

**EUTROPHIC  
LENTIC  
AQUATIC HABITAT**

**HIGH  
NUTRIENT CONTENT**

**EUTROPHIC  
LENTIC  
AQUATIC HABITAT**



# LENTIC AQUATIC HABITAT



**HIGH  
NUTRIENT CONTENT  
EUTROPHIC**



**LENTIC  
EUTROPHIC  
AQUATIC HABITAT**

# AGRICULTURE LANDS



# AGRICULTURE LANDS

## HIGH CROP YIELD



HIGH CROP YIELD

**CORN**

# AGRICULTURE LANDS

## FARMERS ADD FERTILIZER



FERTILIZER

CORN

# AGRICULTURE LANDS

RAINS



RAINS

CORN

**AGRICULTURE LANDS**

**NUTRIENTS LEACH INTO LAKE**



**RAINS**

**CORN**



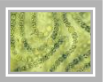
# LAKE / LENTIC AQUATIC HABITAT

E



**NUTRIENT INCREASE**

# LAKE / LENTIC AQUATIC HABITAT



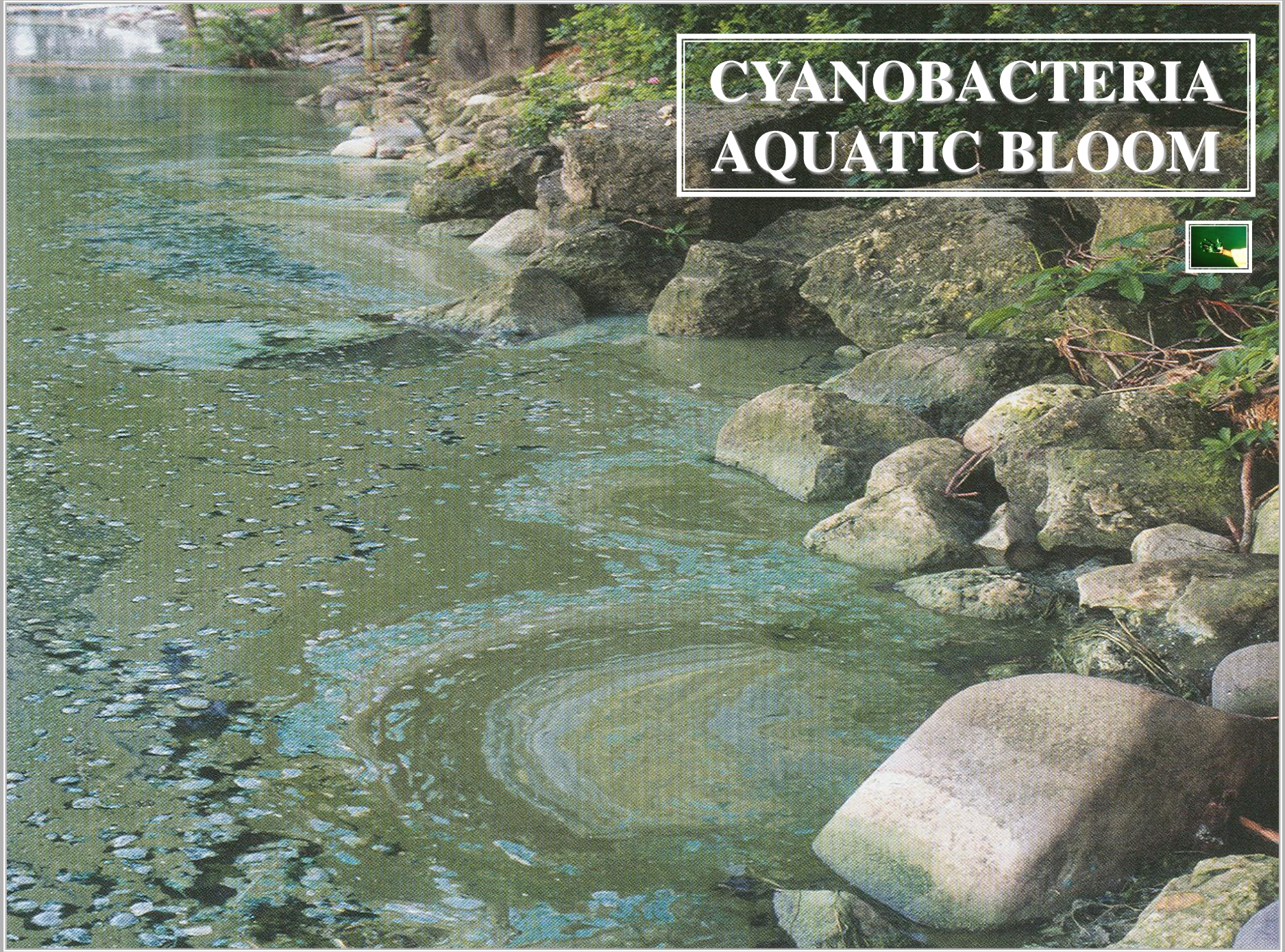
**EUTROPHIC LAKE**

# LAKE / LENTIC AQUATIC HABITAT



**CYANOBACTERIA  
UNDERGO  
AQUATIC BLOOM**

# CYANOBACTERIA AQUATIC BLOOM



# CYANOBACTERIA AQUATIC BLOOM

EX



CYANOBACTERIA

# CYANOBACTERIA AQUATIC BLOOM

## CYANOBACTERIA EXHAUST NUTRIENTS



**CYANOBACTERIA**

**DO**

+

**CYANOBACTERIA  
AQUATIC BLOOM**

**CYANOBACTERIA  
EXHAUST  
NUTRIENTS**

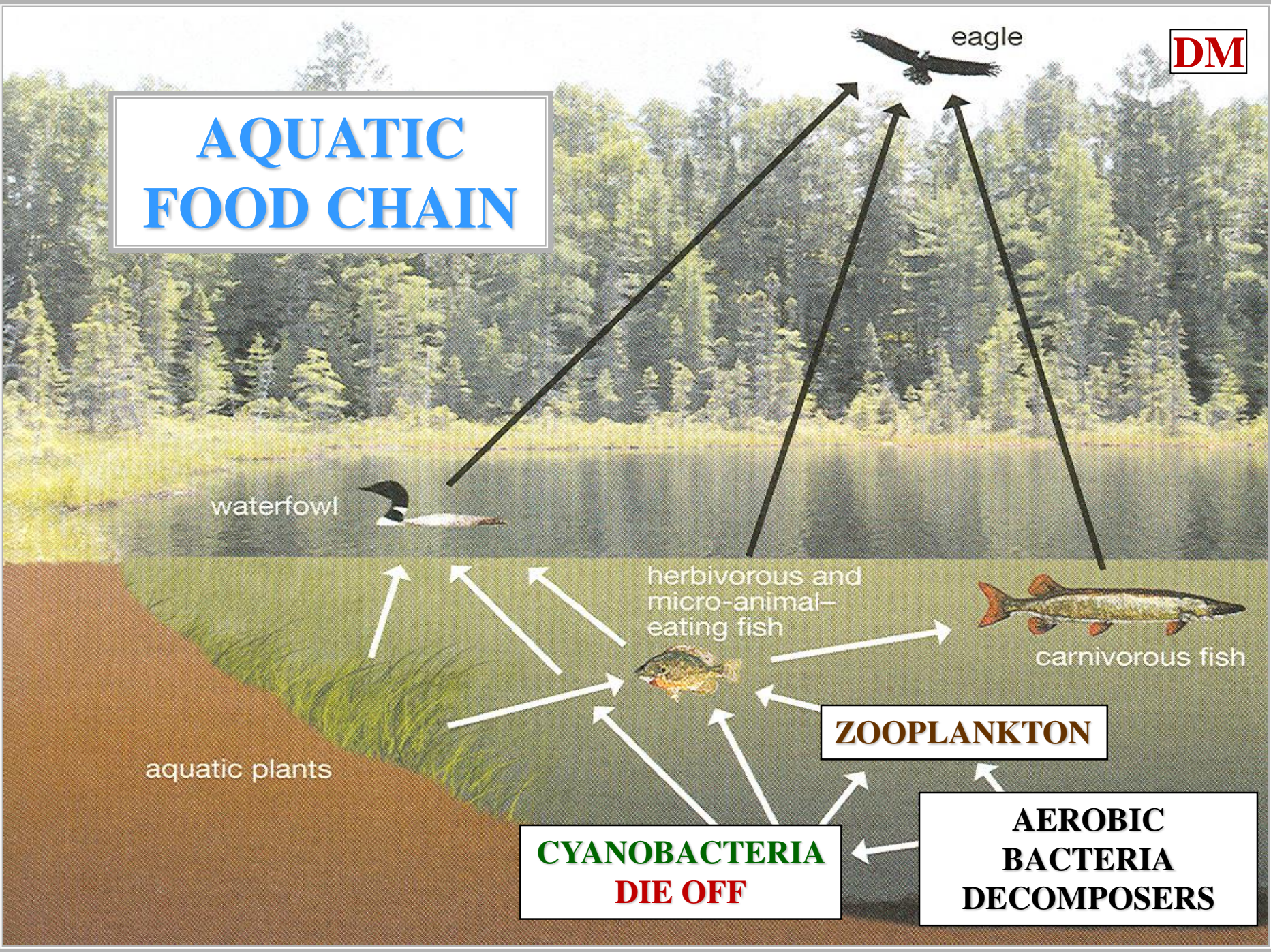
**CYANOBACTERIA  
DIE OFF**



**CYANOBACTERIA**

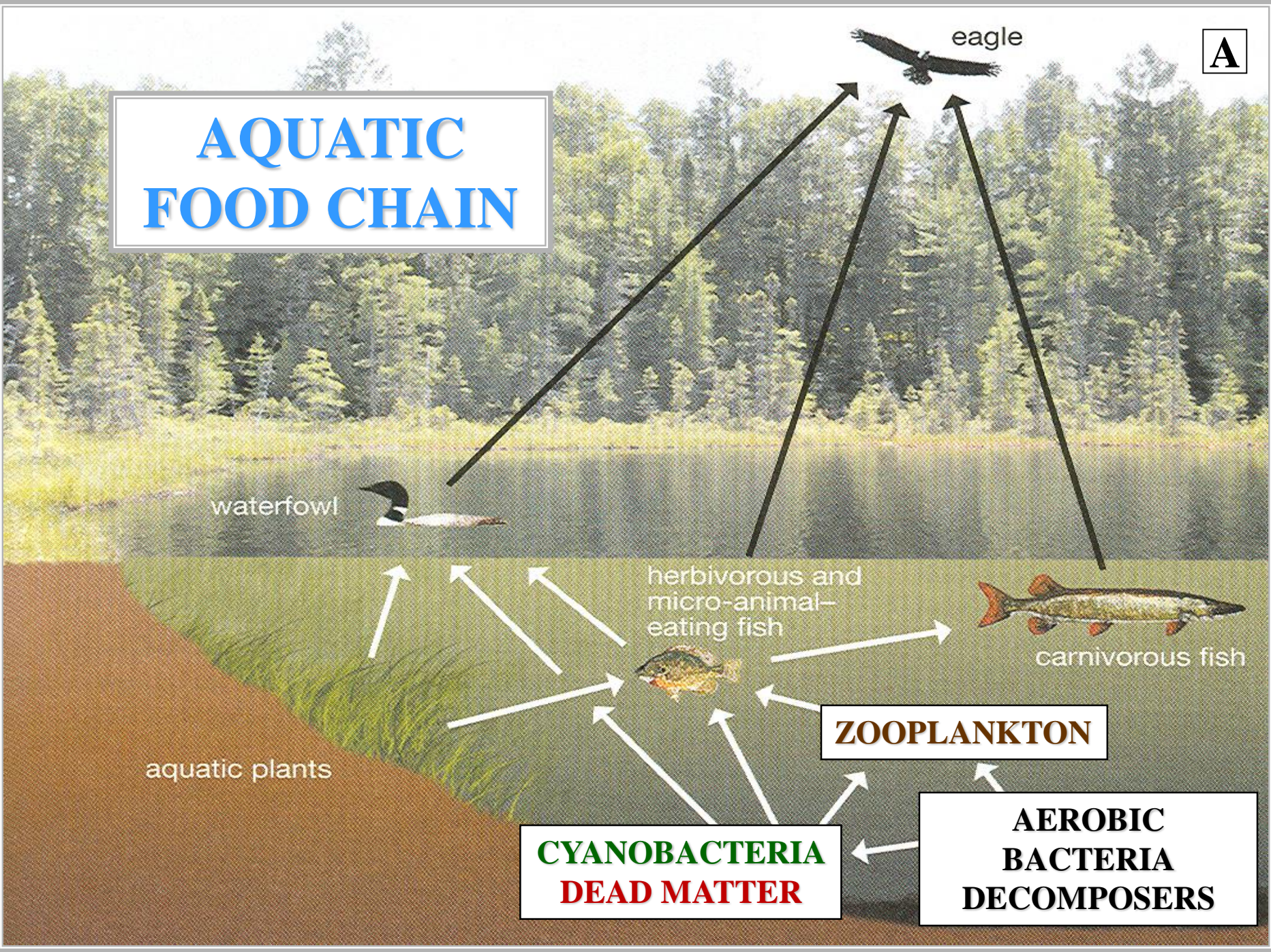


# AQUATIC FOOD CHAIN





# AQUATIC FOOD CHAIN



waterfowl

eagle

herbivorous and  
micro-animal-  
eating fish

carnivorous fish

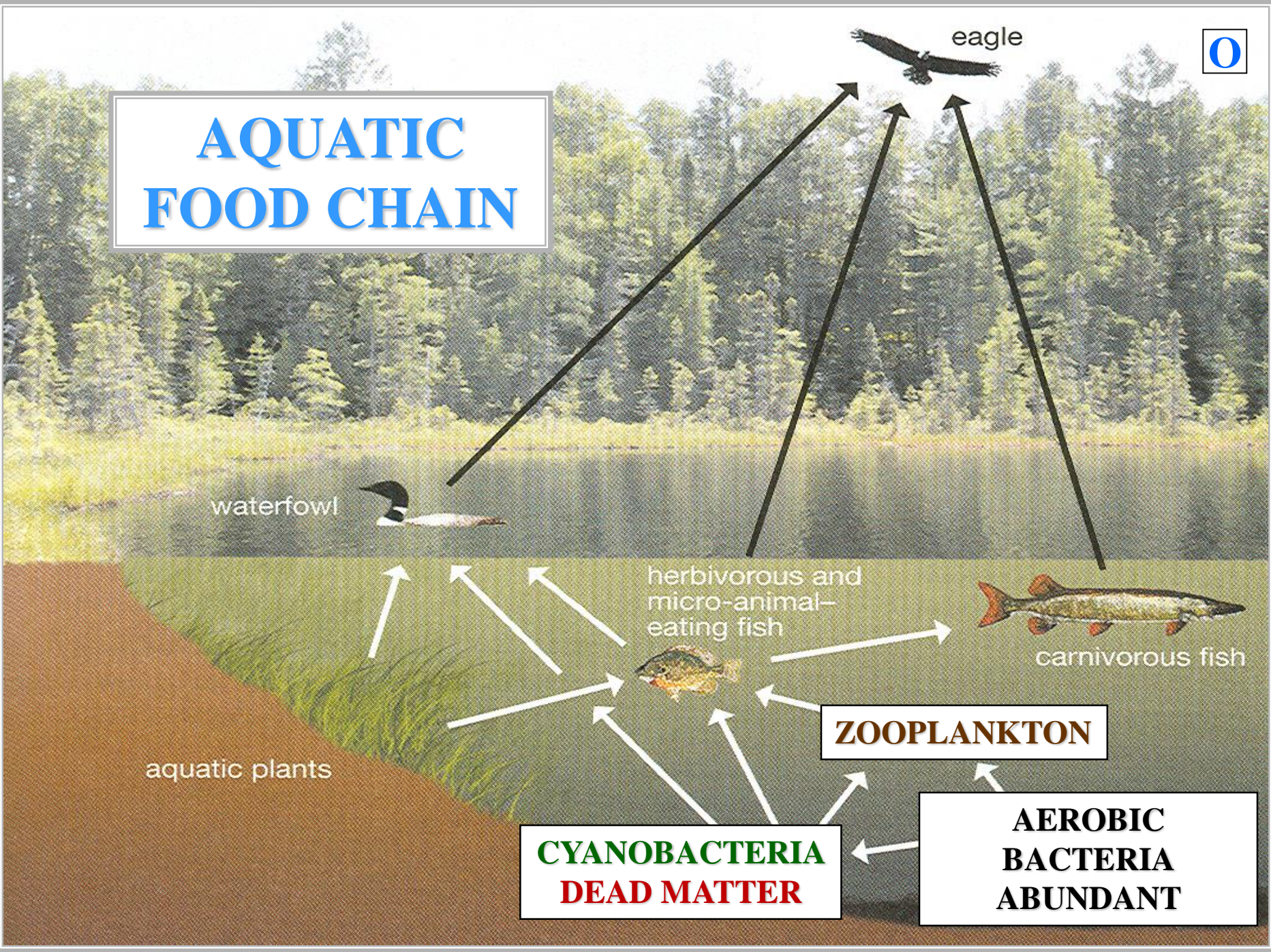
aquatic plants

**ZOOPLANKTON**

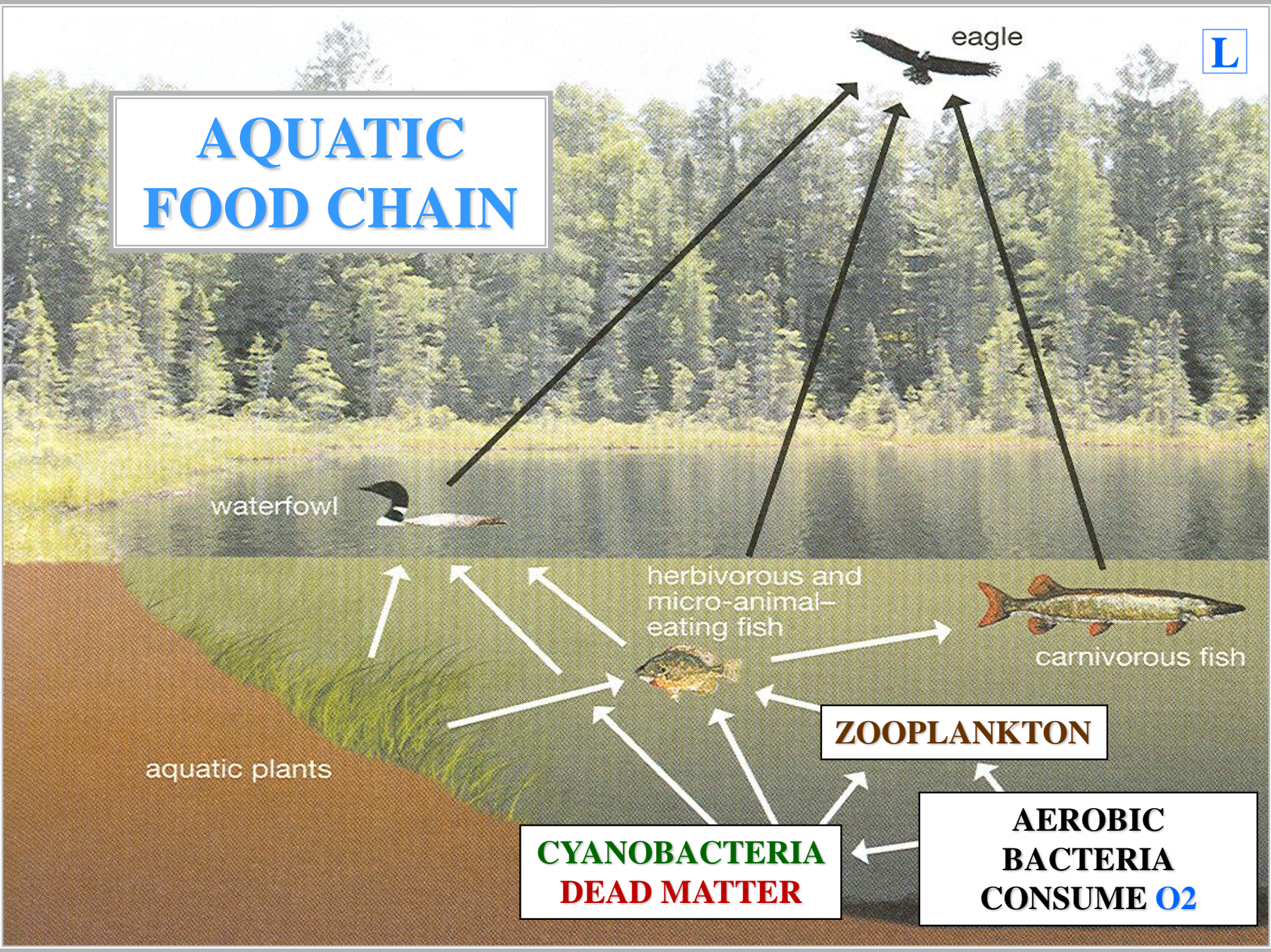
**CYANOBACTERIA  
DEAD MATTER**

**AEROBIC  
BACTERIA  
DECOMPOSERS**

# AQUATIC FOOD CHAIN



# AQUATIC FOOD CHAIN



waterfowl

eagle

herbivorous and  
micro-animal-  
eating fish

carnivorous fish

aquatic plants

**ZOOPLANKTON**

**CYANOBACTERIA**  
**DEAD MATTER**

**AEROBIC  
BACTERIA  
CONSUME O<sub>2</sub>**

# AQUATIC FOOD CHAIN



eagle

waterfowl

herbivorous and  
micro-animal-  
eating fish

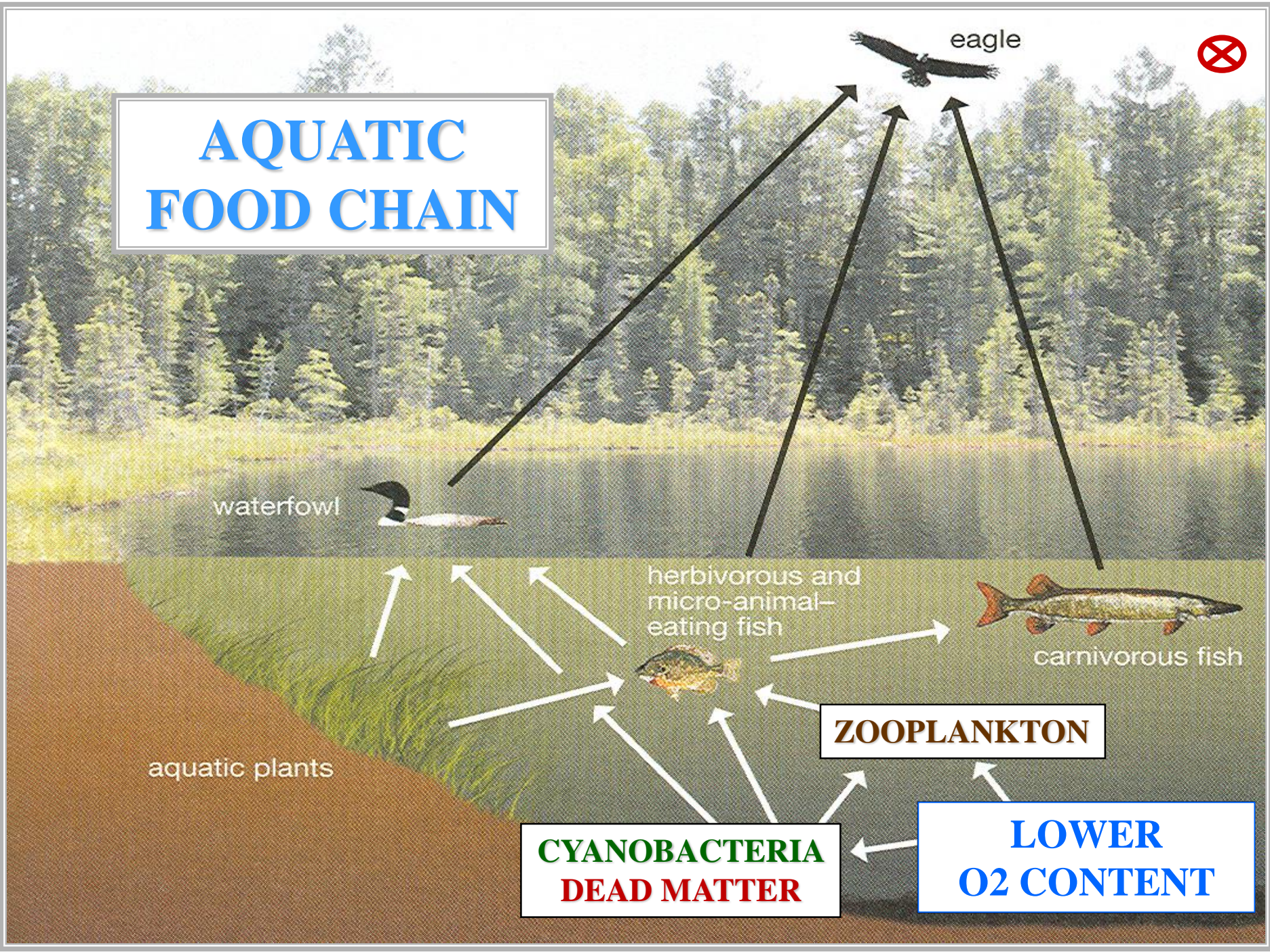
carnivorous fish

aquatic plants

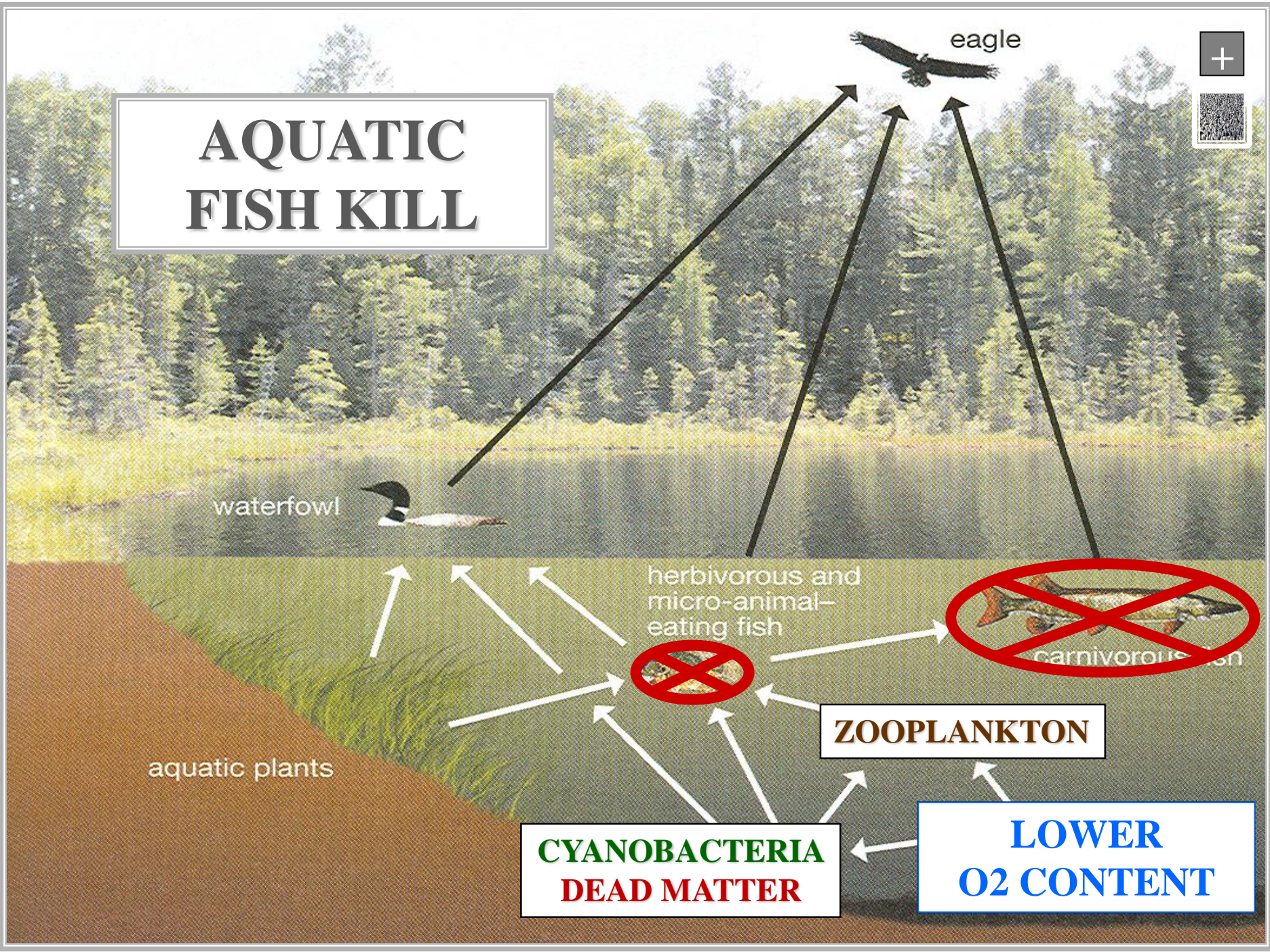
**ZOOPLANKTON**

**CYANOBACTERIA  
DEAD MATTER**

**LOWER  
O2 CONTENT**



# AQUATIC FISH KILL



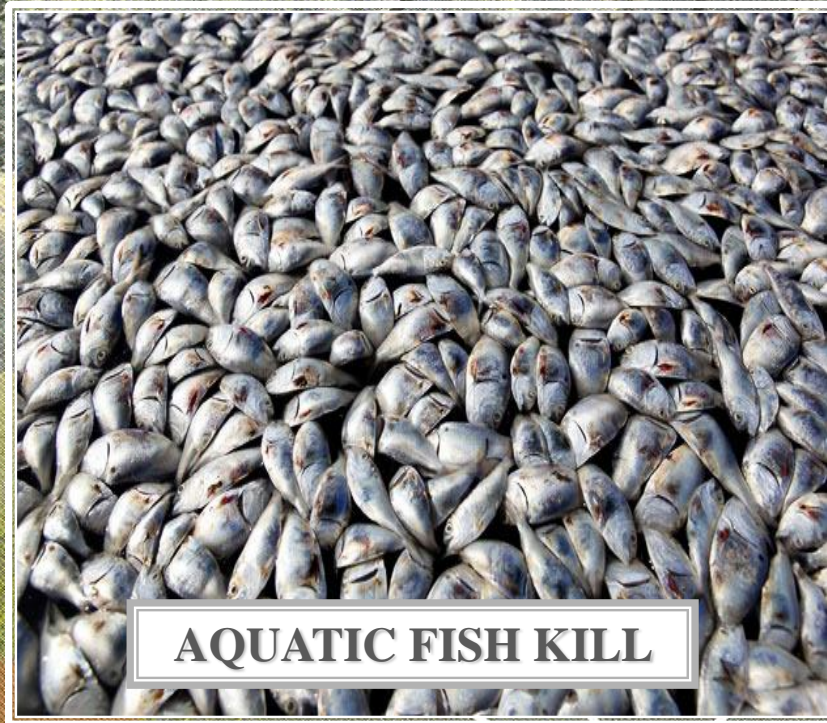


# AQUATIC FISH KILL

eagle

waterfowl

aquatic plants



## AQUATIC FISH KILL



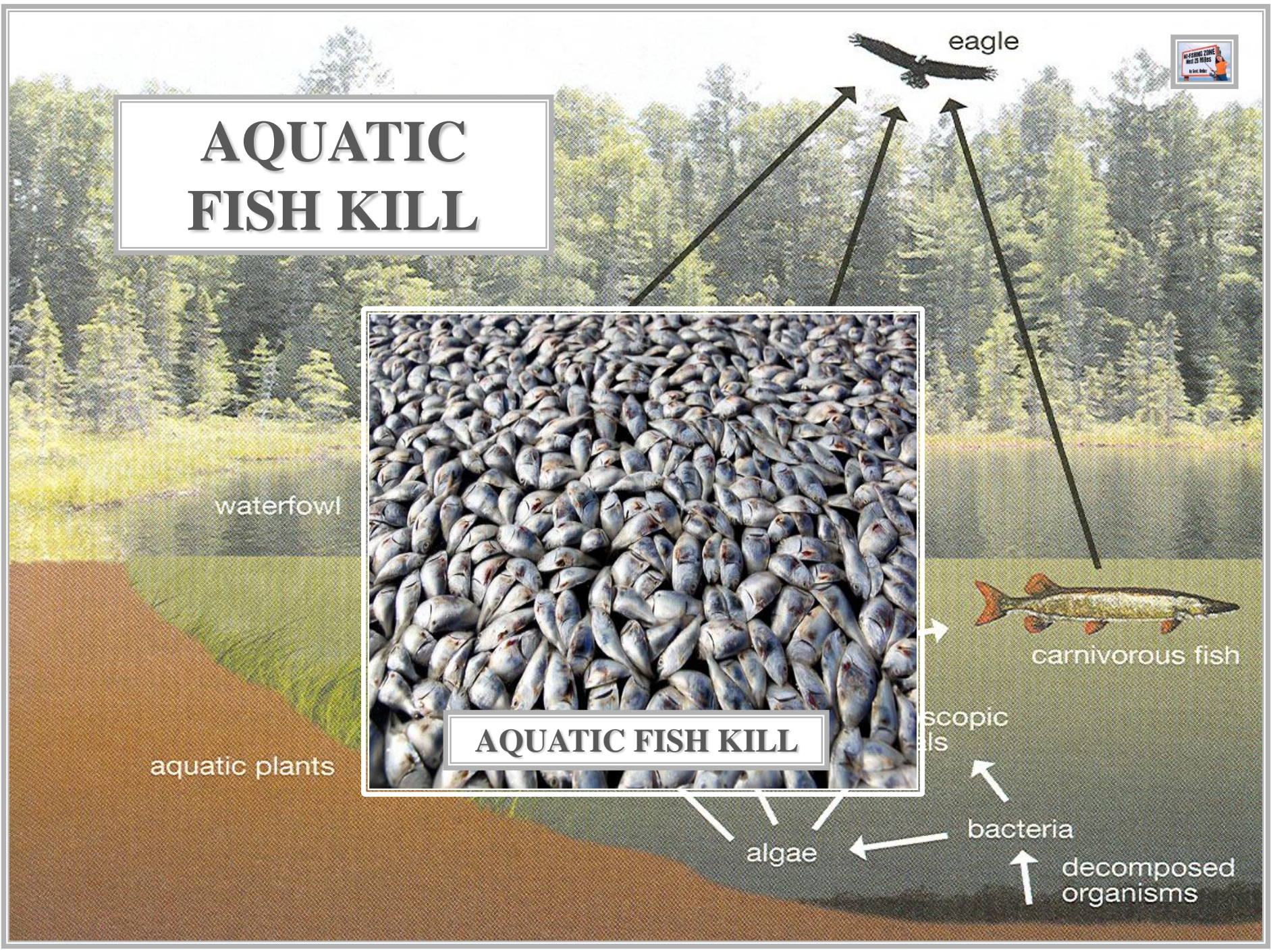
carnivorous fish

microscopic  
algae

algae

bacteria

decomposed  
organisms



# AQUATIC FISH KILL

eagle



waterfowl

aquatic plants

**NO-FISHING ZONE**  
**Next 25 Miles**

**By Govt. Order**

**ECONOMIC LOSS**



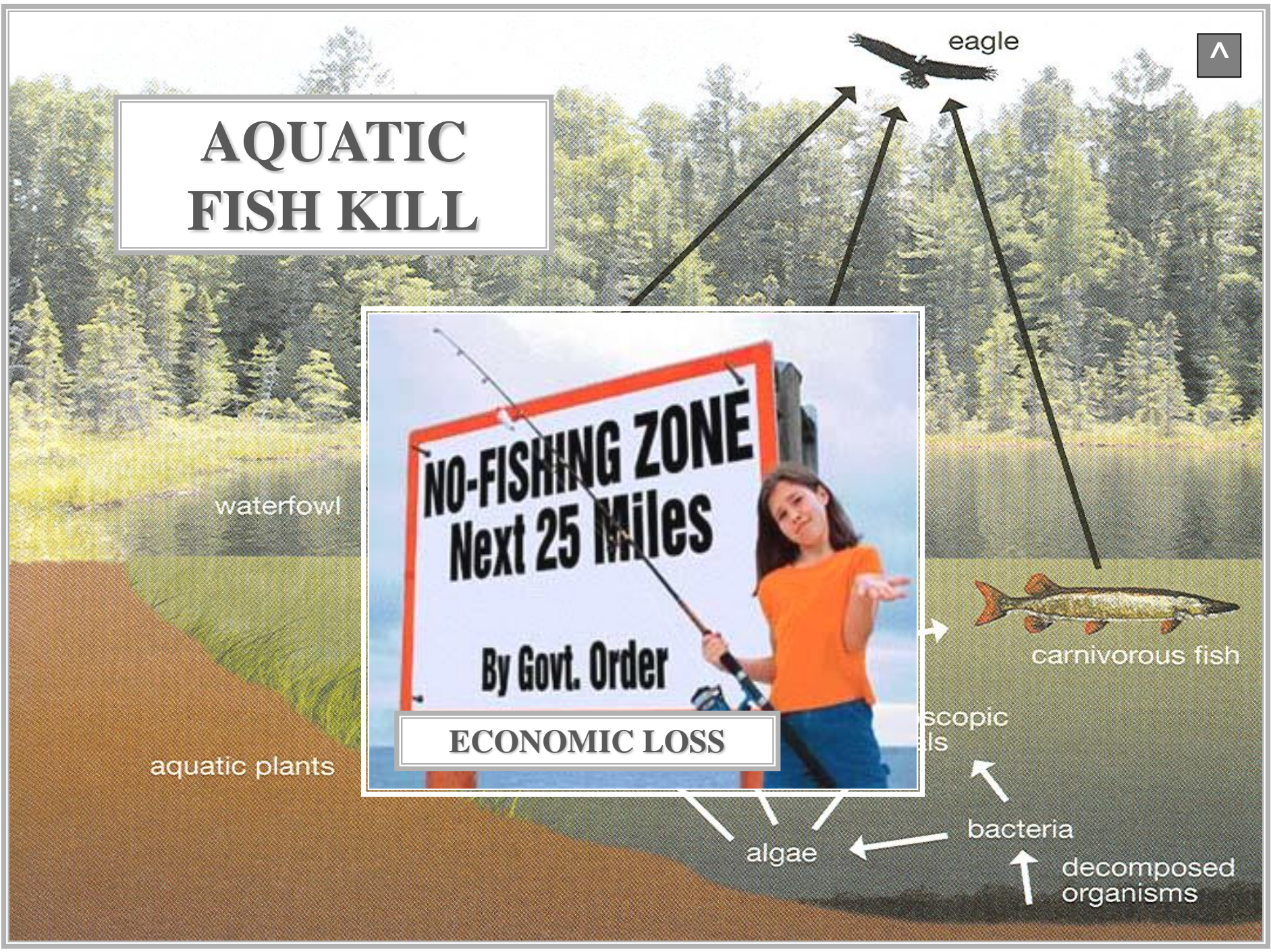
carnivorous fish

microscopic  
algae

algae

bacteria

decomposed  
organisms



# NITROGEN FIXATION



# **NITROGEN FIXATION**

# NITROGEN FIXATION

NITROGEN GAS  
CONVERTED VIA  
NITROGENASE  
TO NITRATES

# NITROGEN FIXATION

**NITROGENASE**

**NITROGEN FIXATION**

**N**

**NITROGENASE**

**NITROGEN FIXATION**

**ENZYME**

**NITROGEN FIXATION**

**NITROGENASE**

**NITRATES**

# **NITROGEN FIXATION NITRATES**



## **NITROGEN BASED COMPOUNDS**

# **NITROGEN FIXATION NITRATES**

**NITROGEN FIXATION**

**NITRATES**

**NITROGEN**

**BASED COMPOUNDS**

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**REQUIRED**

**ALL ORGANISMS**

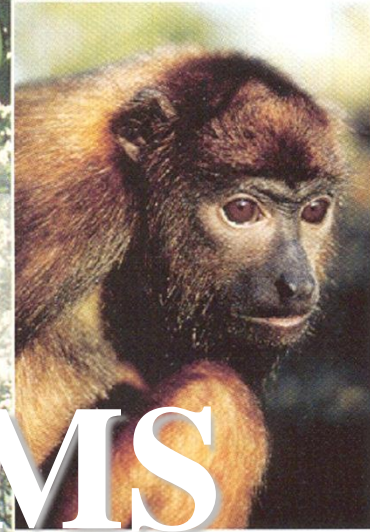
**NITROGEN FIXATION**

**NITRATES**





E

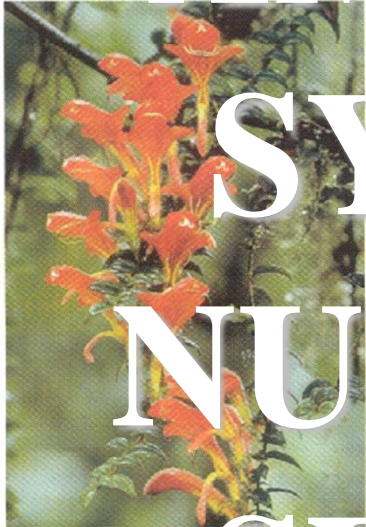
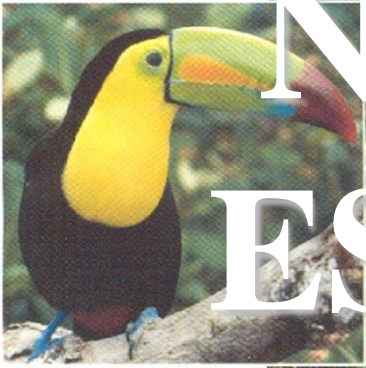


NITRATES  
REQUIRED  
ALL  
LIVING  
ORGANISMS





E



NITRATES

ESSENTIAL

AMINO ACID

SYNTHESIS

NUCLEOTIDE

SYNTHESIS



A microscopic image showing several chains of cyanobacteria. The chains are composed of numerous small, spherical cells, some of which are larger and more distinct than others. The overall color is a vibrant green, and the background is a lighter, slightly hazy green. The chains are arranged in a somewhat circular pattern across the frame.

# CYANOBACTERIA CONDUCT NITROGEN FIXATION

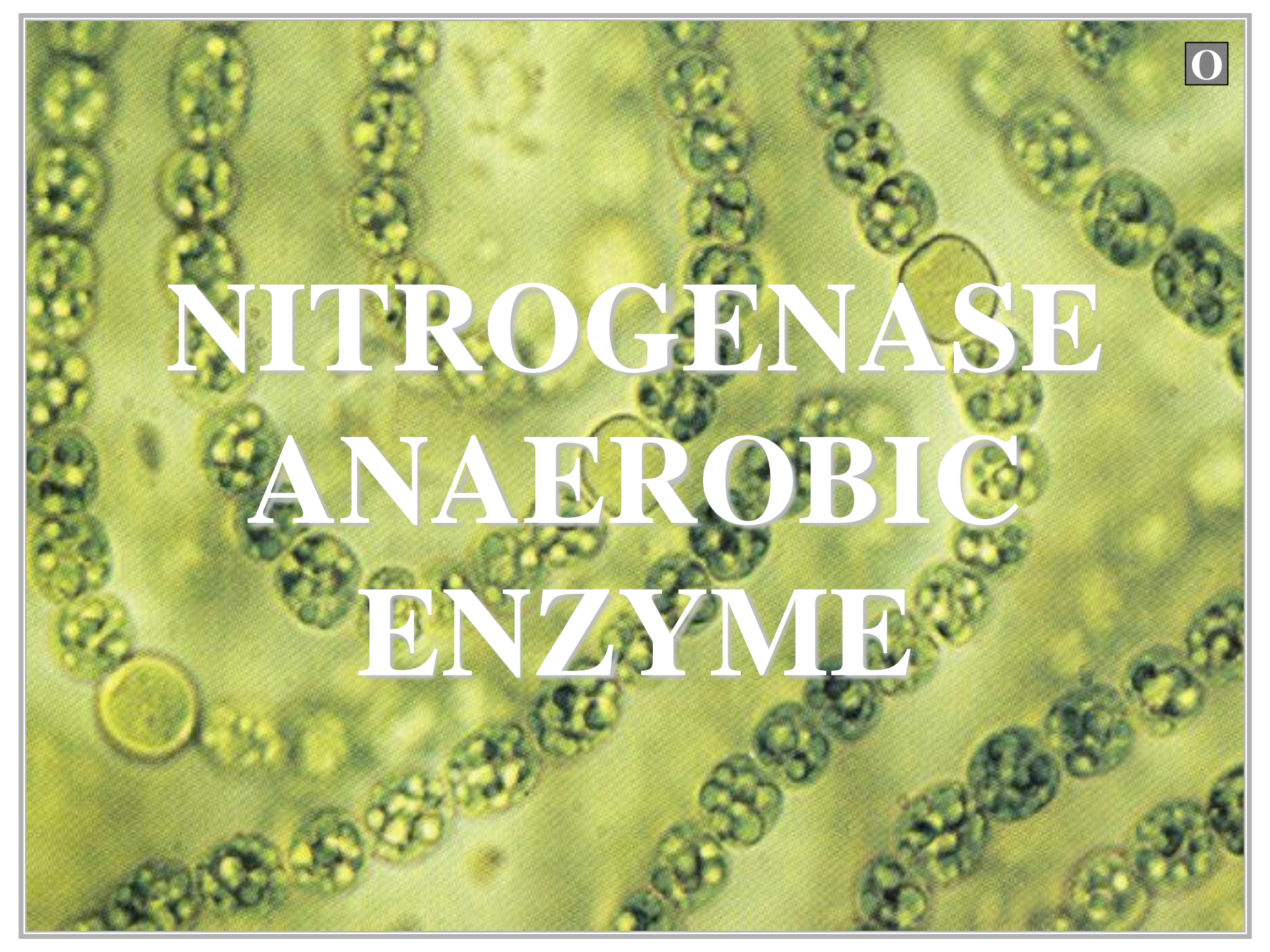


# NITROGENASE

A microscopic image showing several chains of cyanobacteria. The chains are composed of small, spherical cells, some of which are larger and more distinct than others. The overall color is a pale greenish-yellow. The chains are arranged in a somewhat parallel fashion, with some cells appearing to be in different stages of division or having different internal structures.

**NITROGENASE**

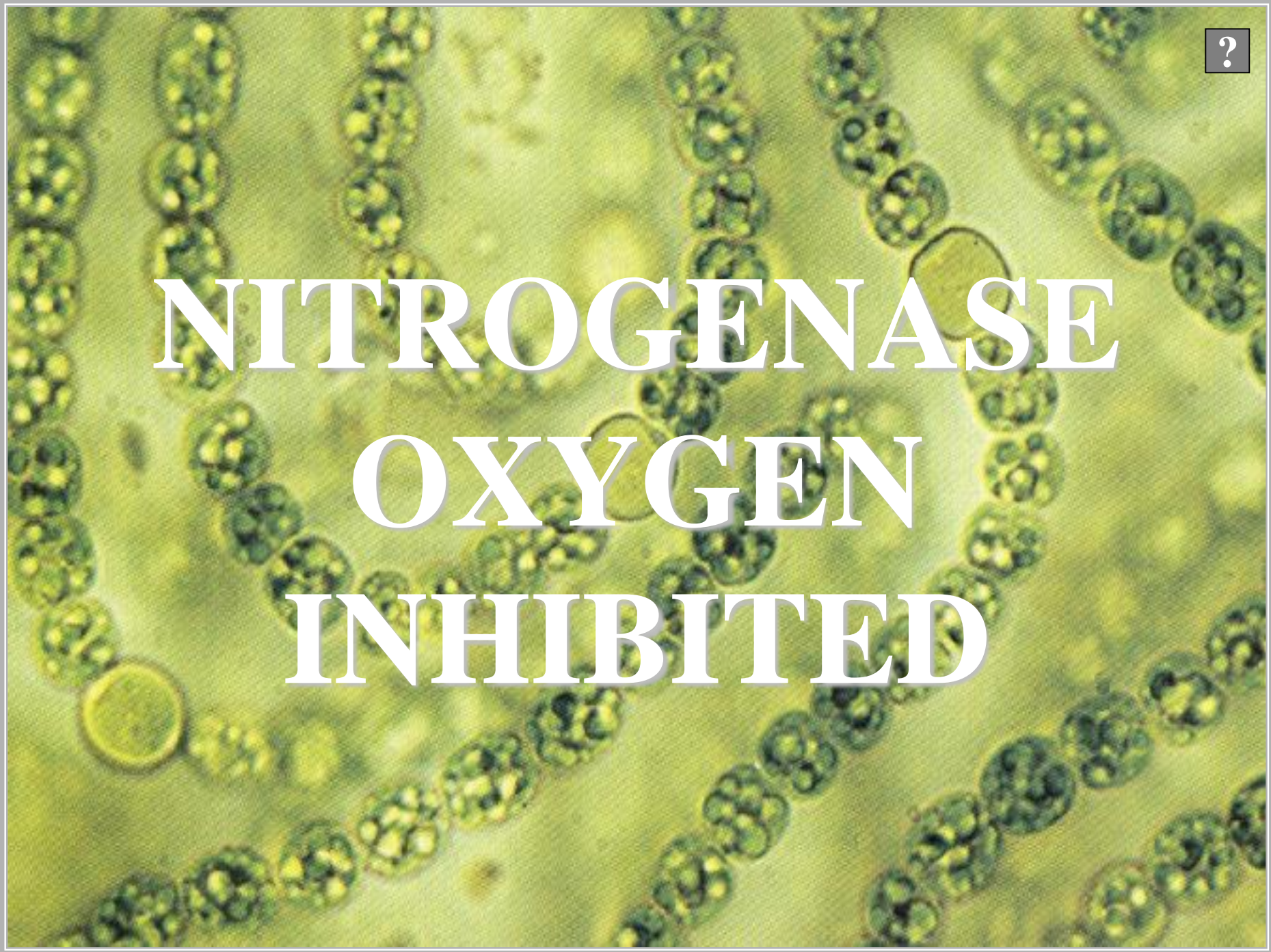
**$N_2$  GAS  $\rightarrow$  NITRATES**

A microscopic view of green algae cells, showing several chains of spherical cells. The cells are arranged in parallel lines, and each cell contains internal structures, likely chloroplasts, giving them a greenish-yellow appearance. The background is a light, yellowish-green color.

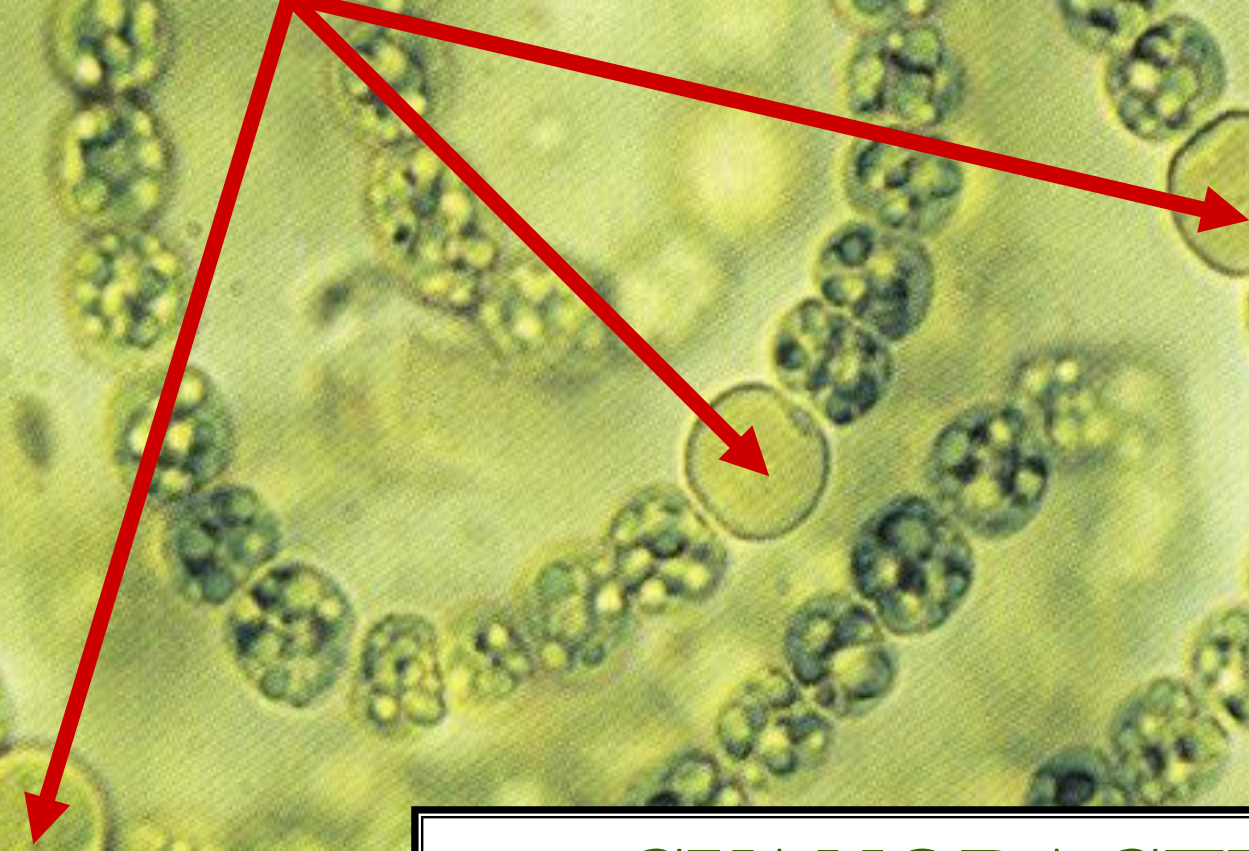
# NITROGENASE ANAEROBIC ENZYME



# NITROGENASE OXYGEN INHIBITED



?



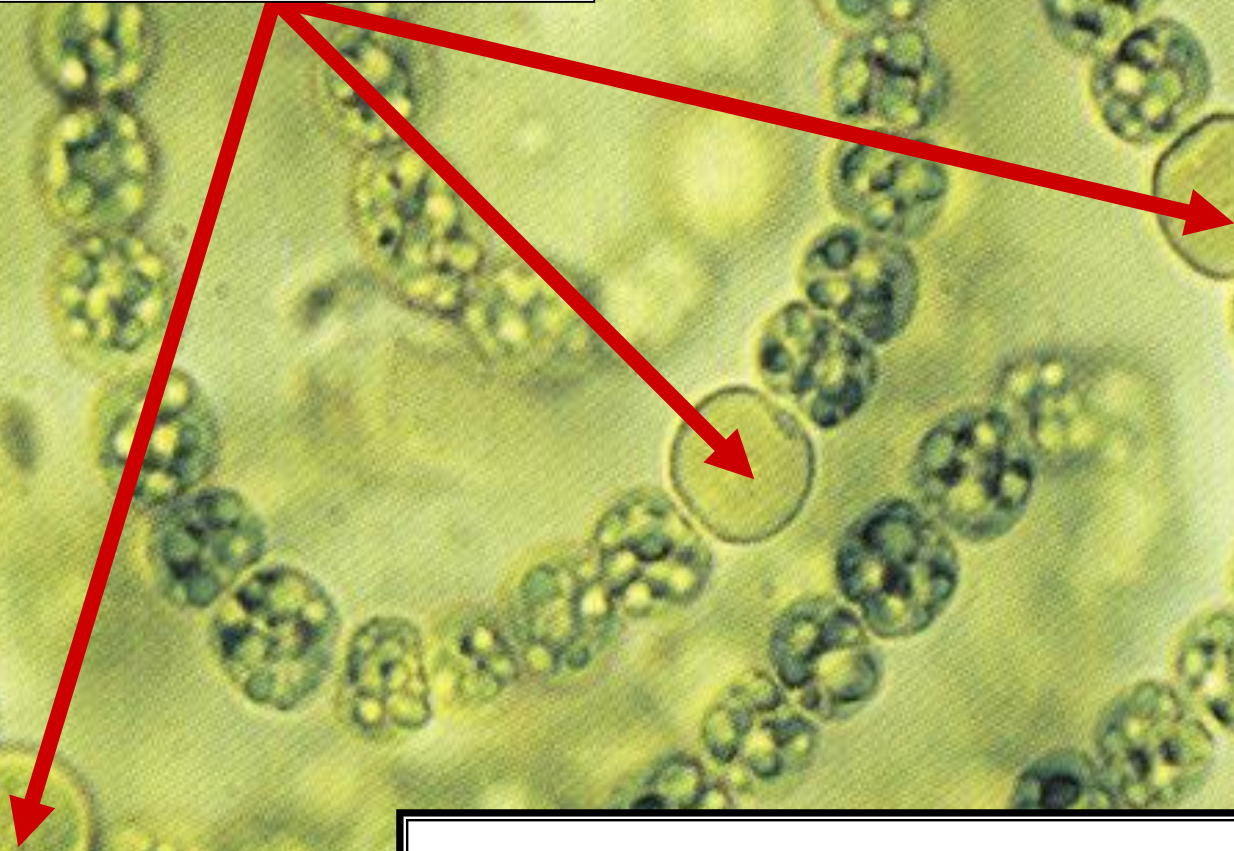
**CYANOBACTERIA**

**BLUE-GREEN BACTERIA**





**HETEROCYSTS**



**CYANOBACTERIA**

**BLUE-GREEN BACTERIA**

# HETERO CYST

**HETERO CYST**

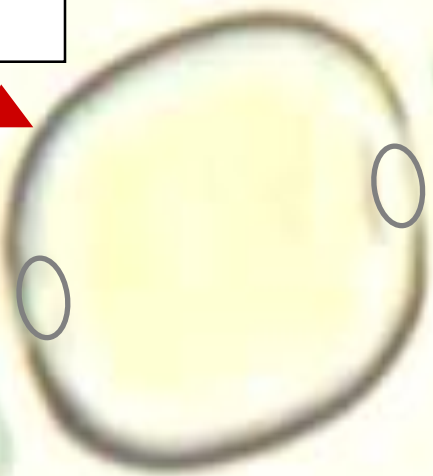
**HETEROCYST**



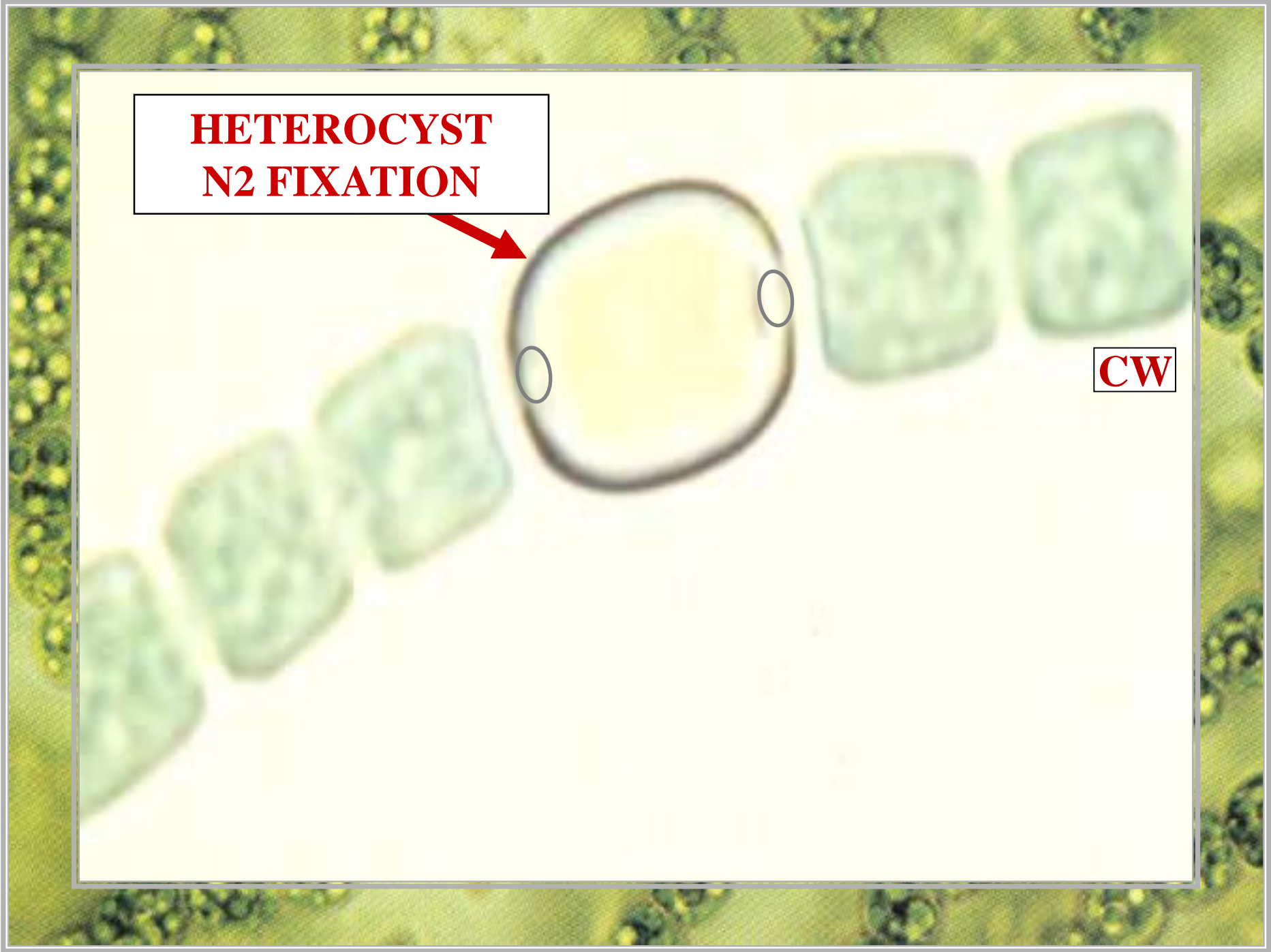
**MODIFIED CELL  
CONDUCTS  
NITROGEN FIXATION**

**HETEROCYST**

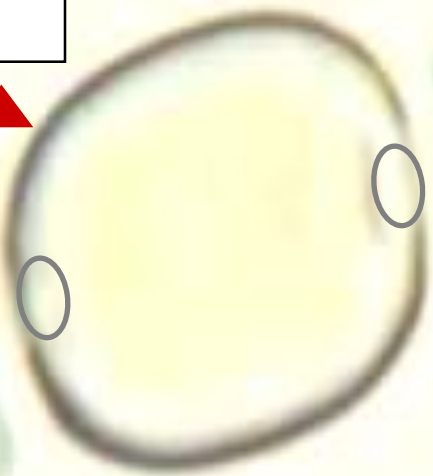
**HETEROCYST  
N<sub>2</sub> FIXATION**



**CW**

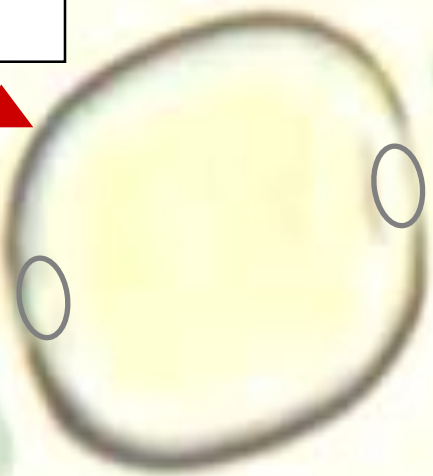


**HETEROCYST  
CELL WALL**



**D**

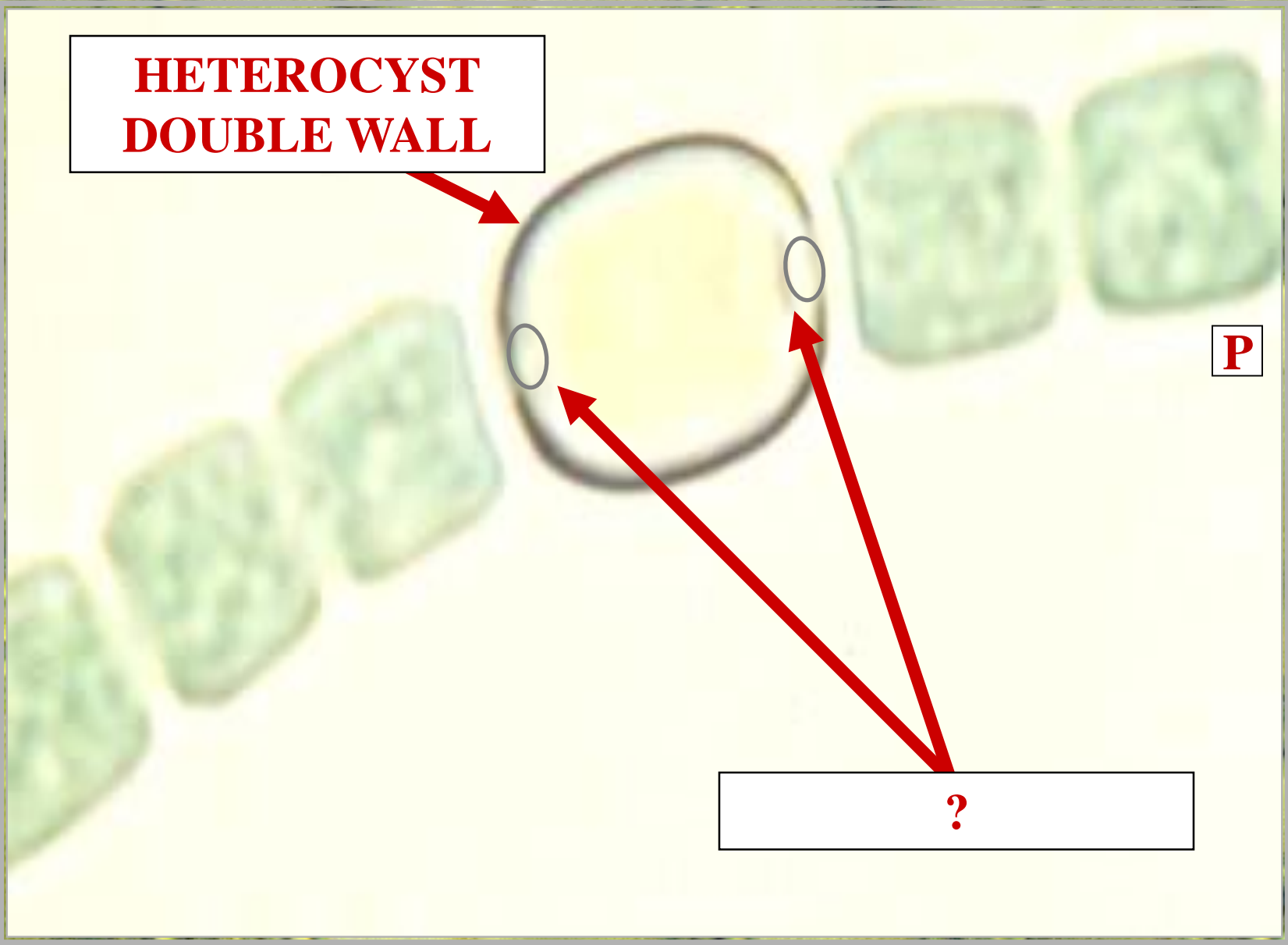
**HETEROCYST  
DOUBLE WALL**



**HETEROCYST  
DOUBLE WALL**

**P**

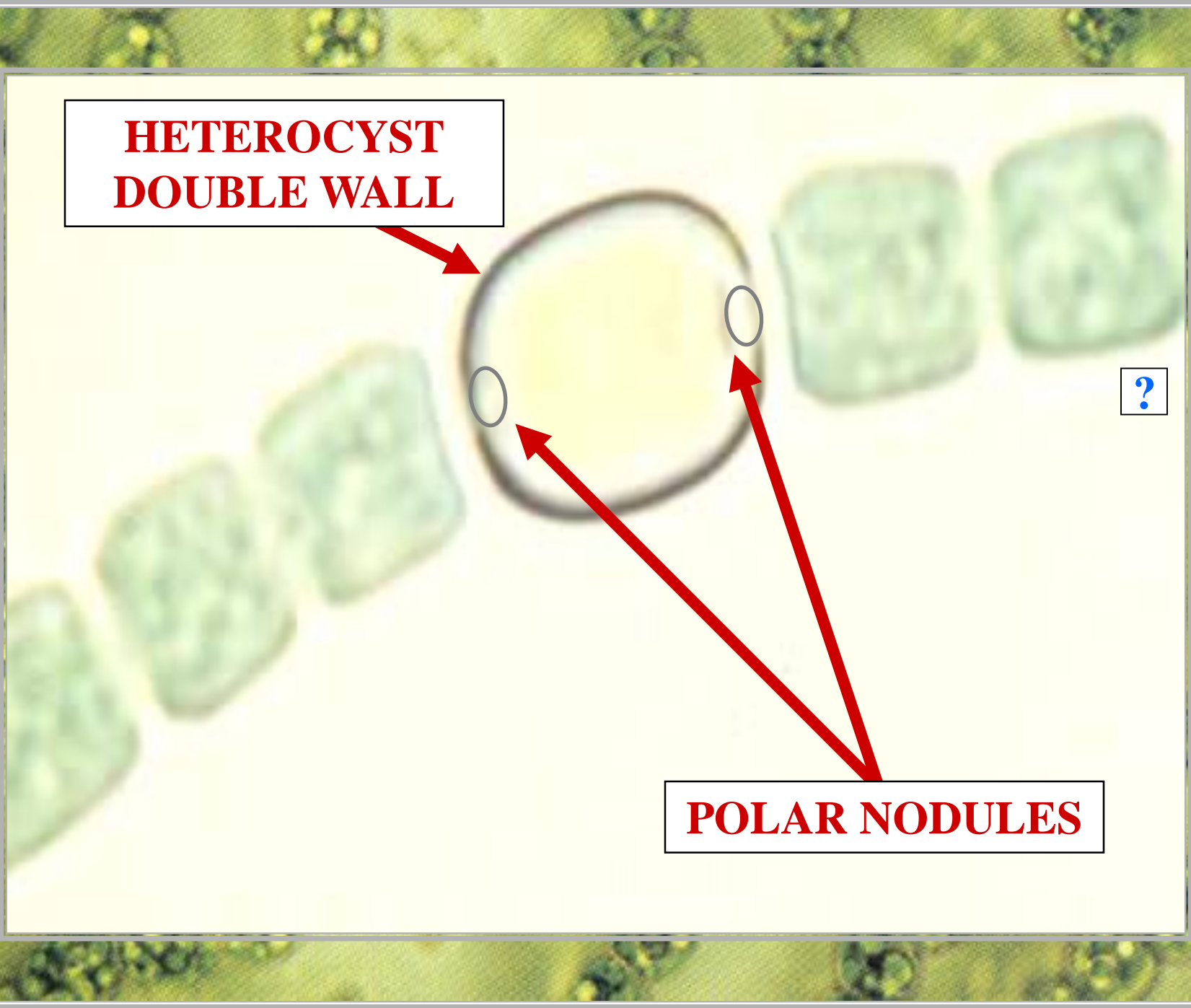
**?**





**HETEROCYST  
DOUBLE WALL**

**POLAR NODULES**

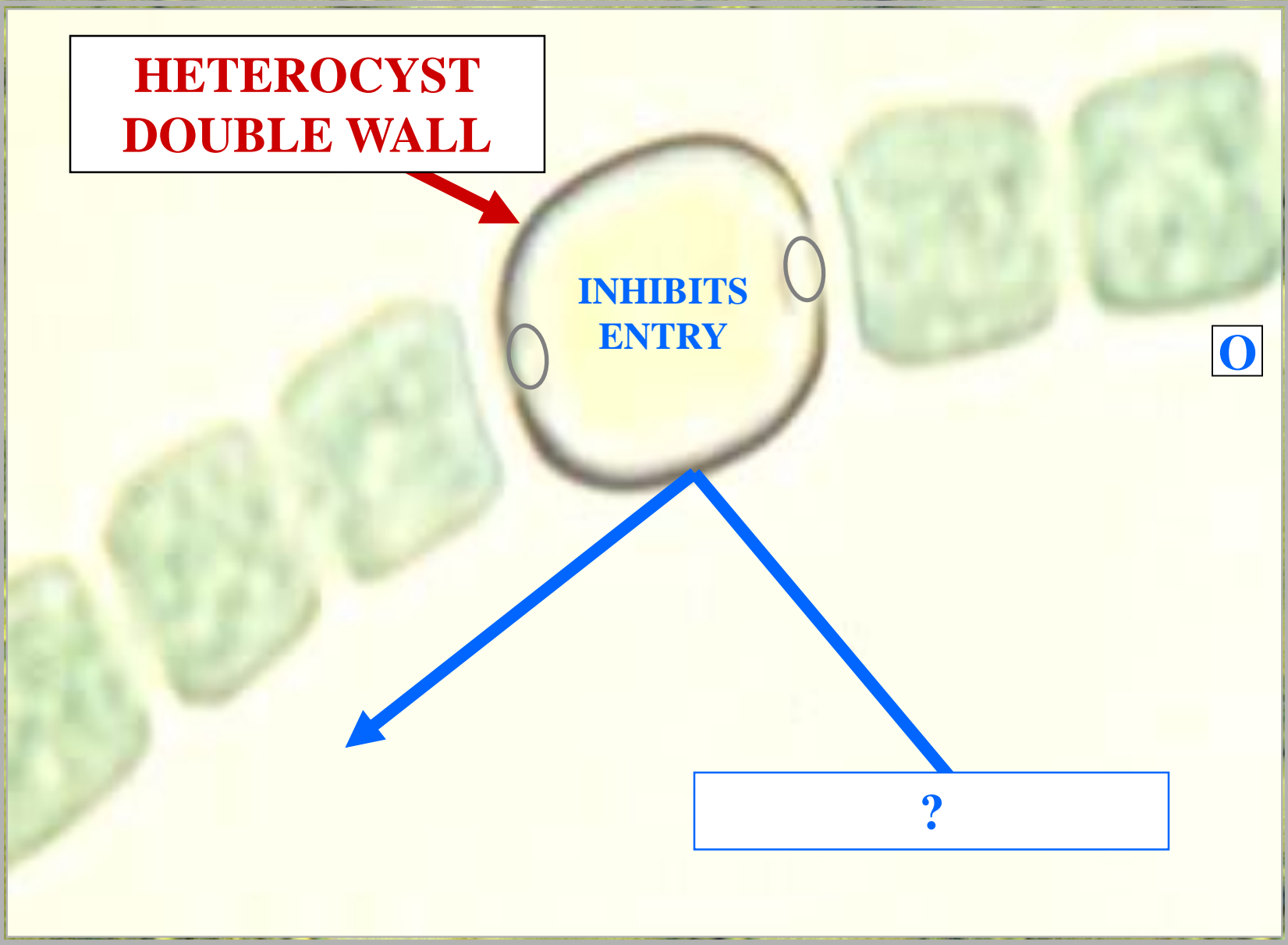


**HETEROCYST  
DOUBLE WALL**

**INHIBITS  
ENTRY**

**O**

**?**

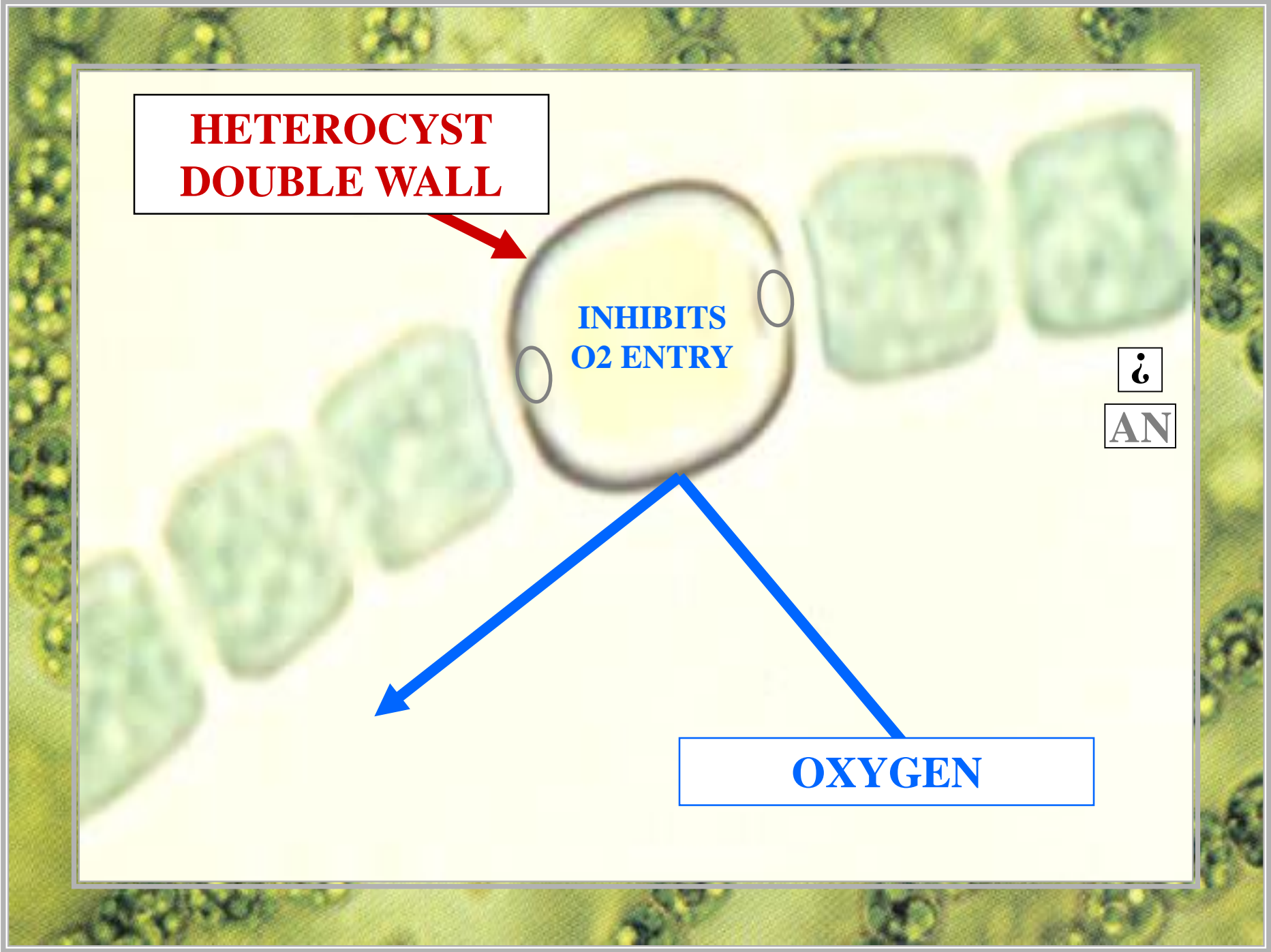


**HETEROCYST  
DOUBLE WALL**

**INHIBITS  
O<sub>2</sub> ENTRY**

**OXYGEN**

**i**  
**AN**

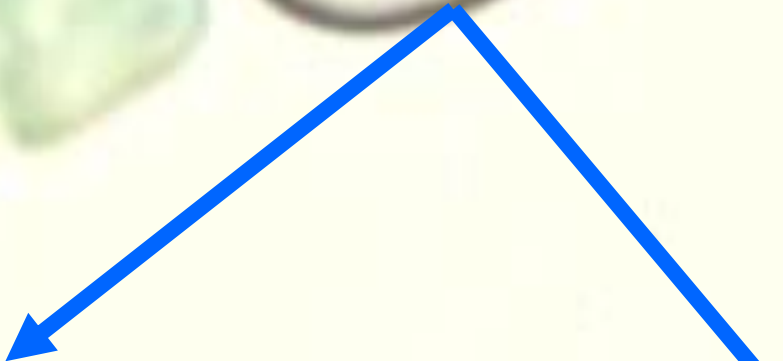


**HETEROCYST  
DOUBLE WALL**

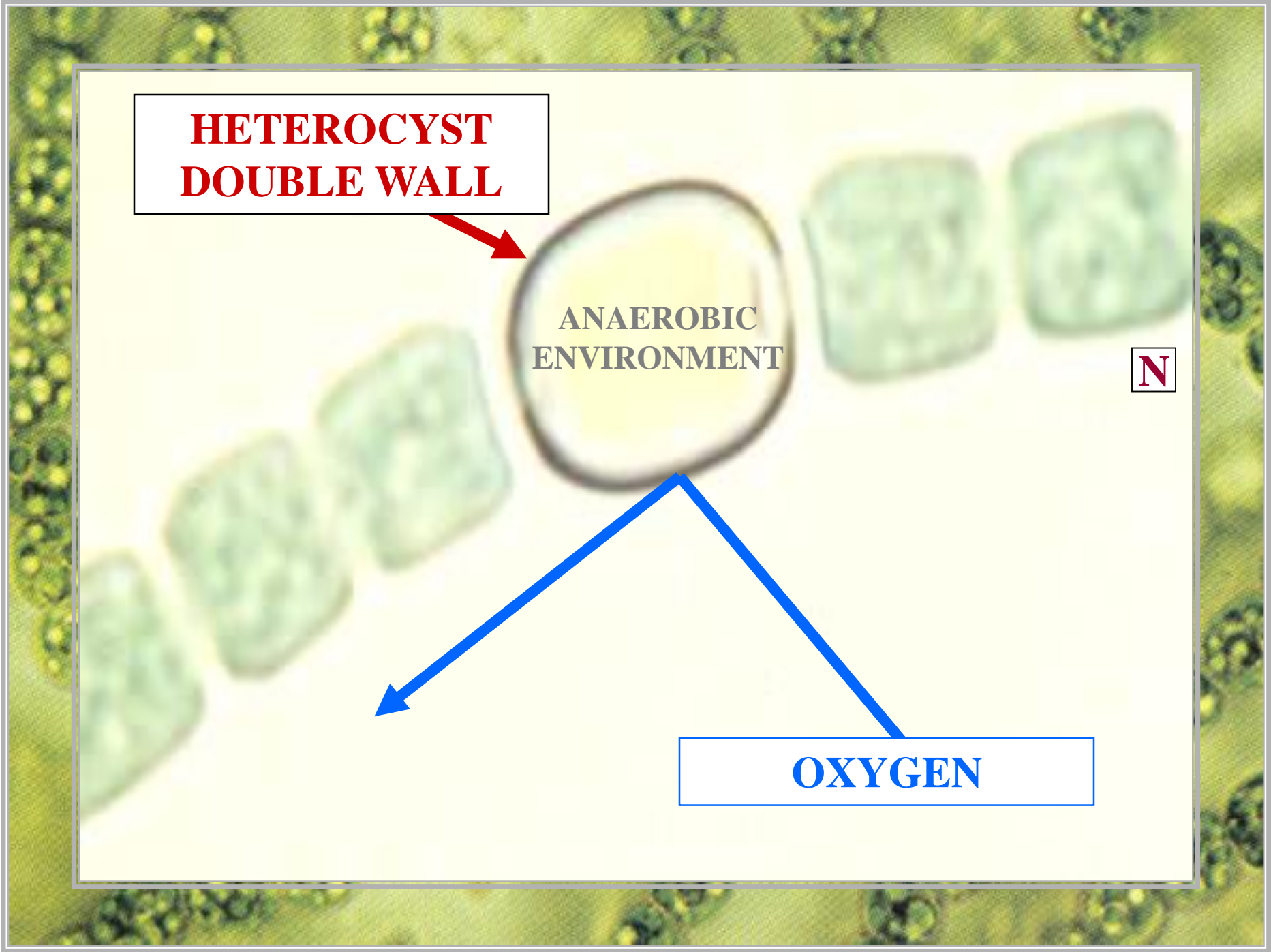


**ANAEROBIC  
ENVIRONMENT**

**N**



**OXYGEN**

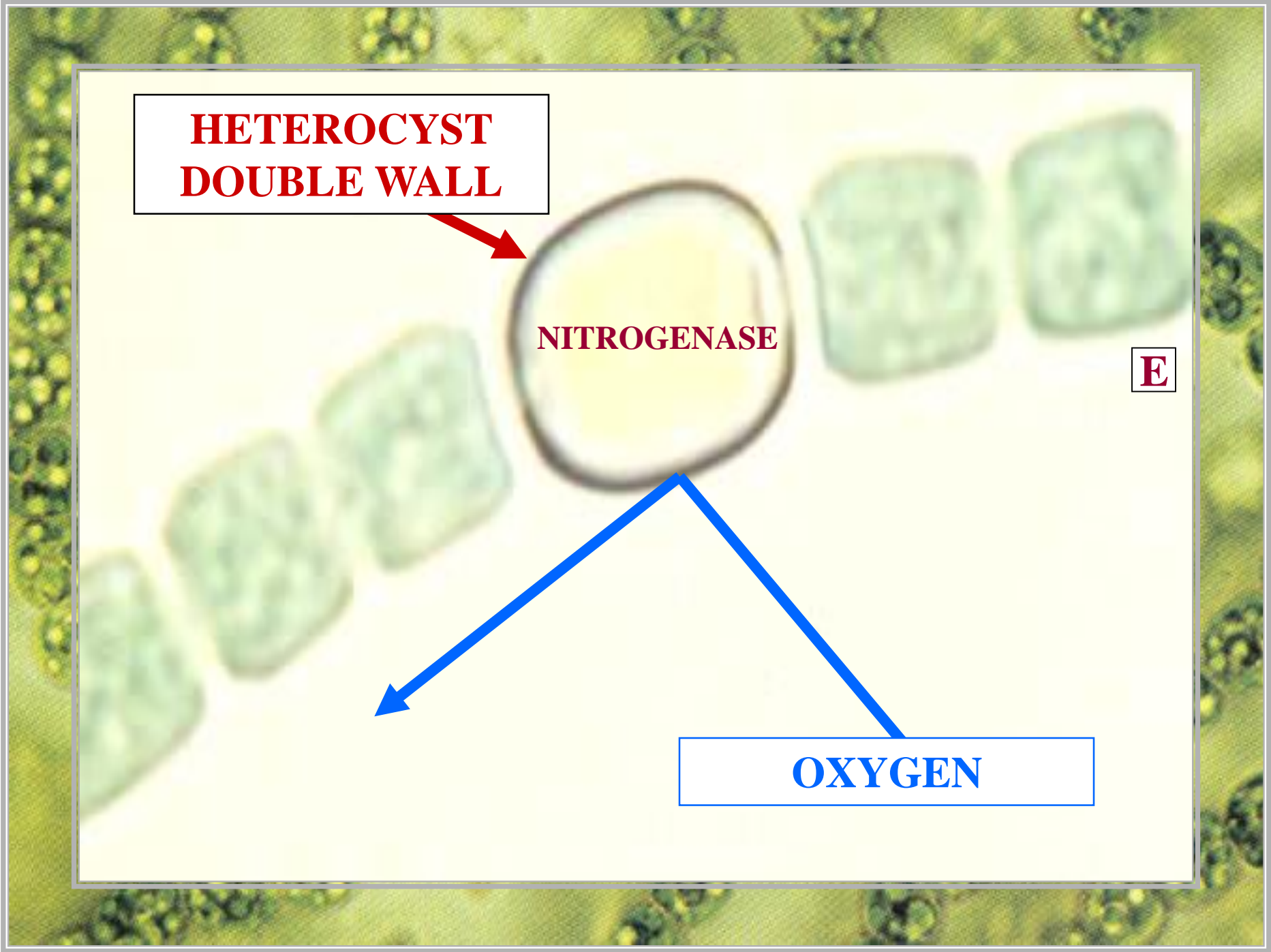


**HETEROCYST  
DOUBLE WALL**

**NITROGENASE**

**E**

**OXYGEN**

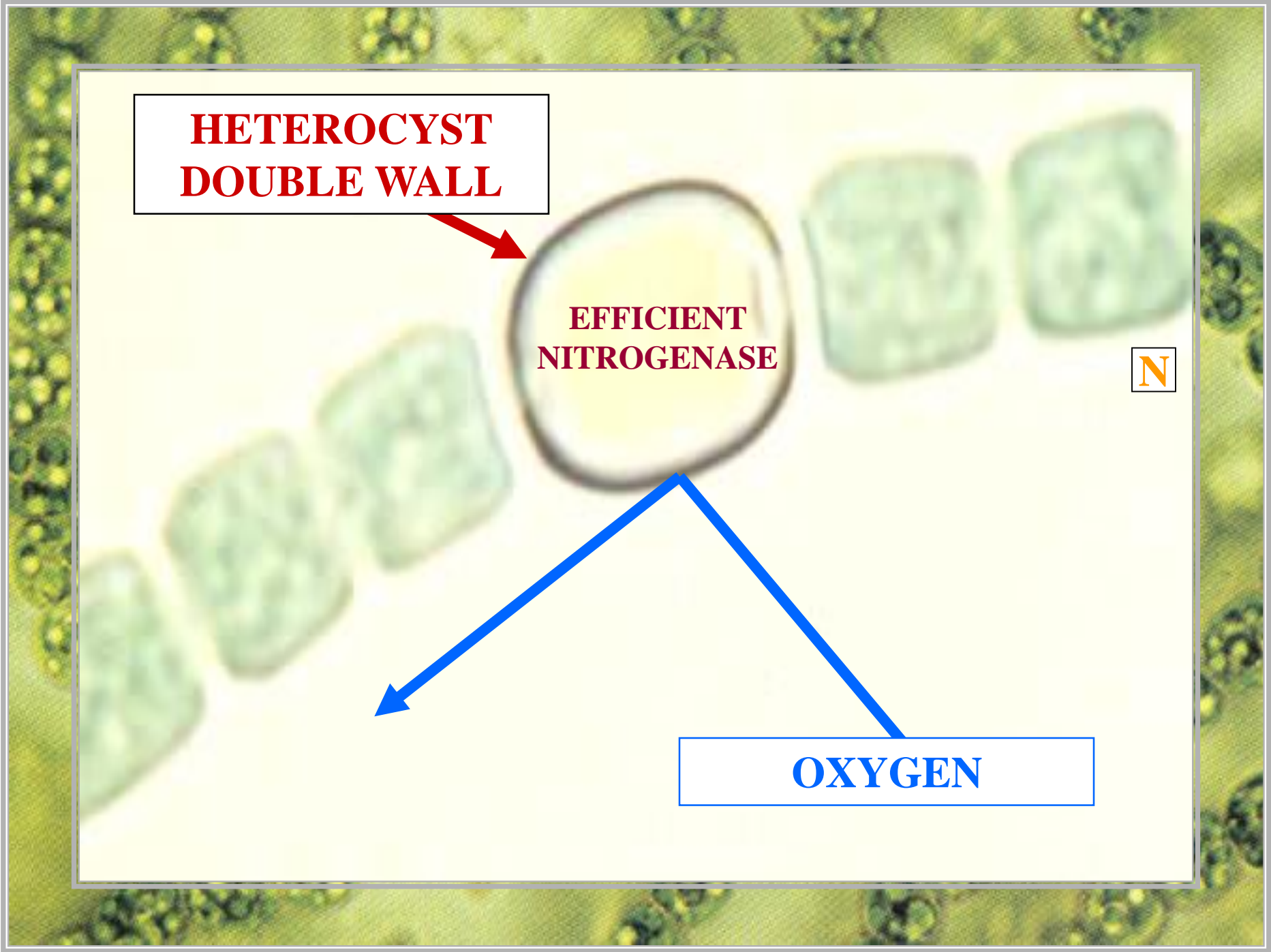


**HETEROCYST  
DOUBLE WALL**

**EFFICIENT  
NITROGENASE**

**N**

**OXYGEN**

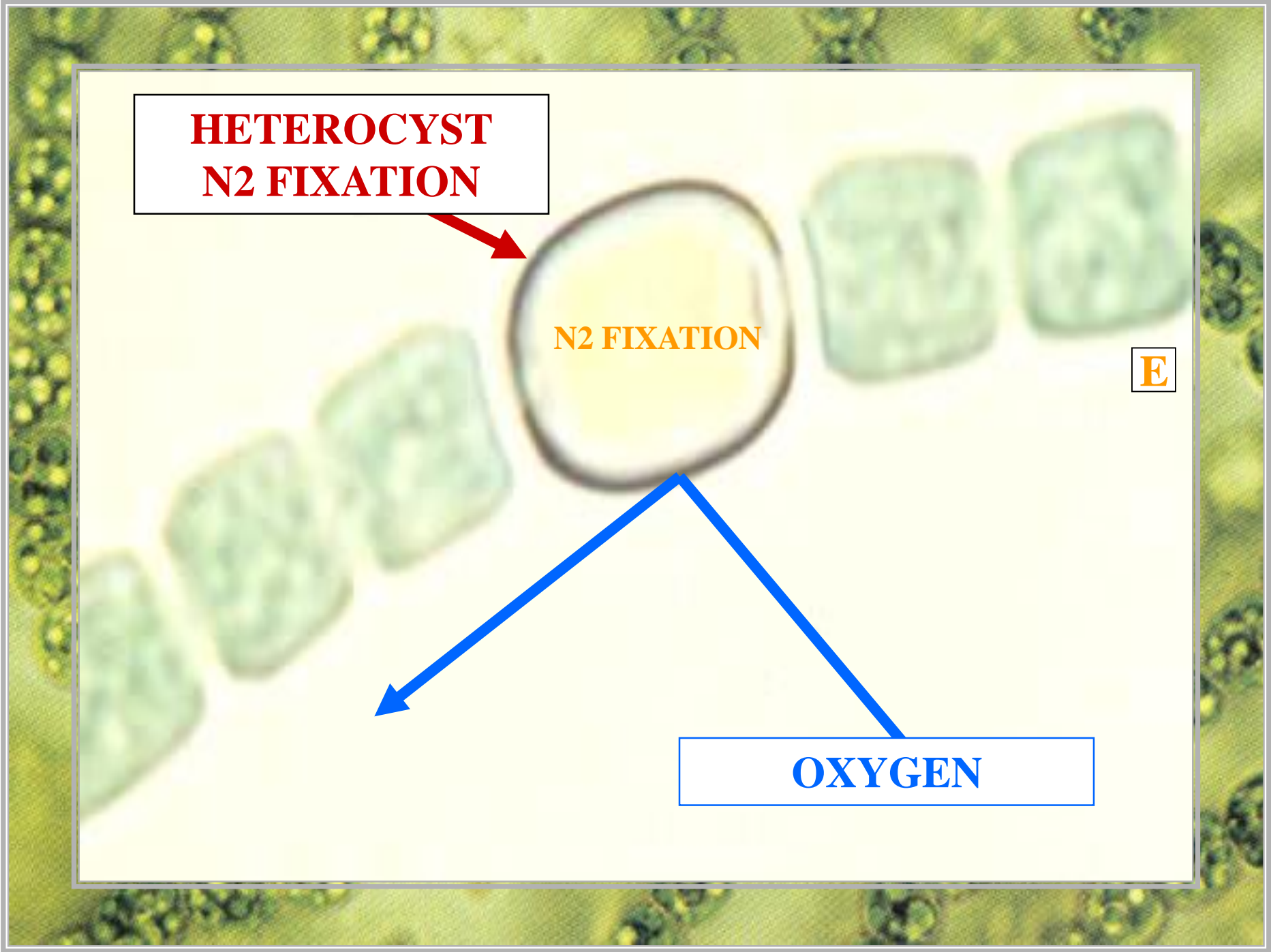


**HETEROCYST  
N<sub>2</sub> FIXATION**

**N<sub>2</sub> FIXATION**

**E**

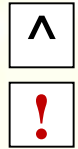
**OXYGEN**



**HETEROCYST  
N<sub>2</sub> FIXATION**

**EFFICIENT  
N<sub>2</sub> FIXATION**

**OXYGEN**





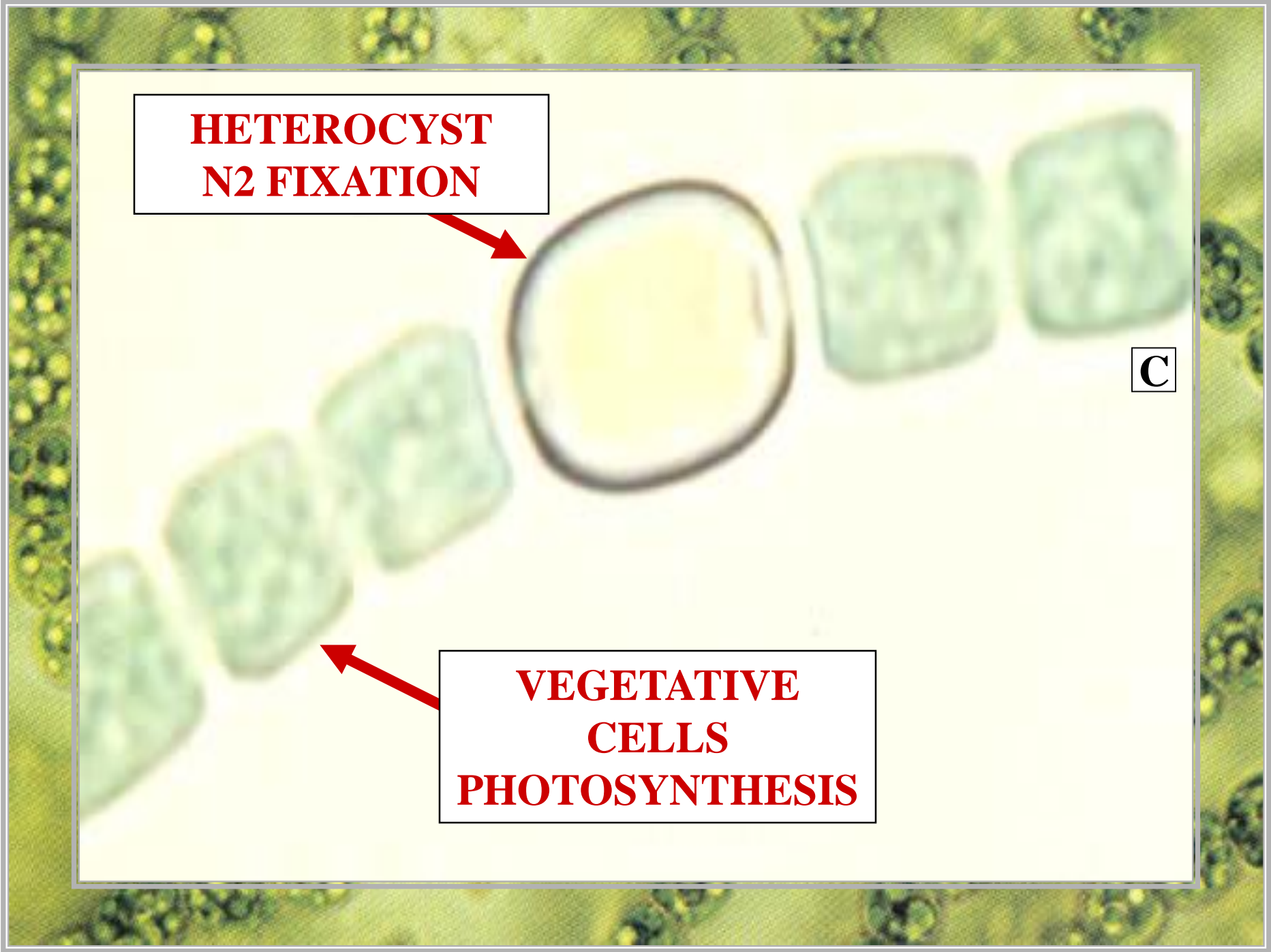
**HETEROCYST  
N<sub>2</sub> FIXATION**



**VEGETATIVE  
CELLS  
PHOTOSYNTHESIS**



**C**

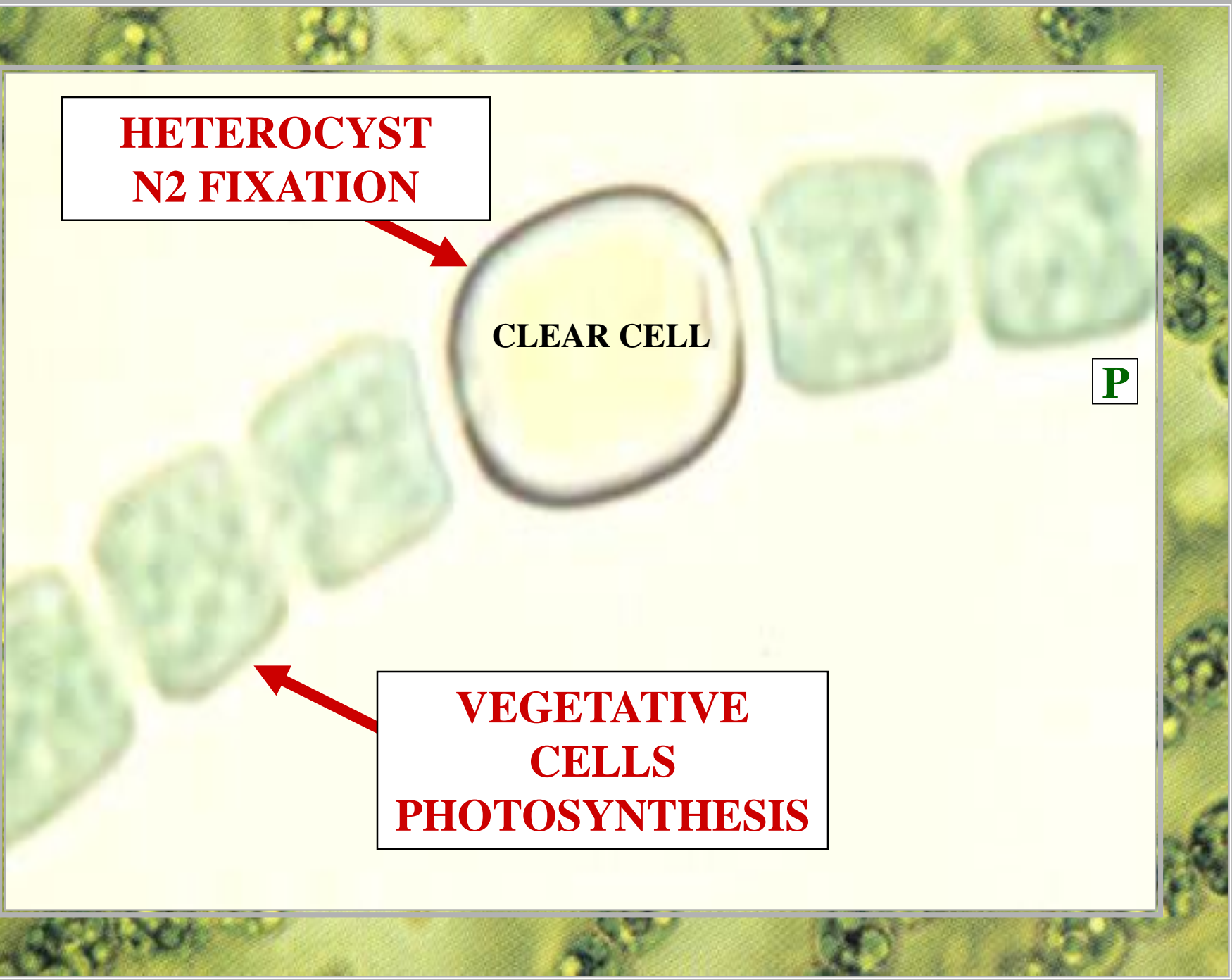


**HETEROCYST  
N<sub>2</sub> FIXATION**

**CLEAR CELL**

**P**

**VEGETATIVE  
CELLS  
PHOTOSYNTHESIS**



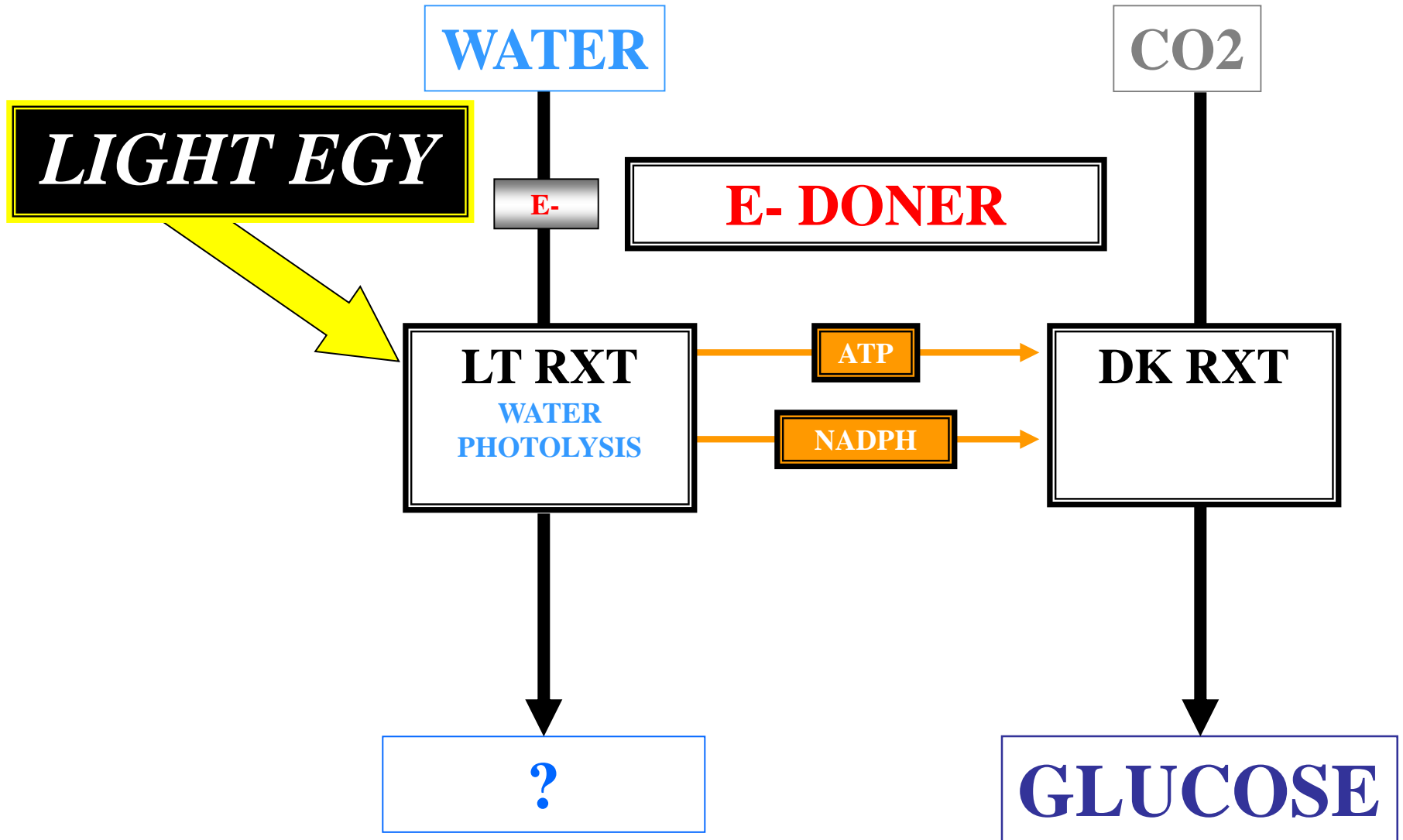
**HETEROCYST  
N<sub>2</sub> FIXATION**

**PSYN  
LIMITED  
LT RXT  
LIMITED**

**VEGETATIVE  
CELLS  
PHOTOSYNTHESIS**



# TRUE CHLOROPHYLL PHOTOSYNTHESIS

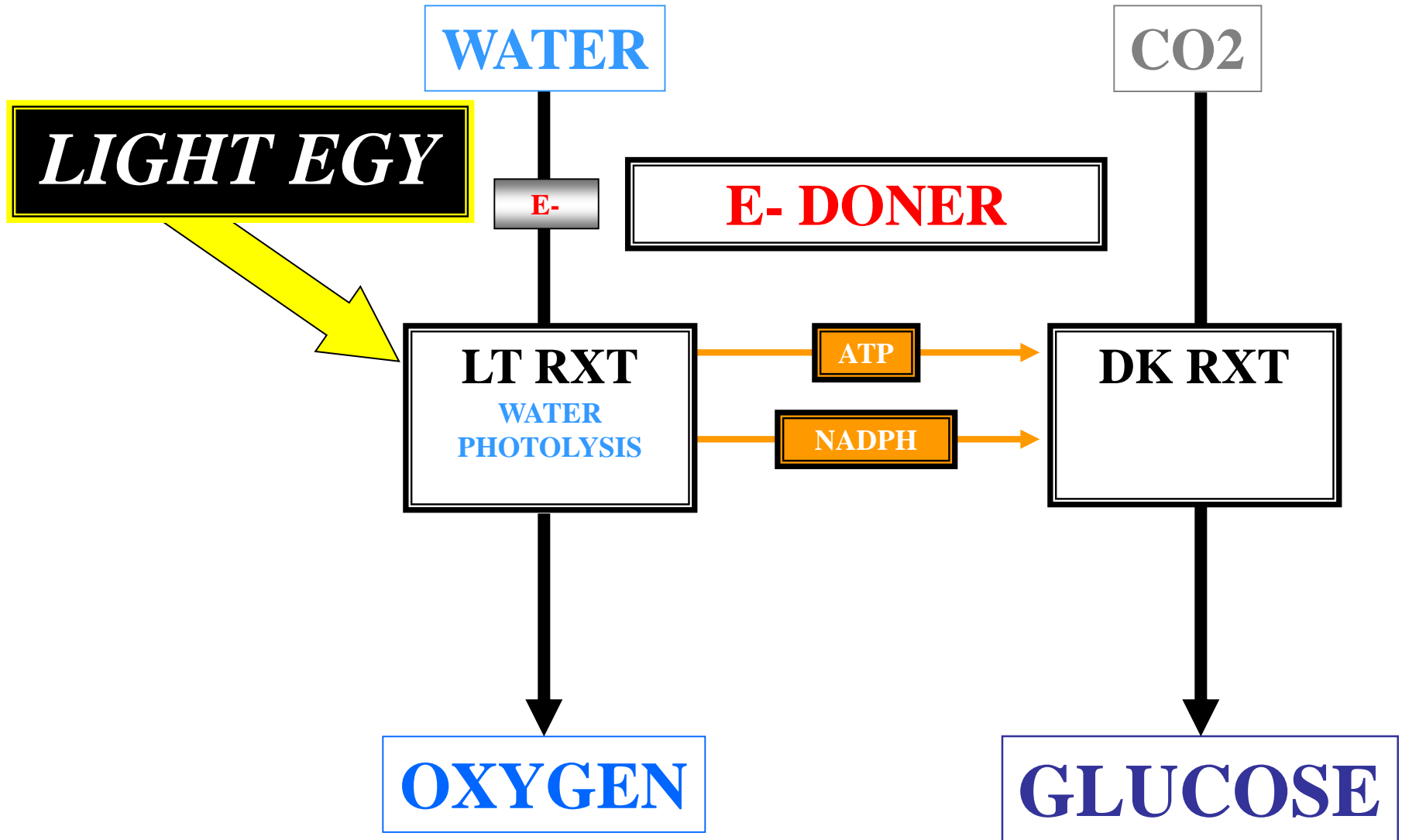


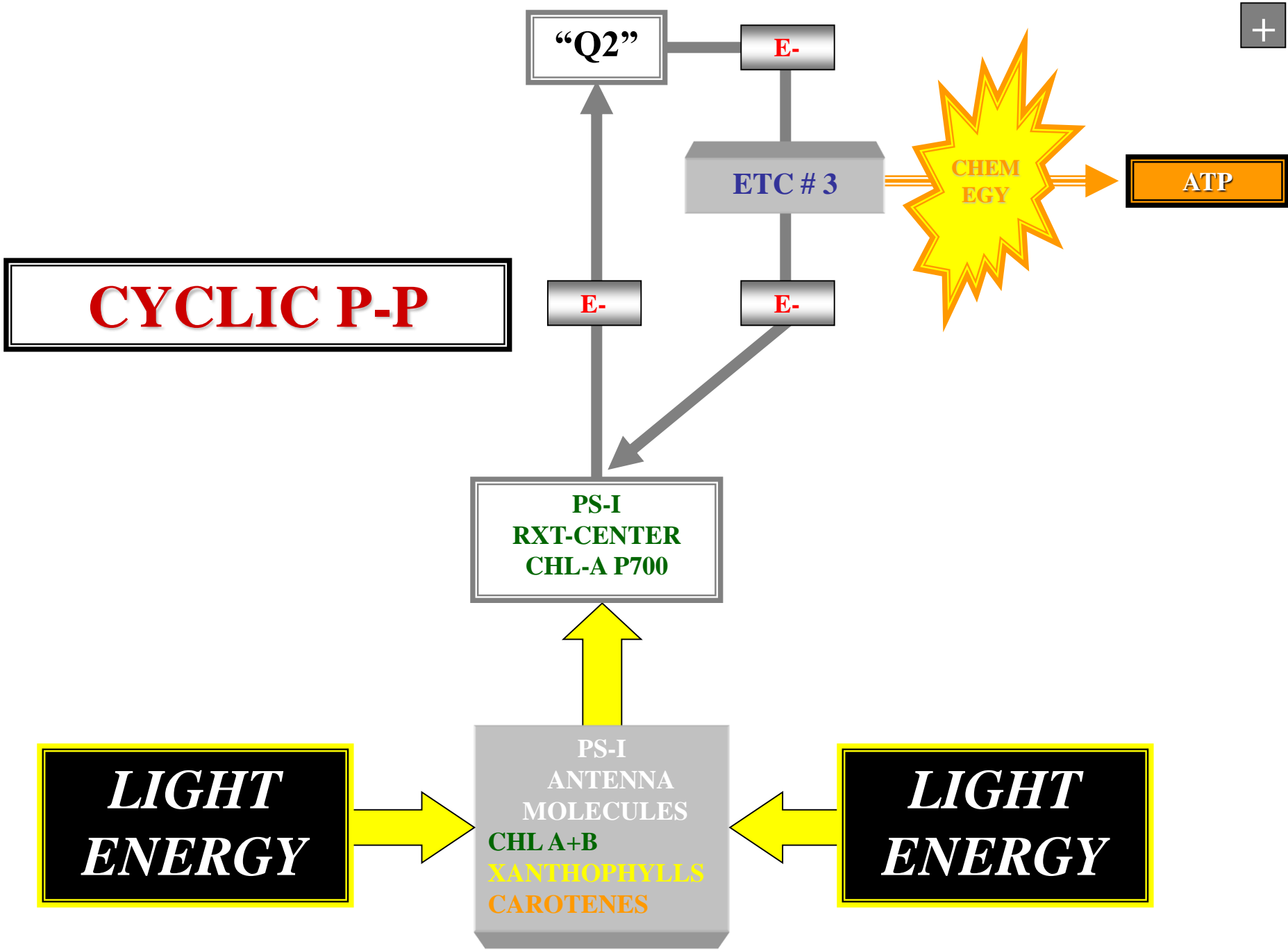
# TRUE CHLOROPHYLL PHOTOSYNTHESIS

LT

?

2





**CYCLIC P-P**

**"Q2"**

**E-**

**ETC # 3**



**ATP**

**+**

**LIGHT ENERGY**

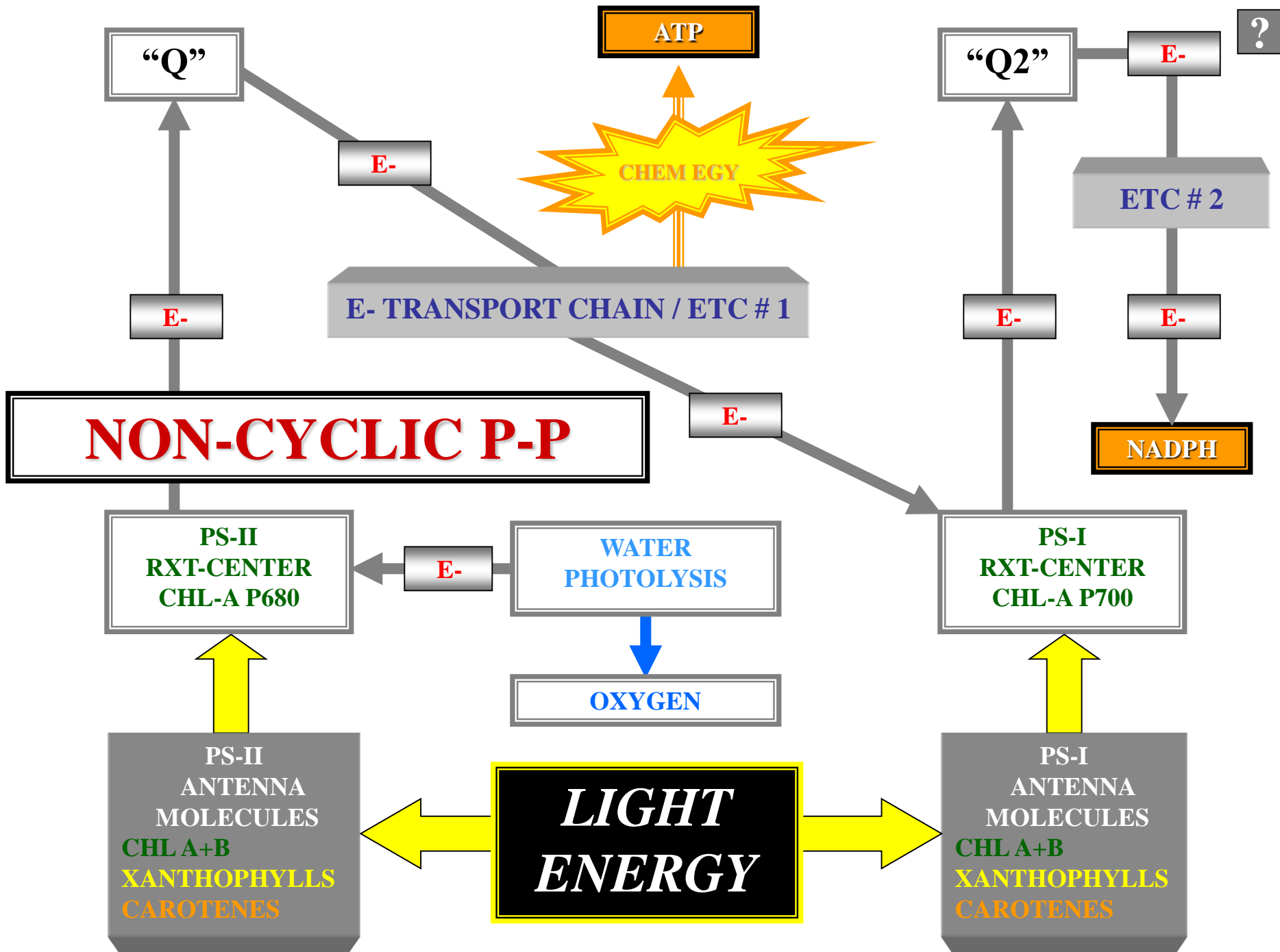
**PS-I ANTENNA MOLECULES**  
**CHL A+B**  
**XANTHOPHYLLS**  
**CAROTENES**

**LIGHT ENERGY**

**PS-I RXT-CENTER**  
**CHL-A P700**

**E-**

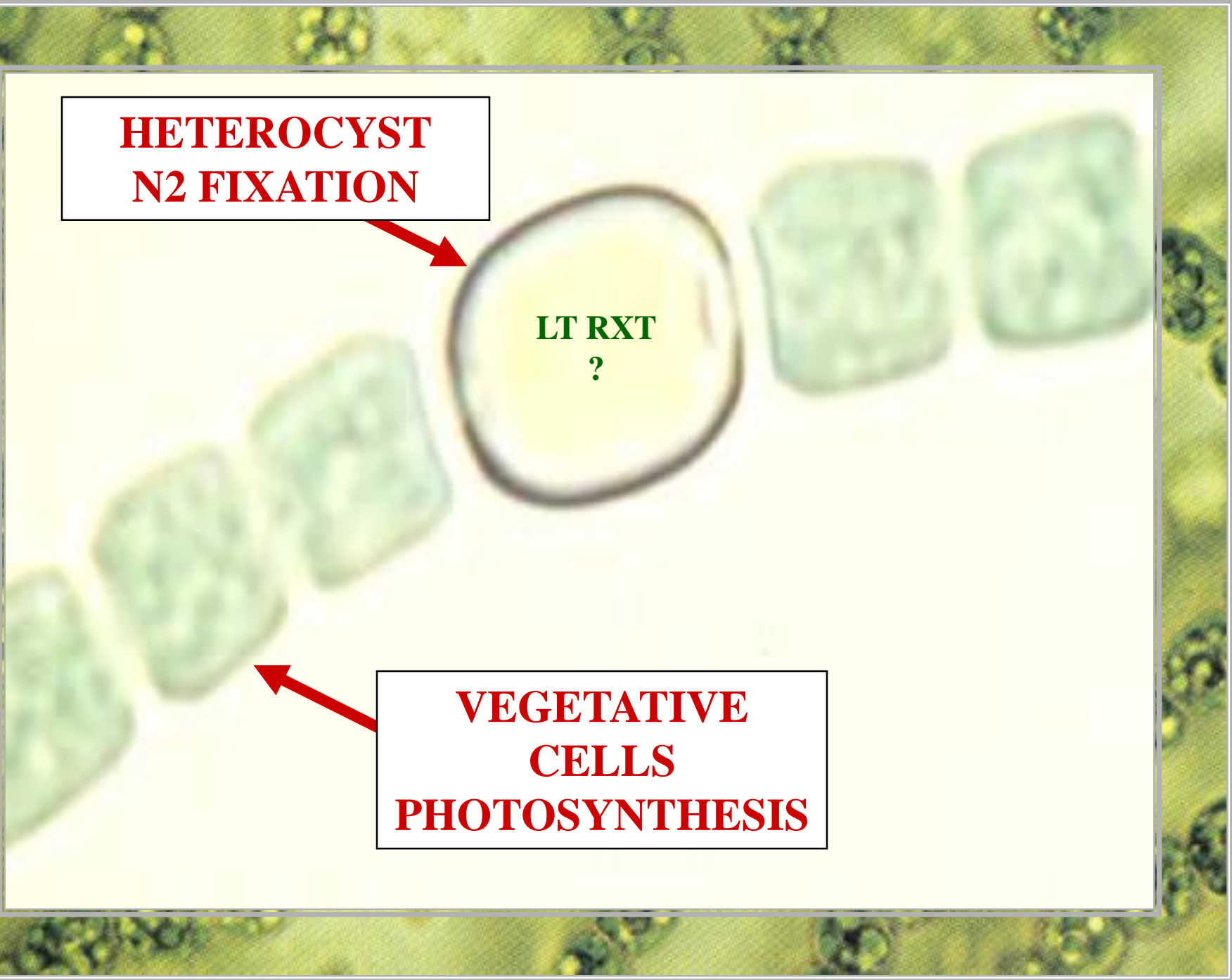
**E-**



**HETEROCYST  
N<sub>2</sub> FIXATION**

**LT RXT  
?**

**VEGETATIVE  
CELLS  
PHOTOSYNTHESIS**



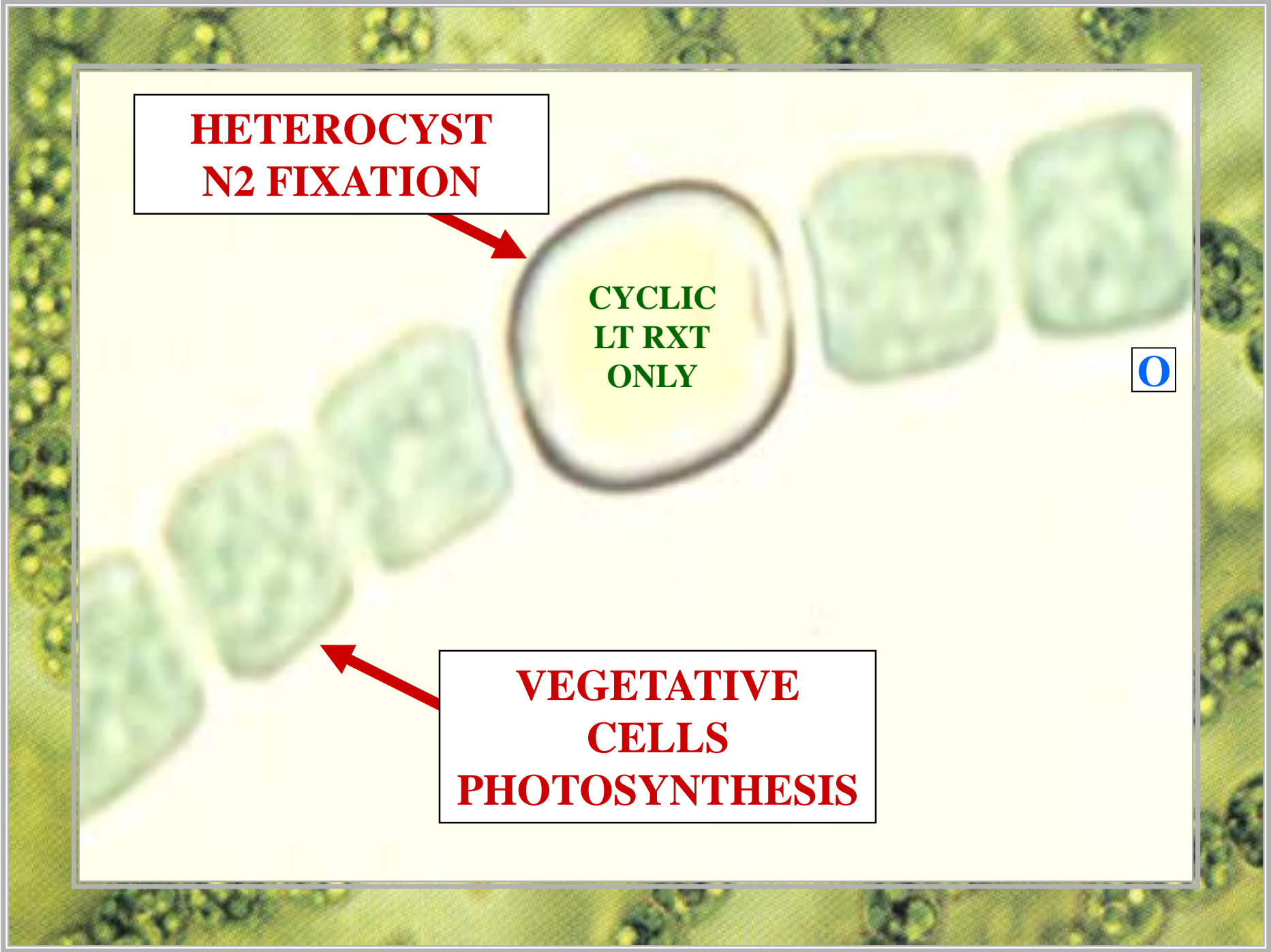


**HETEROCYST  
N<sub>2</sub> FIXATION**

**CYCLIC  
LT RXT  
ONLY**

**O**

**VEGETATIVE  
CELLS  
PHOTOSYNTHESIS**

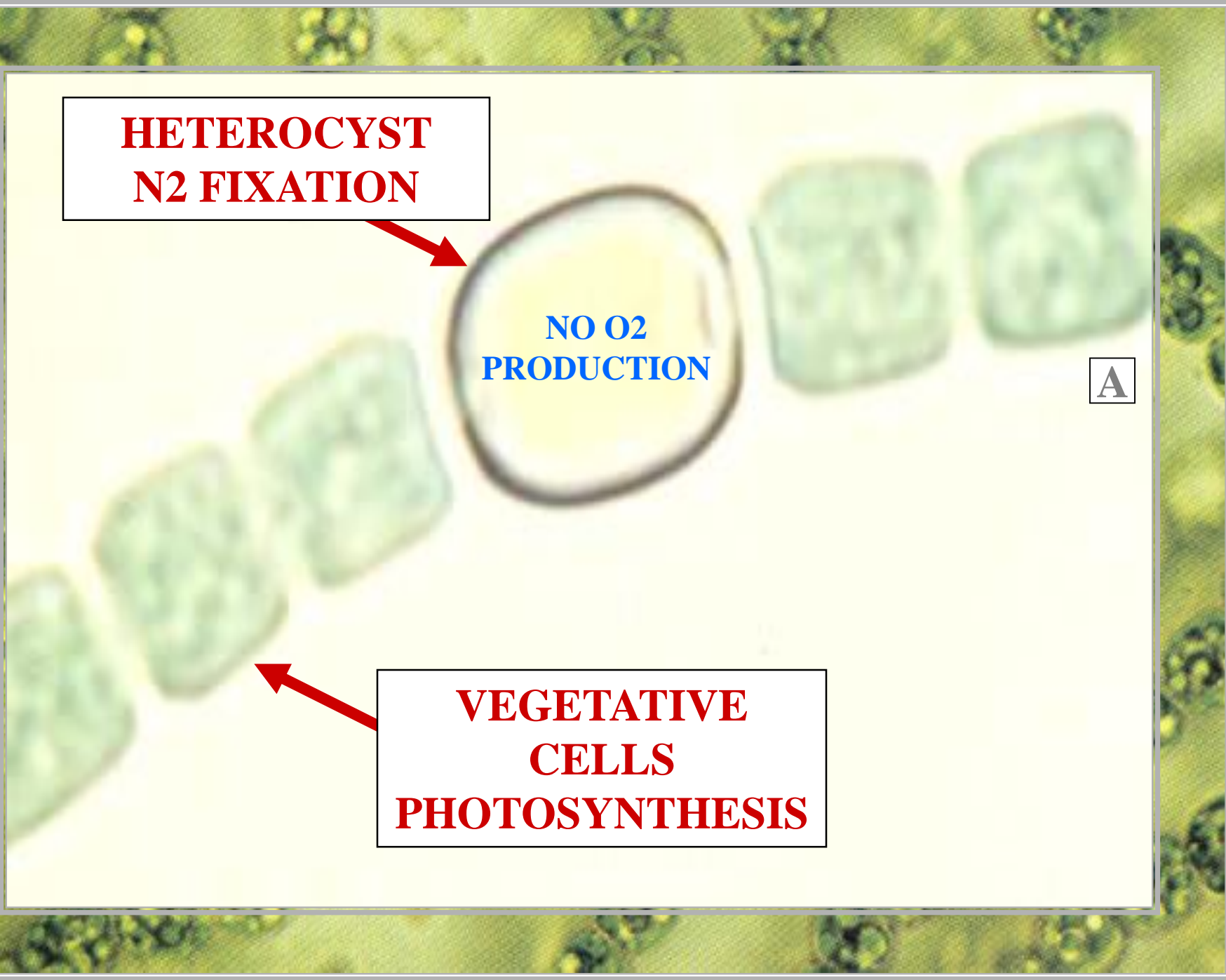


**HETEROCYST  
N<sub>2</sub> FIXATION**

**NO O<sub>2</sub>  
PRODUCTION**

**A**

**VEGETATIVE  
CELLS  
PHOTOSYNTHESIS**

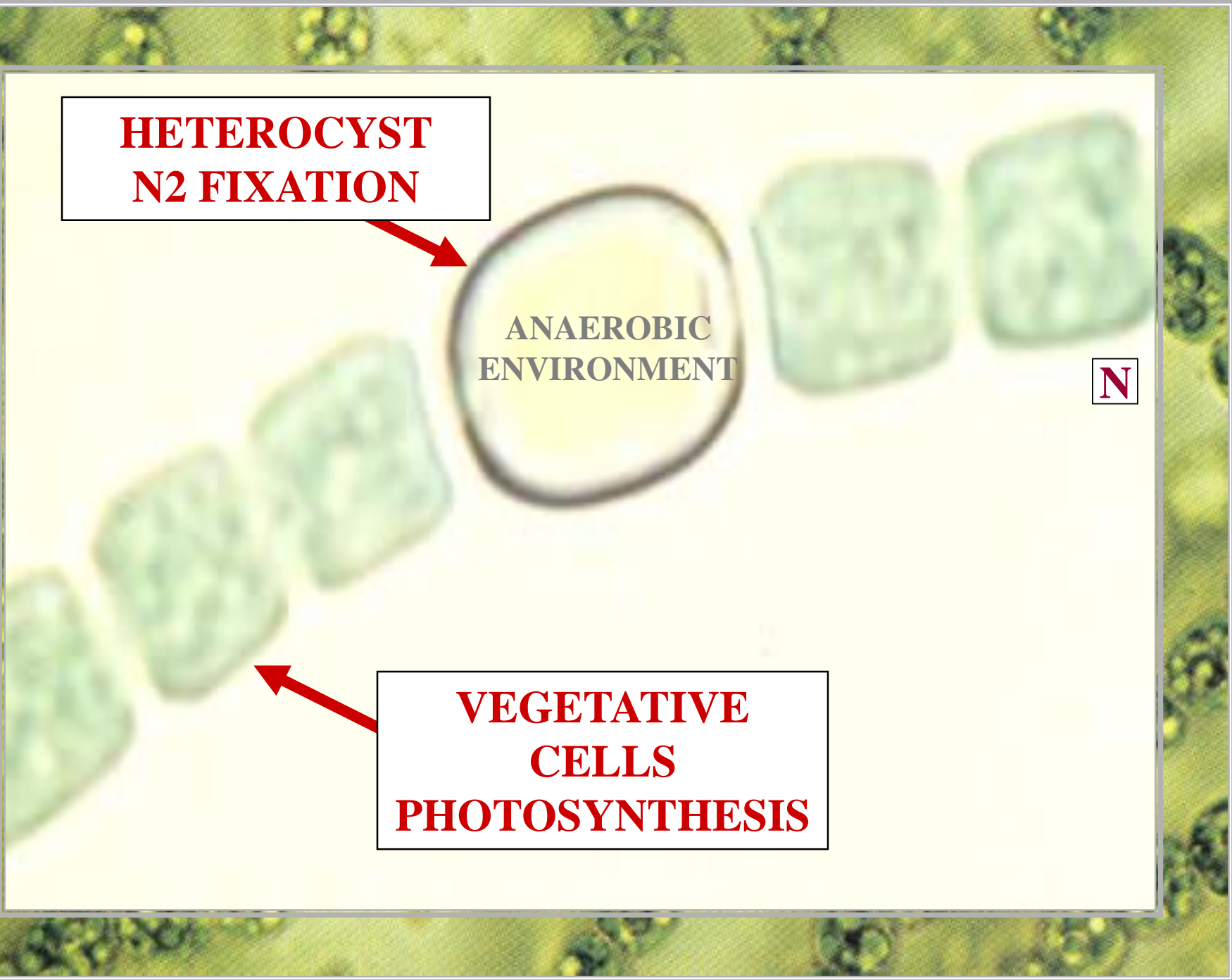


**HETEROCYST  
N<sub>2</sub> FIXATION**

**ANAEROBIC  
ENVIRONMENT**

**N**

**VEGETATIVE  
CELLS  
PHOTOSYNTHESIS**

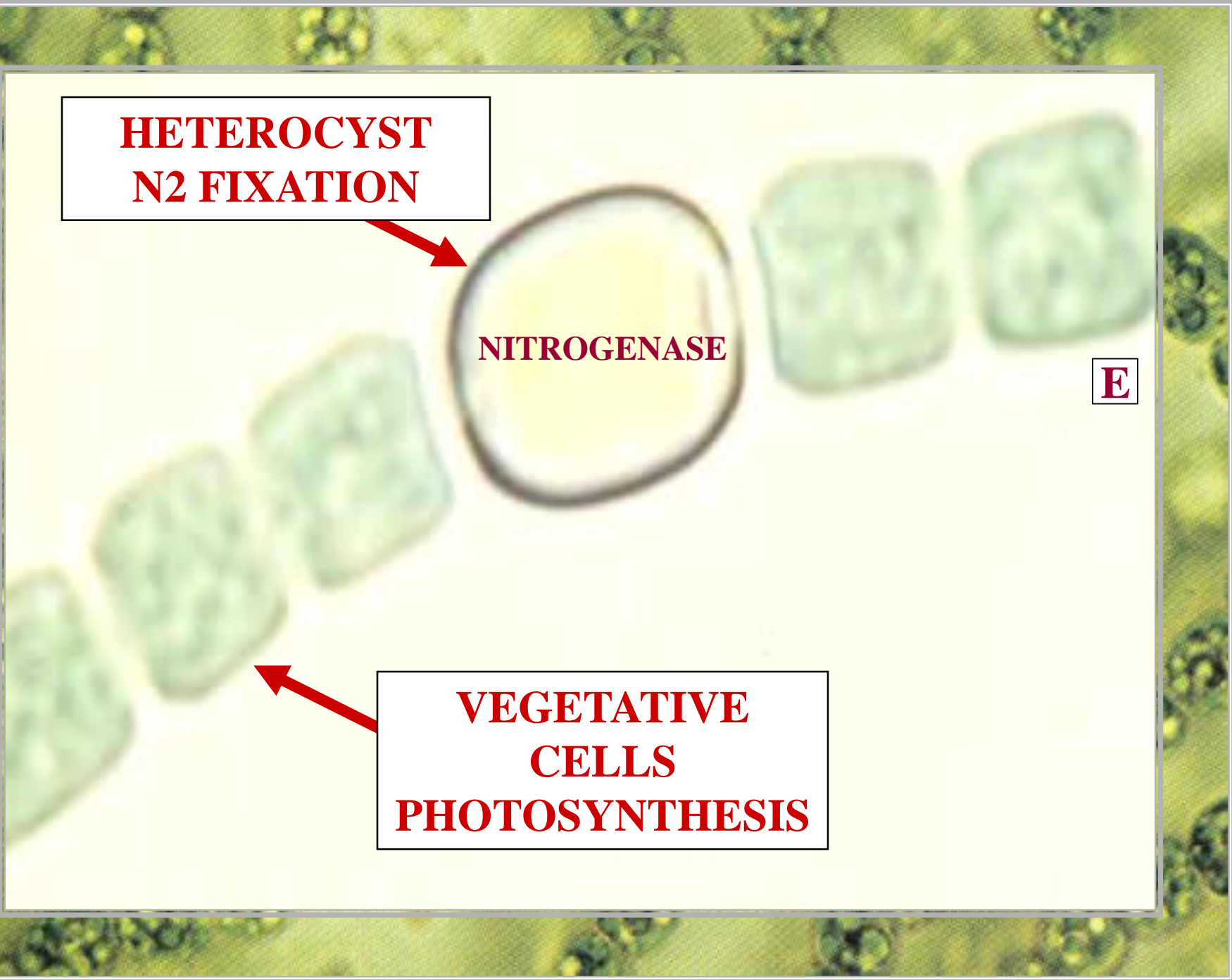


**HETEROCYST  
N<sub>2</sub> FIXATION**

**NITROGENASE**

**E**

**VEGETATIVE  
CELLS  
PHOTOSYNTHESIS**

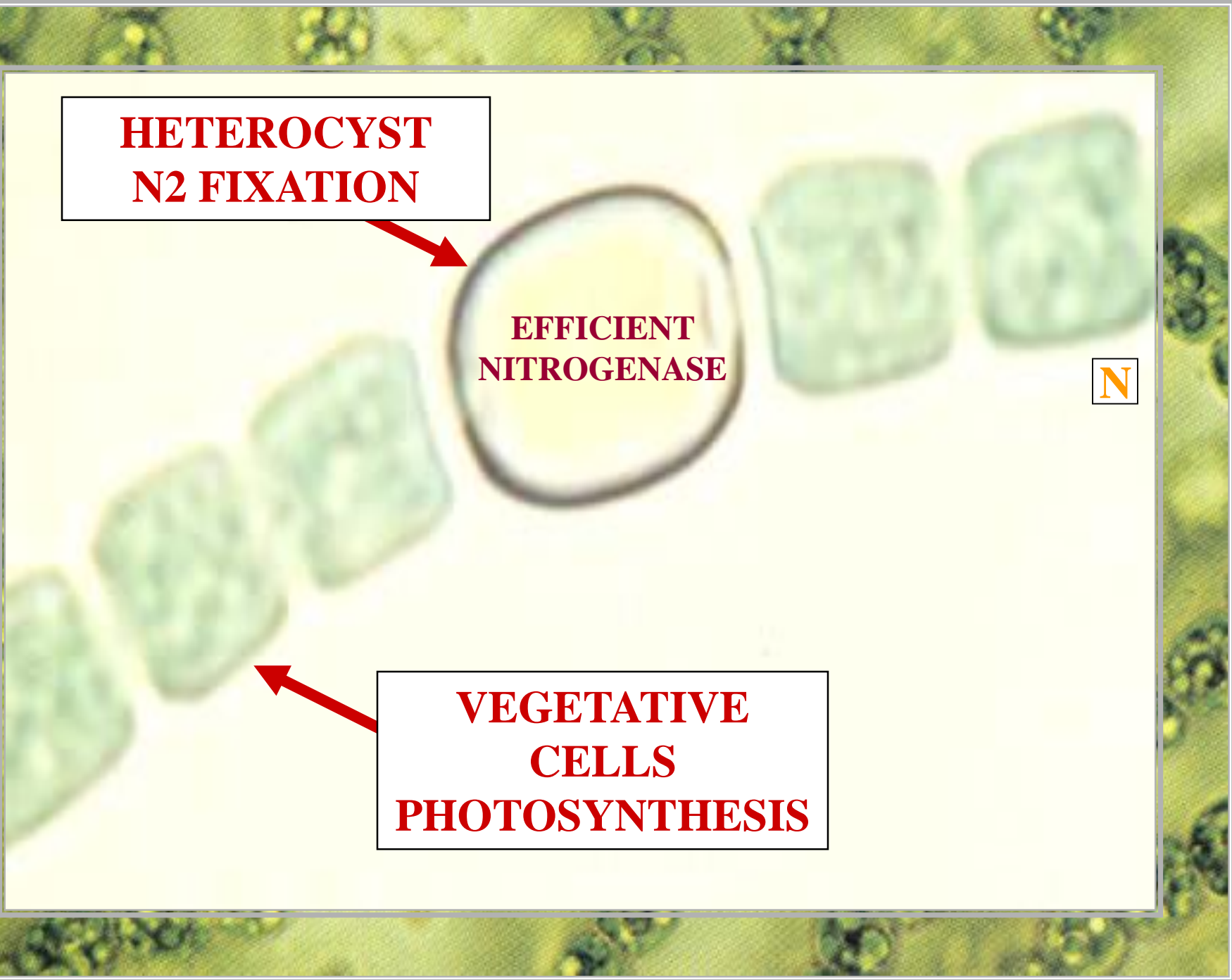


**HETEROCYST  
N<sub>2</sub> FIXATION**

**EFFICIENT  
NITROGENASE**

**N**

**VEGETATIVE  
CELLS  
PHOTOSYNTHESIS**

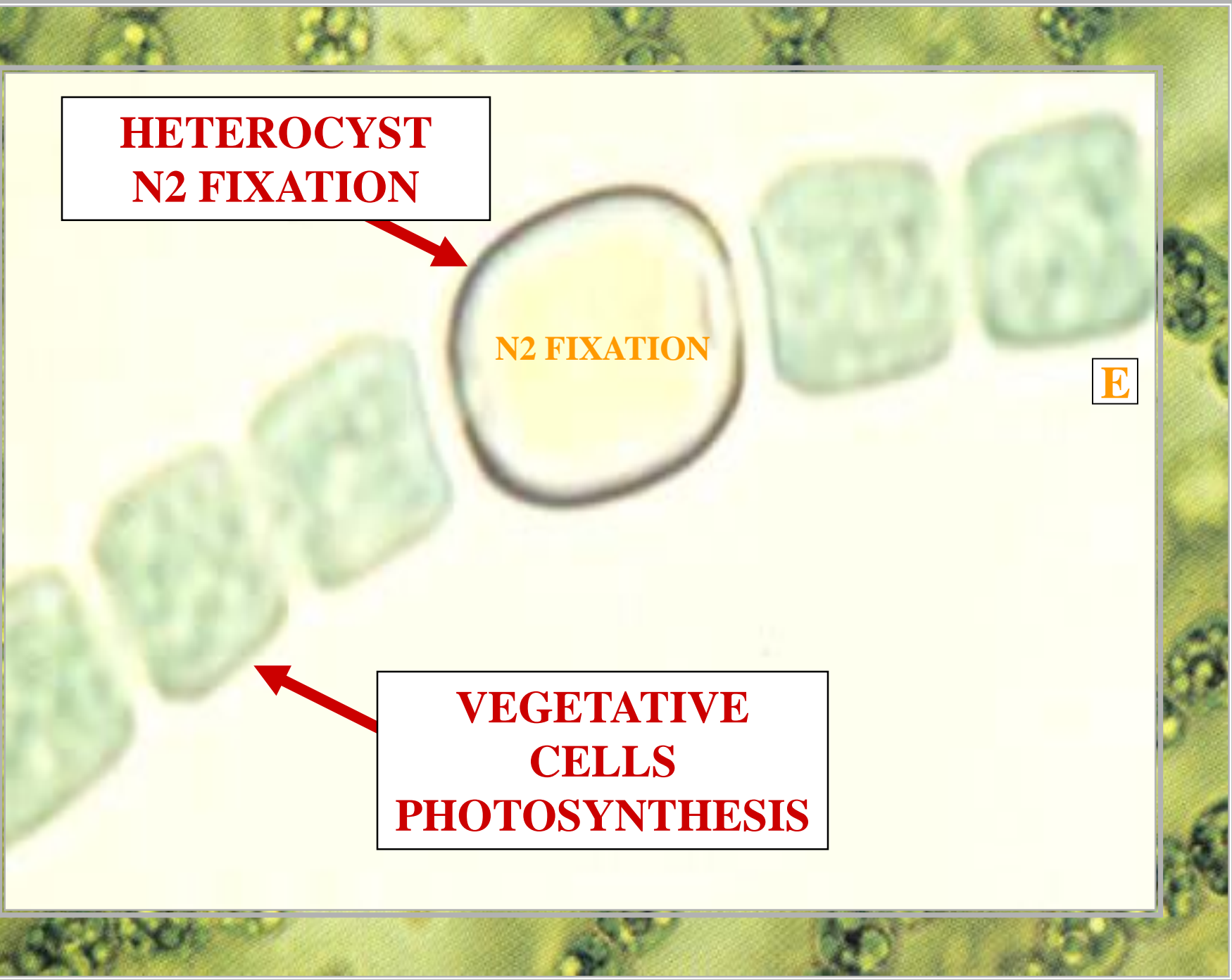


**HETEROCYST  
N<sub>2</sub> FIXATION**

**N<sub>2</sub> FIXATION**

**E**

**VEGETATIVE  
CELLS  
PHOTOSYNTHESIS**



**HETEROCYST  
N<sub>2</sub> FIXATION**

**EFFICIENT  
N<sub>2</sub> FIXATION**

**VEGETATIVE  
CELLS  
PHOTOSYNTHESIS**

S



A microscopic image showing several chains of cyanobacteria. The chains are composed of numerous small, spherical cells, some of which are larger and more distinct than others, possibly representing heterocysts. The overall color is a vibrant green, and the background is a lighter, slightly hazy green.

# CYANOBACTERIA CONDUCT NITROGEN FIXATION



# CYANOBACTERIA SYMBIOSIS

# **SYMBIOSIS**



# **SYMBIOSIS**

**2 SPECIES**

**LIVING INTRICATE  
ASSOCIATION**

# **SYMBIOSIS**

# 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**

# INDIAN PIPE

FL



# INDIAN PIPE



**AB**



**FLOWER**

# INDIAN PIPE

P



**CHLOROPLASTS: ABSENT**

# INDIAN PIPE

N



**PHOTOSYNTHESIS: ABSENT**

A photograph of an Indian Pipe plant, a pale, translucent, and non-photosynthetic species. The plant has several upright, stem-like structures with clusters of small, bell-shaped flowers. It is growing in a forest floor covered with brown, fallen leaves and some green foliage. The background is slightly blurred, showing more of the forest environment.

**INDIAN PIPE**

**P**

**NON-PSYN PLANT**

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, fallen leaves. To the left of the plant, there is a small, green, needle-leaved plant. The background is a soft-focus forest floor with more leaves and branches.

# INDIAN PIPE

^

# PARASITISM

# COMMENSALISM





# **SYMBIOSIS**

# **COMMENSALISM**

**ONE SPECIES BENEFITS**  
**ONE SPECIES UNAFFECTED**

# **SYMBIOSIS**

# **COMMENSALISM**

# AFRICAN SAVANNA





C



**COMMENSALISM**

**MUTUALISM**

# SYMBIOSIS TYPES

## MUTUALISM

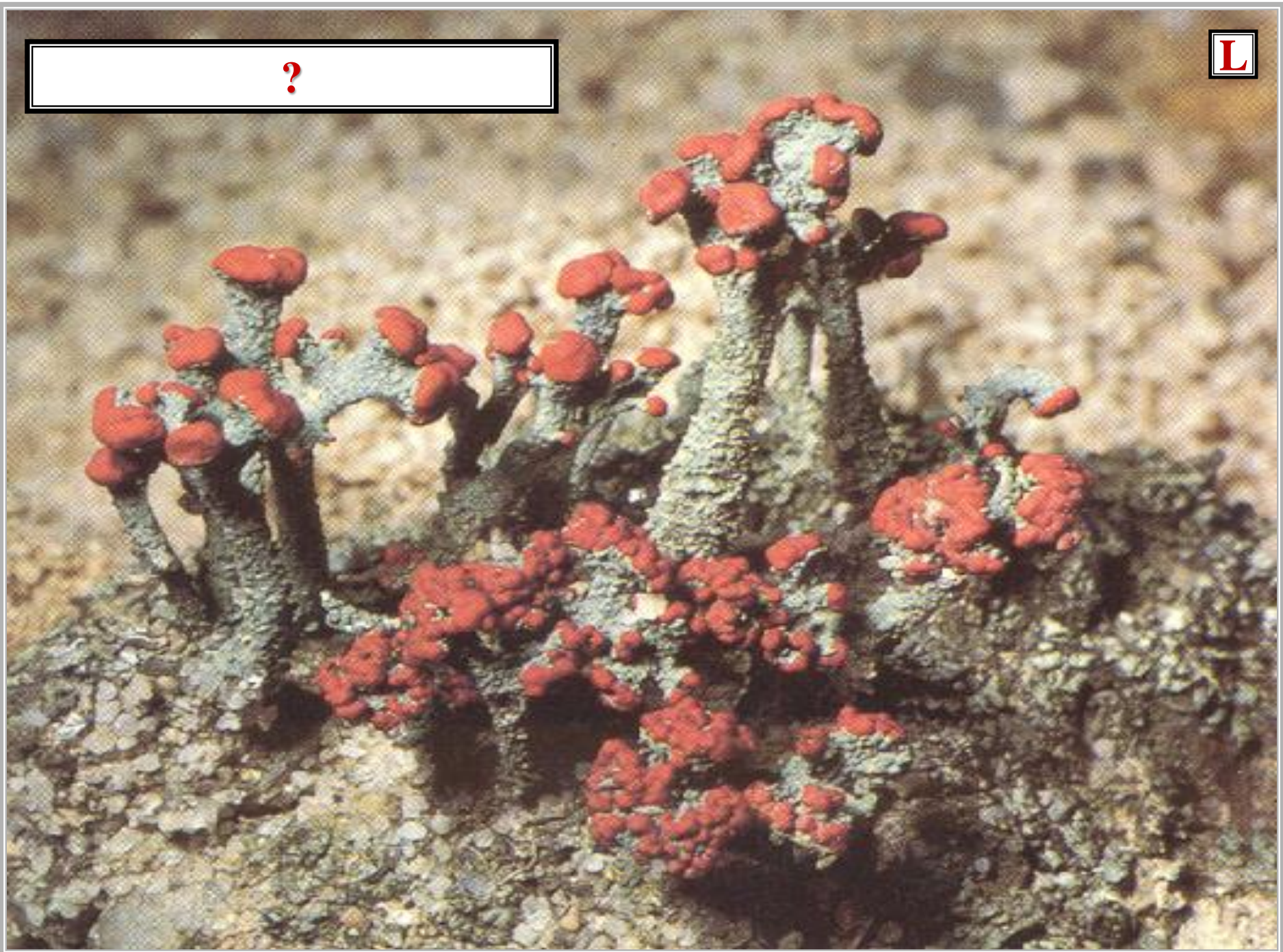


TWO/BOTH  
SPECIES BENEFIT

# SYMBIOSIS TYPES

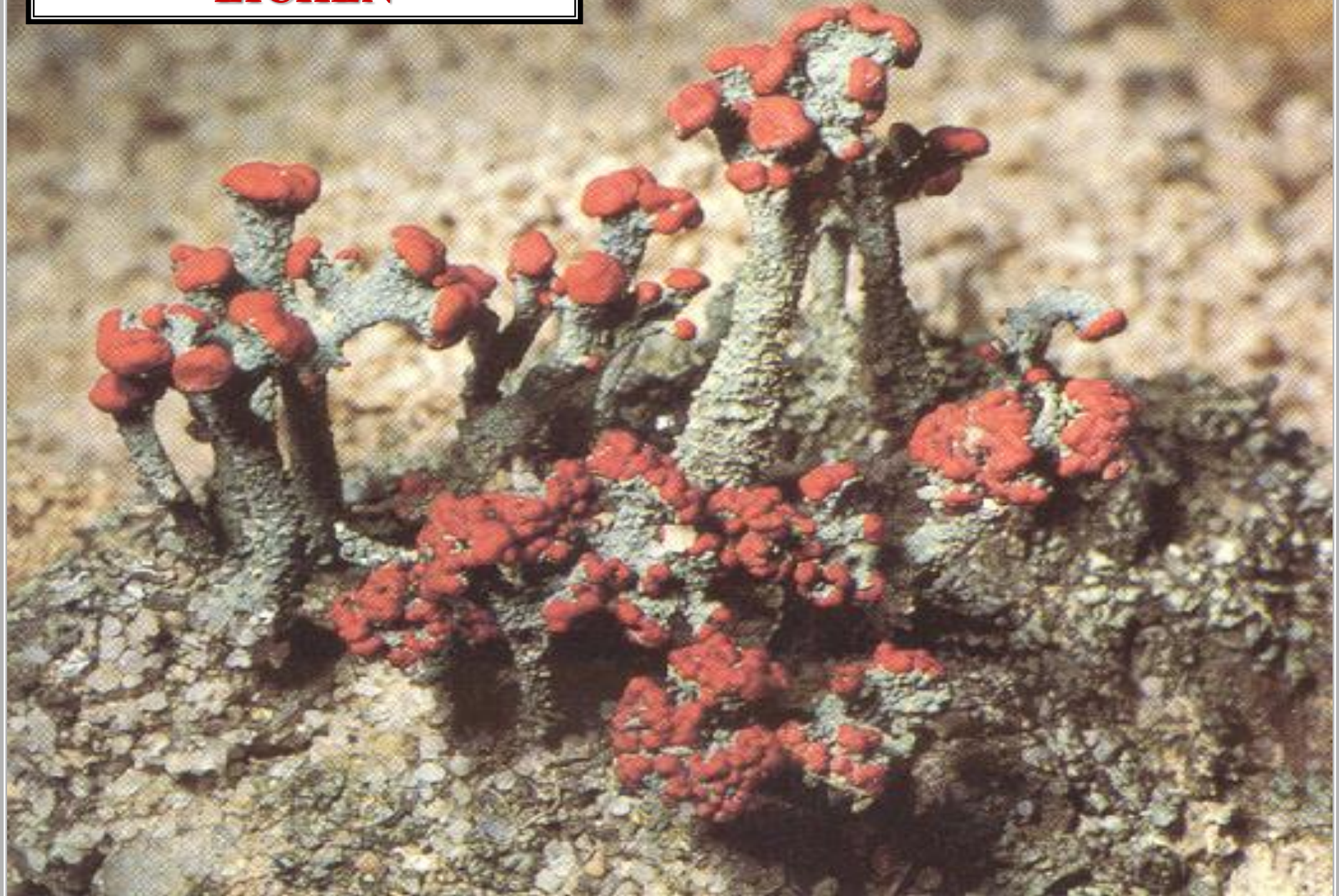
## MUTUALISM

?



# LICHEN

M

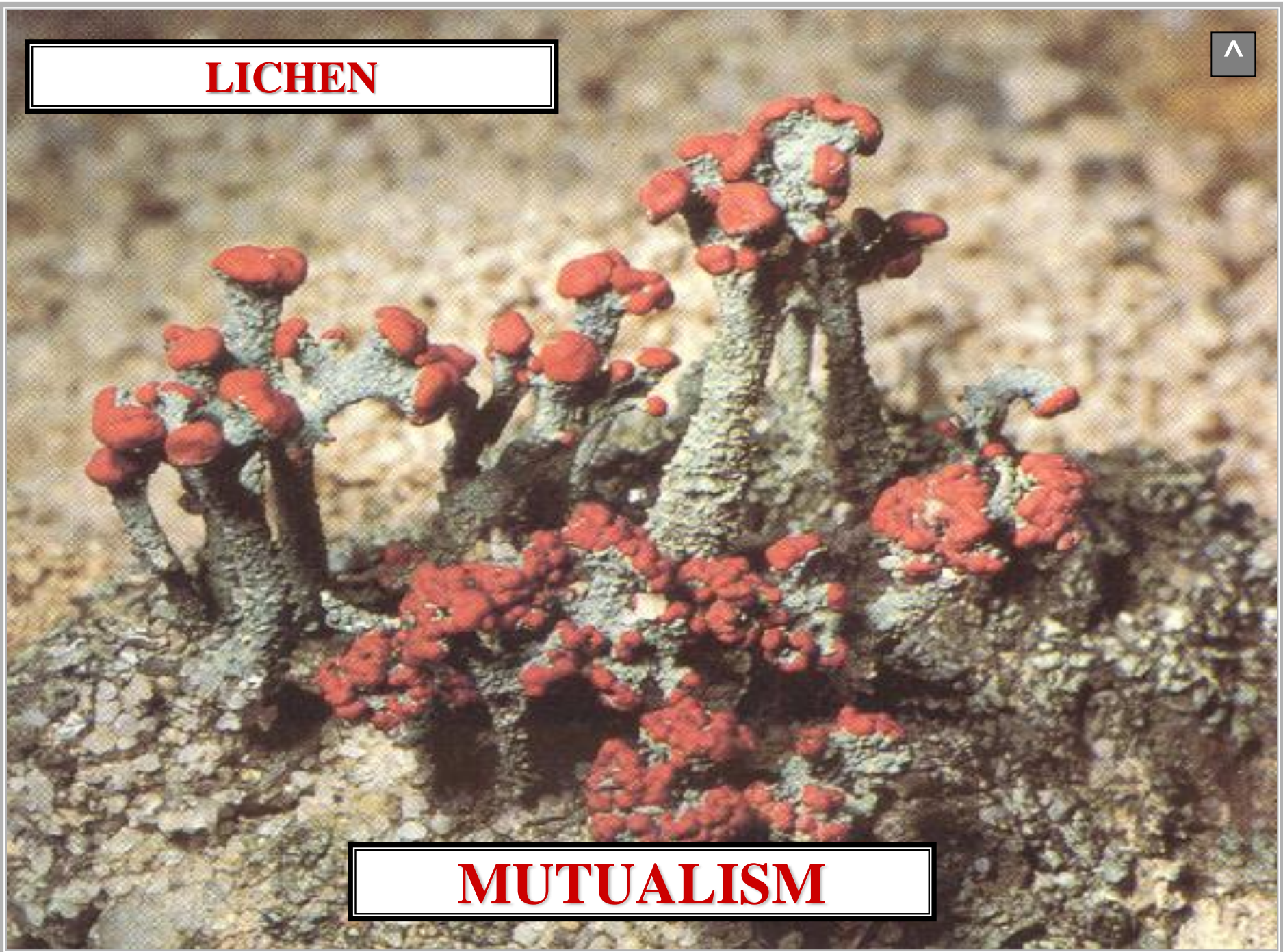




**LICHEN**



**MUTUALISM**



# LICHEN

**LICHEN**



**LICHEN**

**MUTUALISTIC  
SYMBIOTIC  
RELATIONSHIP**

**LICHEN**