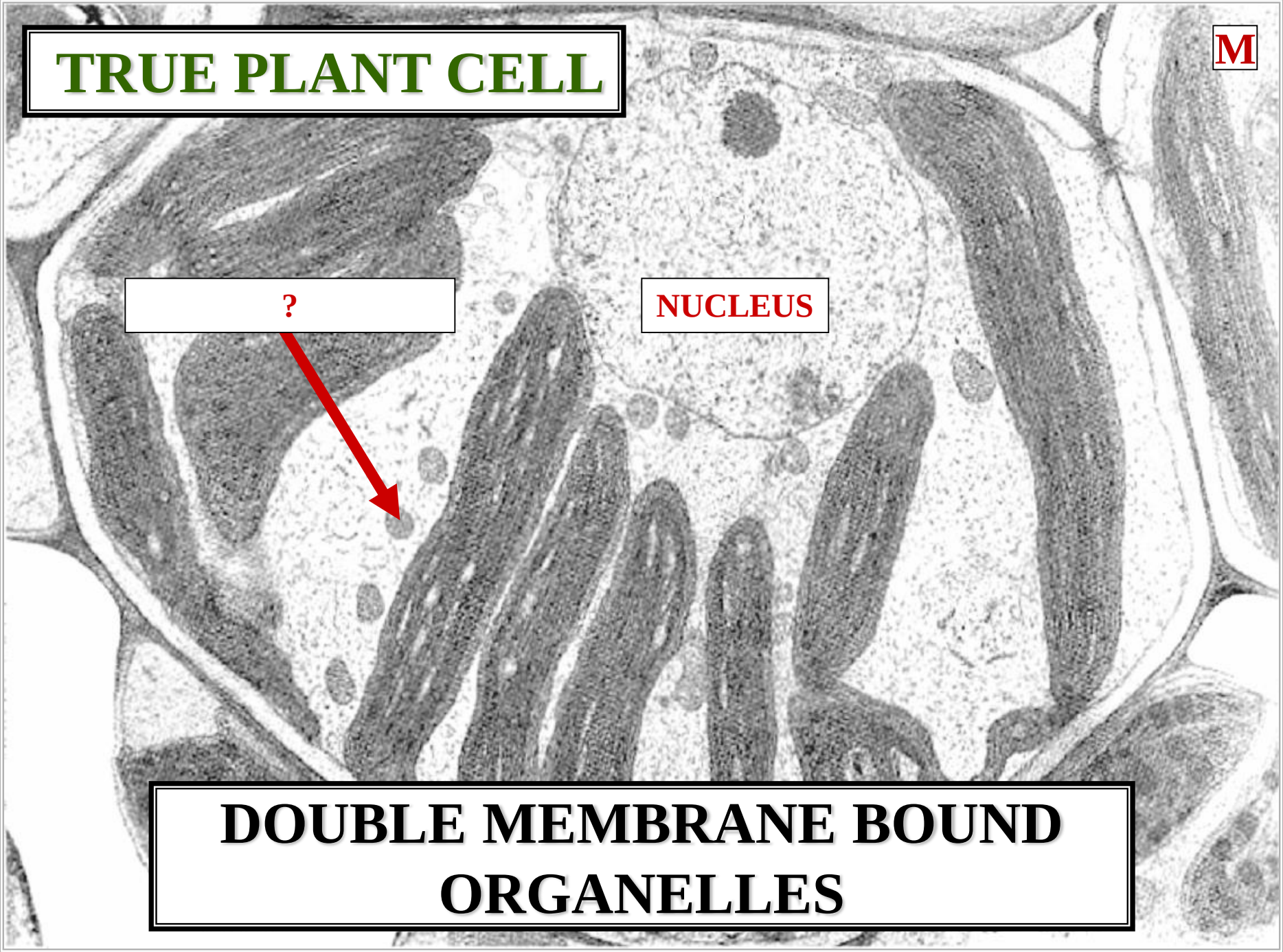
?



DOUBLE MEMBRANE BOUND ORGANELLES

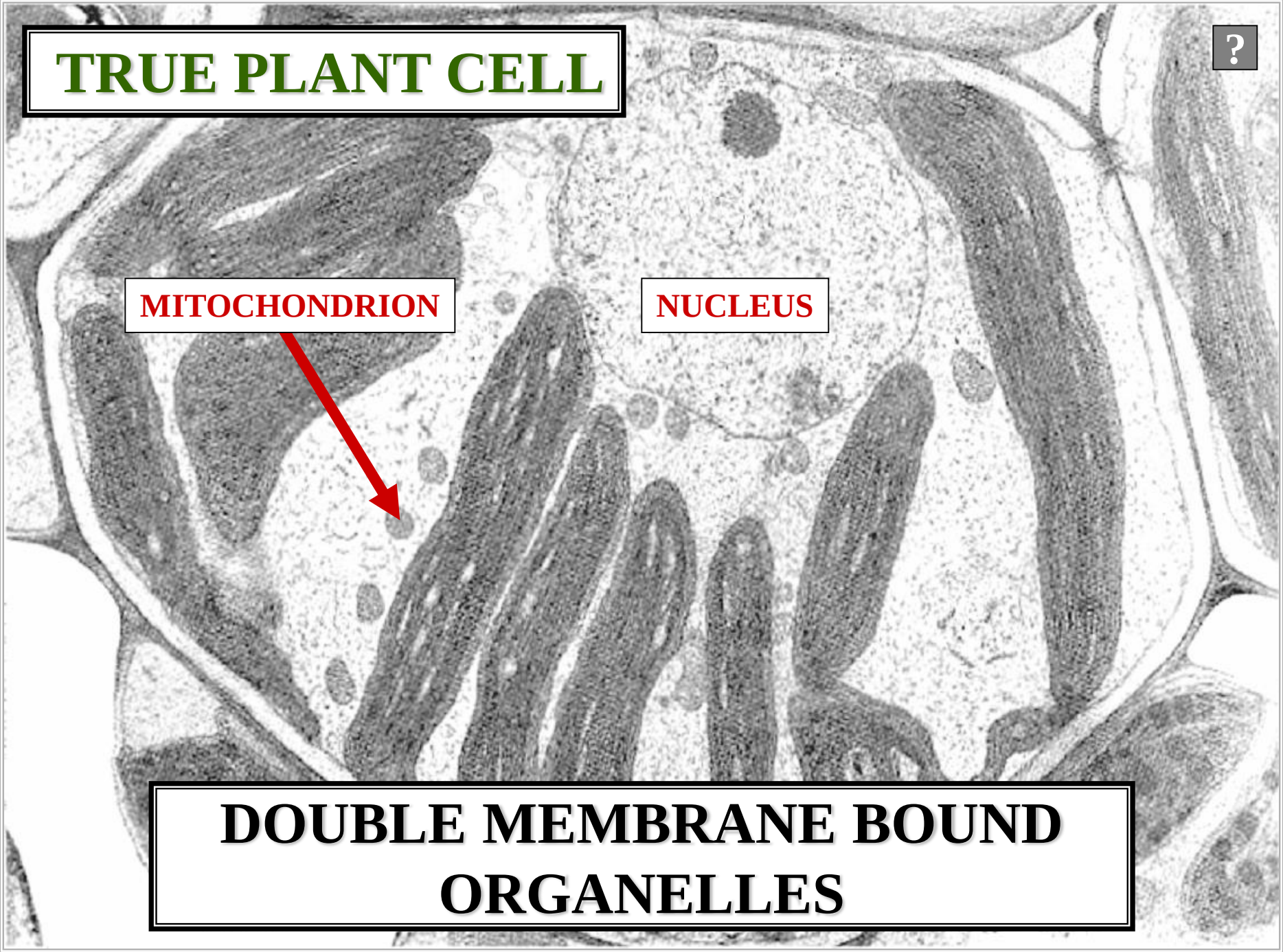
TRUE PLANT CELL

M



DOUBLE MEMBRANE BOUND ORGANELLES

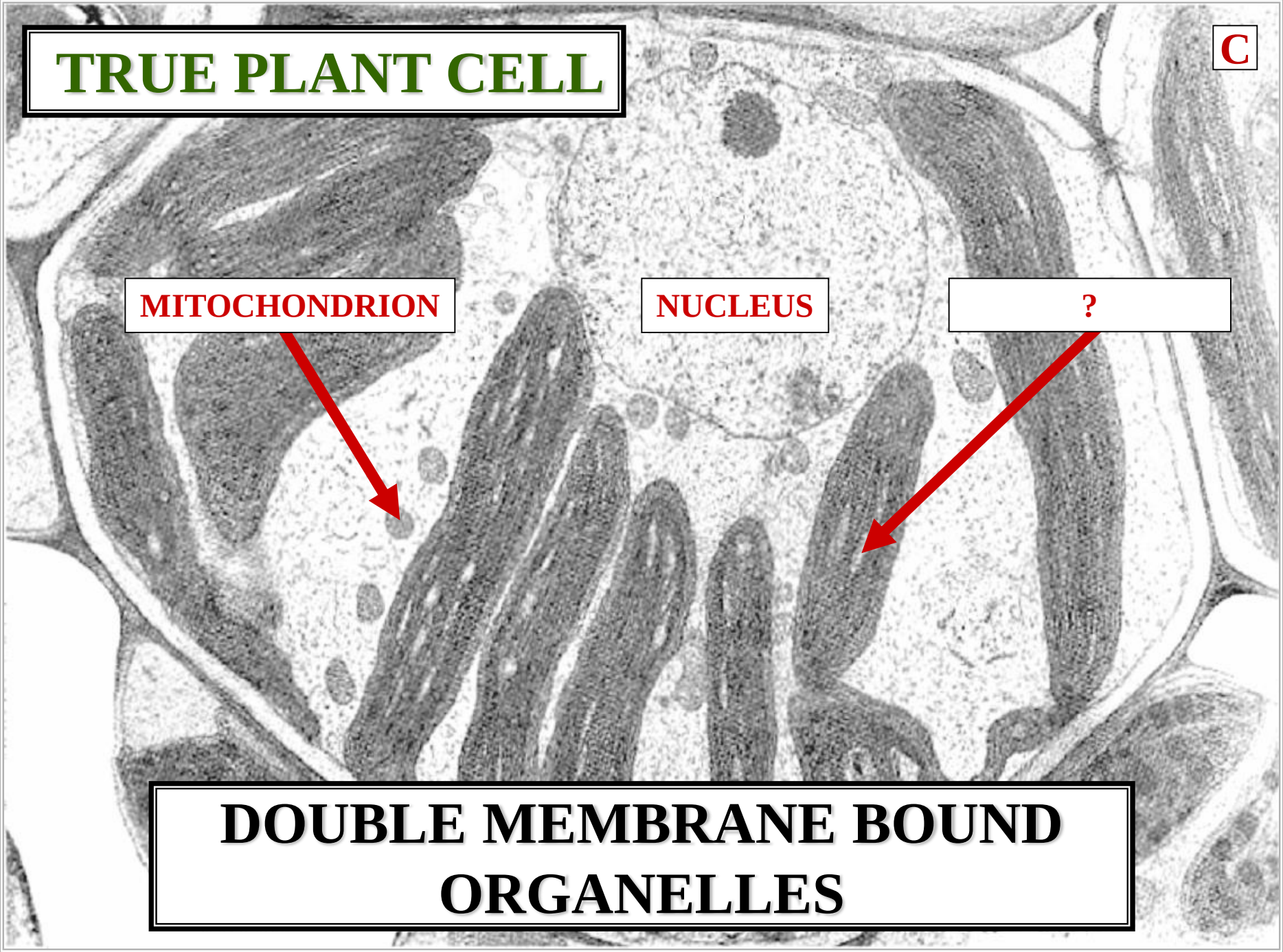
TRUE PLANT CELL



DOUBLE MEMBRANE BOUND ORGANELLES

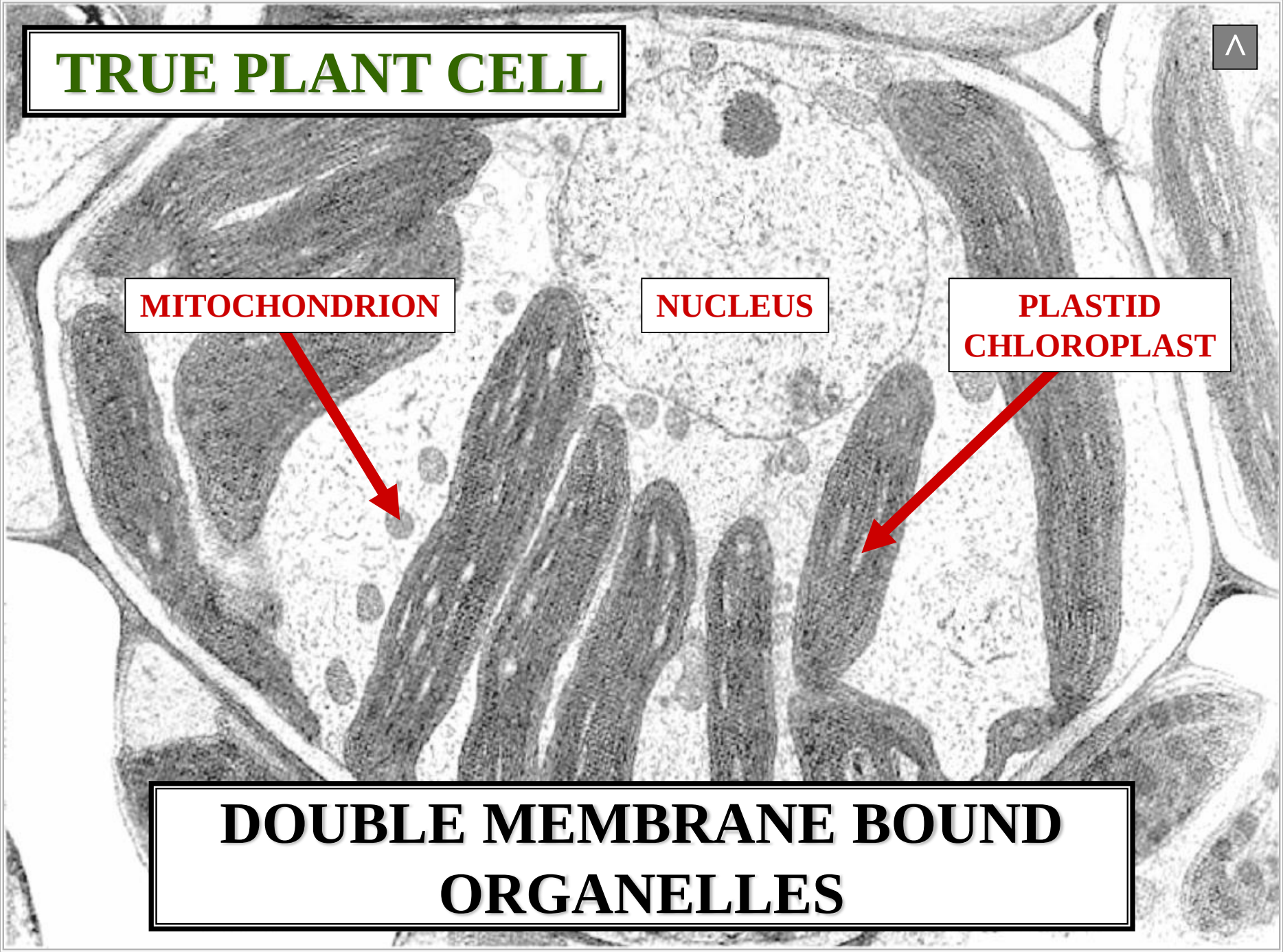
TRUE PLANT CELL

C



DOUBLE MEMBRANE BOUND ORGANELLES

TRUE PLANT CELL



DOUBLE MEMBRANE BOUND ORGANELLES

DOUBLE MEMBRANE BOUND ORGANELLE EVOLUTION

A

AUTOGENOUS THEORY

AUTOGENOUS THEORY

AUTOGENOUS THEORY

NUCLEUS EVOLUTION

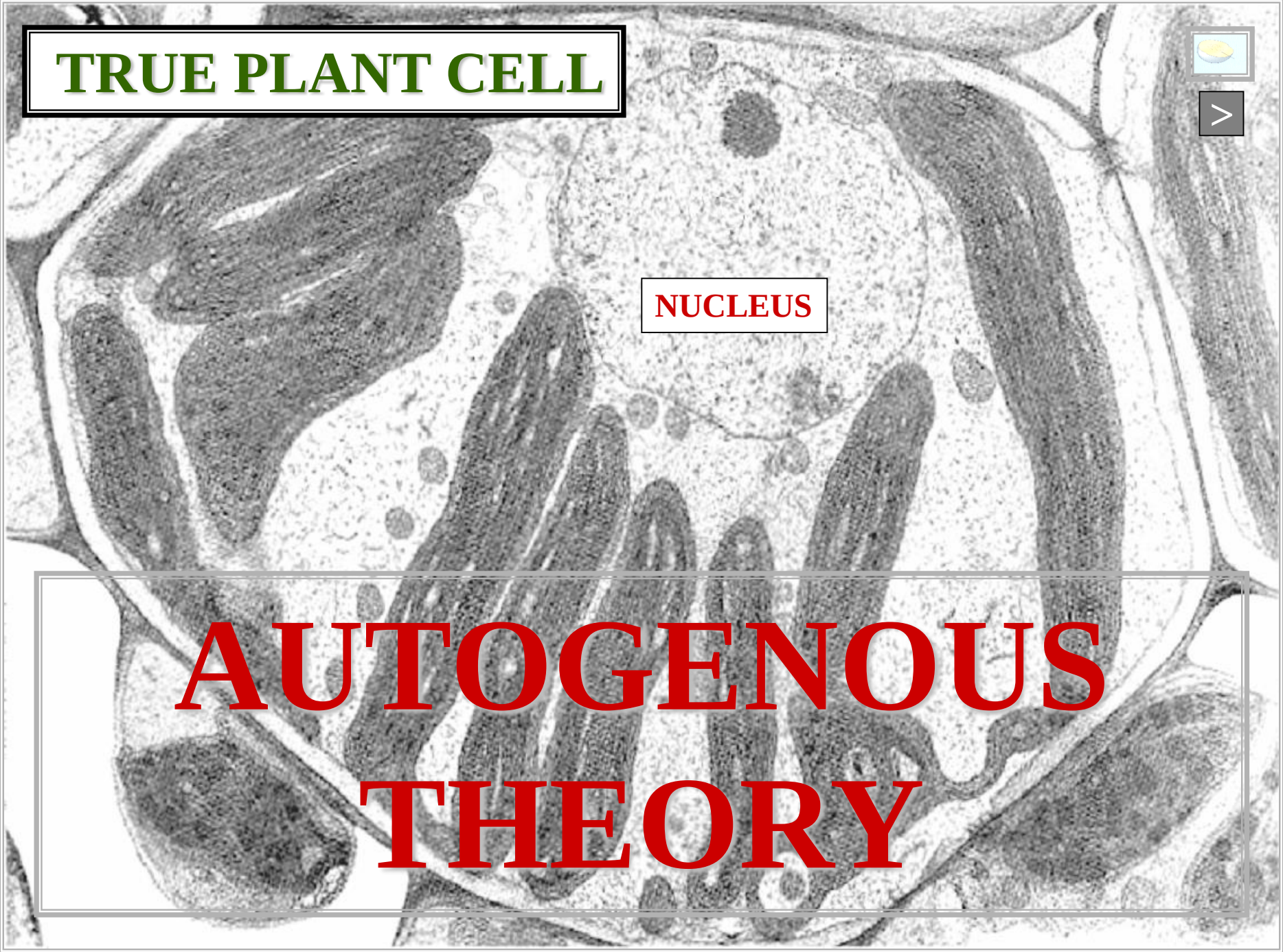
AUTOGENOUS THEORY

AUTOGENOUS THEORY

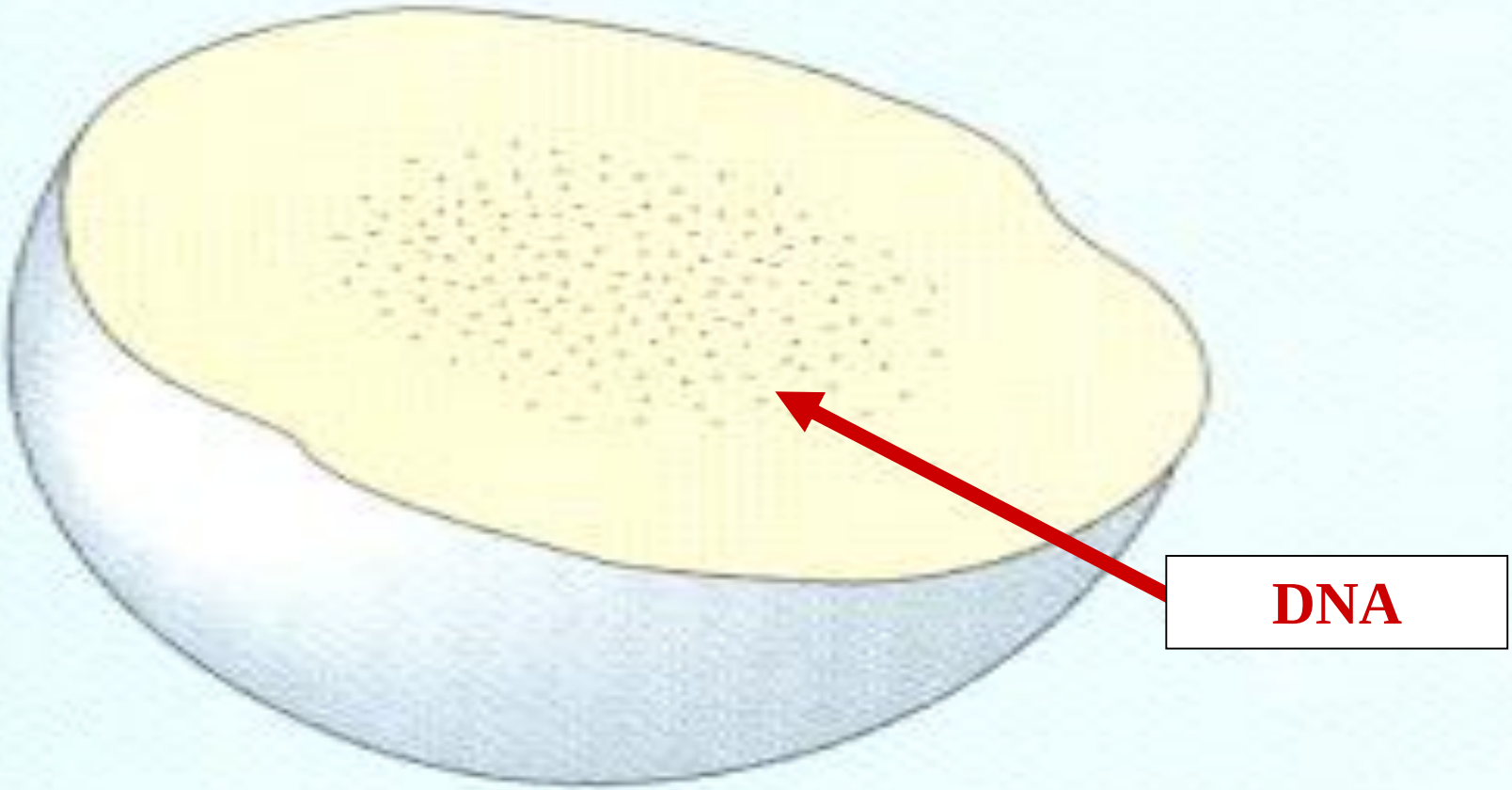
VIA PROKARYOTE MESOSOME SPECALIZATION

AUTOGENOUS THEORY

TRUE PLANT CELL



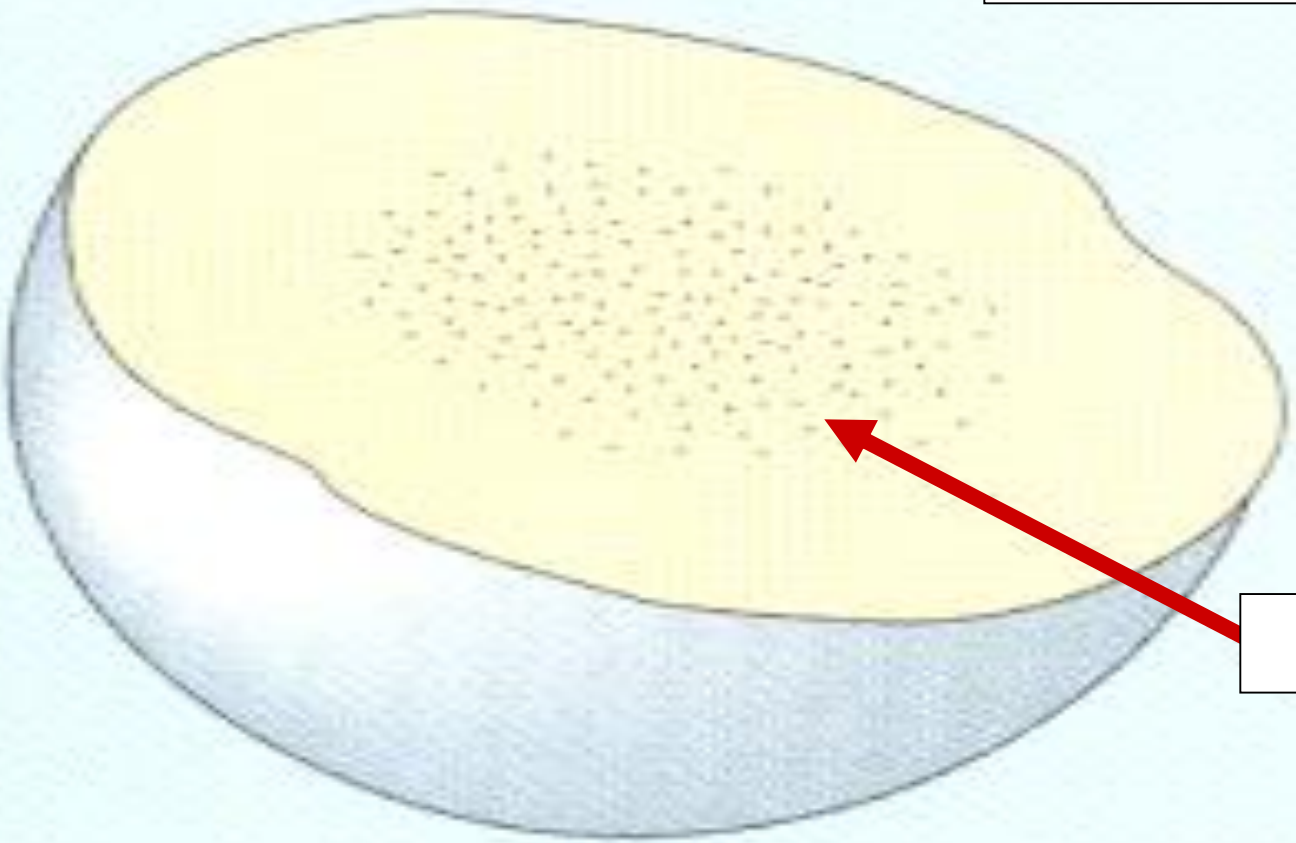
AUTOGENOUS THEORY



ANCESTRAL PROKARYOTE

NU
AB

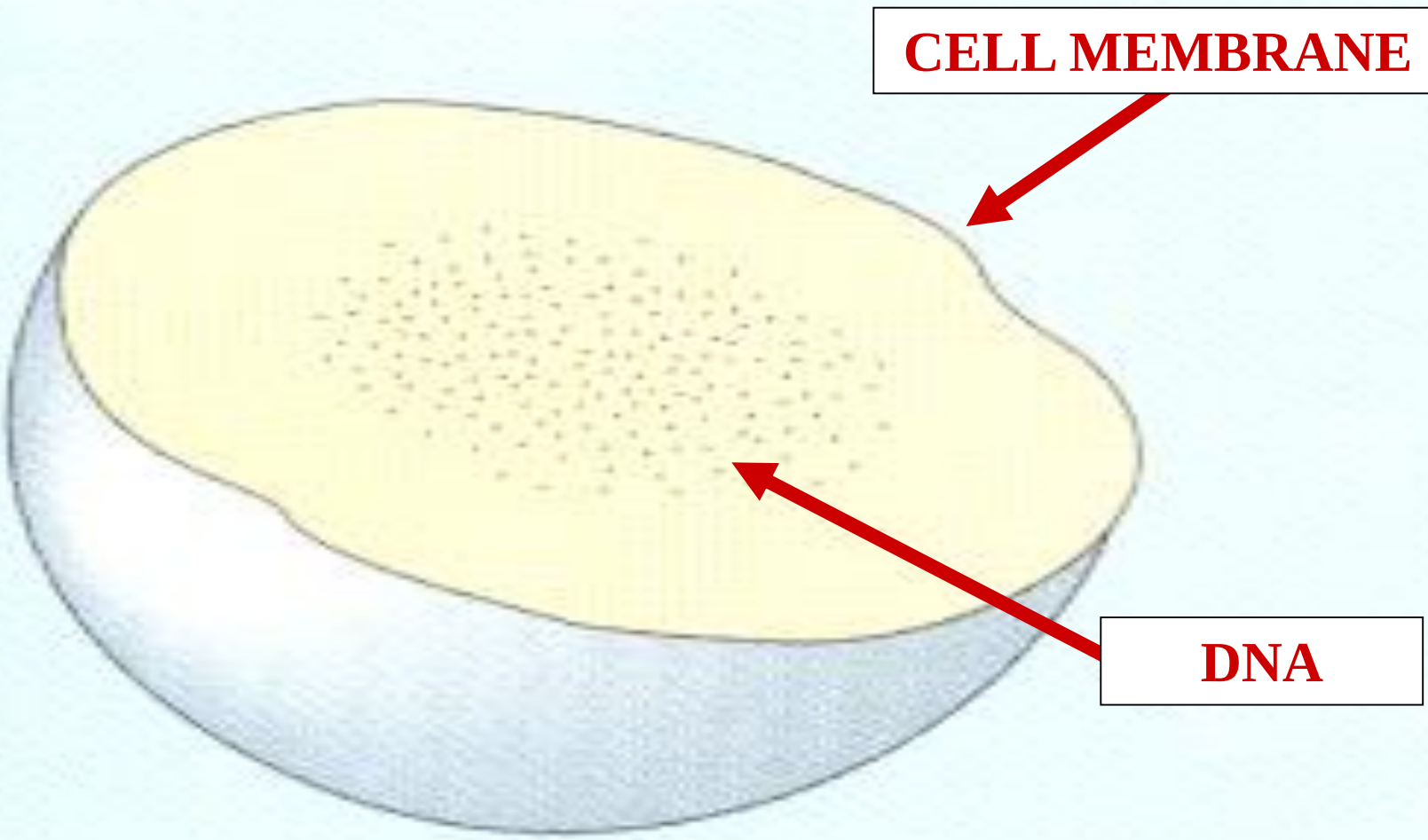
NUCLEUS: ABSENT



DNA

ANCESTRAL PROKARYOTE

CM

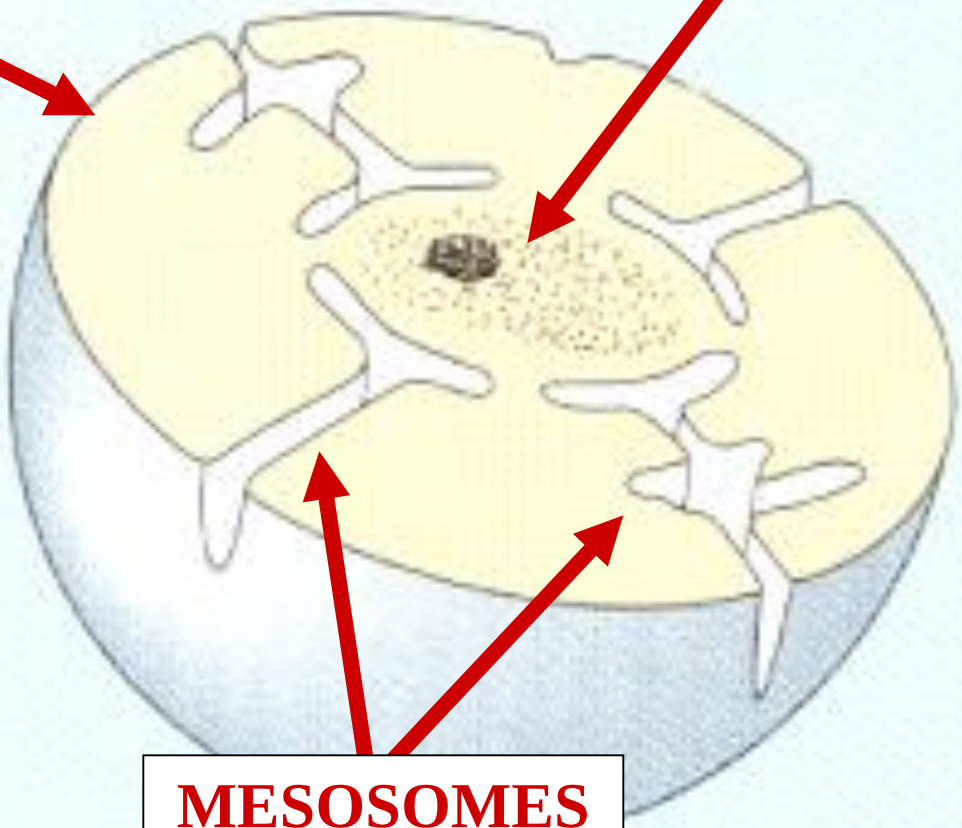


ANCESTRAL PROKARYOTE

M

CELL MEMBRANE

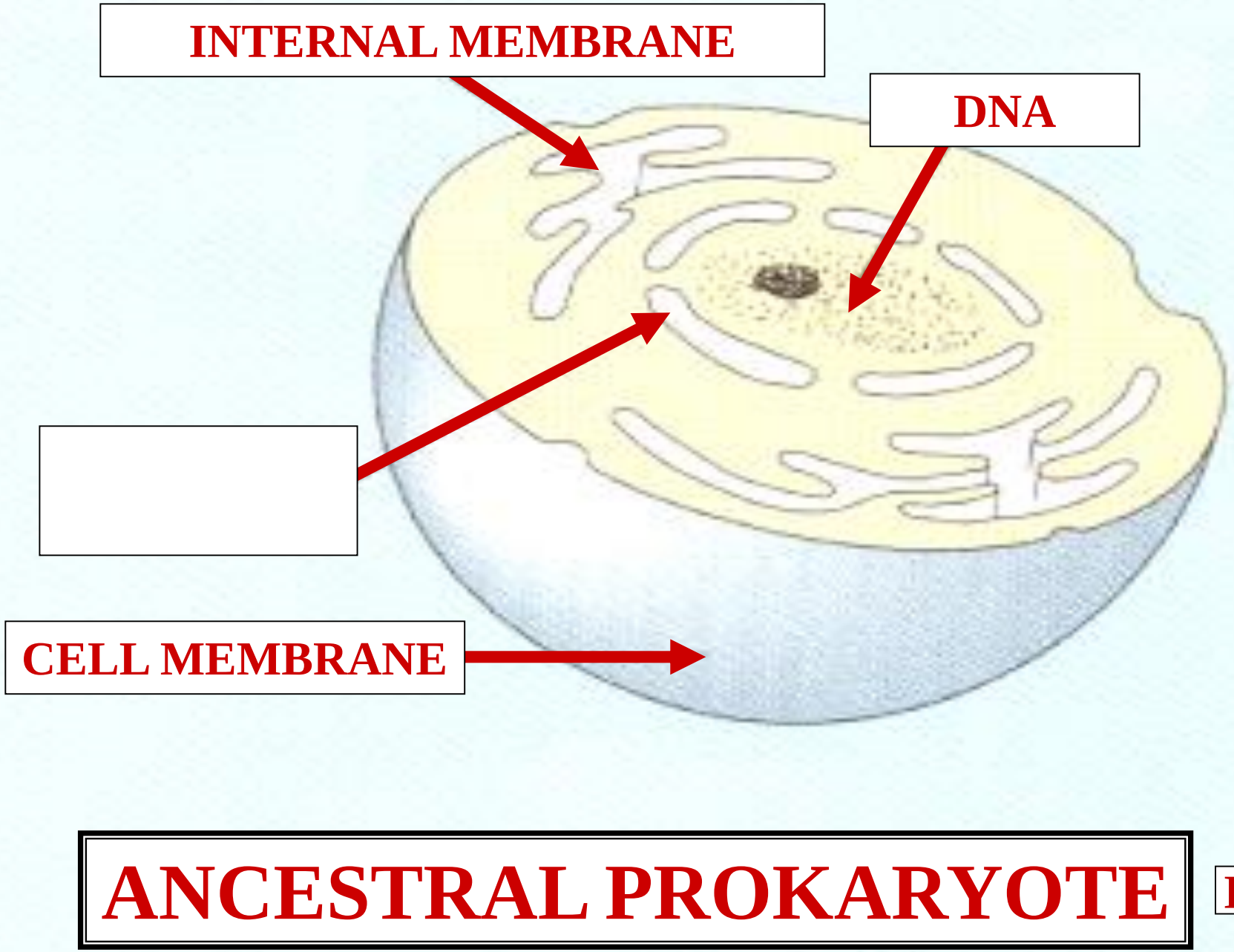
DNA



MESOSOMES

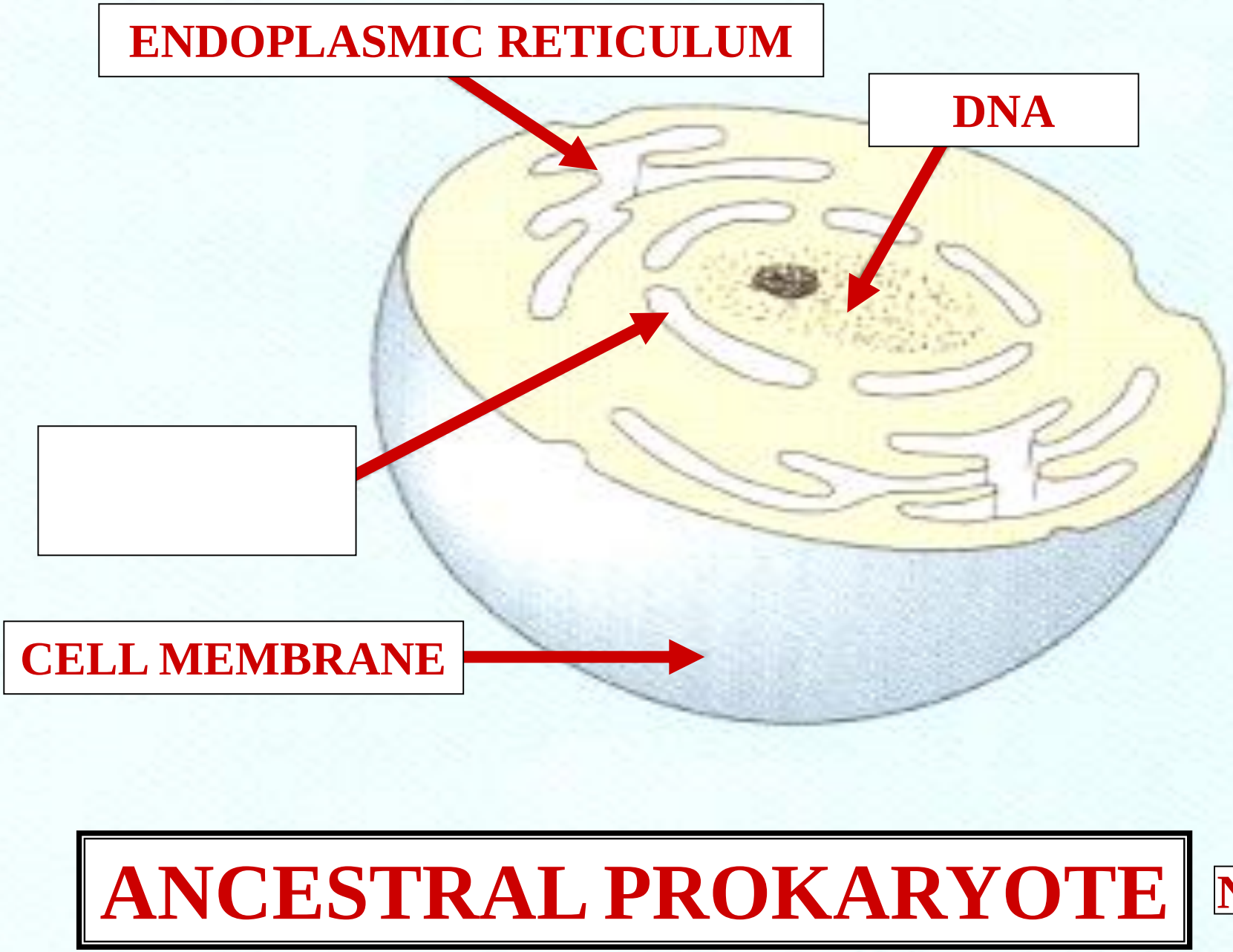
ANCESTRAL PROKARYOTE

IM



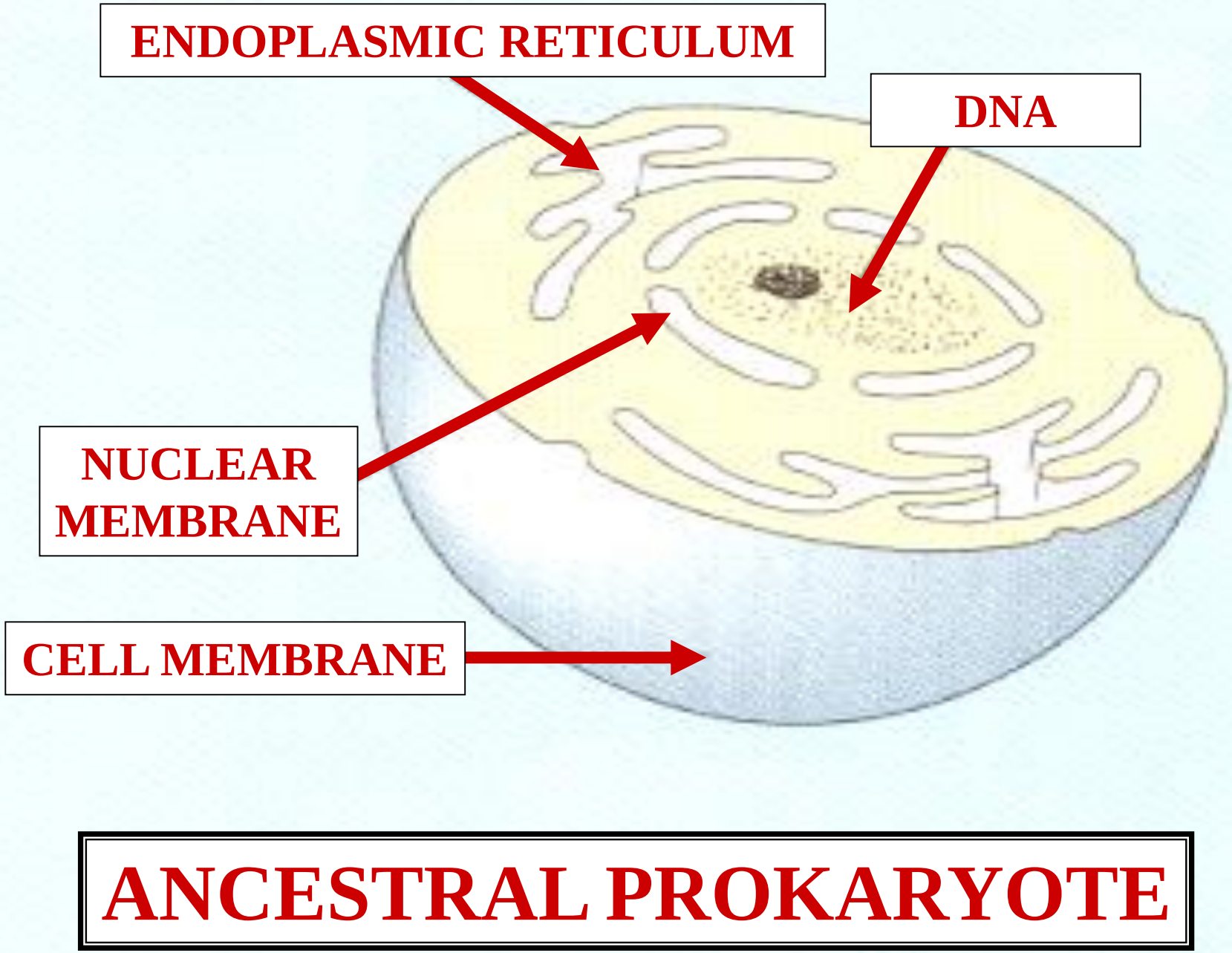
ANCESTRAL PROKARYOTE

ER



ANCESTRAL PROKARYOTE

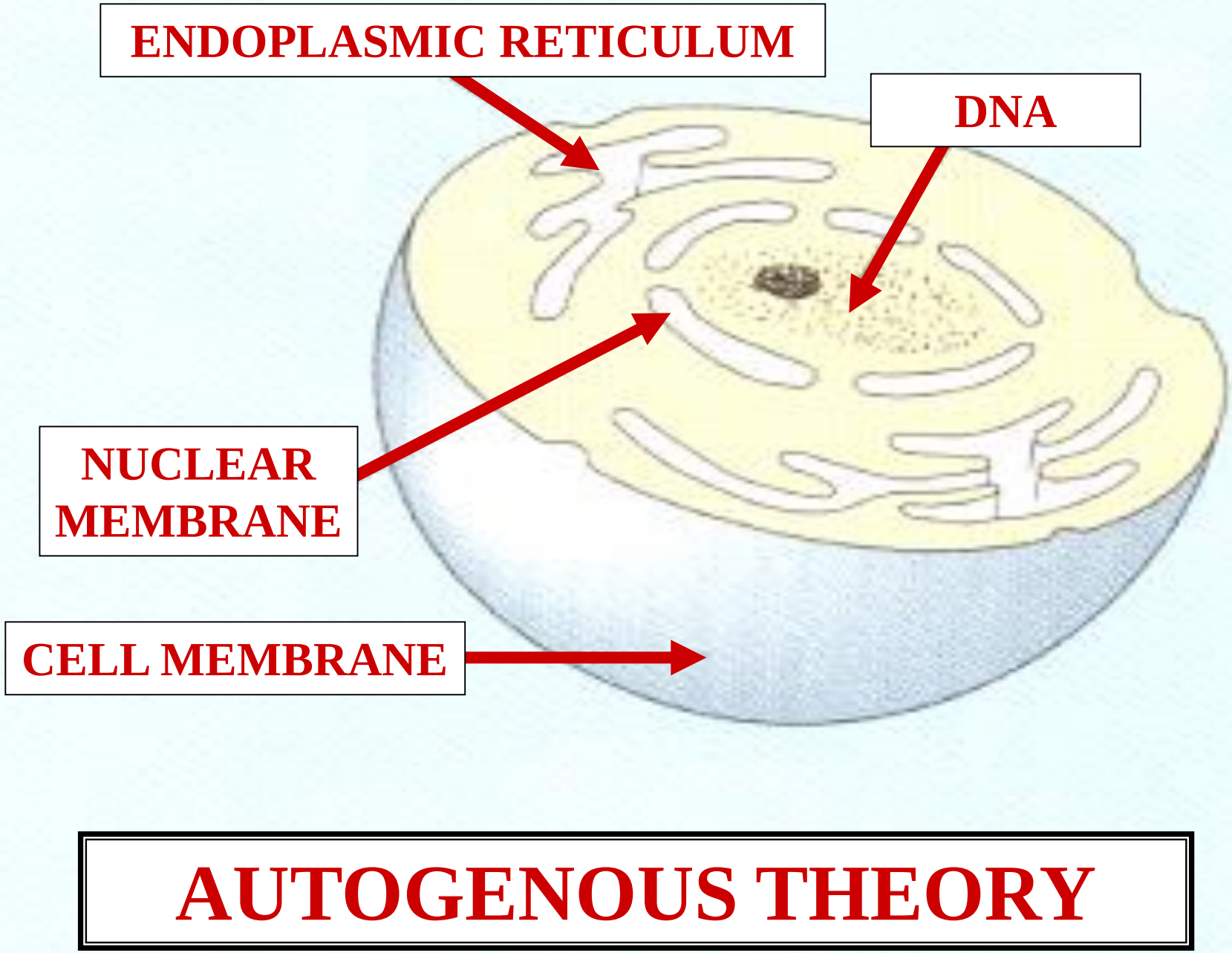
NM



ANCESTRAL PROKARYOTE

AUTOGENOUS THEORY

SUMMARY



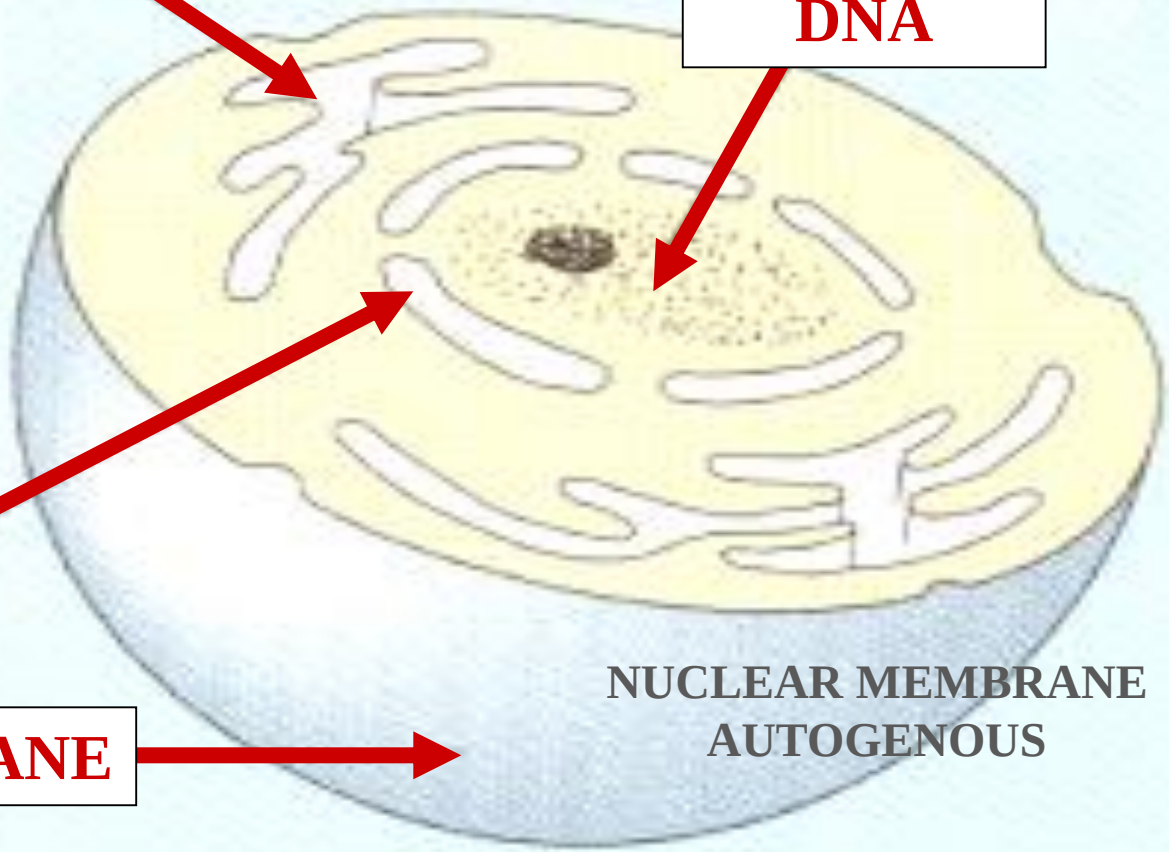
AUTOGENOUS THEORY

ENDOPLASMIC RETICULUM

DNA

NUCLEAR MEMBRANE

CELL MEMBRANE

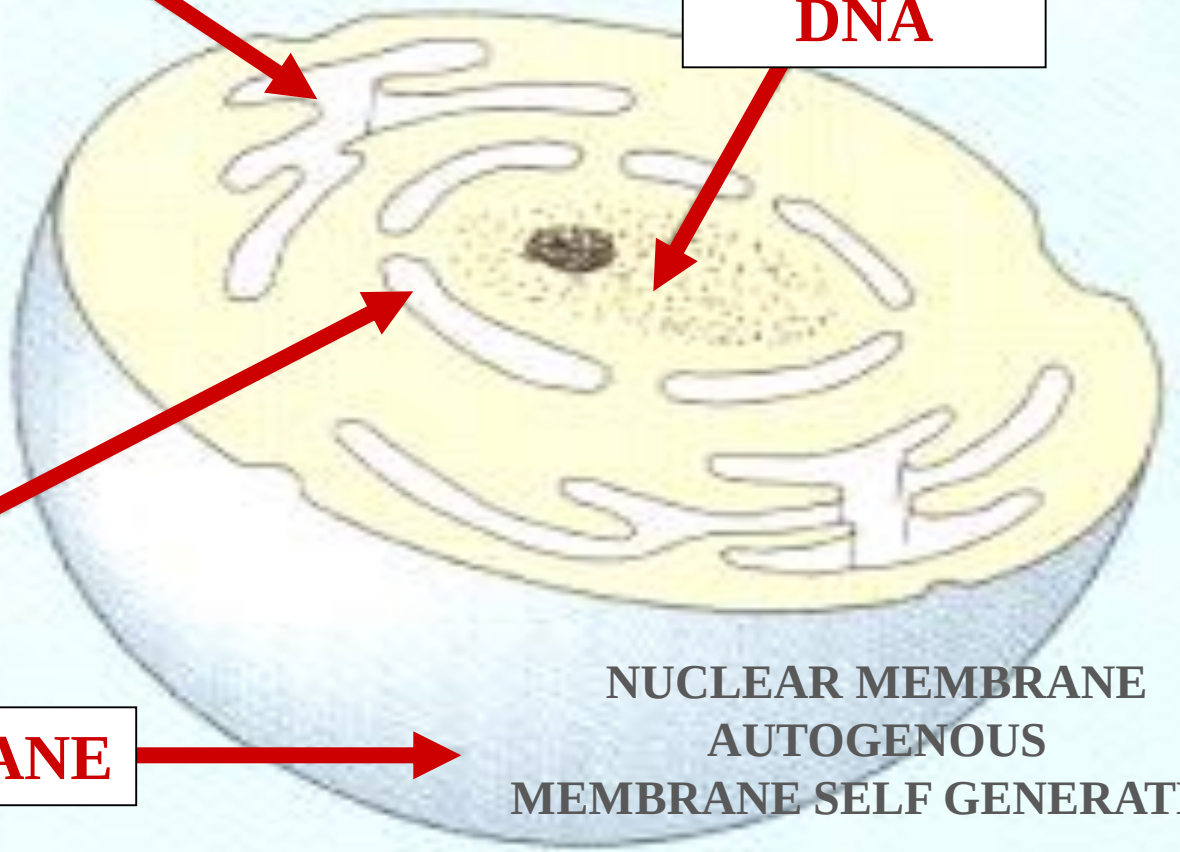


NUCLEAR MEMBRANE AUTOGENOUS

AUTOGENOUS THEORY

ENDOPLASMIC RETICULUM

DNA



NUCLEAR MEMBRANE

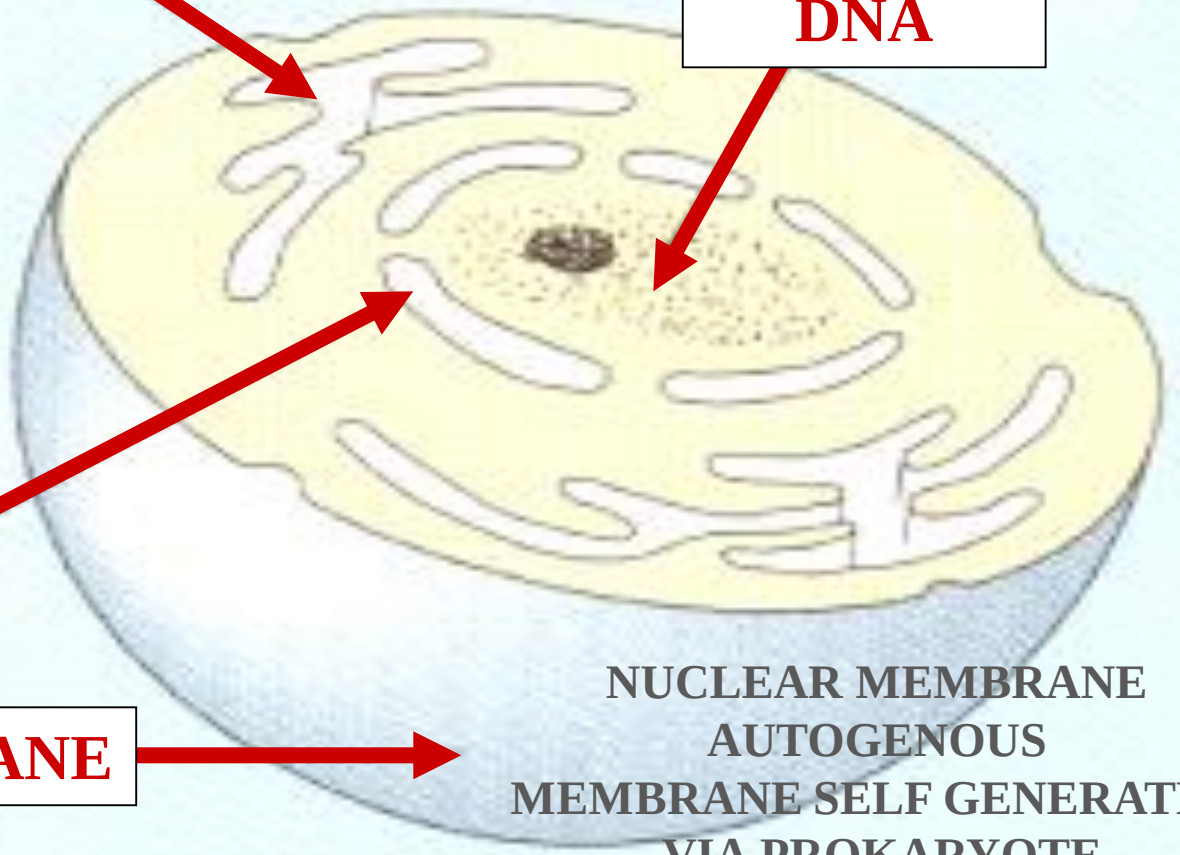
CELL MEMBRANE

NUCLEAR MEMBRANE
AUTOGENOUS
MEMBRANE SELF GENERATED

AUTOGENOUS THEORY

ENDOPLASMIC RETICULUM

DNA



NUCLEAR MEMBRANE

CELL MEMBRANE

NUCLEAR MEMBRANE
AUTOGENOUS
MEMBRANE SELF GENERATED
VIA PROKARYOTE
MESOSOME SPECIALIZATION

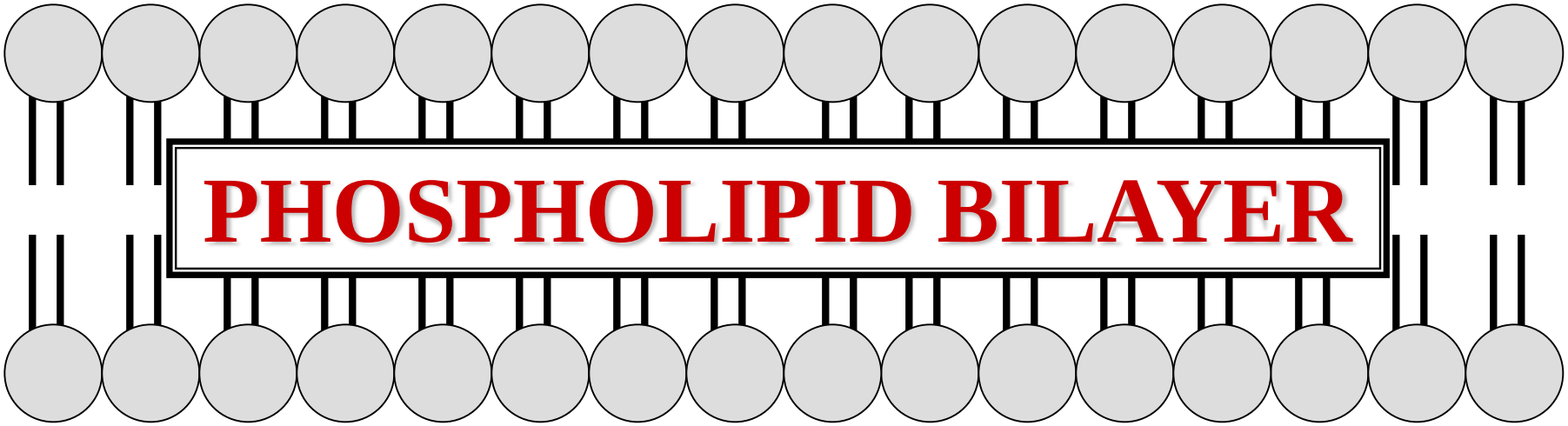
AUTOGENOUS THEORY

AUTOGENOUS THEORY SUPPORTING EVIDENCE

CELL MEMBRANE, ER & NUCLEAR MEMBRANE

CM

WATER WATER WATER

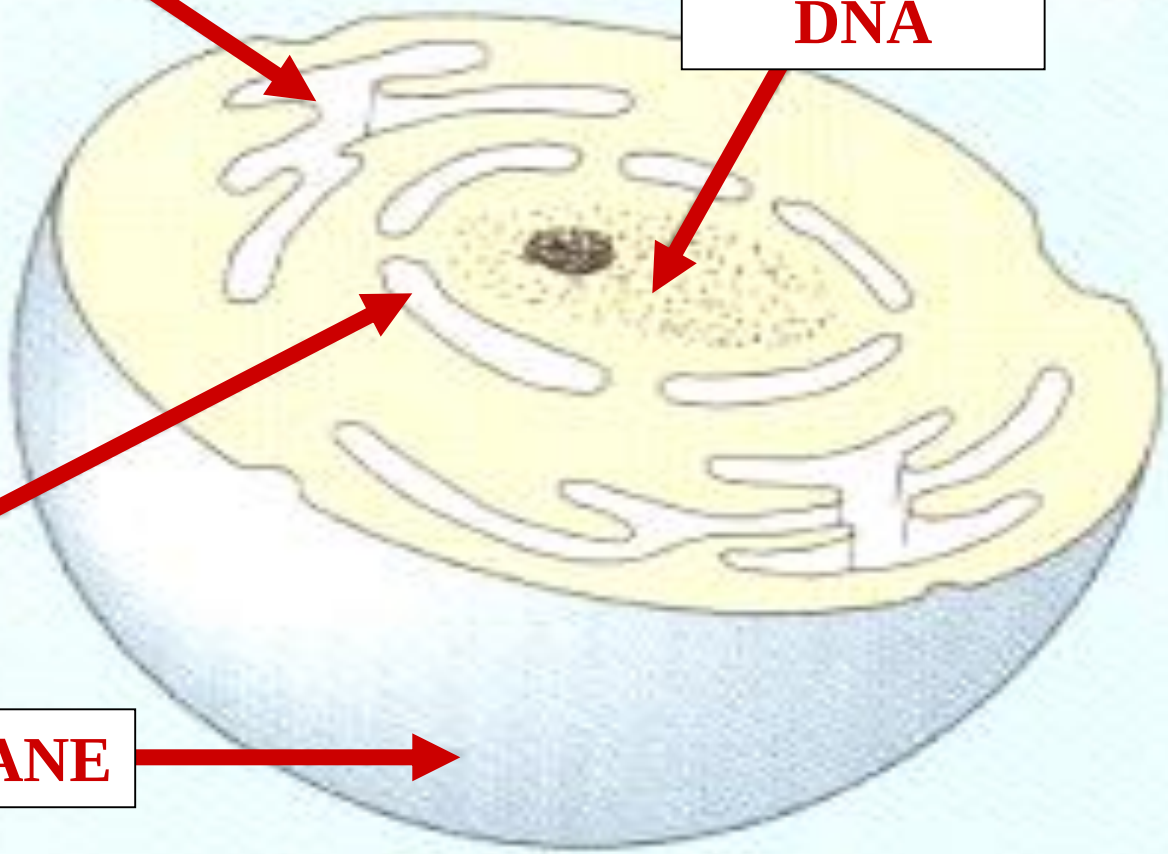


WATER WATER WATER

CELL MEMBRANE, ER & NUCLEAR MEMBRANE

ER

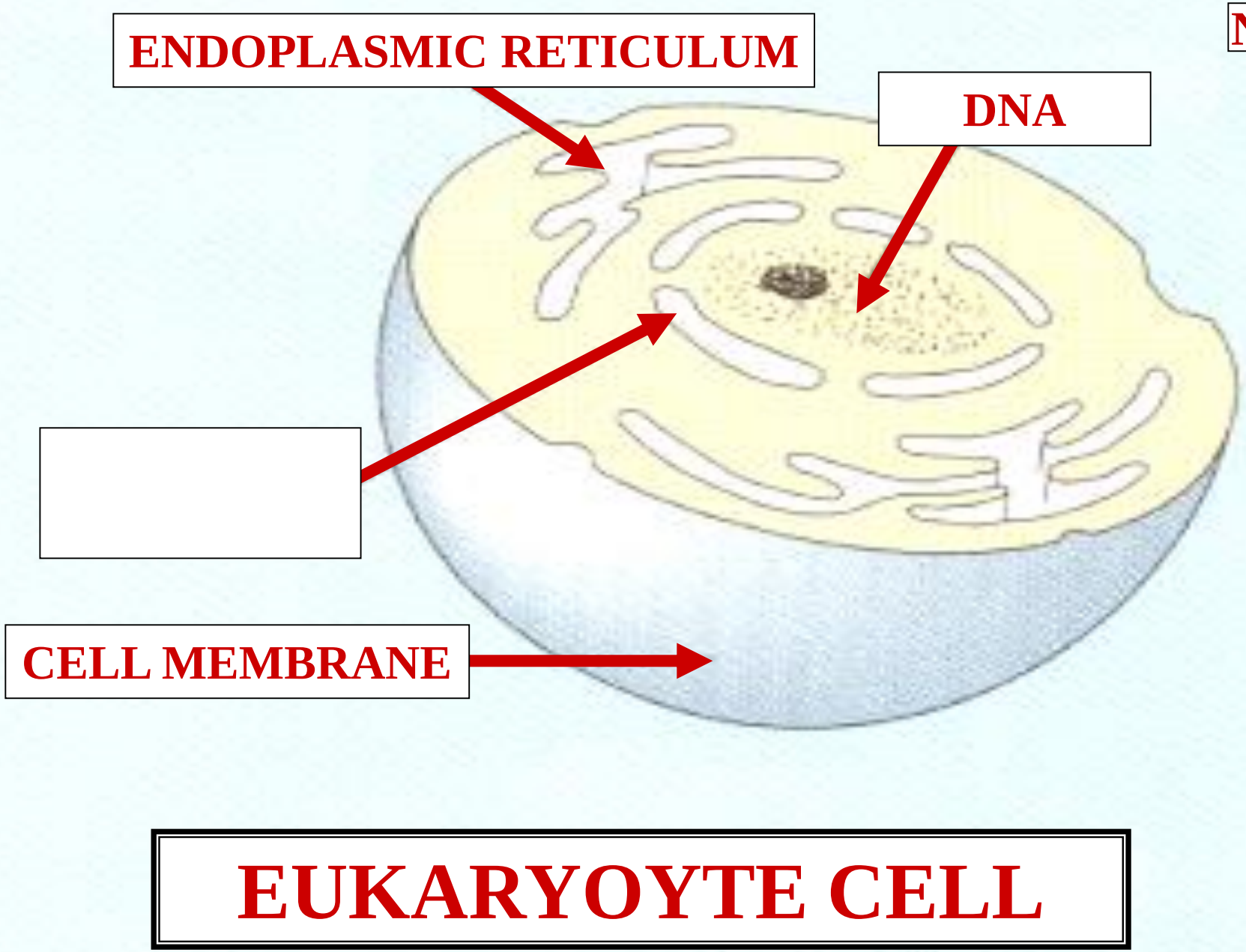
DNA



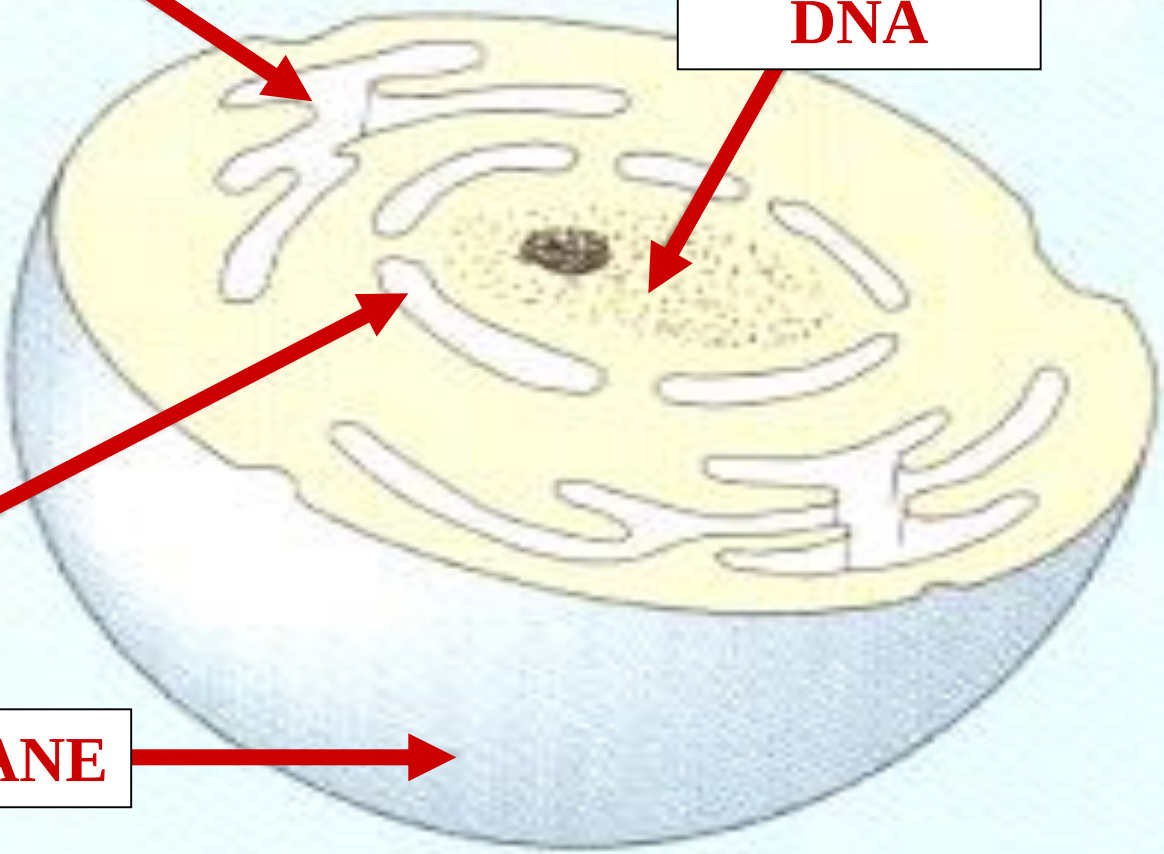
CELL MEMBRANE

EUKARYOYTE CELL

NM



EUKARYOYTE CELL

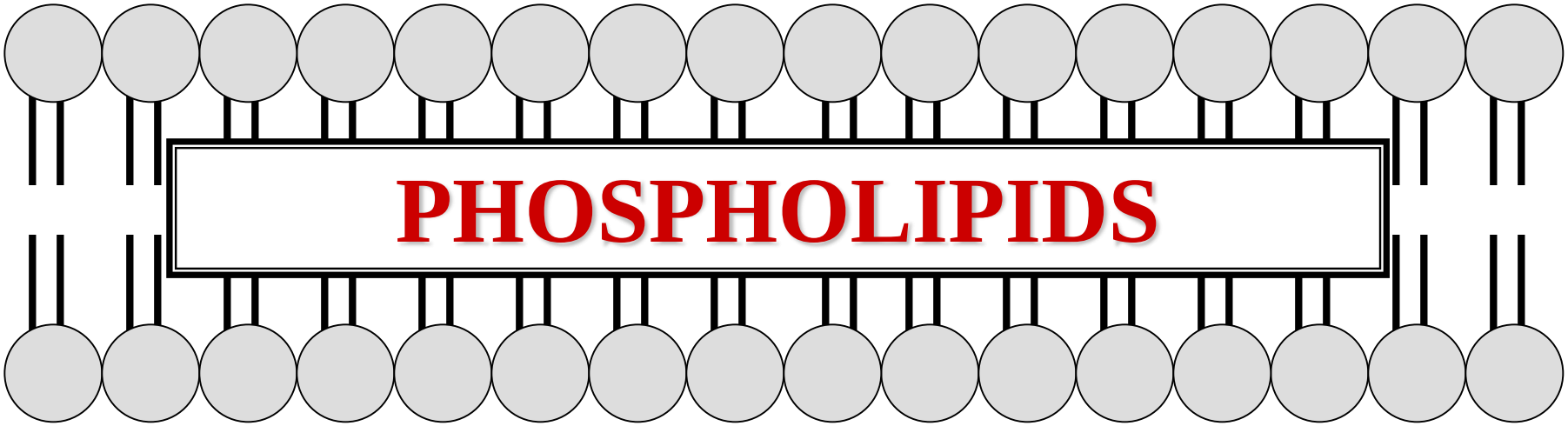


EUKARYOYTE CELL

ID

CELL MEMBRANE, ER & NUCLEAR MEMBRANE

WATER WATER WATER

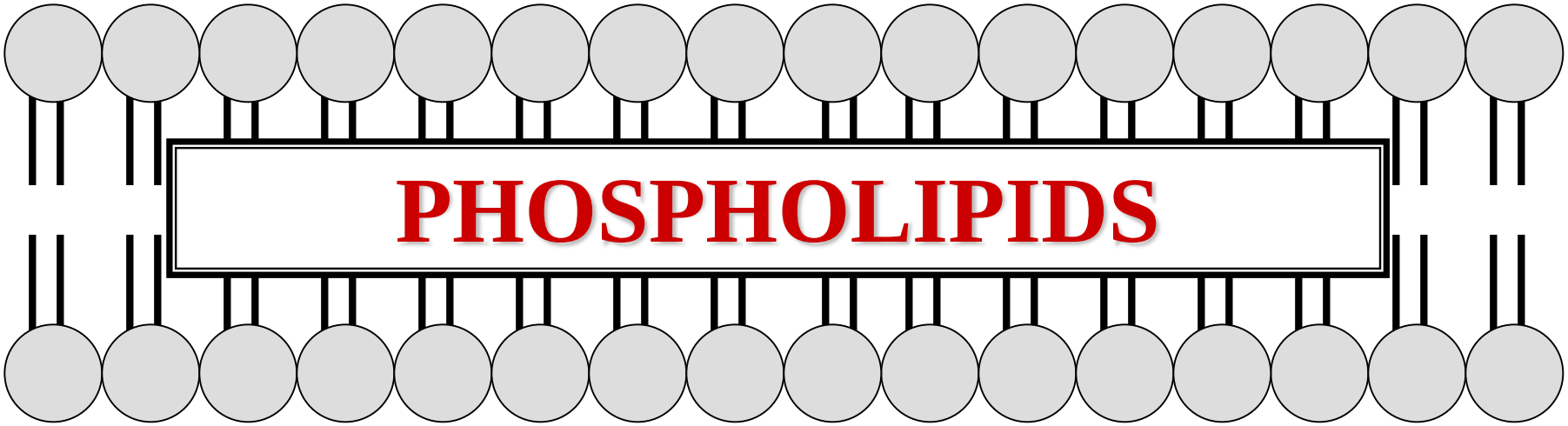


WATER WATER WATER

PHOSPHOLIPIDS

CELL MEMBRANE, ER & NUCLEAR MEMBRANE

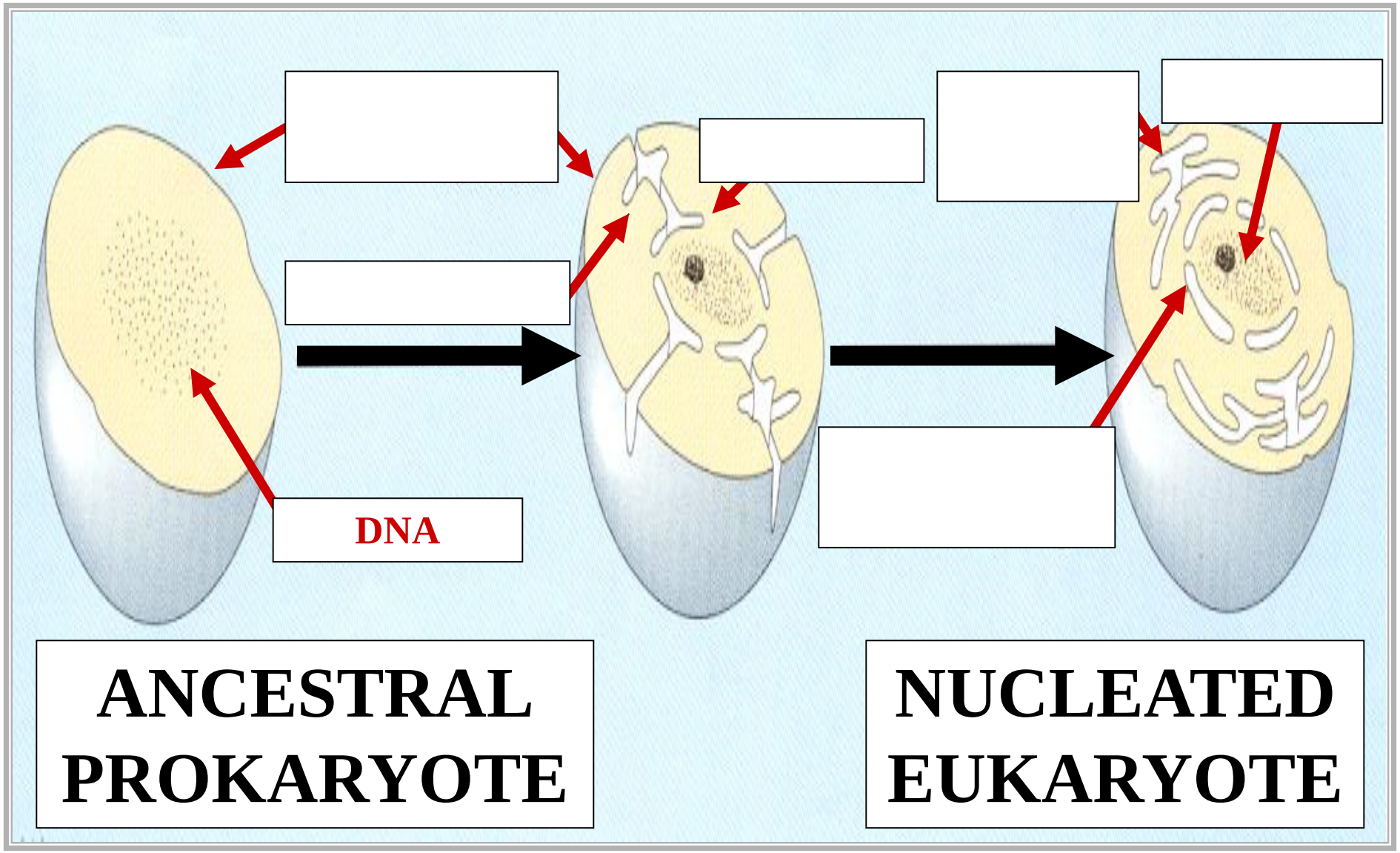
WATER WATER WATER



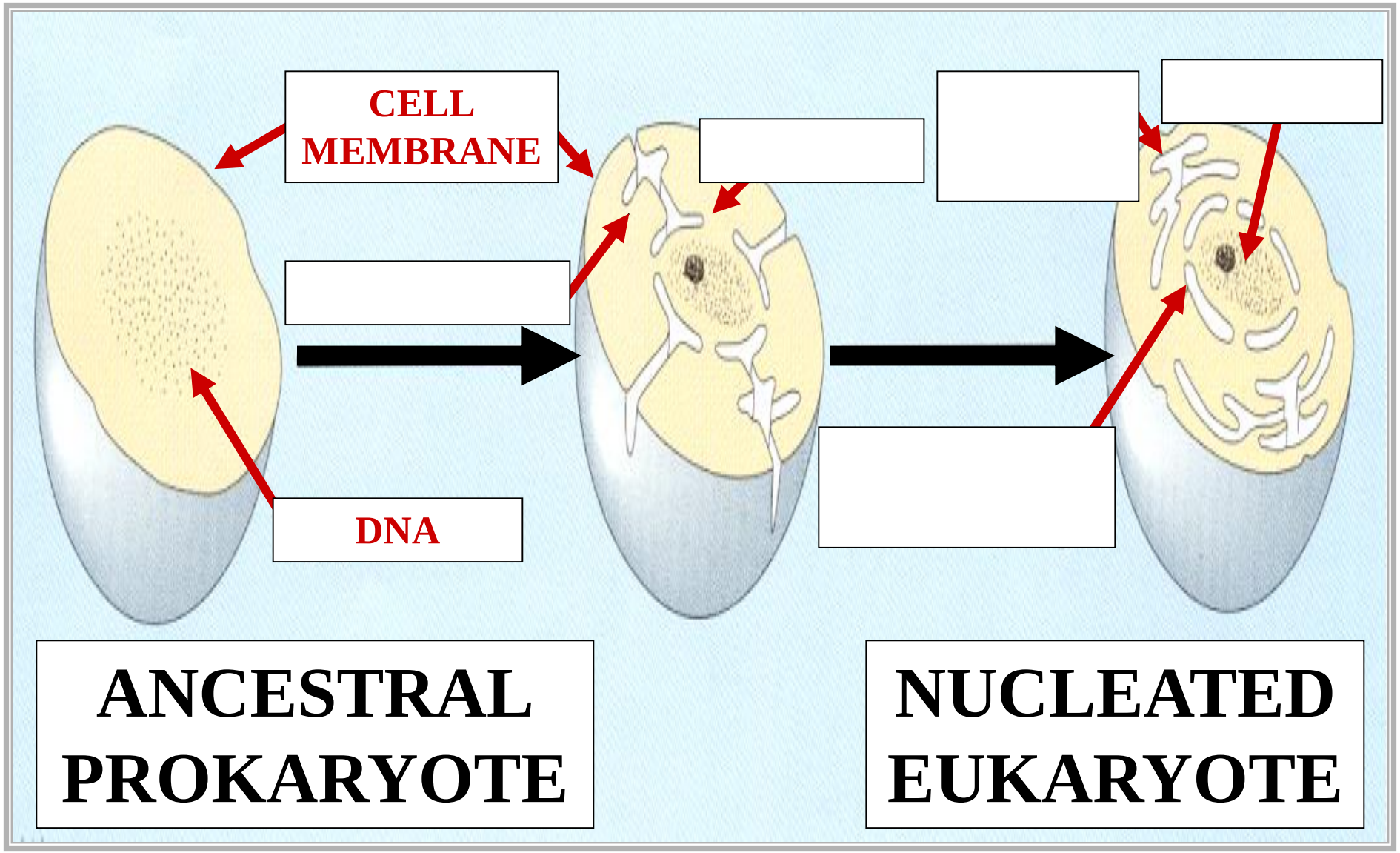
WATER WATER WATER

PHOSPHOLIPIDS IDENTICAL

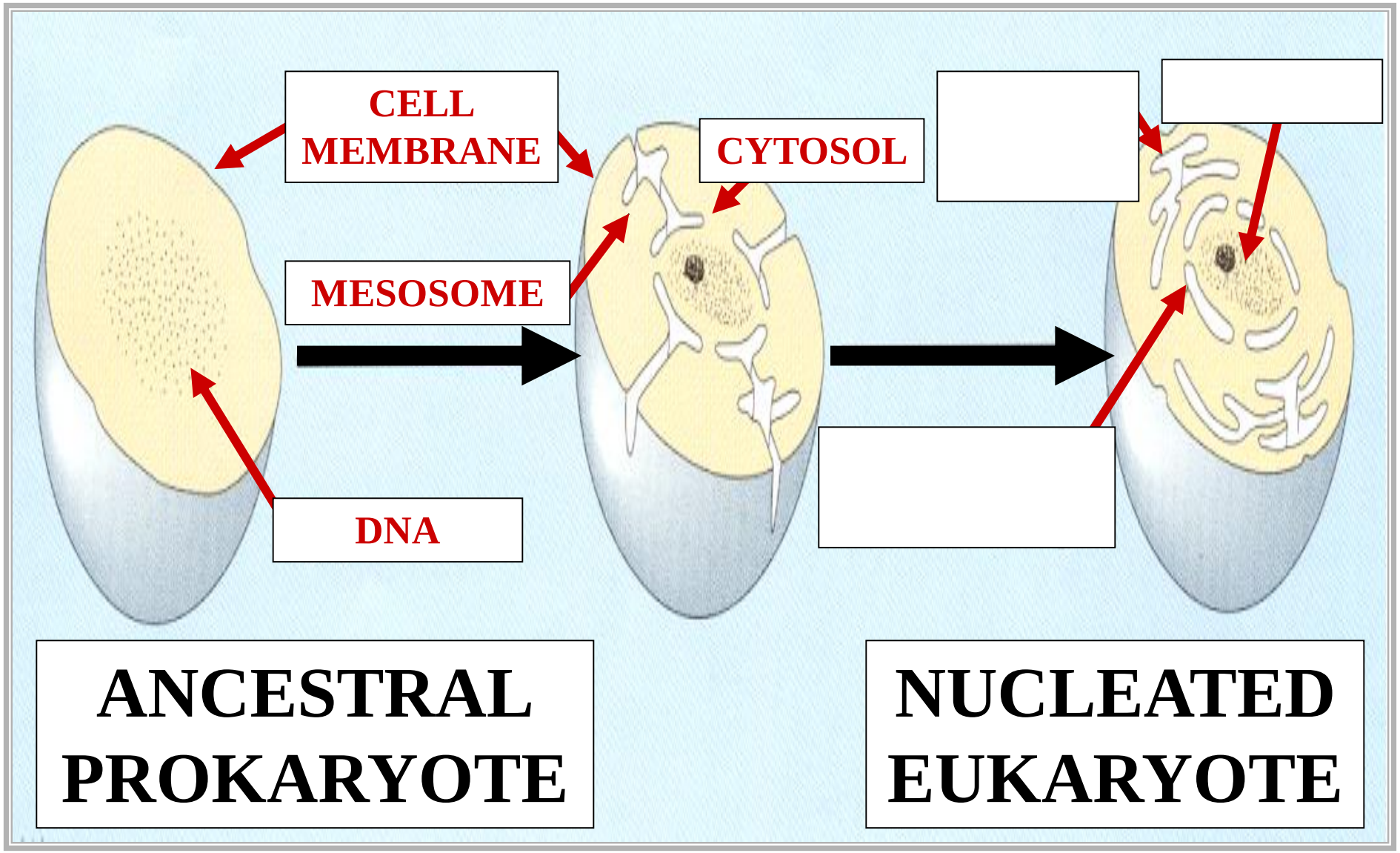
AUTOGENOUS THEORY



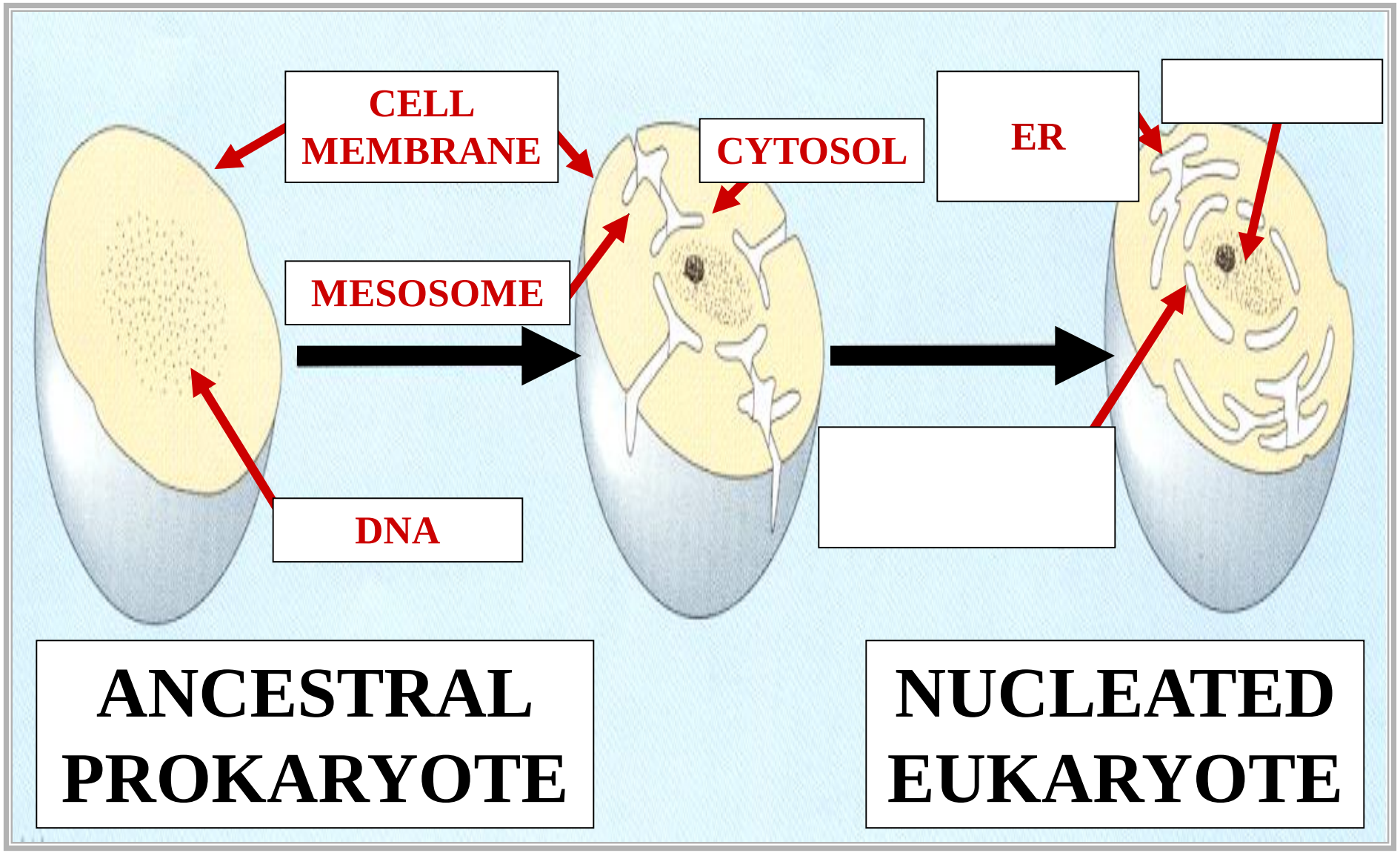
AUTOGENOUS THEORY



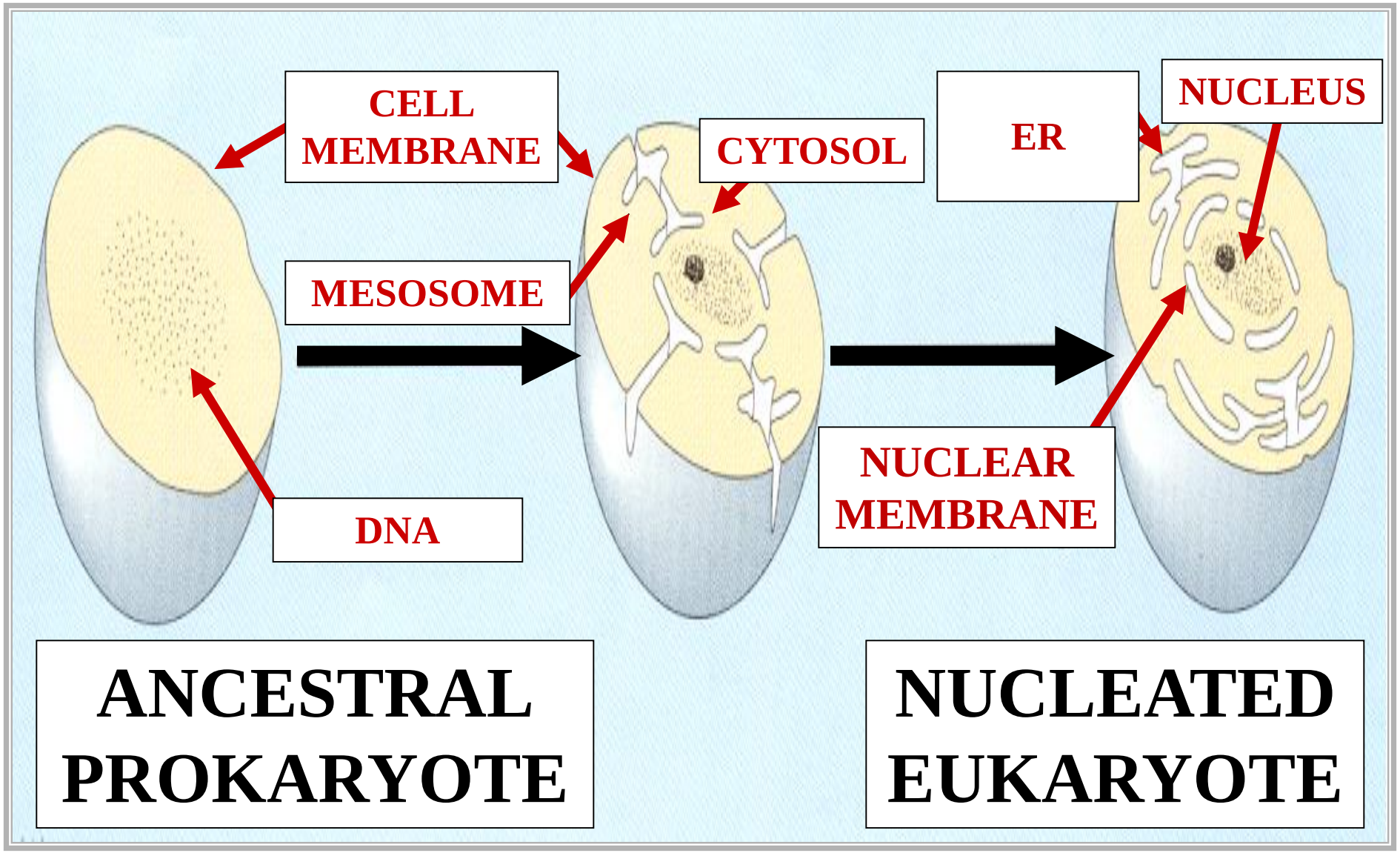
AUTOGENOUS THEORY



AUTOGENOUS THEORY



AUTOGENOUS THEORY



TRUE PLANT CELL

NUCLEUS EVOLUTION EVIDENSE SUPPORTS AUTOGENOUS THEORY

E

ENDOSYMBIOTIC THEORY

ENDOSYMBIOTIC THEORY

ENDOSYMBIOTIC THEORY

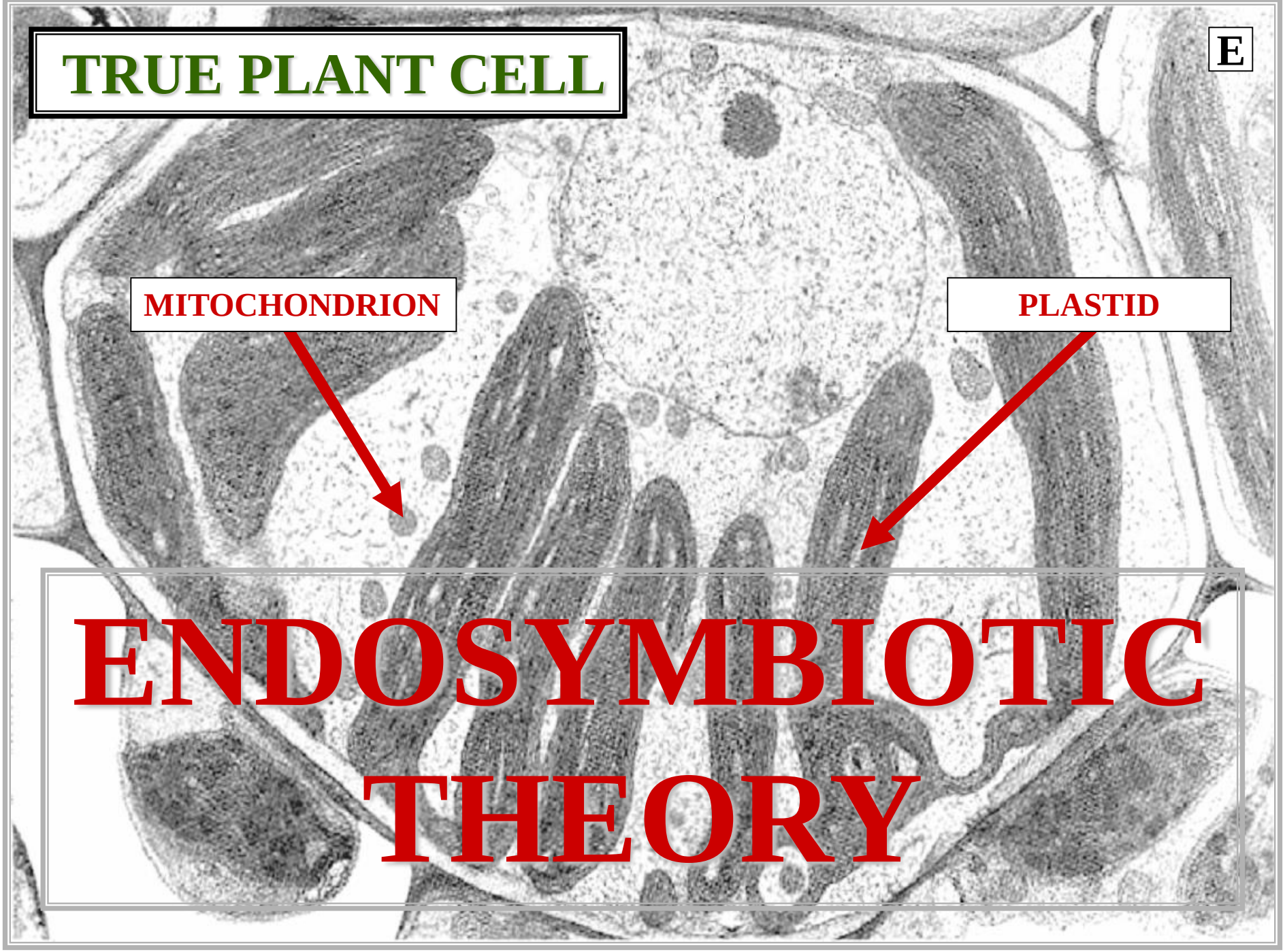
PLASTID & MITOCHONDRION EVOLUTION

ENDOSYMBIOTIC THEORY

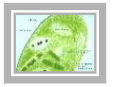
ENDOSYMBIOTIC THEORY

VIA PROKARYOTE ENDOSYMBIOSIS

ENDOSYMBIOTIC THEORY


TRUE PLANT CELL
E
MITOCHONDRION
PLASTID
ENDOSYMBIOTIC THEORY

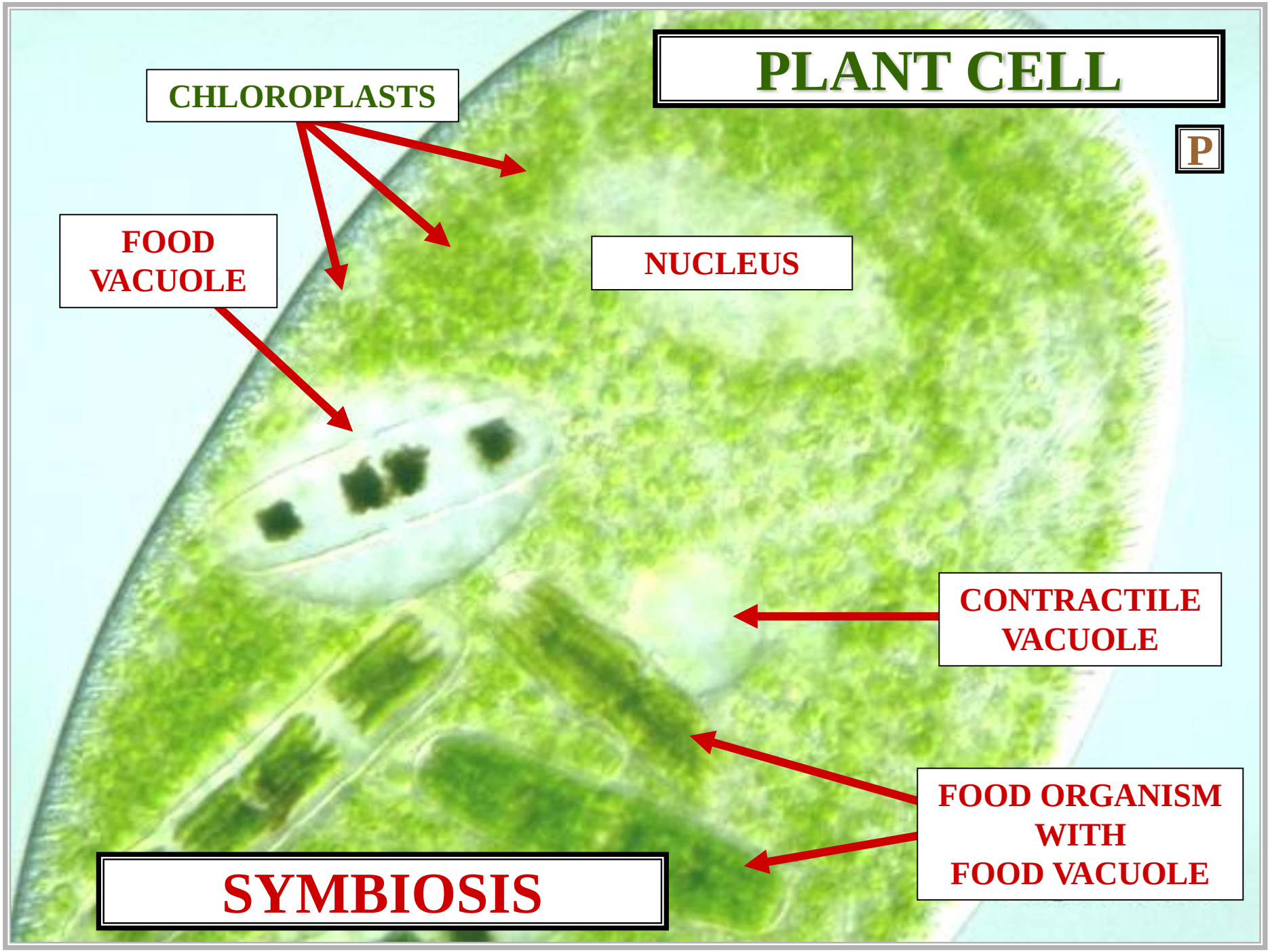
ENDOSYMBIOSIS

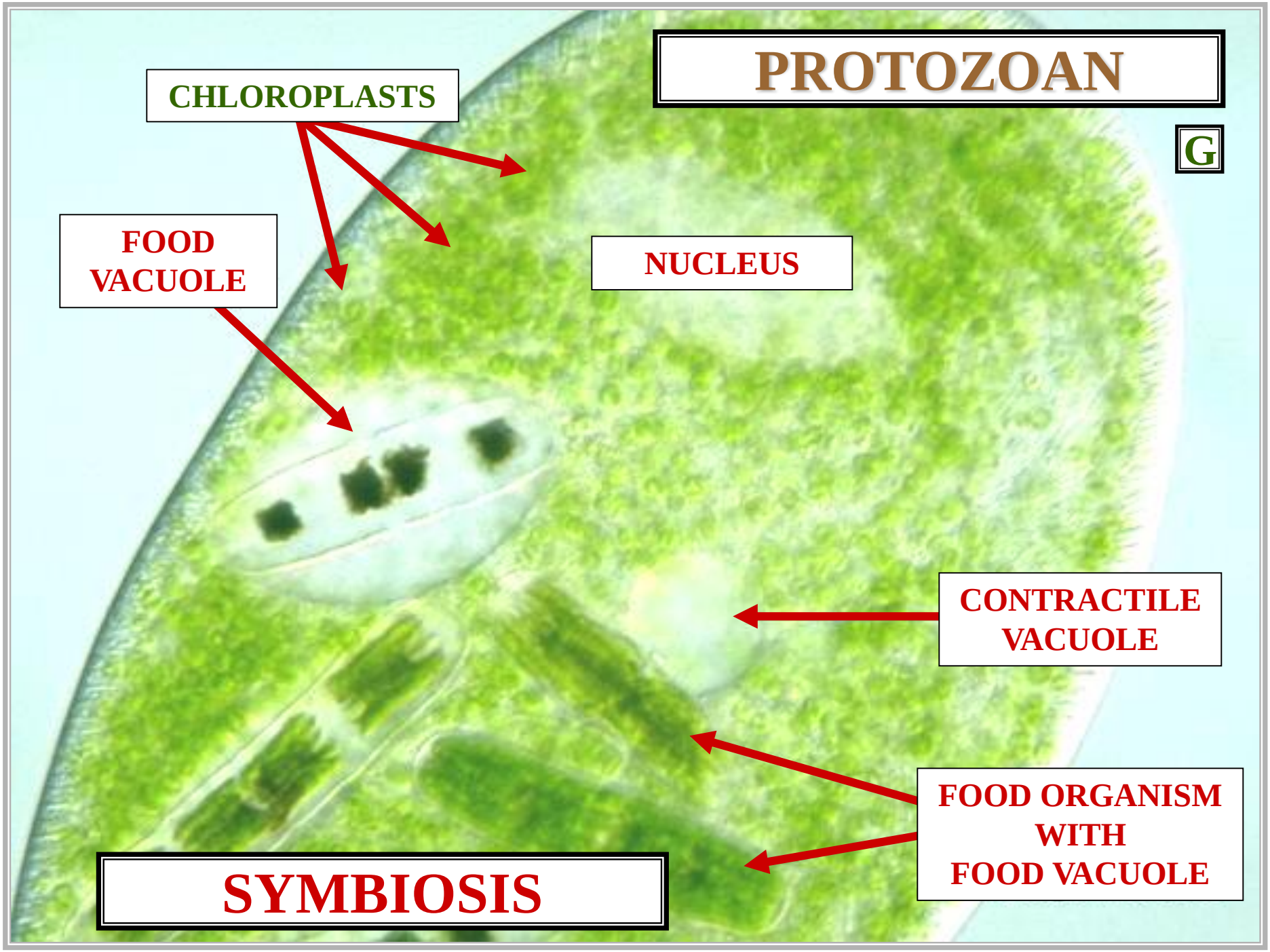


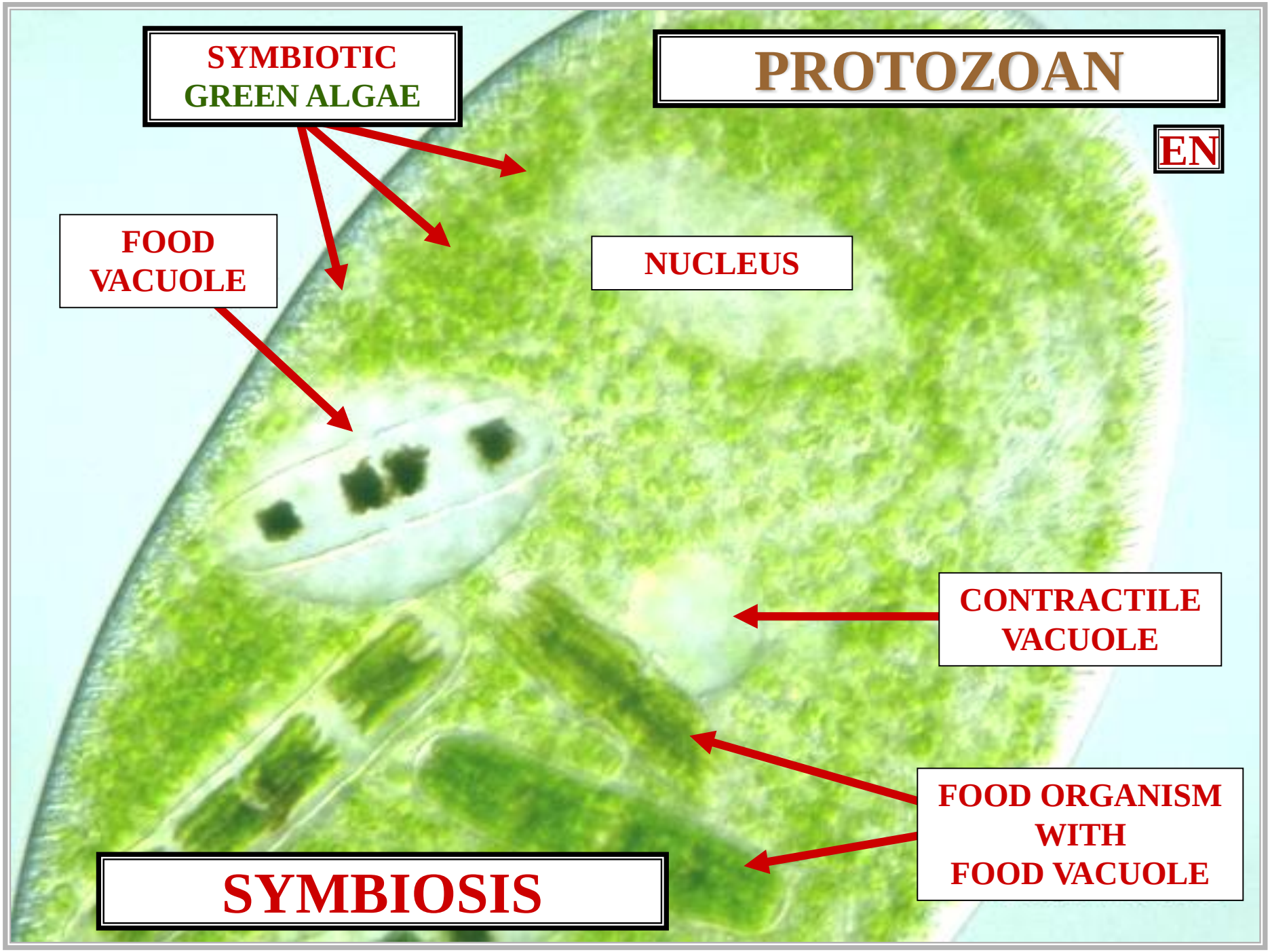
ENDOSYMBIOSIS

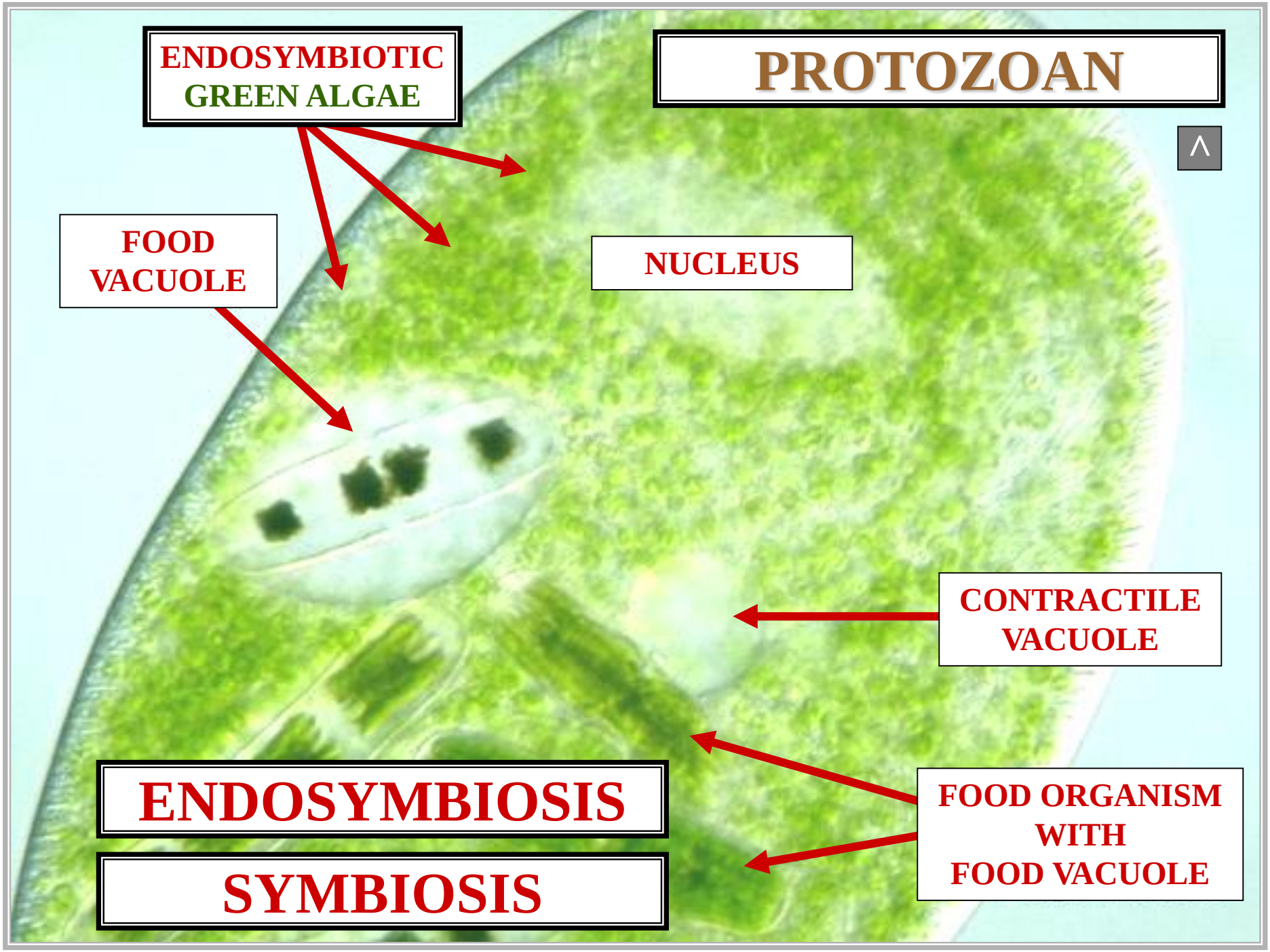
ONE SPECIES LIVING WITHIN SECOND HOST SPECIES

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


SYMBIOTIC GREEN ALGAE
PROTOZOAN
EN
FOOD VACUOLE
NUCLEUS
CONTRACTILE VACUOLE
FOOD ORGANISM WITH FOOD VACUOLE
SYMBIOSIS


ENDOSYMBIOTIC GREEN ALGAE
PROTOZOAN
FOOD VACUOLE
NUCLEUS
CONTRACTILE VACUOLE
FOOD ORGANISM WITH FOOD VACUOLE
ENDOSYMBIOSIS
SYMBIOSIS

PLASTID EVOLUTION

PLASTID EVOLUTION

HYPOTHETICAL SCENARIO

S

HETEROTROPHIC
HOST CELL

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES

AUTOTROPHIC
PROKARYOTE

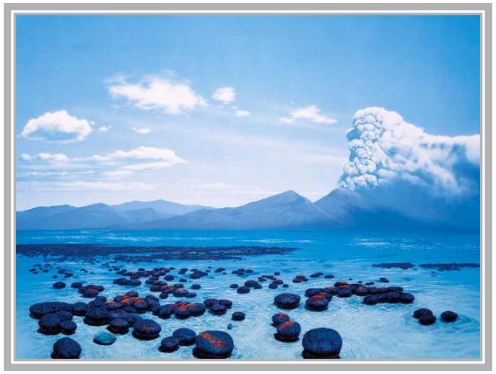
DNA W\OUT HISTONE PROTEINS

SMALL RIBOSOMES

HETEROTROPHIC
HOST CELL

DNA W\ HISTONE PROTEINS

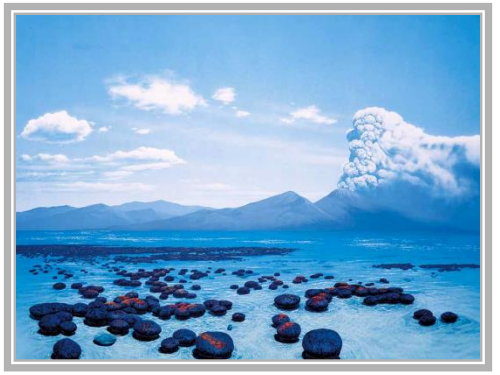
LARGE RIBOSOMES



AUTOTROPHIC
PROKARYOTE

DNA W\OUT HISTONE PROTEINS

SMALL RIBOSOMES



HETEROTROPH & AUTOTROPH: SAME HABITAT

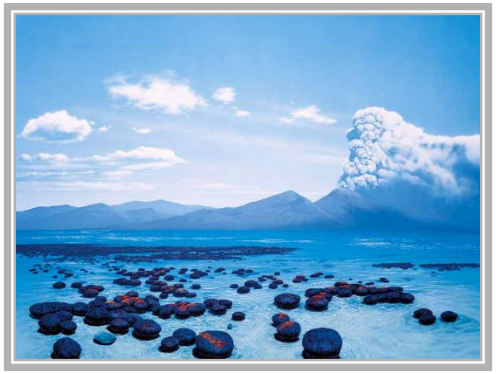
C

HETEROTROPHIC
HOST CELL

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES

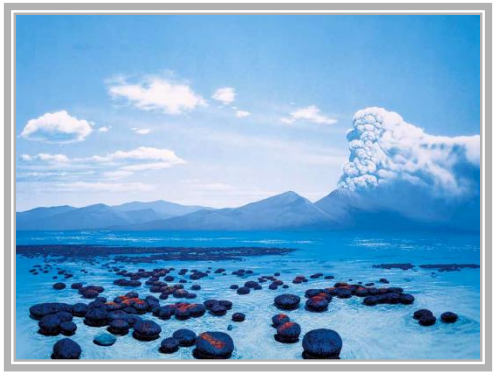
***CANNOT DERIVED* GLUCOSE**



AUTOTROPHIC
PROKARYOTE

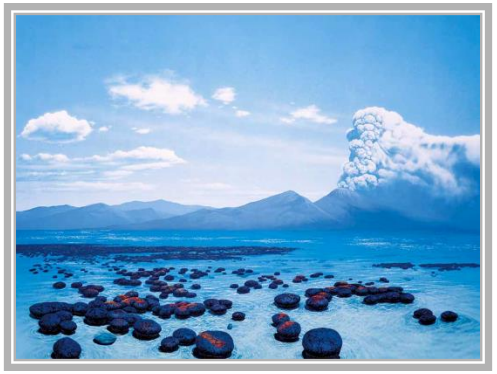
PHOTOSYNTHESIS

GLUCOSE



HETEROTROPHIC
HOST CELL

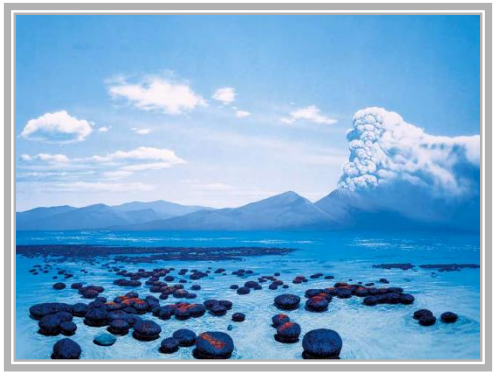
CONSUMES OTHER ORGANISMS
CONSUMES AUTOTROPH



AUTOTROPHIC
PROKARYOTE

PHOTOSYNTHESIS

GLUCOSE

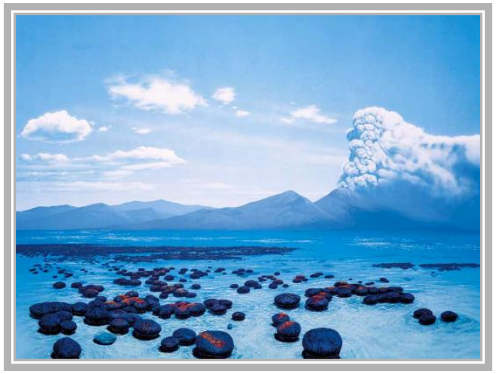


E

+

HETEROTROPHIC
HOST CELL

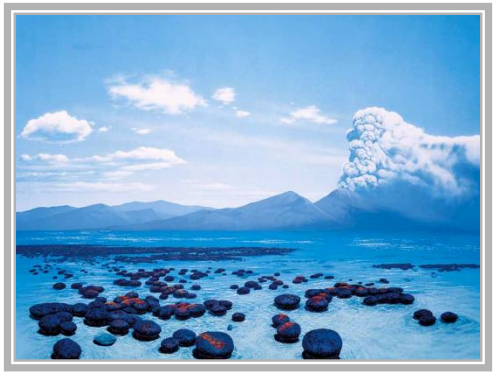
CONSUMES OTHER ORGANISMS
CONSUMES AUTOTROPH
VIA ENDOCYTOSIS



AUTOTROPHIC
PROKARYOTE

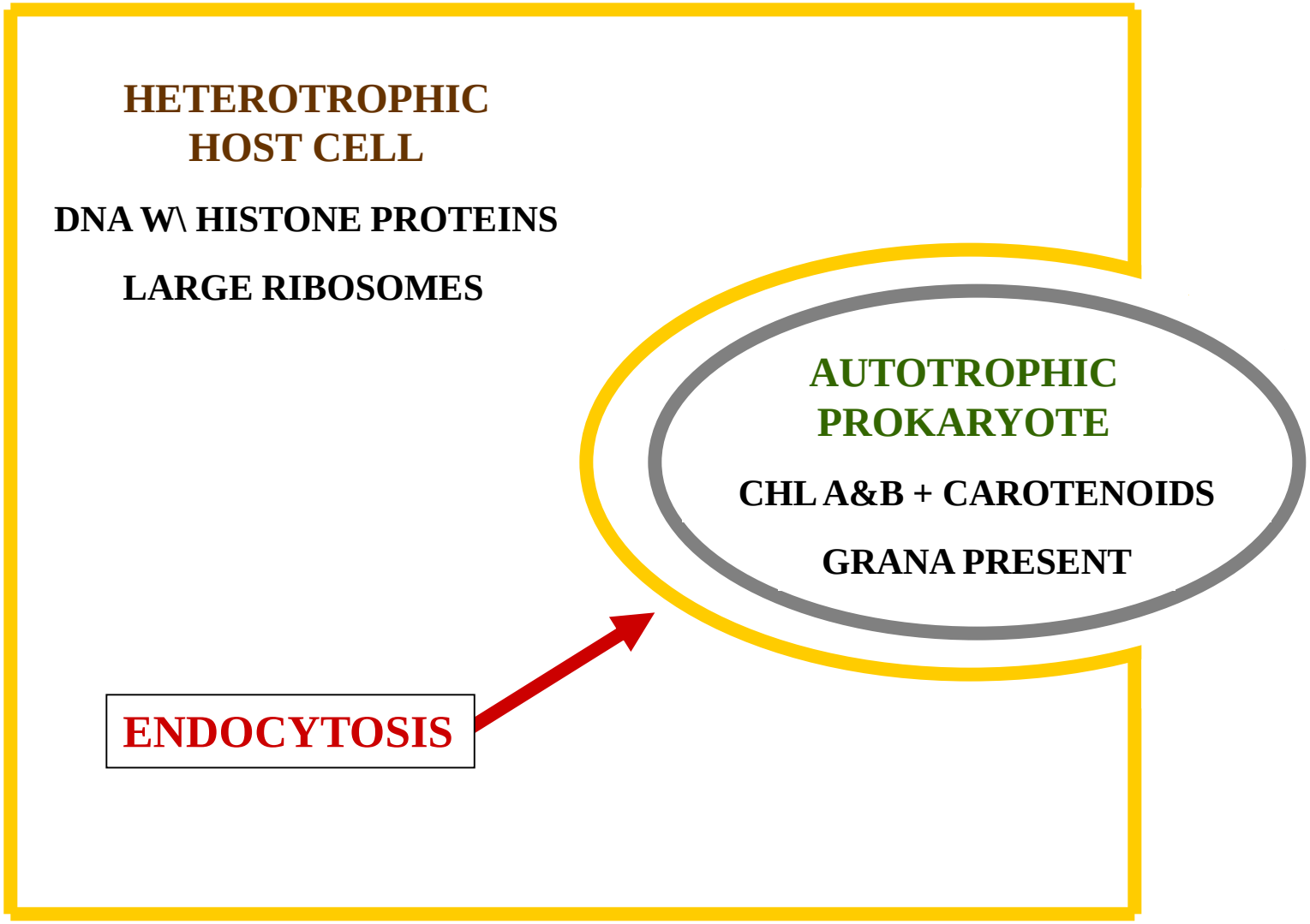
PHOTOSYNTHESIS

GLUCOSE



HETEROTROPH CONSUMES AUTOTROPH

E



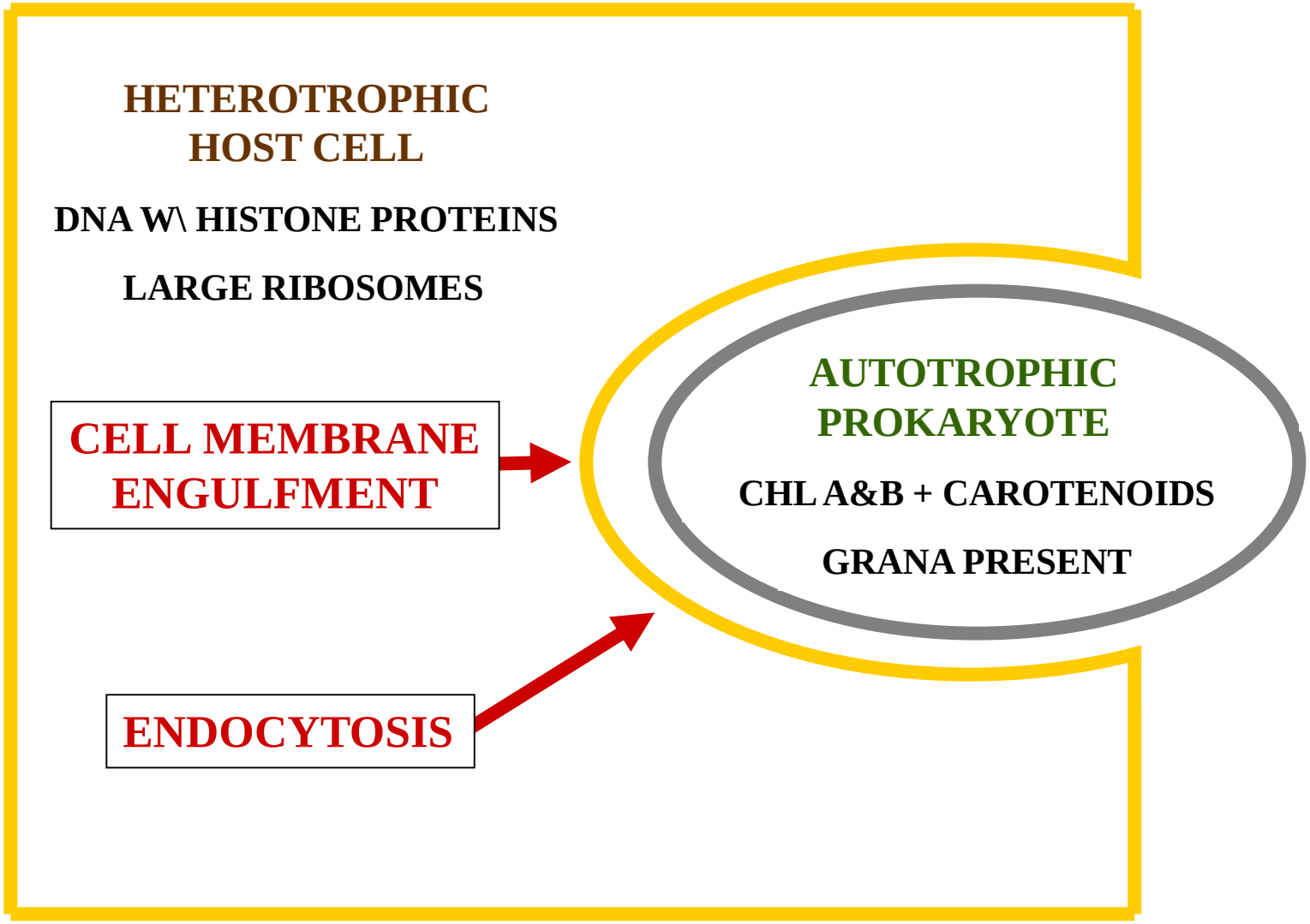
ENDOCYTOSIS

ENDOCYTOSIS

CELL MEMBRANE ENGULFMENT INTO HOST CELL

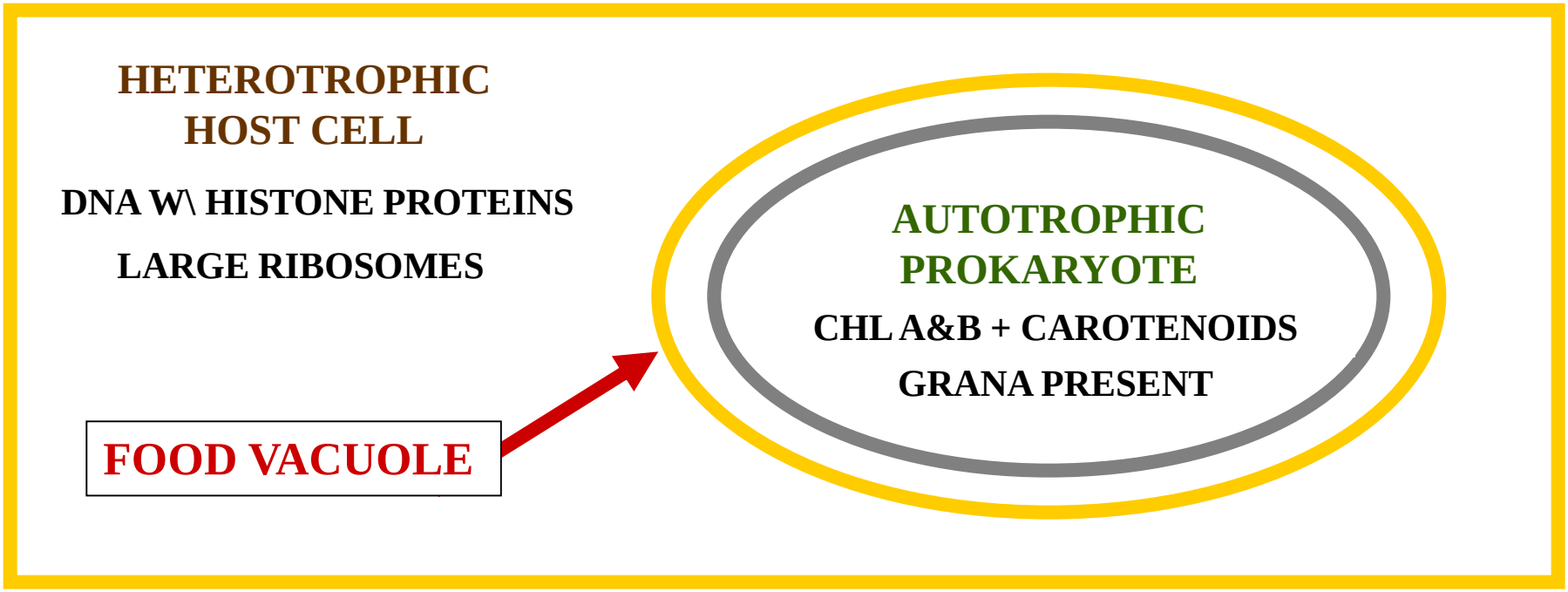
ENDOCYTOSIS

F

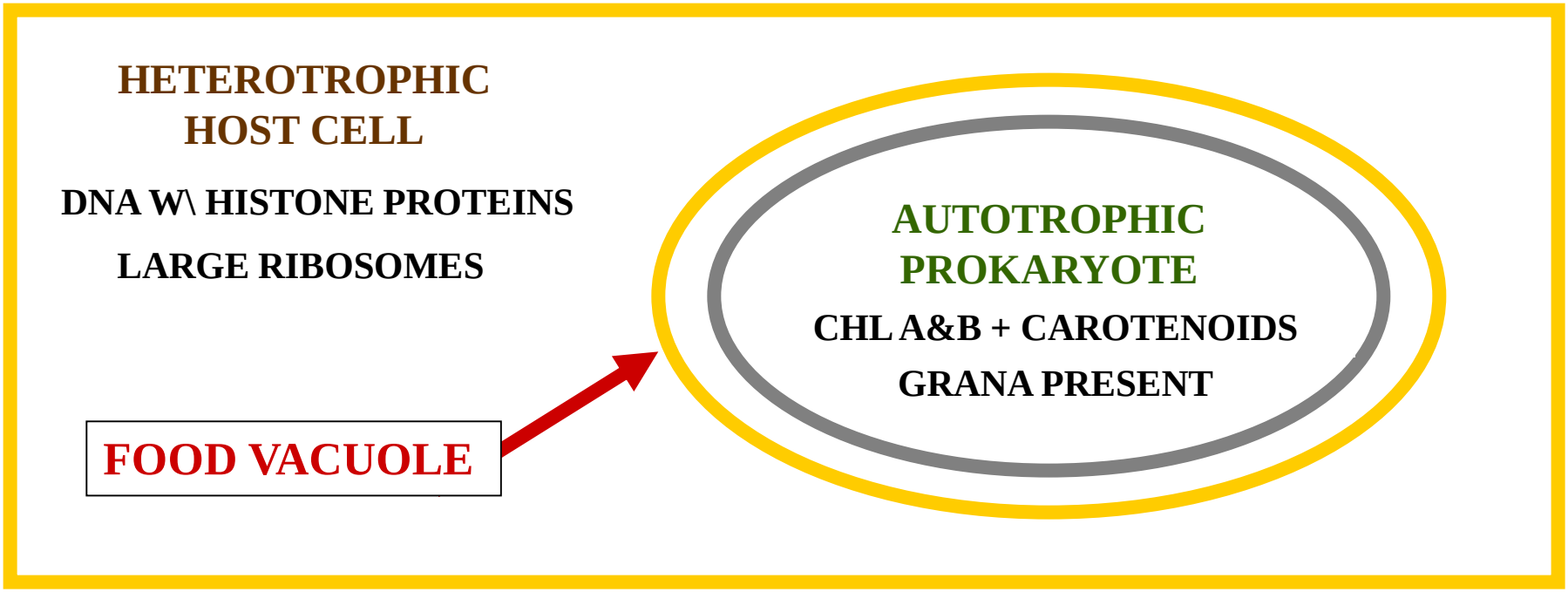

HETEROTROPHIC
HOST CELL
DNA W\ HISTONE PROTEINS
LARGE RIBOSOMES
CELL MEMBRANE
ENGULFMENT
ENDOCYTOSIS
AUTOTROPHIC
PROKARYOTE
CHL A&B + CAROTENOIDS
GRANA PRESENT

AUTOTROPH WITHIN HETEROTROPH FOOD VACUOLE

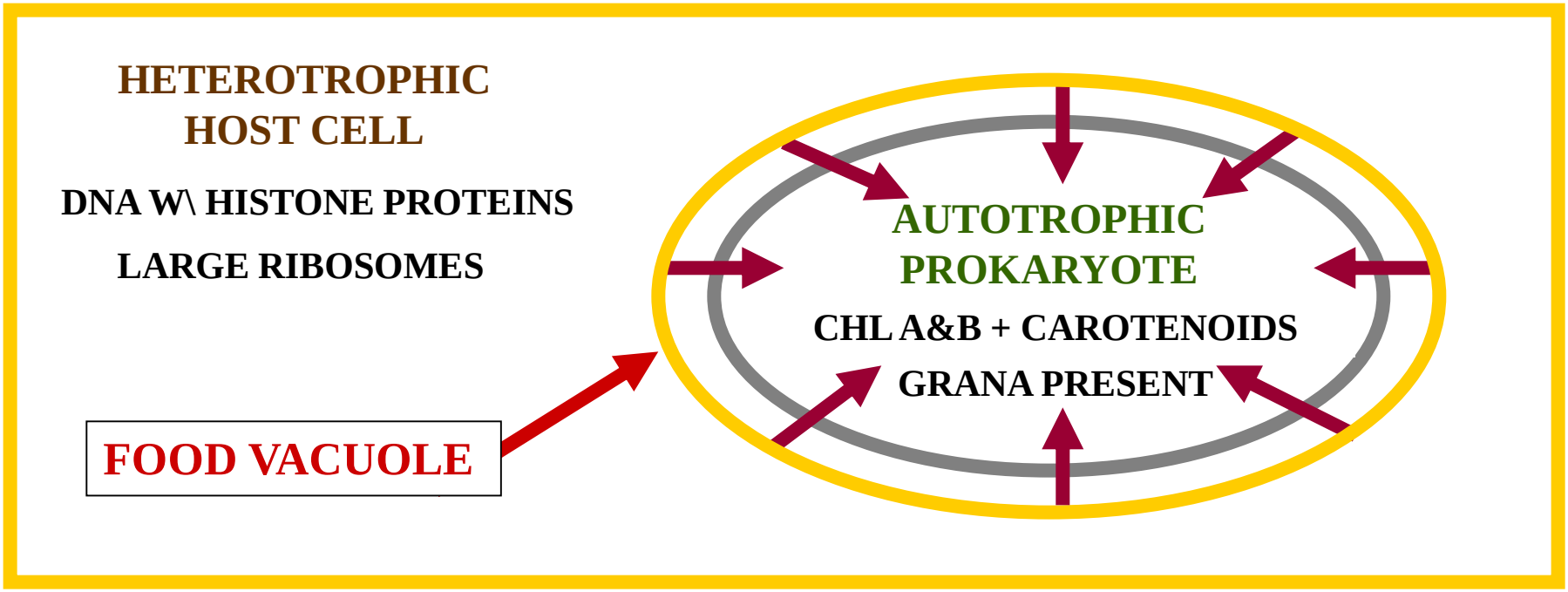
I



INITIALLY HETEROTROPH DIGESTS AUTOTROPH

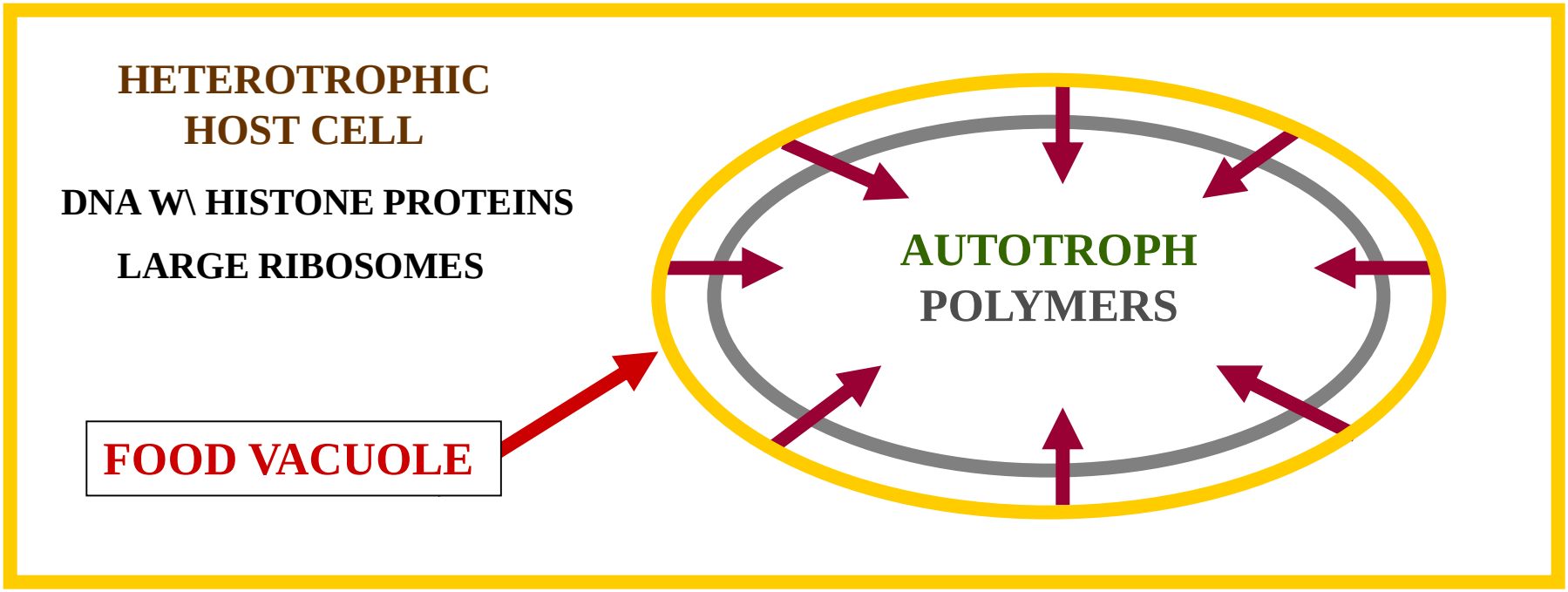


INITIALLY HETEROTROPH DIGESTS AUTOTROPH



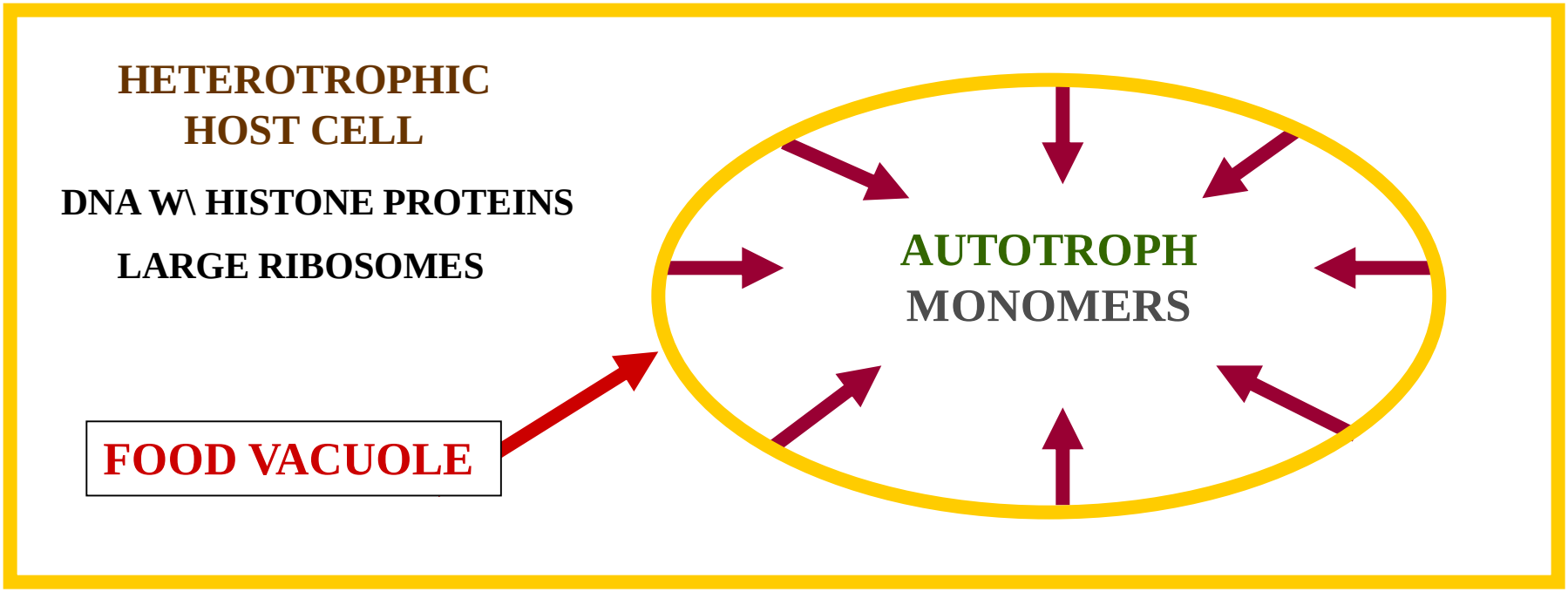
= ENZYMES

INITIALLY HETEROTROPH DIGESTS AUTOTROPH



= ENZYMES

INITIALLY HETEROTROPH DIGESTS AUTOTROPH



= ENZYMES

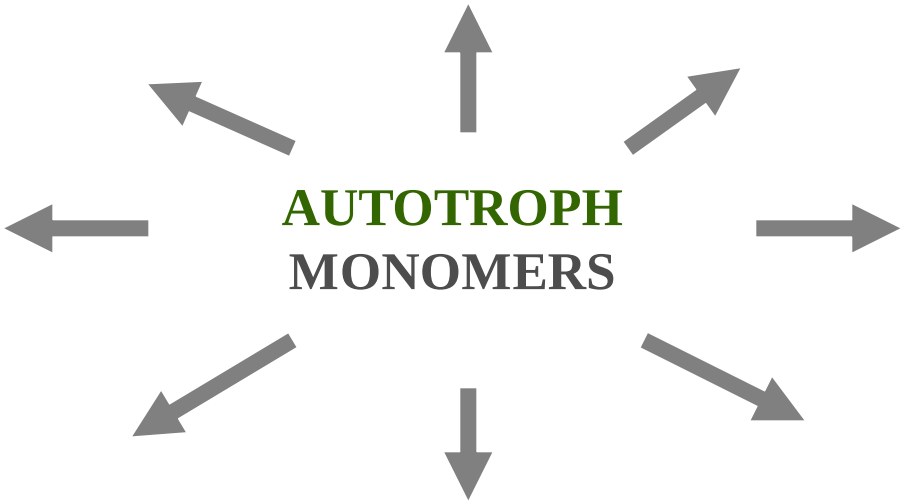
INITIALLY HETEROTROPH DIGESTS AUTOTROPH

HETEROTROPHIC HOST CELL

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES

CYTOSOL



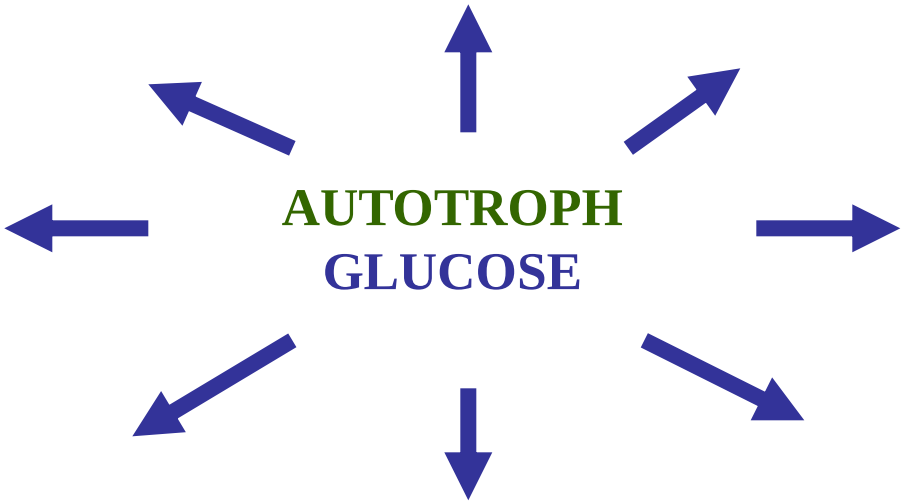
INITIALLY HETEROTROPH DIGESTS AUTOTROPH

HETEROTROPHIC HOST CELL

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES

CYTOSOL



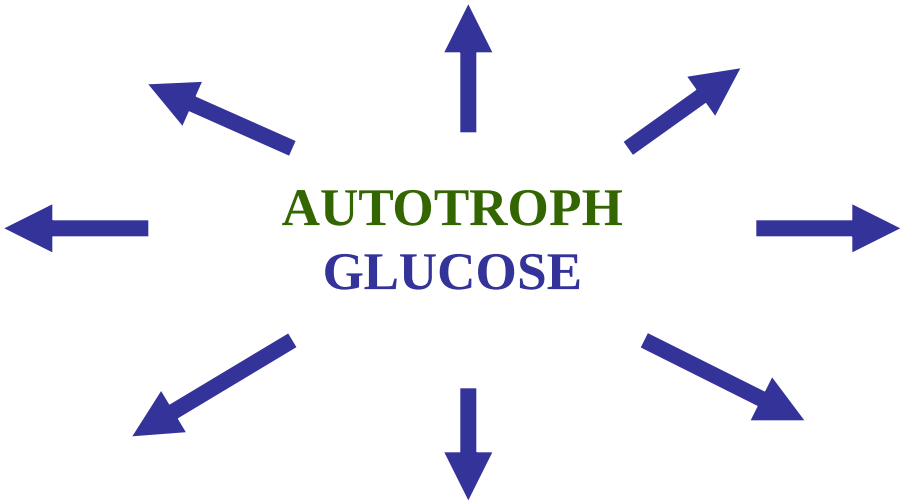
INITIALLY HETEROTROPH DIGESTS AUTOTROPH

HETEROTROPHIC HOST CELL

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES

METABOLISM



EVENTUALLY
“DAWNS ON HETEROTROPH”

HETEROTROPHIC HOST CELL

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES

EVENTUALLY
“DAWNS ON HETEROTROPH”

HETEROTROPHIC HOST CELL

DNA W\ HISTONE PROTEINS

LARGE RIBOSOMES