

An electron micrograph showing several rod-shaped bacterial cells. The cells are arranged in a chain, with some showing internal structures like a central, lighter-colored region. The overall appearance is that of a bacterial culture.

PR

**ASEXUAL
REPRODUCTION**

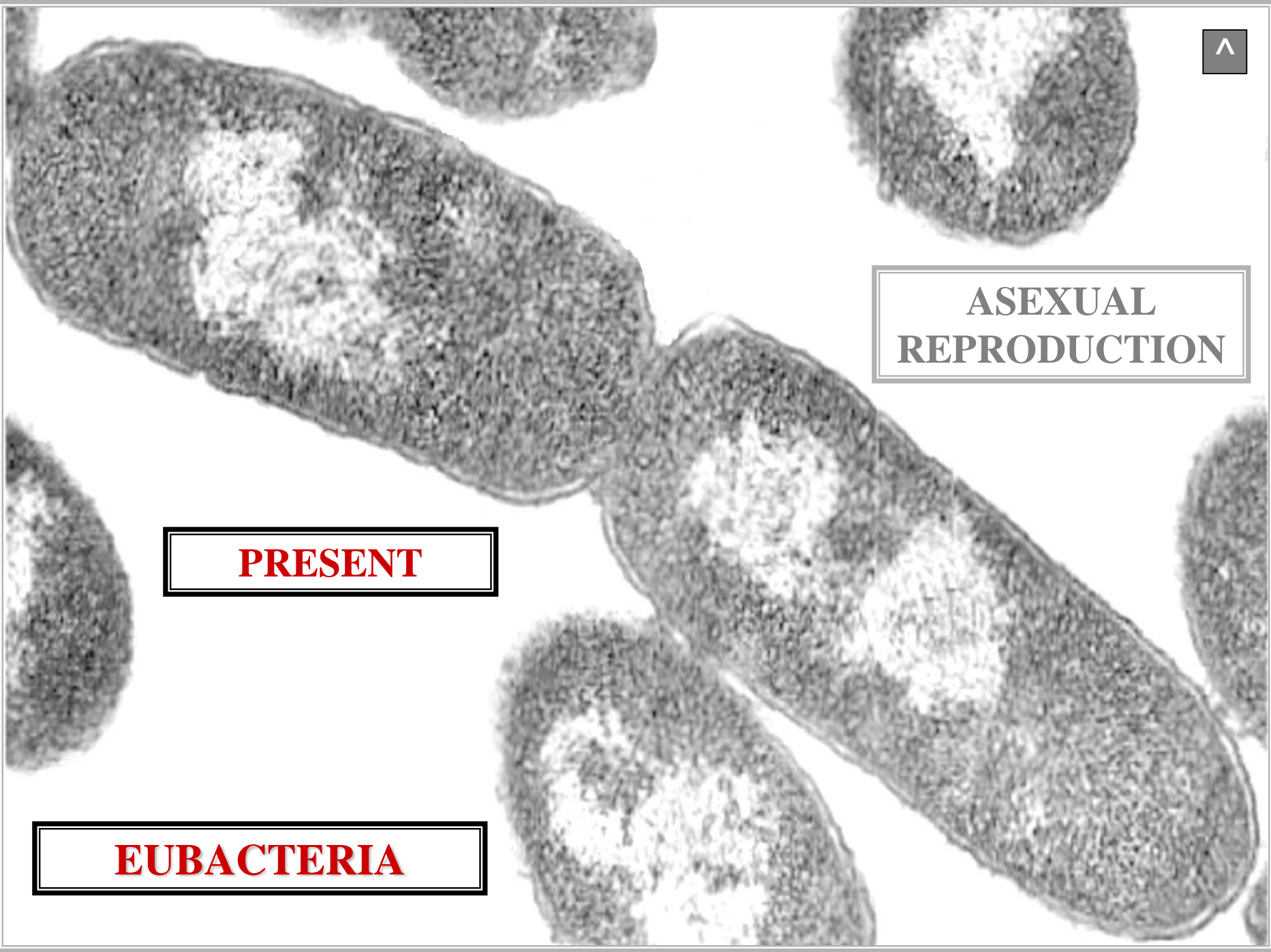
EUBACTERIA



**ASEXUAL
REPRODUCTION**

PRESENT

EUBACTERIA



BINARY FISSION

BINARY FISSION



BINARY FISSION

CYTOSOL DIVISION

BINARY FISSION

BINARY FISSION

CYTOSOL DIVISION

--

WITHOUT

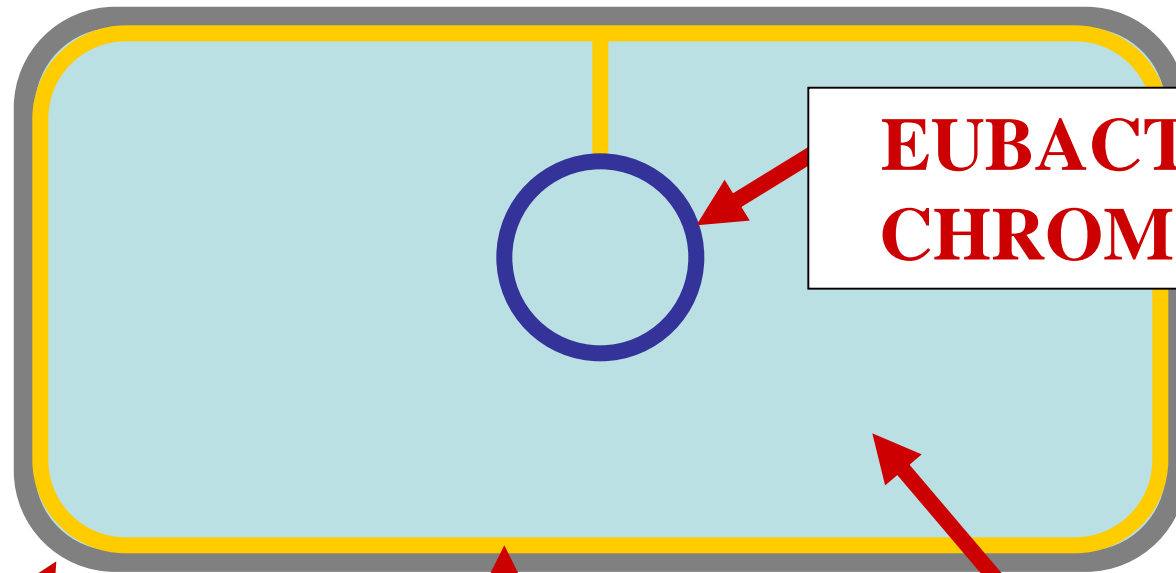
NUCLEAR DIVISION

BINARY FISSION



BINARY FISSION APPLIED

EUBACTERIUM MOTHER CELL



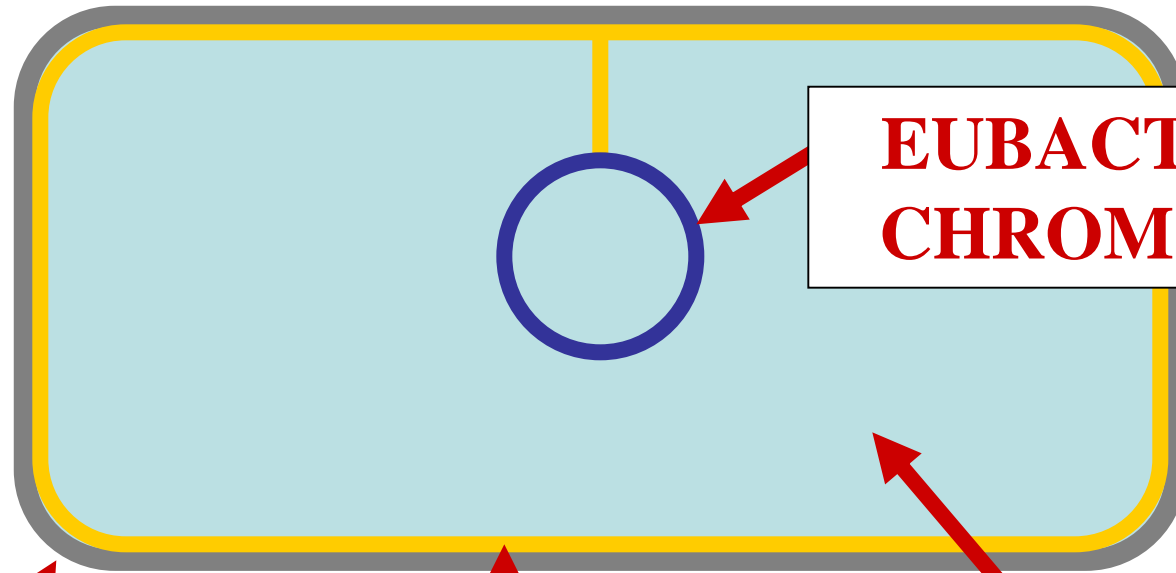
**EUBACTERIUM
CHROMOSOME**

CELL WALL

CELL MEMBRANE

CYTOSOL

BINARY FISSION MOTHER CELL



**EUBACTERIUM
CHROMOSOME**

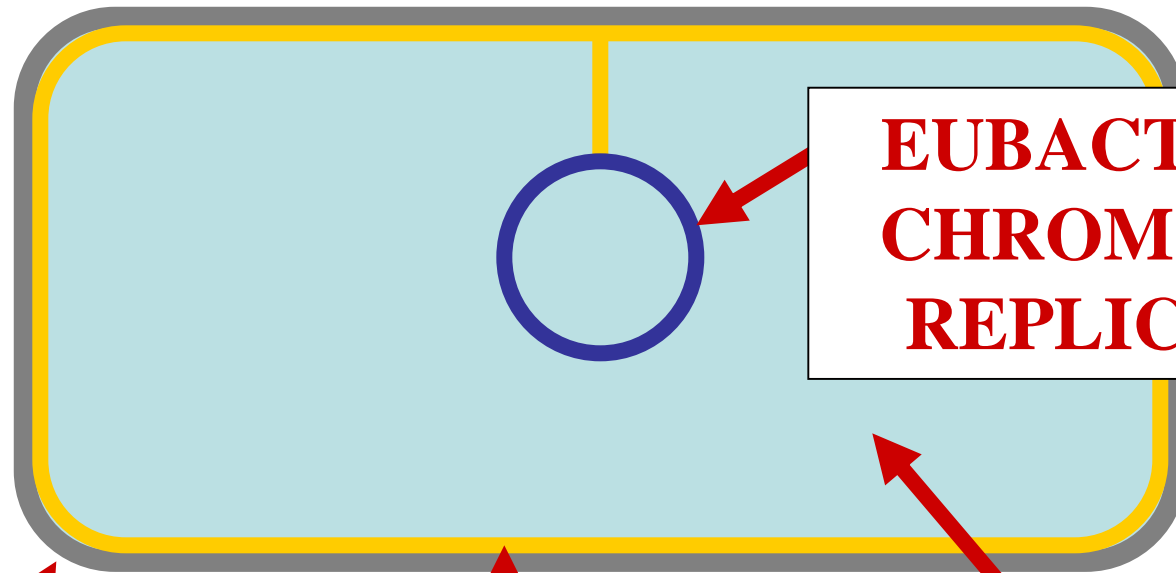
CELL WALL

CELL MEMBRANE

CYTOSOL



BINARY FISSION MOTHER CELL



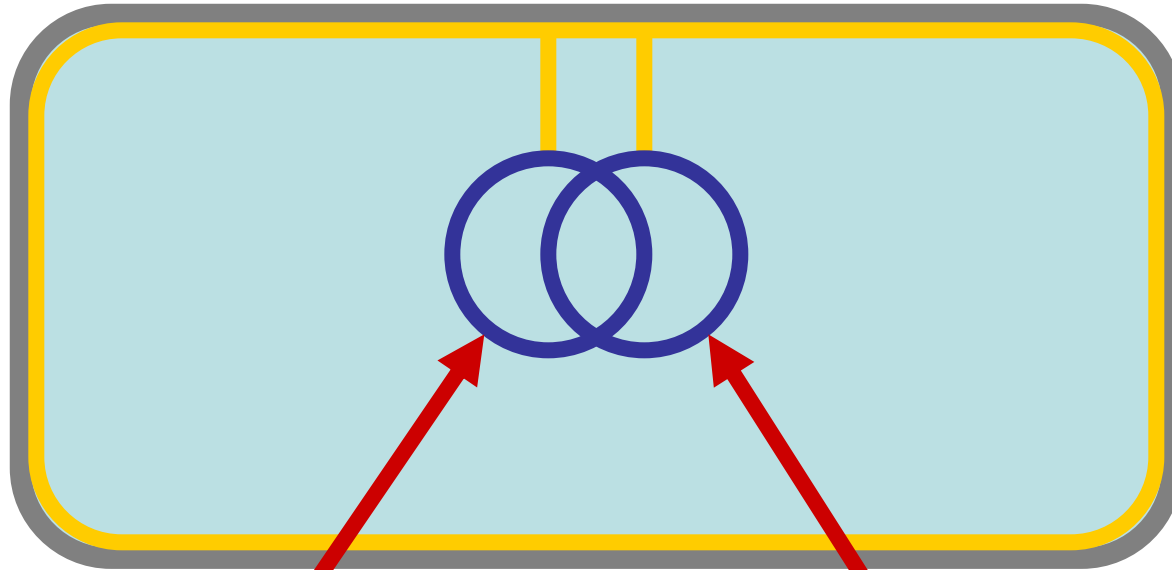
**EUBACTERIUM
CHROMOSOME
REPLICATION**

CELL WALL

CELL MEMBRANE

CYTOSOL

BINARY FISSION MOTHER CELL

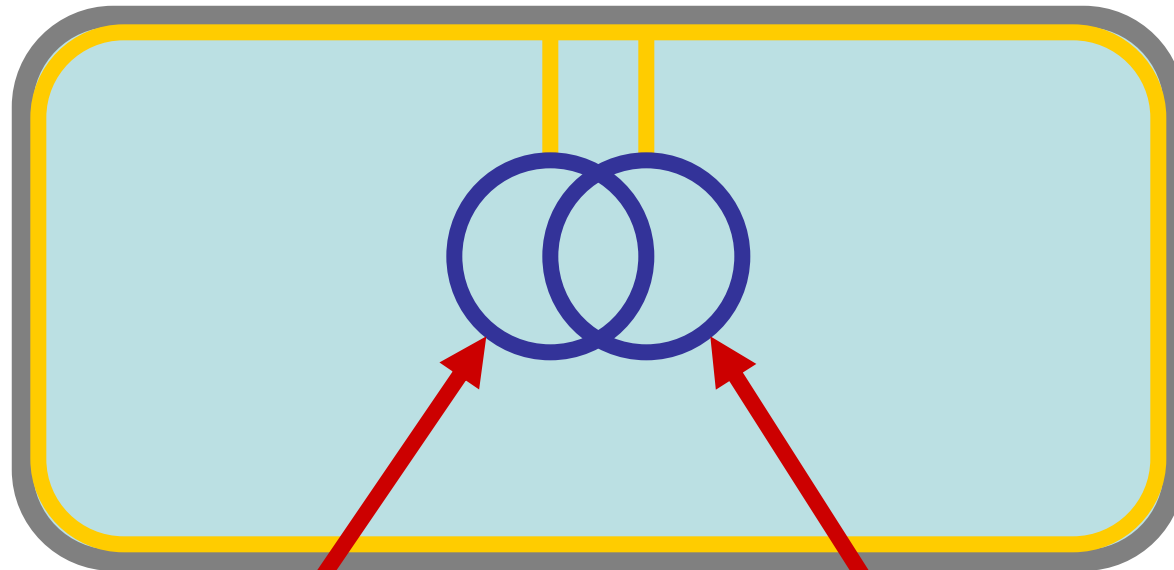


**REPLICATED
EUBACTERIUM
CHROMOSOME**

**REPLICATED
EUBACTERIUM
CHROMOSOME**

BINARY FISSION

MOTHER CELL



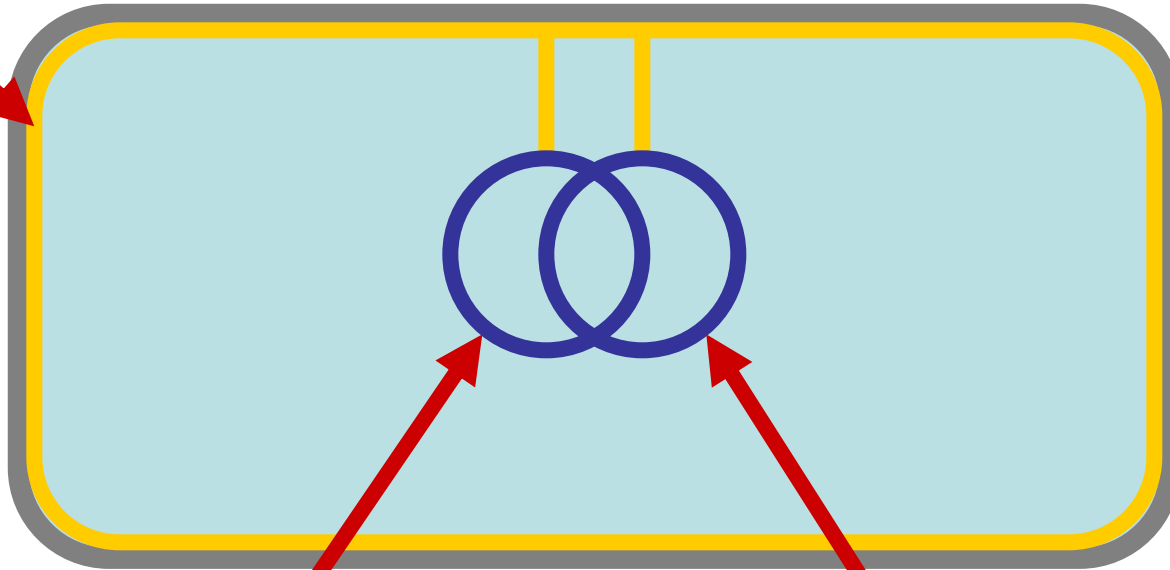
**DNA
CONTENT
DOUBLED**

**DNA
CONTENT
DOUBLED**



BINARY FISSION MOTHER CELL

CELL MEMBRANE



**CELL MEMBRANE
CHROMOSOME
ATTACHED**

**CELL MEMBRANE
CHROMOSOME
ATTACHED**

BINARY FISSION

MOTHER CELL



**CELL
GROWTH
CELL MEMBRANE
GROWTH**

**CELL
GROWTH
CELL MEMBRANE
GROWTH**

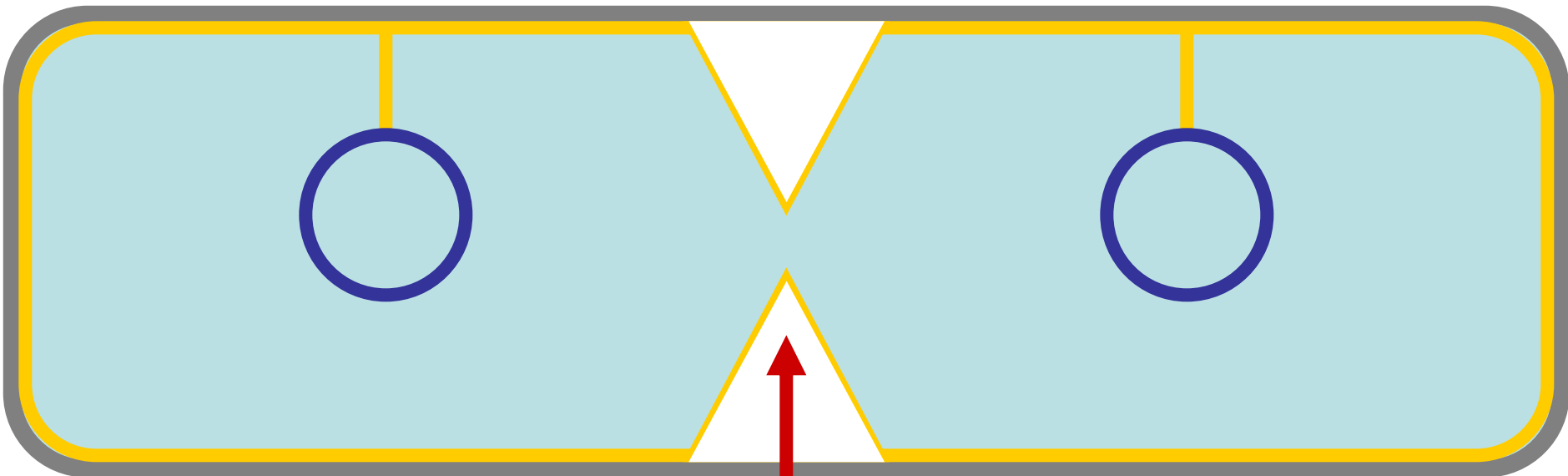
BINARY FISSION MOTHER CELL



**REPLICATED
CHROMOSOME
SEPARATE**

**REPLICATED
CHROMOSOMES
SEPARATE**

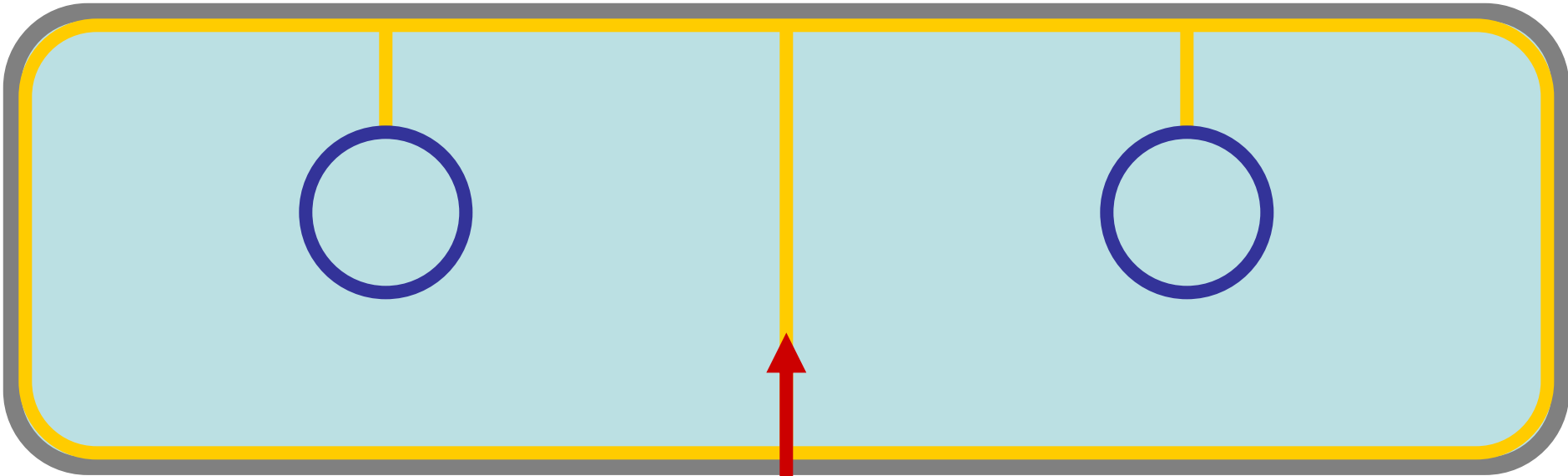
BINARY FISSION MOTHER CELL



**CELL MEMBRANE
INVAGINATION**

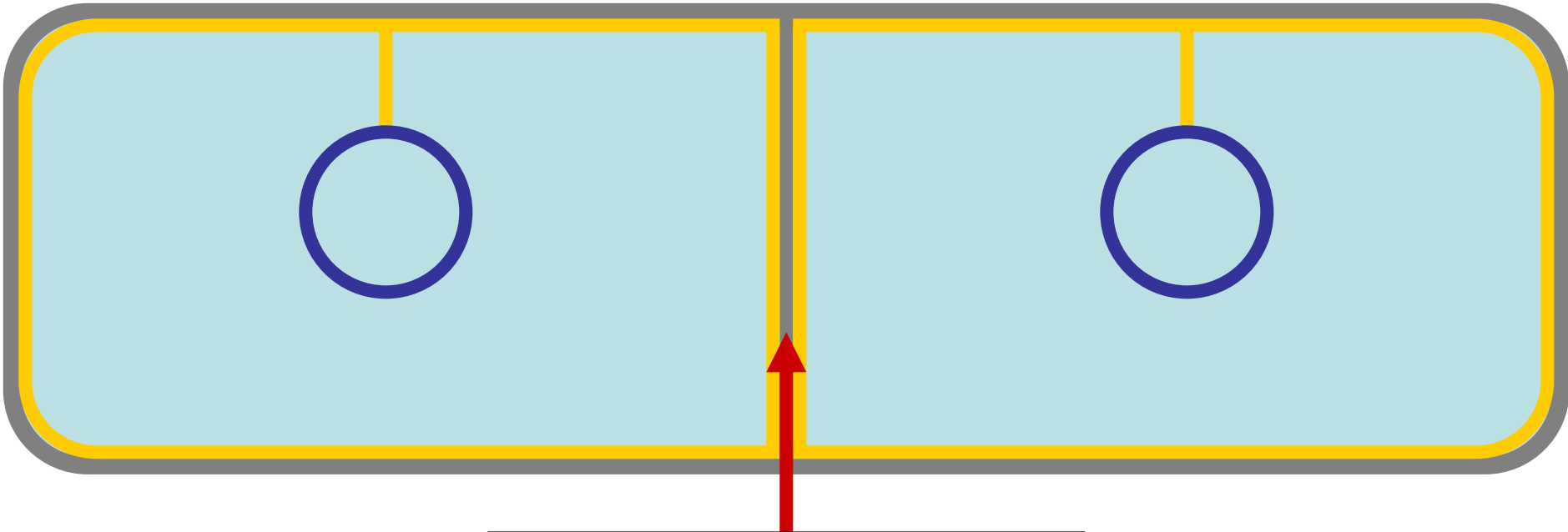
BINARY FISSION

MOTHER CELL



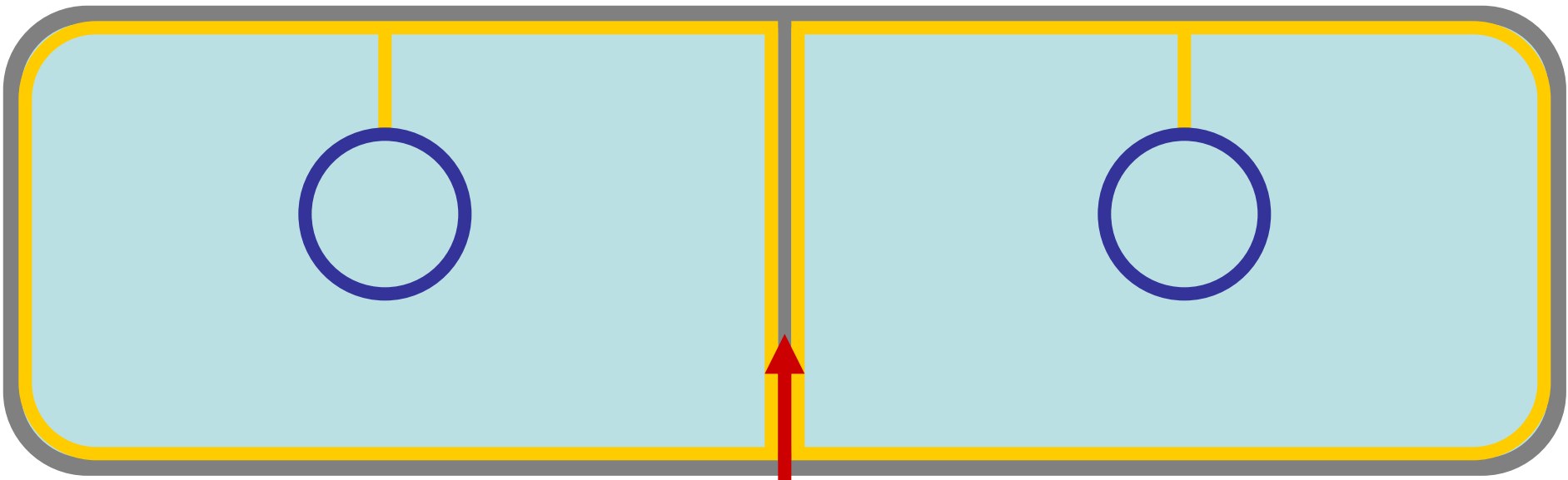
**CELL MEMBRANE
ISOLATES
CHROMOSOMES**

BINARY FISSION MOTHER CELL



**CELL WALL
FORMATION**

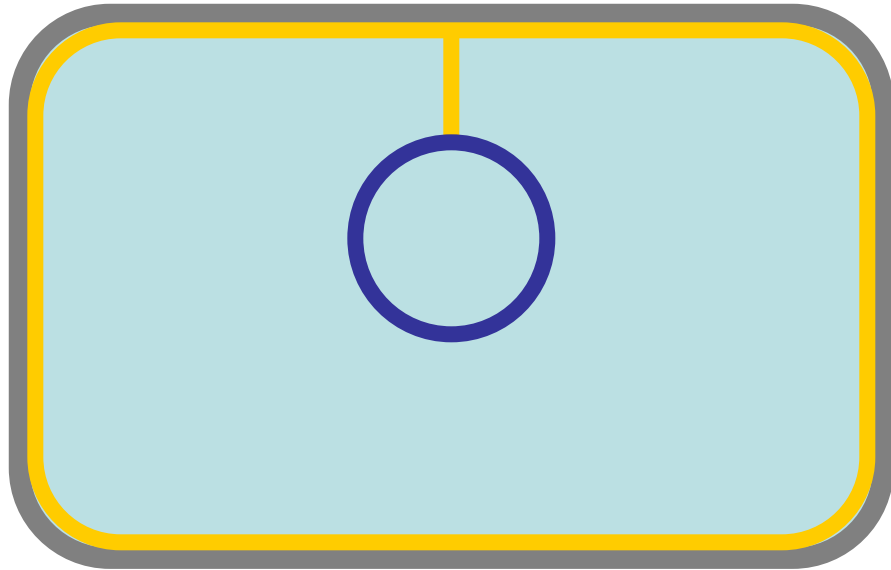
BINARY FISSION MOTHER CELL



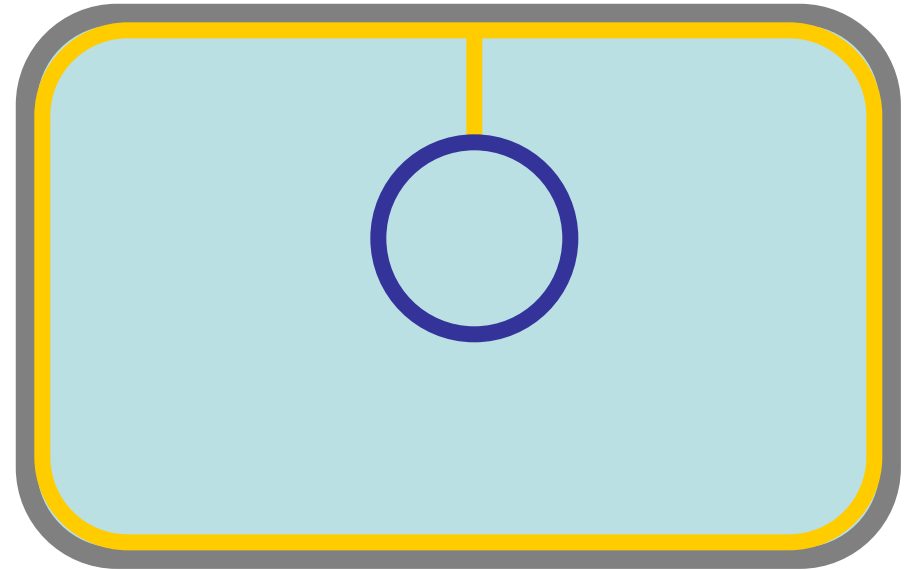
**CELL WALL
PARTITIONS
MOTHER CELL CYTOSOL**

BINARY FISSION

MOTHER CELL



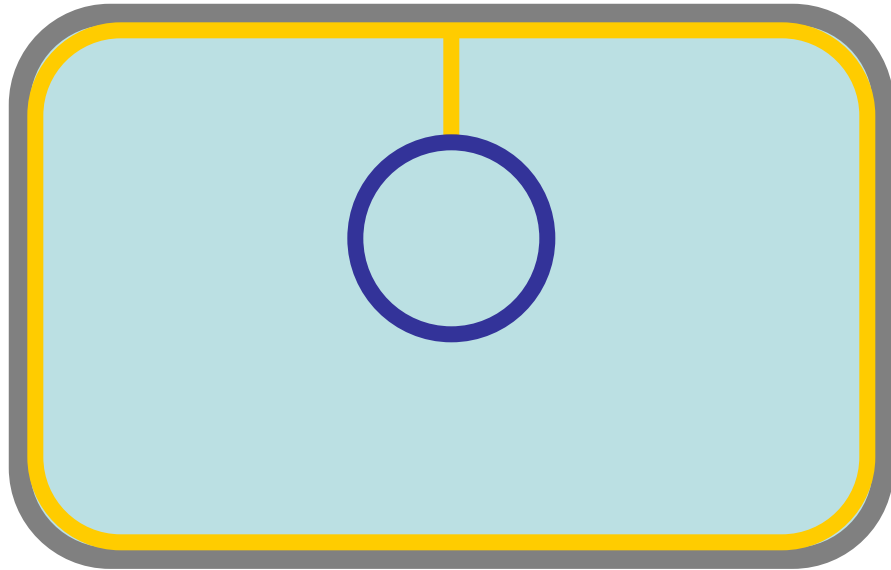
**EUBACTERIUM
CELL**



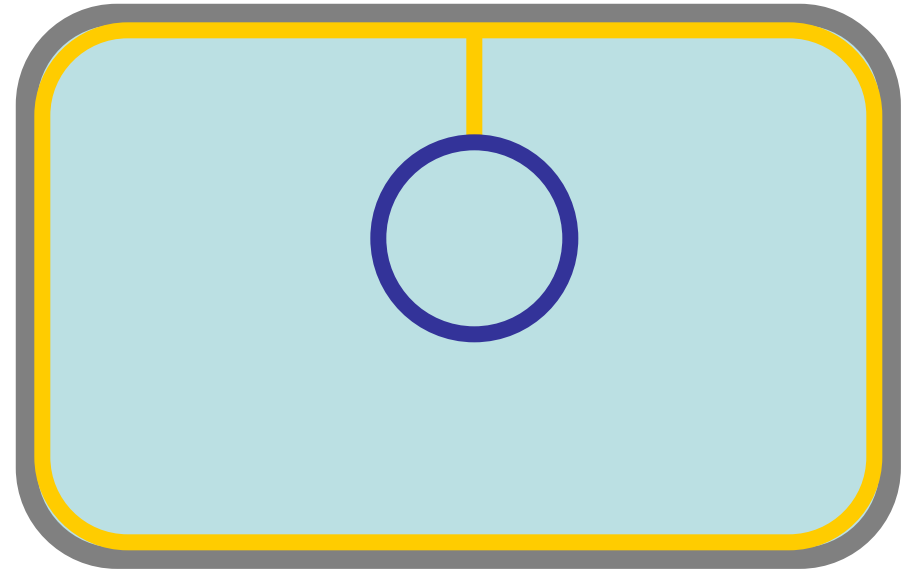
**EUBACTERIUM
CELL**

BINARY FISSION

MOTHER CELL

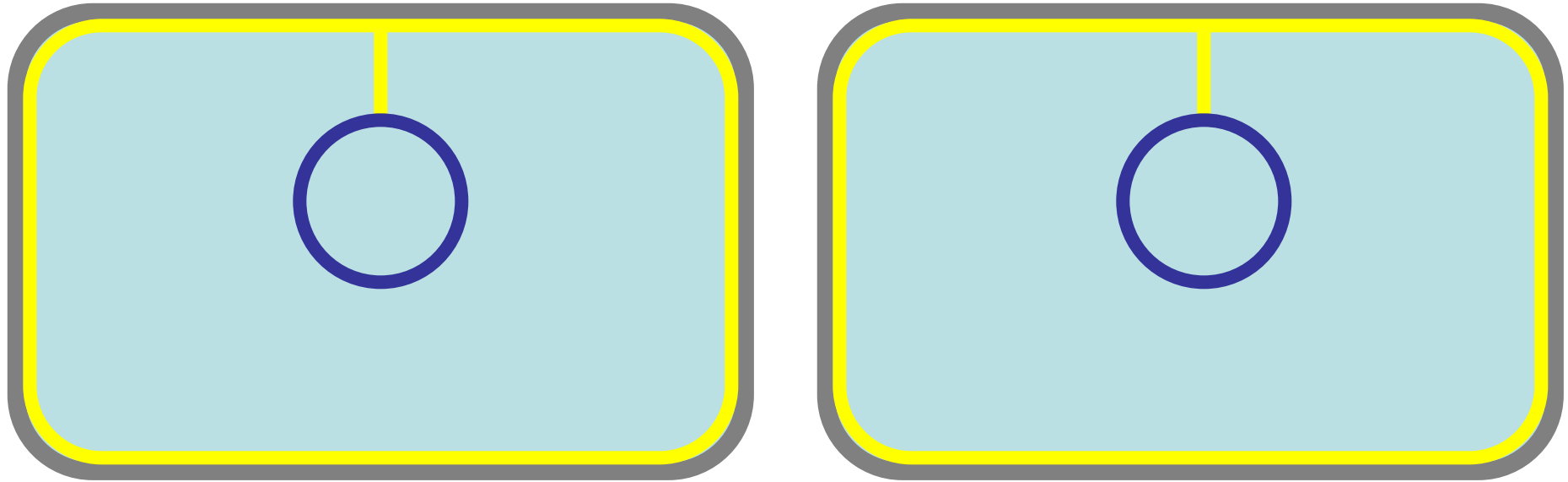


**DAUGHTER
CELL**



**DAUGHTER
CELL**

DAUGHTER CELLS



GENETICALLY IDENTICAL

FRAAGMENTATION

F R A G M E N T A T I O N

FRAGMENTATION

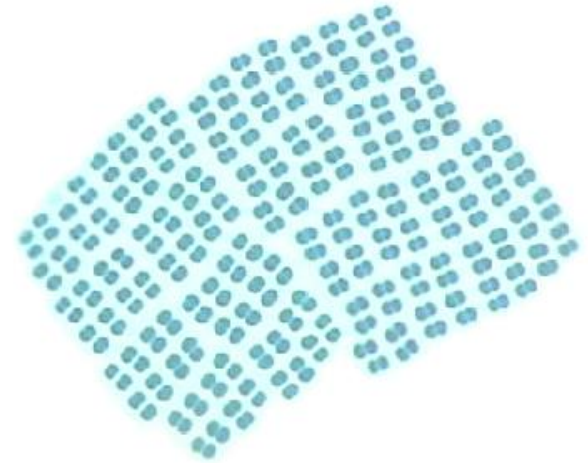
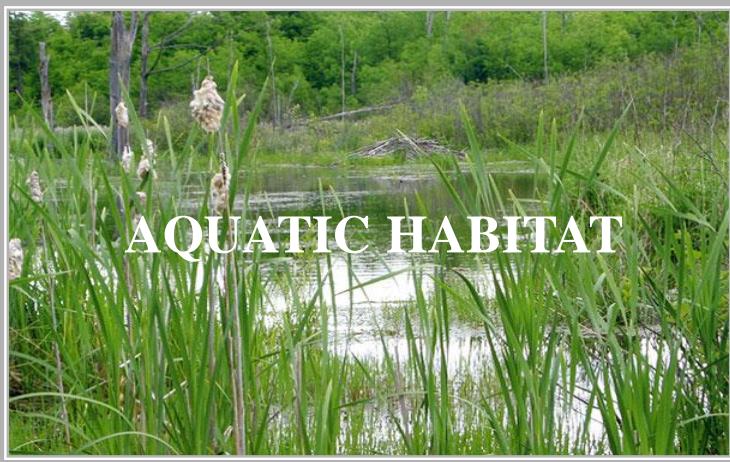
COLONY OR FILAMENT
BREAK-UP

FRAGMENTATION



FRAAGMENTATION APPLIED

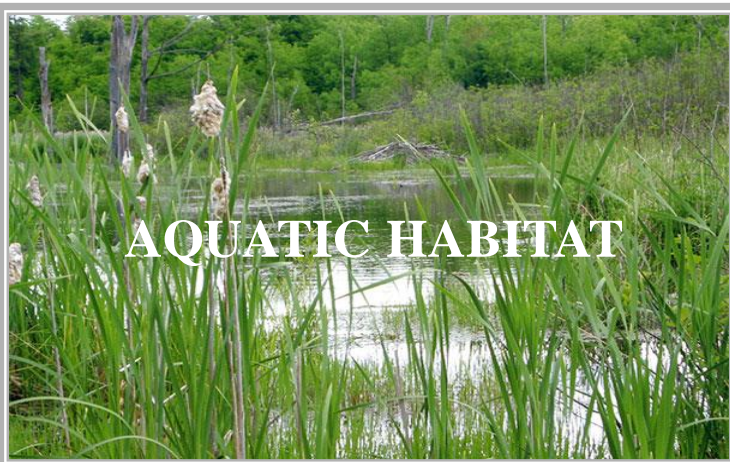
COLONY



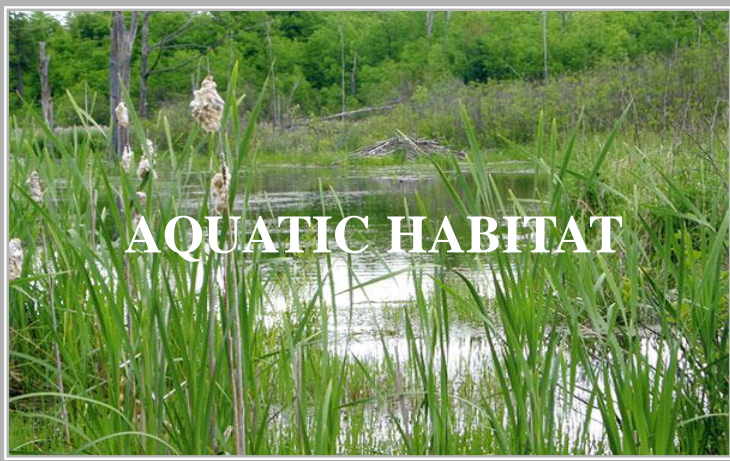
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F

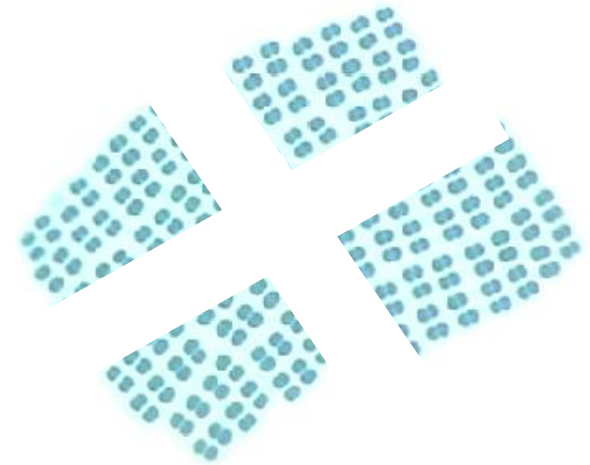
FILAMENT



COLONY



AQUATIC HABITAT

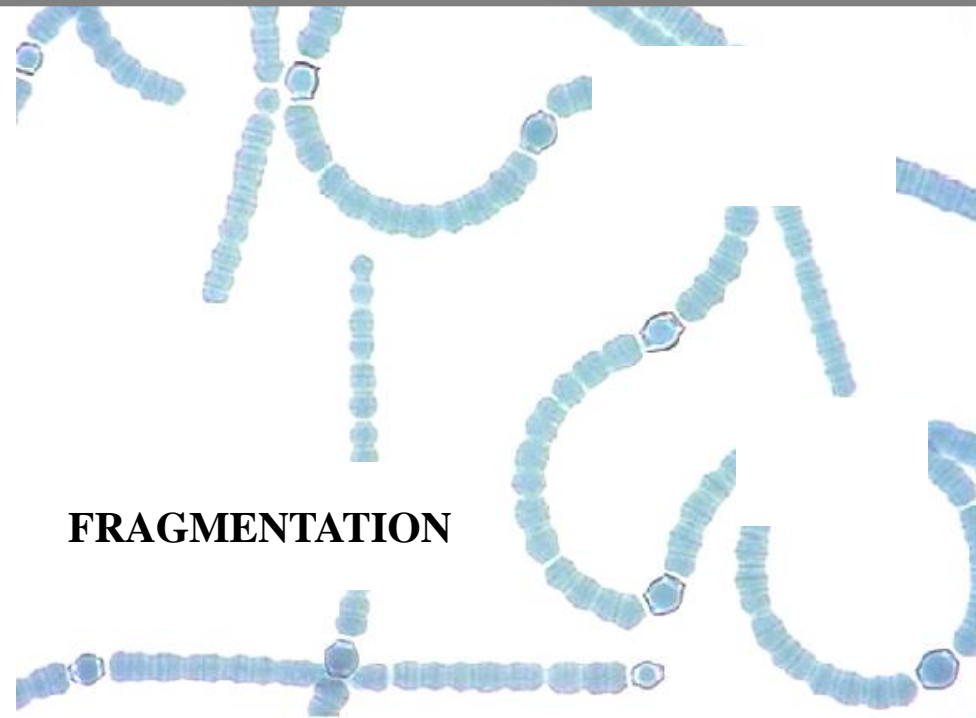


FRAGMENTATION

FILAMENT



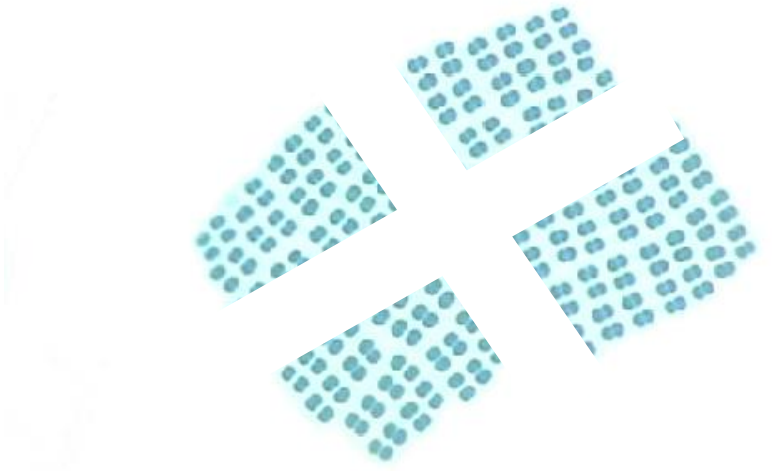
AQUATIC HABITAT



FRAGMENTATION

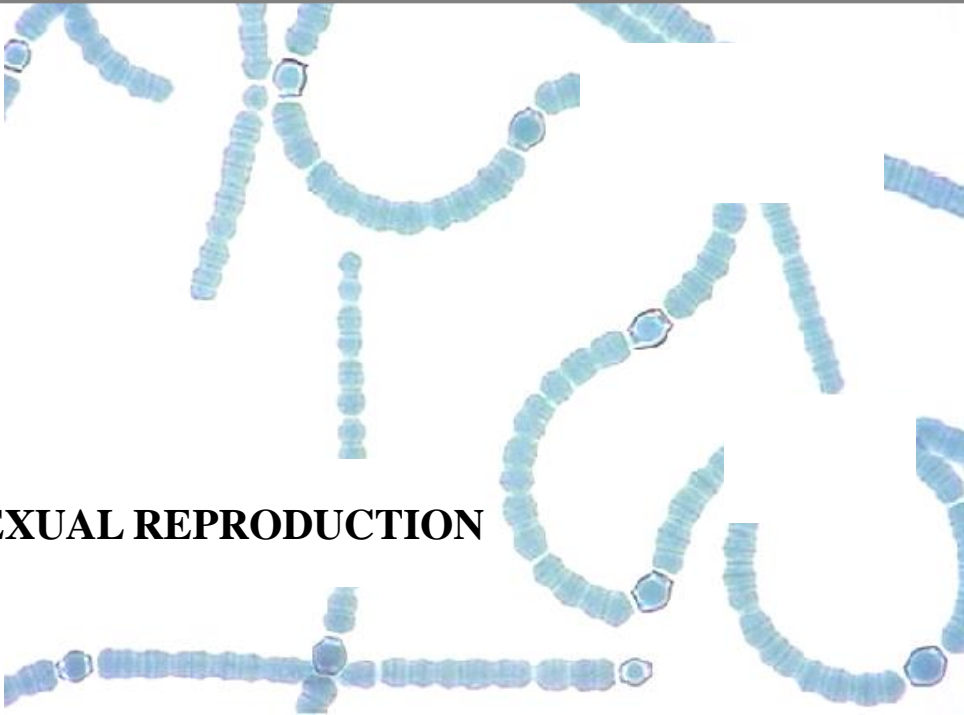


COLONY



ASEXUAL REPRODUCTION

FILAMENT



ASEXUAL REPRODUCTION



EUBACTERIA METABOLISM



EUBACTERIA
METABOLISM
HIGHLY DIVERSE
RESPIRATION
&
NUTRITION

QUESTION



**WHAT ARE THE
RESPIRATION
TYPES?**

QUESTION

A transmission electron micrograph showing a filament of cyanobacteria. The central cell is a heterocyst, which is larger and has a distinct internal structure compared to the vegetative cells. The vegetative cells are smaller and have a more uniform internal structure.

**RESPIRATION
TYPES**

**?
RESPIRATION**

A transmission electron micrograph showing a filament of cyanobacteria. The central cell is a heterocyst, which is larger and has a distinct internal structure compared to the vegetative cells. The vegetative cells are smaller and have a more uniform internal structure.

**RESPIRATION
TYPES**

A

**?
RESPIRATION**



**RESPIRATION
TYPES**

**ANAEROBIC
RESPIRATION**



**RESPIRATION
TYPES**

**AEROBIC
RESPIRATION**

^

E

EUBACTERIA RESPIRATION MODES

**EUBACTERIA
RESPIRATION
MODES**

OBLIGATE ANAEROBES

**EUBACTERIA
RESPIRATION
MODES**

**EUBACTERIA
RESPIRATION
MODES**

OBLIGATE ANAEROBES

FACULTATIVE ANAEROBES

**EUBACTERIA
RESPIRATION
MODES**

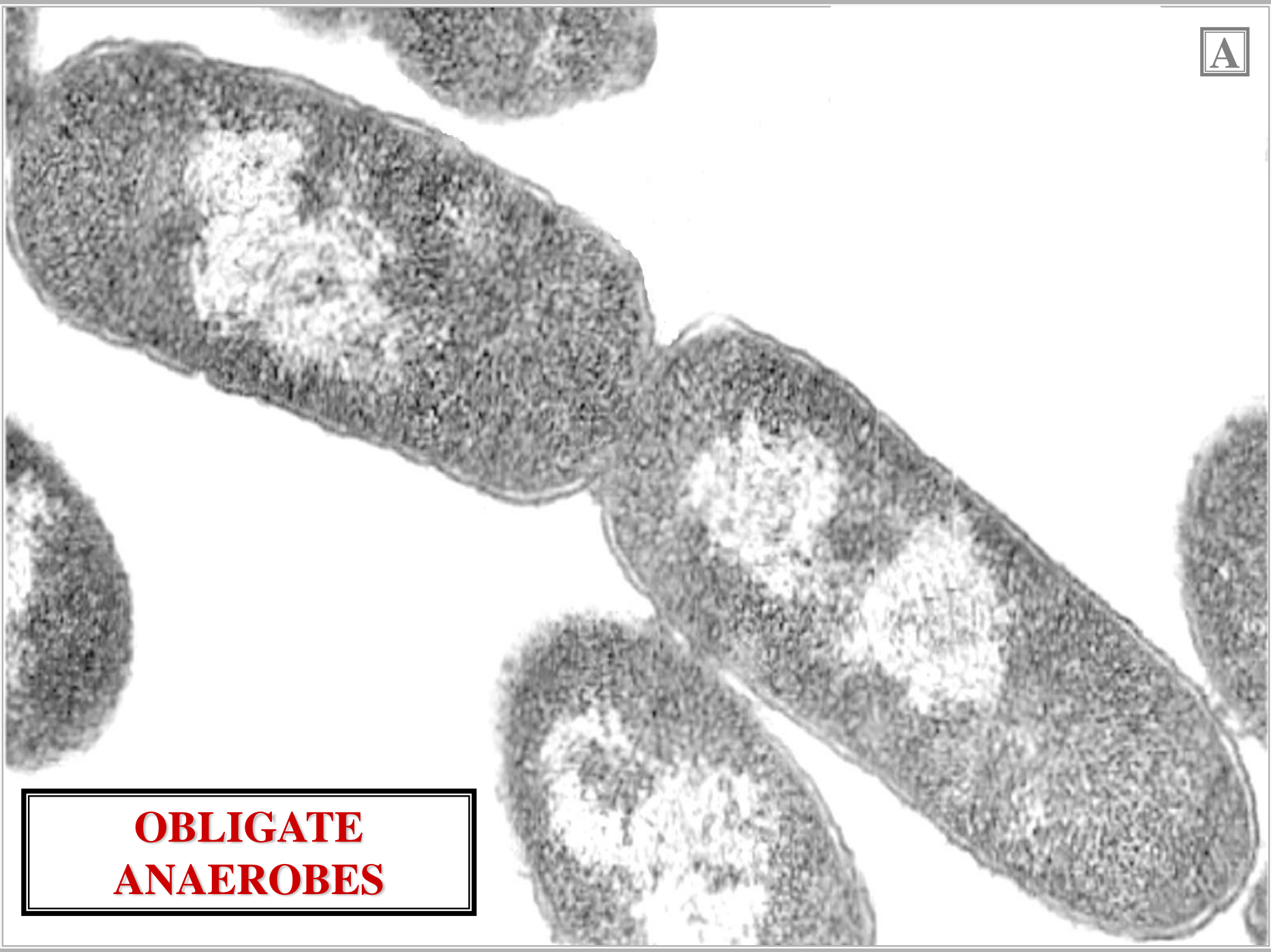
**EUBACTERIA
RESPIRATION
MODES**

**OBLIGATE ANAEROBE
FACULTATIVE ANAEROBES
OBLIGATE AEROBES**

**EUBACTERIA
RESPIRATION
MODES**



OBLIGATE ANAEROBES



**OBLIGATE
ANAEROBES**

UTILIZE
ANAEROBIC
RESPIRATION

**OBLIGATE
ANAEROBES**



**UTILIZE
ANAEROBIC
RESPIRATION**

**OXYGEN
LETHAL**

**OBLIGATE
ANAEROBES**



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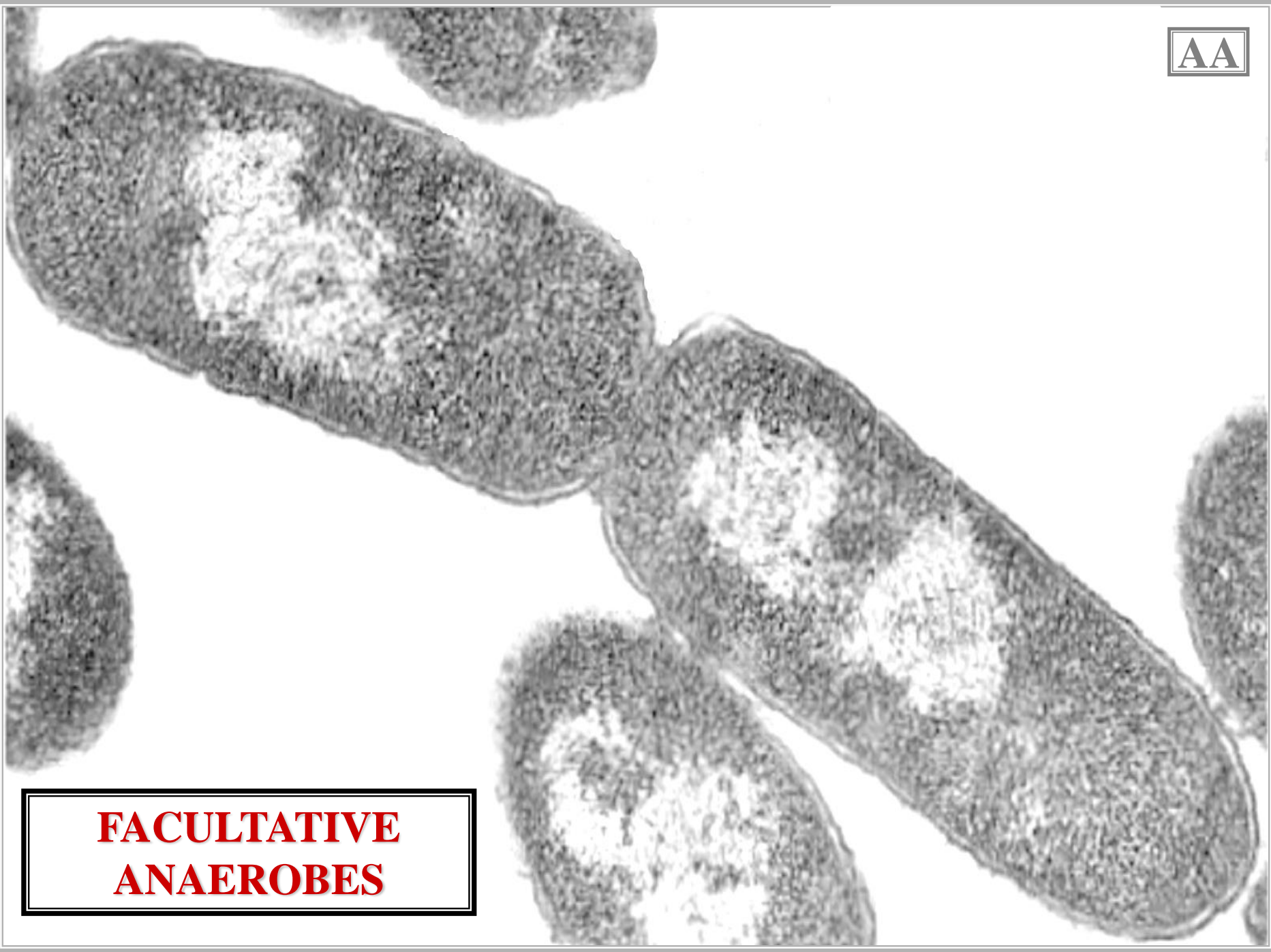
**CONFINED
ANAEROBIC
HABITATS**

**OXYGEN
LETHAL**

**OBLIGATE
ANAEROBES**



FACULTATIVE ANAEROBES



**FACULTATIVE
ANAEROBES**



UTILIZE
ANAEROBIC
RESPIRATION

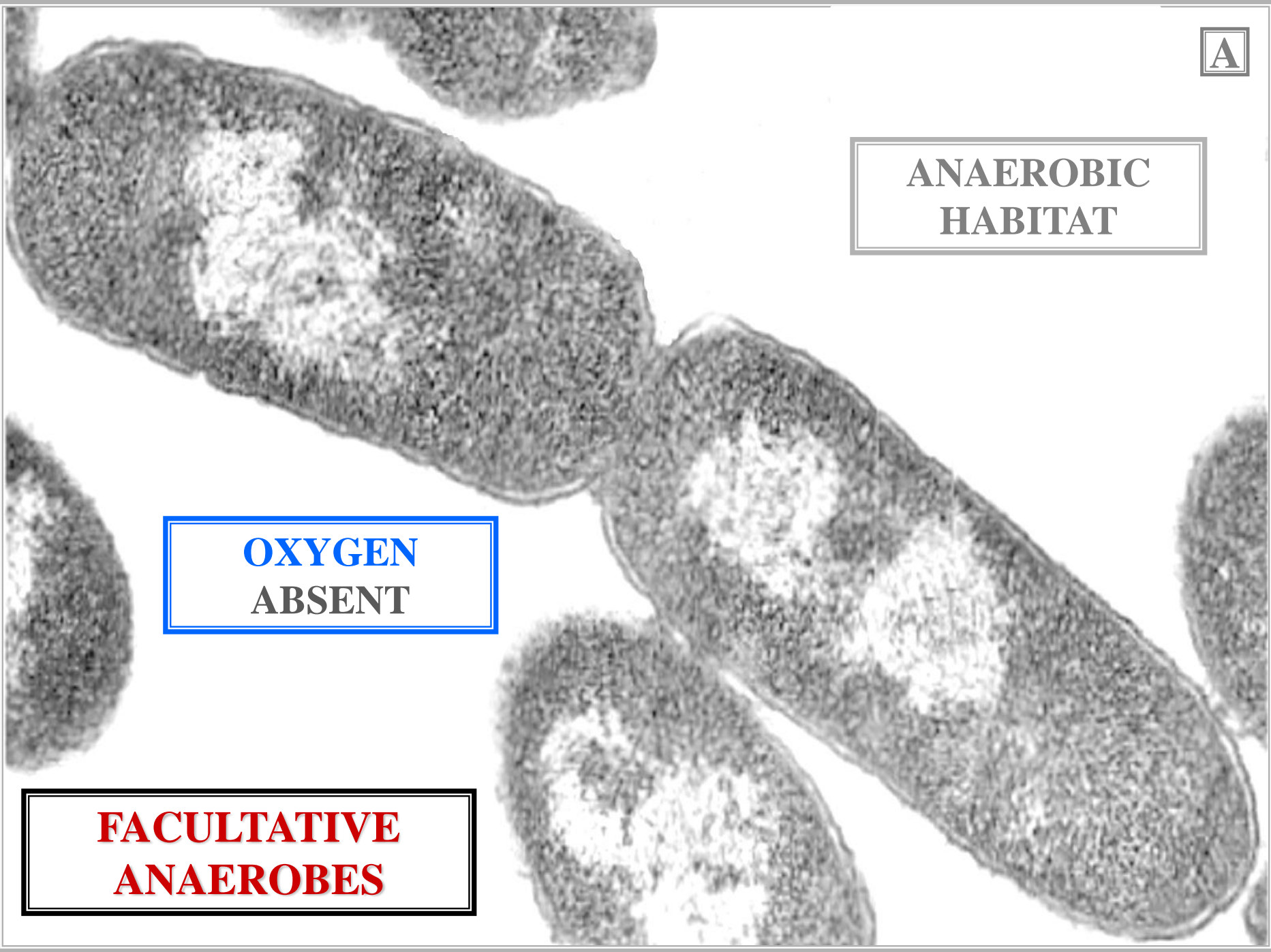
UTILIZE
AEROBIC
RESPIRATION

**FACULTATIVE
ANAEROBES**

**ANAEROBIC
HABITAT**

**OXYGEN
ABSENT**

**FACULTATIVE
ANAEROBES**



UTILIZE
ANAEROBIC
RESPIRATION

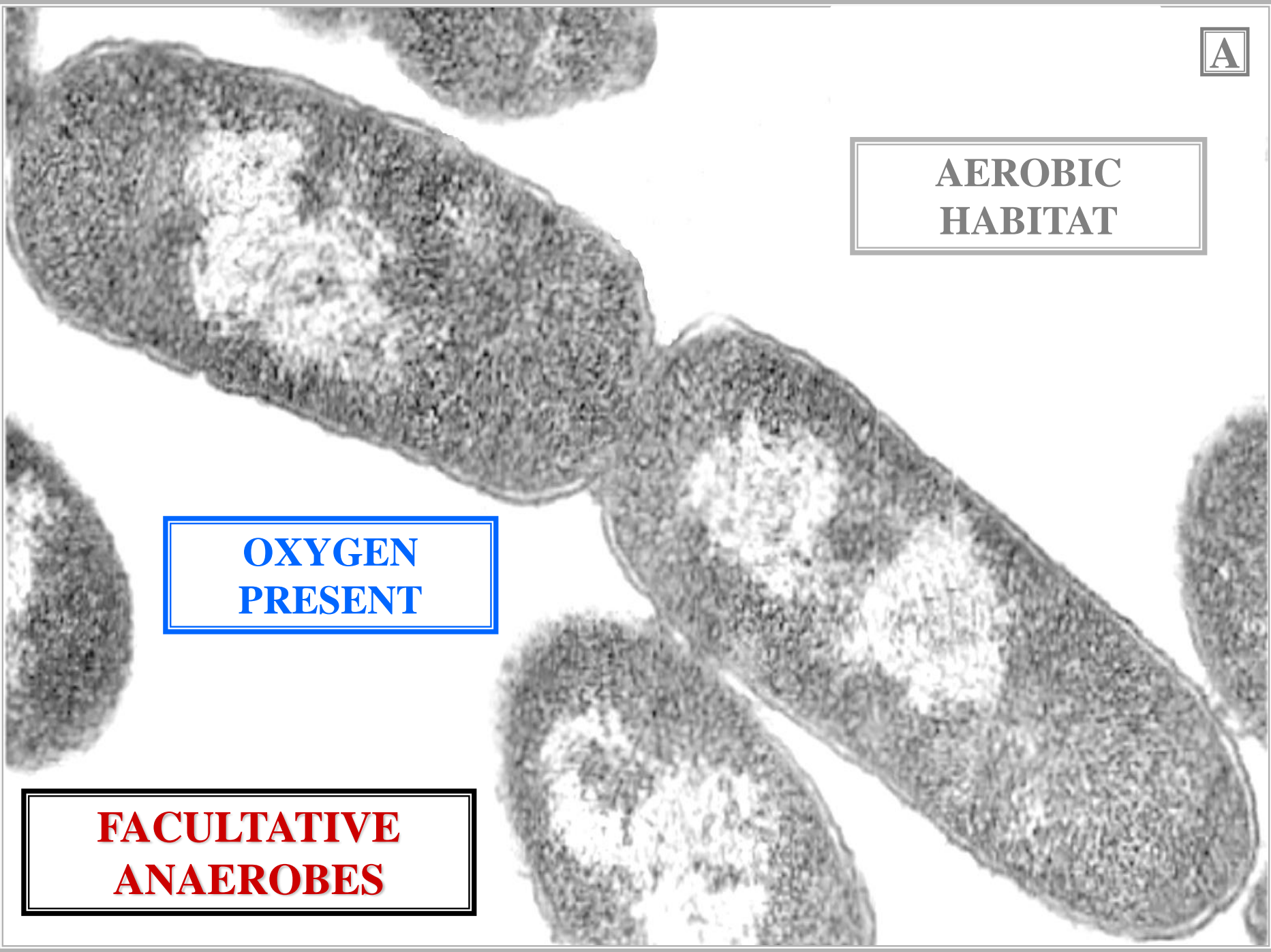
OXYGEN
ABSENT

FACULTATIVE
ANAEROBES

**AEROBIC
HABITAT**

**OXYGEN
PRESENT**

**FACULTATIVE
ANAEROBES**



A black and white micrograph showing several rod-shaped bacteria. Each bacterium has a distinct lighter-colored region in the center, likely representing a nucleus or a specialized organelle. The bacteria are scattered across the field of view.

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O

UTILIZE
AEROBIC
RESPIRATION

OXYGEN
PRESENT

FACULTATIVE
ANAEROBES



OBLIGATE AEROBES

**OBLIGATE
AEROBES**



UTILIZE
AEROBIC
RESPIRATION

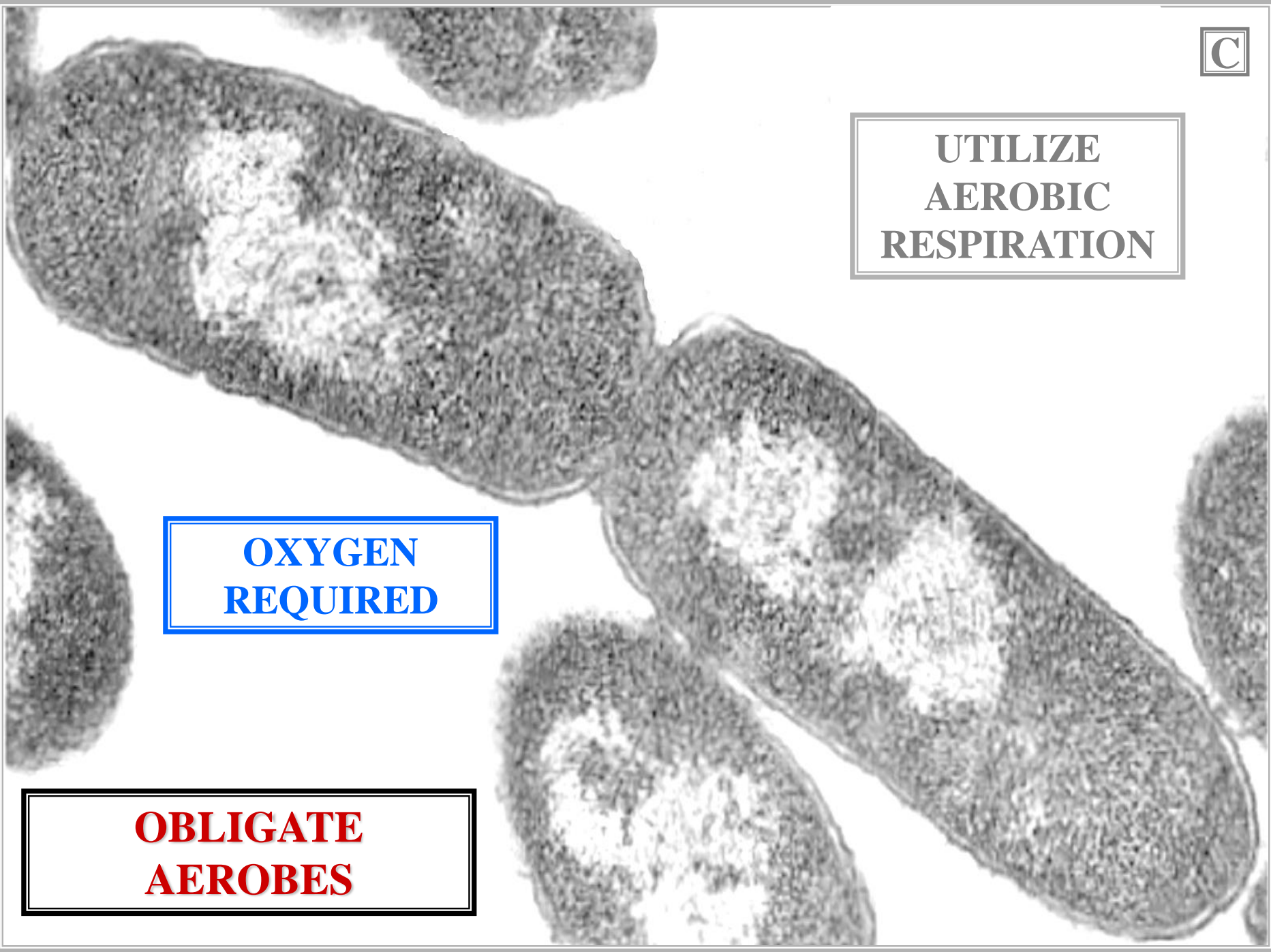
**OBLIGATE
AEROBES**



UTILIZE
AEROBIC
RESPIRATION

OXYGEN
REQUIRED

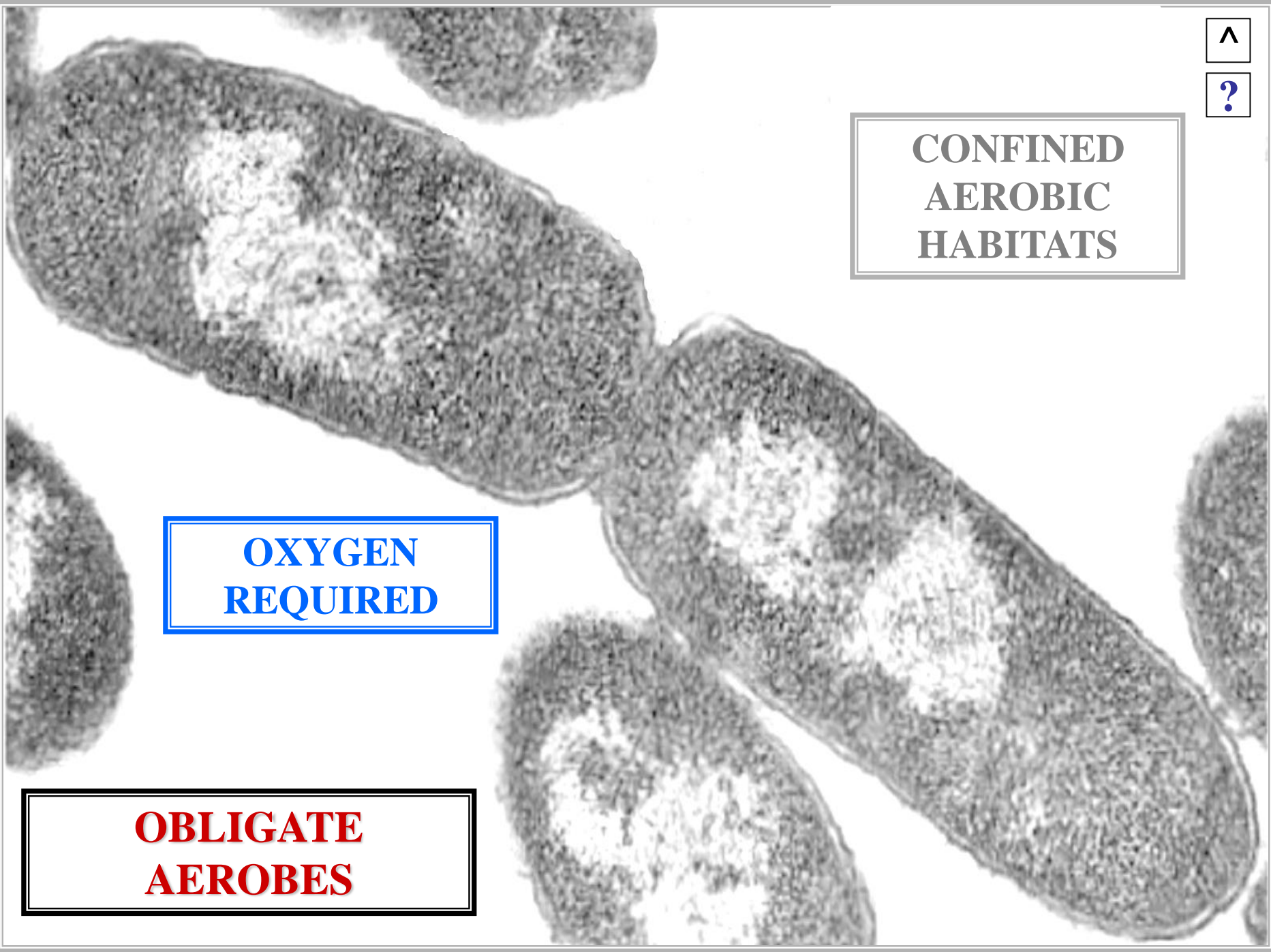
OBLIGATE
AEROBES



**CONFINED
AEROBIC
HABITATS**

**OXYGEN
REQUIRED**

**OBLIGATE
AEROBES**



QUESTION



**WHAT ARE THE
NUTRITION
TYPES?**

QUESTION

A black and white micrograph showing several rod-shaped bacteria. The bacteria are elongated and have a granular texture. Some are in pairs, while others are single. They are oriented in various directions across the field of view.

**NUTRITION
TYPES**

**?
NUTRITION**

A color micrograph showing numerous green, oval-shaped microorganisms. They are arranged in several distinct chains or filaments. The organisms have a slightly granular appearance and are set against a light green background.

**NUTRITION
TYPES**

**H
A**

**?
NUTRITION**

A black and white micrograph showing several elongated, rod-shaped organisms. The organisms have a textured, granular appearance and are arranged in various orientations, some overlapping. They appear to be heterotrophic, possibly bacteria or fungi.

**NUTRITION
TYPES**

**HETEROTROPHIC
NUTRITION**

A color micrograph showing numerous small, green, oval-shaped organisms. They are arranged in several parallel chains, with some individual cells also visible. The organisms have a distinct internal structure, possibly chloroplasts, and are likely autotrophic, such as algae or cyanobacteria.

**NUTRITION
TYPES**

**AUTOTROPHIC
NUTRITION**



EUBACTERIA

NUTRITION

MODES

HETEROTROPHIC EUBACTERIA



HETEROTROPHIC EUBACTERIA



**CANNOT
SYNTHESIZE
FOOD SUGARS**

**HETEROTROPHIC
EUBACTERIA**

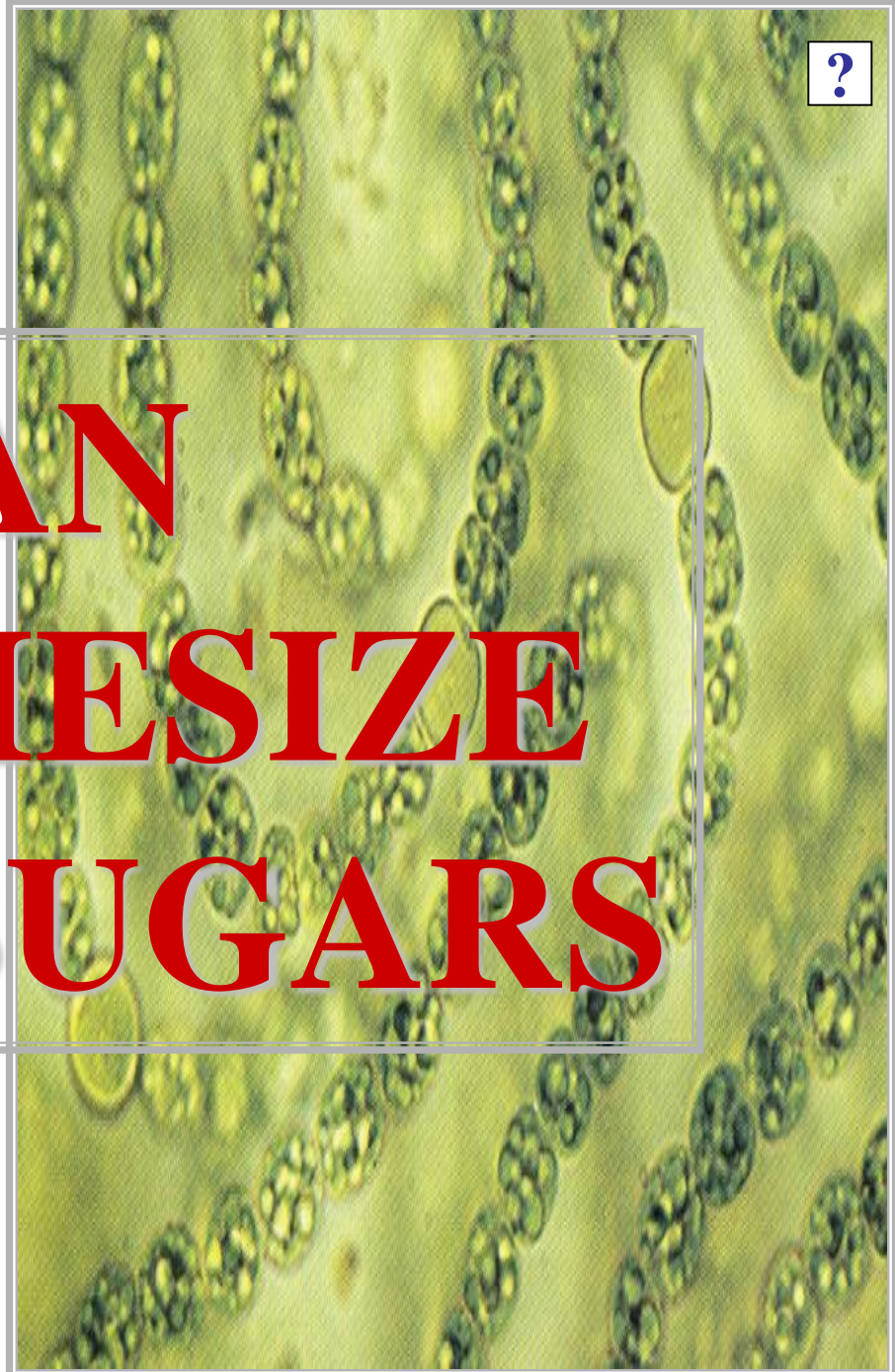
AUTOTROPHIC EUBACTERIA



AUTOTROPHIC EUBACTERIA



**CAN
SYNTHESIZE
FOOD SUGARS**



QUESTION



**WHAT ARE THE
AUTOTROPHIC
NUTRITION
MODES?**

QUESTION

AUTOTROPHIC NUTRITION

?

AUTOTROPHIC NUTRITION

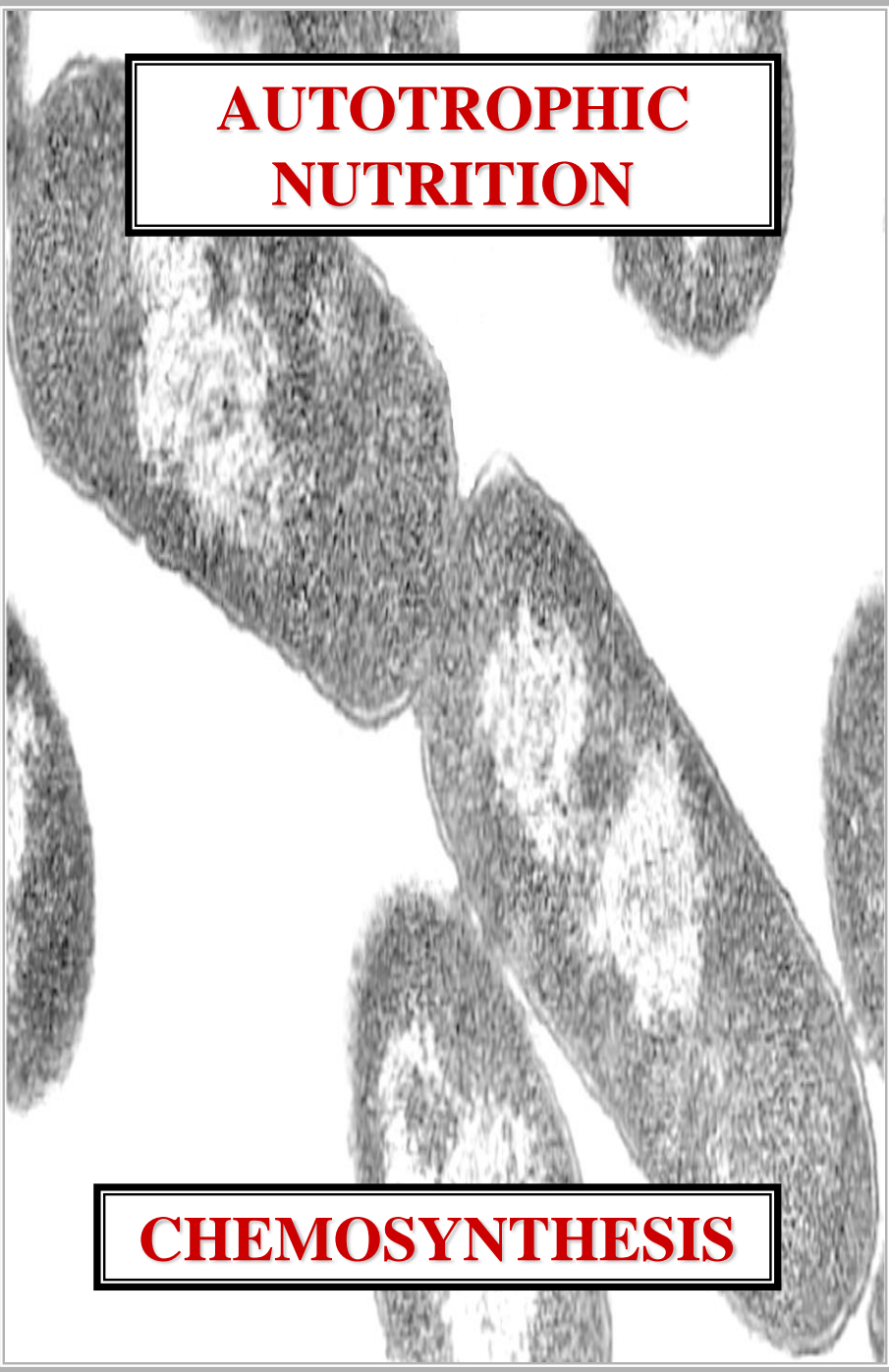
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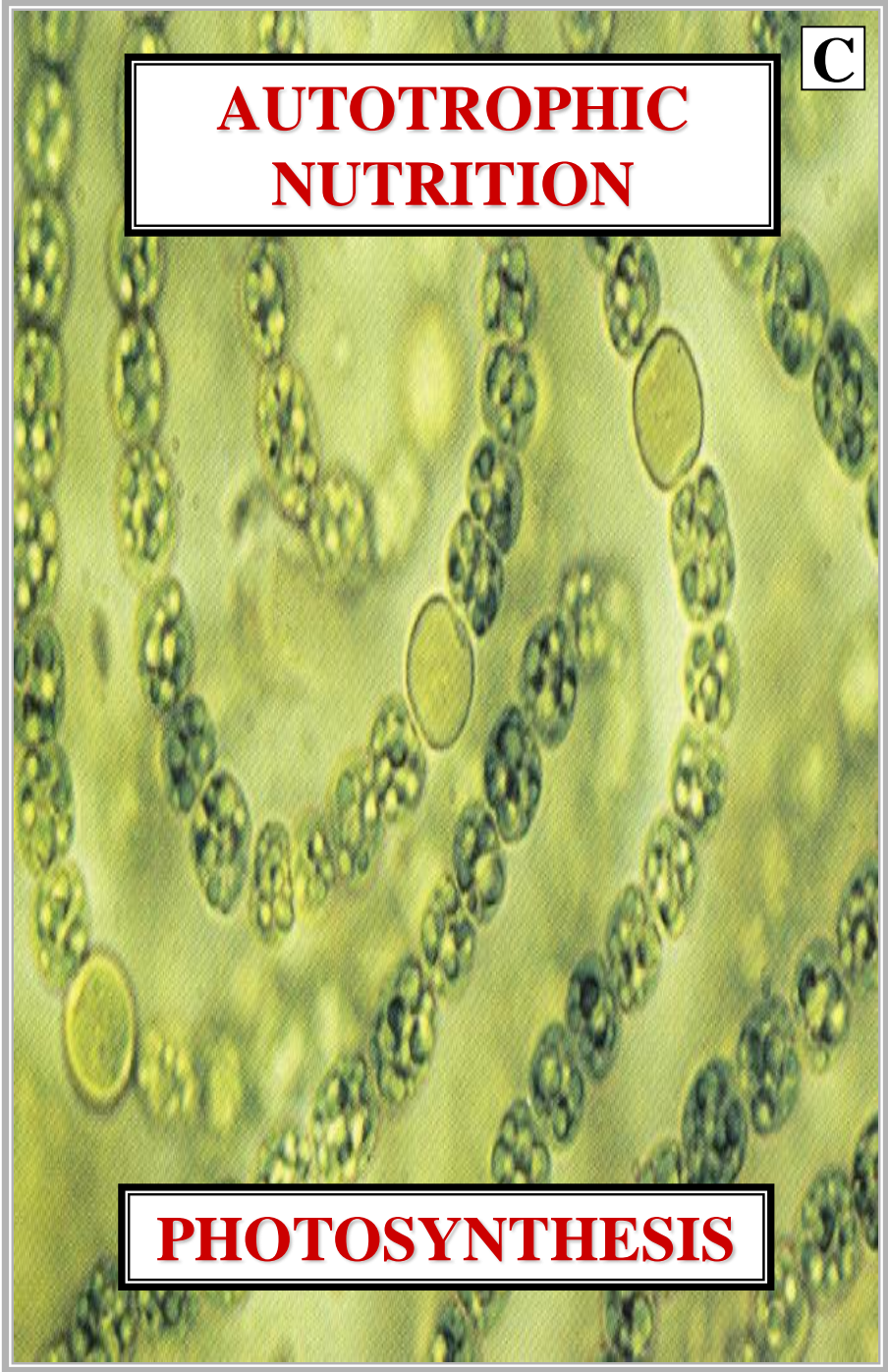
**AUTOTROPHIC
NUTRITION**

CHEMOSYNTHESIS



**AUTOTROPHIC
NUTRITION**

PHOTOSYNTHESIS



C



CHEMOSYNTHESIS



**INITIAL
ENERGY SOURCE**

**CHEMOSYNTHETIC
EUBACTERIA**

A black and white micrograph showing several rod-shaped bacteria with internal granular structures. The bacteria are scattered across the frame, with some showing a distinct lighter-colored region in the center. The background is light and slightly grainy.

C

A

!

**INITIAL
ENERGY SOURCE
CHEMICAL ENERGY**

**CHEMOSYNTHETIC
EUBACTERIA**

**CHLOROPHYLL
ABSENT**

**CHEMOSYNTHETIC
EUBACTERIA**



PHOTOSYNTHESIS

A microscopic image showing several parallel chains of green, oval-shaped cells, likely algae or cyanobacteria. The cells are arranged in long, slightly curved lines. The background is a light, yellowish-green color.

INITIAL ENERGY SOURCE

**PHOTOSYNTHETIC
EUBACTERIA**

A microscopic view of green algae filaments, showing multiple parallel chains of spherical cells. Each cell contains numerous small, yellowish-green granules, likely chloroplasts. The background is a light, yellowish-green color.

C

P

!

**INITIAL
ENERGY SOURCE
LIGHT ENERGY**

**PHOTOSYNTHETIC
EUBACTERIA**



CHLOROPHYLL PRESENT

**PHOTOSYNTHETIC
EUBACTERIA**



EUBACTERIA CHLOROPHYLLS TYPES

BACTERIA

CHLOROPHYLL

BACTERIA CHLOROPHYLL

**BACTERIA CHLOROPHILL
LT RXT E- DONOR**



HYDROGEN SULFIDE

**BACTERIA CHLOROPHILL
LT RXT E- DONOR**

BACTERIA CHLOROPHYLL PHOTOSYNTHESIS



HYDROGEN SULFIDE

CO₂

LIGHT ENERGY

E-

E- DONER

LT RXT
**HYDROGEN
SULFIDE
PHOTOLYSIS**

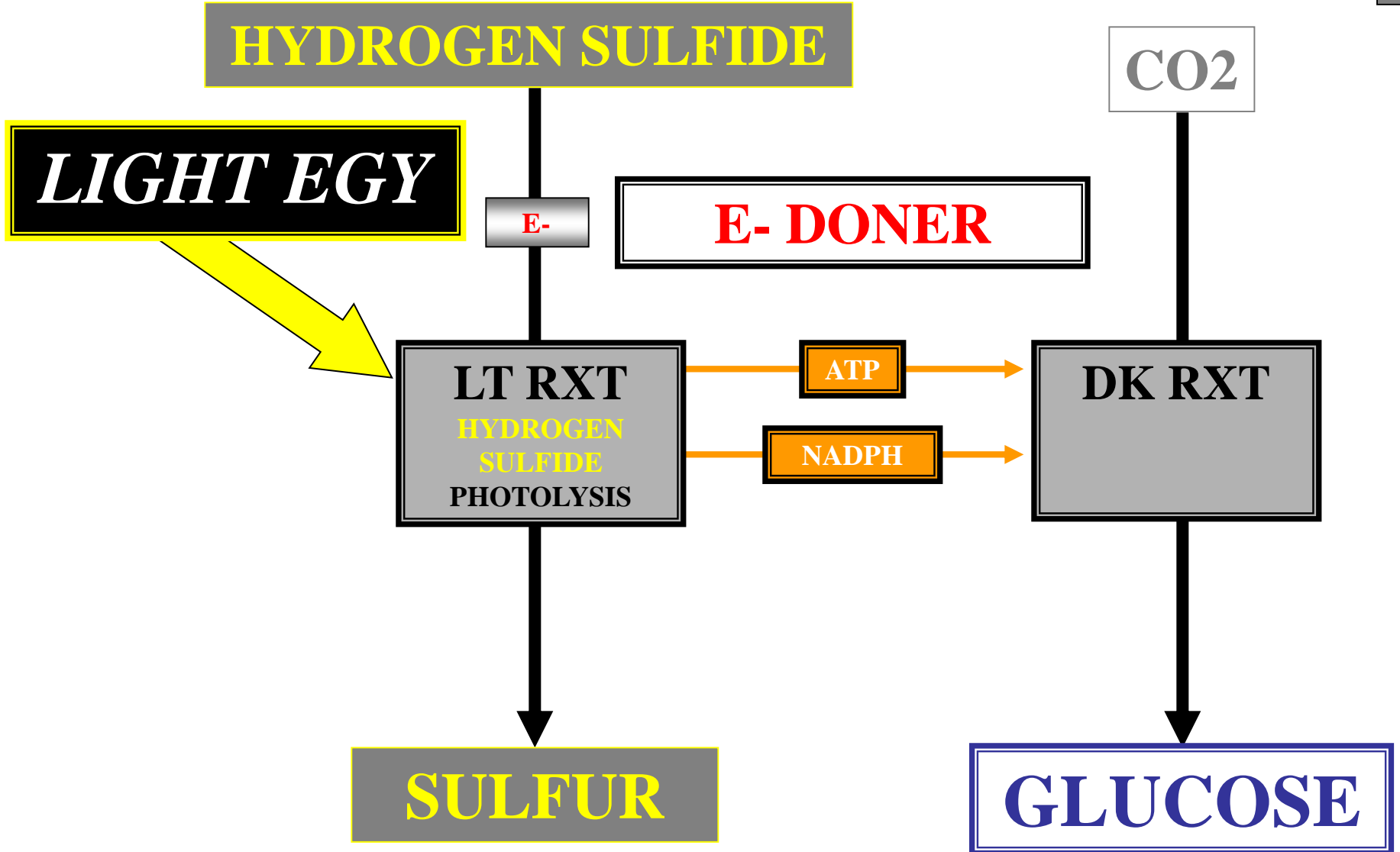
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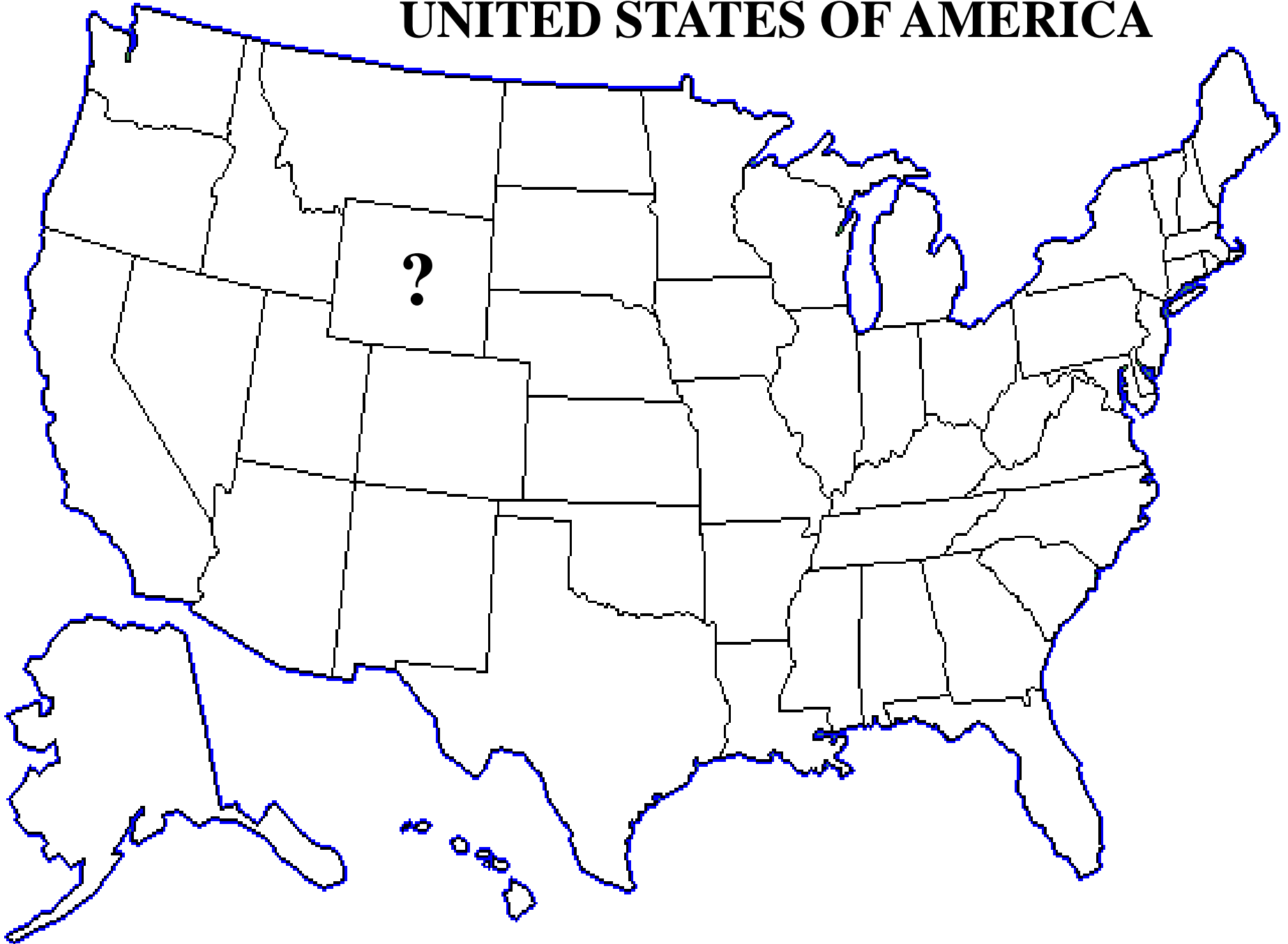
DK RXT

SULFUR

GLUCOSE



UNITED STATES OF AMERICA



UNITED STATES OF AMERICA



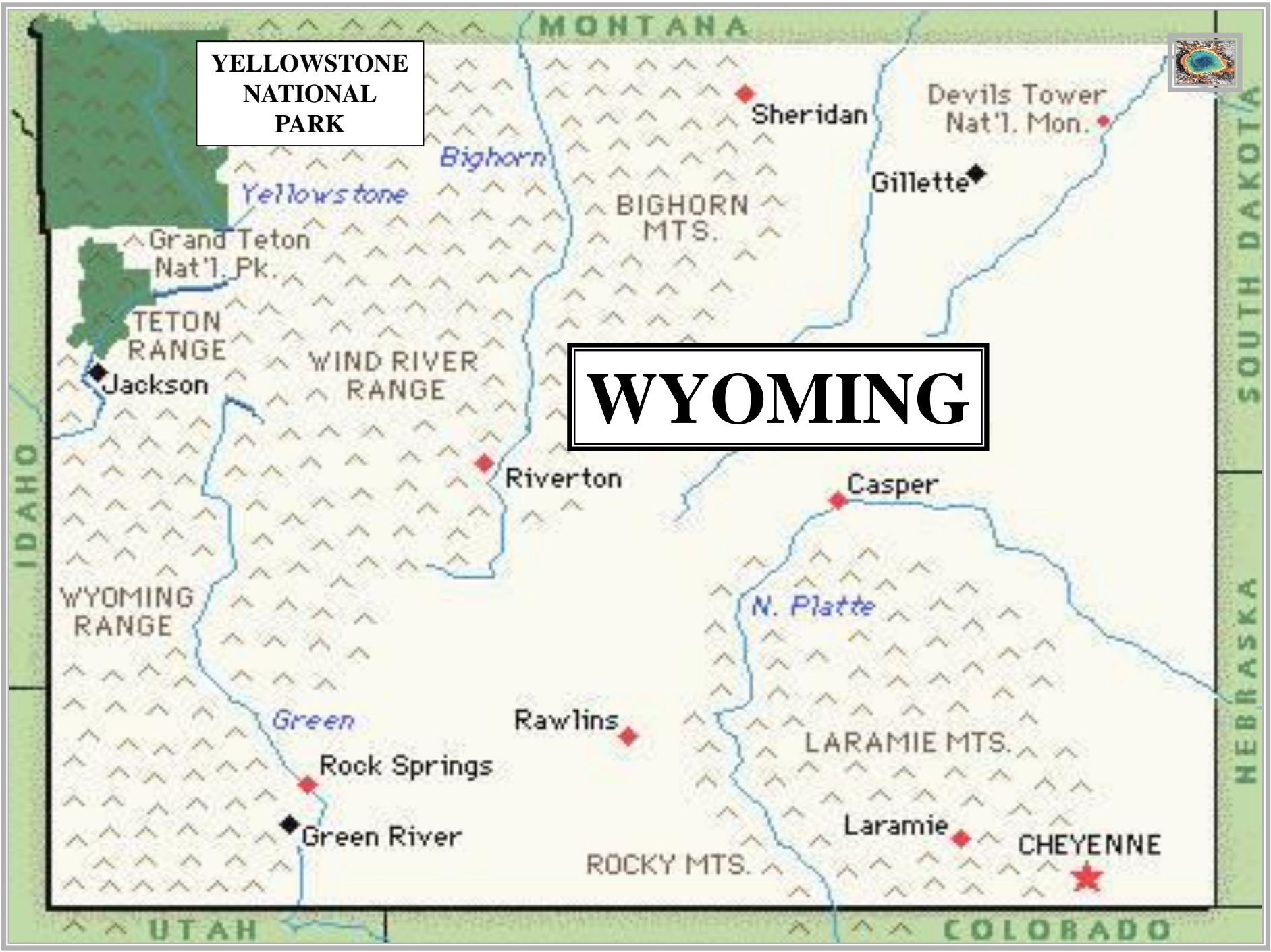
WYOMING



**YELLOWSTONE
NATIONAL
PARK**

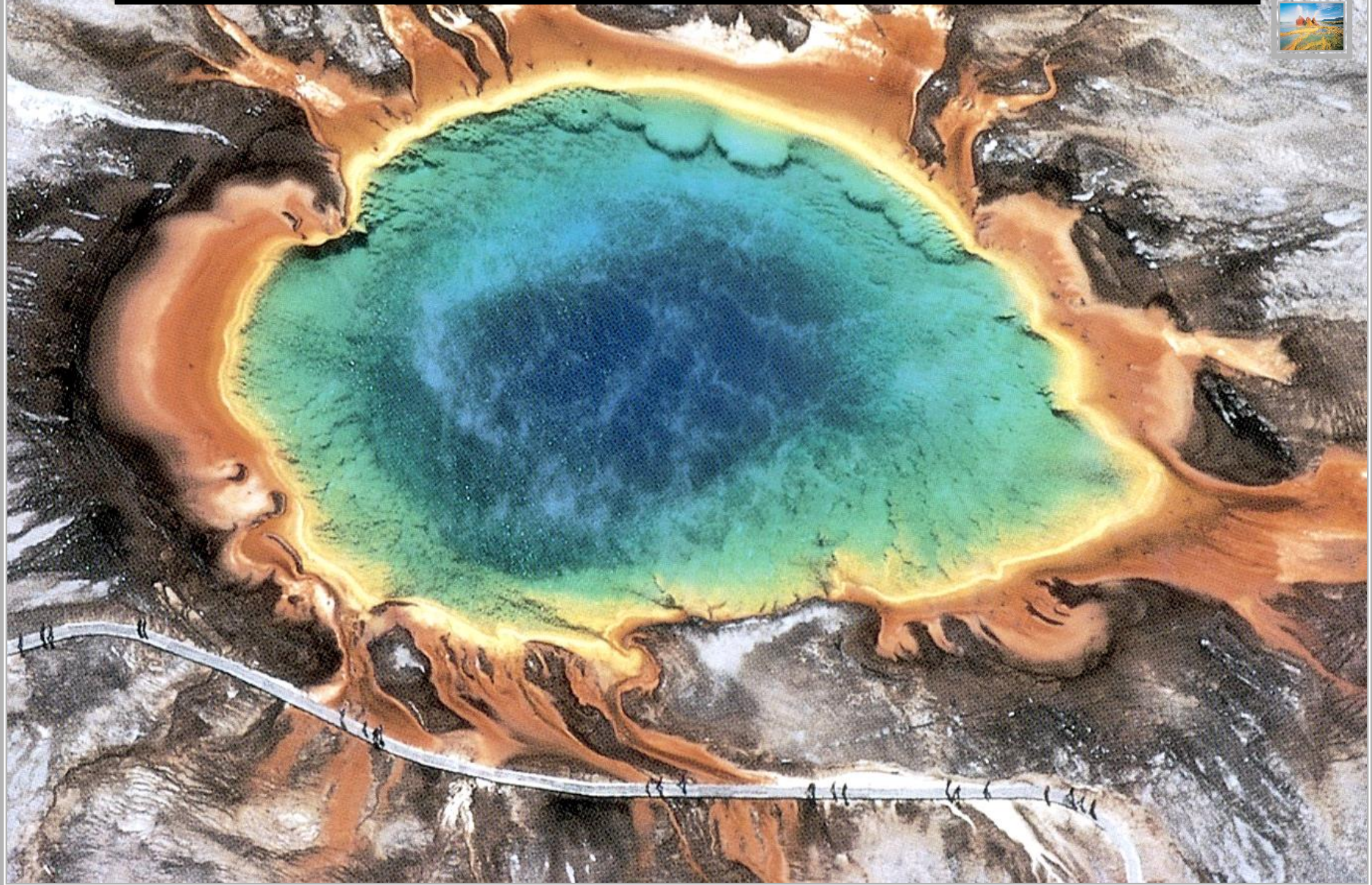


WYOMING



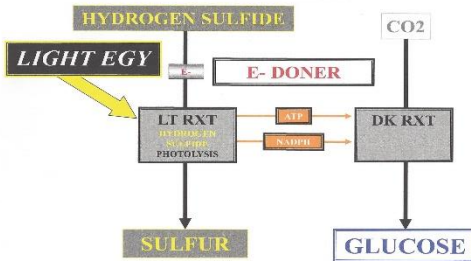
YELLOWSTONE: HOT SPRINGS

EG





BACTERIA CHLOROPHYLL PHOTOSYNTHESIS



PURPLE-SULFUR EUBACTERIA

TRUE CHLOROPHYLL

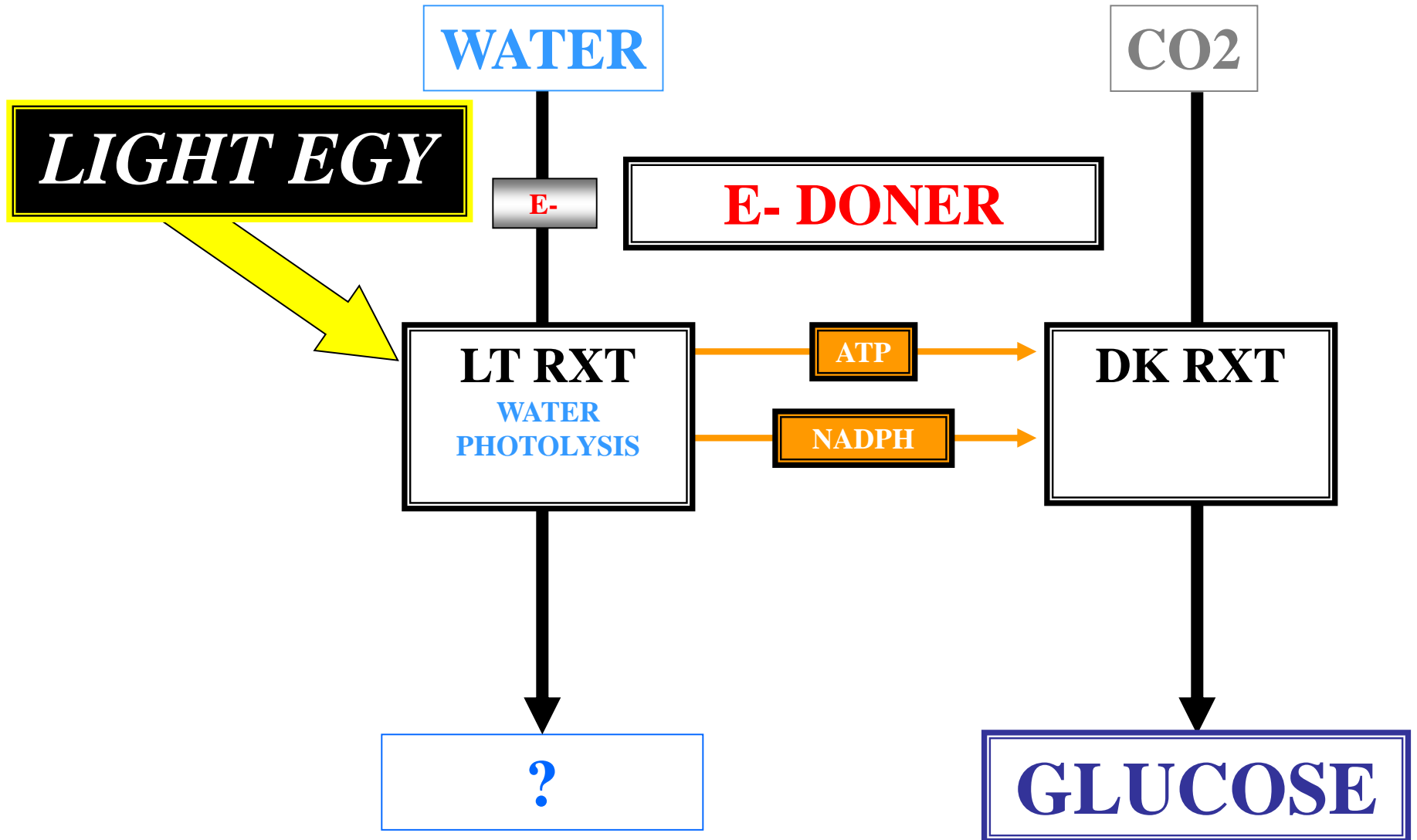
TRUE CHLOROPHYLL

**TRUE CHLOROPHYLL
LTX E- DONOR**

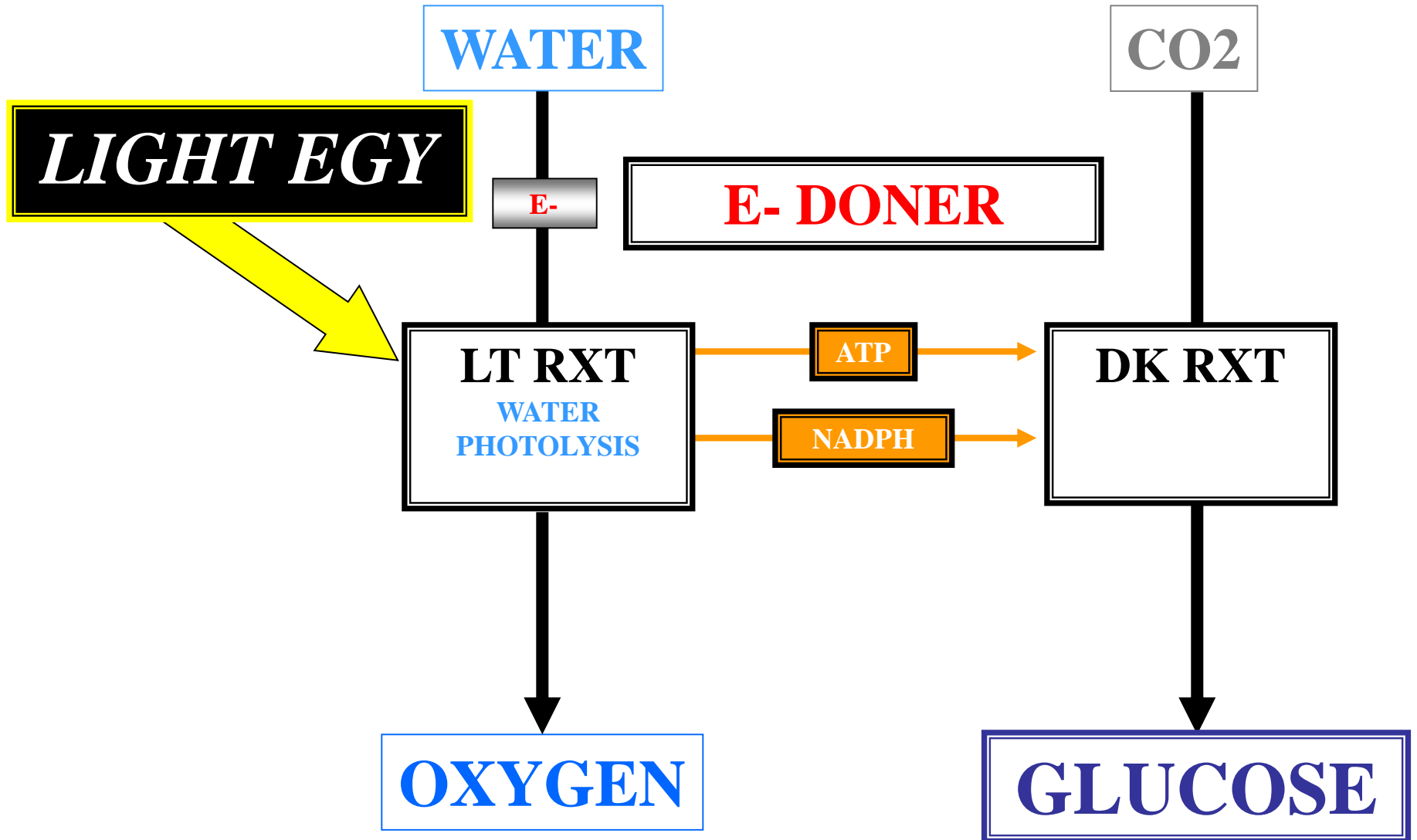
WATER

**TRUE CHLOROPHYLL
LTX E- DONOR**

TRUE CHLOROPHYLL PHOTOSYNTHESIS



TRUE CHLOROPHYLL PHOTOSYNTHESIS



A microscopic image showing several chains of cyanobacteria. The chains are composed of small, spherical cells, some of which are larger and more prominent than others. The background is a light, yellowish-green color. The chains are arranged in a somewhat circular pattern.

CYANOBACTERIA

OBLIGATE AEROBES



CYANOBACTERIA

A microscopic image showing several chains of cyanobacteria. The chains are composed of small, spherical cells, some of which are larger and more prominent than others. The background is a light, yellowish-green color.

OBLIGATE AEROBES

PHOTOSYNTHETIC

CYANOBACTERIA

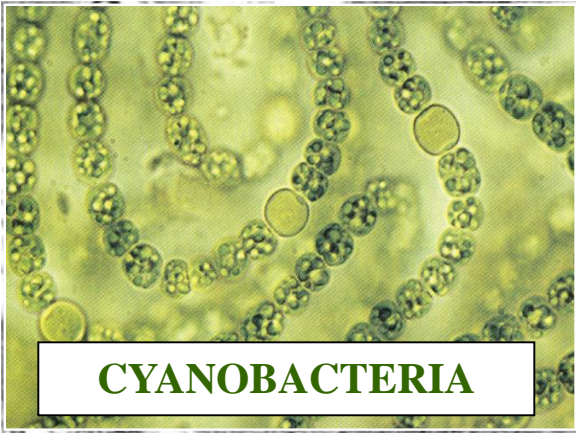
OBLIGATE AEROBES

PHOTOSYNTHETIC

TRUE CHLOROPHYLL

CYANOBACTERIA



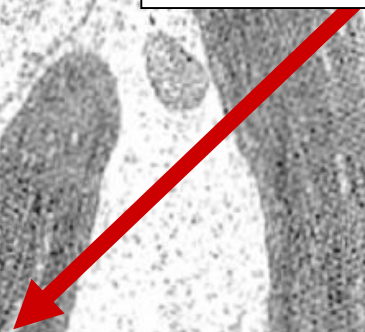


CYANOBACTERIA



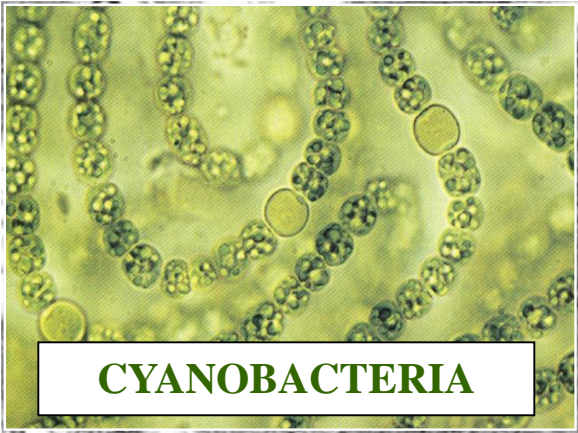
EN

CHLOROPLAST

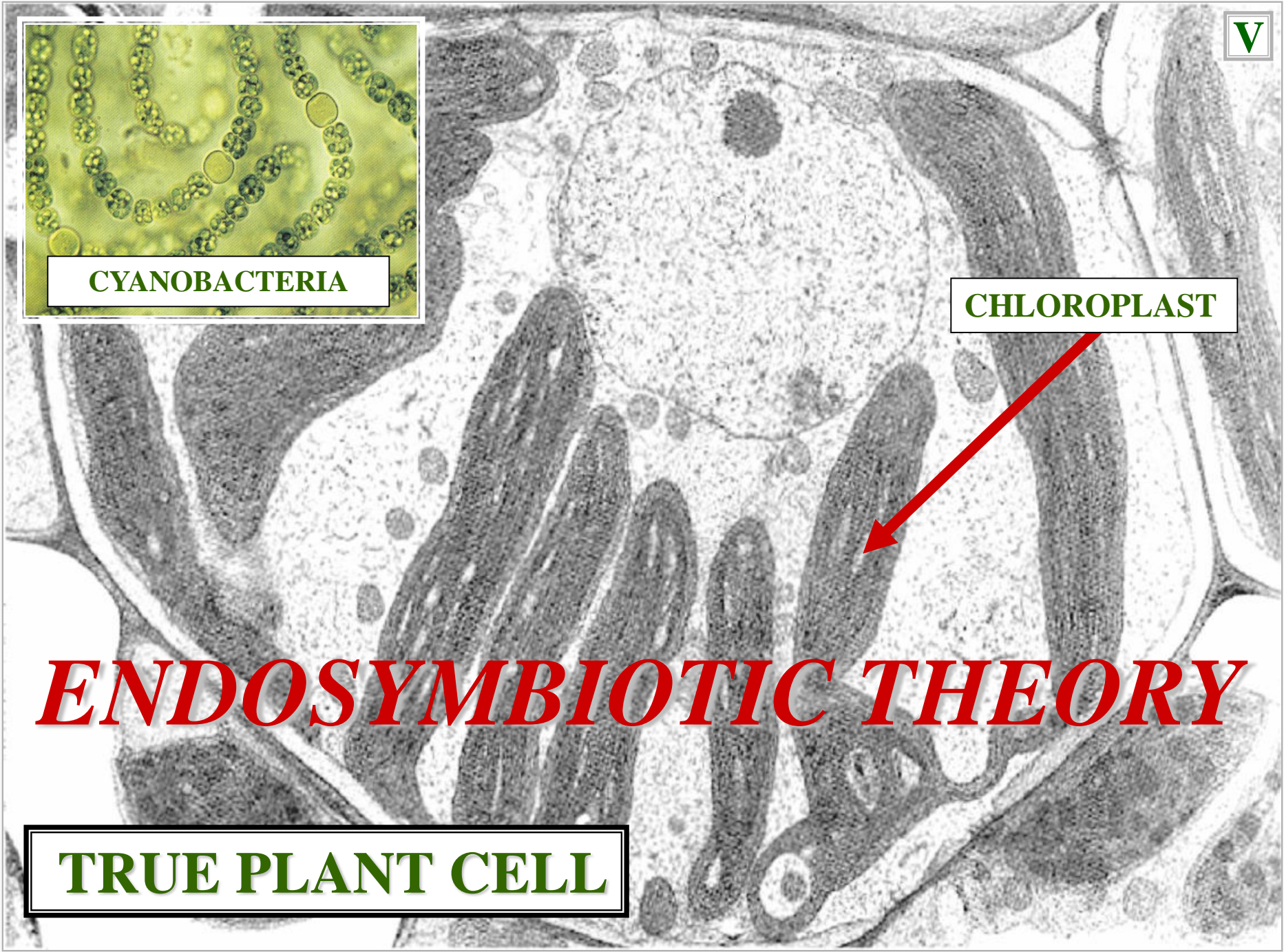


***CYANOBACTERIA
EVOLVED TRUE PLANT
CHLOROPLASTS***

TRUE PLANT CELL



CYANOBACTERIA



CHLOROPLAST

ENDOSYMBIOTIC THEORY

TRUE PLANT CELL



VASCULAR PLANT EVOLUTION



2.7

BILLION YEARS

~2.7 BILLION YEARS AGO



CYANOPHYTA EVOLVE

