

**!!!GLYCOLYSIS: SUGAR SPLITTING!!!**



**2 PYRUVATE / GLUCOSE**

# GLYCOLYSIS

# OUTCOME

**OUTCOME / GLUCOSE:**

**2 PYRUVATE:      →**

# GLYCOLYSIS

# OUTCOME

**OUTCOME / GLUCOSE:**

**2 PYRUVATE:      →      KREBS CYCLE**



**NADH**



**? NADH / GLUCOSE**

FRUCTOSE-1-6-BISPHOSPHATE

ALDOLASE  
ISOMERASE

 = CHEM ENERGY

PHOSPHOGLYCERALDEHYDE - PGAL

PHOSPHOGLYCERALDEHYDE - PGAL

TRI-PHOSPHATE DEHYDROGENASE

TRI-PHOSPHATE DEHYDROGENASE



1-3-BISPHOSPHOGLYCERATE

1-3-BISPHOSPHOGLYCERATE

PHOSPHOGLYCEROKINASE

PHOSPHOGLYCEROKINASE



3-PHOSPHOGLYCERATE - PGA

3-PHOSPHOGLYCERATE - PGA



**2 NADH / GLUCOSE**



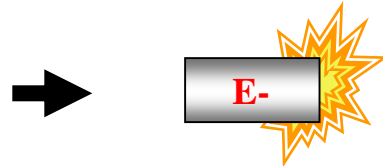
# GLYCOLYSIS

# OUTCOME

**OUTCOME / GLUCOSE:**

**2 PYRUVATE:      →      KREBS CYCLE**

**2 NADH:**



# GLYCOLYSIS

# OUTCOME

**OUTCOME / GLUCOSE:**

**2 PYRUVATE:      →      KREBS CYCLE**

**2 NADH:            →      ETC**



**ATP**



**? ATP / GLUCOSE**

# GLYCOLYSIS

GLUCOSE

# GLYCOLYSIS

HEXOKINASE

REMEBER !

ATP  
EXPENDED

EGY

ADP

GLUCOSE-6-PHOSPHATE

PHOSPHOGLUCOISOMERASE

RED = ENZYME

FRUCTOSE-6-PHOSPHATE

PHOSPHOFRUCTOKINASE

REMEBER !

ATP  
EXPENDED

EGY

ADP

FRUCTOSE-1-6-BISPHOSPHATE

= CHEM ENERGY

+

**FRUCTOSE-1-6-BISPHOSPHATE**

**ALDOLASE  
ISOMERASE**

 = **CHEM ENERGY**

**PHOSPHOGLYCERALDEHYDE - PGAL**

**PHOSPHOGLYCERALDEHYDE - PGAL**



FRUCTOSE-1-6-BISPHOSPHATE

ALDOLASE  
ISOMERASE

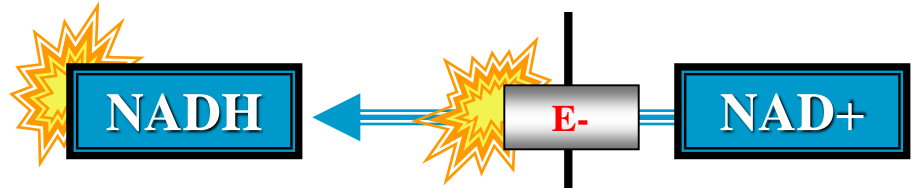
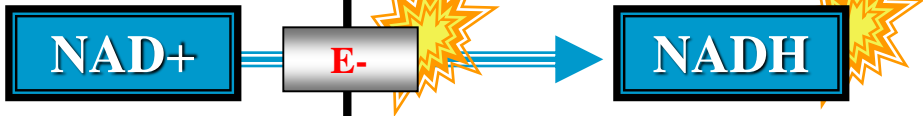


PHOSPHOGLYCERALDEHYDE - PGAL

PHOSPHOGLYCERALDEHYDE - PGAL

TRI-PHOSPHATE DEHYDROGENASE

TRI-PHOSPHATE DEHYDROGENASE



1-3-BISPHOSPHOGLYCERATE

1-3-BISPHOSPHOGLYCERATE

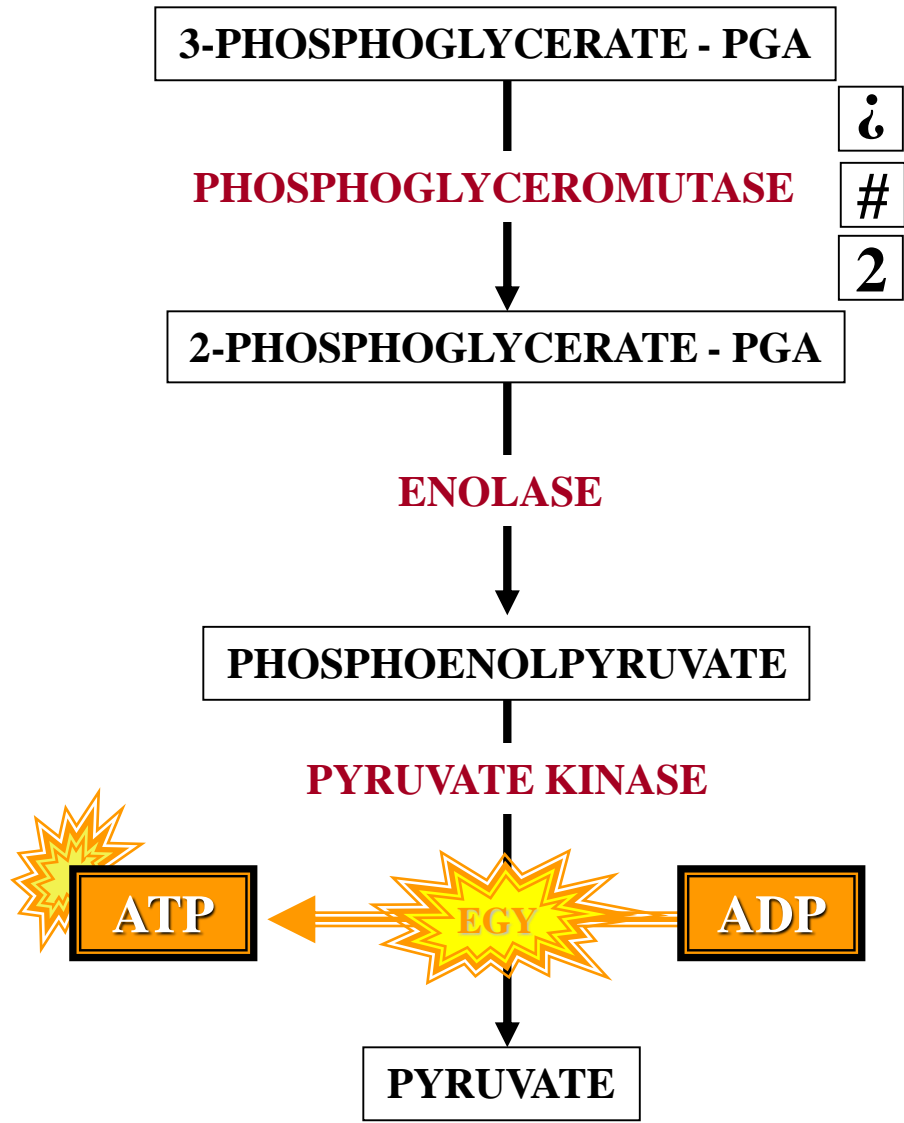
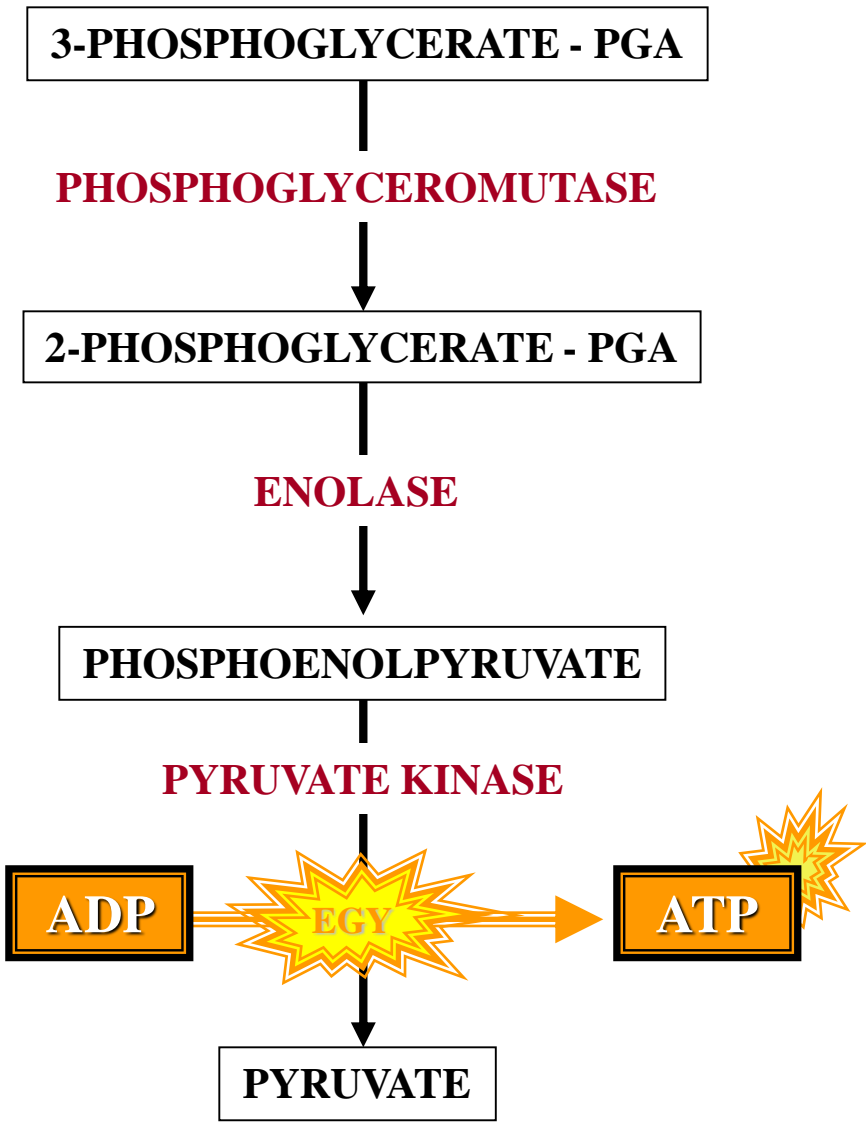
PHOSPHOGLYCEROKINASE

PHOSPHOGLYCEROKINASE



3-PHOSPHOGLYCERATE - PGA

3-PHOSPHOGLYCERATE - PGA



**!!!GLYCOLYSIS: SUGAR SPLITTING!!!**





**2 ATP**  
**NET / GLUCOSE**

# GLYCOLYSIS

# OUTCOME

**OUTCOME / GLUCOSE:**

**2 PYRUVATE:      →      KREBS CYCLE**

**2 NADH:            →      ETC**

**2 ATP:              →**

# GLYCOLYSIS

# OUTCOME

**OUTCOME / GLUCOSE:**

**2 PYRUVATE:      →      KREBS CYCLE**

**2 NADH:            →      ETC**

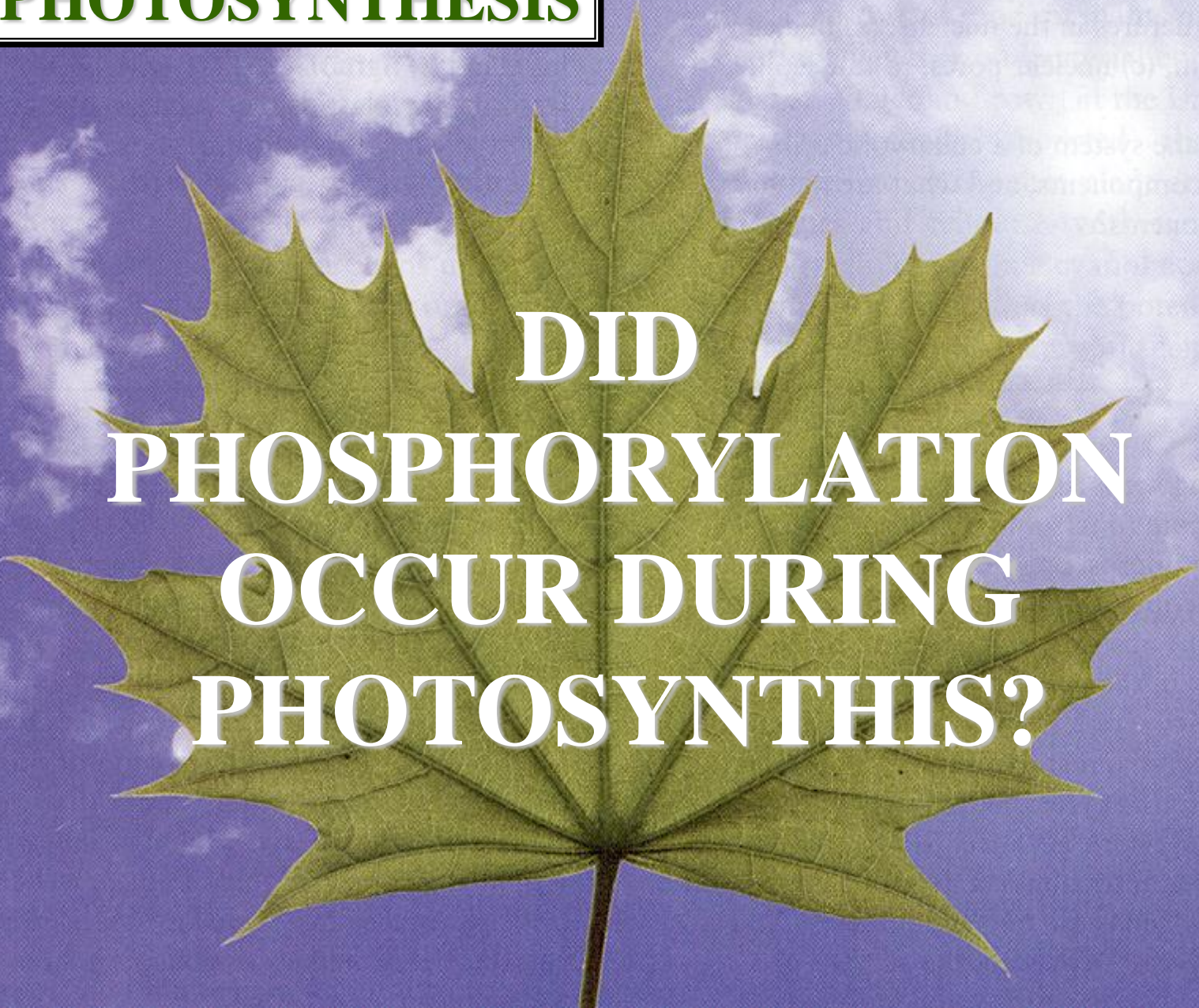
**2 ATP:              →      METABOLISM**



# GLYCOLYSIS PHOSPHORYLATION

# PHOTOSYNTHESIS

A



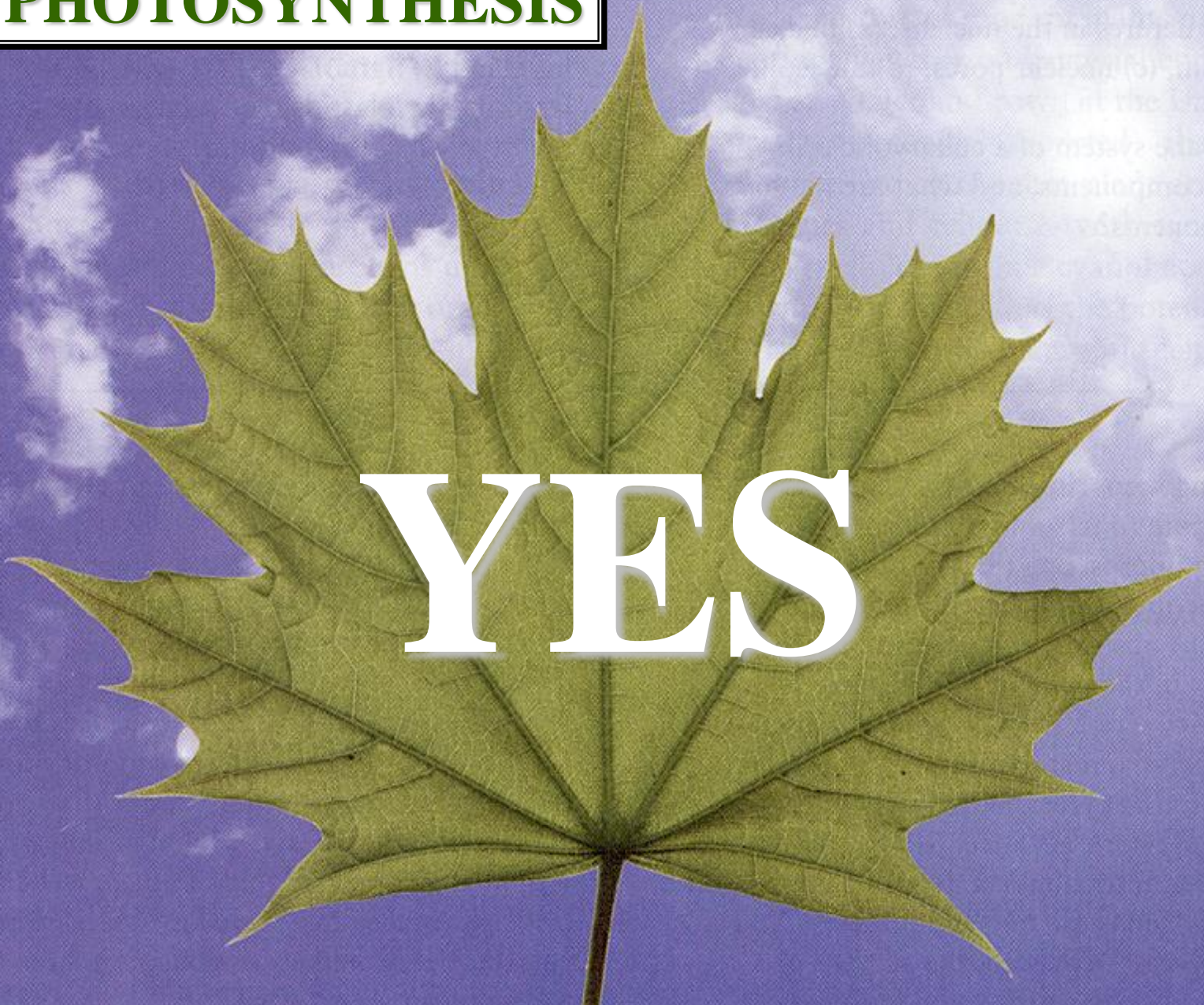
**DID  
PHOSPHORYLATION  
OCCUR DURING  
PHOTOSYNTHESIS?**

# PHOTOSYNTHESIS

P



YES



# PHOTOSYNTHESIS

P



WATER

CO<sub>2</sub>

**LIGHT ENERGY**

**PHOTO**

ATMOSPHERE

E-

PHOTOLYSIS



LT RXT

THYLAKOID  
GRANUM

ATP  
NADPH

DK RXT

STROMA

CHLOROPLAST

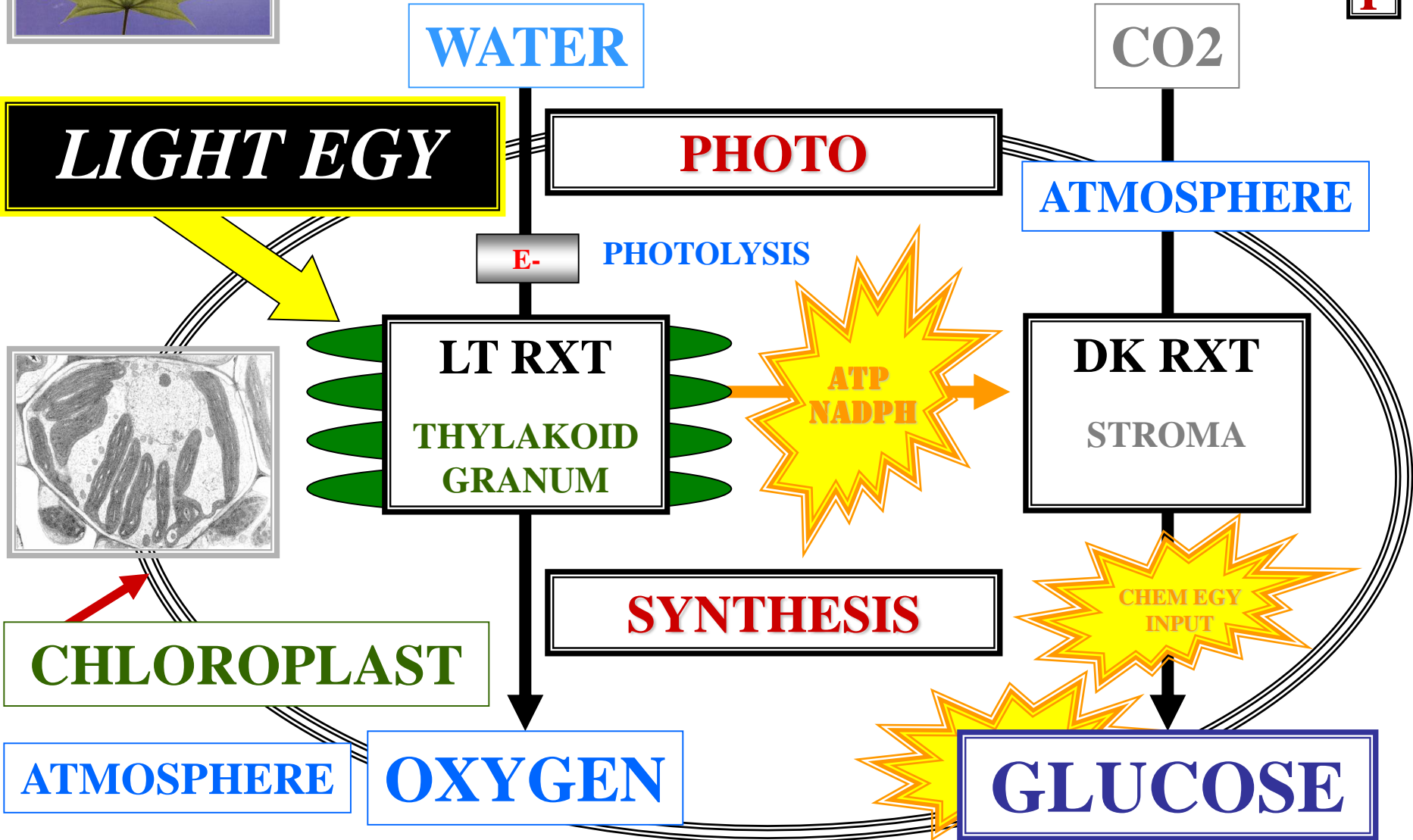
**SYNTHESIS**

CHEMICAL  
INPUT

ATMOSPHERE

OXYGEN

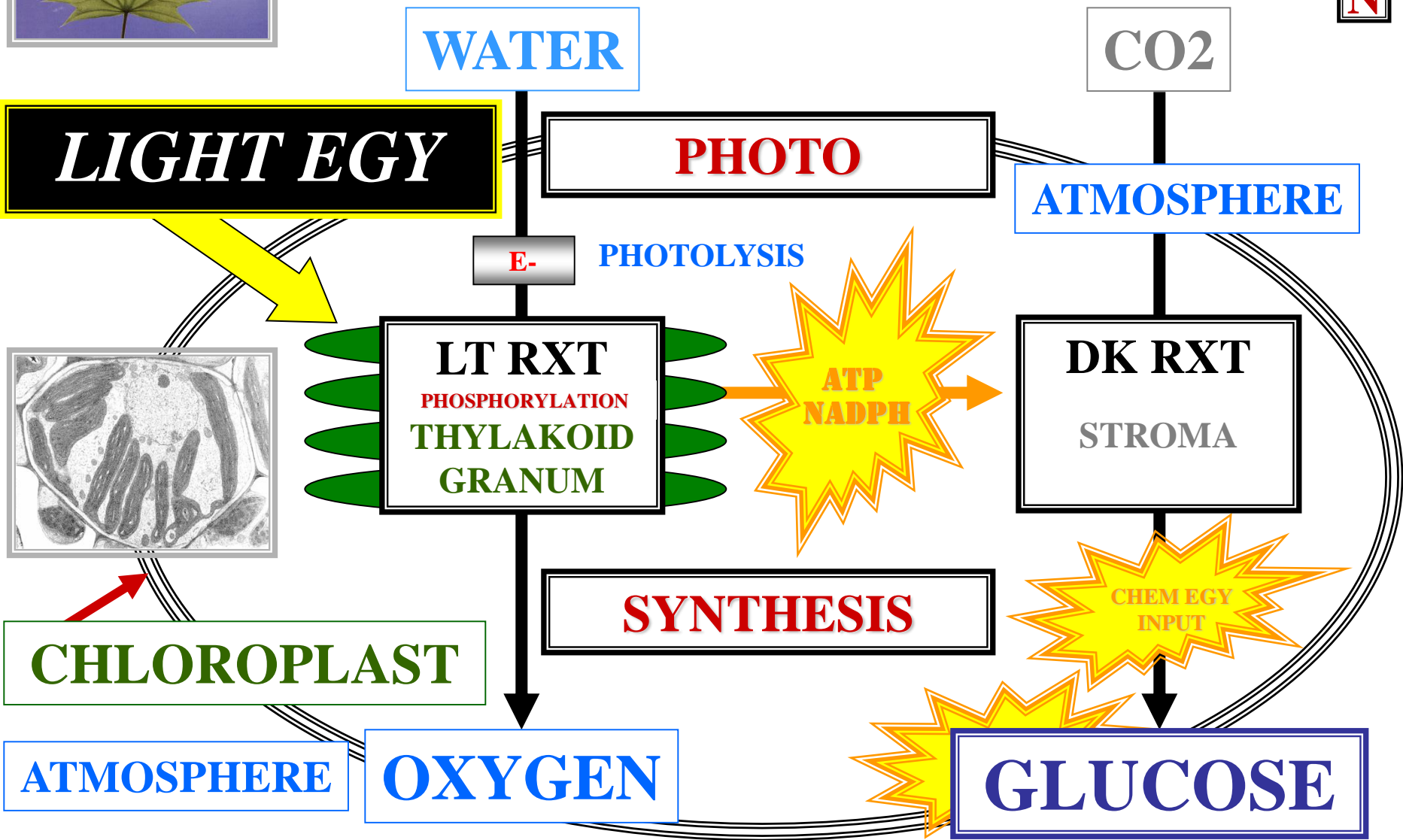
GLUCOSE



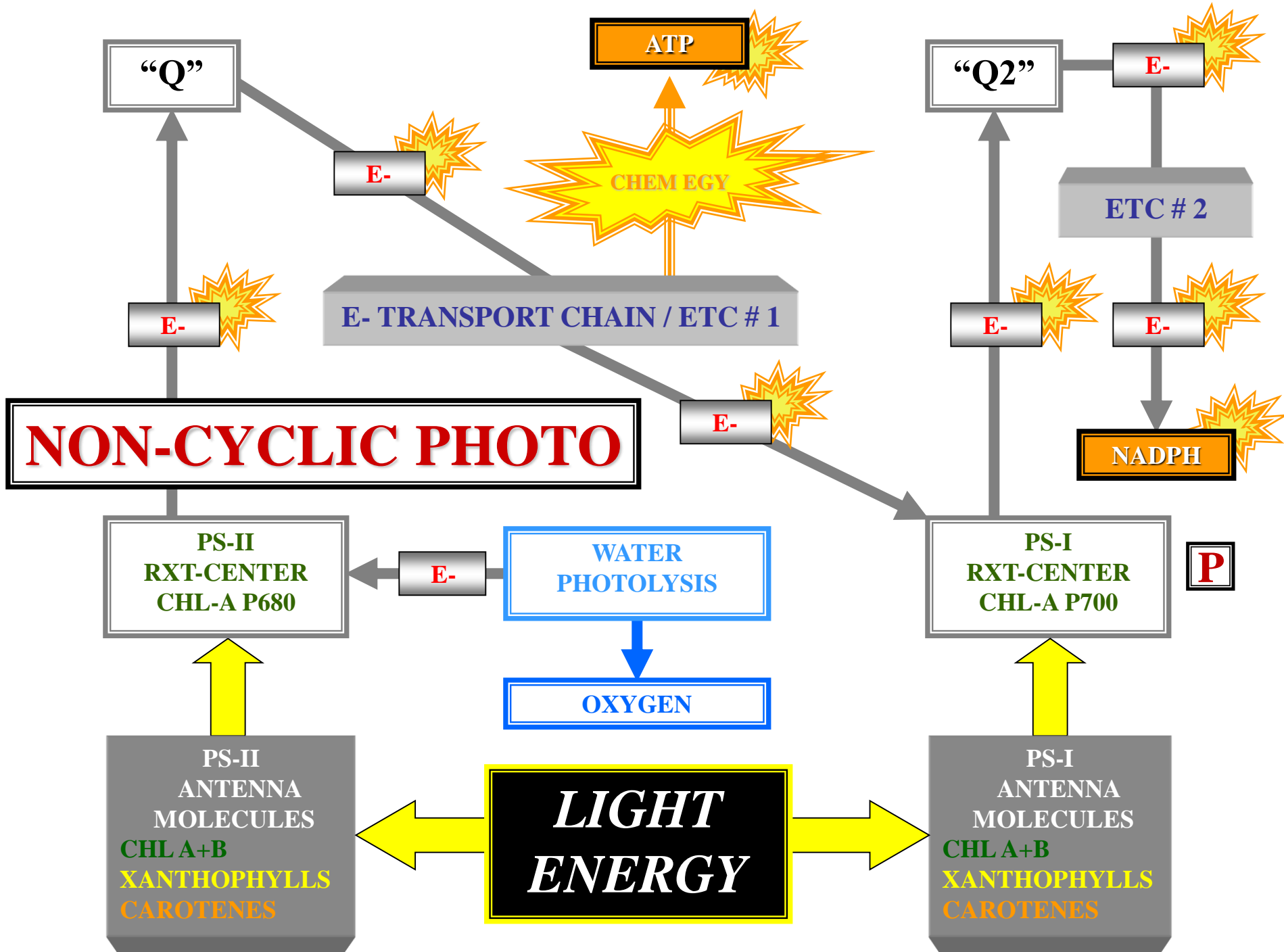
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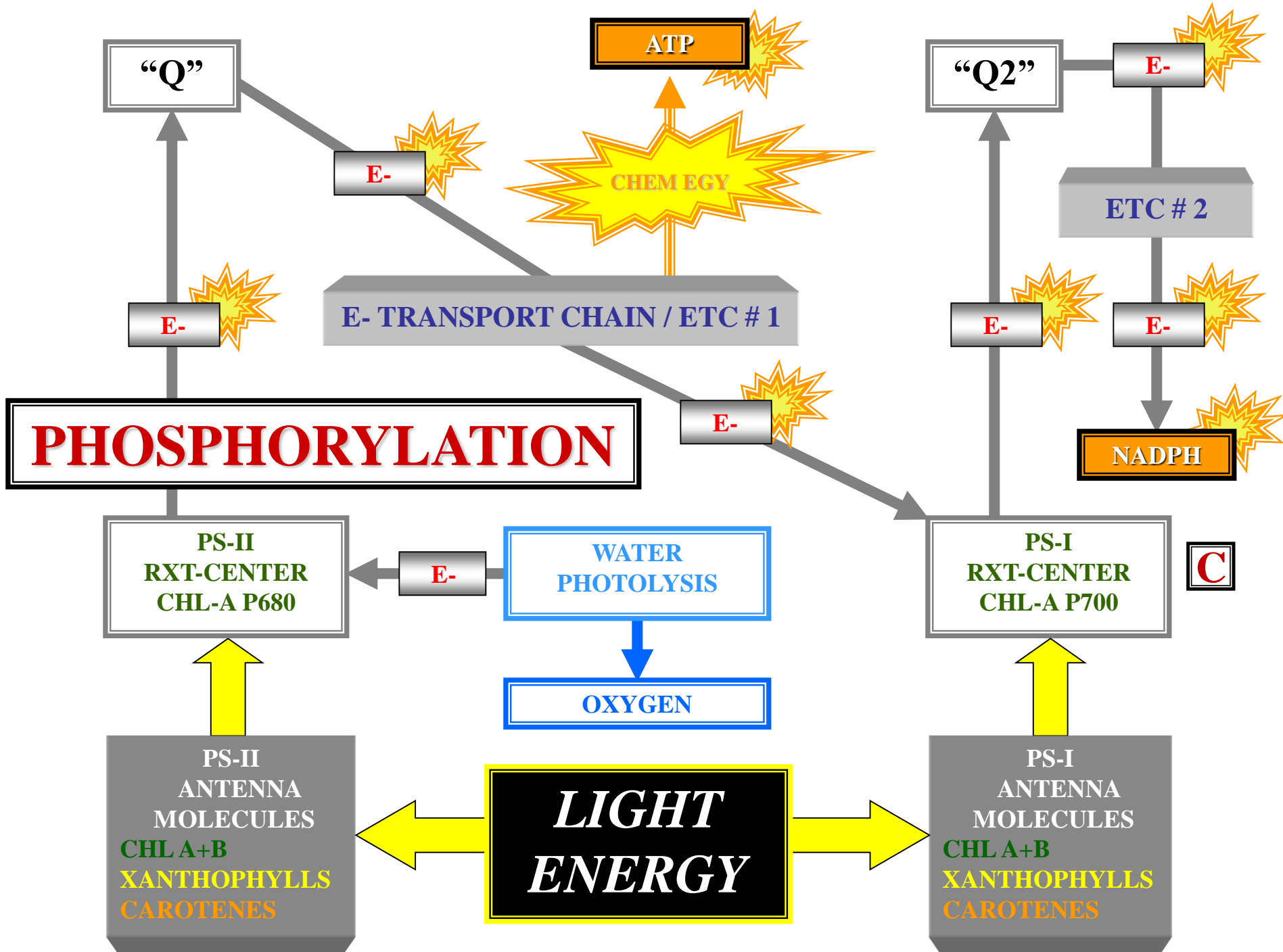


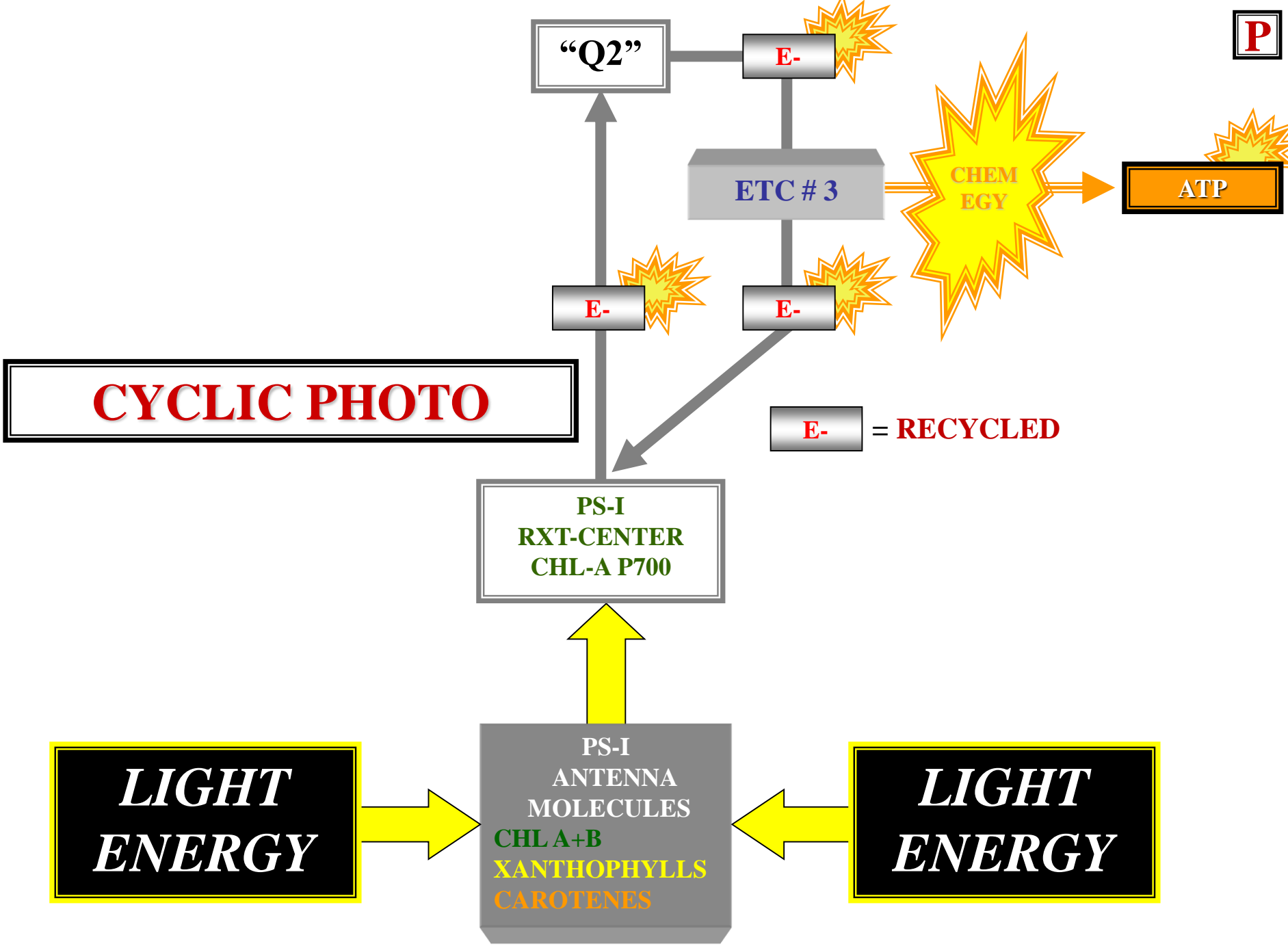
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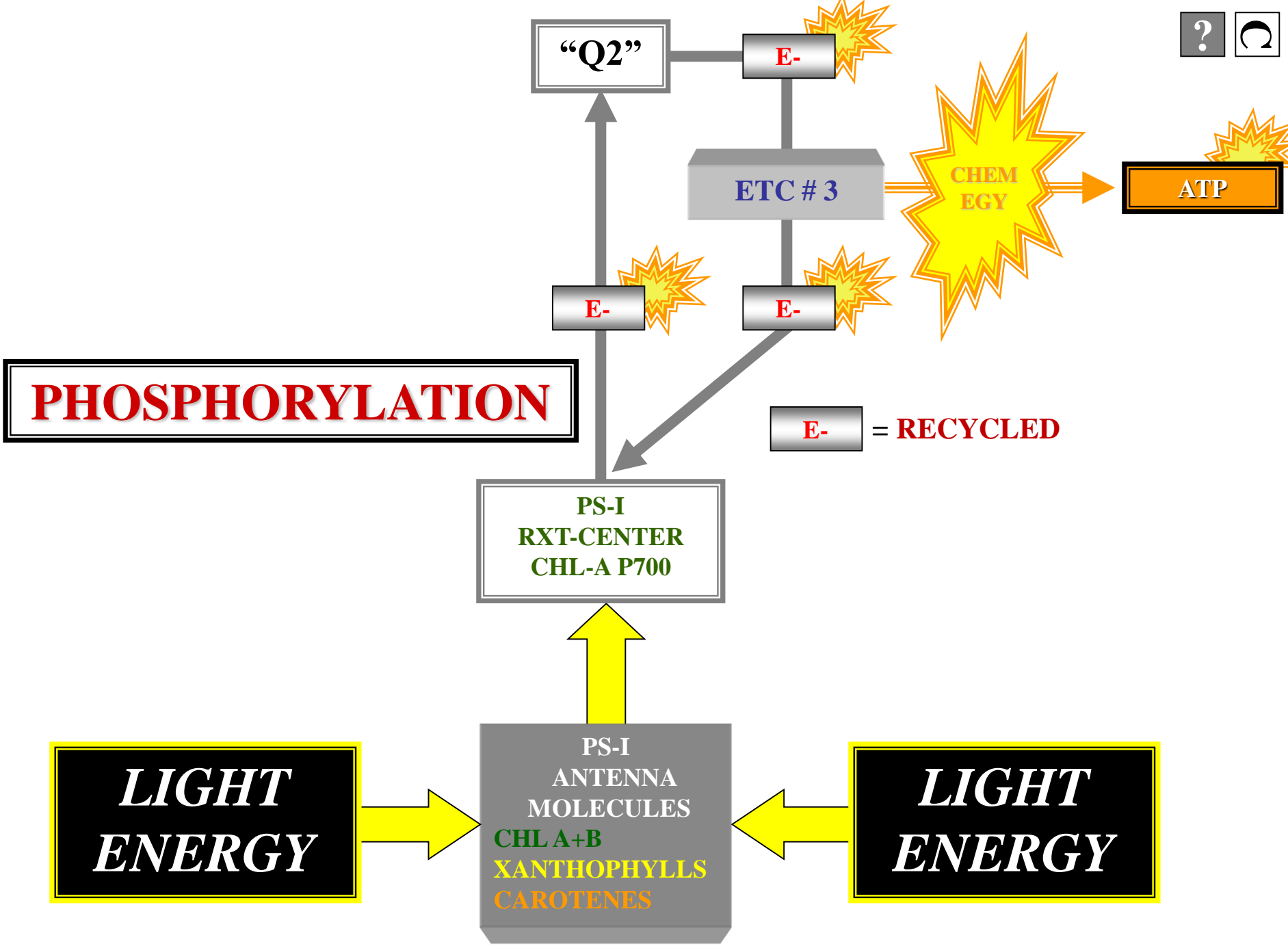












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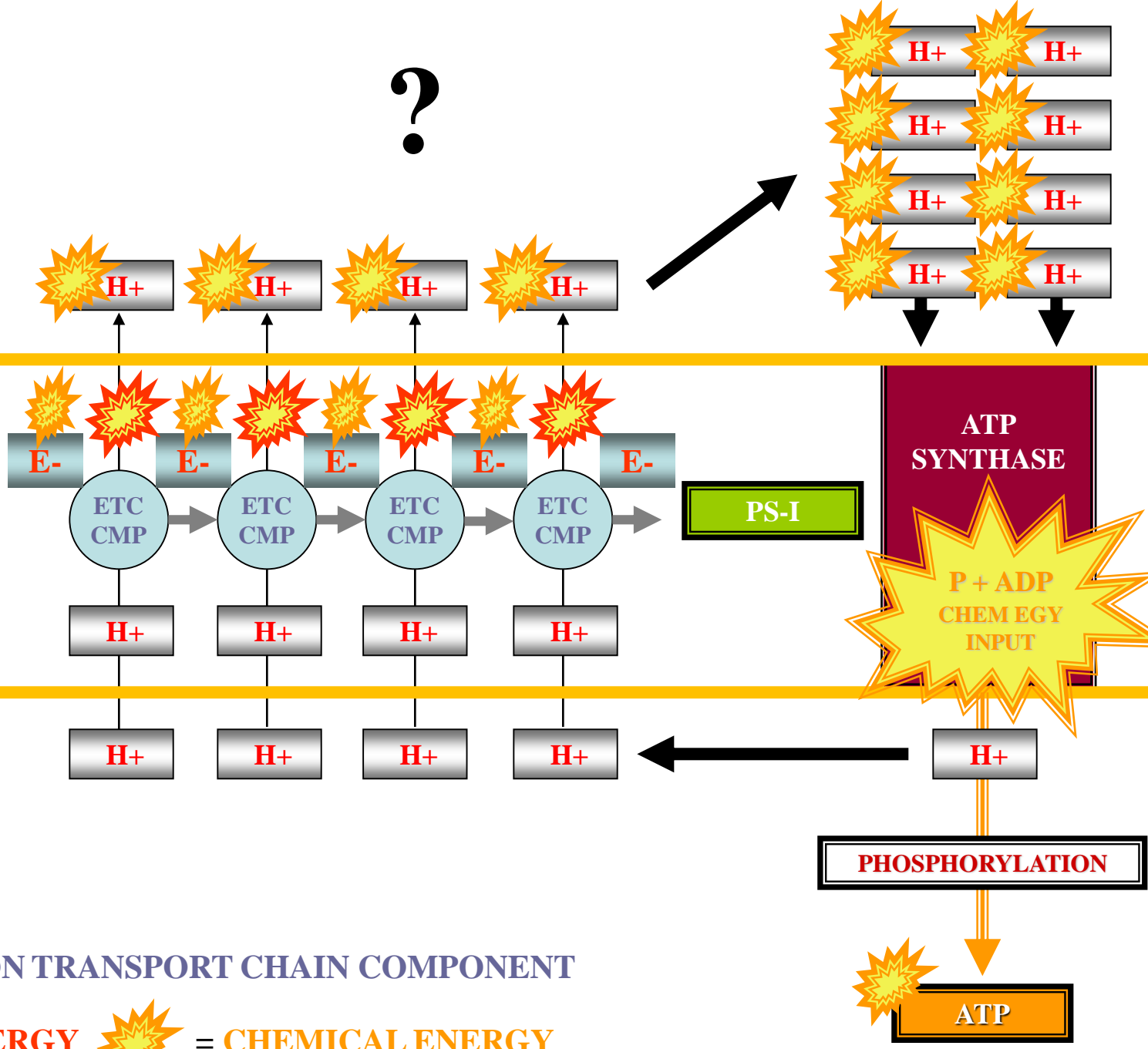
CHLOROPLAST THYLAKOID SPACE

PS-II / PS-I  
CHLOROPLAST THYLAKOID MEMBRANE

CHLOROPLAST STROMA

?

● = ELECTRON TRANSPORT CHAIN COMPONENT  
☀ = HEAT ENERGY ☀ = CHEMICAL ENERGY

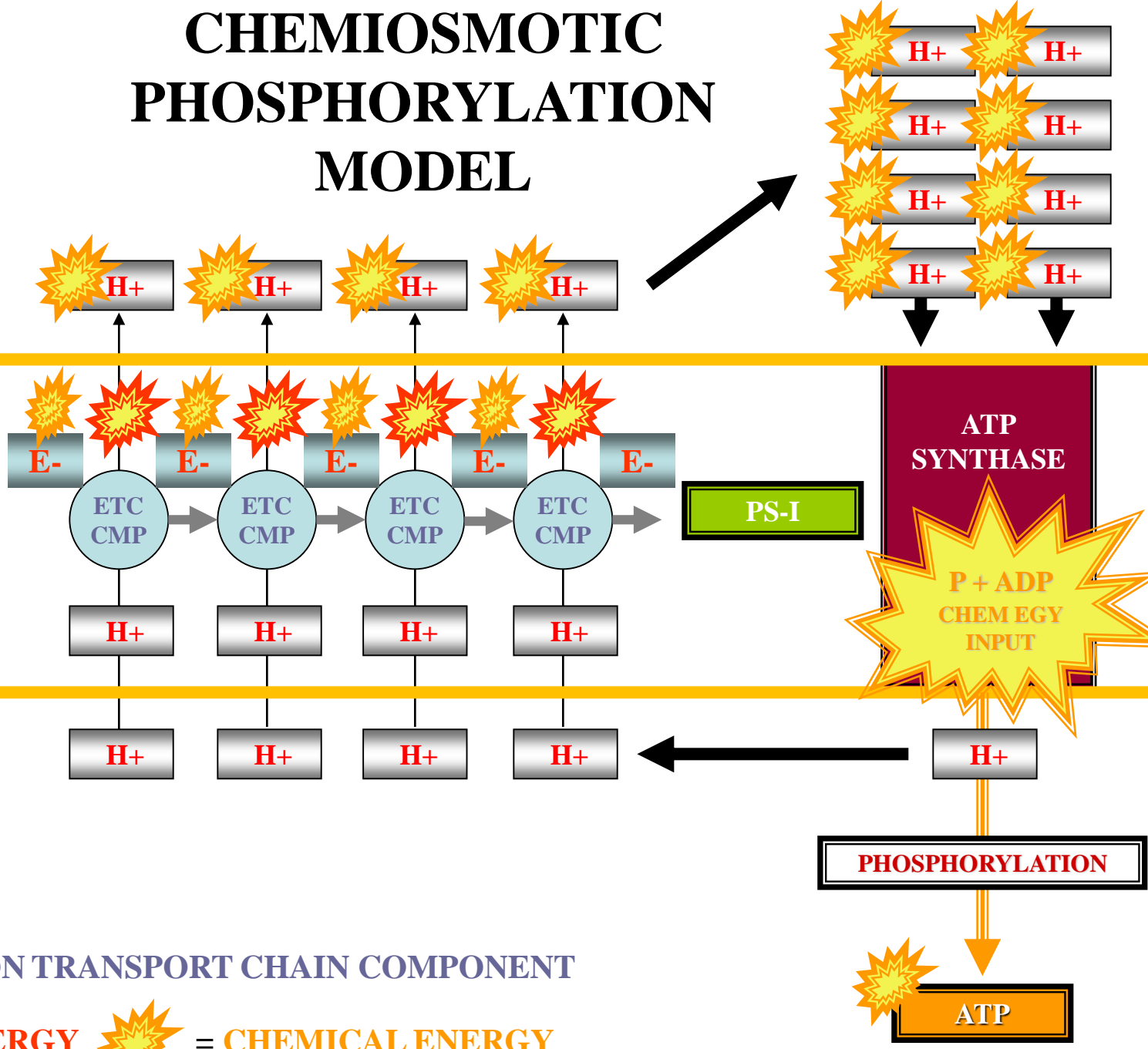


# CHEMIOSMOTIC PHOSPHORYLATION MODEL

CHLOROPLAST THYLAKOID SPACE

PS-II / PS-I  
CHLOROPLAST THYLAKOID MEMBRANE

CHLOROPLAST STROMA



● = ELECTRON TRANSPORT CHAIN COMPONENT

★ = HEAT ENERGY    ★ = CHEMICAL ENERGY

PHOSPHORYLATION

ATP

# GLYCOLYSIS

# OUTCOME

**OUTCOME / GLUCOSE:**

**2 PYRUVATE:      →      KREBS CYCLE**

**2 NADH:            →      ETC**

**2 ATP:              →      METABOLISM**

**!!!2 ATP: NOT PHOSPHORYLATED VIA CHEMIOSMOTIC MODEL!!!**



***GLYCOLYSIS***  
***SUBSTRATE***  
***PHOSPHORYLATION***



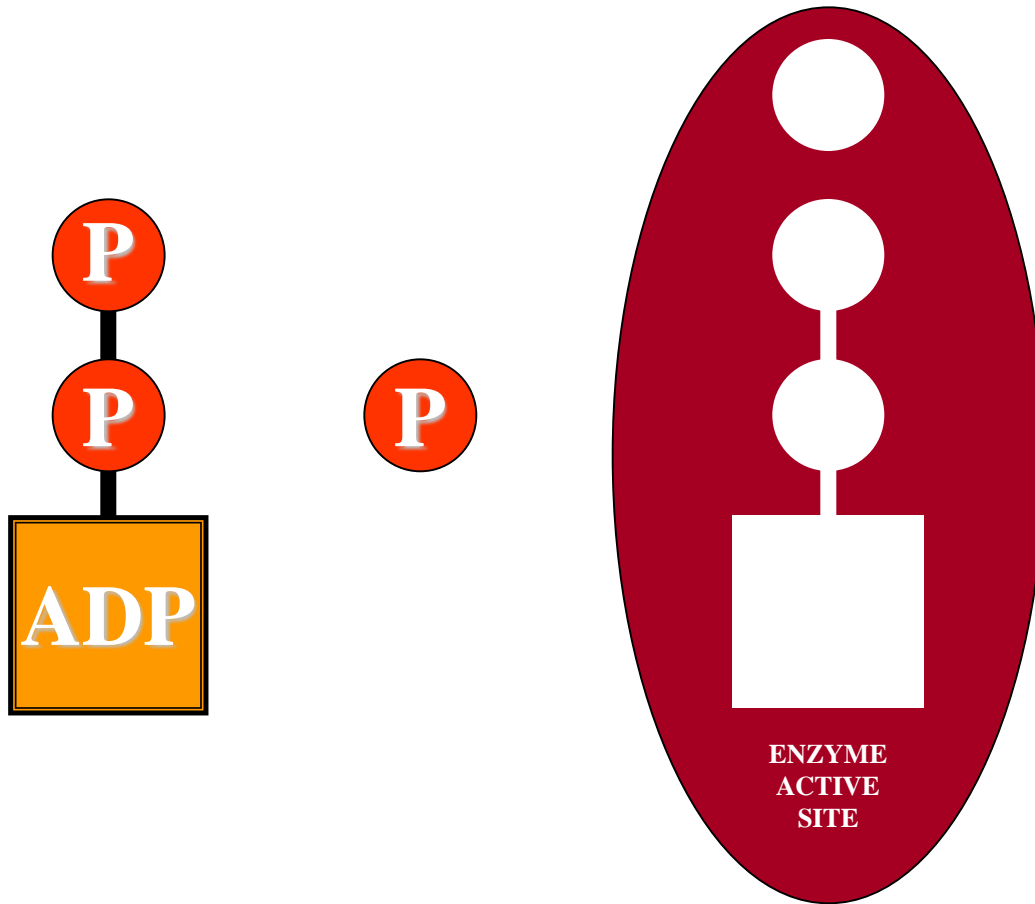
The background of the slide is a grayscale electron micrograph of a mitochondrion. It shows the characteristic internal structure of cristae, which are folded membranes that increase the surface area for enzymatic reactions. The cristae appear as dark, parallel bands within a lighter, granular matrix.

***GLYCOLYSIS***  
***DIRECT ENZYME***  
***PHOSPHORYLATION***

# GLYCOLYSIS



## SUBSTRATE PHOSPHORYLATION

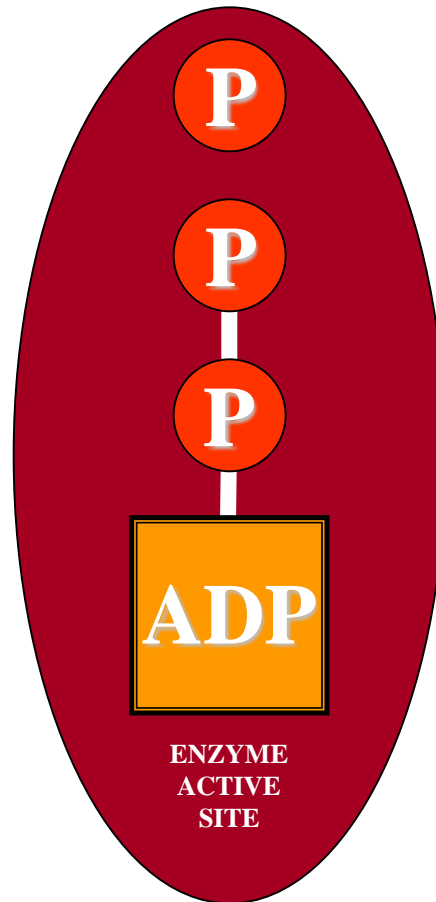


**PYRUVATE KINASE**



# GLYCOLYSIS

## SUBSTRATE PHOSPHORYLATION

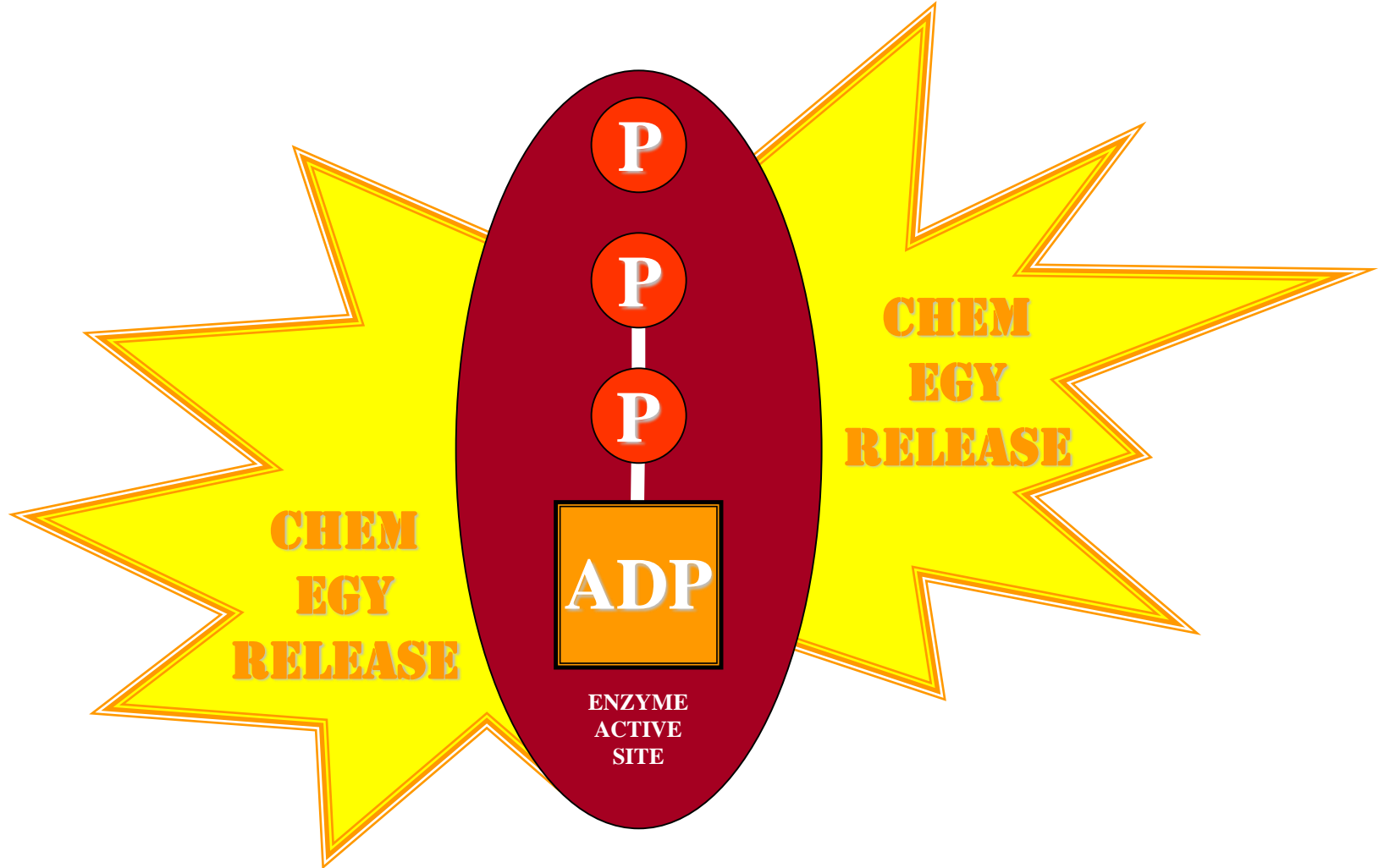


# PYRUVATE KINASE

# GLYCOLYSIS

EX

## SUBSTRATE PHOSPHORYLATION



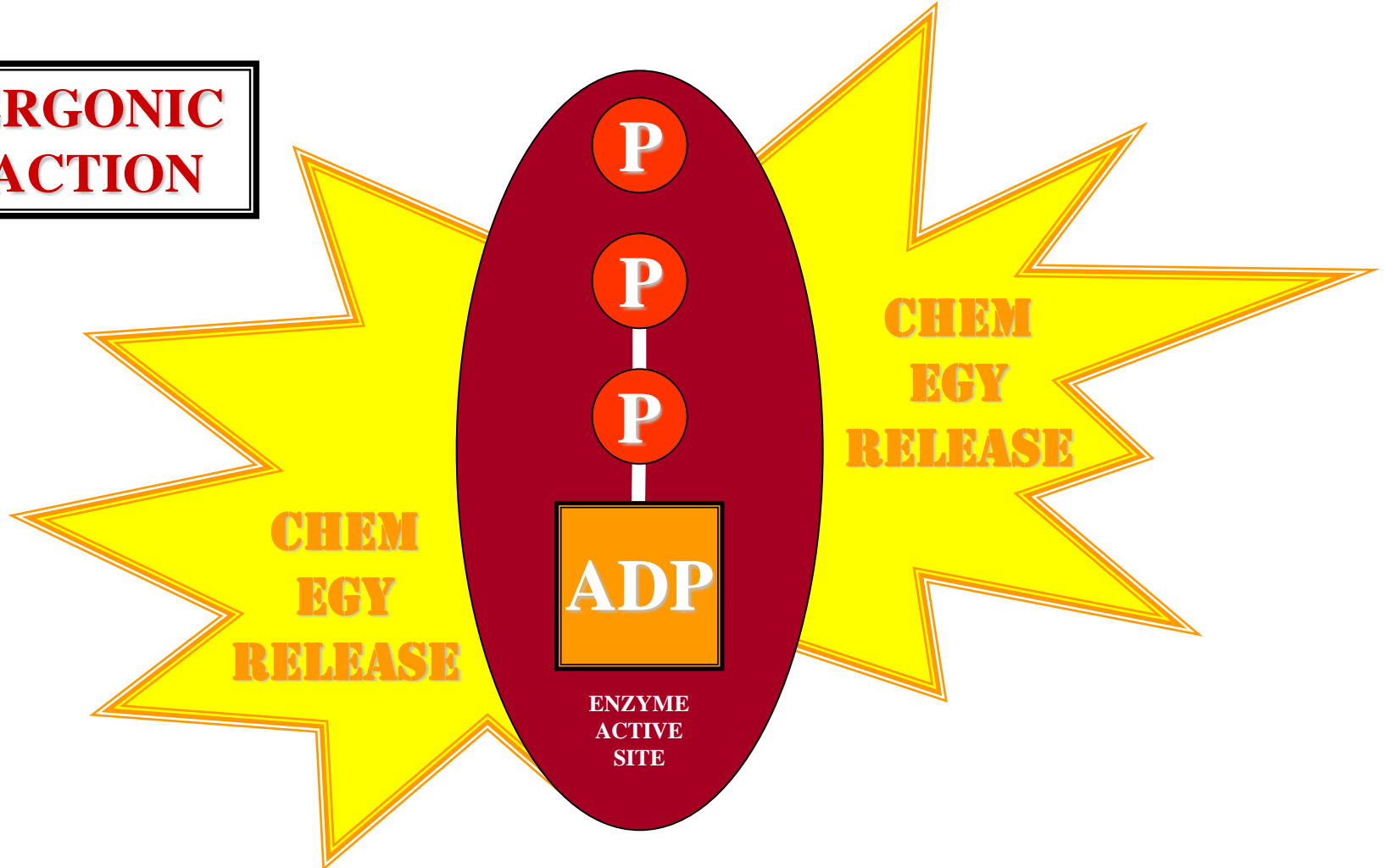
# PYRUVATE KINASE

# GLYCOLYSIS

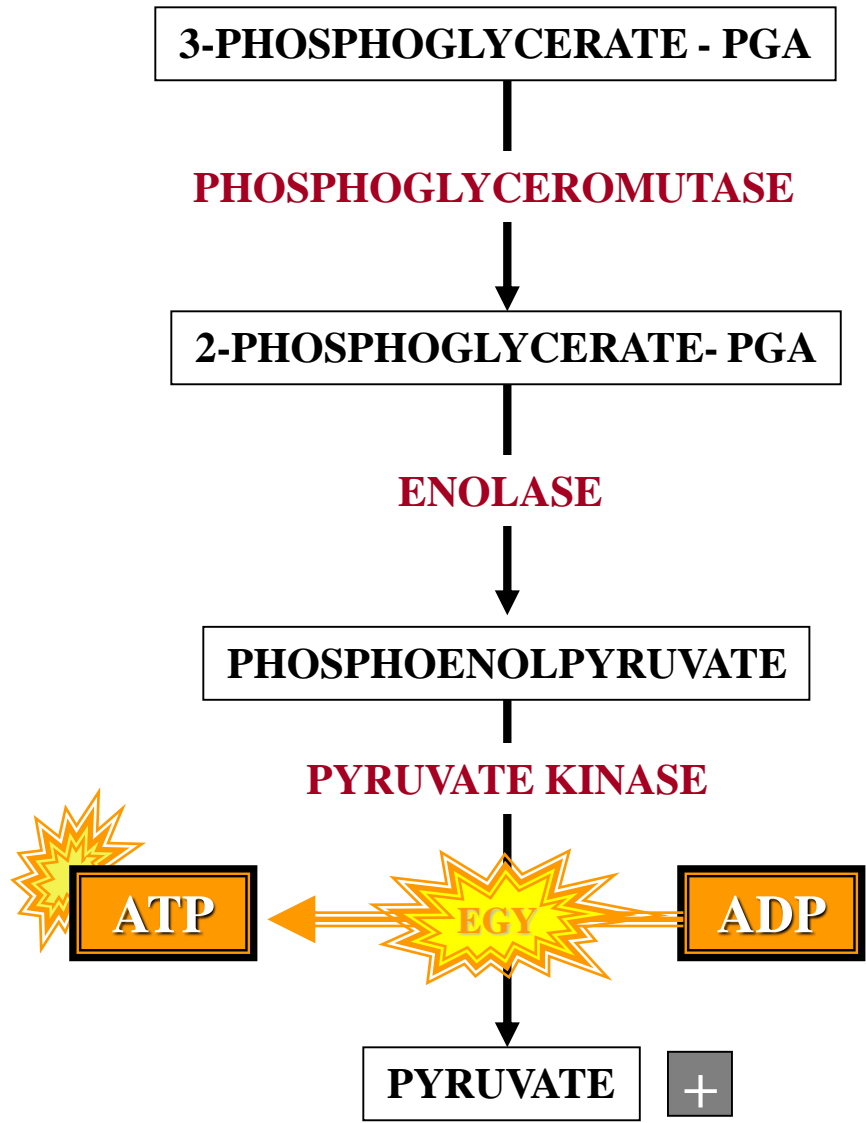
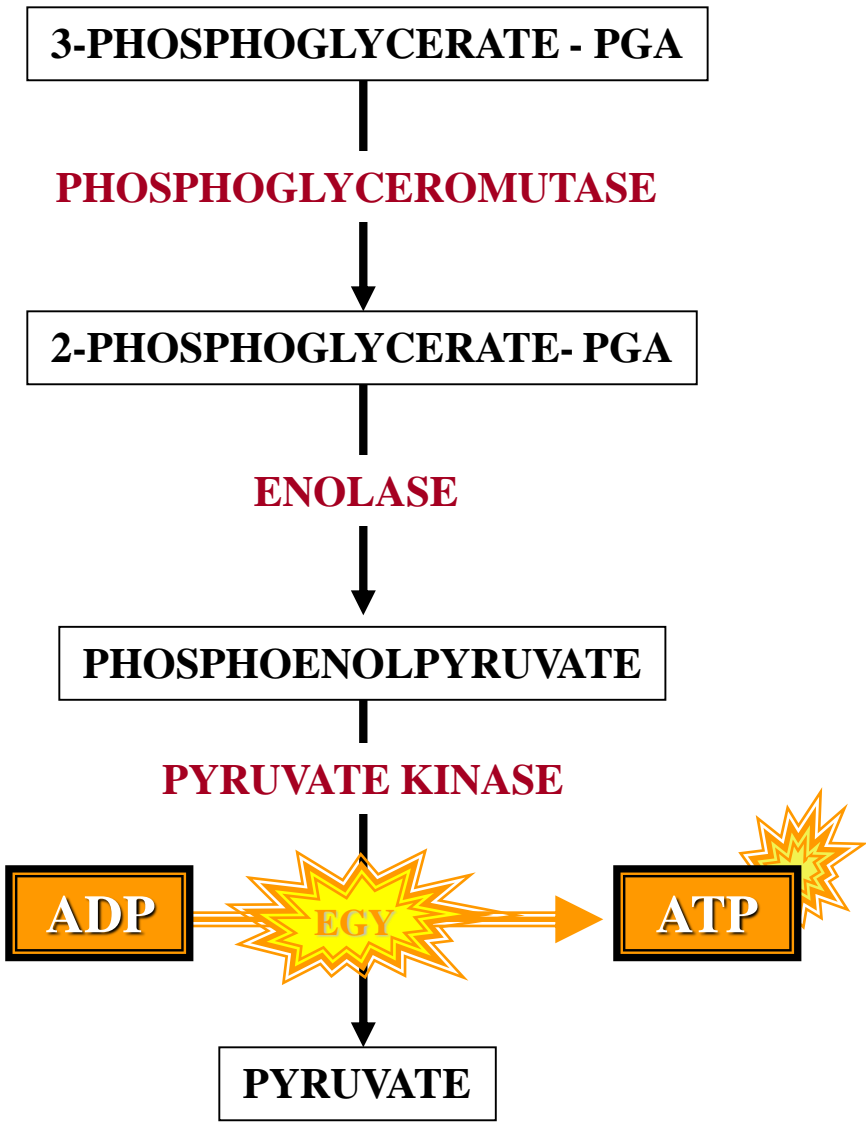


## SUBSTRATE PHOSPHORYLATION

**EXERGONIC  
REACTION**



**PYRUVATE KINASE**



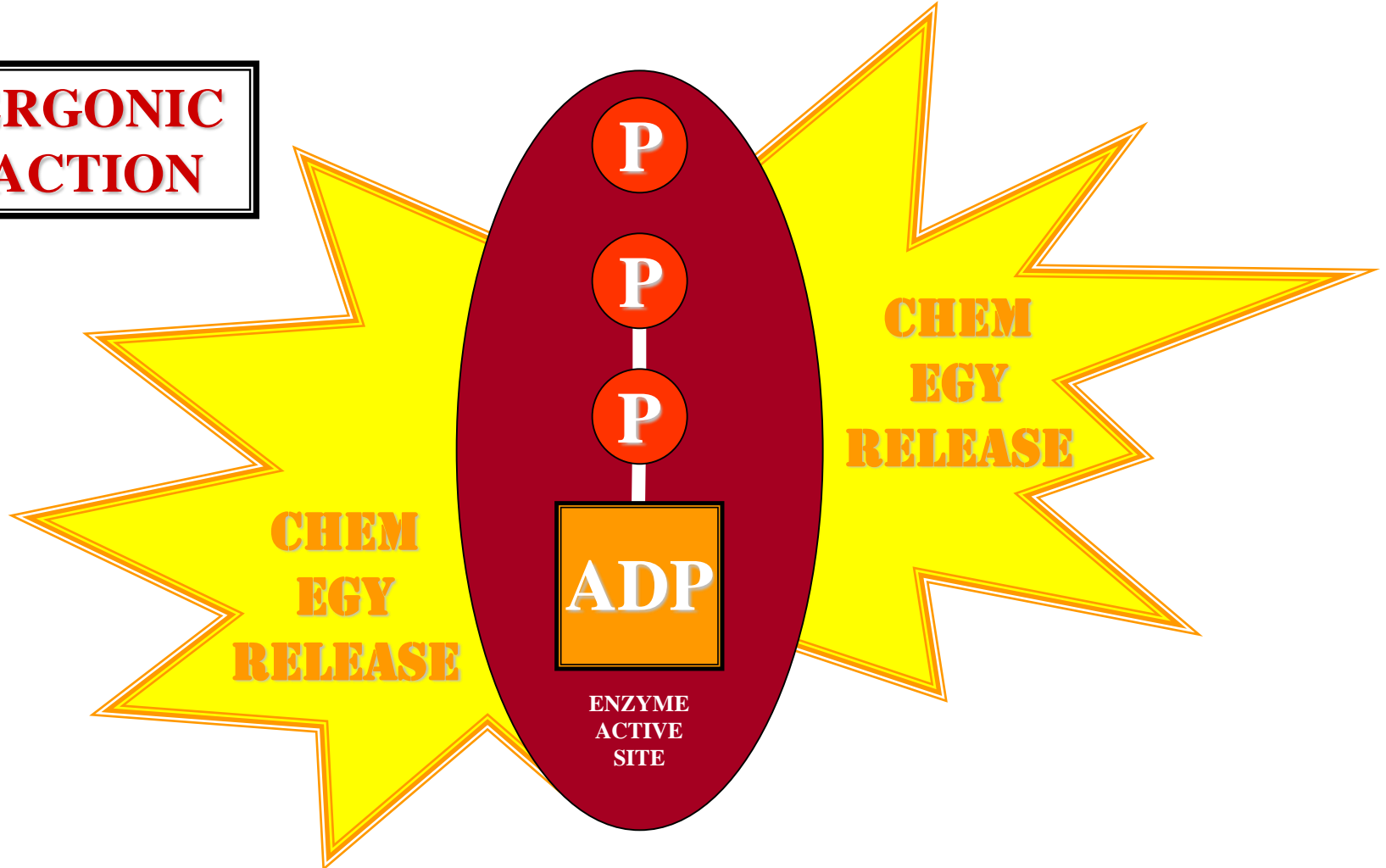
 = CHEM ENERGY

# GLYCOLYSIS

P

## SUBSTRATE PHOSPHORYLATION

**EXERGONIC  
REACTION**



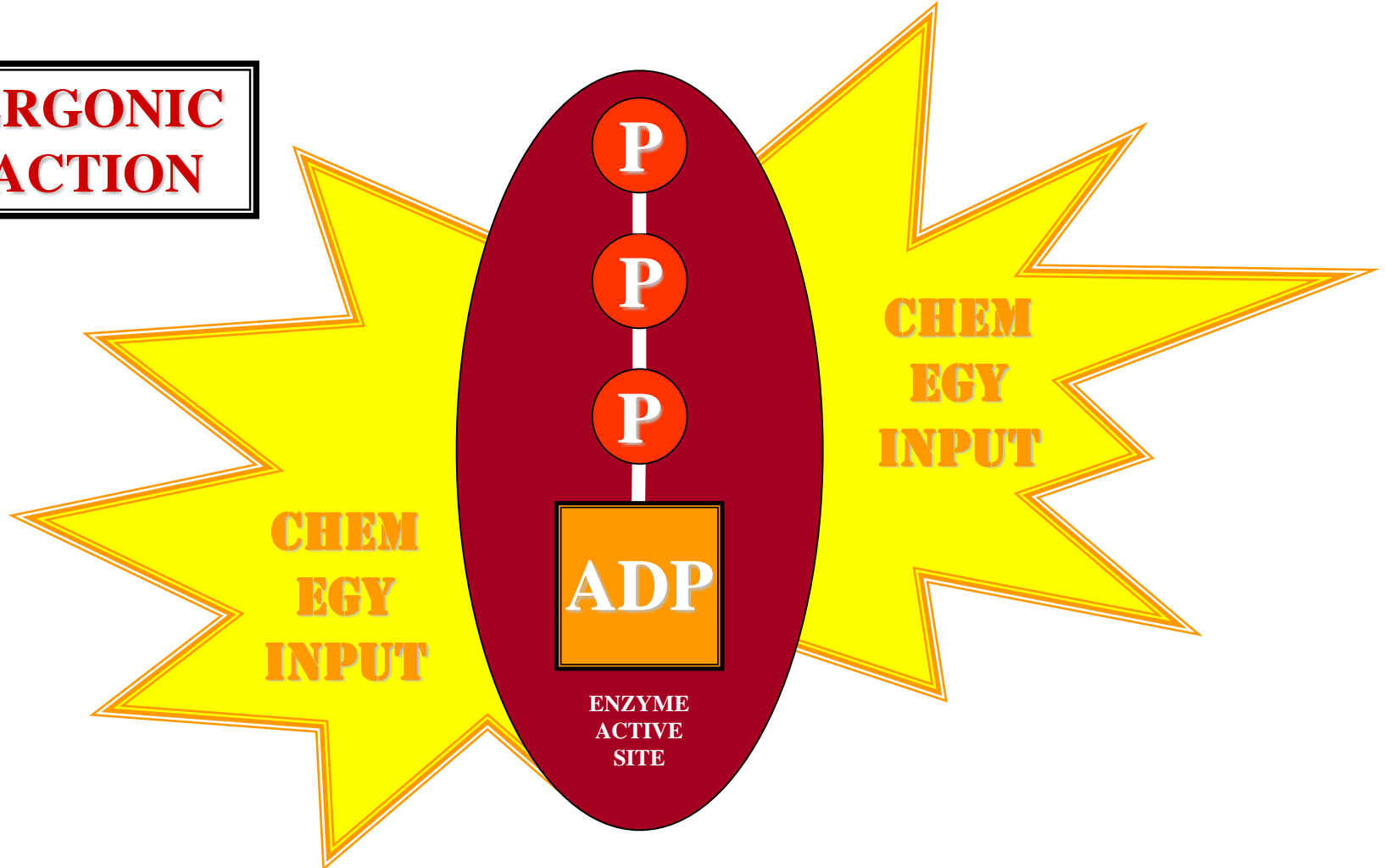
**PYRUVATE KINASE**

# GLYCOLYSIS

EN

## SUBSTRATE PHOSPHORYLATION

**EXERGONIC  
REACTION**

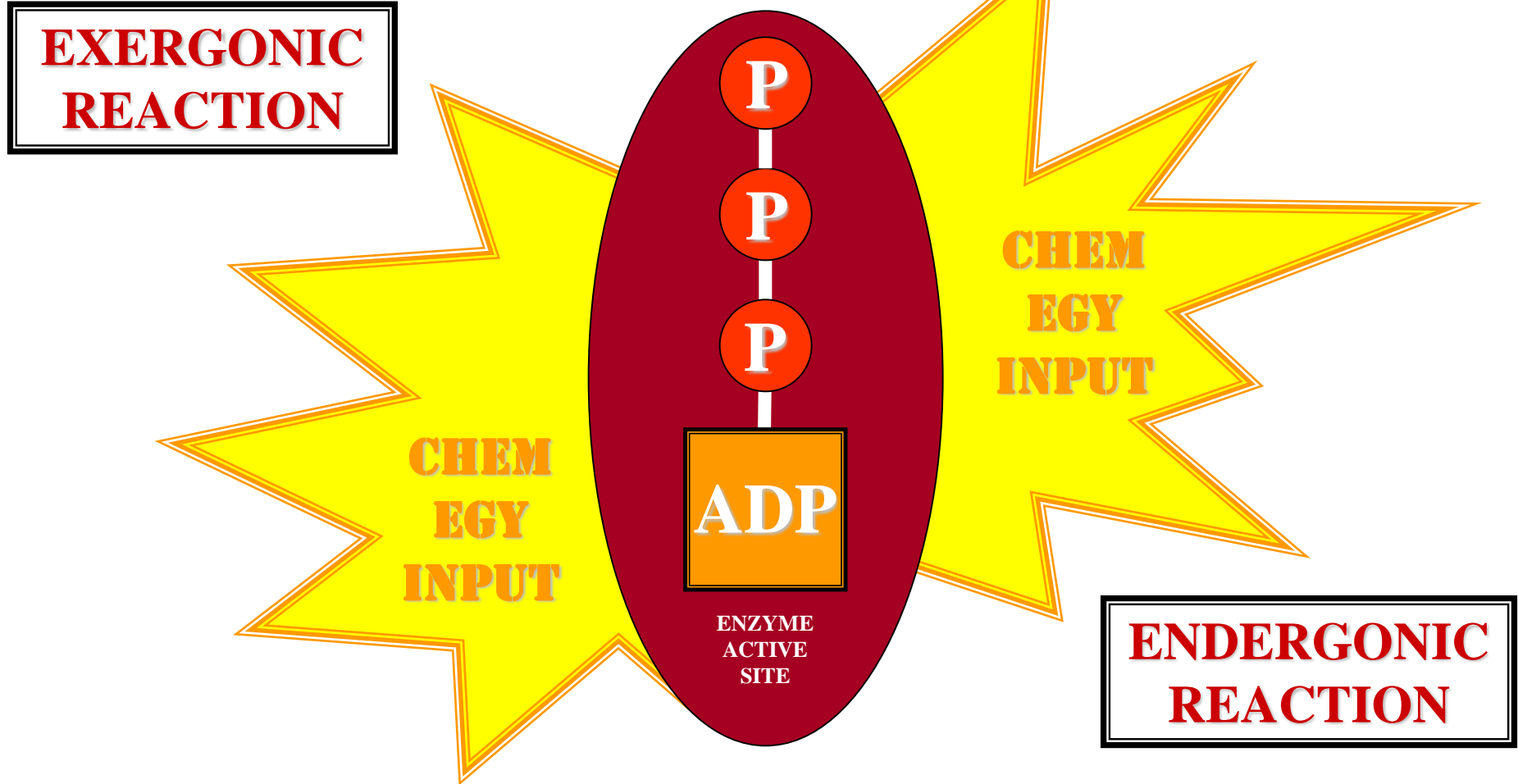


**PYRUVATE KINASE**



# GLYCOLYSIS

## SUBSTRATE PHOSPHORYLATION

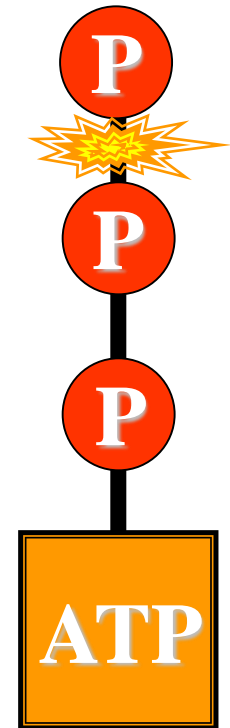
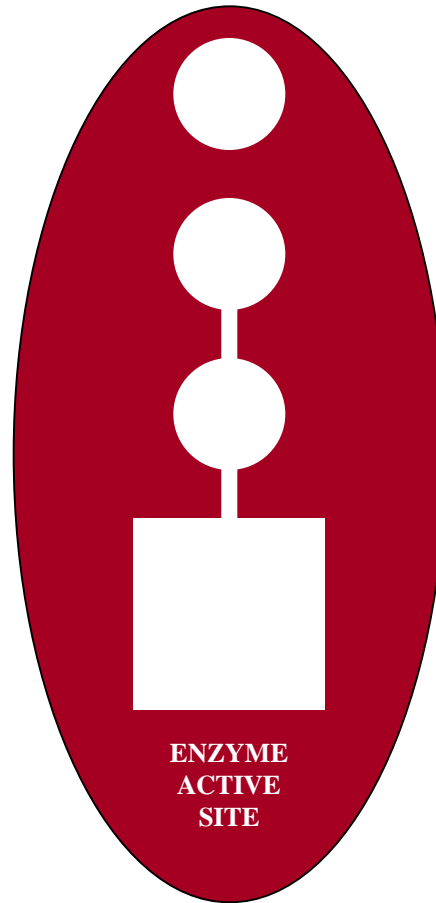


# PYRUVATE KINASE

# GLYCOLYSIS



## SUBSTRATE PHOSPHORYLATION



 = CHEM ENERGY

## PYRUVATE KINASE

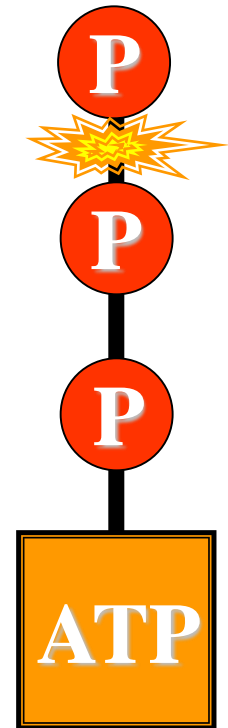
# GLYCOLYSIS



ETC

## SUBSTRATE PHOSPHORYLATION

**DIRECT ENZYME  
SUBSTRATE  
PHOSPHORYLATION**

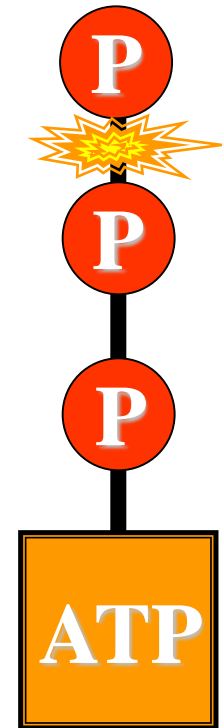


 = CHEM ENERGY

# GLYCOLYSIS

## SUBSTRATE PHOSPHORYLATION

**DIRECT ENZYME  
SUBSTRATE  
PHOSPHORYLATION**



**!!!ETC: ABSENT!!!**

 = CHEM ENERGY



# GLYCOLYSIS

## ATP NET



# **GLYCOLYSIS**

## **ATP NET**

### **?**



# GLYCOLYSIS

## ATP NET

### 2 ATP

# METABOLISM

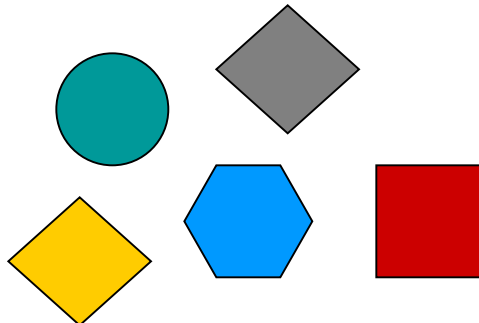
## GLUCOSE



**CATABOLIC  
METABOLISM**

**AEROBIC  
RESPIRATION**

**GLYCOLYSIS**



**BUILDING BLOCKS**



**AM**



# METABOLISM

## GLUCOSE



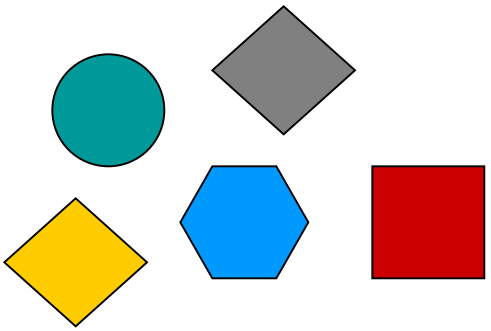
**CATABOLIC METABOLISM**

**AEROBIC RESPIRATION**

**GLYCOLYSIS**



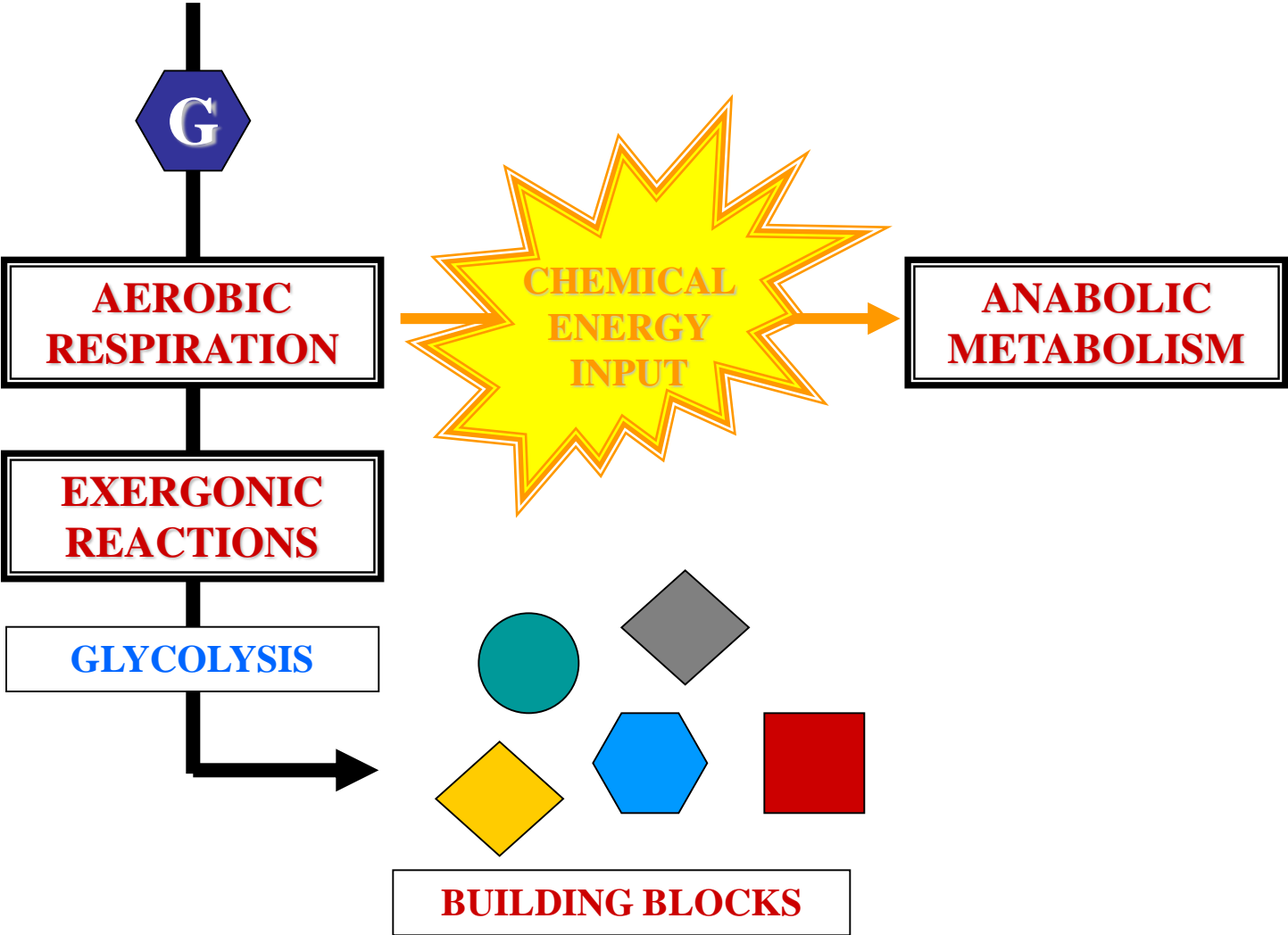
**ANABOLIC METABOLISM**



**BUILDING BLOCKS**

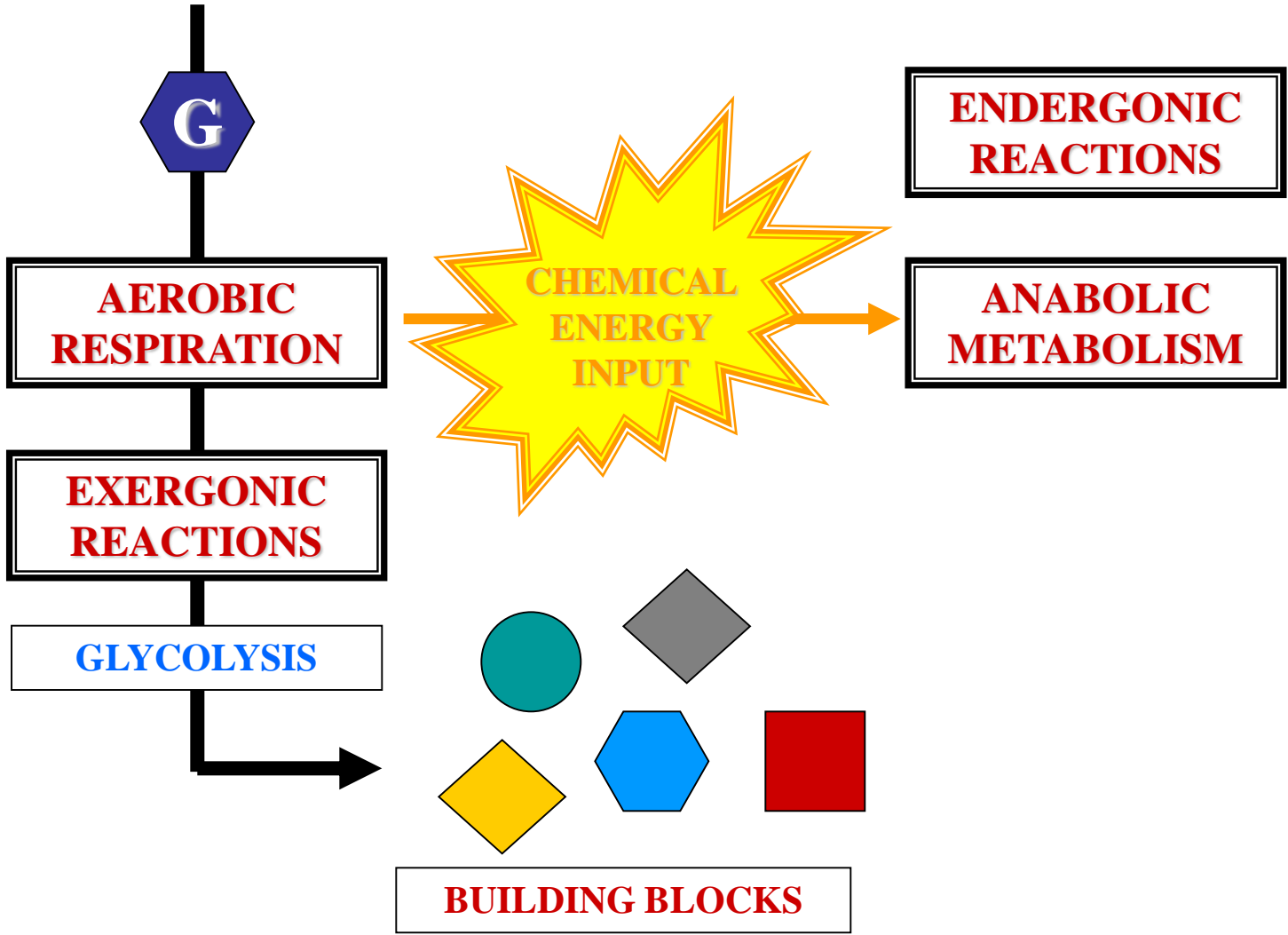
# METABOLISM

## GLUCOSE



# METABOLISM

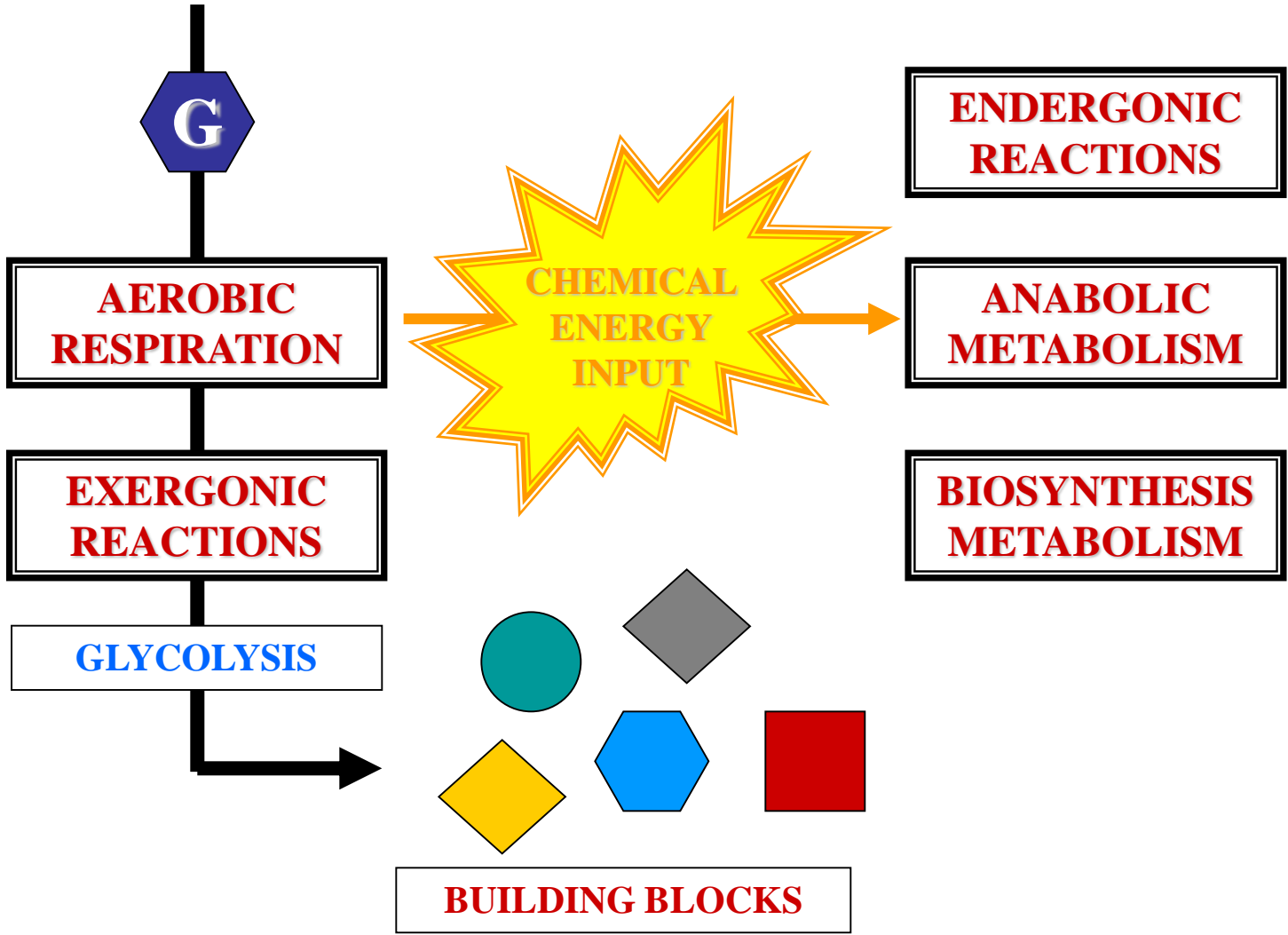
## GLUCOSE





# METABOLISM

## GLUCOSE

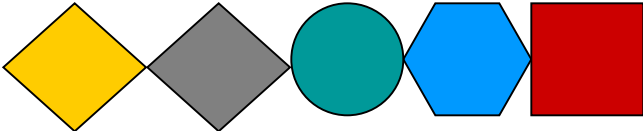




# METABOLISM

## GLUCOSE

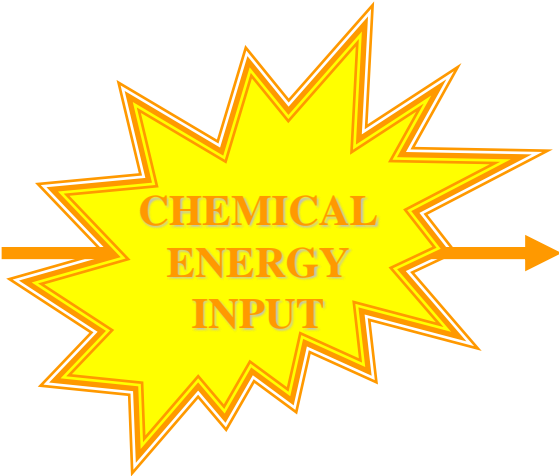
## COMPLEX BIO-CHEM-CMPS



**AEROBIC  
RESPIRATION**

**EXERGONIC  
REACTIONS**

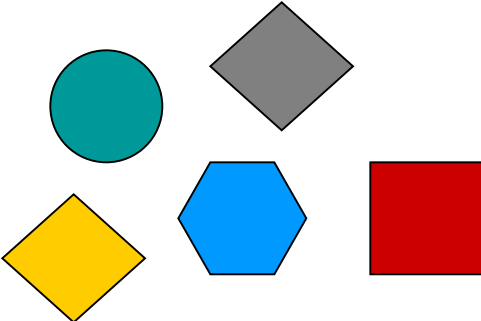
**GLYCOLYSIS**



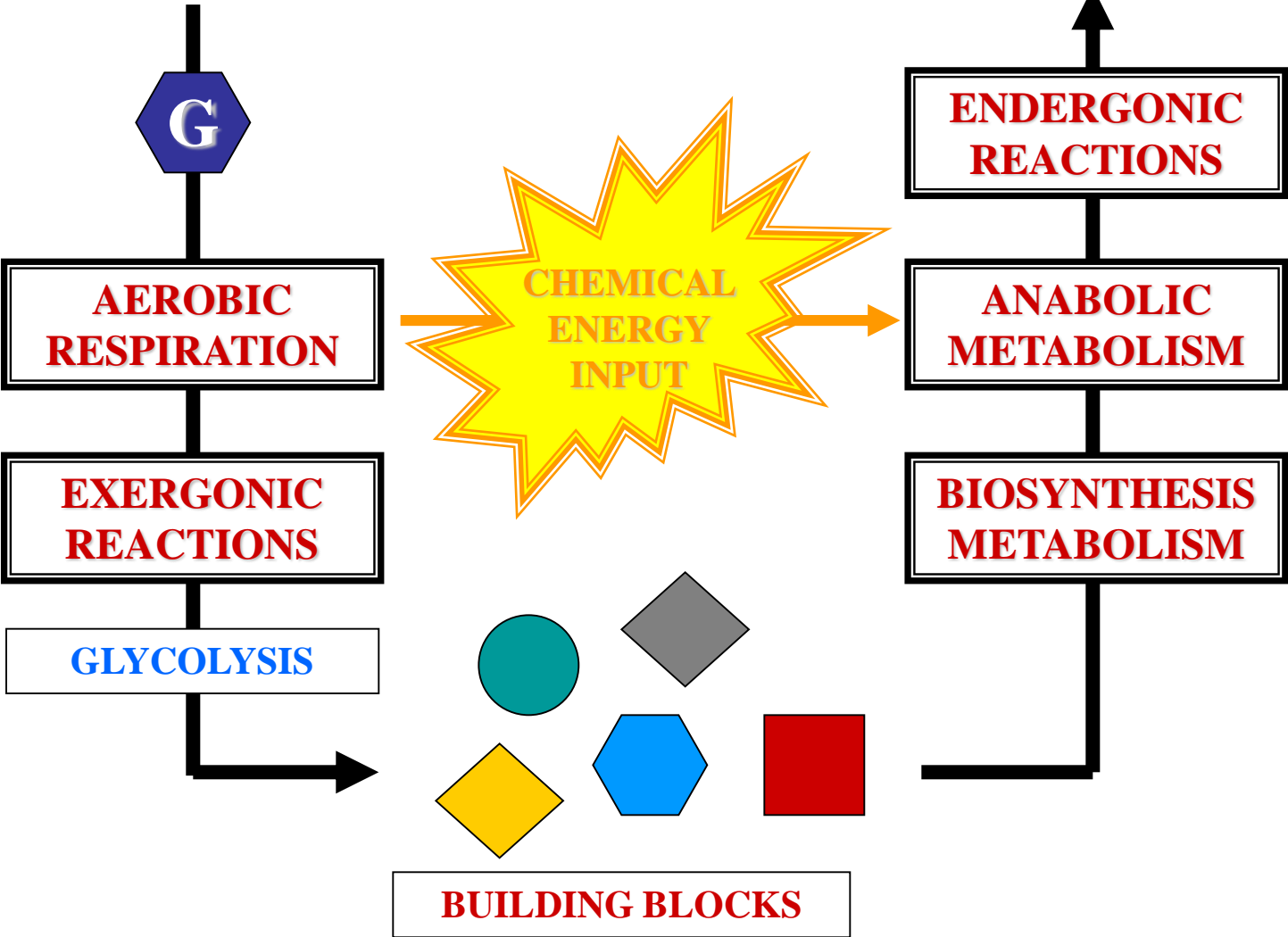
**ENDERGONIC  
REACTIONS**

**ANABOLIC  
METABOLISM**

**BIOSYNTHESIS  
METABOLISM**



**BUILDING BLOCKS**



***CELL  
GROWTH  
&  
MAINTENANCE***

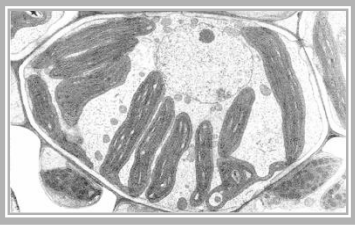


# ***HOMEOSTASIS***

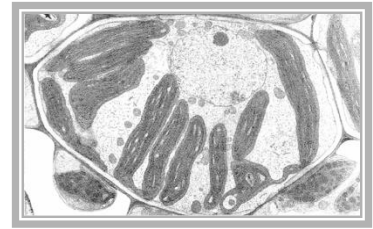


# **GLYCOLYSIS SUMMARY**

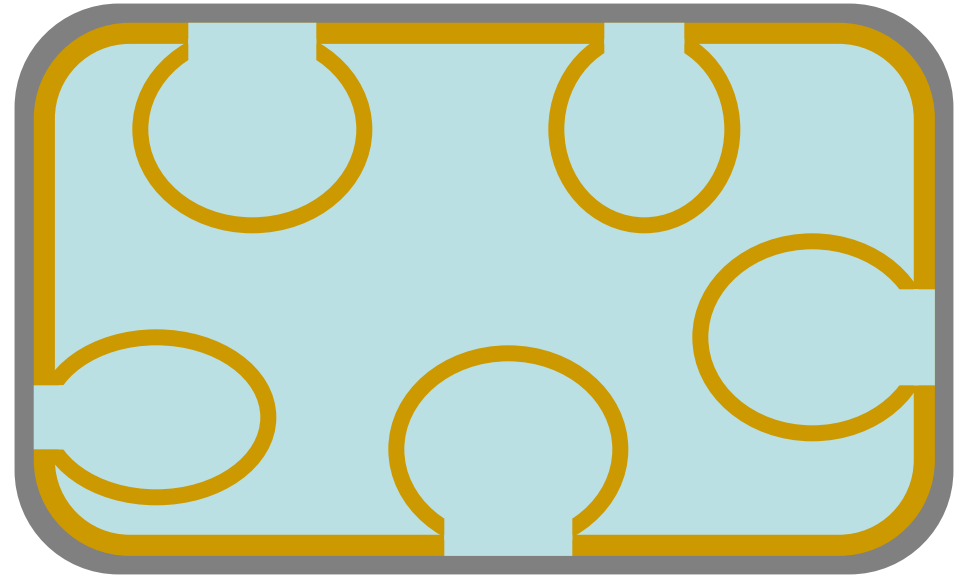




# AEROBIC RESPIRATION

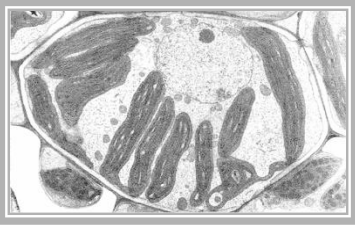


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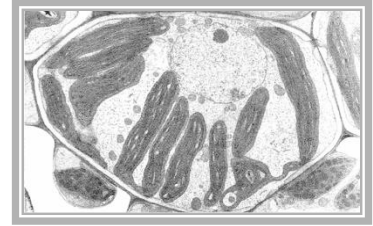


**CELL**

 = CHEMICAL ENERGY



# AEROBIC RESPIRATION

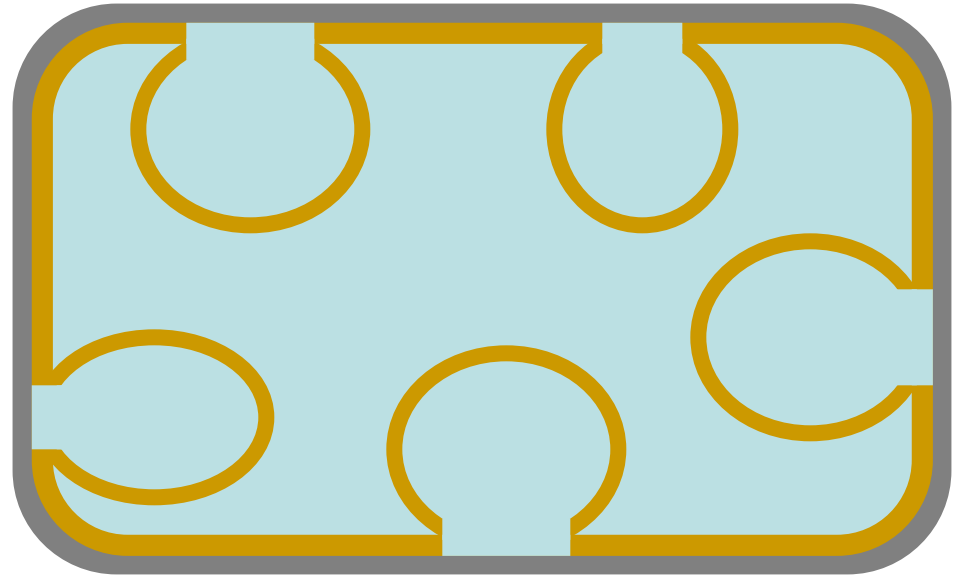


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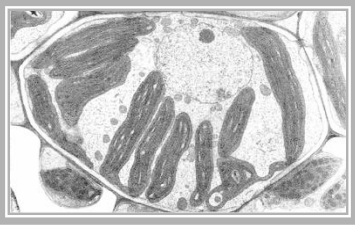
GLYCOLYSIS

CYTOSOL

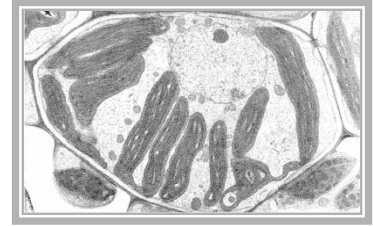
CELL



 = CHEMICAL ENERGY



# AEROBIC RESPIRATION



S

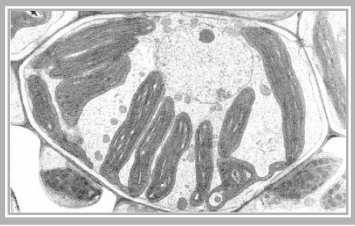
GLYCOLYSIS

GLUCOSE

CYTOSOL

CELL

 = CHEMICAL ENERGY



# AEROBIC RESPIRATION



P

GLYCOLYSIS

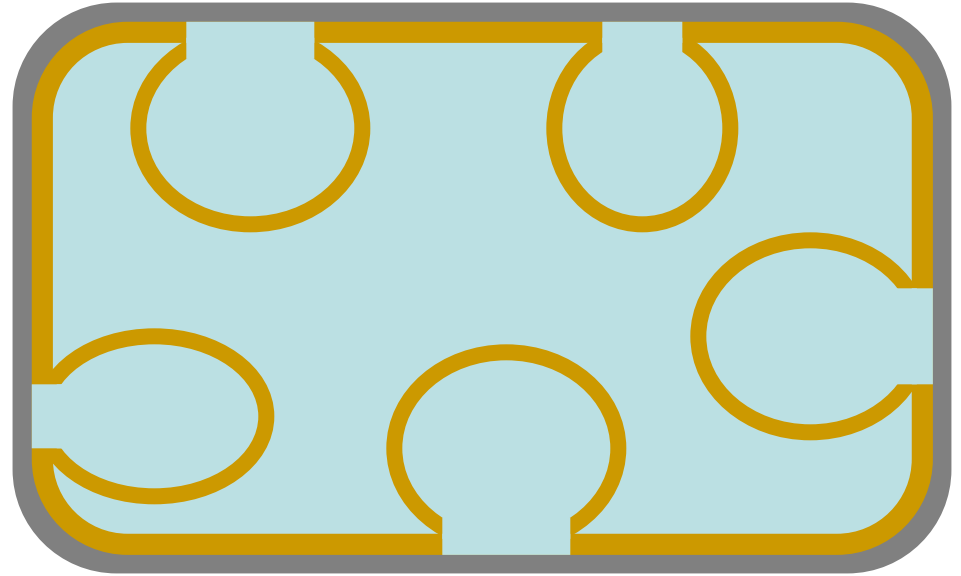
GLUCOSE

SPLIT

CYTOSOL

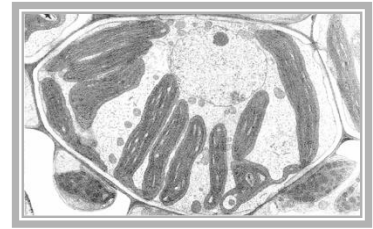
CELL

 = CHEMICAL ENERGY





# AEROBIC RESPIRATION



K

GLYCOLYSIS

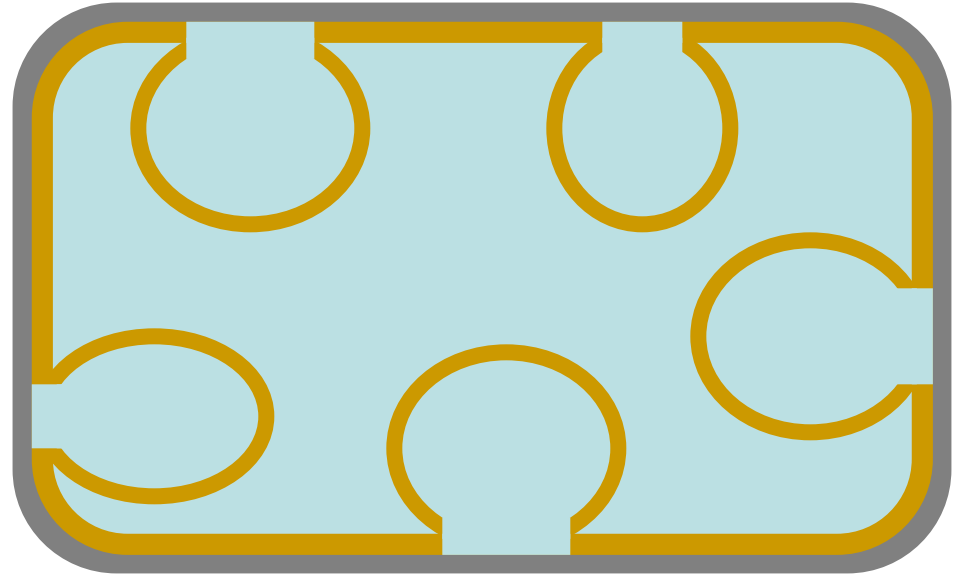
GLUCOSE

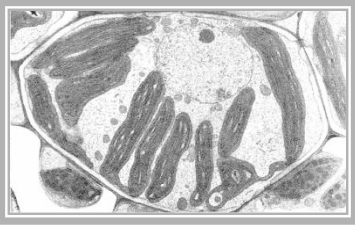


2 PYRUVATE

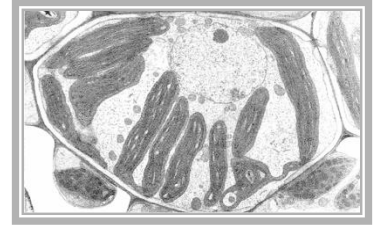
CYTOSOL

CELL



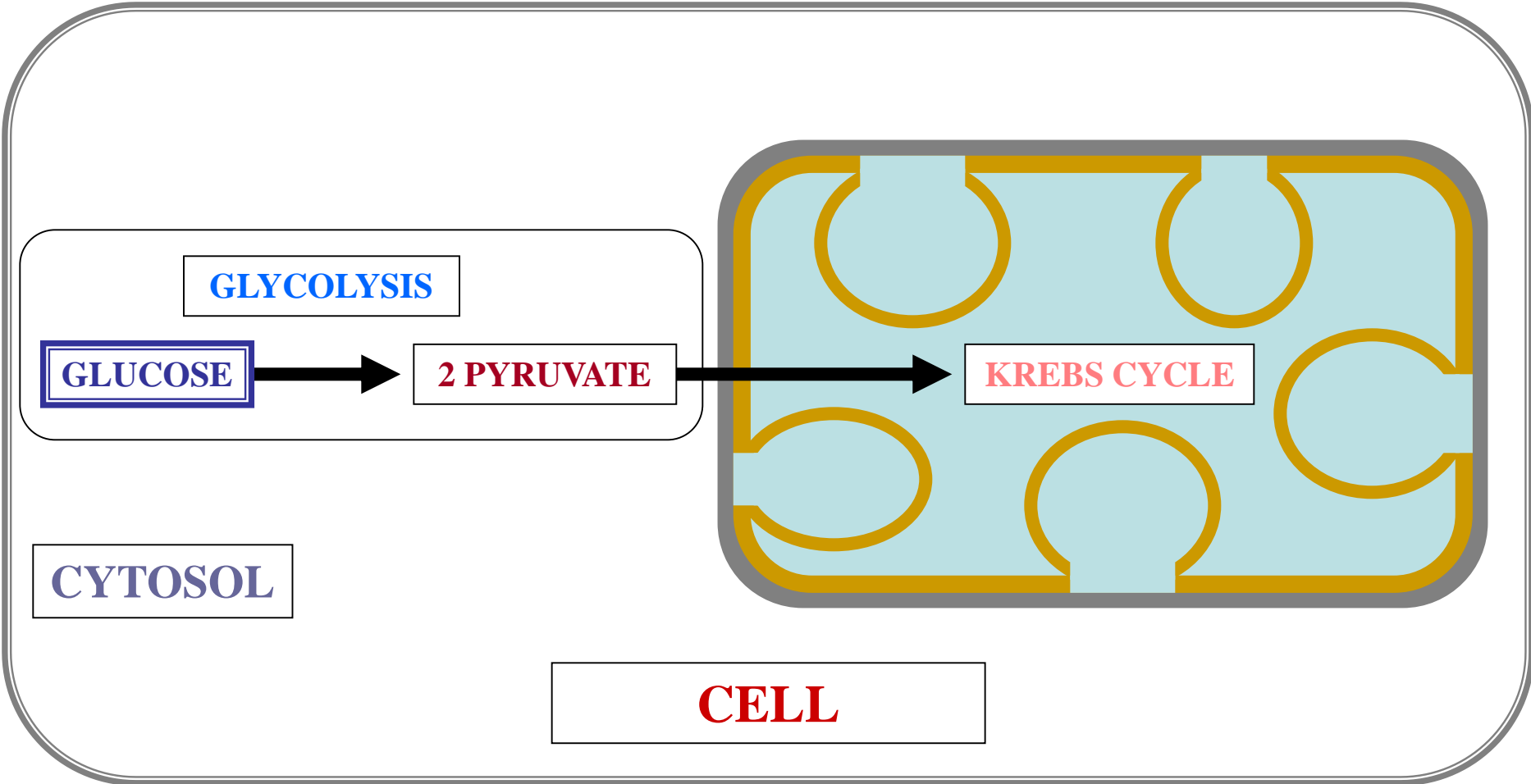


# AEROBIC RESPIRATION



?

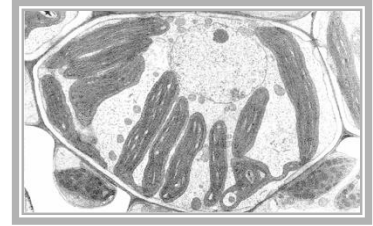
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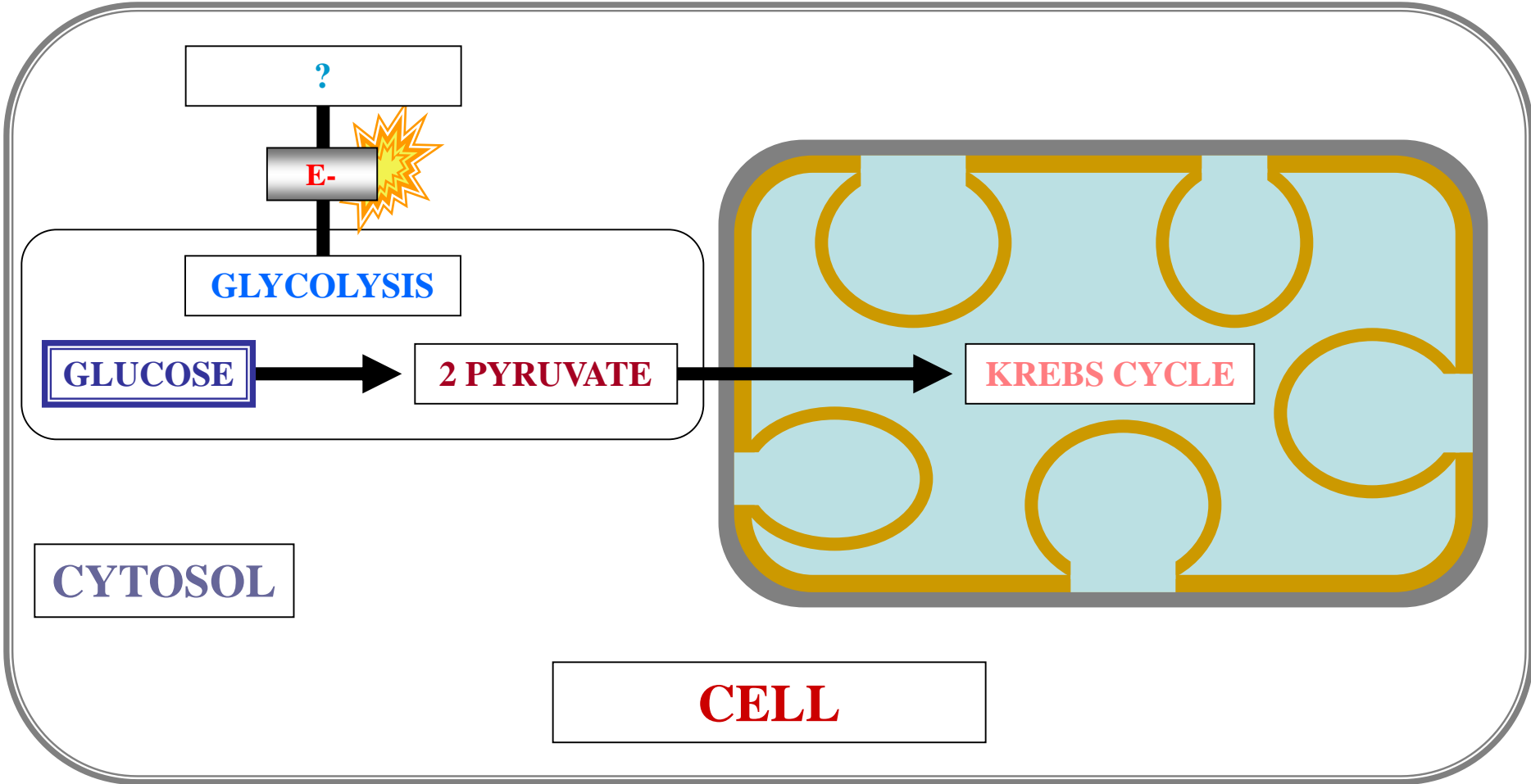
 = CHEMICAL ENERGY



# AEROBIC RESPIRATION



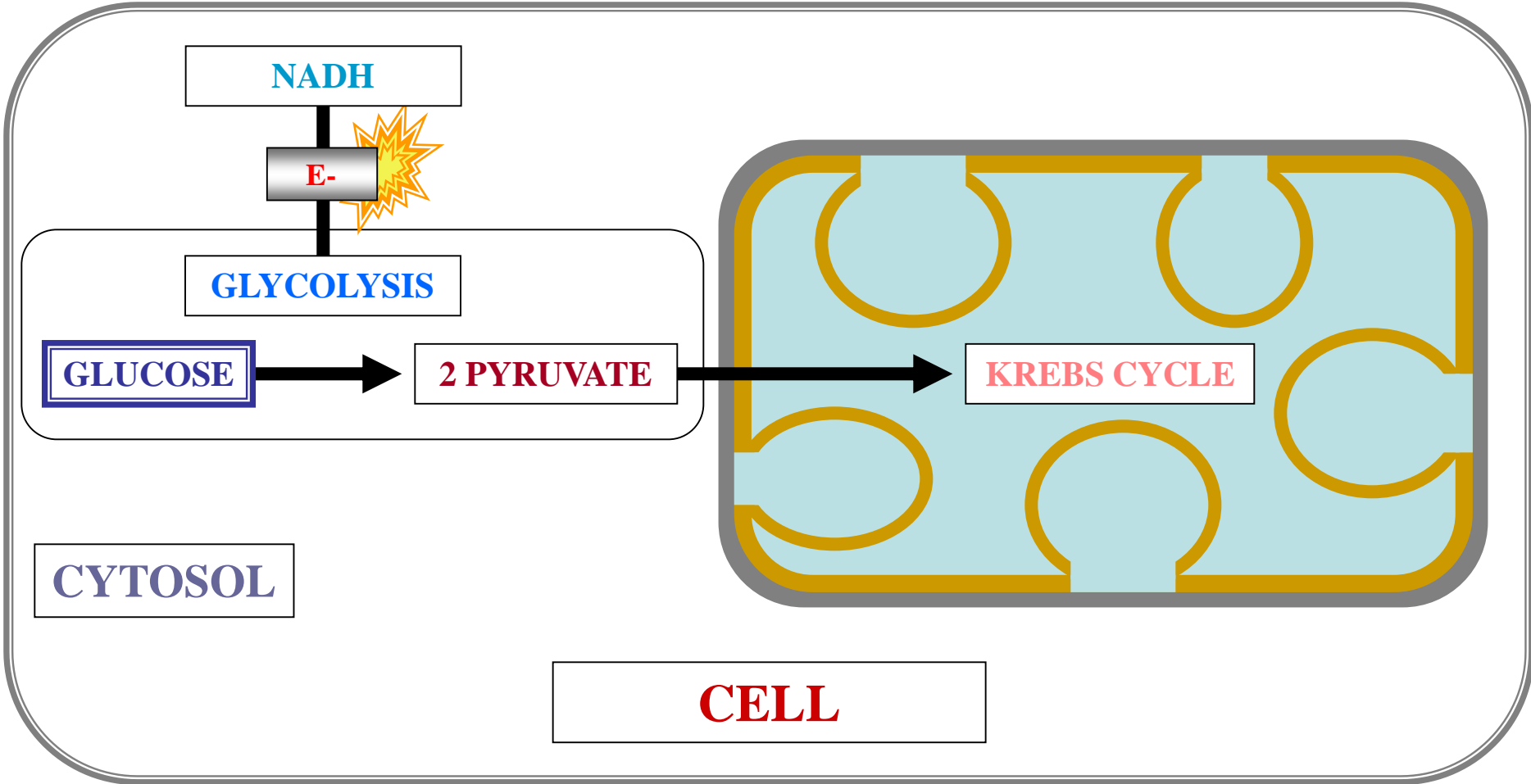
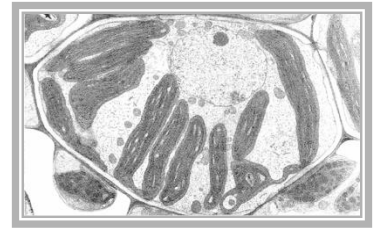
N



 = CHEMICAL ENERGY

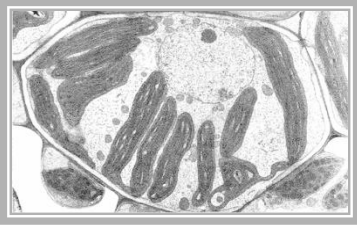


# AEROBIC RESPIRATION

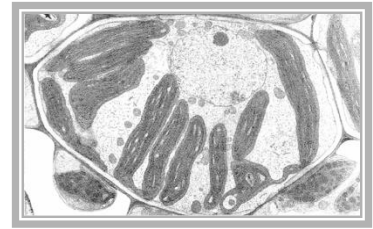


 = CHEMICAL ENERGY

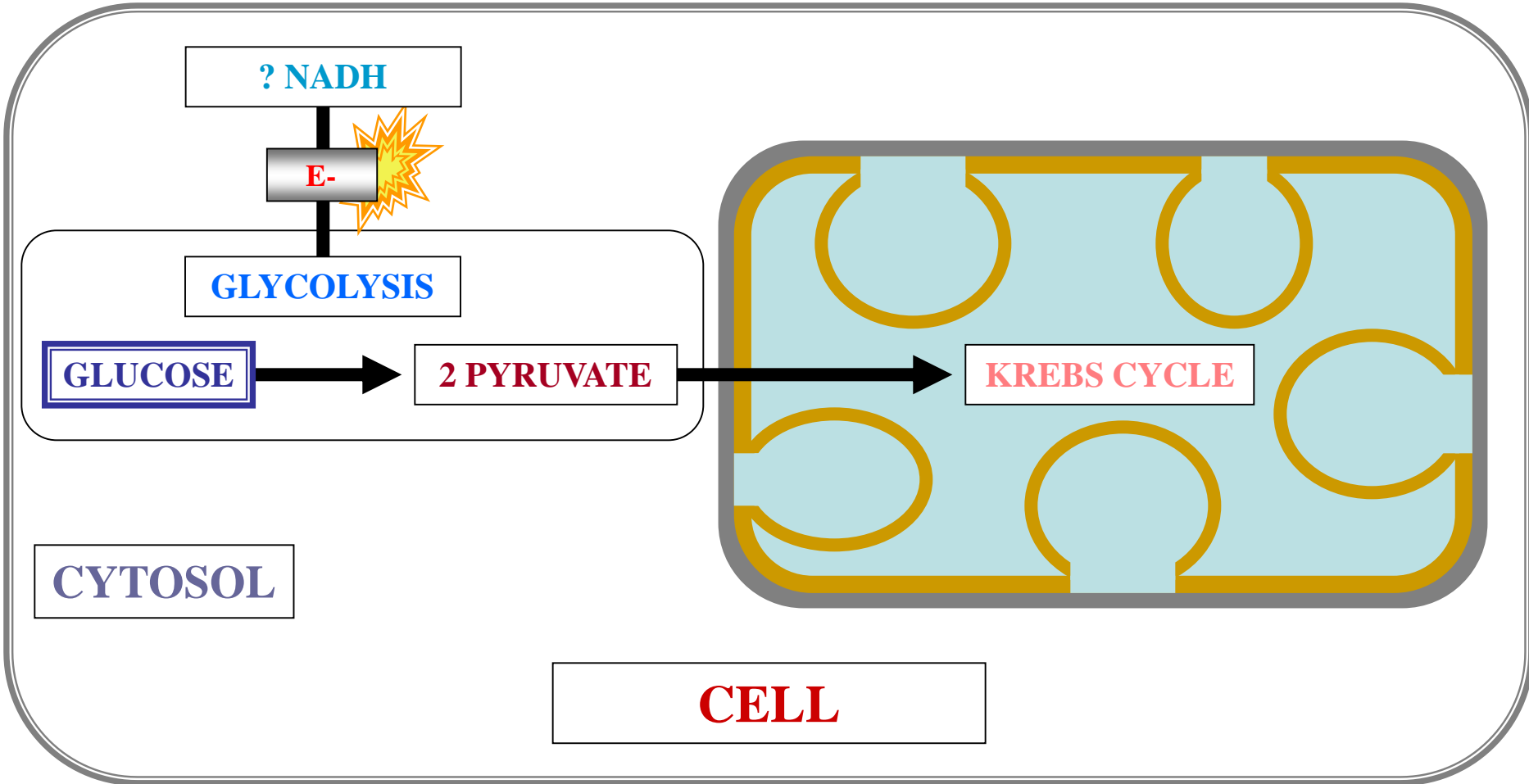




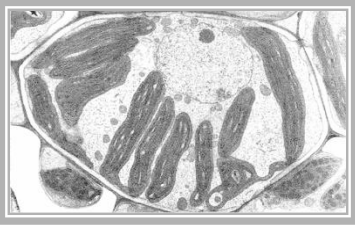
# AEROBIC RESPIRATION



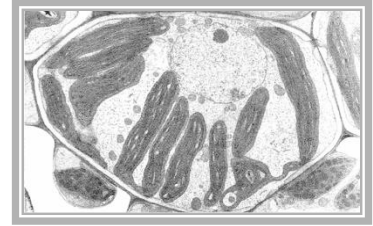
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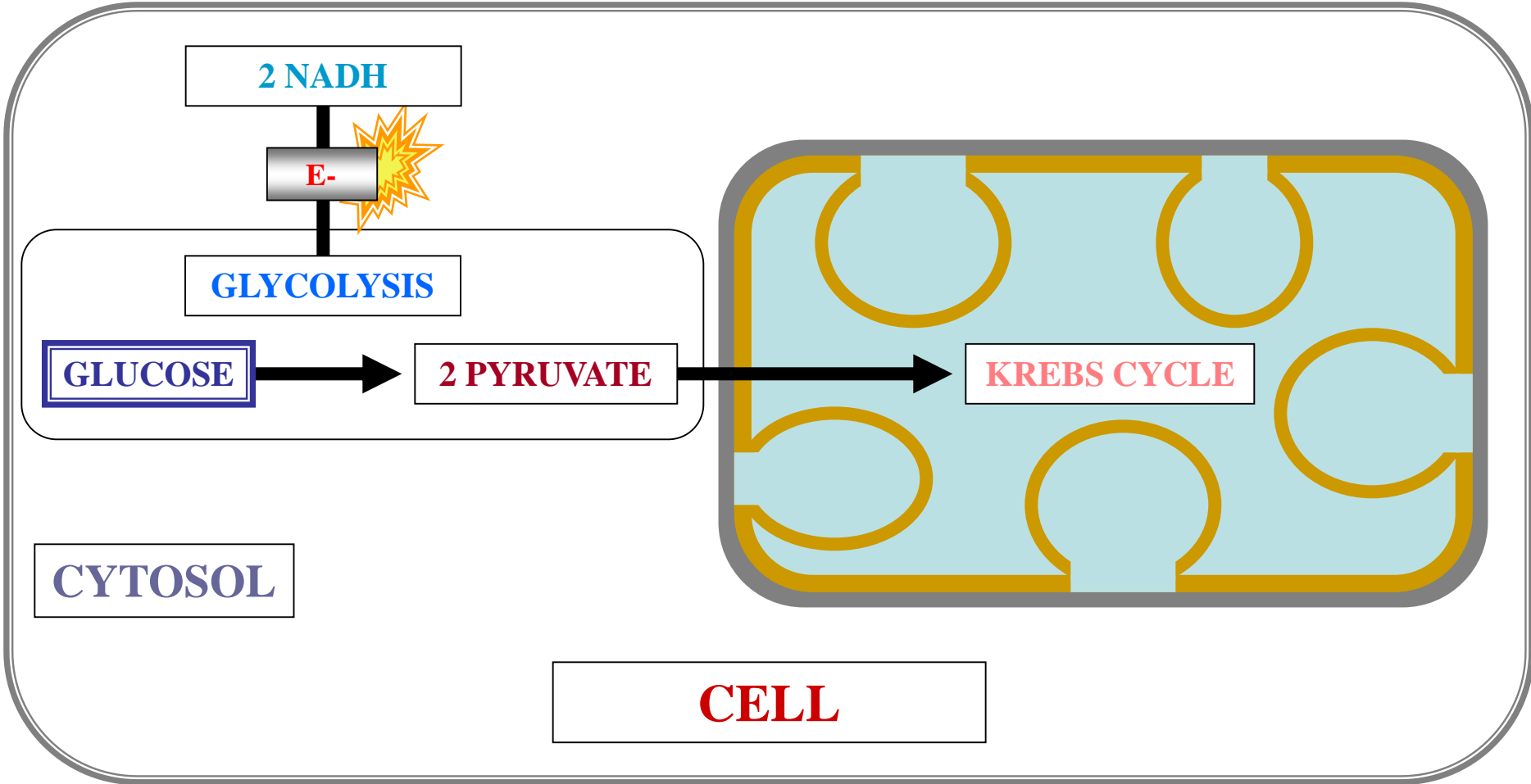
 = **CHEMICAL ENERGY**



# AEROBIC RESPIRATION

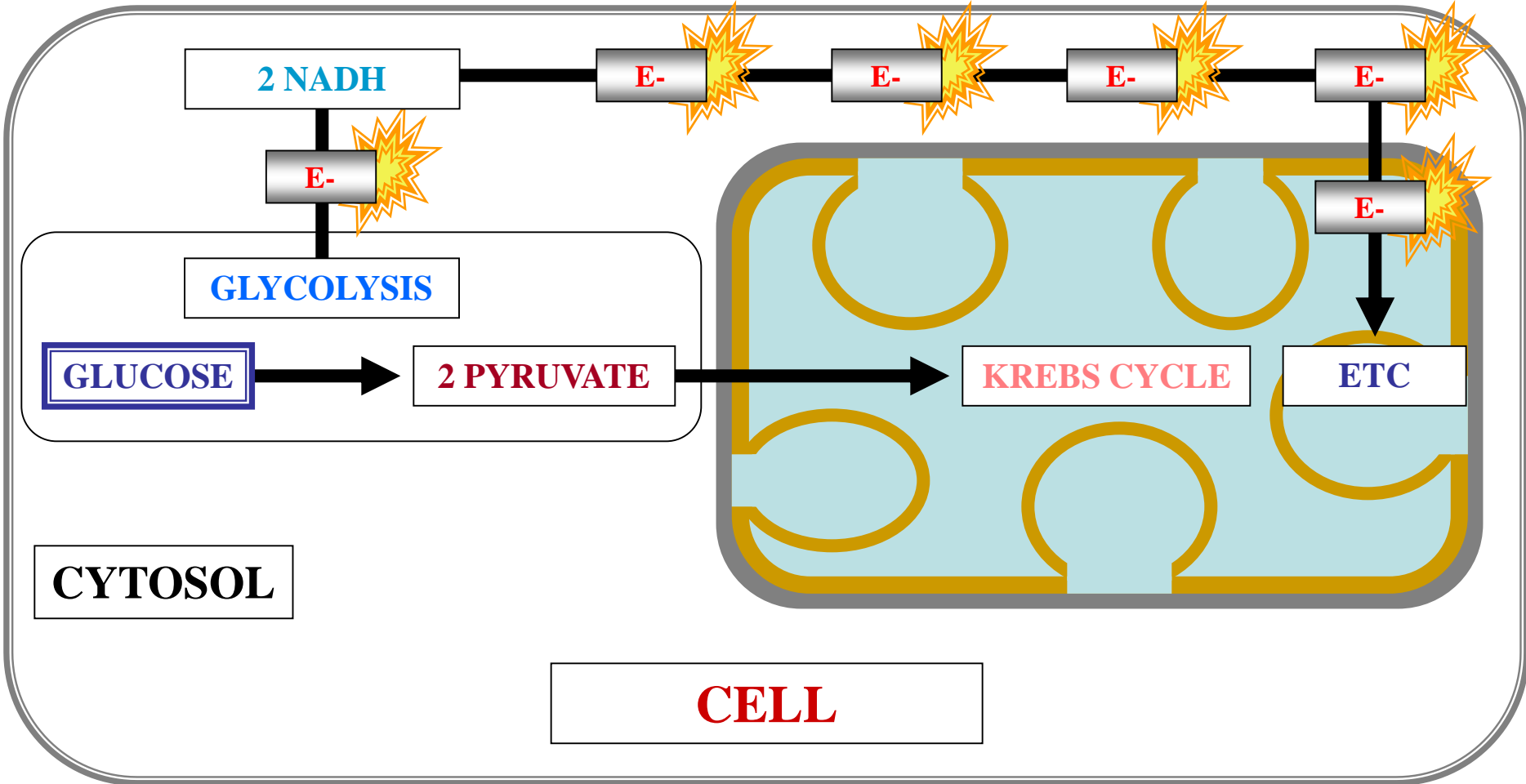
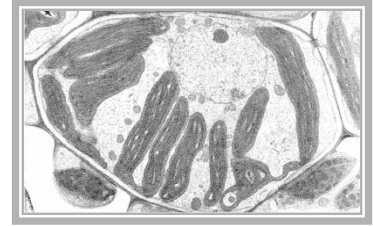
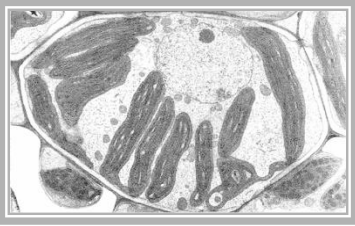


E

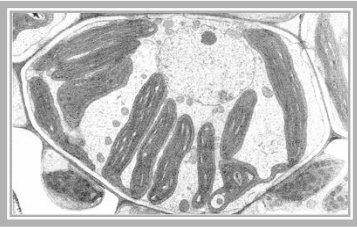


 = CHEMICAL ENERGY

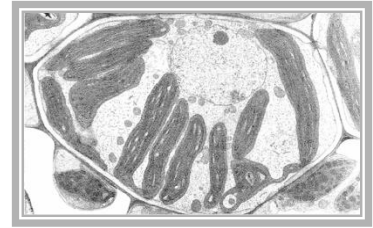
# AEROBIC RESPIRATION



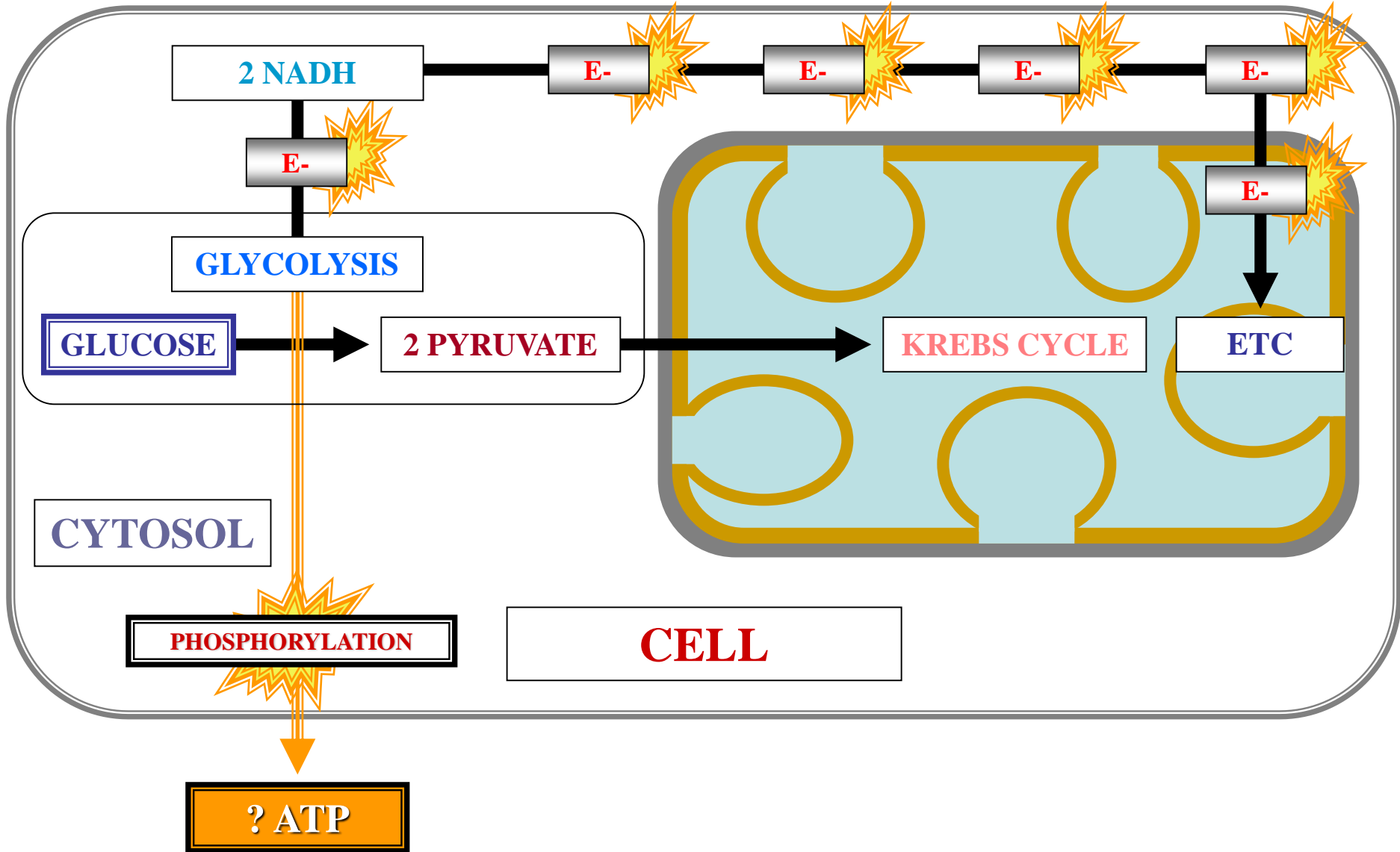
 = CHEMICAL ENERGY

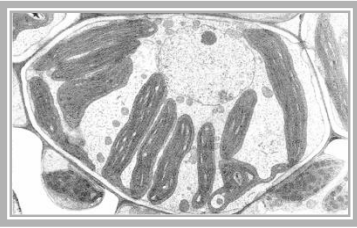


# AEROBIC RESPIRATION

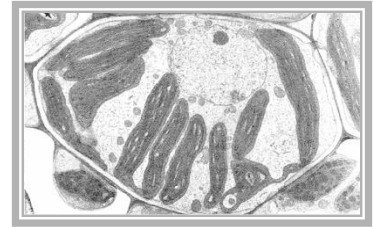


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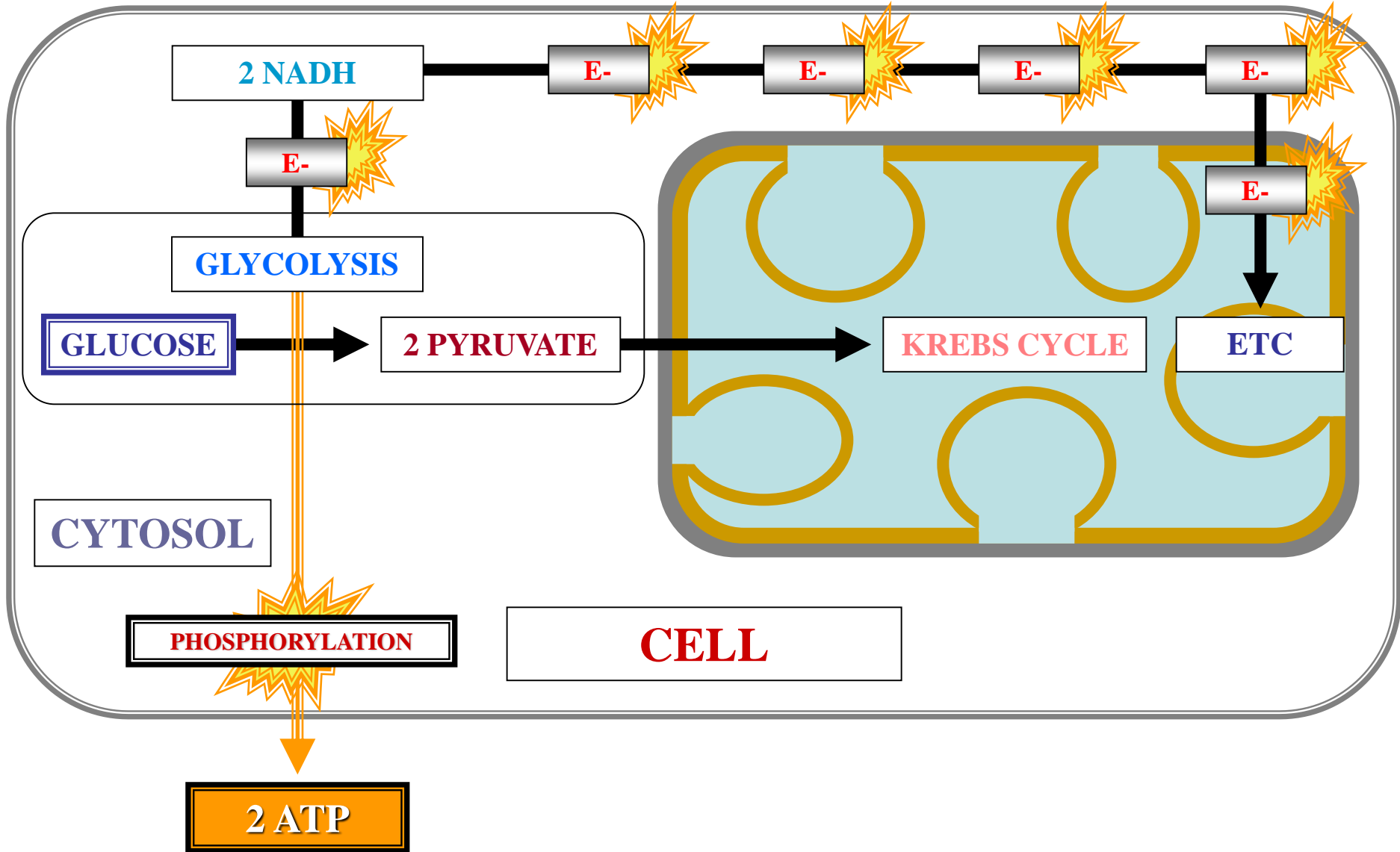




# AEROBIC RESPIRATION



**P**  
**D**

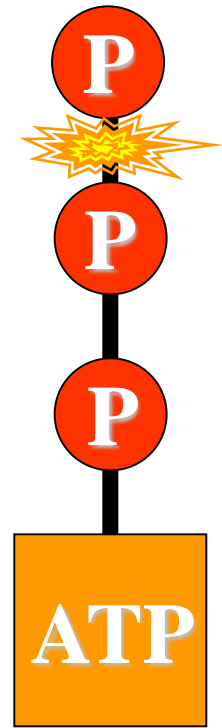




# GLYCOLYSIS

## SUBSTRATE PHOSPHORYLATION

**DIRECT ENZYME  
SUBSTRATE  
PHOSPHORYLATION**

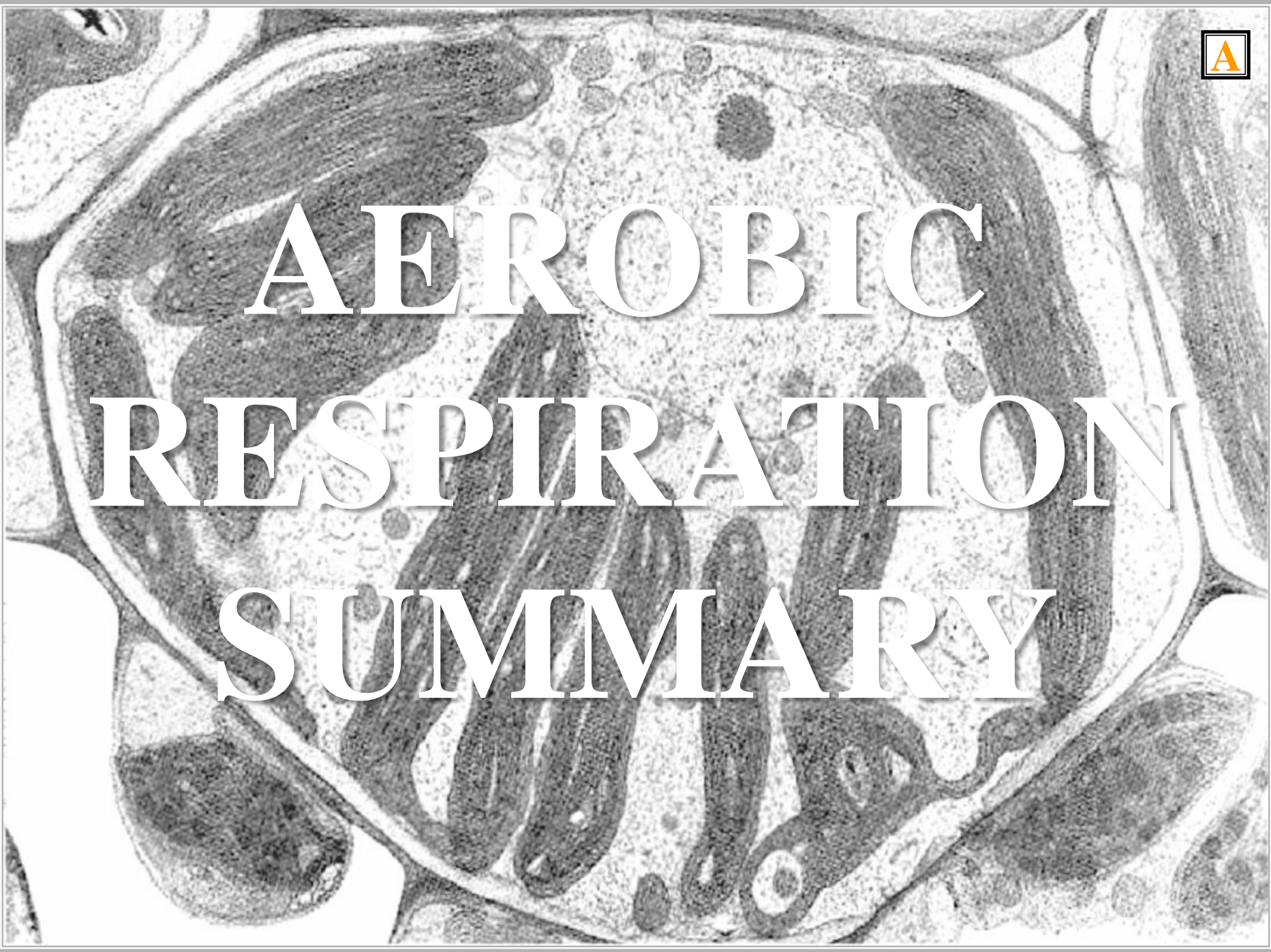


**!!!ETC: ABSENT!!!**

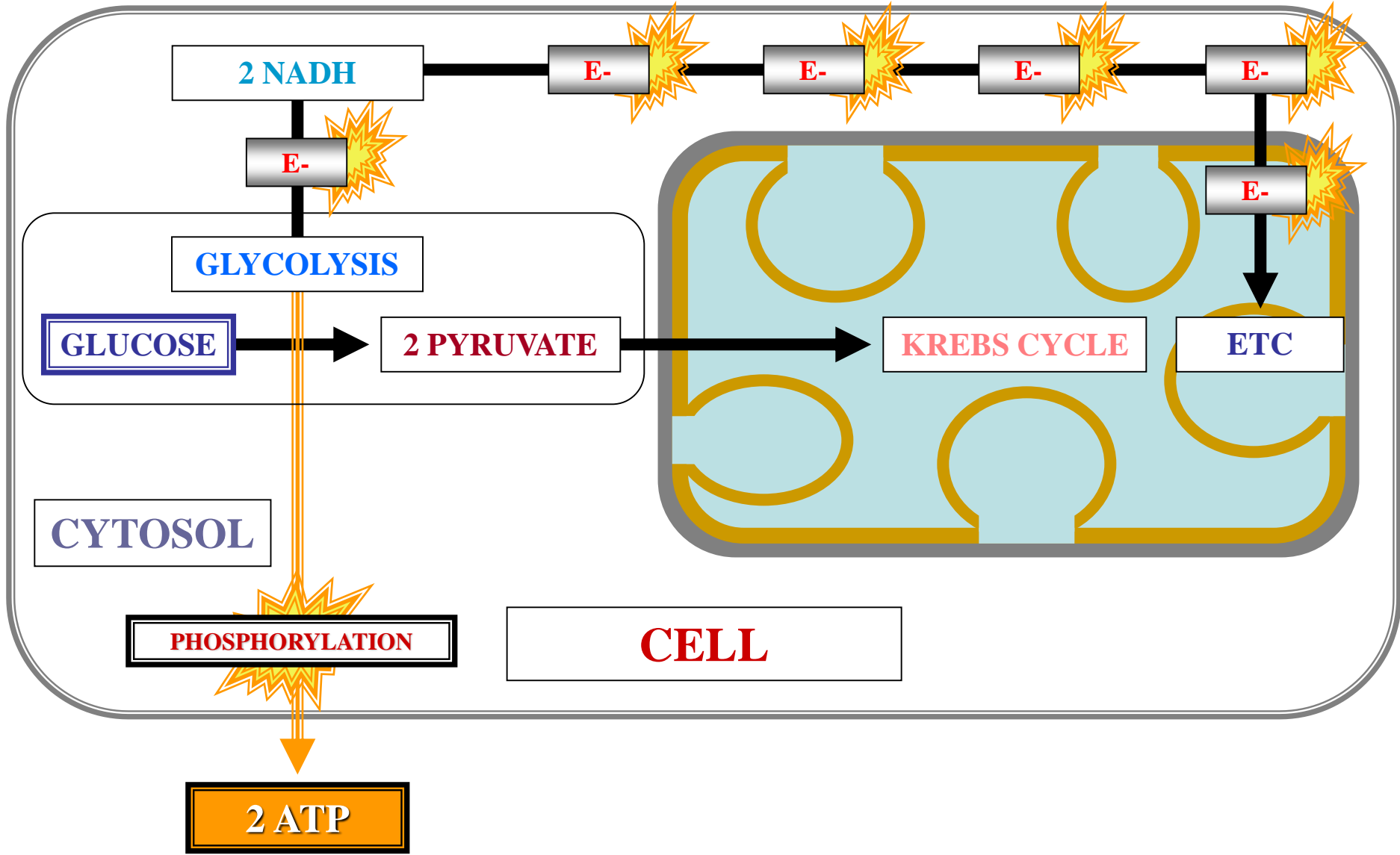
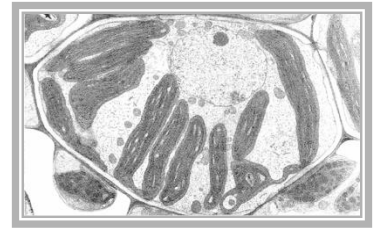
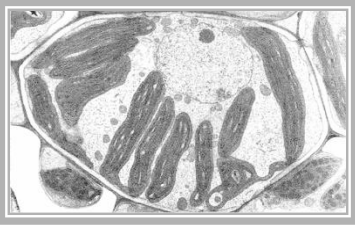
 = CHEM ENERGY



# AEROBIC RESPIRATION SUMMARY



# AEROBIC RESPIRATION



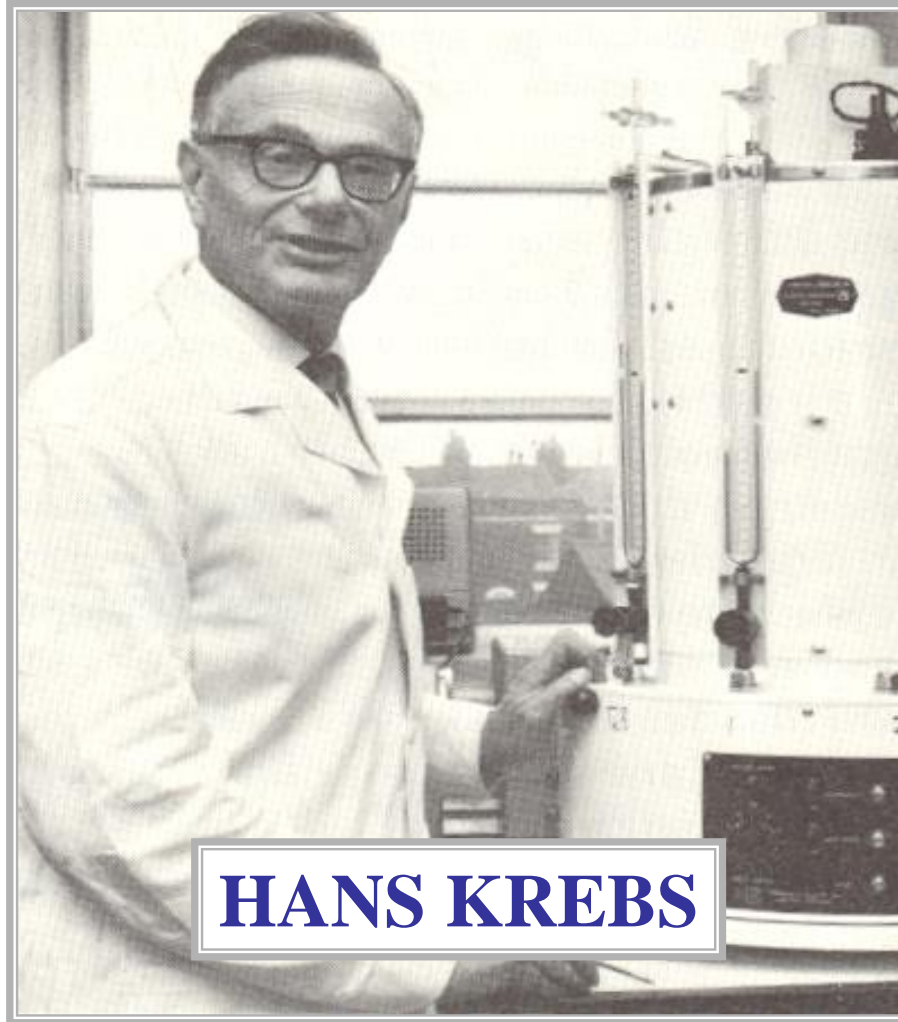




# **AEROBIC RESPIRATION KERBS CYCLE**



# KREBS CYCLE OVERVIEW



**HANS KREBS**

**PHYSIOLOGIST  
ELUCIDATED KREBS CYCLE**

**KREBS CYCLE**

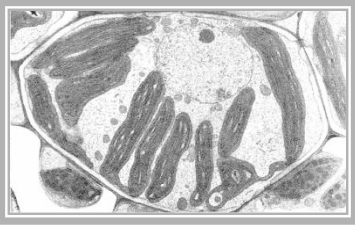
**SYNONYMOUS**

**CITRIC ACID CYCLE**

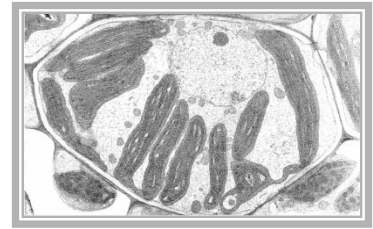


# KREBS CYCLE

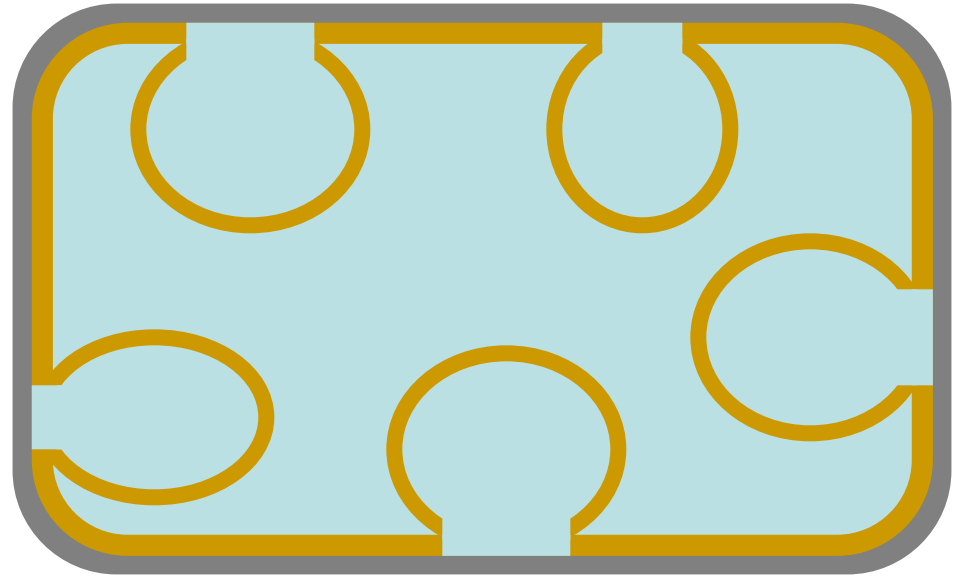
# CELL LOCATION



# AEROBIC RESPIRATION



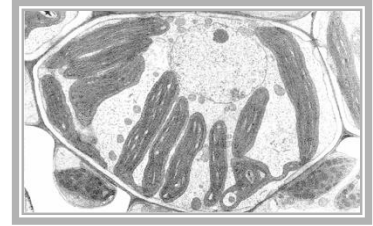
M



**CELL**



# AEROBIC RESPIRATION

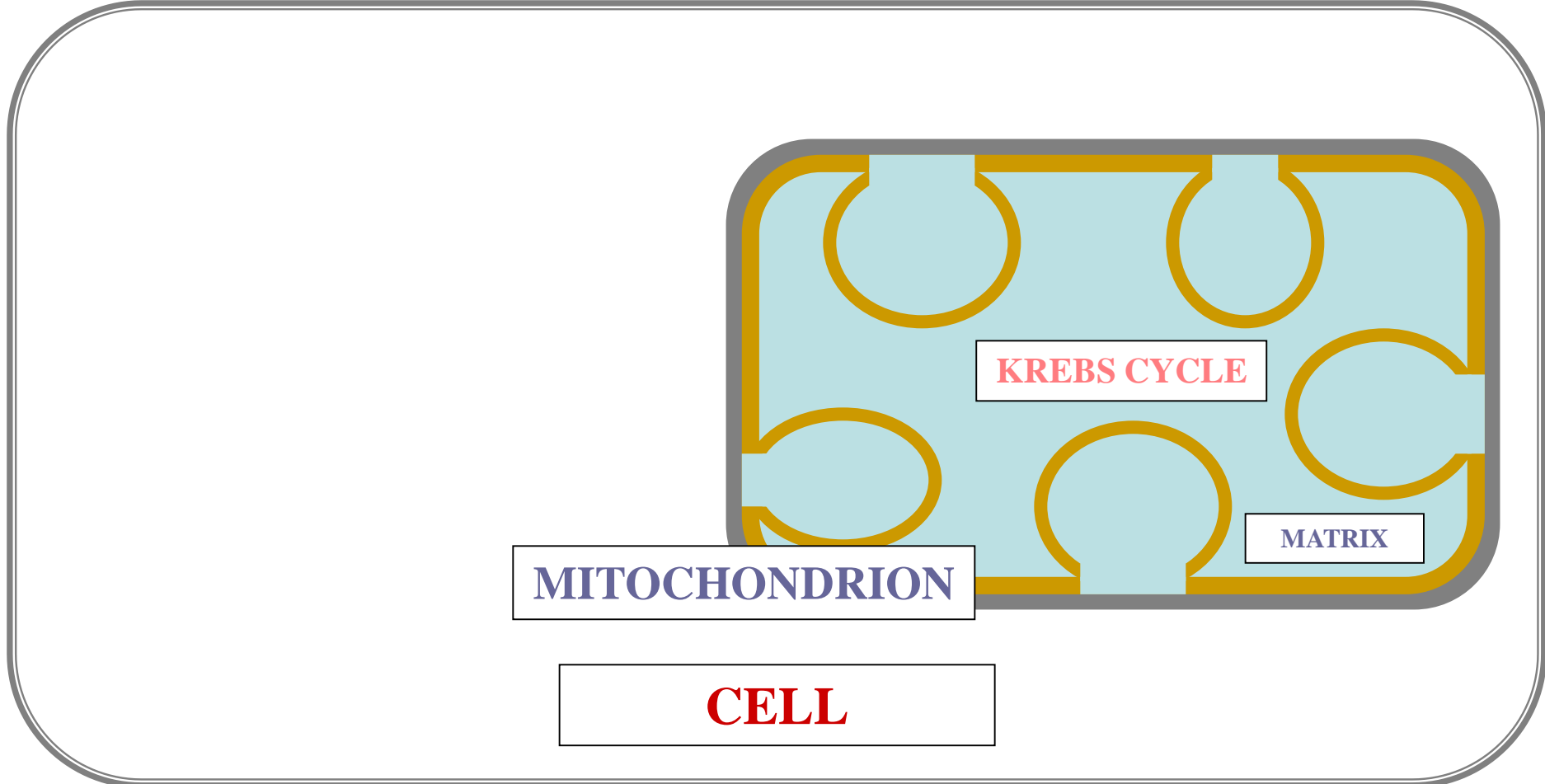


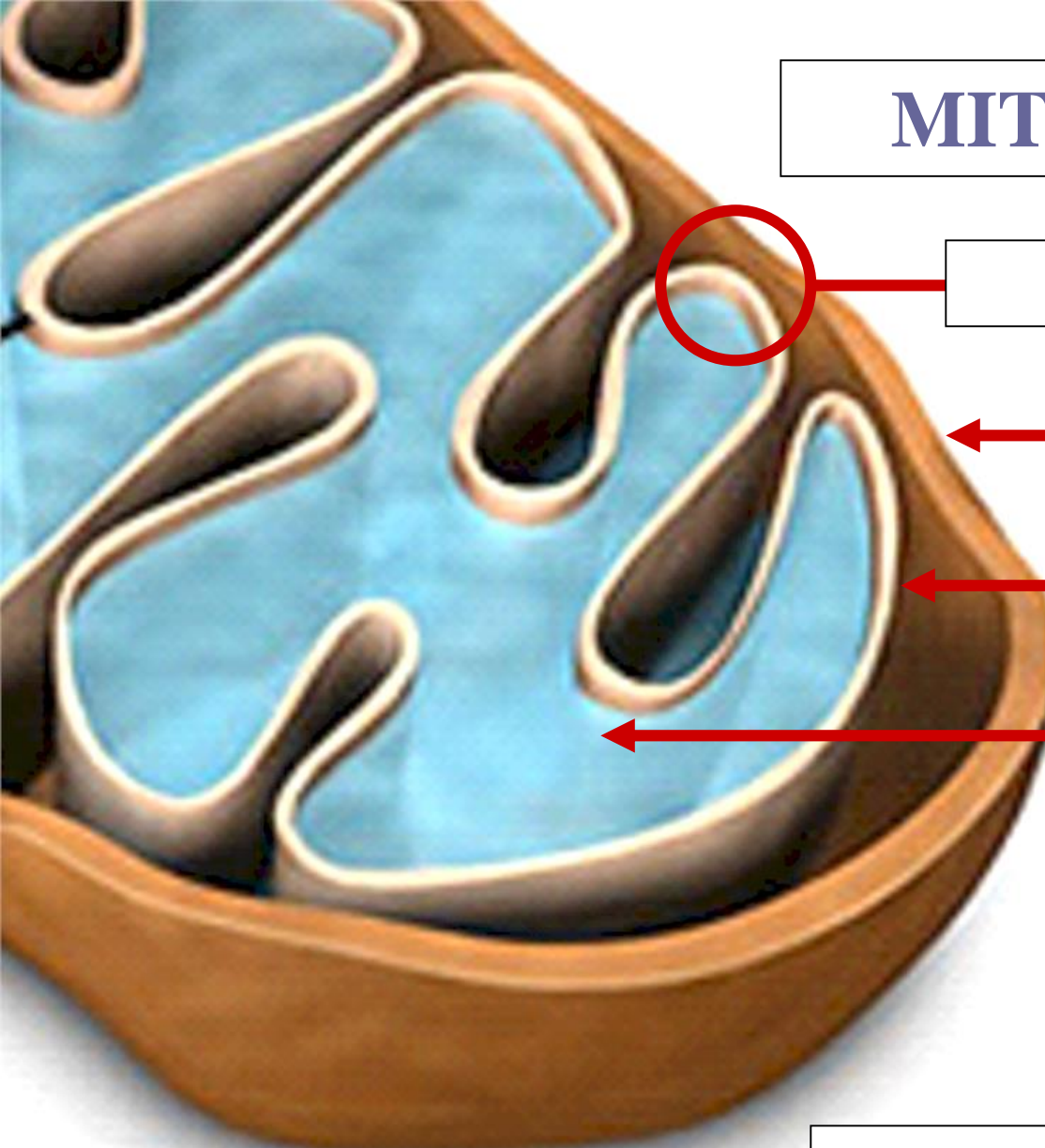
**MITOCHONDRION**

**CELL**

**KREBS CYCLE**

**MATRIX**





# MITOCHONDRION

**DOUBLE MEMBRANE**

**OUTER MEMBRANE**

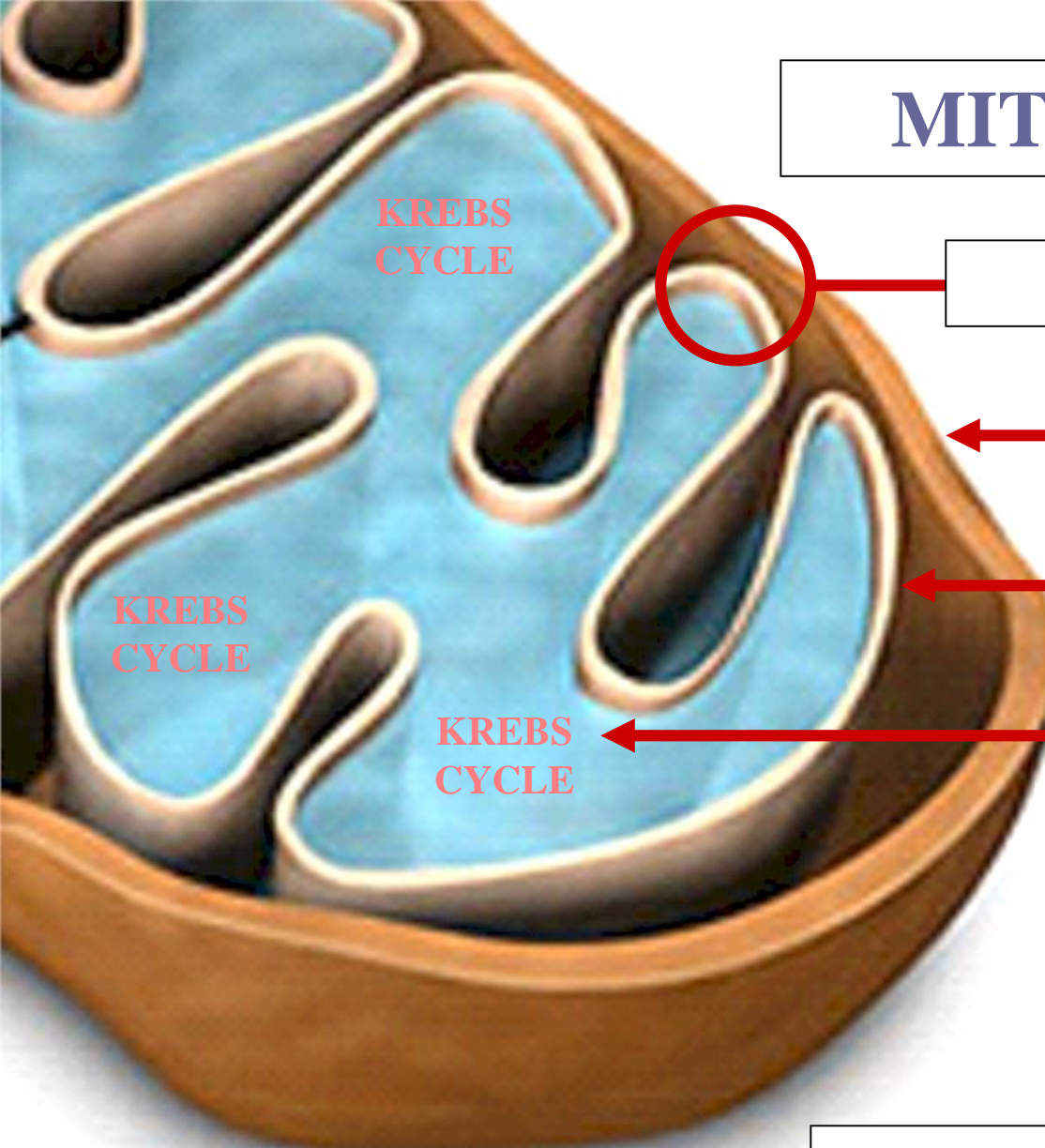
**CRISTAE MEMBRANE**

**MATRIX**

**K**

**CELL CYTOSOL**





# MITOCHONDRION

**DOUBLE MEMBRANE**

**OUTER MEMBRANE**

**CRISTAE MEMBRANE**

**MATRIX**

+

?

**CELL CYTOSOL**

?

# KREBS CYCLE

?

**PYRUVATE**

# **KREBS CYCLE**

**PYRUVATE**



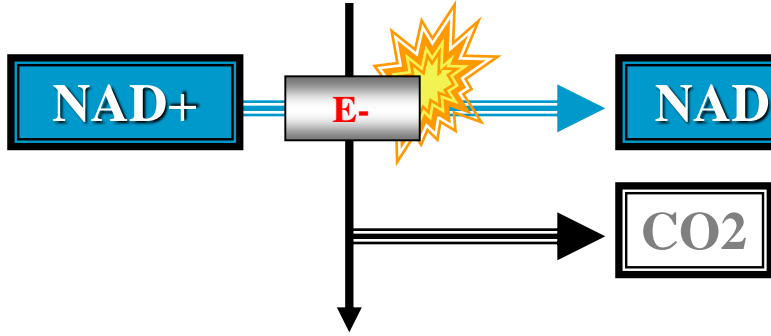


# KREBS CYCLE

RED = ENZYME

PYRUVATE

PYRUVATE DEHYDROGENASE



ACETYL CO-A

OXALOACETATE

CITRATE SYNTHETASE

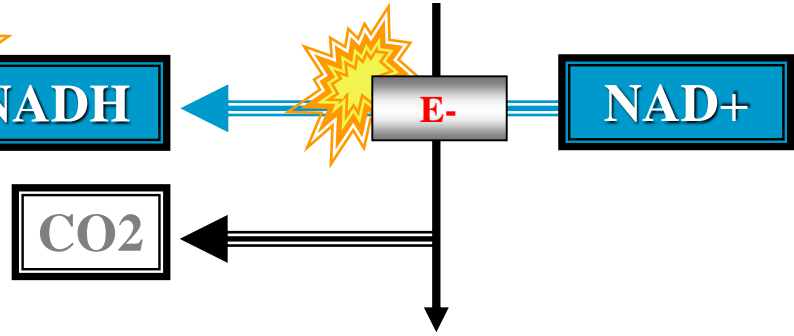
CITRIC ACID

ACONITASE

ISOCITRATE

PYRUVATE

PYRUVATE DEHYDROGENASE



ACETYL CO-A

OXALOACETATE

CITRATE SYNTHETASE

CITRIC ACID

ACONITASE

ISOCITRATE

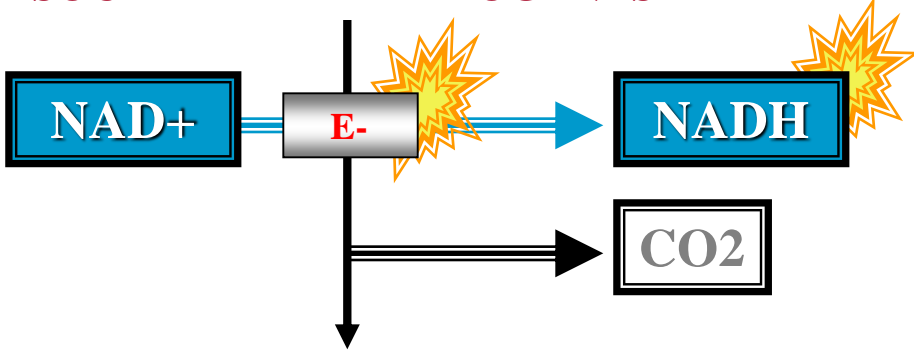


# KREBS CYCLE

RED = ENZYME

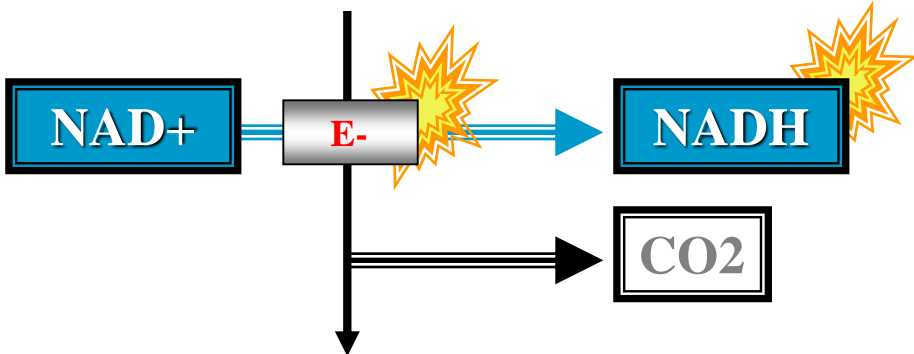
ISOCITRATE

ISOCITRATE DEHYDROGENASE



A-KETOGLUTARATE

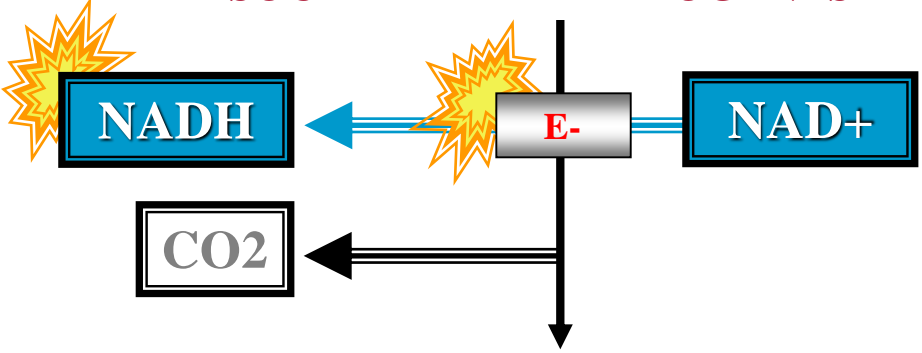
A-KETOGLUTARATE DEHYDROGENASE



SUCCINYL-CO-A

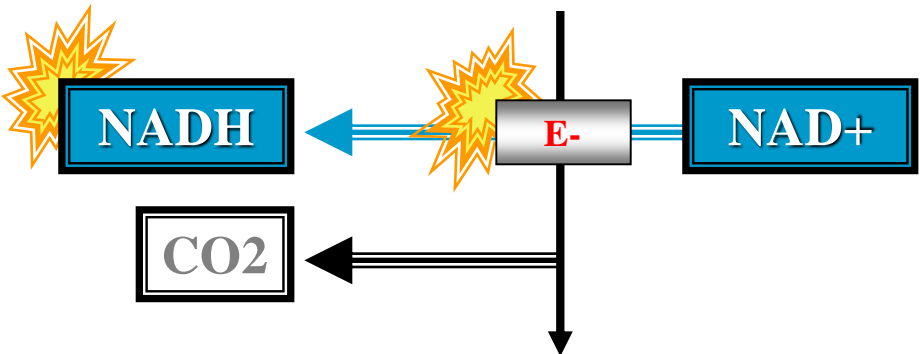
ISOCITRATE

ISOCITRATE DEHYDROGENASE



A-KETOGLUTARATE

A-KETOGLUTARATE DEHYDROGENASE



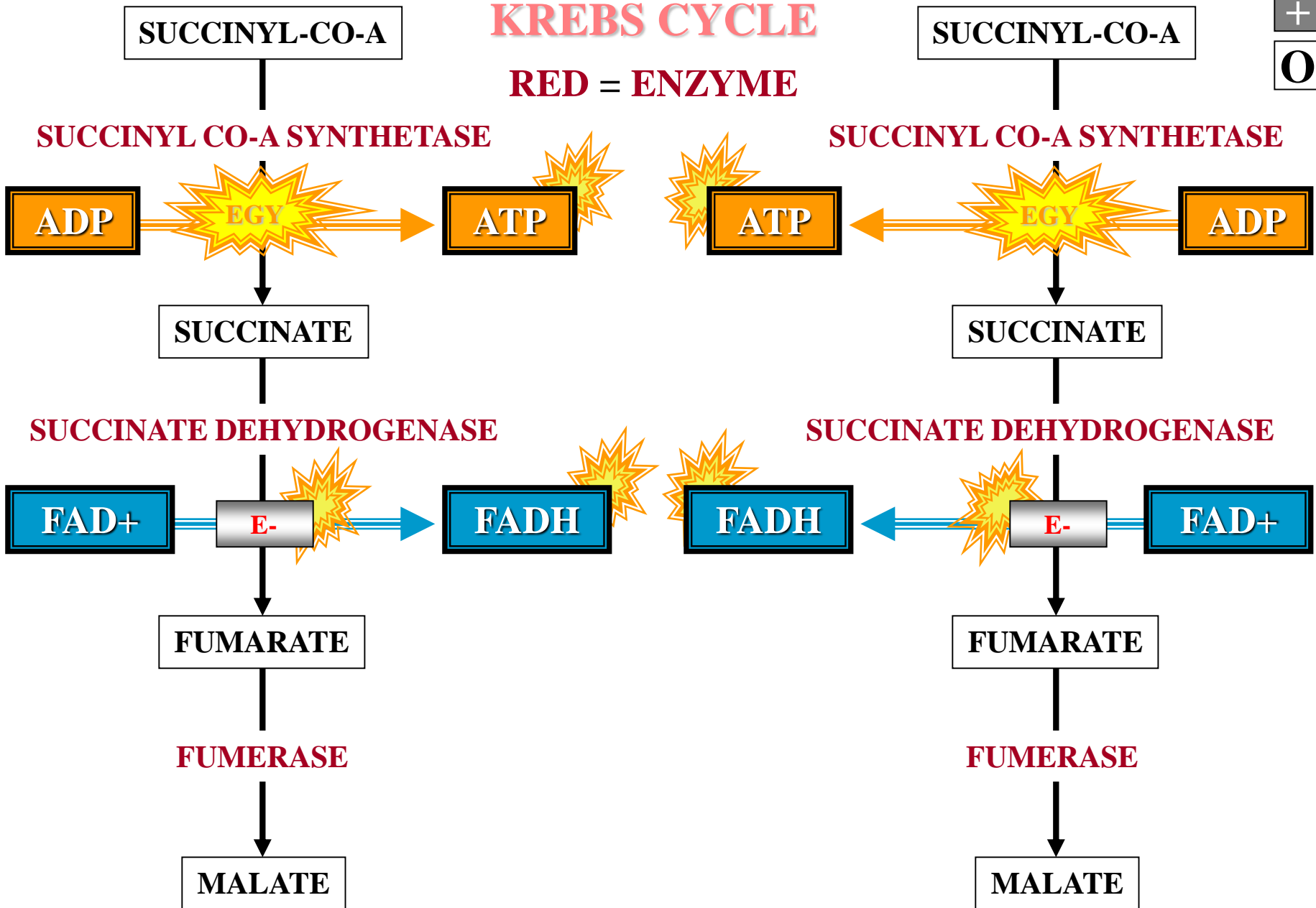
SUCCINYL-CO-A

# KREBS CYCLE

RED = ENZYME

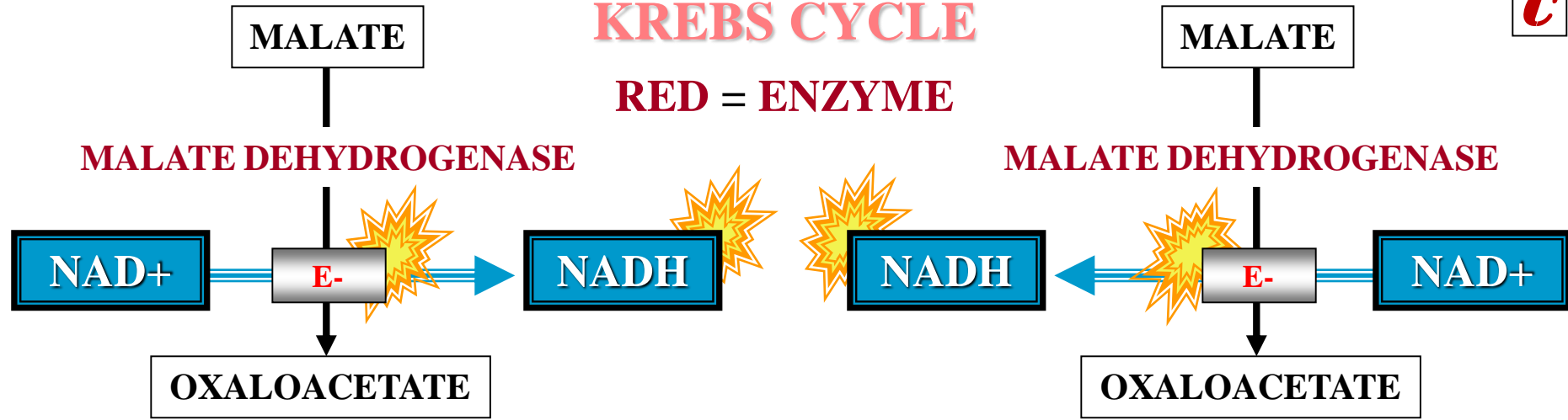
+

0



# KREBS CYCLE

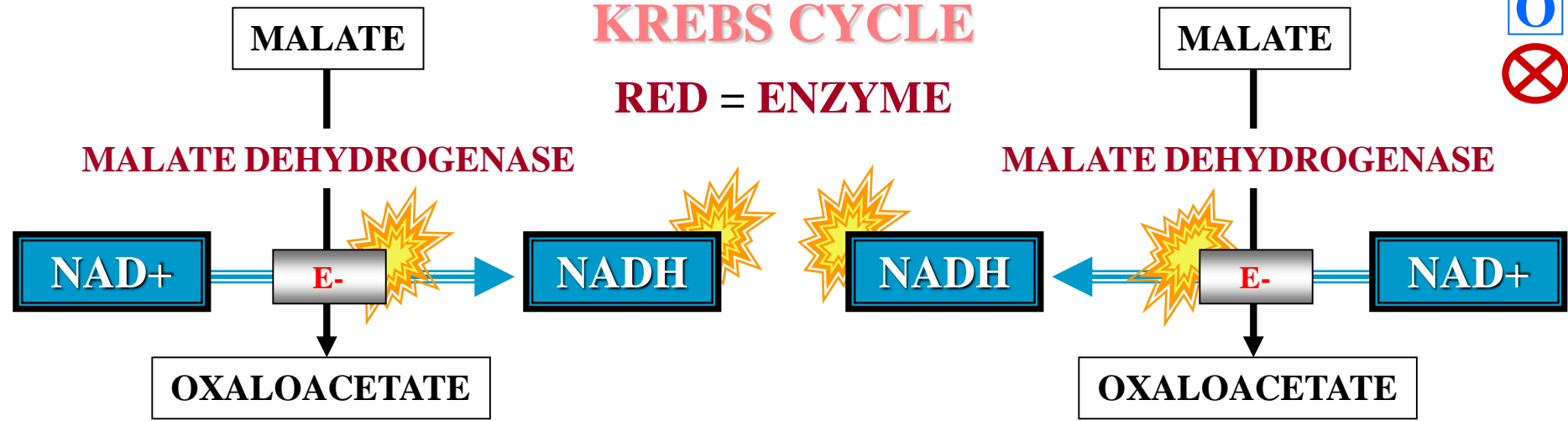
RED = ENZYME



 = CHEM ENERGY

# KREBS CYCLE

RED = ENZYME



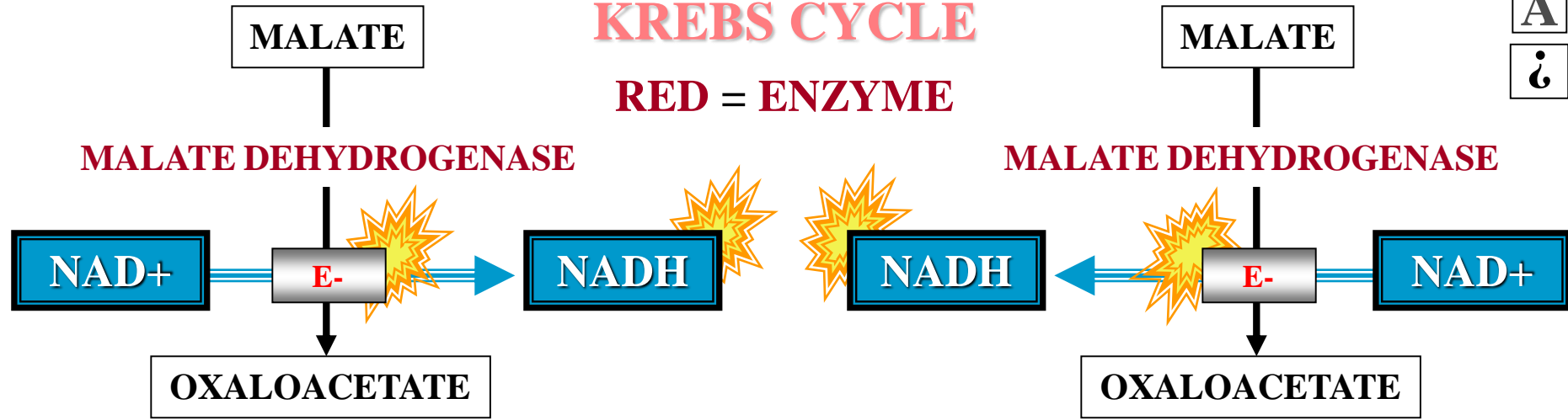
**!!!COMPLEX SERIES ENZYMATIC RXTS!!!**

 = CHEM ENERGY



# KREBS CYCLE

RED = ENZYME

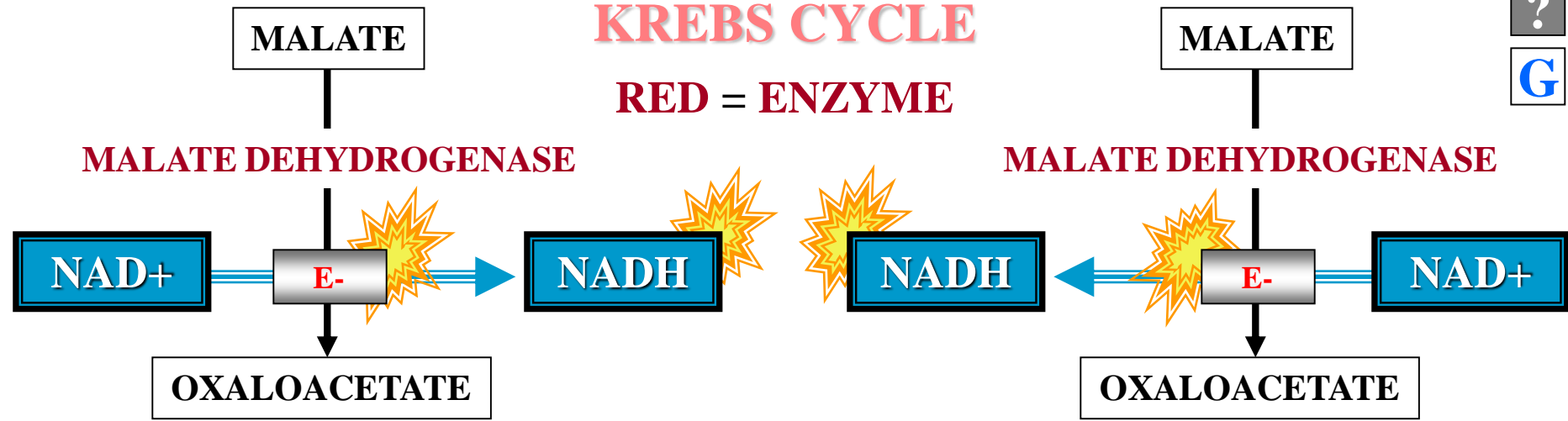


**!!!KREBS CYCLE: DOES NOT REQUIRE O2!!!**

 = CHEM ENERGY

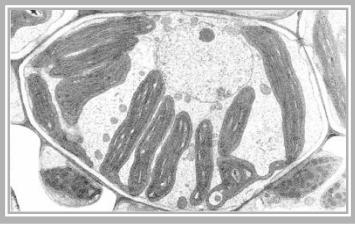
# KREBS CYCLE

RED = ENZYME



**!!!KREBS CYCLE: ANAEROBIC PATHWAY!!!**

 = CHEM ENERGY



# AEROBIC RESPIRATION



A

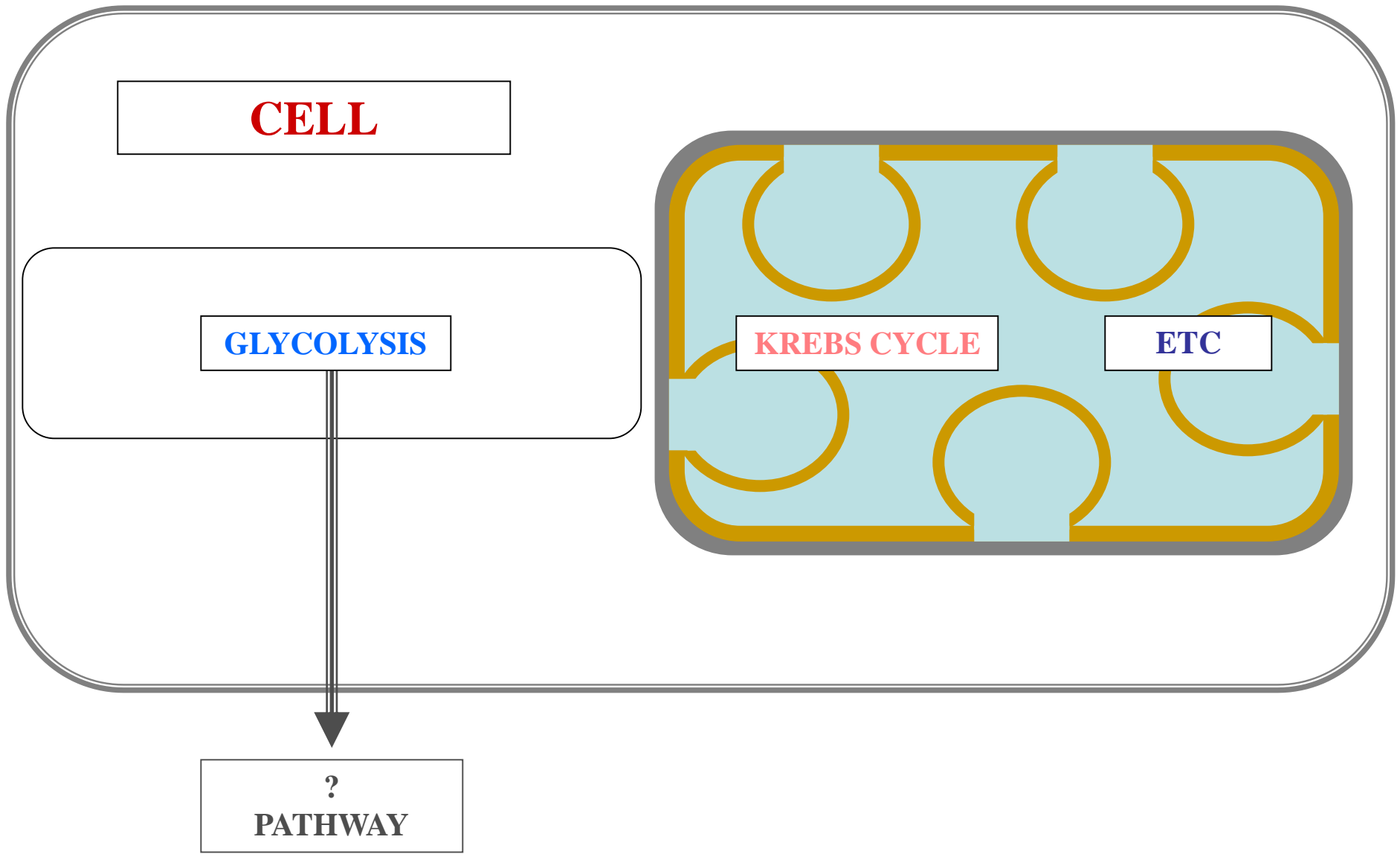
**CELL**

**GLYCOLYSIS**

**KREBS CYCLE**

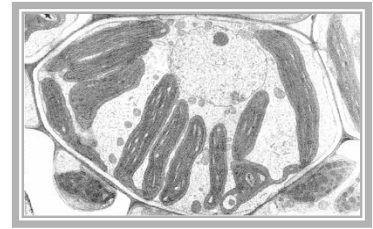
**ETC**

**?  
PATHWAY**





# AEROBIC RESPIRATION



**K**

**A**

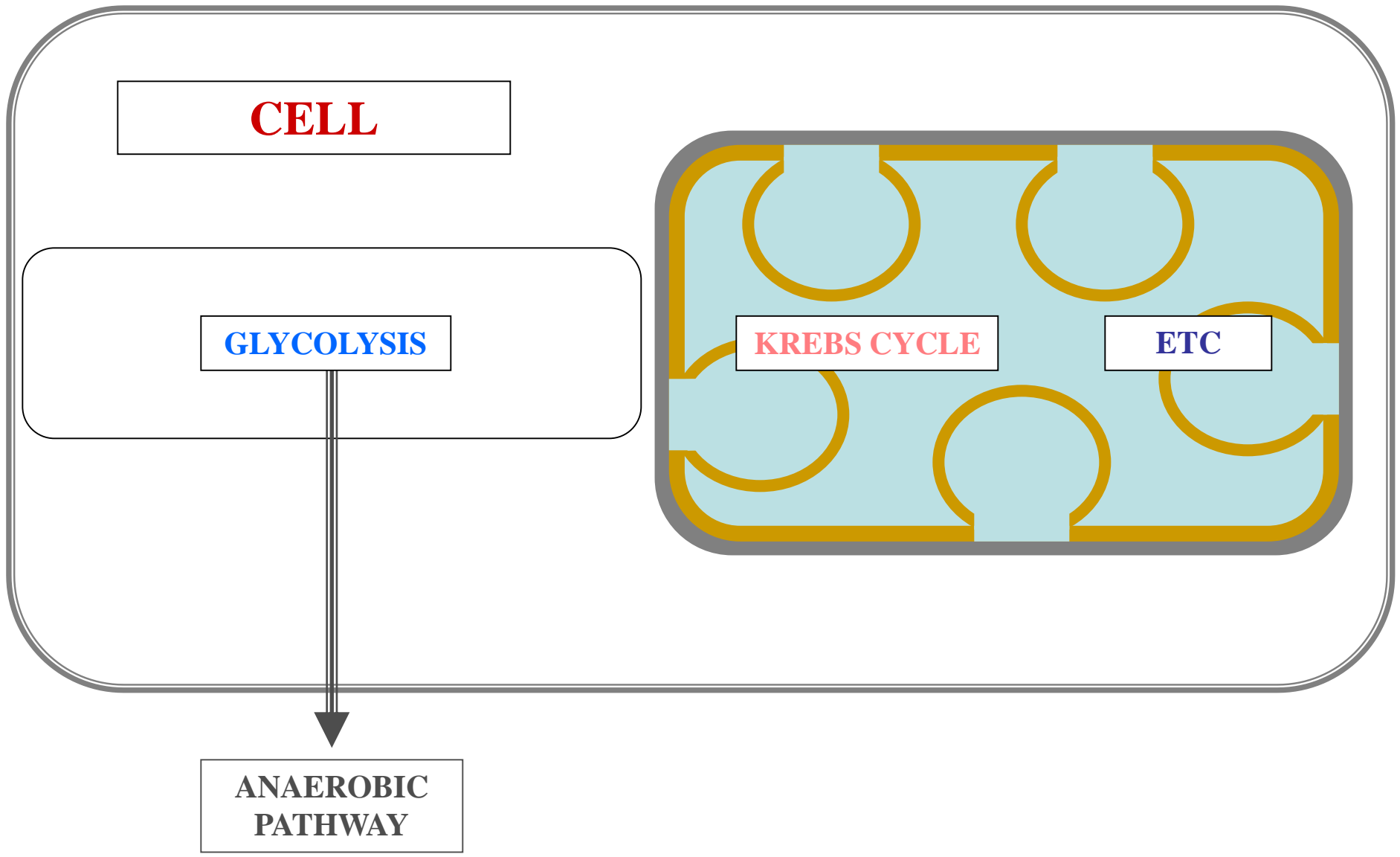
**CELL**

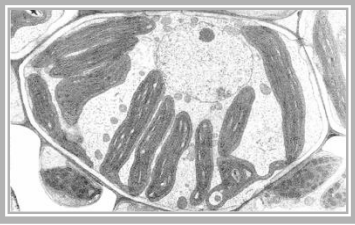
**GLYCOLYSIS**

**KREBS CYCLE**

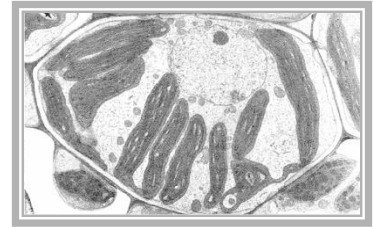
**ETC**

**ANAEROBIC  
PATHWAY**





# AEROBIC RESPIRATION



**E**  
**O**

**CELL**

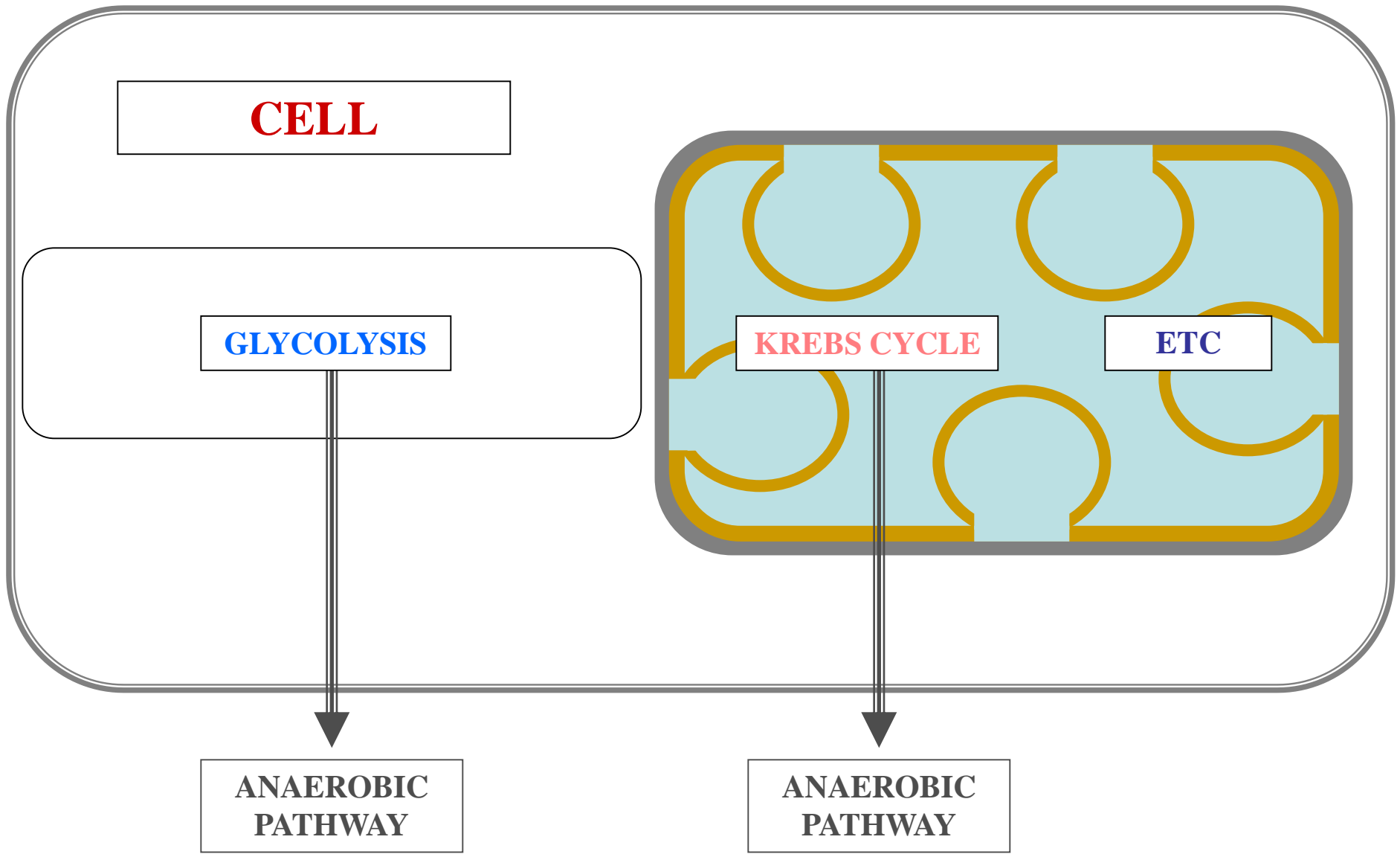
**GLYCOLYSIS**

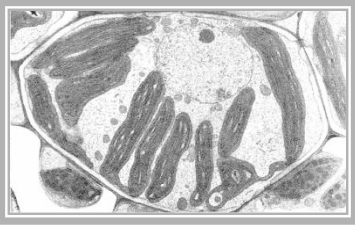
**KREBS CYCLE**

**ETC**

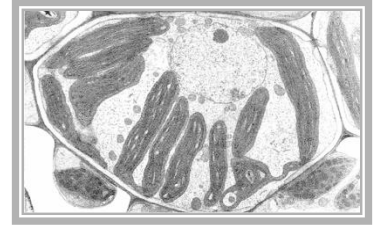
**ANAEROBIC  
PATHWAY**

**ANAEROBIC  
PATHWAY**





# AEROBIC RESPIRATION



**CELL**

**GLYCOLYSIS**

**KREBS CYCLE**

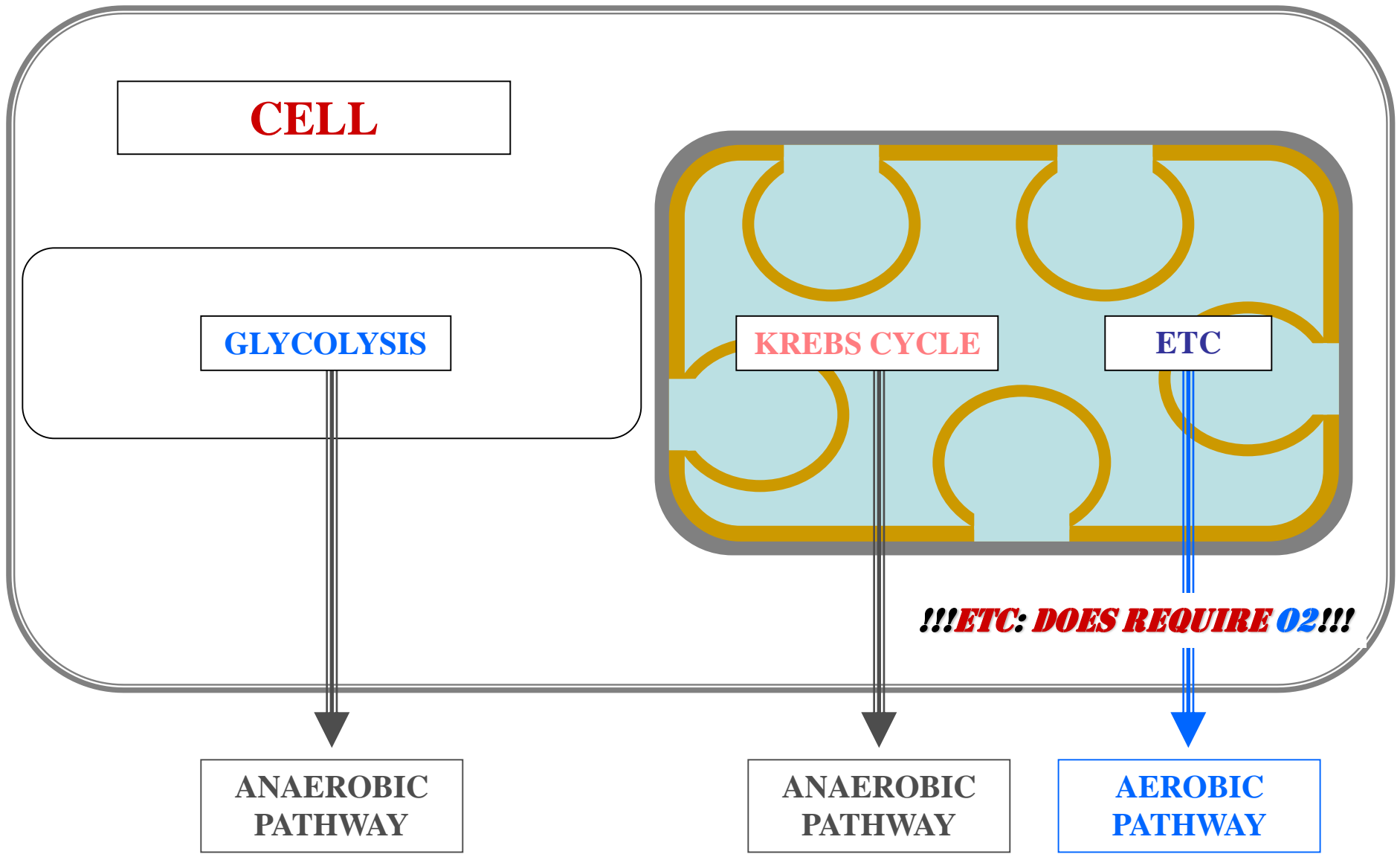
**ETC**

**!!!ETC: DOES REQUIRE O<sub>2</sub>!!!**

**ANAEROBIC  
PATHWAY**

**ANAEROBIC  
PATHWAY**

**AEROBIC  
PATHWAY**



# **KREBS CYCLE ACRONYM**

**FADH**



**FADH**



**FLAVIN ADENINE  
DINUCLEOTIDE**

**FADH**

**FADH**



**FLAVIN ADENINE  
DINUCLEOTIDE**

**---**

**ENERGY MOLECULE**

**FADH**



**FADH**

**FLAVIN ADENINE  
DINUCLEOTIDE**

---

**ENERGY MOLECULE**

---

**ETC E- DONOR**

**FADH**



# KREBS CYCLE SPECIFICS