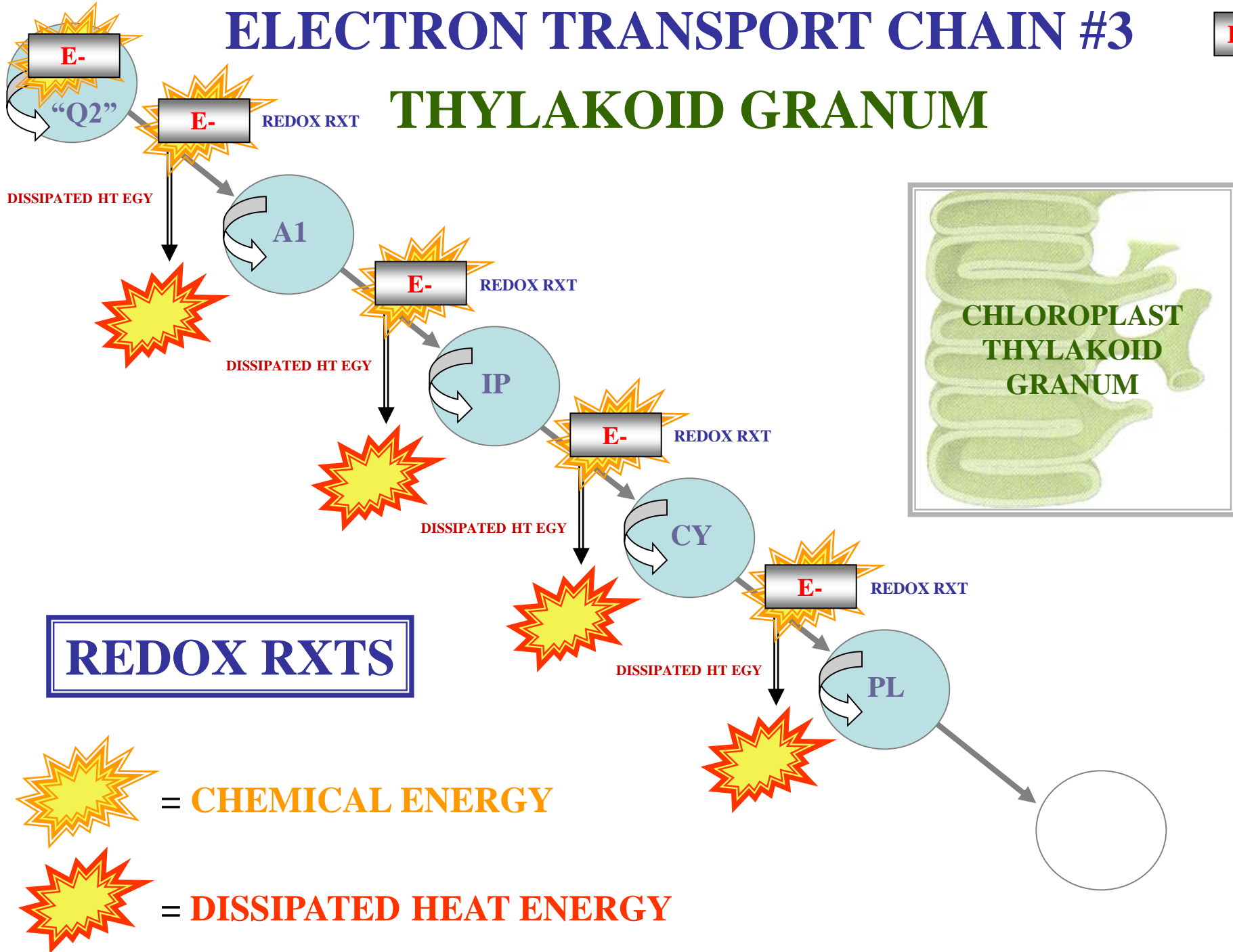


ELECTRON TRANSPORT CHAIN #3

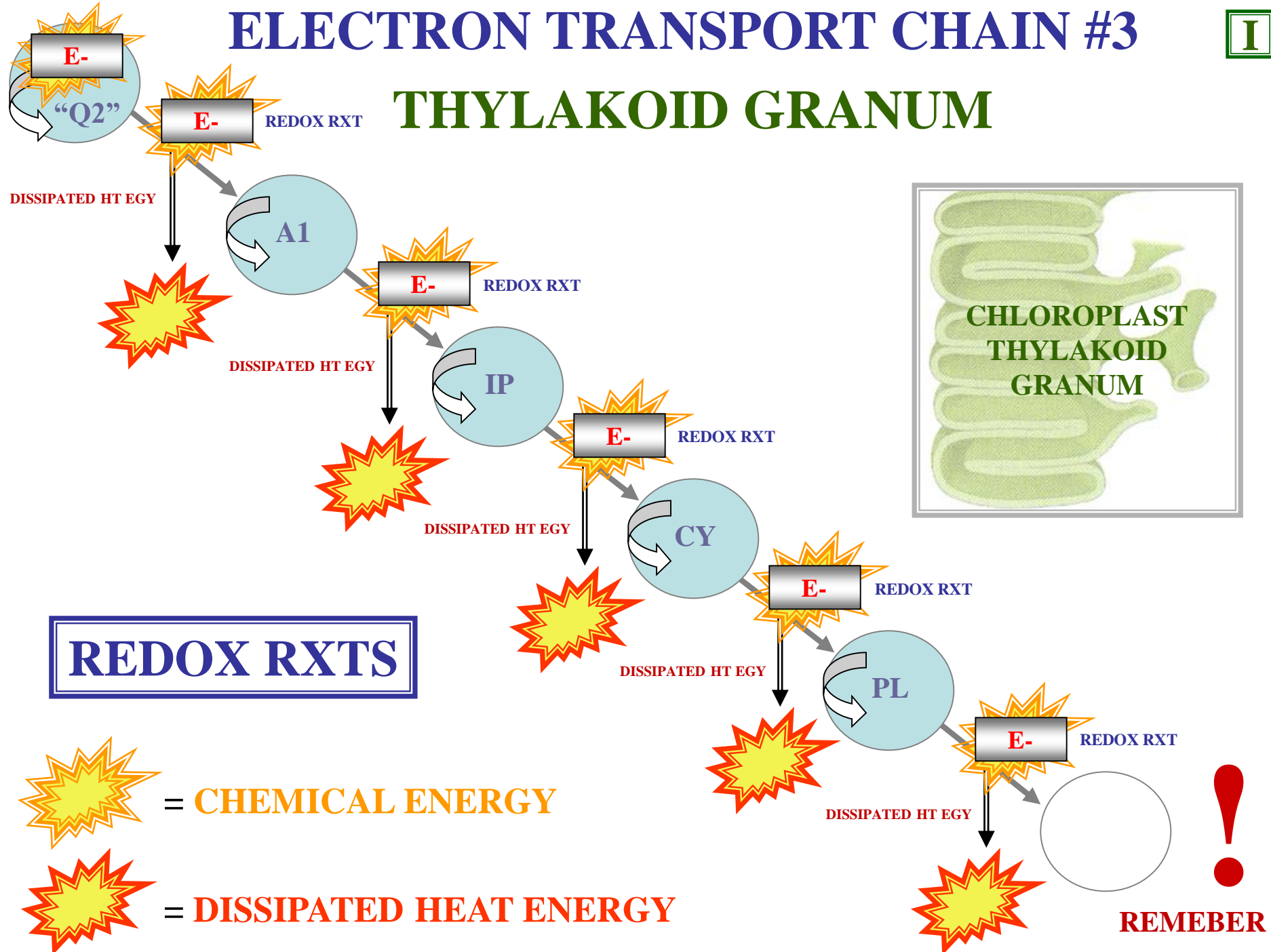
E-

THYLAKOID GRANUM



ELECTRON TRANSPORT CHAIN #3

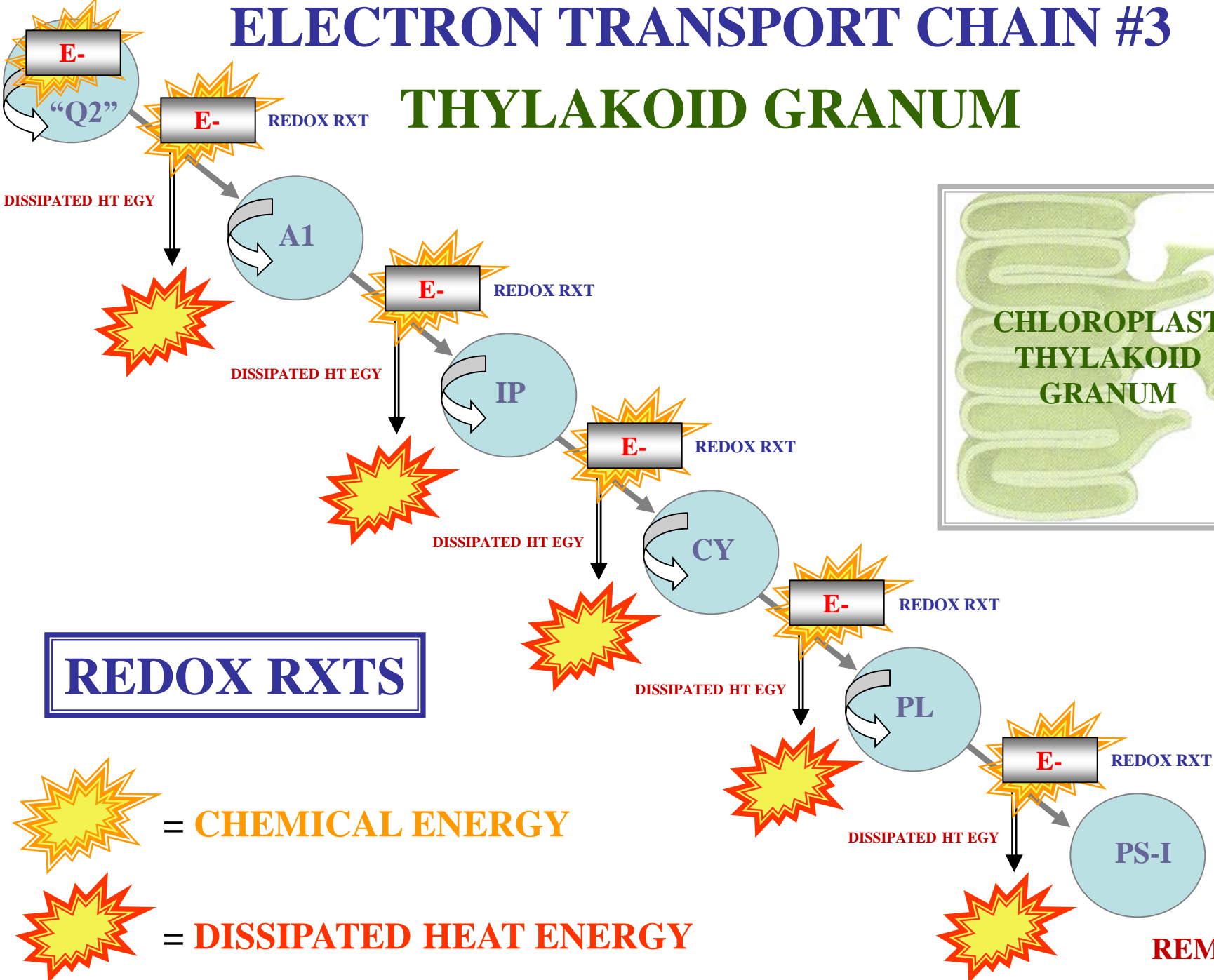
THYLAKOID GRANUM



ELECTRON TRANSPORT CHAIN #3



THYLAKOID GRANUM



CHLOROPLAST
THYLAKOID
GRANUM

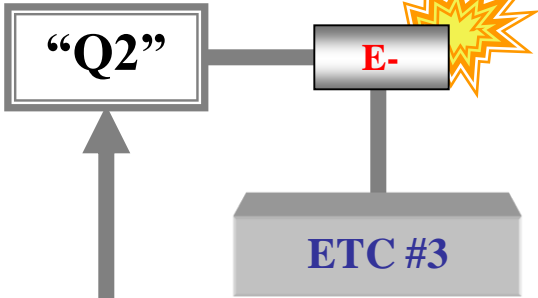
REDOX RXTS

 = CHEMICAL ENERGY

 = DISSIPATED HEAT ENERGY

REMEBER 

CYCLIC P-P



! REMEMBER

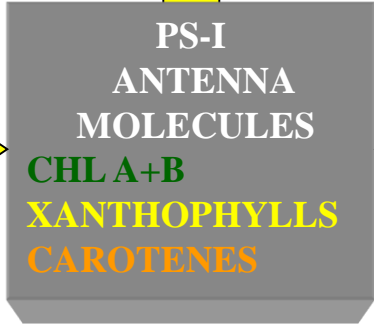
+

E-

I



LIGHT ENERGY

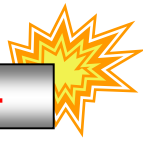


LIGHT ENERGY

CYCLIC P-P

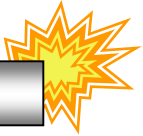
“Q2”

E-

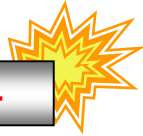


ETC #3

E-



E-



REMEMBER

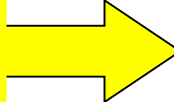
ETC3

E-

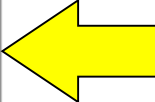
+

PS-I
RXT-CENTER
CHL-A P700

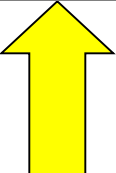
LIGHT ENERGY



PS-I
ANTENNA
MOLECULES
CHL A+B
XANTHOPHYLLS
CAROTENES



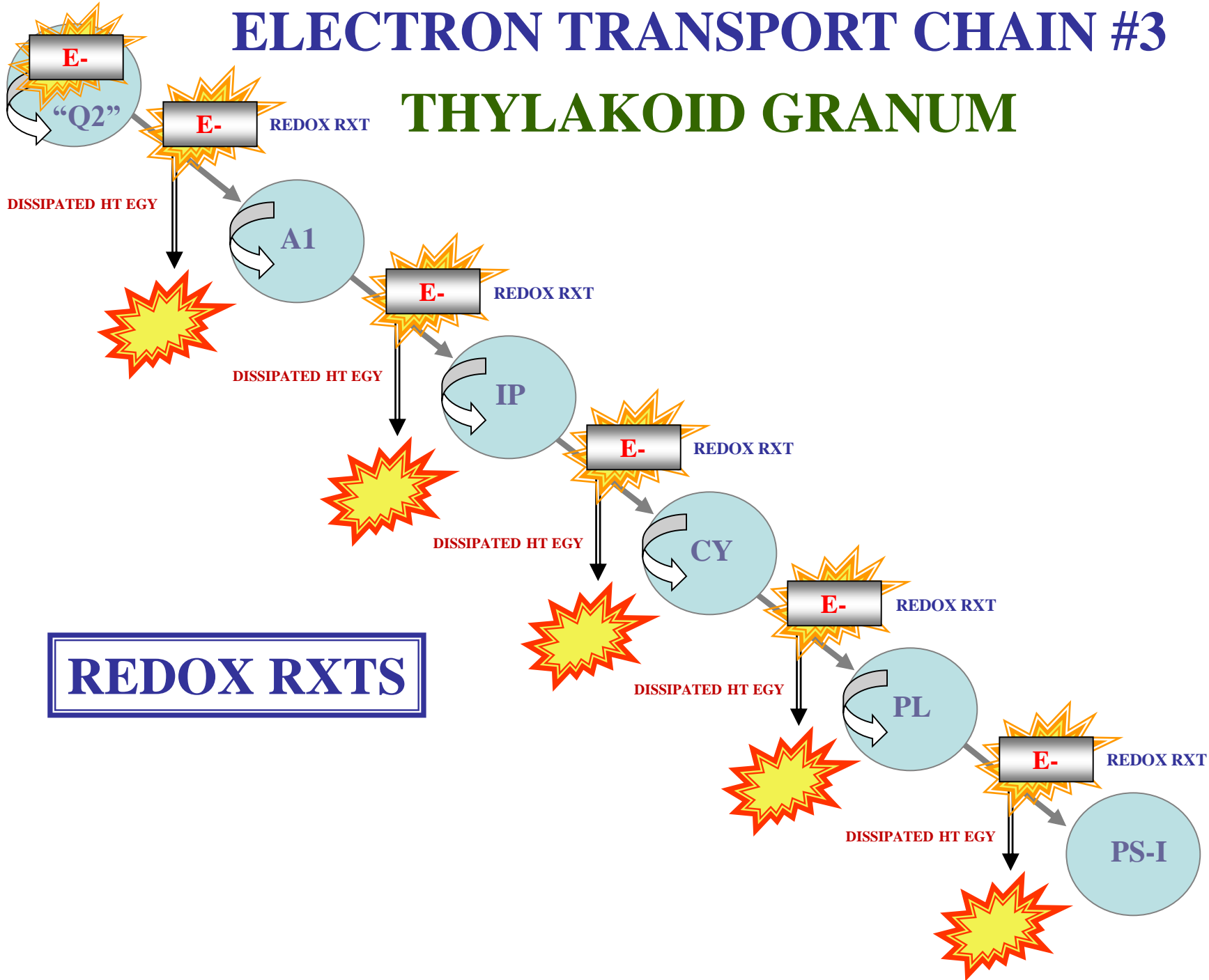
LIGHT ENERGY



ELECTRON TRANSPORT CHAIN #3

E-

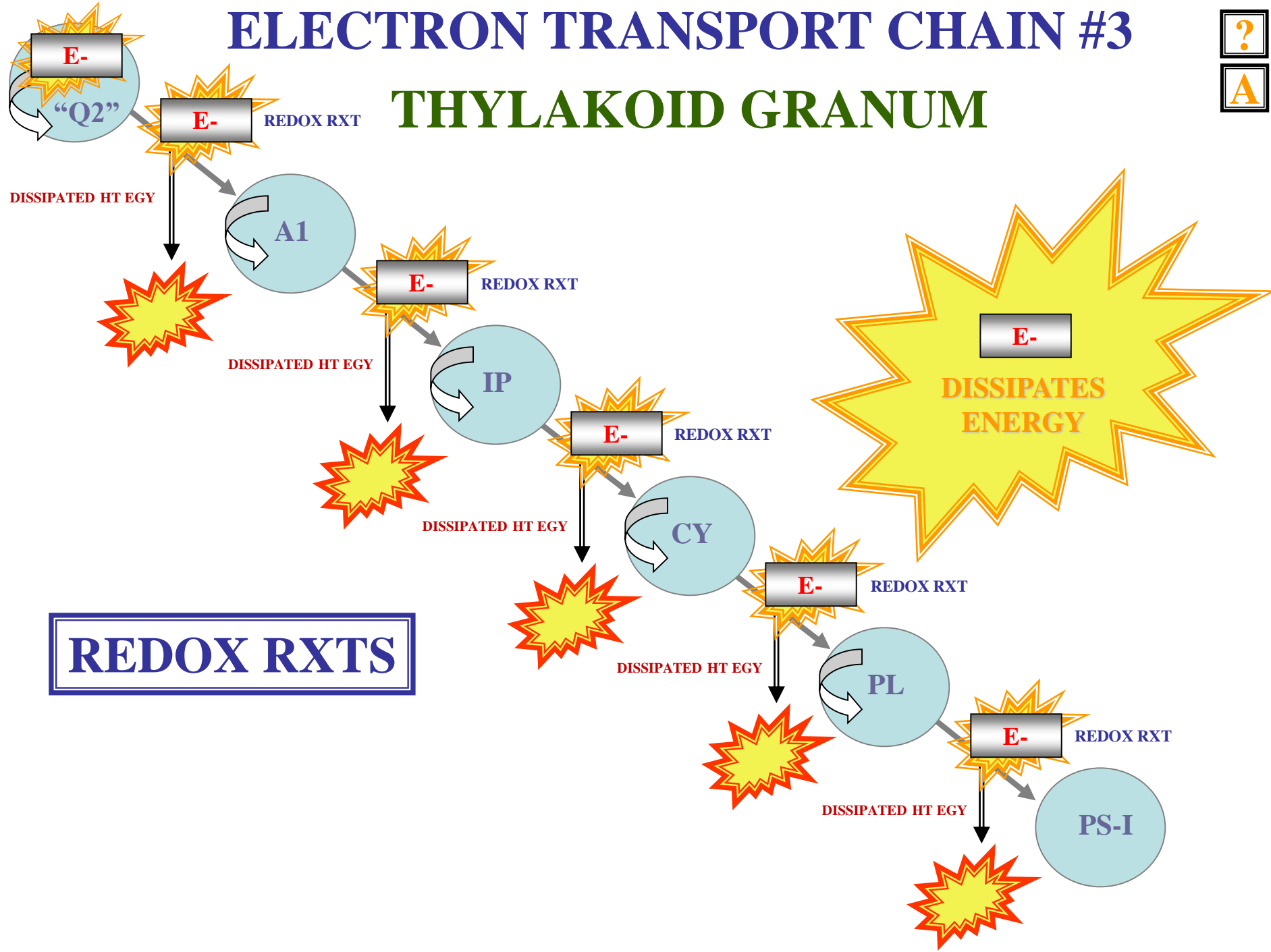
THYLAKOID GRANUM



ELECTRON TRANSPORT CHAIN #3



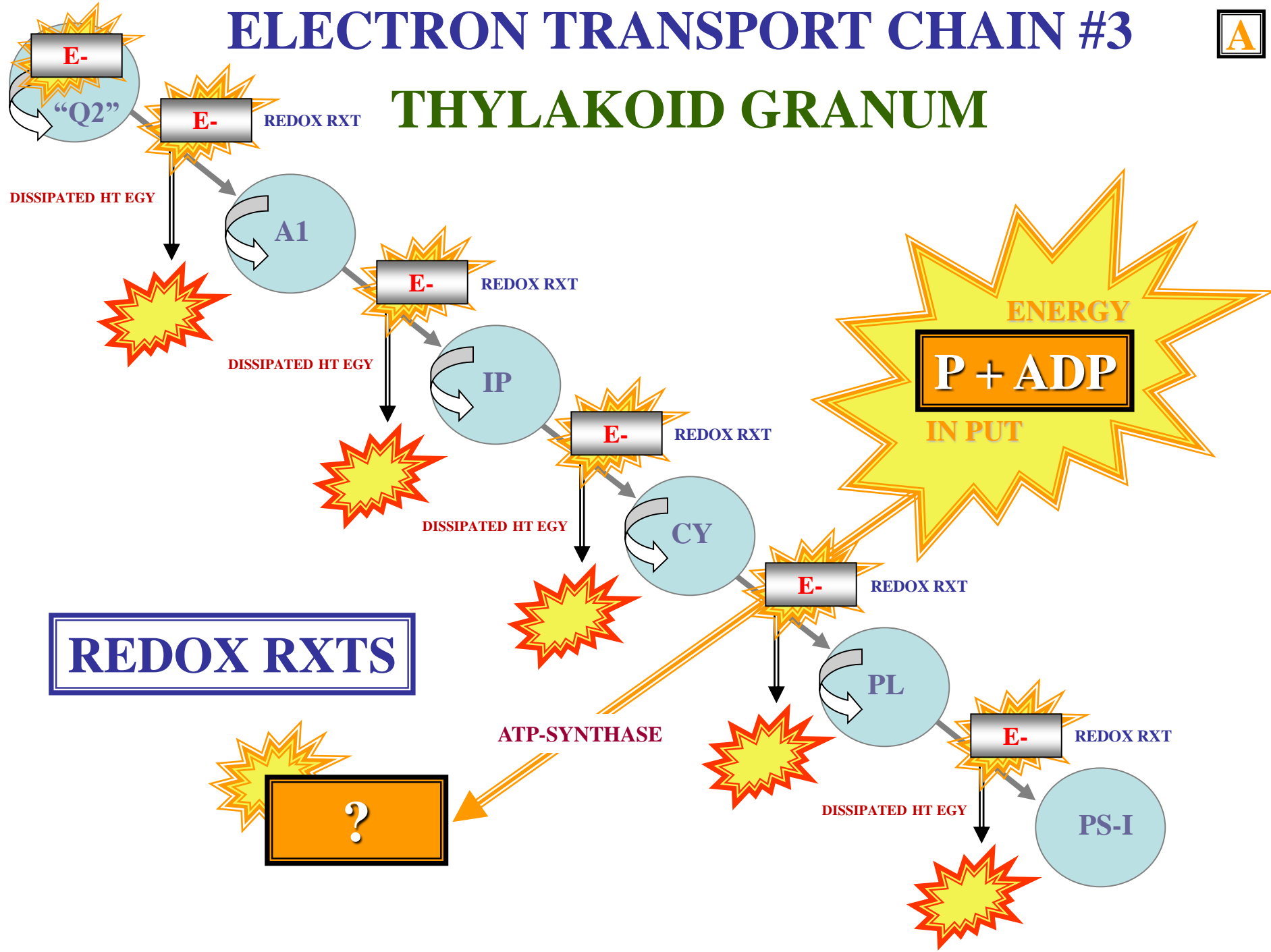
THYLAKOID GRANUM



ELECTRON TRANSPORT CHAIN #3



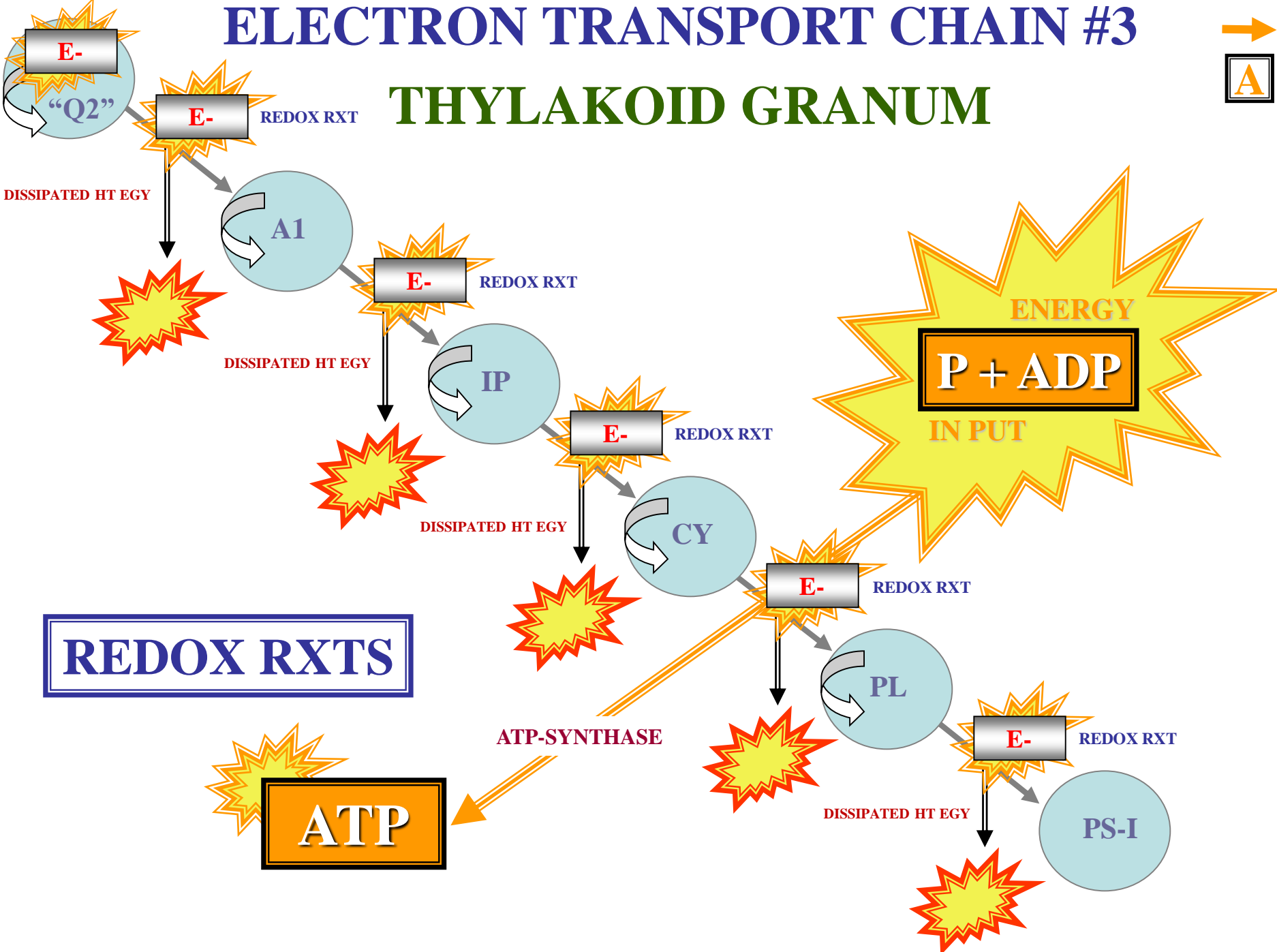
THYLAKOID GRANUM



ELECTRON TRANSPORT CHAIN #3



THYLAKOID GRANUM

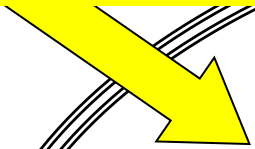


PHOTOSYNTHESIS

DK



LIGHT ENERGY



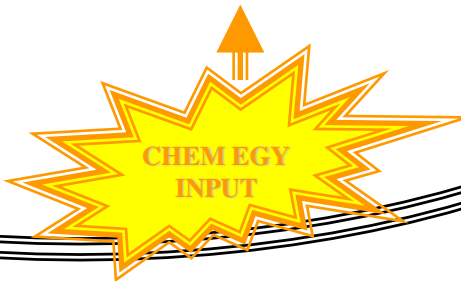
CHLOROPLAST



**LIGHT REACTION
THYLAKOID
GRANUM**



PASSED



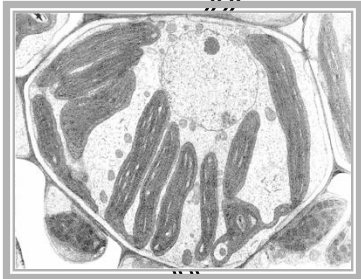
**CHEMICAL
ENERGY
INPUT**

PHOTOSYNTHESIS

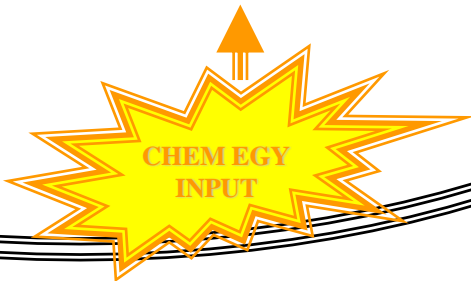
P



LIGHT ENERGY



CHLOROPLAST



PHOTOSYNTHESIS

LT

P

LIGHT ENERGY

PHOSPHORYLATION

LT RXT

THYLAKOID
GRANUM

ATP

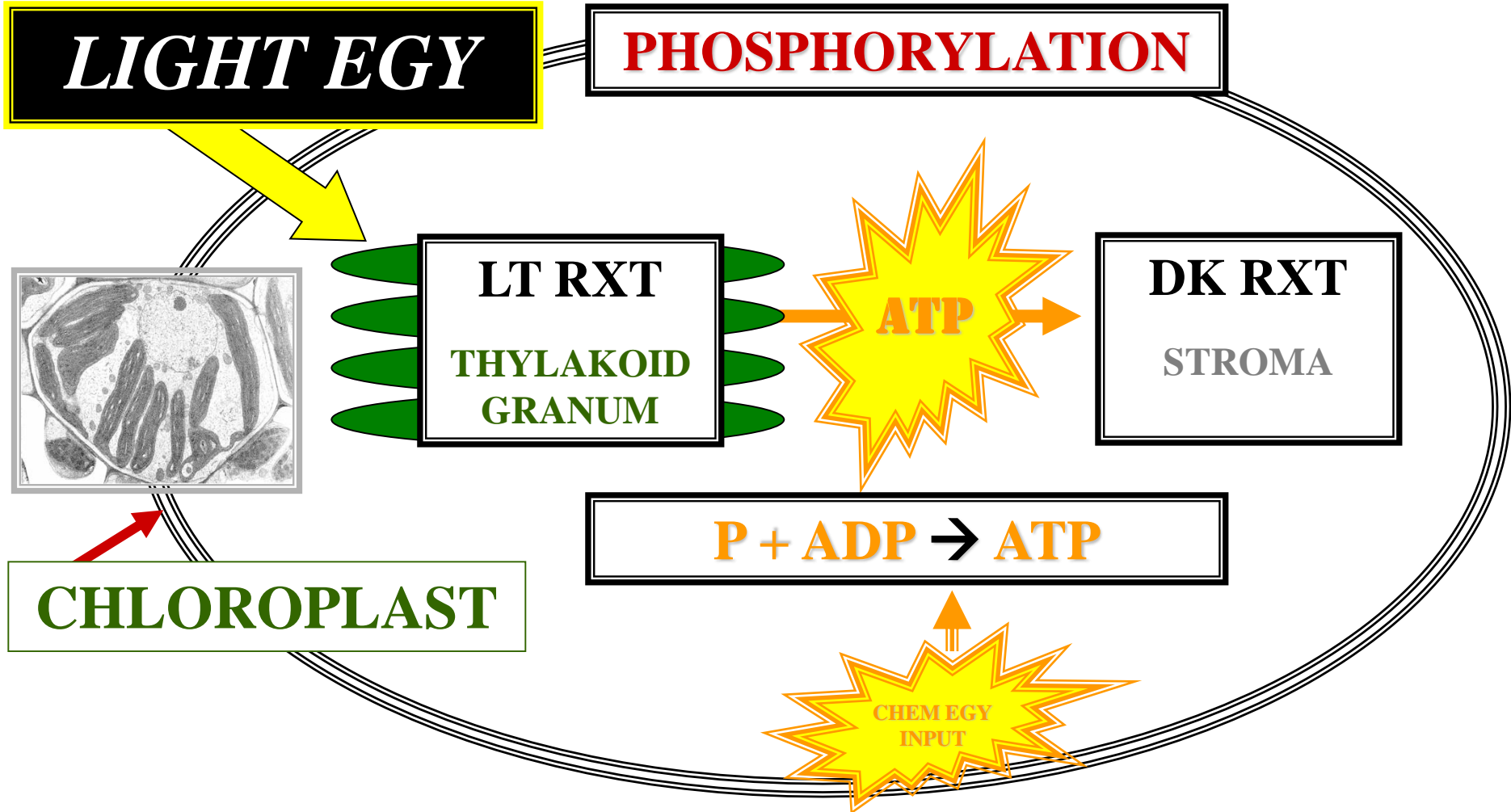
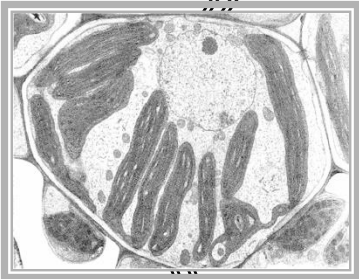
DK RXT

STROMA

$P + ADP \rightarrow ATP$

CHEMICAL
INPUT

CHLOROPLAST



PHOTOSYNTHESIS



C

>

LIGHT ENERGY

PHOTO-PHOSPHORYLATION



LT RXT
THYLAKOID
GRANUM

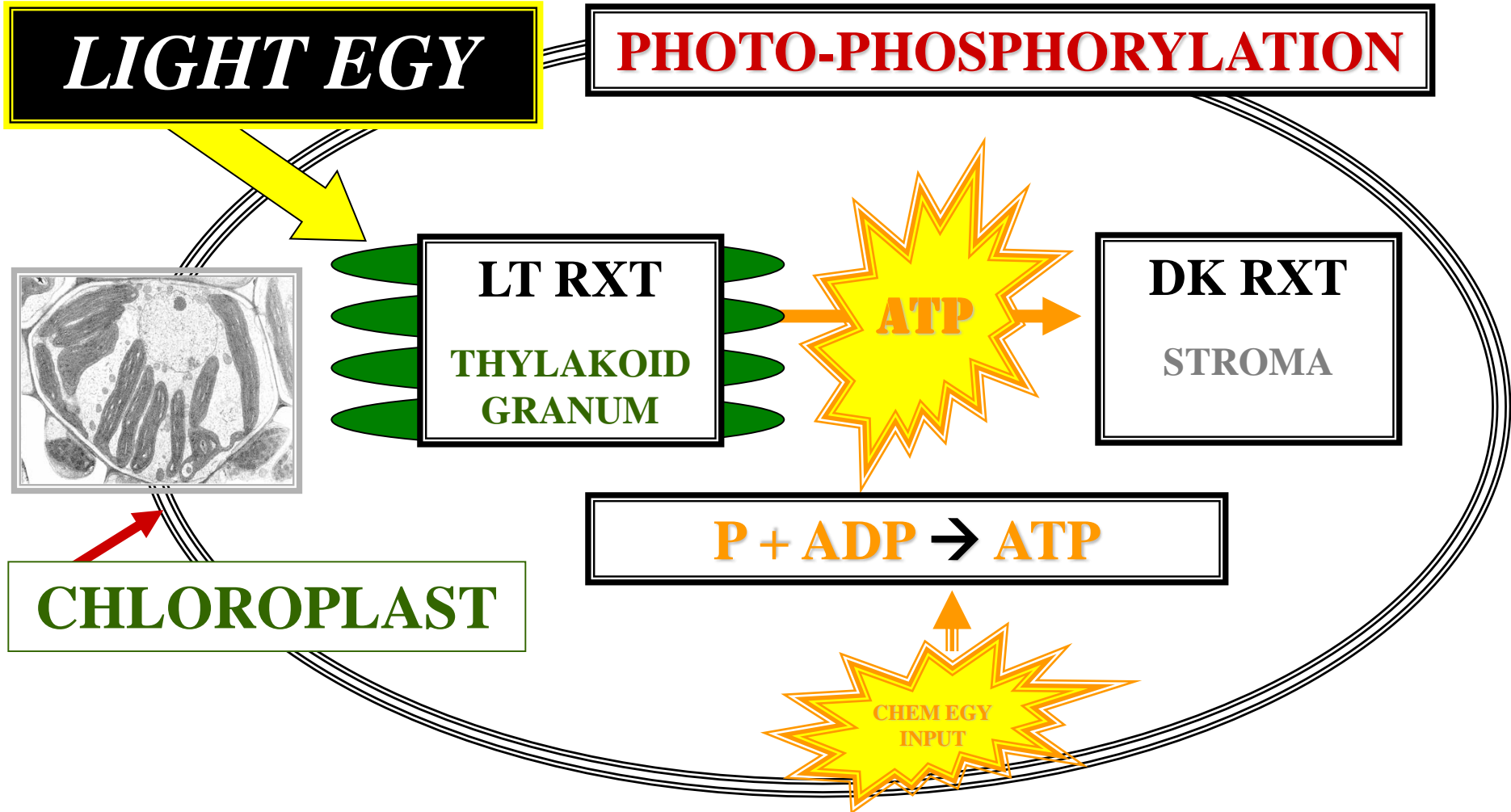
ATP

DK RXT
STROMA



CHLOROPLAST

CHEMICAL
INPUT



PHOTOSYNTHESIS

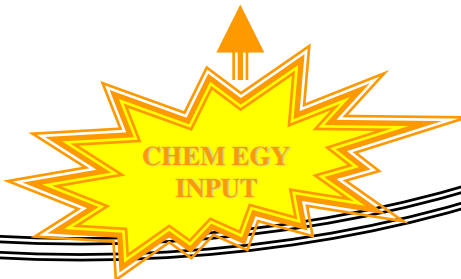
CYCLIC

PHOTO-PHOSPHORYLATION

LIGHT ENERGY



CHLOROPLAST



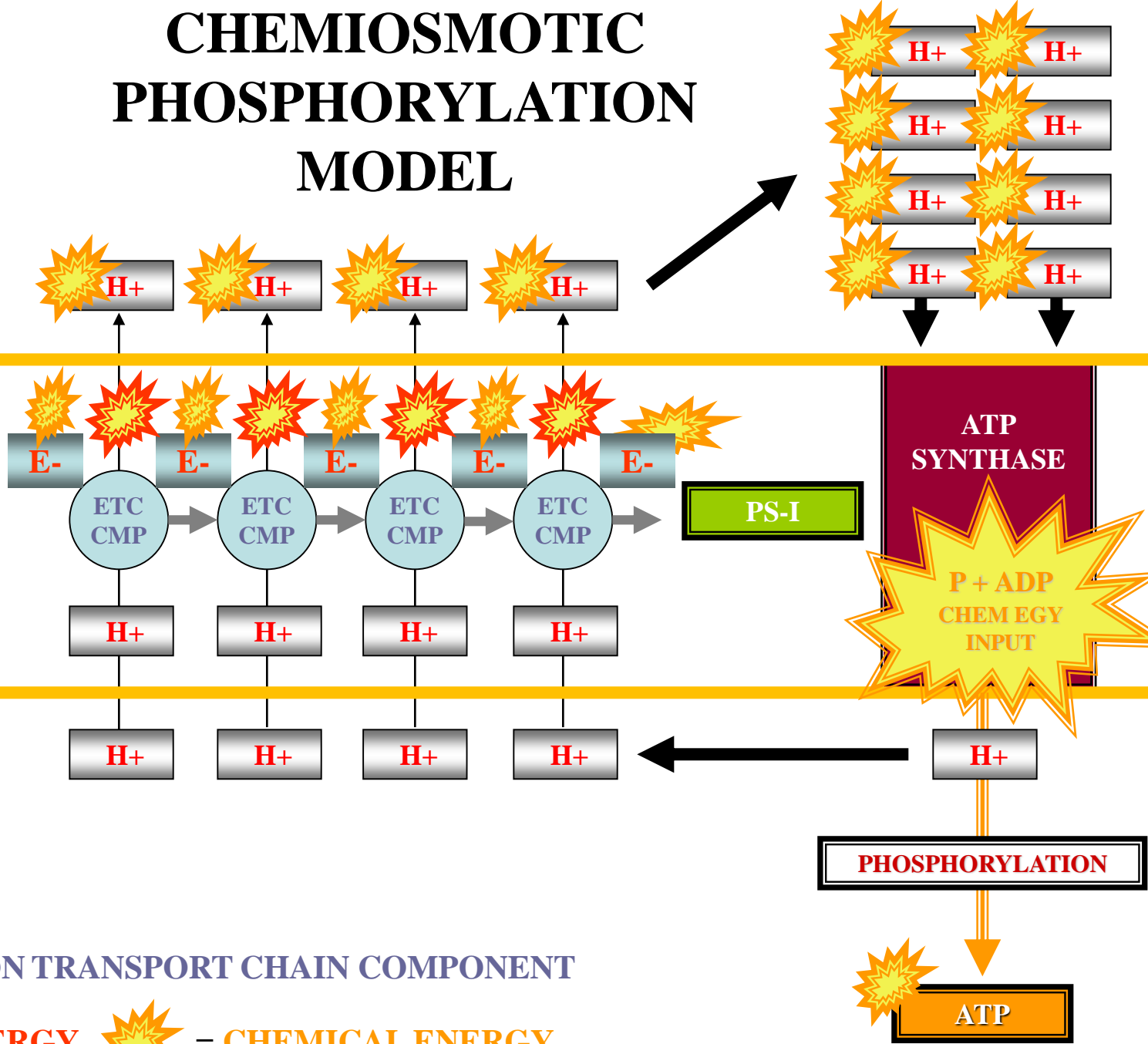
↔ \$ C

CHEMIOSMOTIC PHOSPHORYLATION MODEL

CHLOROPLAST THYLAKOID SPACE

PS-II / PS-I
CHLOROPLAST THYLAKOID ETC

CHLOROPLAST STROMA

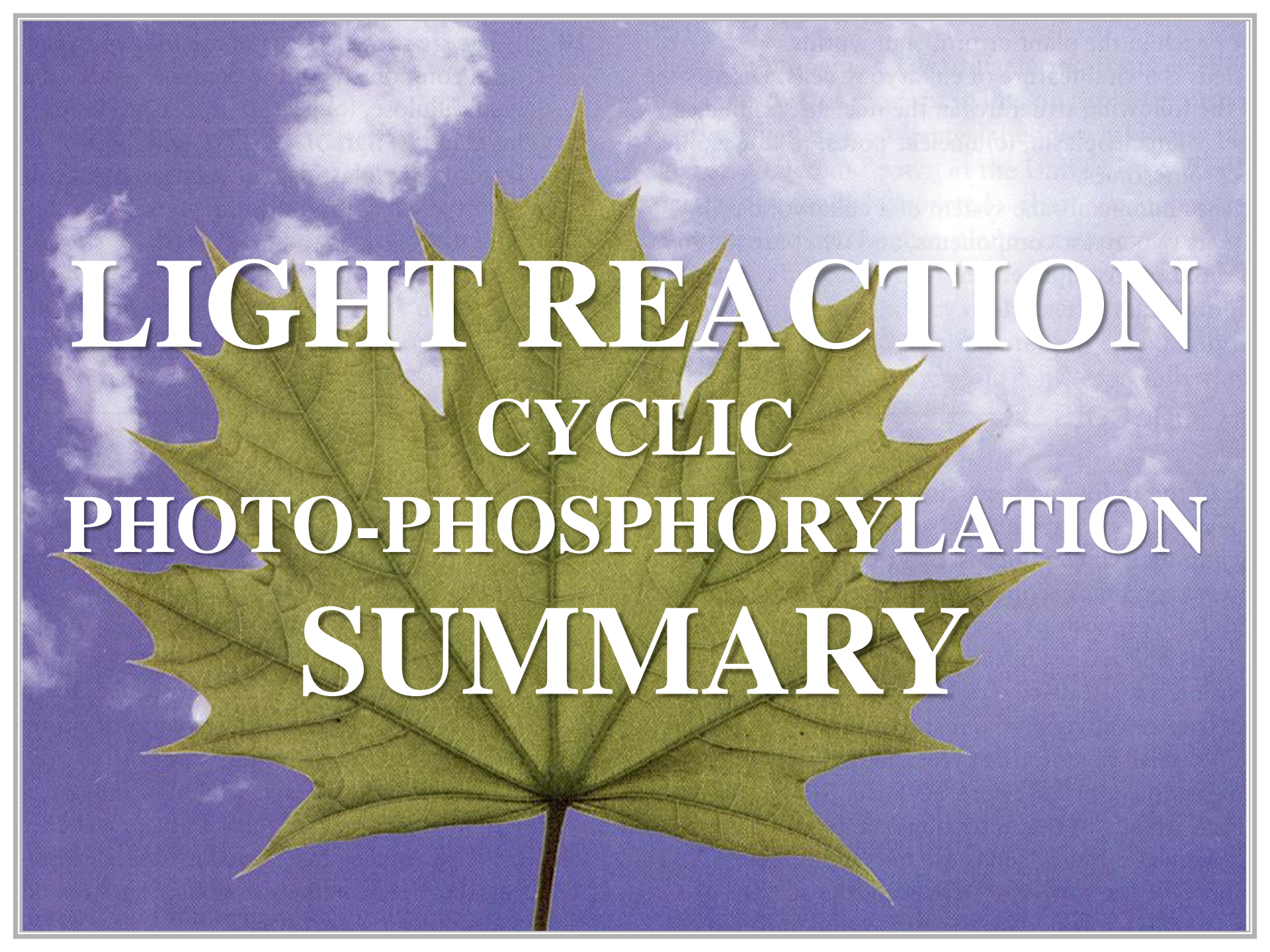


● = ELECTRON TRANSPORT CHAIN COMPONENT

★ = HEAT ENERGY ★ = CHEMICAL ENERGY

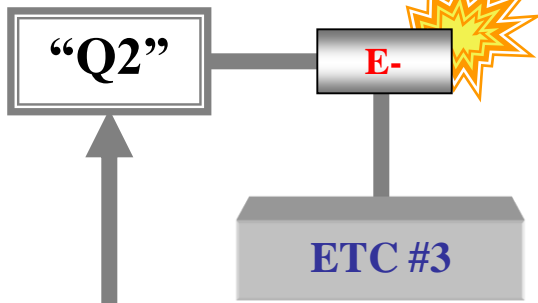
PHOSPHORYLATION

ATP

A large, vibrant green maple leaf is the central focus, set against a background of a bright blue sky with scattered white clouds. The leaf's veins are clearly visible, and its stem extends downwards. The overall image has a slightly grainy texture.

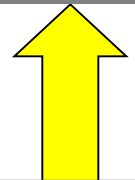
LIGHT REACTION
CYCLIC
PHOTO-PHOSPHORYLATION
SUMMARY

CYCLIC P-P

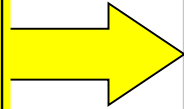


ENERGIZED E-

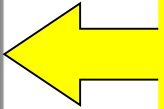
PS-I
RXT-CENTER
CHL-A P700



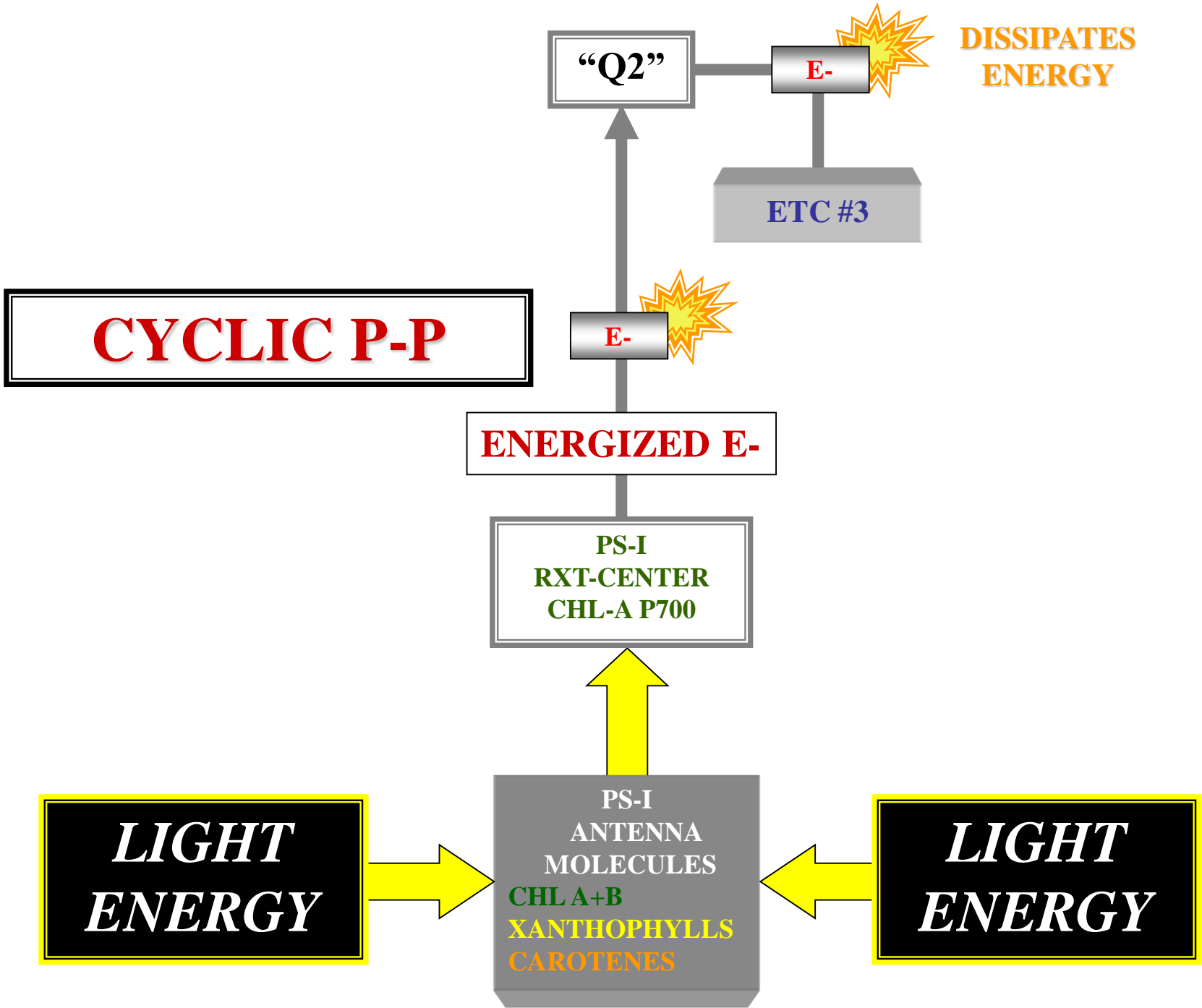
LIGHT ENERGY

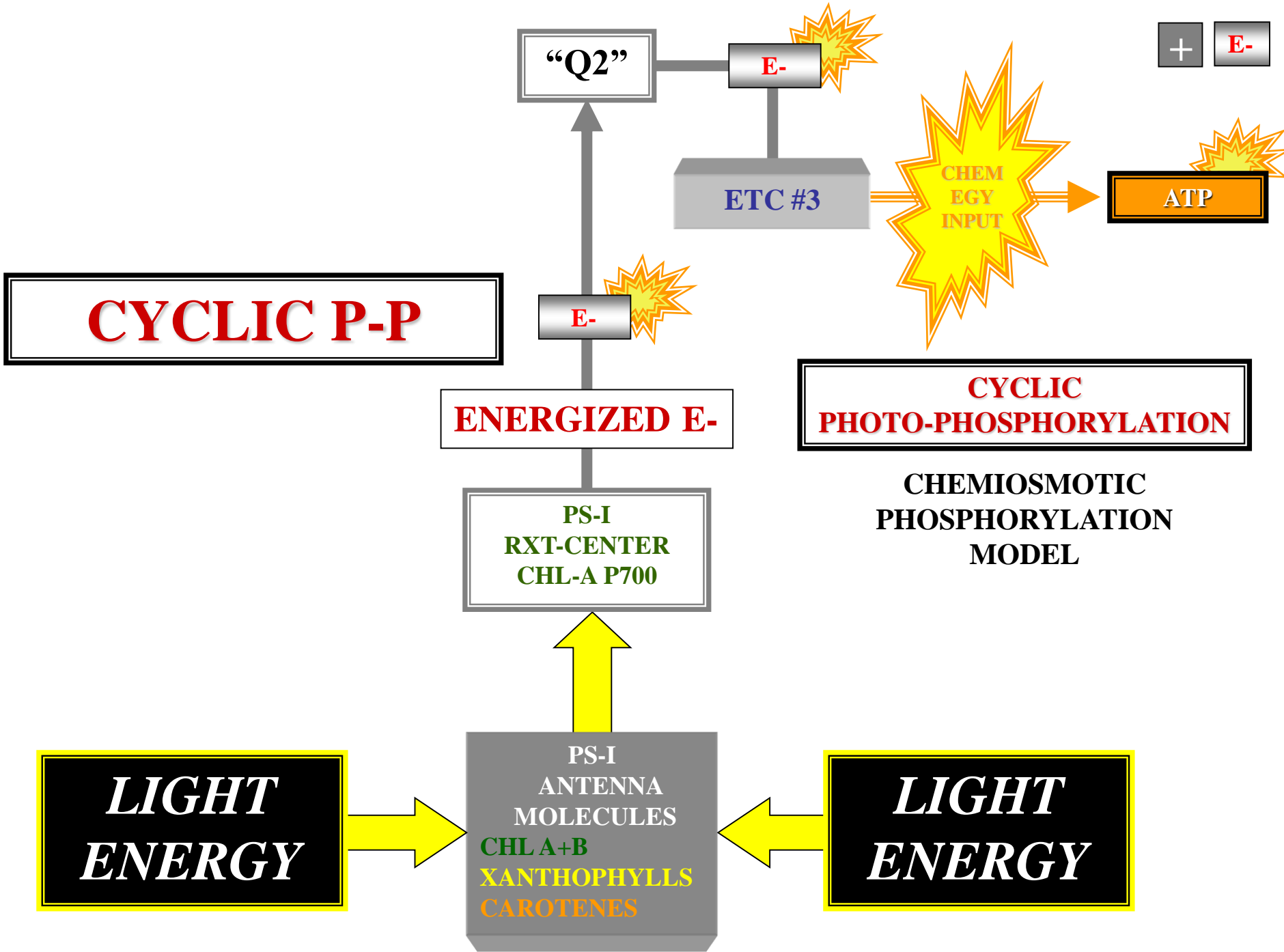


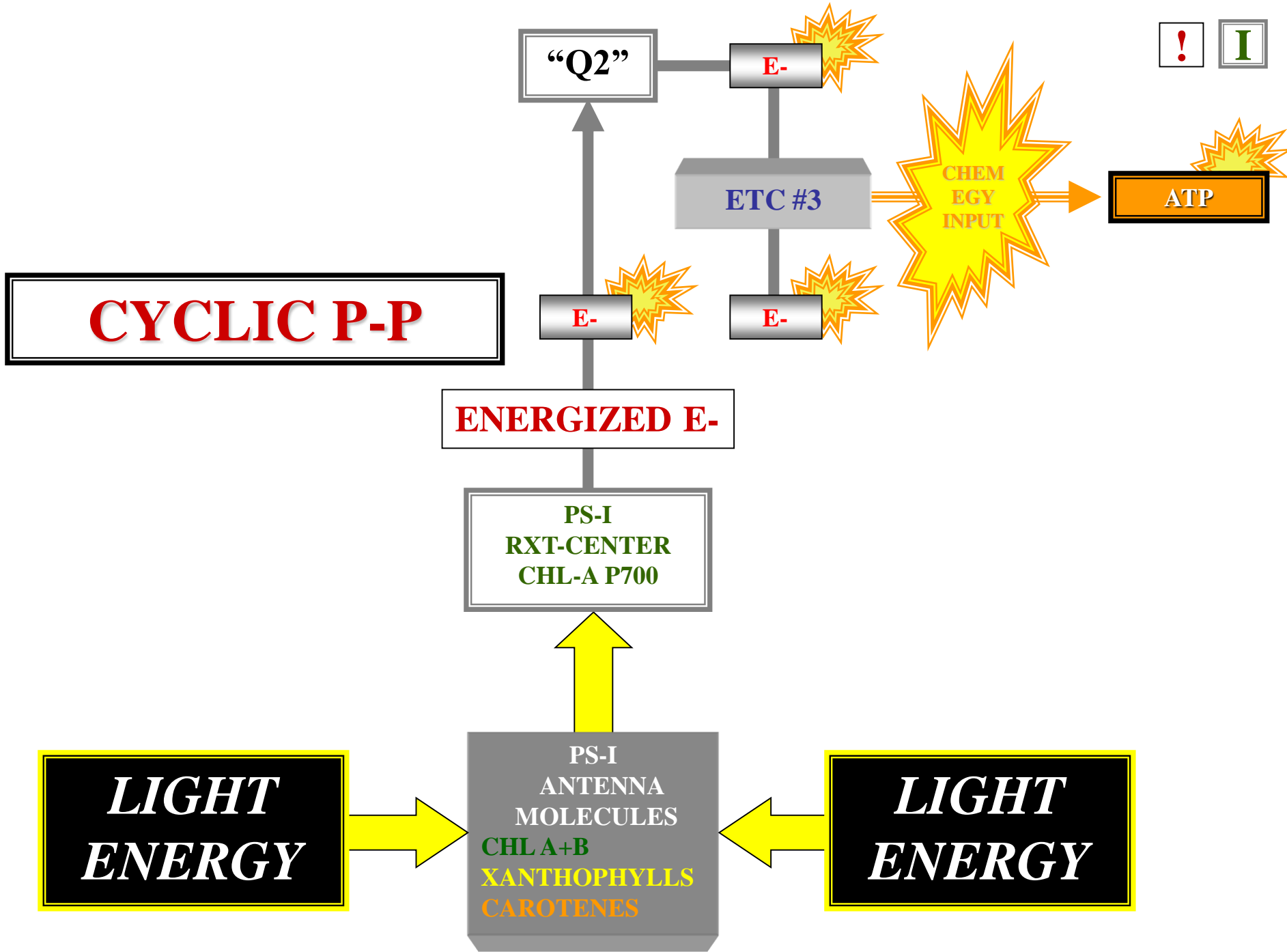
PS-I
ANTENNA
MOLECULES
CHL A+B
XANTHOPHYLLS
CAROTENES

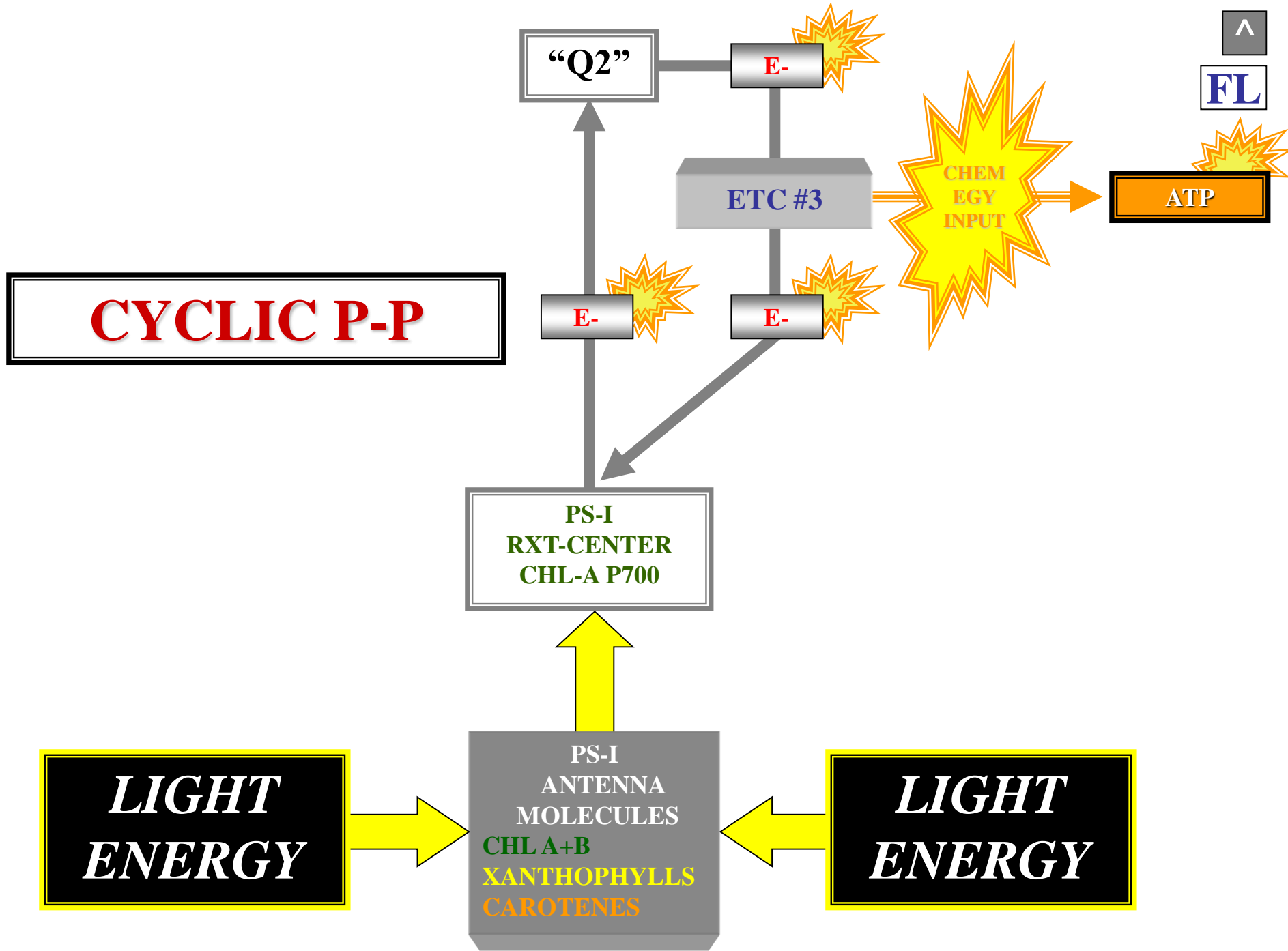


LIGHT ENERGY







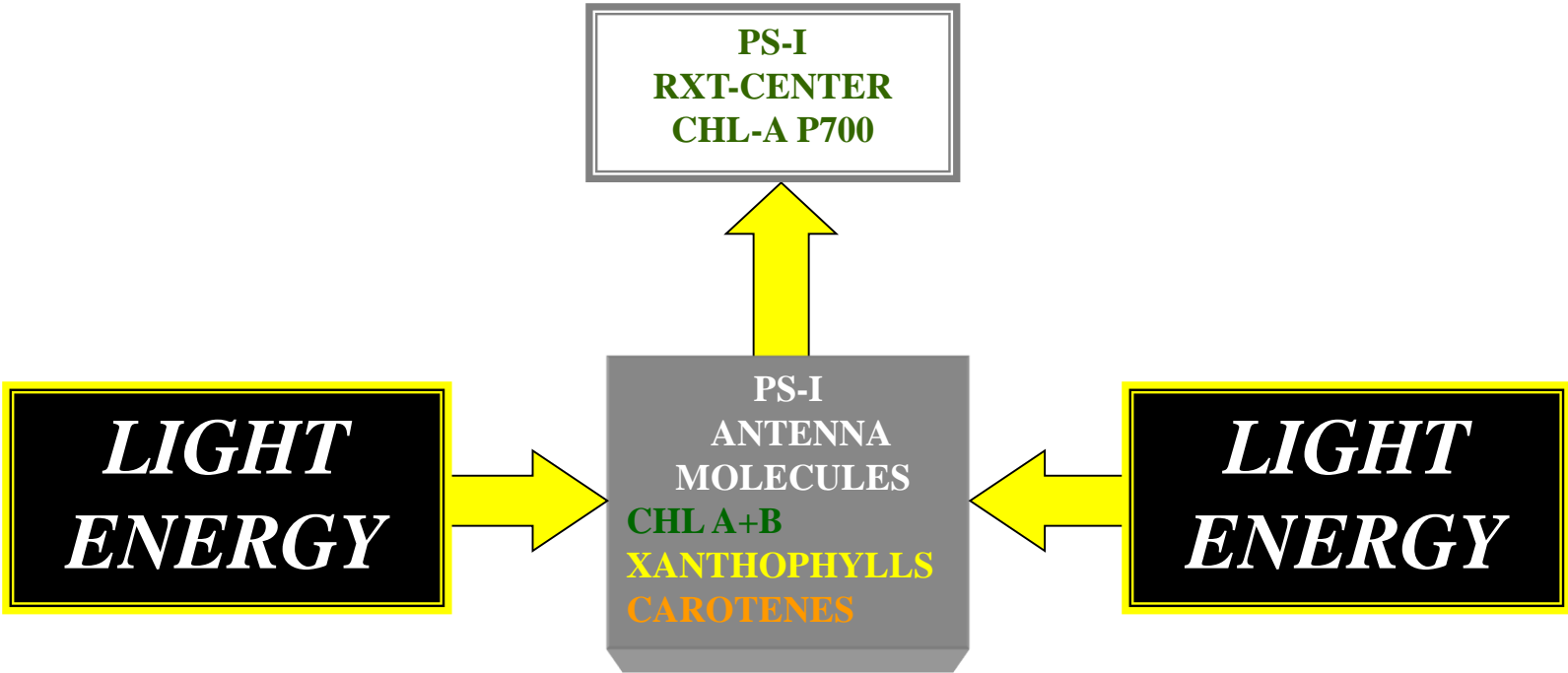


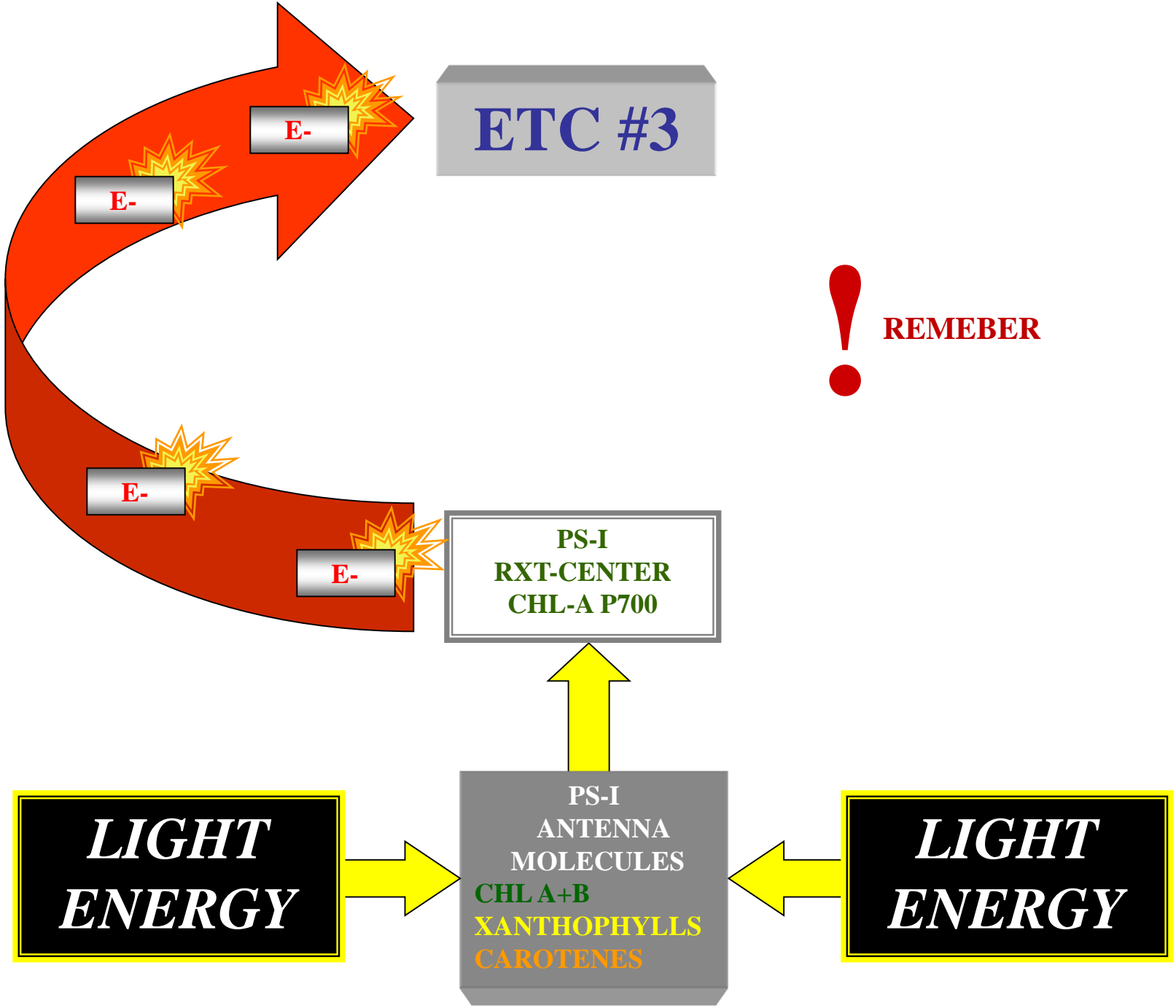


LIGHT REACTION
CYCLIC
PHOTO-PHOSPHORYLATION
E- FLOW



ETC #3





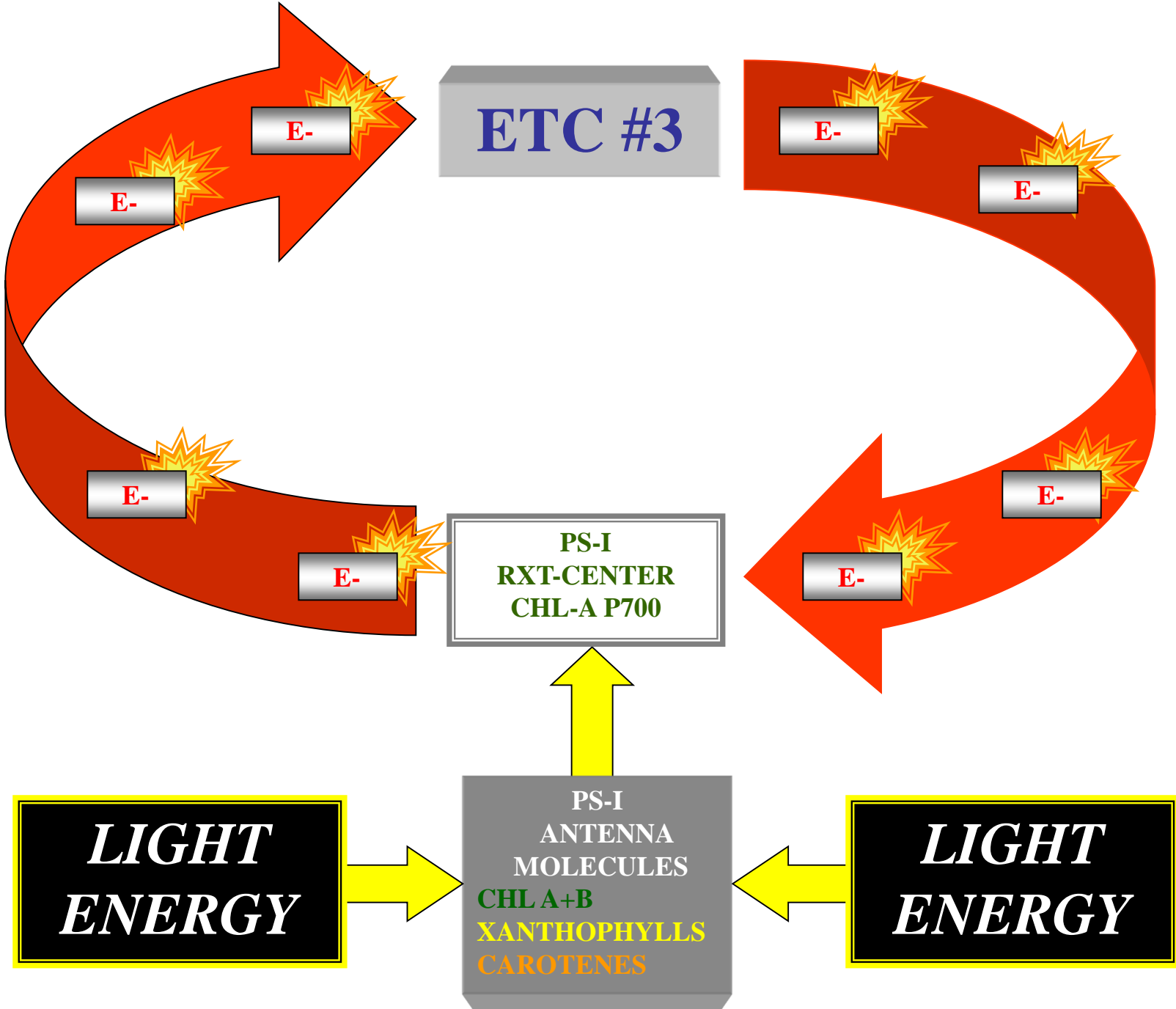
E-

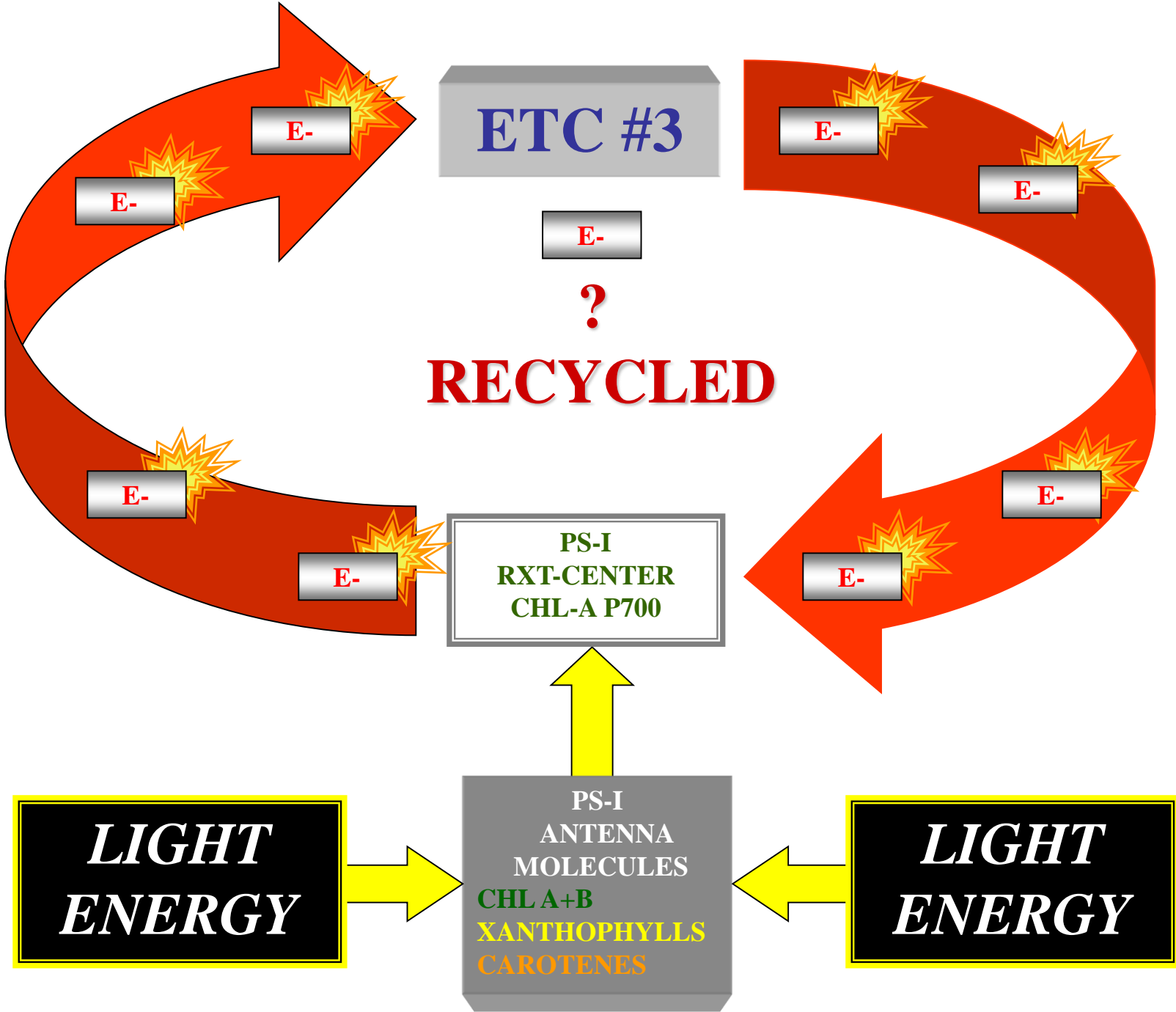


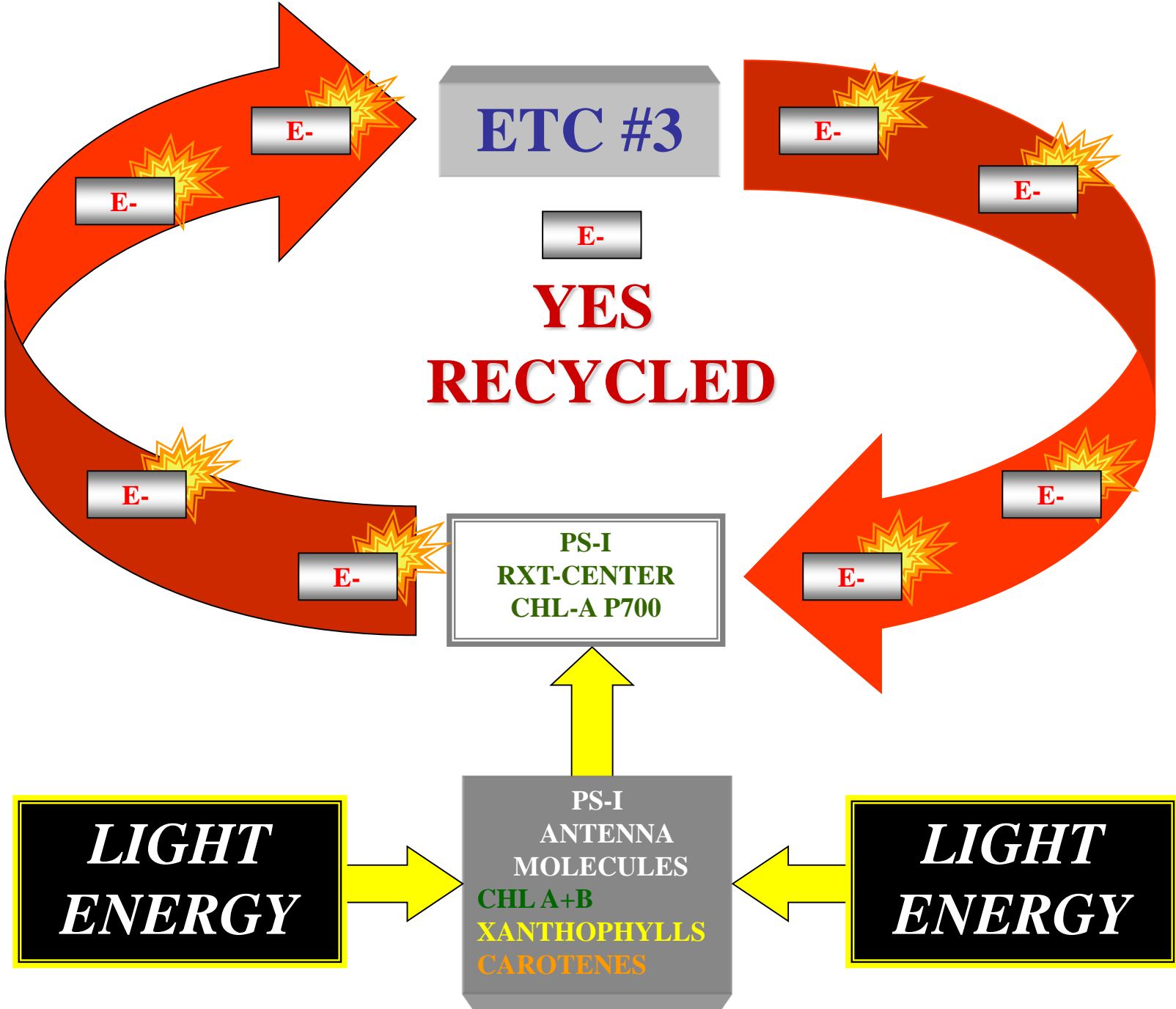
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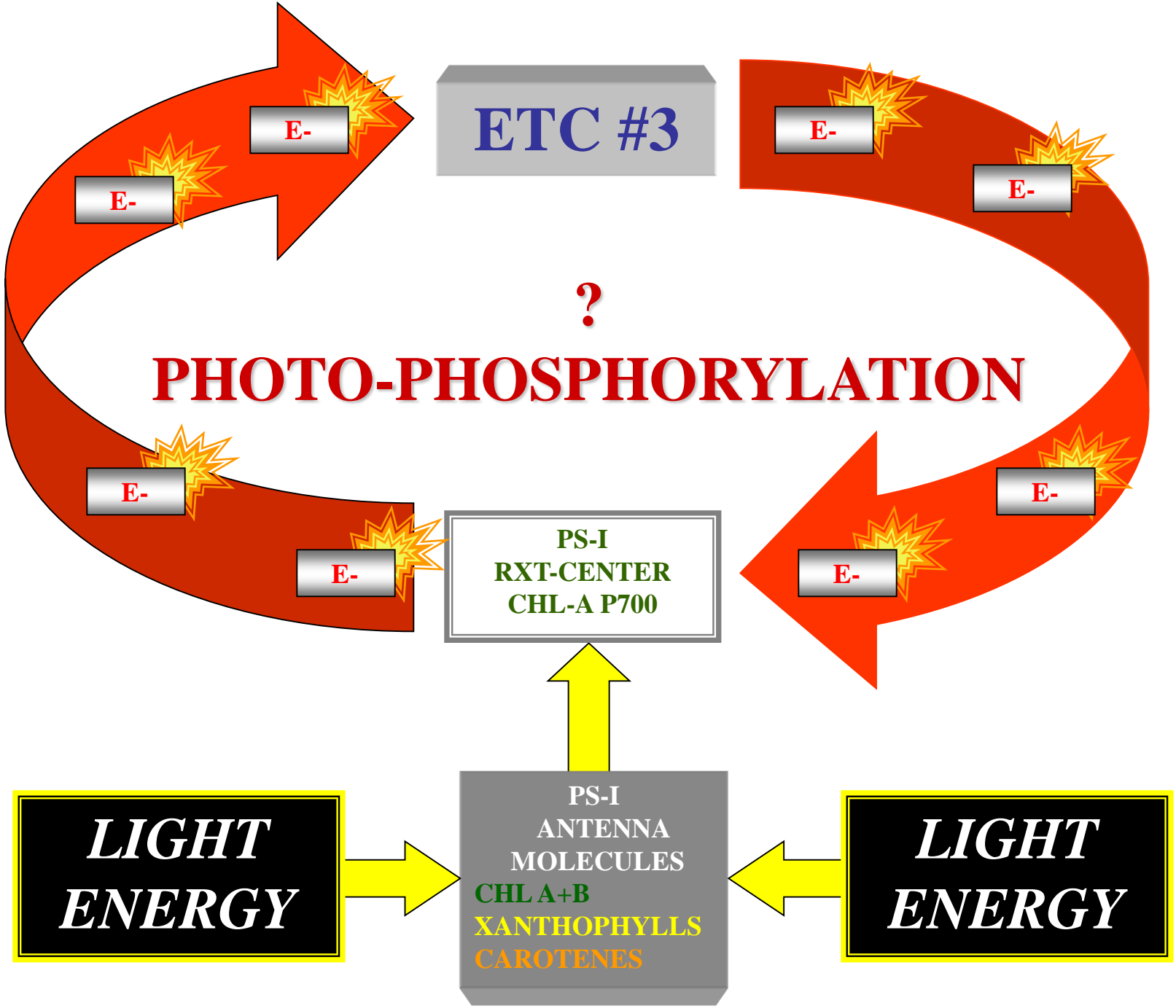


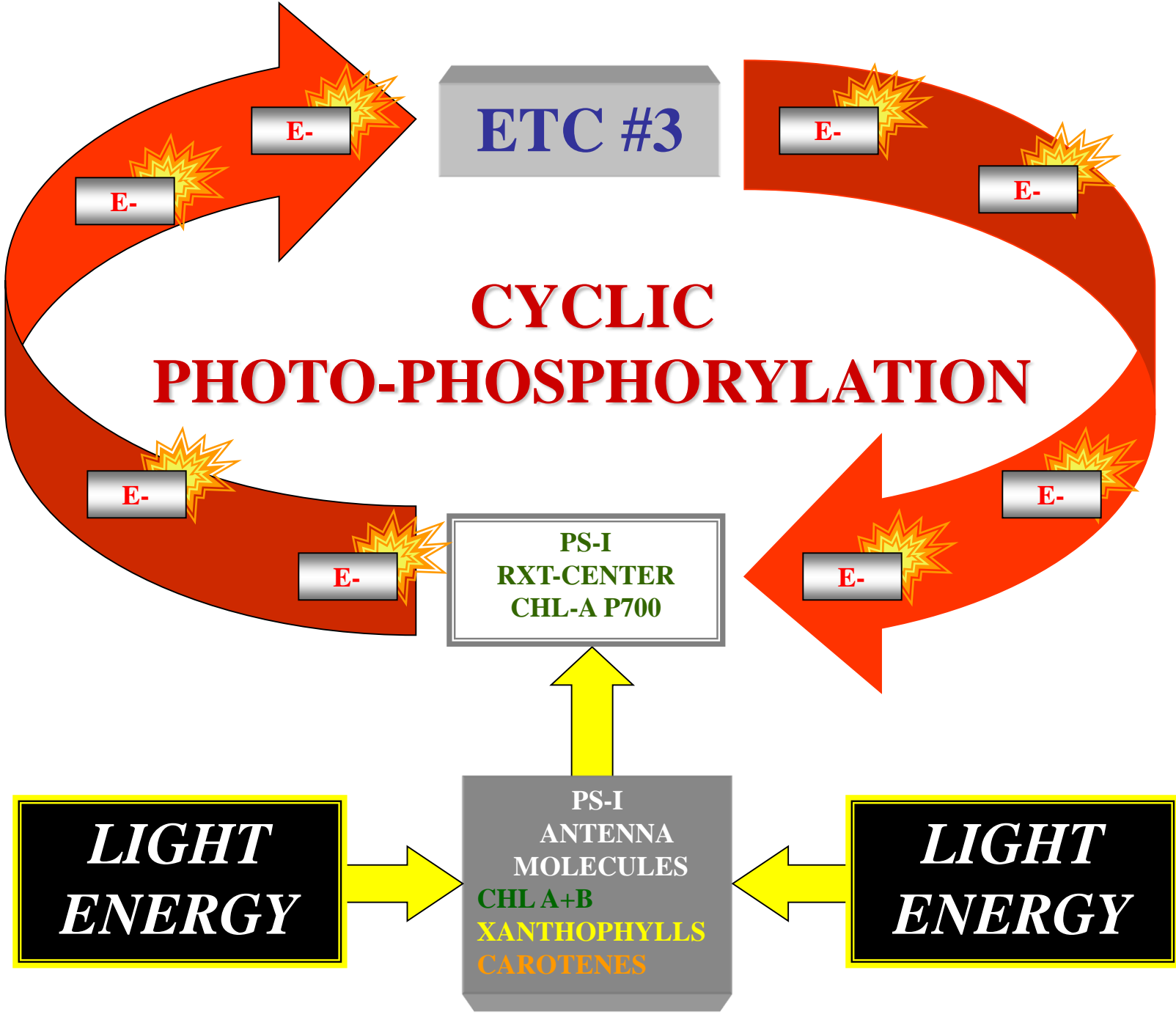
REMEBER











CYCLIC P-P

“Q2”

E-

ETC #3

CHEM
EGY
INPUT

ATP

E-

E-

E- = RECYCLED

PS-I
RXT-CENTER
CHL-A P700

LIGHT
ENERGY

PS-I
ANTENNA
MOLECULES
CHL A+B
XANTHOPHYLLS
CAROTENES

LIGHT
ENERGY

? A

PHOTOSYNTHESIS

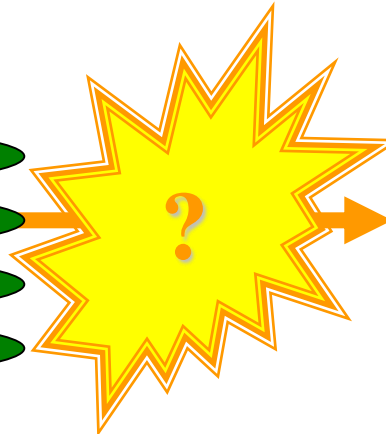
A



LIGHT ENERGY



CHLOROPLAST

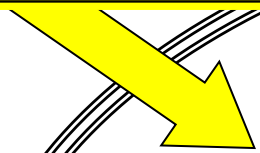


CYCLIC P-P

PHOTOSYNTHESIS



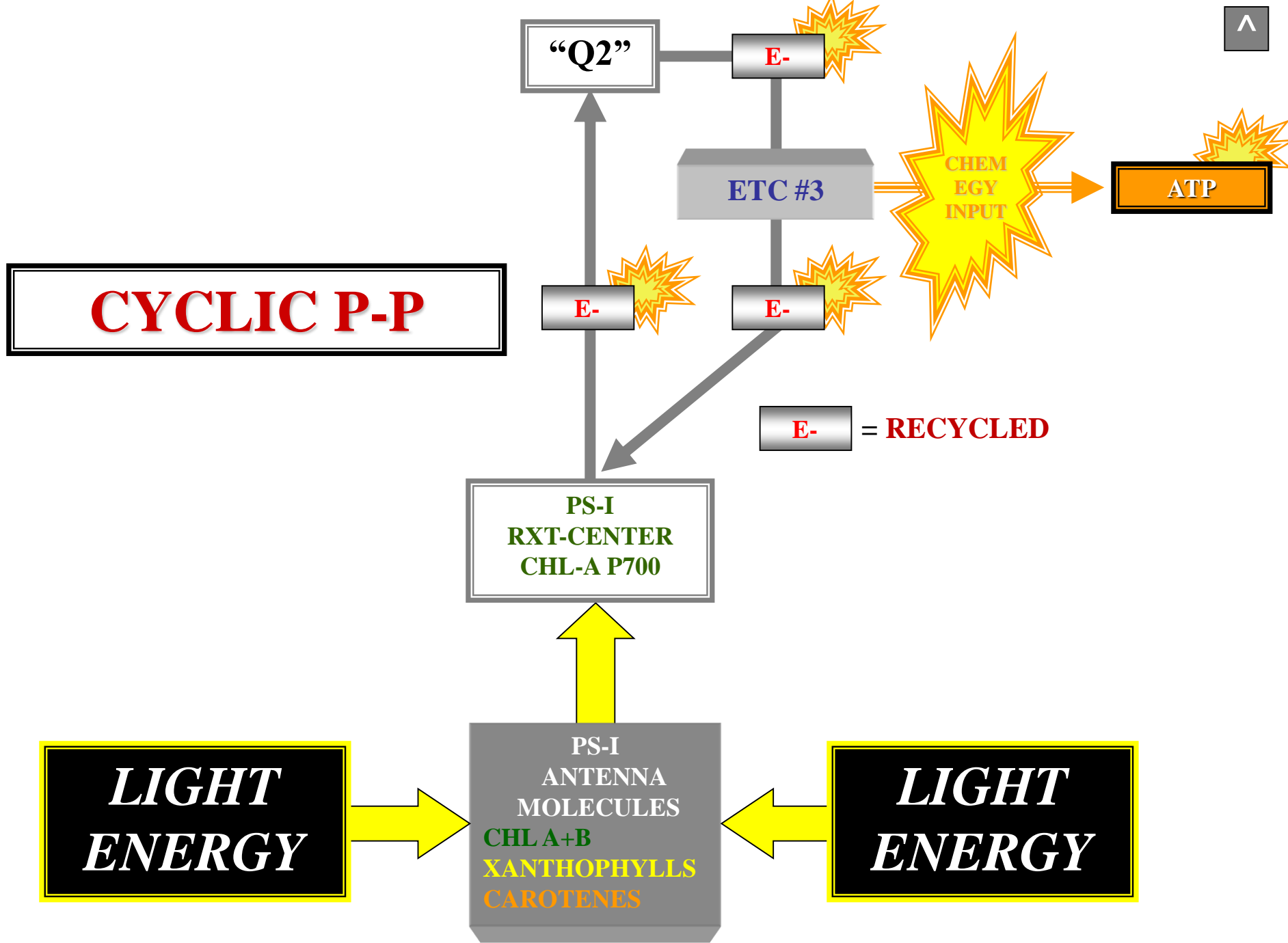
LIGHT ENERGY



CHLOROPLAST



CYCLIC P-P



CYCLIC PHOTO PHOSPHORYLATION IMPORTANCE

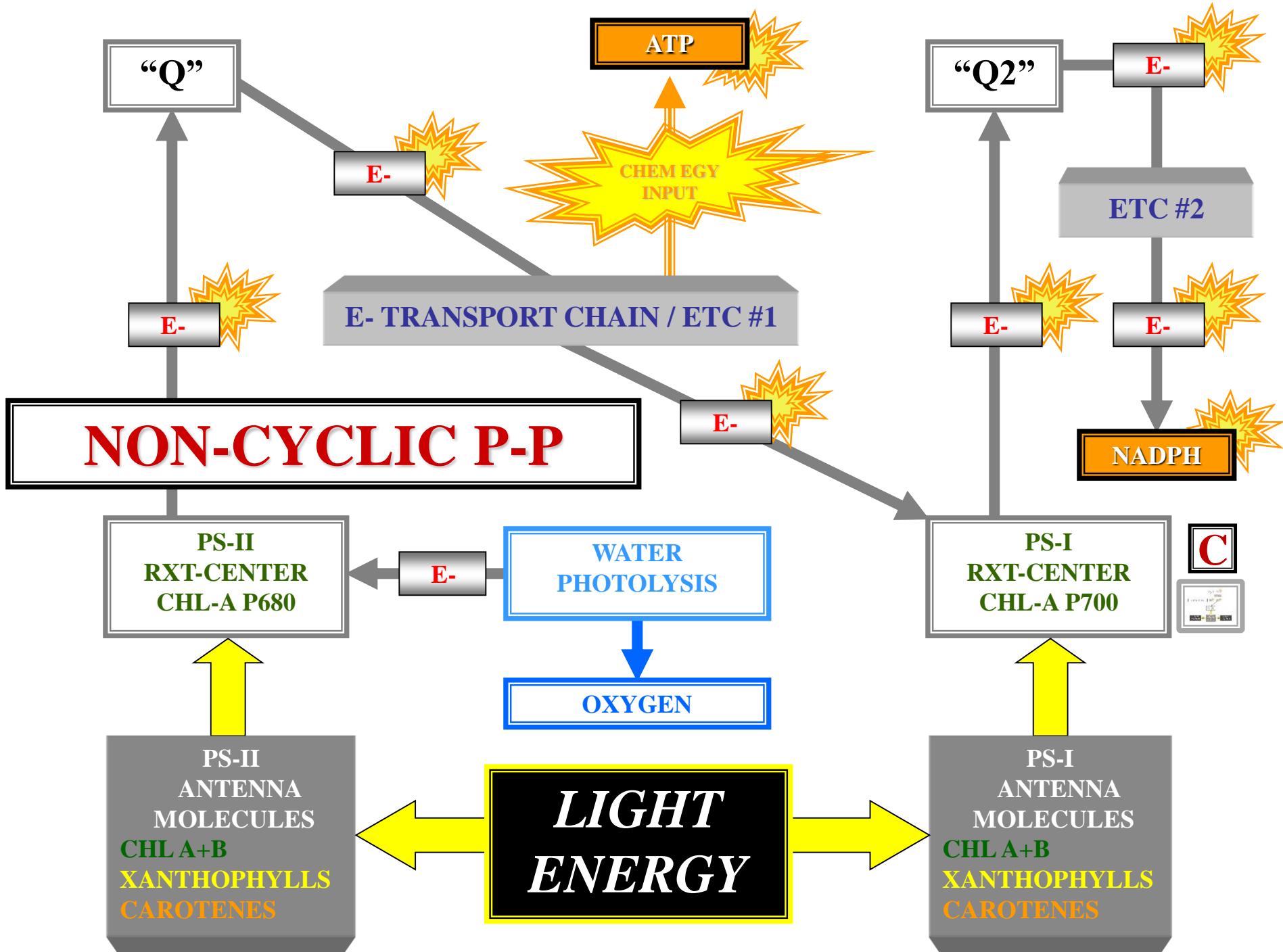
PHOTOSYNTHESIS

N



LIGHT REACTION

MAPLE



CYCLIC P-P

LIGHT ENERGY

LIGHT ENERGY

PS-I
ANTENNA
MOLECULES
CHL A+B
XANTHOPHYLLS
CAROTENES

PS-I
RXT-CENTER
CHL-A P700

“Q2”

ETC #3

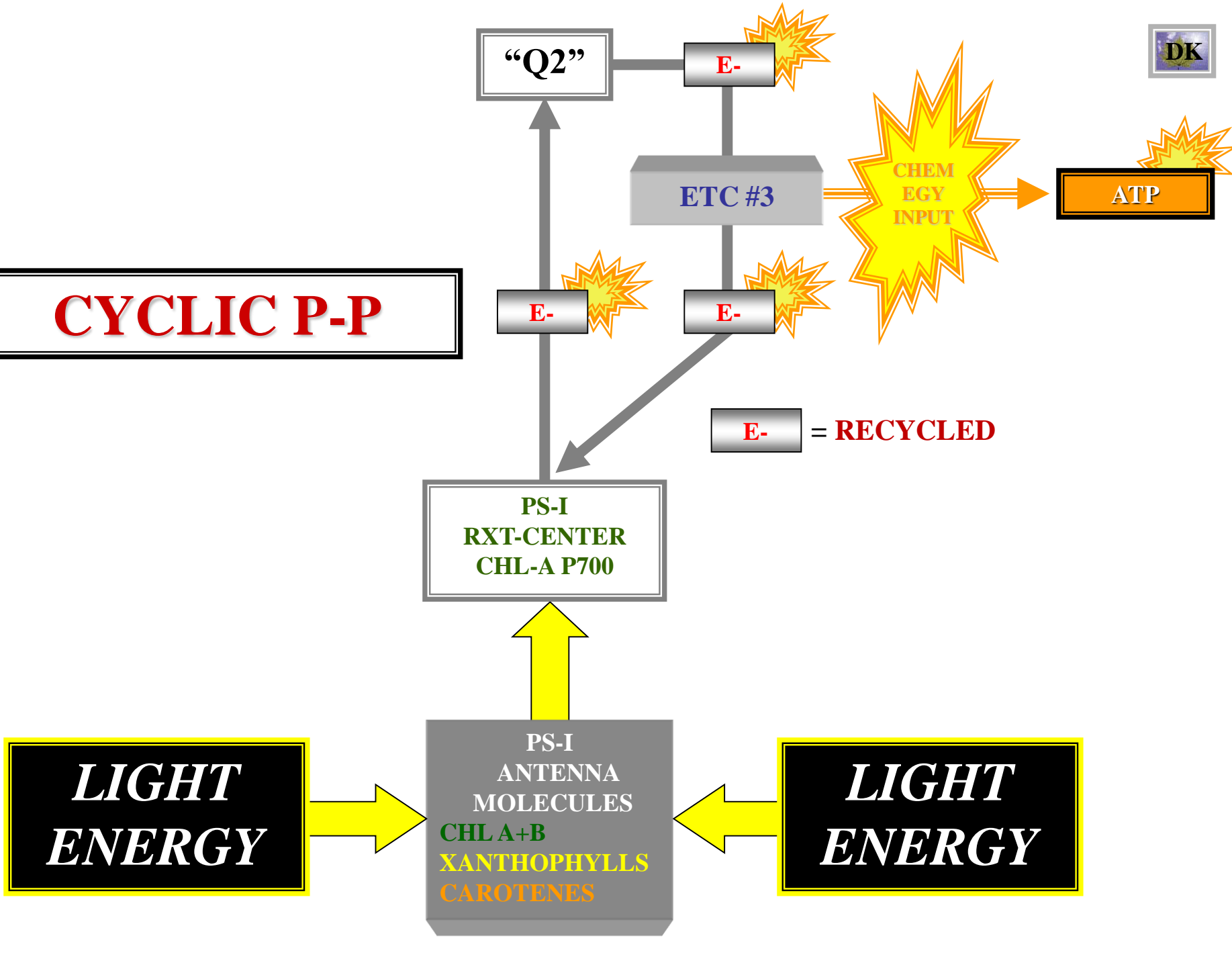
ATP

E-

E-

E- = RECYCLED

CHEM
EGY
INPUT



DARK REACTION^G

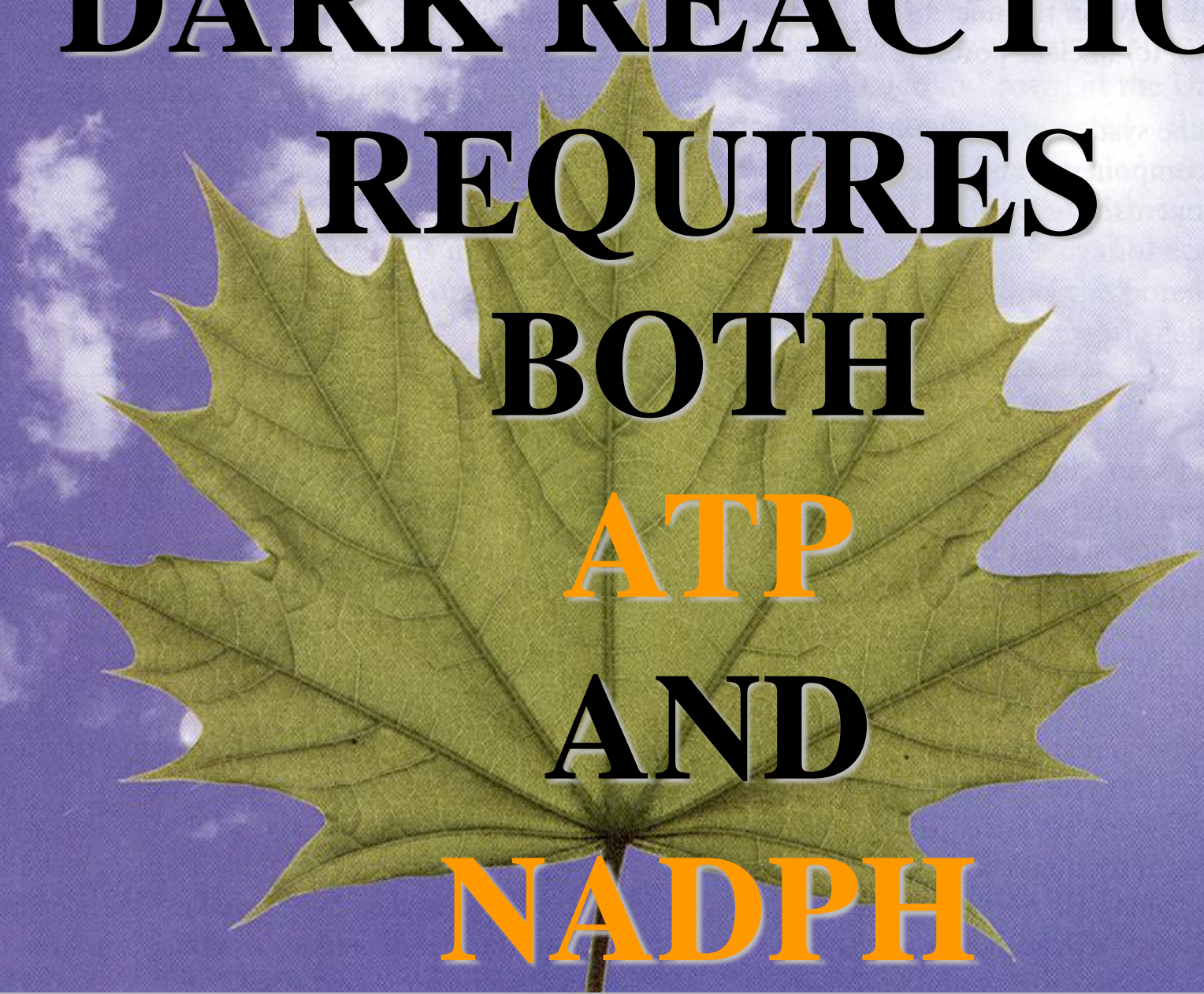
REQUIRES

BOTH

ATP

AND

NADPH





CO₂ + RIBULOSE BISPHOSPHATE / (RUBP)

RIBULOSE BISPHOSPHATE CARBOXYLASE (RUBP-CARBOXYLASE)



PHOSPHOGLYCERATE / (PGA)

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

ATP

ATP

?

C

BISPHOGLYCERATE / (BIPGA)

BISPHOGLYCERATE / (BIPGA)

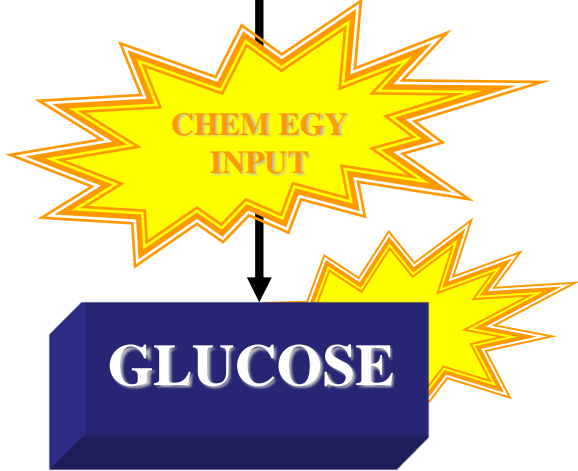
NADPH

NADPH

ALL RXTS REQUIRE A SPECIFIC ENZYME

PHOSPHOGLYCERALDEHYDE / (PGAL)

PHOSPHOGLYCERALDEHYDE / (PGAL)

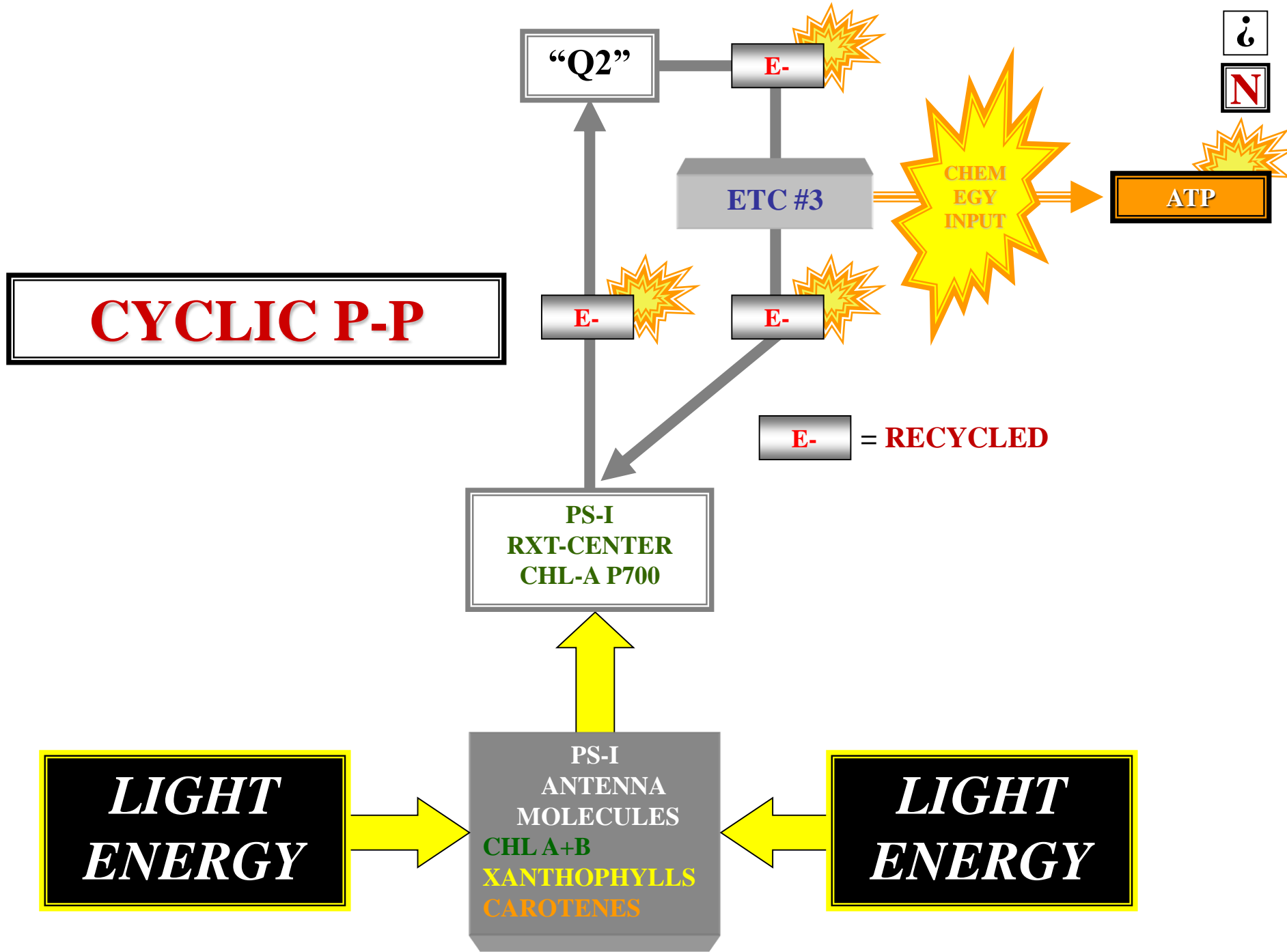


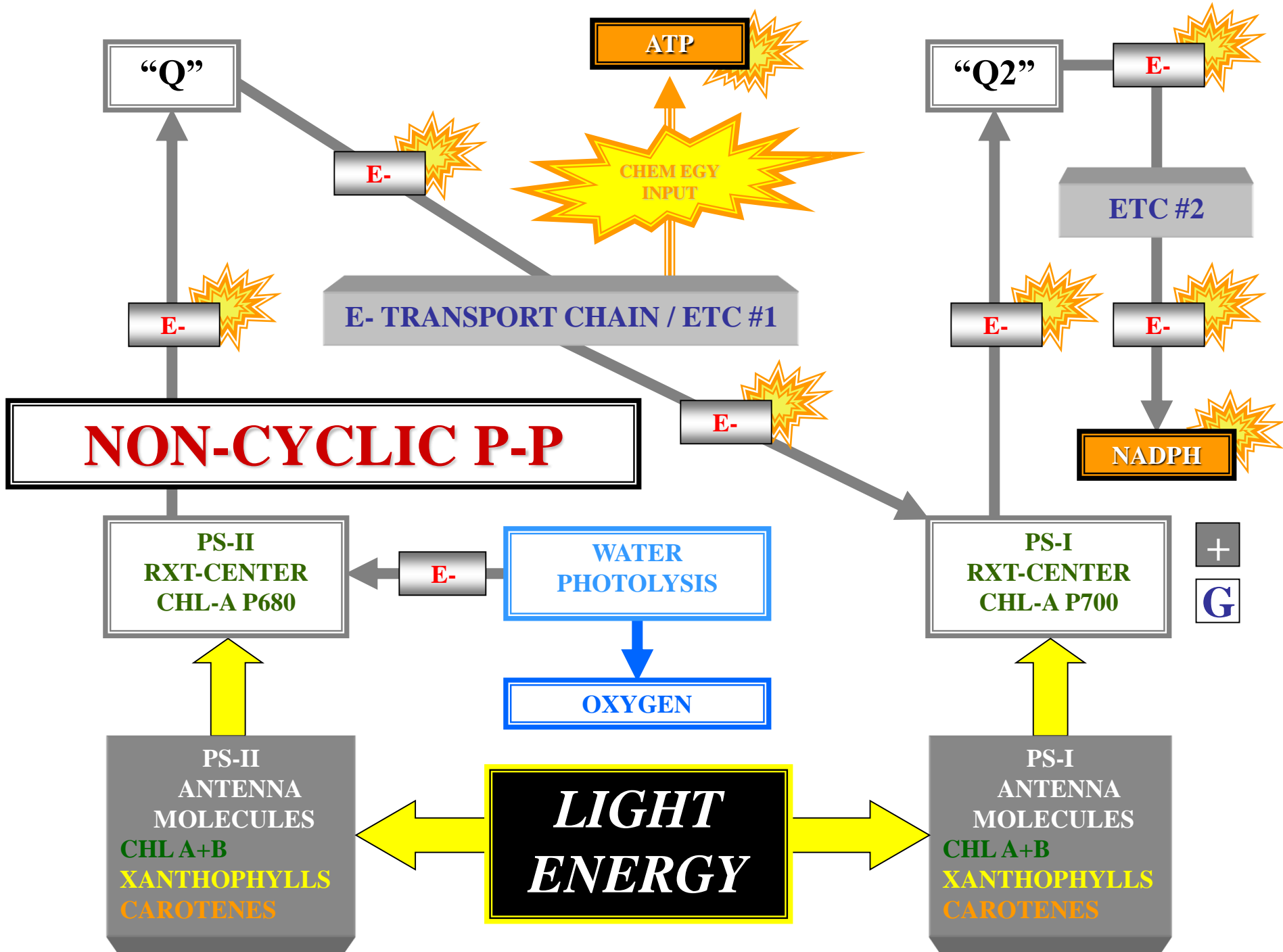
DARK REACTION

COMPLEX SERIES CHEMICAL RXTS (CSCR)

ATP

RIBULOSE BISPHOSPHATE / (RUBP)







CO₂ + **RIBULOSE BISPHOSEPHATE / (RUBP)**

**RIBULOSE BISPHOSEPHATE
CARBOXYLASE
(RUBP-CARBOXYLASE)**



PHOSPHOGLYCERATE / (PGA)

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

ATP

ATP



BISPHOSEPHOGLYCERATE / (BIPGA)

BISPHOSEPHOGLYCERATE / (BIPGA)

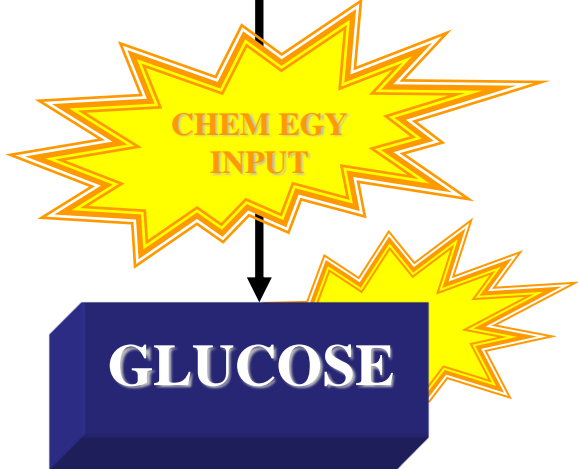
NADPH

NADPH

PHOSPHOGLYCERALDEHYDE / (PGAL)

PHOSPHOGLYCERALDEHYDE / (PGAL)

**ALL RXTS
REQUIRE
A SPECIFIC
ENZYME**



DARK REACTION

**COMPLEX SERIES
CHEMICAL RXTS
(CSCR)**

ATP

RIBULOSE BISPHOSEPHATE / (RUBP)



**PLANTS PREFER
NON-CYCLIC P-P
OVER
CYCLIC P-P**

DARK REACTION^G

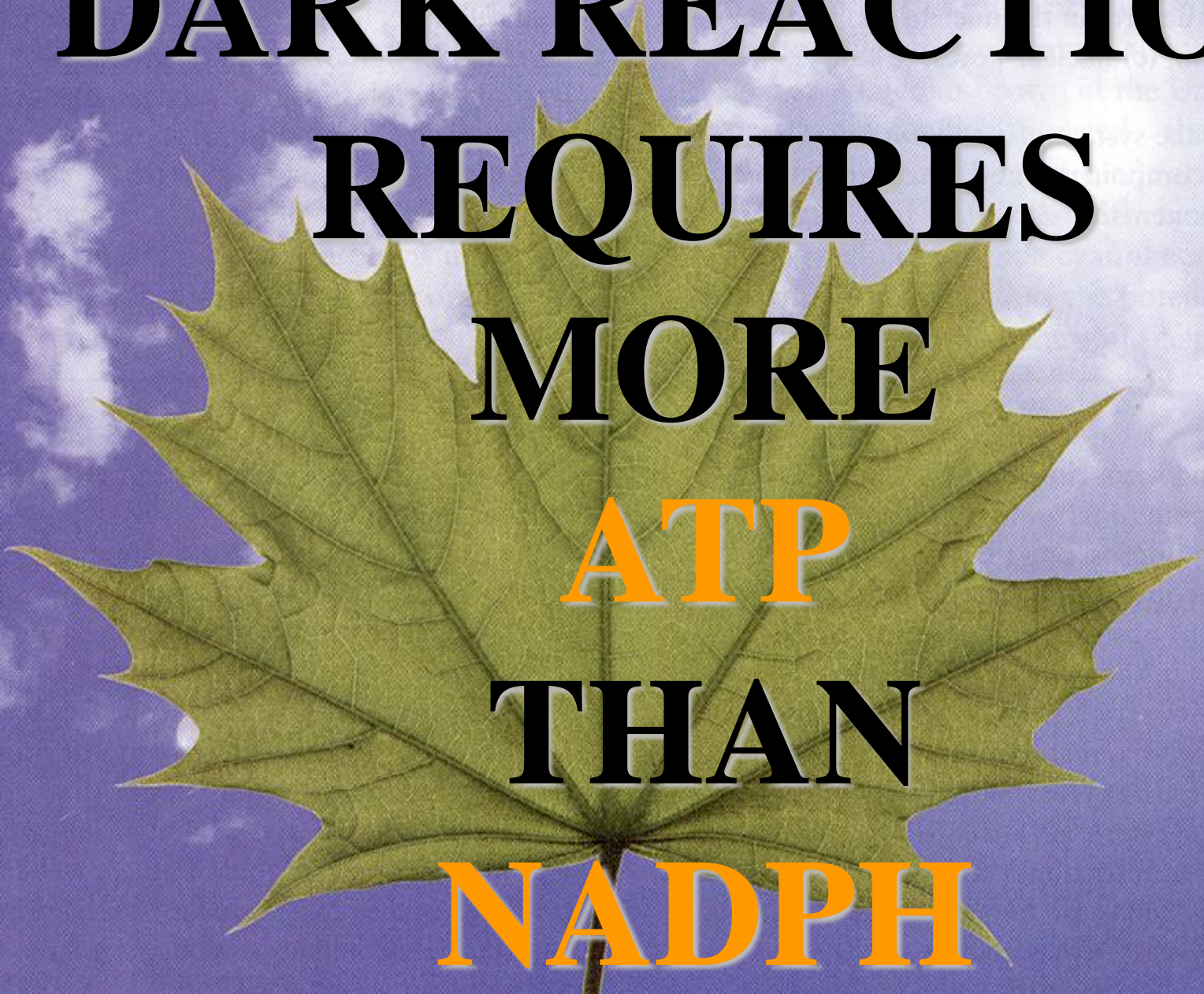
REQUIRES

MORE

ATP

THAN

NADPH





CO₂ + RIBULOSE BIPHOSPHATE / (RUBP)



RIBULOSE BIPHOSPHATE CARBOXYLASE (RUBP-CARBOXYLASE)

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

PHOSPHOGLYCERATE / (PGA)

ATP

ATP

3

BIPHOSPHOGLYCERATE / (BIPGA)

BIPHOSPHOGLYCERATE / (BIPGA)

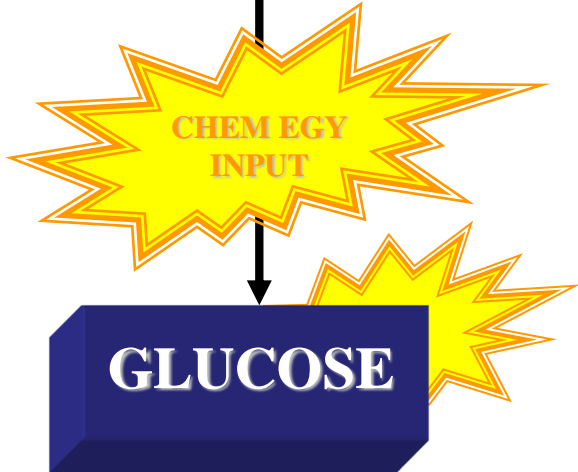
NADPH

NADPH

ALL RXTS REQUIRE A SPECIFIC ENZYME

PHOSPHOGLYCERALDEHYDE / (PGAL)

PHOSPHOGLYCERALDEHYDE / (PGAL)



DARK REACTION

COMPLEX SERIES CHEMICAL RXTS (CSCR)

ATP

RIBULOSE BIPHOSPHATE / (RUBP)



CO₂ + **RIBULOSE BISPHOSPHATE / (RUBP)**

**RIBULOSE BISPHOSPHATE
CARBOXYLASE
(RUBP-CARBOXYLASE)**



PHOSPHOGLYCERATE / (PGA)

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

ATP

ATP

2

BISPHOGLYCERATE / (BIPGA)

BISPHOGLYCERATE / (BIPGA)

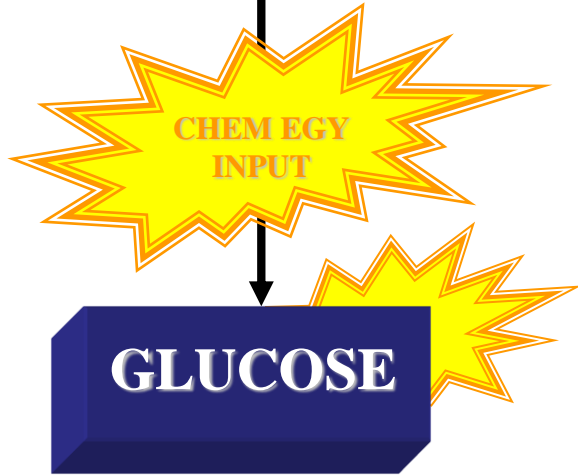
NADPH

NADPH

PHOSPHOGLYCERALDEHYDE / (PGAL)

PHOSPHOGLYCERALDEHYDE / (PGAL)

**ALL RXTS
REQUIRE
A SPECIFIC
ENZYME**



DARK REACTION

**COMPLEX SERIES
CHEMICAL RXTS
(CSR)**

ATP

RIBULOSE BISPHOSPHATE / (RUBP)



CO₂ + **RIBULOSE BISPHOSPHATE / (RUBP)**



**RIBULOSE BISPHOSPHATE
CARBOXYLASE
(RUBP-CARBOXYLASE)**

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

PHOSPHOGLYCERATE / (PGA)

ATP

ATP

N

1

BISPHOGLYCERATE / (BPGA)

BISPHOGLYCERATE / (BPGA)

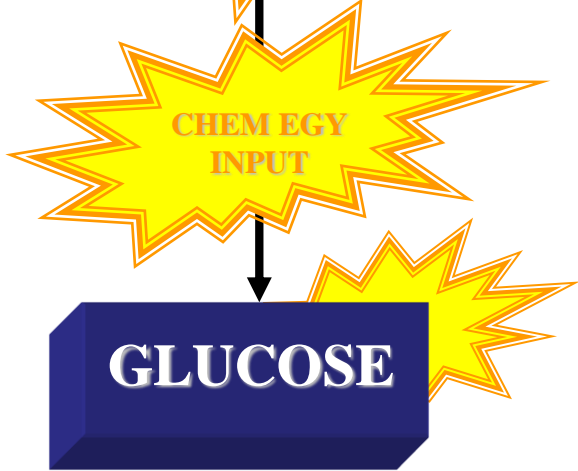
NADPH

NADPH

PHOSPHOGLYCERALDEHYDE / (PGAL)

PHOSPHOGLYCERALDEHYDE / (PGAL)

**ALL RXTS
REQUIRE
A SPECIFIC
ENZYME**

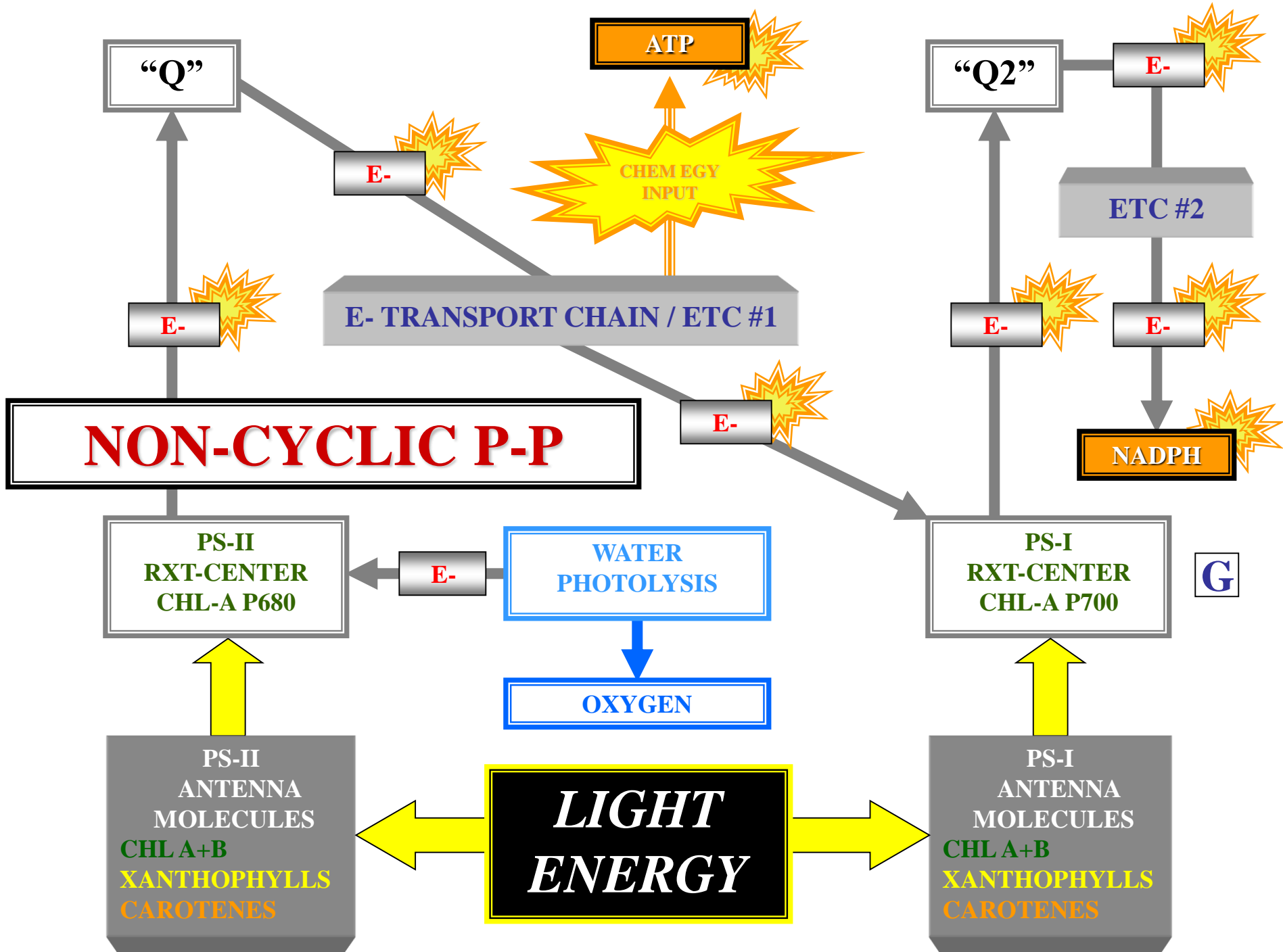


DARK REACTION

**COMPLEX SERIES
CHEMICAL RXTS
(CSCR)**

ATP

RIBULOSE BISPHOSPHATE / (RUBP)





CO₂ + **RIBULOSE BIPHOSPHATE / (RUBP)**



**RIBULOSE BIPHOSPHATE
CARBOXYLASE
(RUBP-CARBOXYLASE)**

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

PHOSPHOGLYCERATE / (PGA)

ATP

ATP

3

BIPHOSPHOGLYCERATE / (BIPGA)

BIPHOSPHOGLYCERATE / (BIPGA)

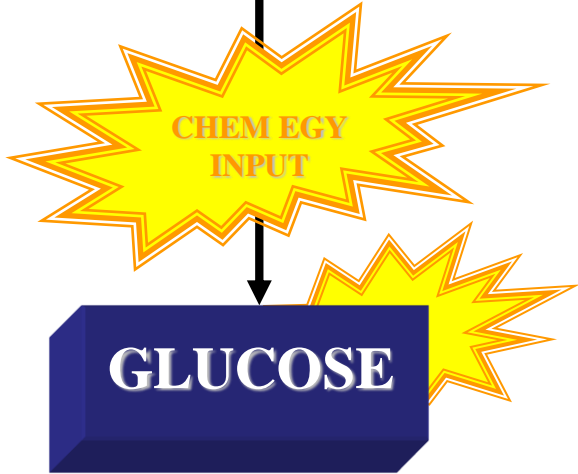
NADPH

NADPH

**ALL RXTS
REQUIRE
A SPECIFIC
ENZYME**

PHOSPHOGLYCERALDEHYDE / (PGAL)

PHOSPHOGLYCERALDEHYDE / (PGAL)



DARK REACTION

**COMPLEX SERIES
CHEMICAL RXTS
(CSCR)**

ATP

RIBULOSE BIPHOSPHATE / (RUBP)



CO₂ + **RIBULOSE BISPHOSEPHATE / (RUBP)**

**RIBULOSE BISPHOSEPHATE
CARBOXYLASE
(RUBP-CARBOXYLASE)**



PHOSPHOGLYCERATE / (PGA)

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

ATP

ATP

2

BISPHOSEPHOGLYCERATE / (BIPGA)

BISPHOSEPHOGLYCERATE / (BIPGA)

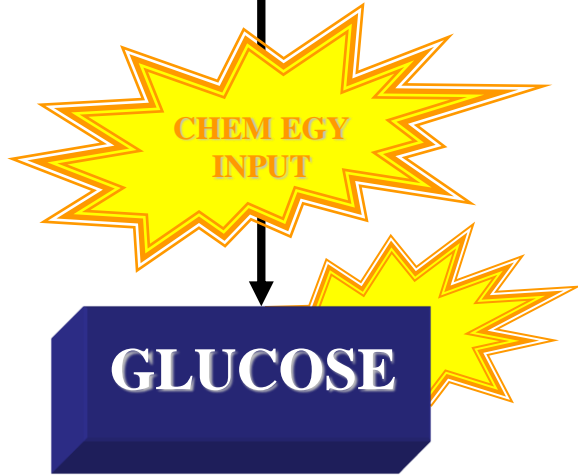
NADPH

NADPH

PHOSPHOGLYCERALDEHYDE / (PGAL)

PHOSPHOGLYCERALDEHYDE / (PGAL)

**ALL RXTS
REQUIRE
A SPECIFIC
ENZYME**



DARK REACTION

**COMPLEX SERIES
CHEMICAL RXTS
(CSR)**

ATP

RIBULOSE BISPHOSEPHATE / (RUBP)



CO₂ + **RIBULOSE BISPHOSPHATE / (RUBP)**



**RIBULOSE BISPHOSPHATE
CARBOXYLASE
(RUBP-CARBOXYLASE)**

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

PHOSPHOGLYCERATE / (PGA)

ATP

ATP



BISPHOGLYCERATE / (BPGA)

BISPHOGLYCERATE / (BPGA)

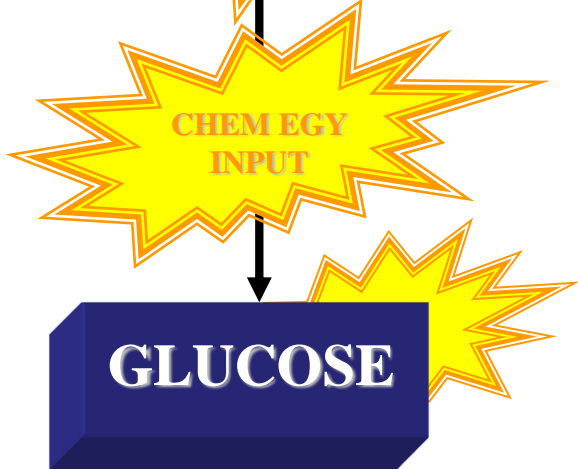
NADPH

NADPH

PHOSPHOGLYCERALDEHYDE / (PGAL)

PHOSPHOGLYCERALDEHYDE / (PGAL)

**ALL RXTS
REQUIRE
A SPECIFIC
ENZYME**



DARK REACTION

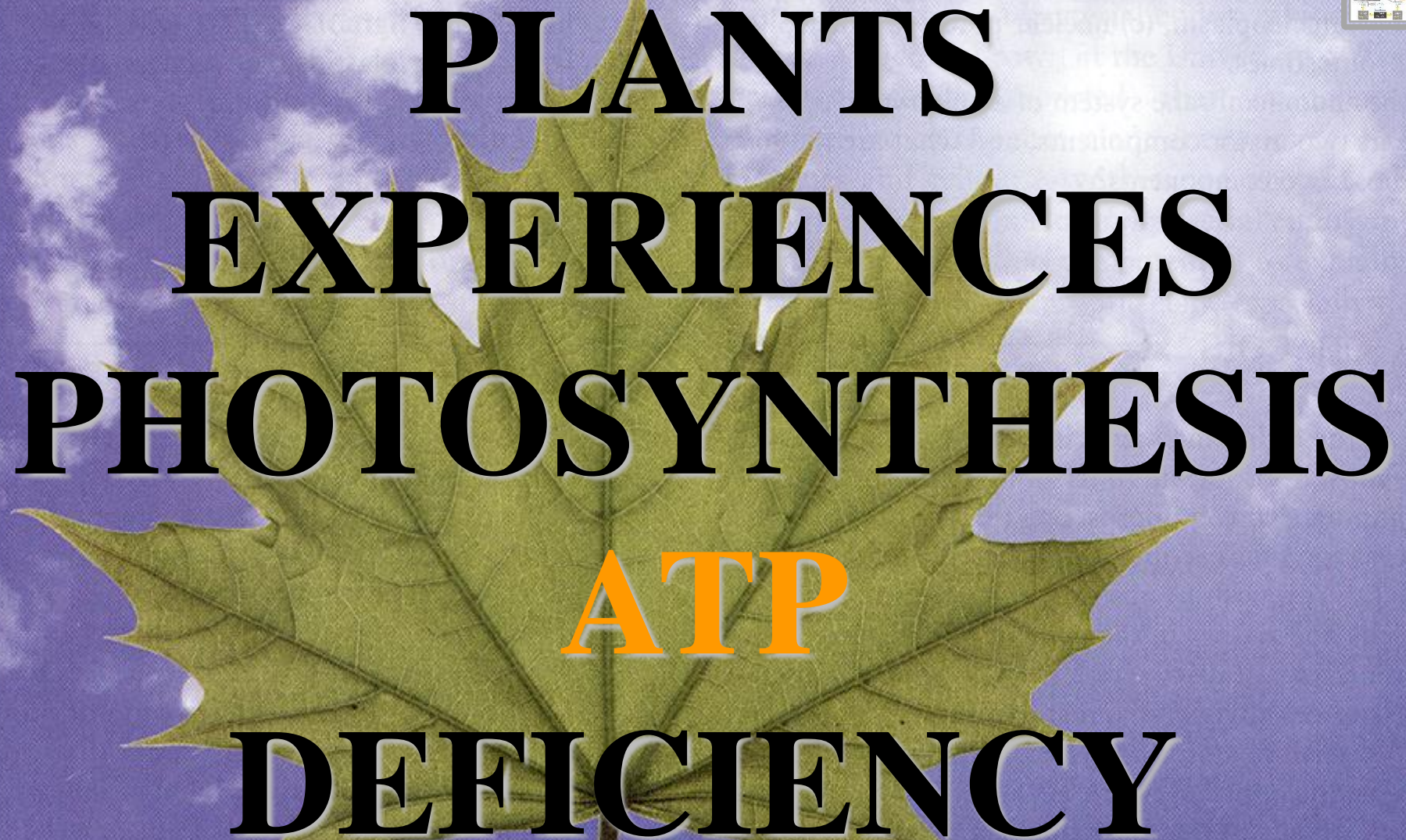
**COMPLEX SERIES
CHEMICAL RXTS
(CSCR)**

ATP

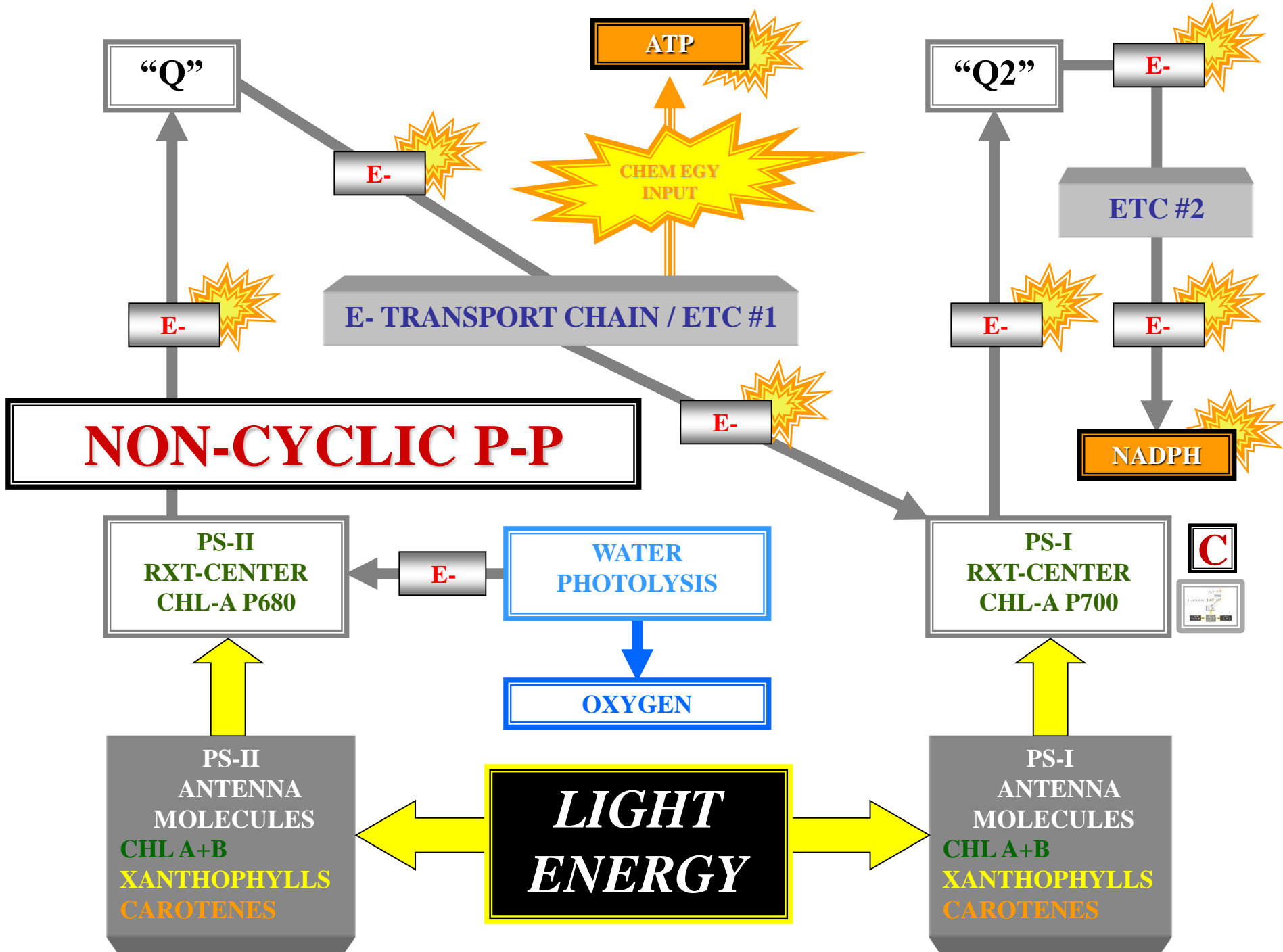
RIBULOSE BISPHOSPHATE / (RUBP)

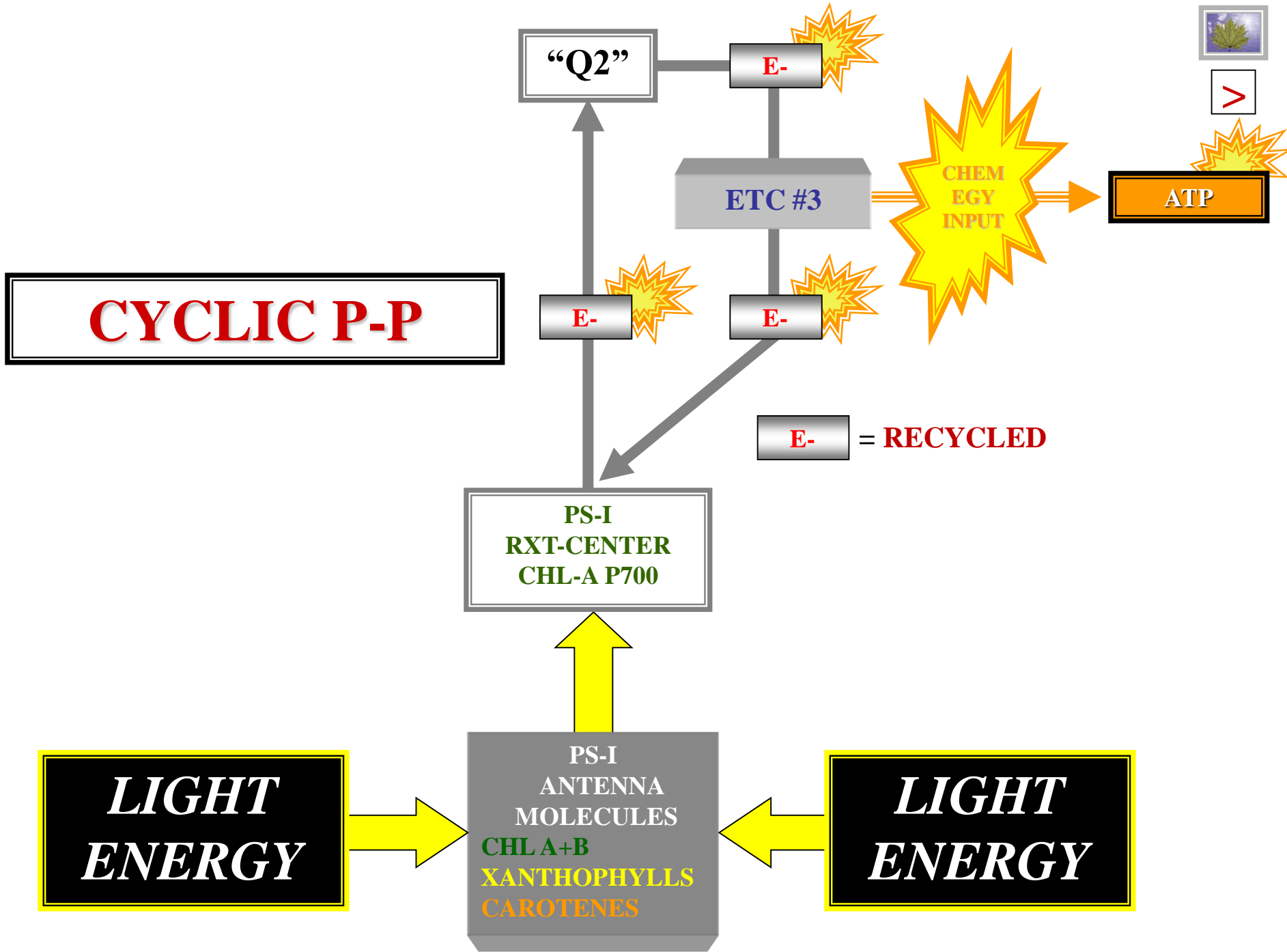


PLANTS
EXPERIENCES
PHOTOSYNTHESIS
?
DEFICIENCY



PLANTS
EXPERIENCES
PHOTOSYNTHESIS
ATP
DEFICIENCY





**PLANTS RELY
CYCLIC P-P
ELIMINATE
PHOTOSYNTHESIS
ATP
DEFICIENCY**





QUESTION

WHAT IS THE ACCEPTED
MODEL FOR ATP
PHOSPHORYLATION DURING
THE LIGHT REACTIONS?

QUESTION

CYCLIC P-P

“Q2”

E-

ETC #3

CHEM
EGY
INPUT

ATP

E-

E-

E- = RECYCLED

PS-I
RXT-CENTER
CHL-A P700

LIGHT
ENERGY

PS-I
ANTENNA
MOLECULES
CHL A+B
XANTHOPHYLLS
CAROTENES

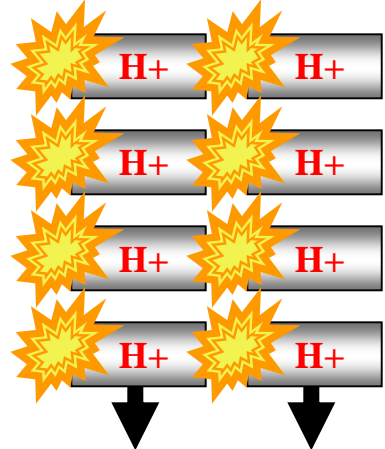
LIGHT
ENERGY

+

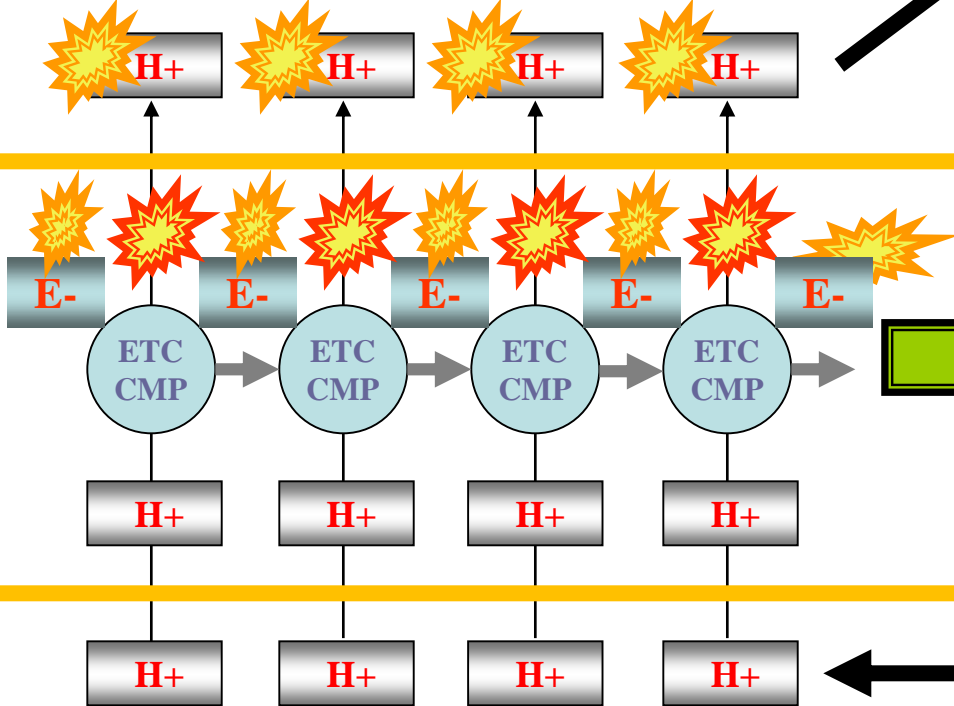
?



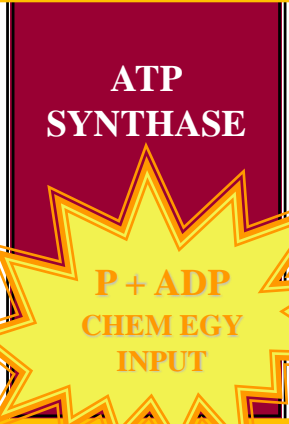
CHLOROPLAST THYLAKOID SPACE



PS-II / PS-I
CHLOROPLAST THYLAKOID MEMBRANE



CHLOROPLAST STROMA

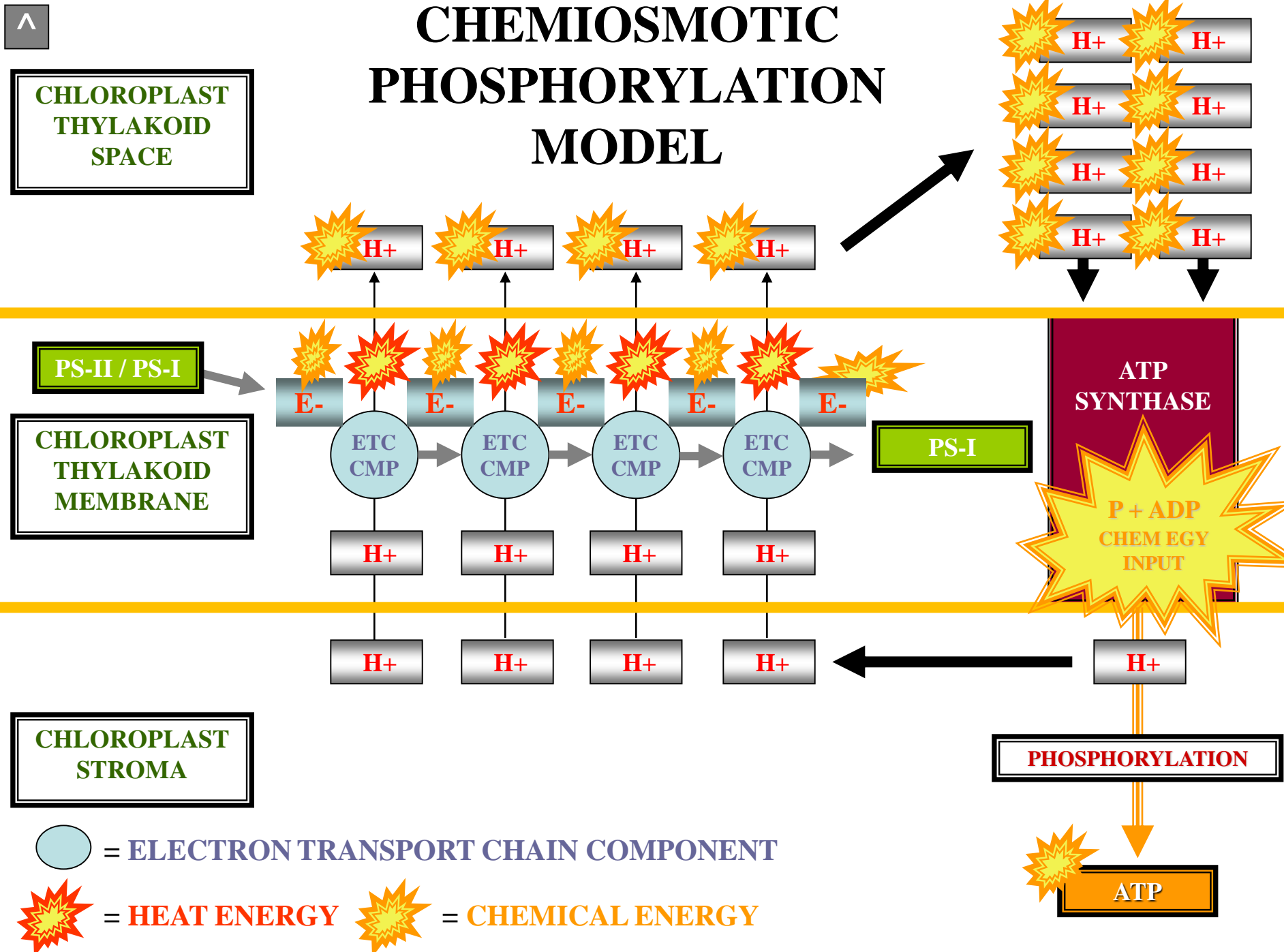


PHOSPHORYLATION



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

CHEMIOSMOTIC PHOSPHORYLATION MODEL





CHEMIOSMOTIC PHOSPHORYLATION MODEL

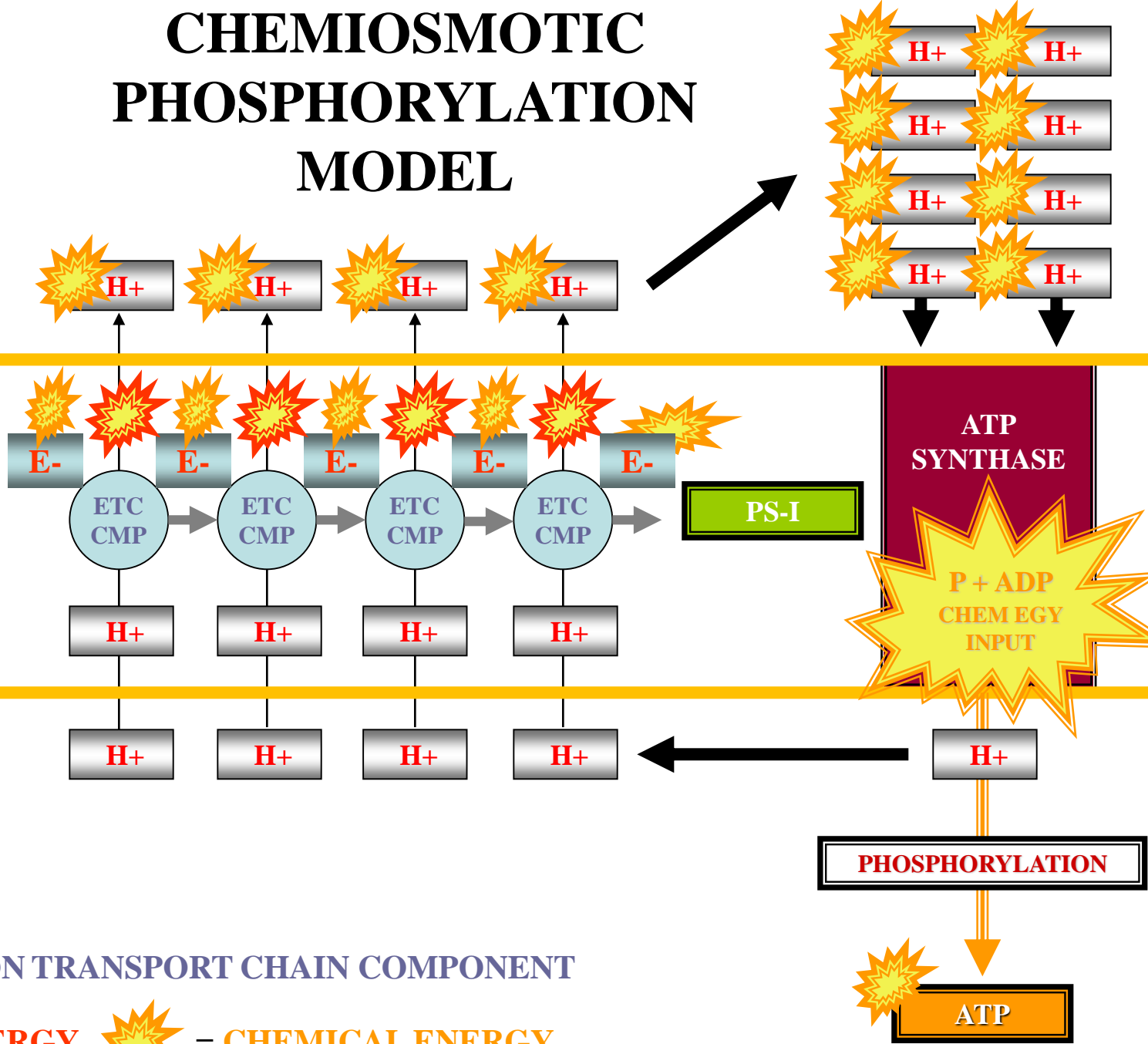


CHEMIOSMOTIC PHOSPHORYLATION MODEL

CHLOROPLAST THYLAKOID SPACE

PS-II / PS-I
CHLOROPLAST THYLAKOID MEMBRANE

CHLOROPLAST STROMA



● = ELECTRON TRANSPORT CHAIN COMPONENT

★ = HEAT ENERGY ★ = CHEMICAL ENERGY

PHOSPHORYLATION

ATP

**CHEMIOSMOTIC
PHOSPHORYLATION
MODEL**

***NOT FULLY
UNDERSTOOD***

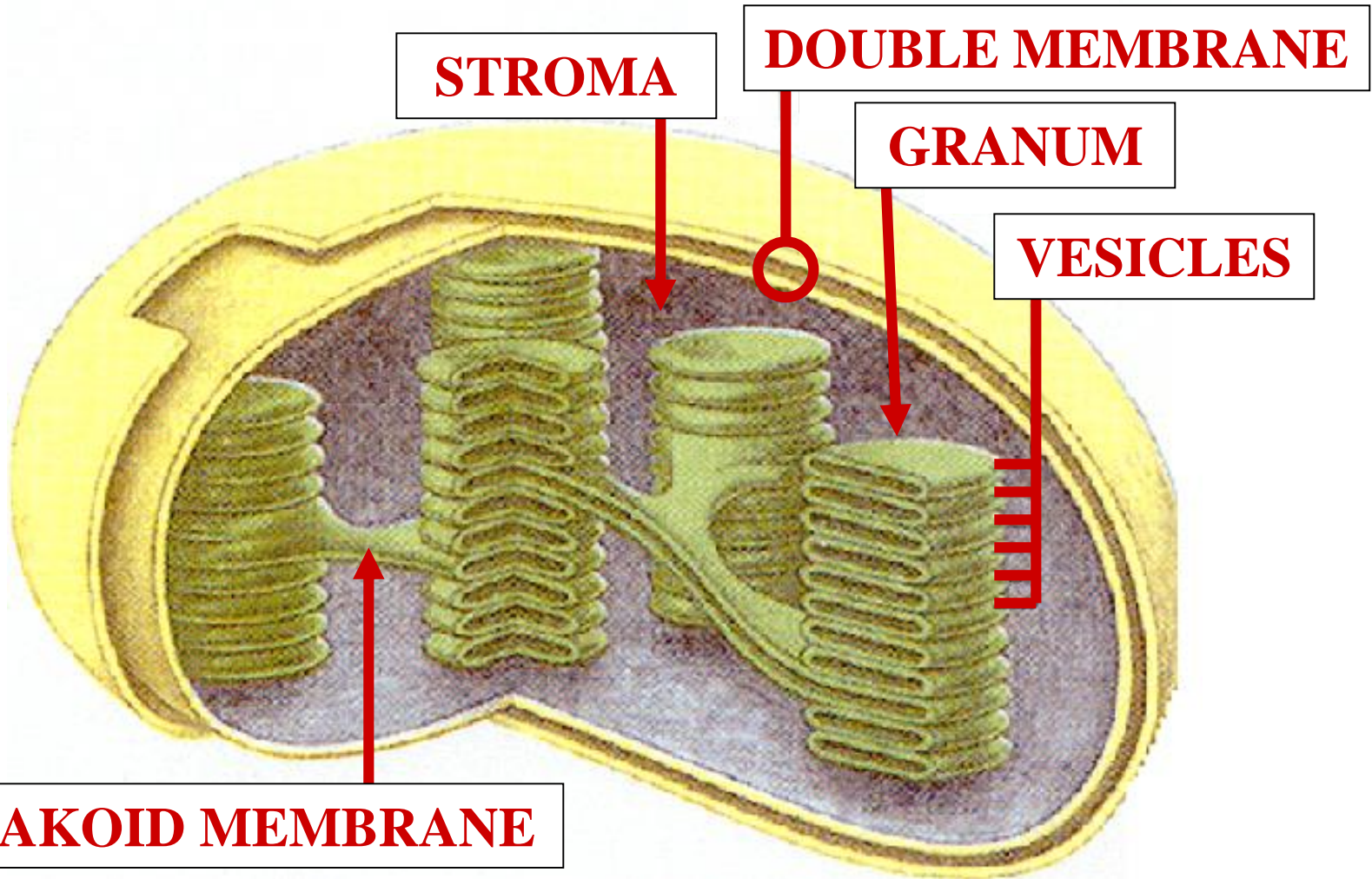


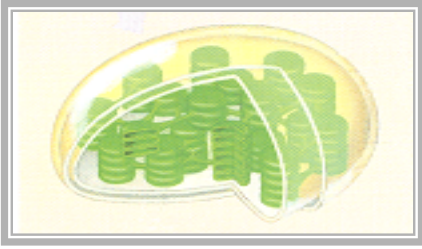
CHEMIOSMOTIC PHOSPHORYLATION CHLOROPLAST

CHLOROPLAST ULTRASTRUCTURE



N

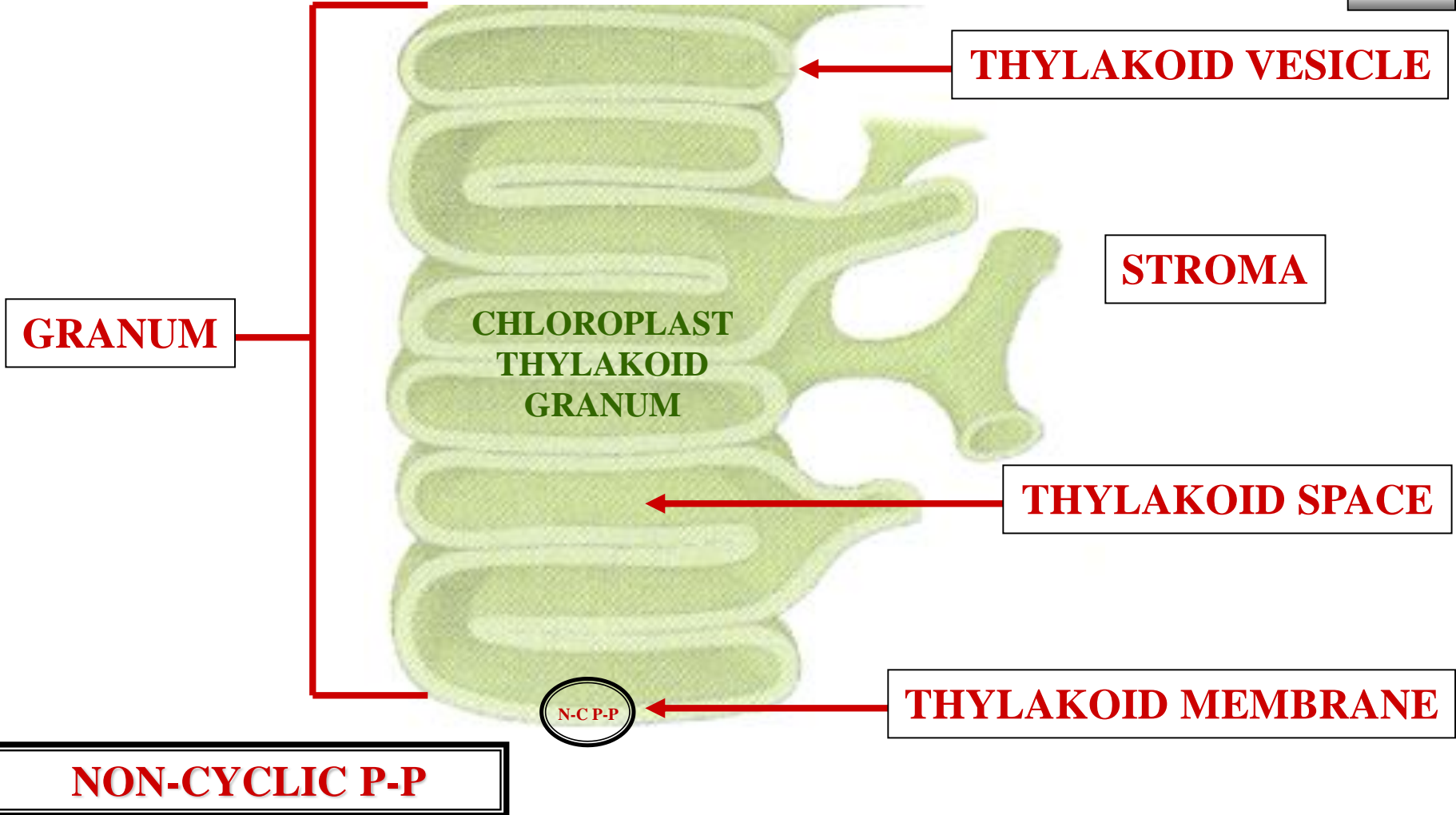


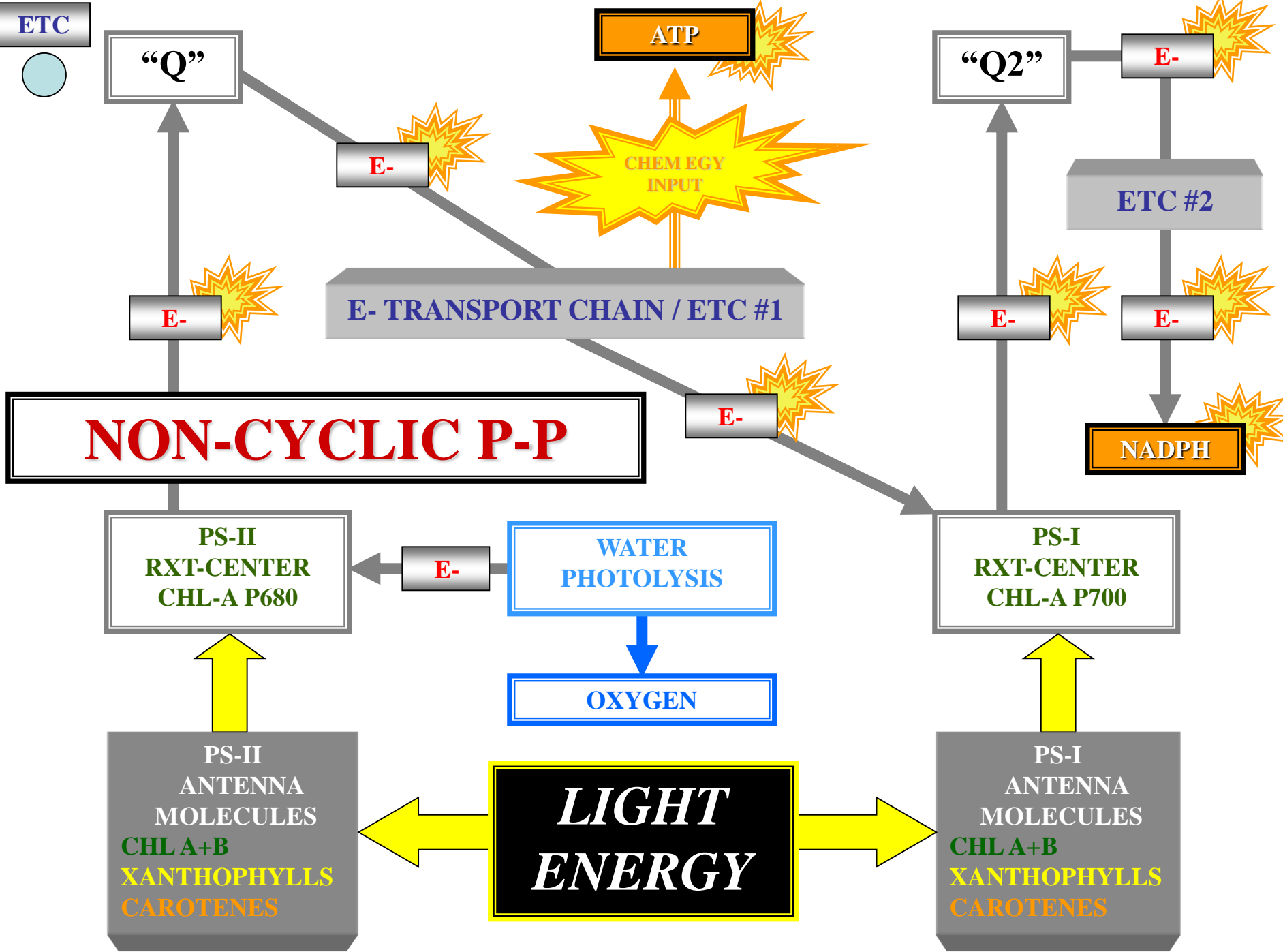


CHLOROPLAST THYLAKOID



ETC

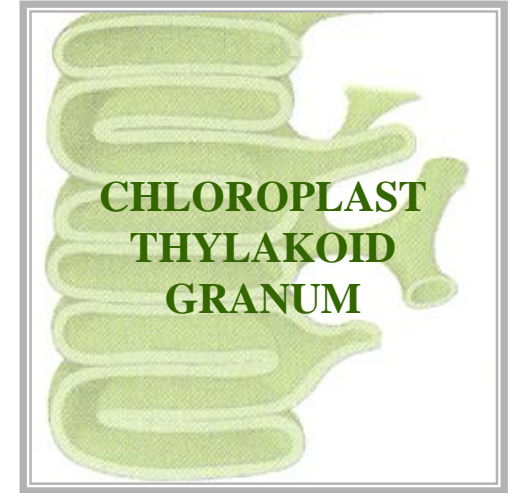
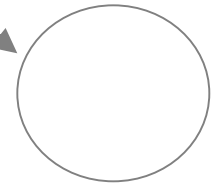
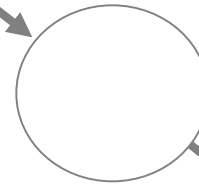
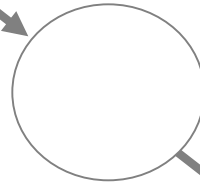
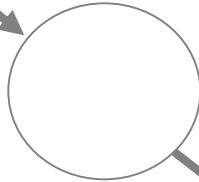
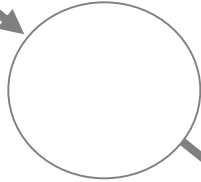




ELECTRON TRANSPORT CHAIN #1



THYLAKOID GRANUM



 = ELECTRON TRANSPORT CHAIN COMPONENT

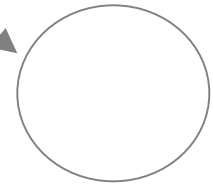
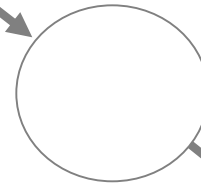
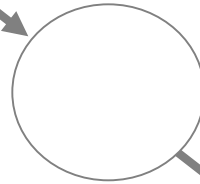
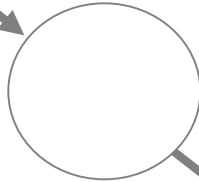
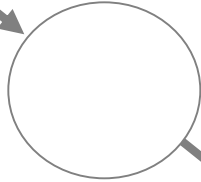
 = CHEMICAL ENERGY

 = DISSIPATED HEAT ENERGY

ELECTRON TRANSPORT CHAIN #1



THYLAKOID GRANUM



REDOX RXTS



= CHEMICAL ENERGY

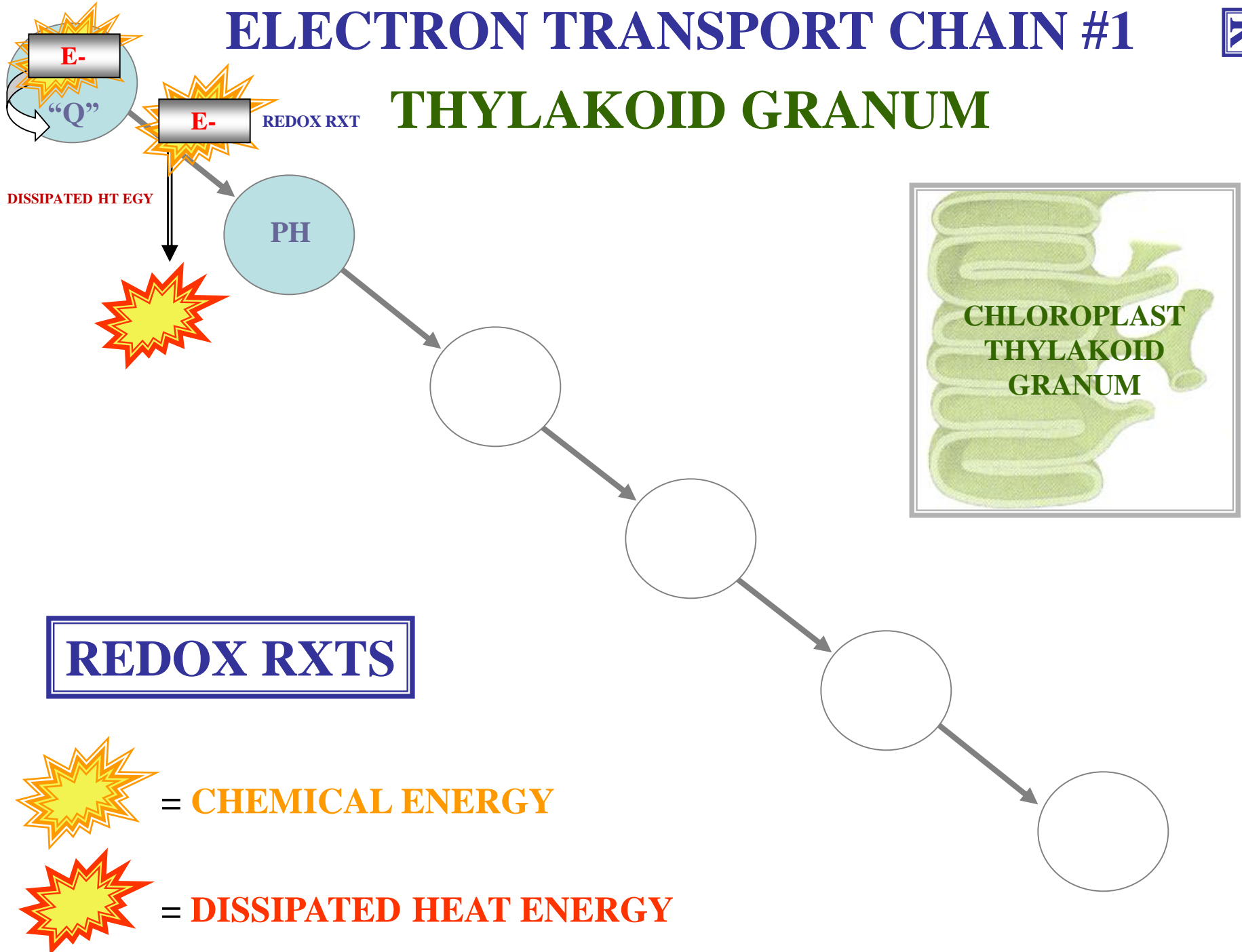


= DISSIPATED HEAT ENERGY

ELECTRON TRANSPORT CHAIN #1



THYLAKOID GRANUM



REDOX RXTS

 = CHEMICAL ENERGY

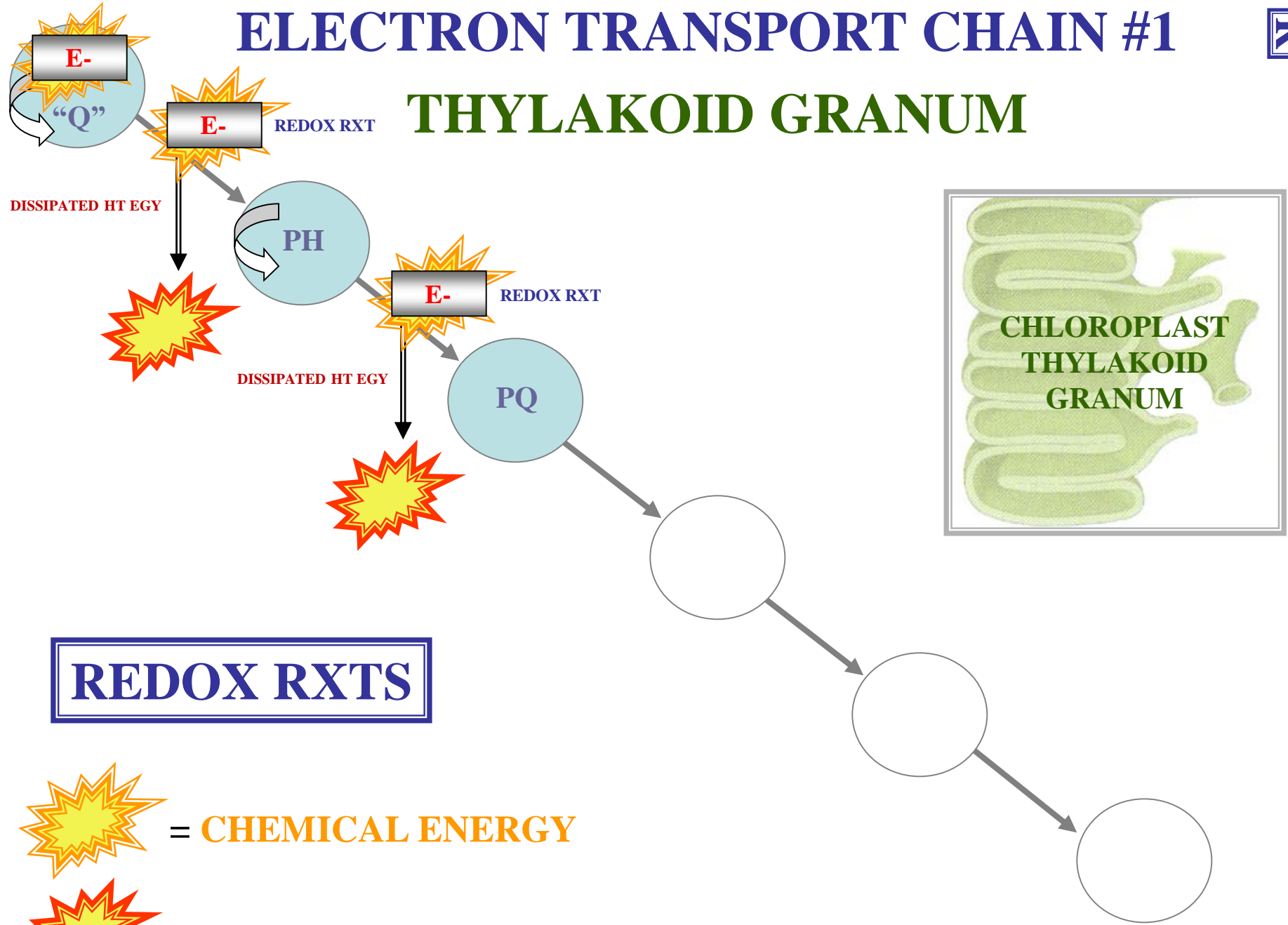
 = DISSIPATED HEAT ENERGY

**CHLOROPLAST
THYLAKOID
GRANUM**

ELECTRON TRANSPORT CHAIN #1



THYLAKOID GRANUM



REDOX RXTS

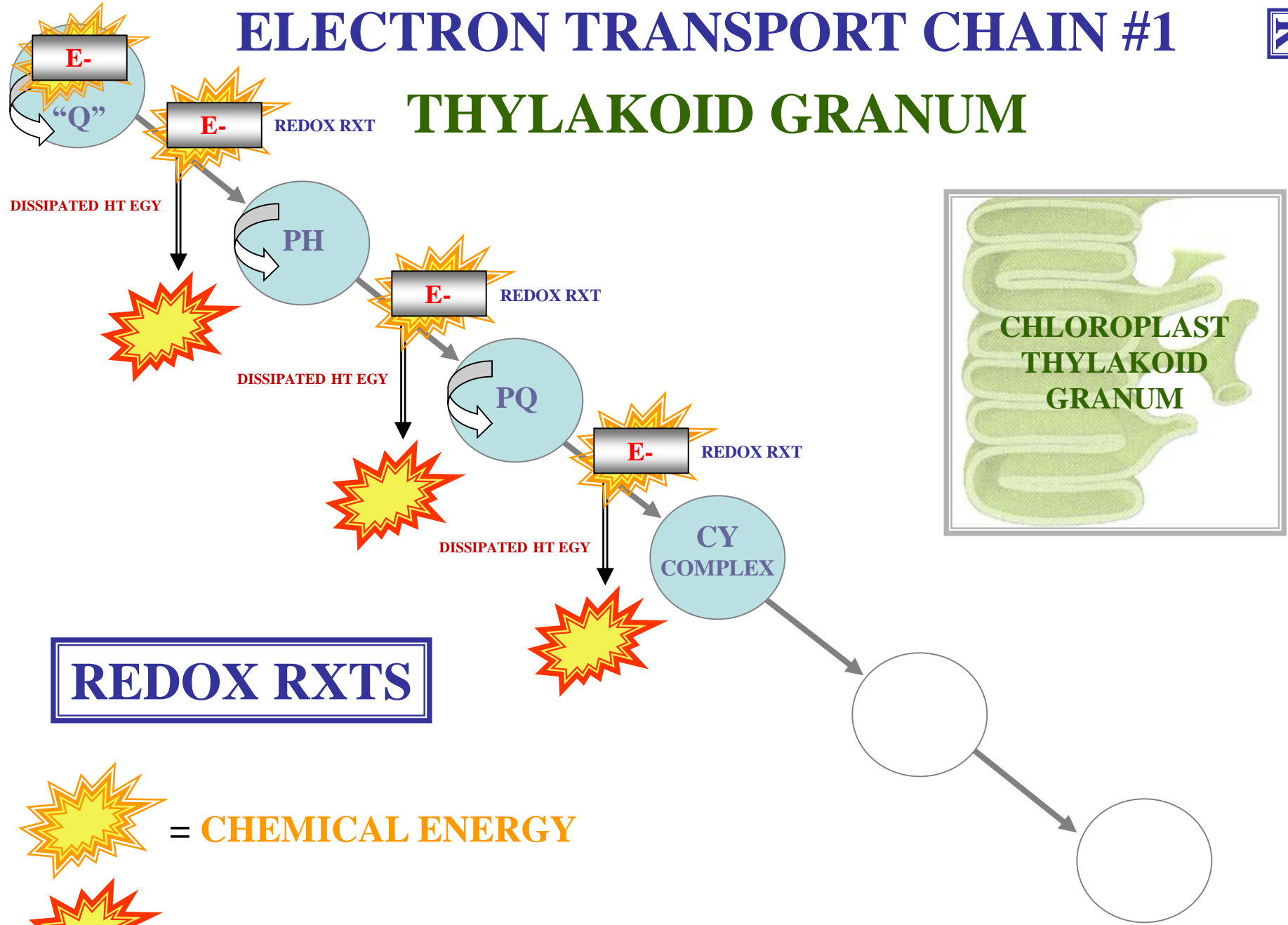
 = CHEMICAL ENERGY

 = DISSIPATED HEAT ENERGY

ELECTRON TRANSPORT CHAIN #1



THYLAKOID GRANUM



REDOX RXTS

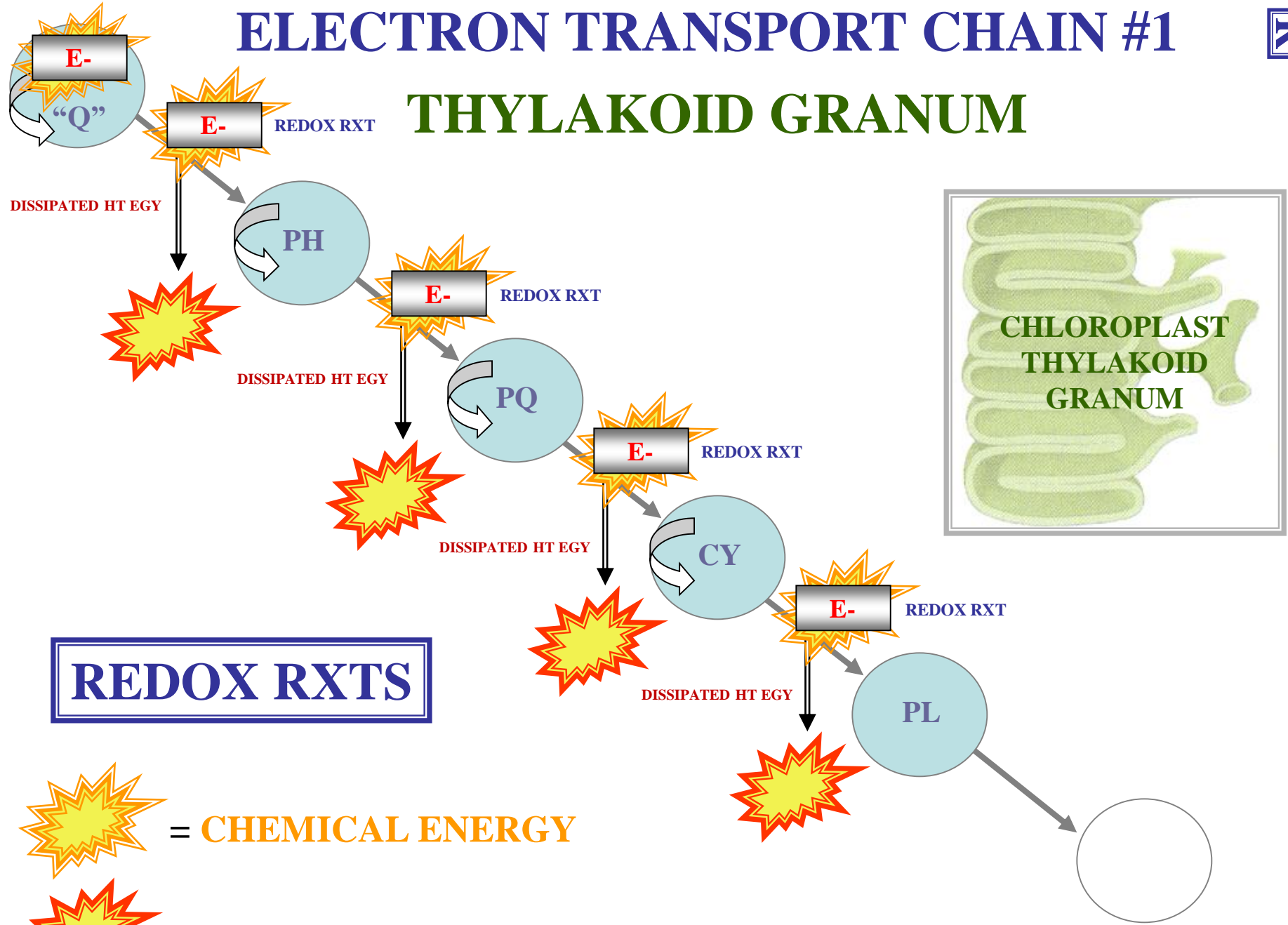
 = **CHEMICAL ENERGY**

 = **DISSIPATED HEAT ENERGY**

ELECTRON TRANSPORT CHAIN #1



THYLAKOID GRANUM



REDOX RXTS

 = CHEMICAL ENERGY

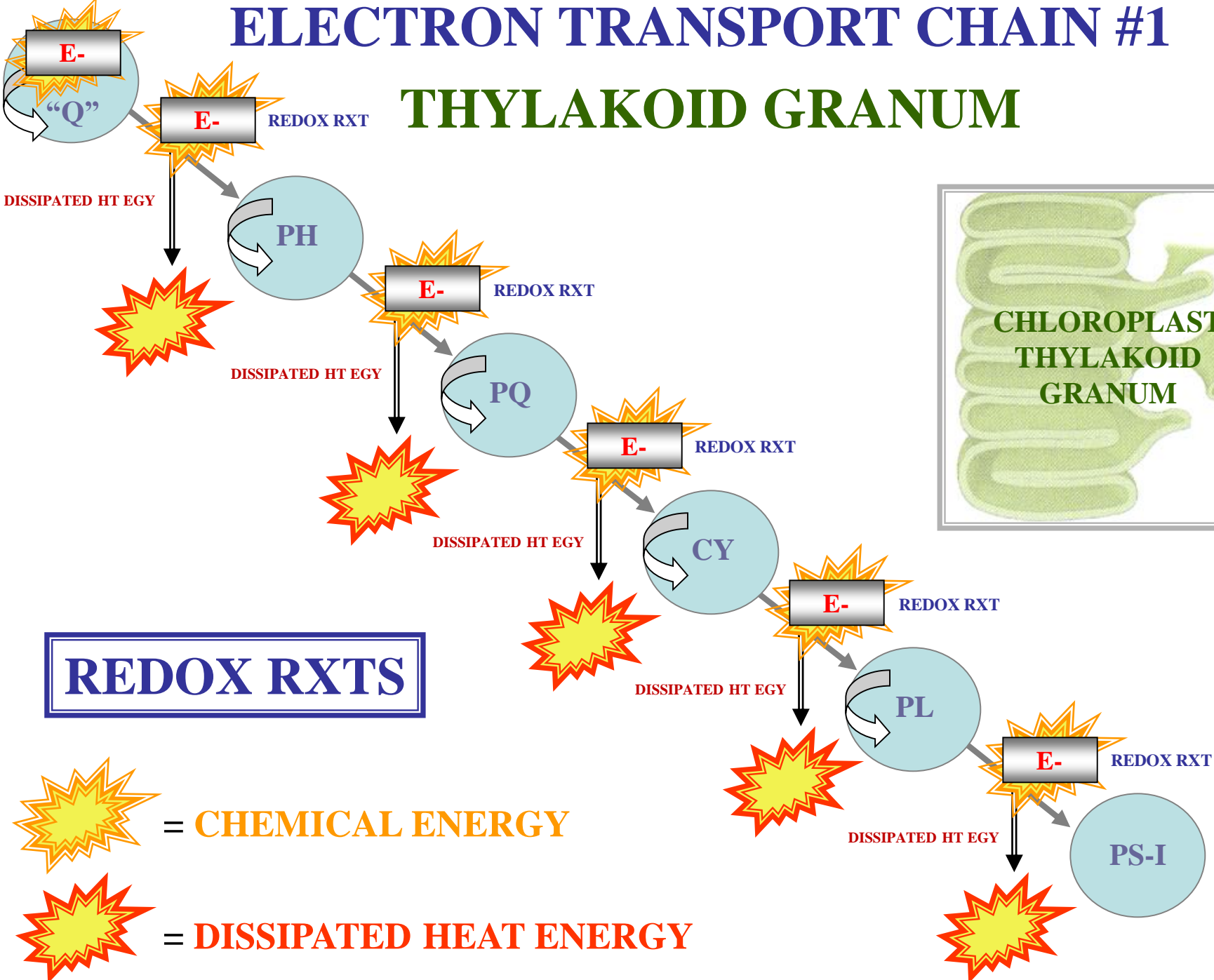
 = DISSIPATED HEAT ENERGY



ELECTRON TRANSPORT CHAIN #1

E-

THYLAKOID GRANUM



REDOX RXTS

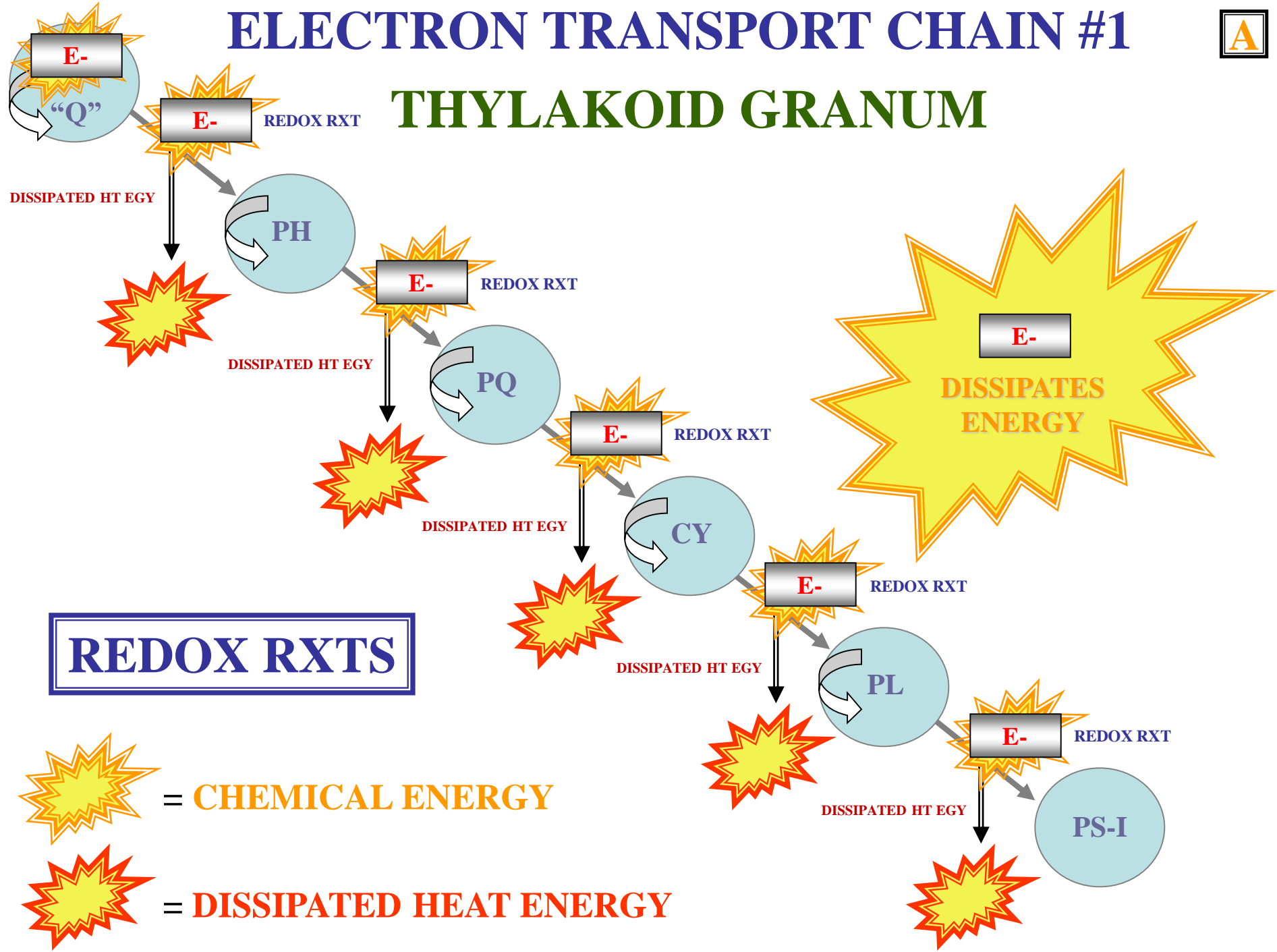
 = CHEMICAL ENERGY

 = DISSIPATED HEAT ENERGY

ELECTRON TRANSPORT CHAIN #1



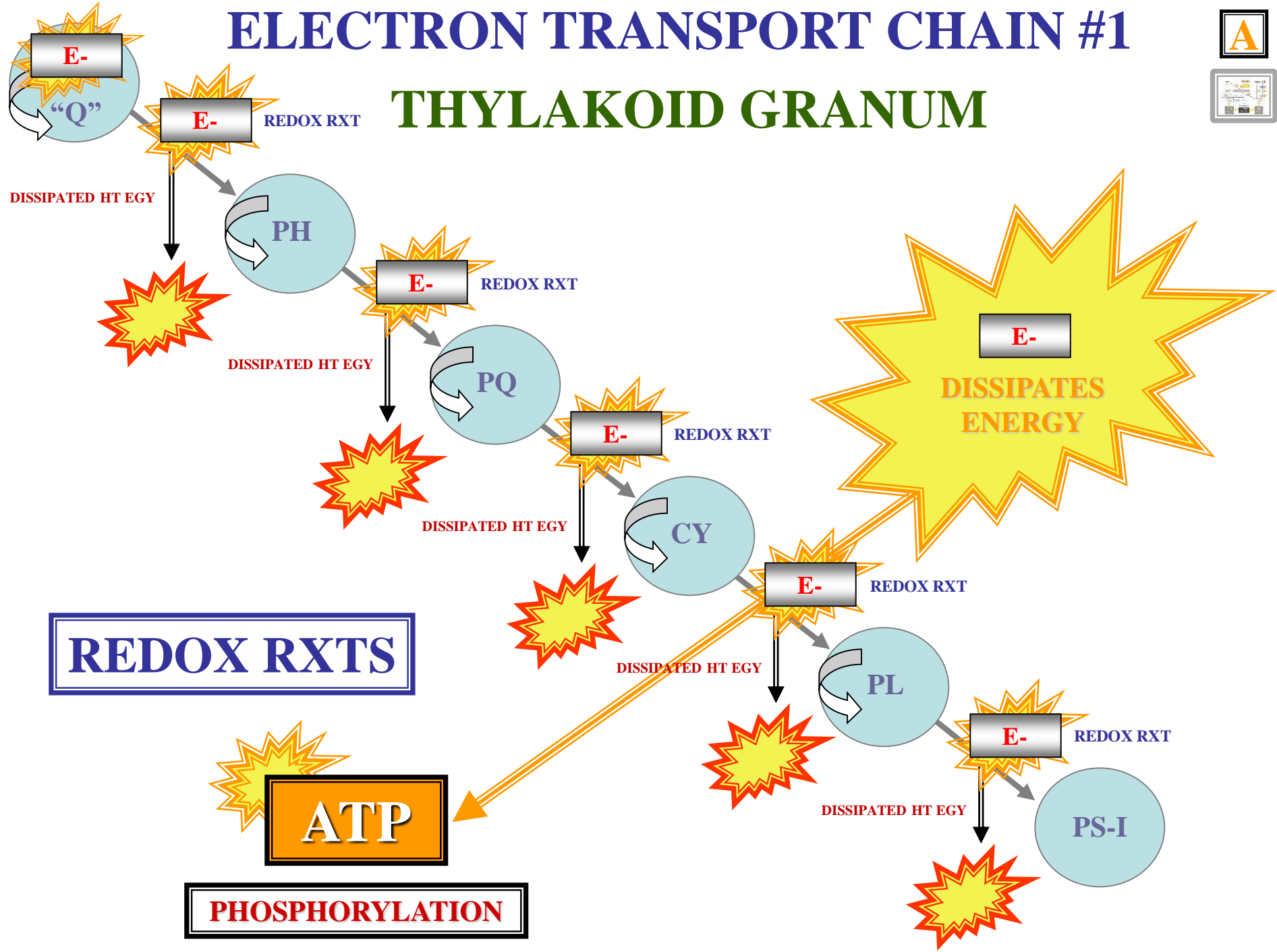
THYLAKOID GRANUM



ELECTRON TRANSPORT CHAIN #1

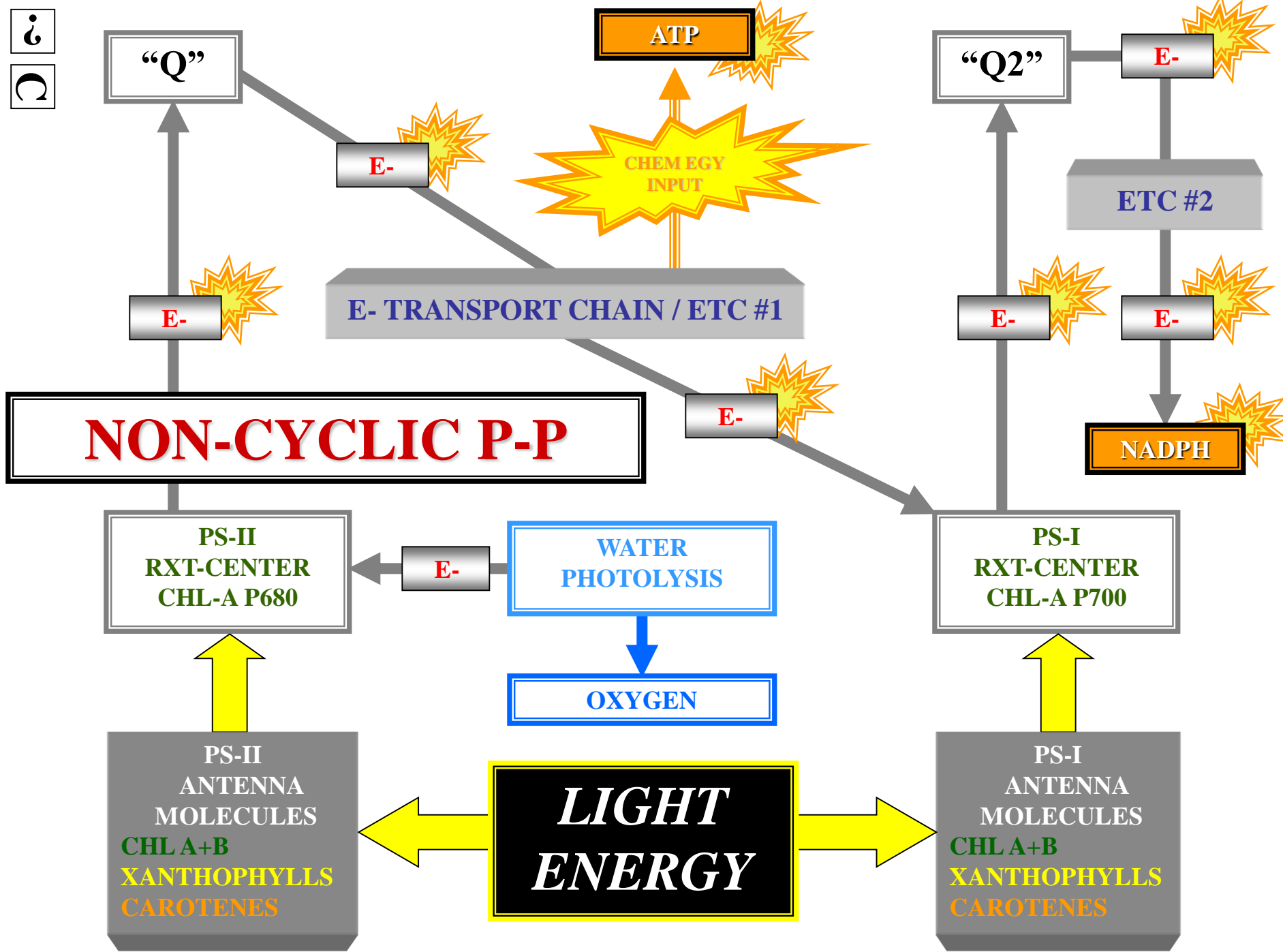


THYLAKOID GRANUM



REDOX RXTS

ATP
PHOSPHORYLATION



CHEMIOSMOTIC PHOSPHORYLATION MODEL

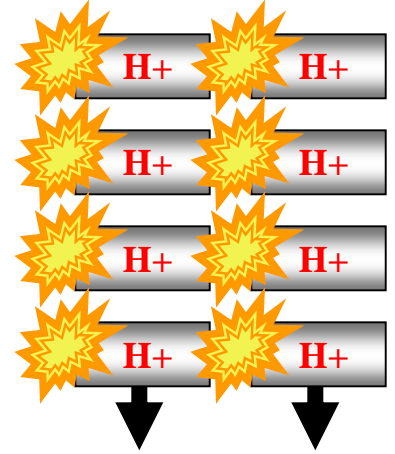
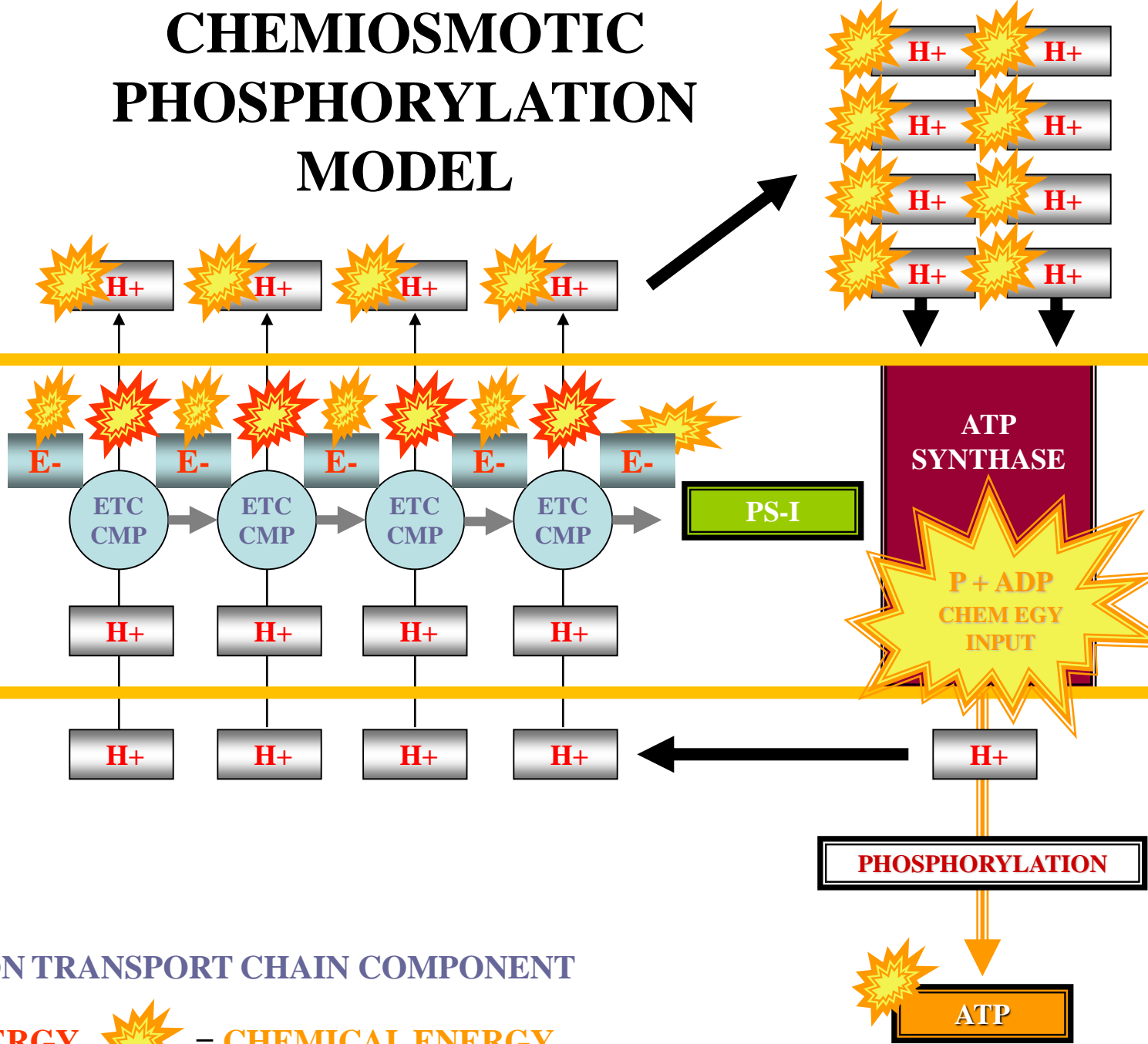
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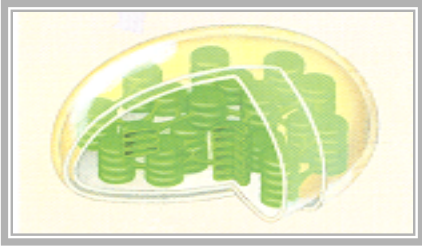
CHLOROPLAST THYLAKOID SPACE

PS-II / PS-I
CHLOROPLAST THYLAKOID MEMBRANE

CHLOROPLAST STROMA

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

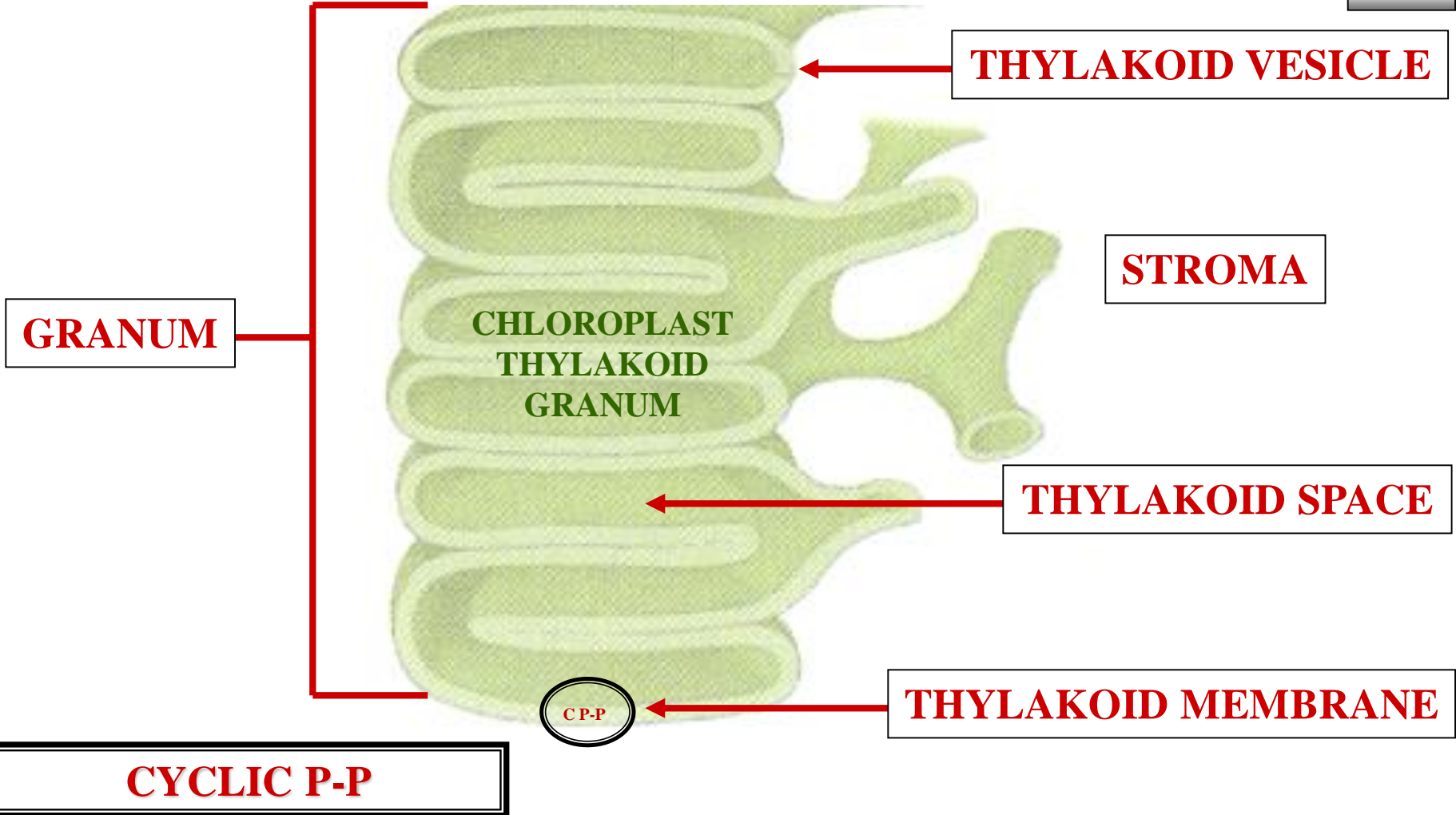




CHLOROPLAST THYLAKOID



ETC



ETC



CYCLIC P-P

“Q2”

E-

ETC #3

CHEM
EGY
INPUT

ATP

E-

E-

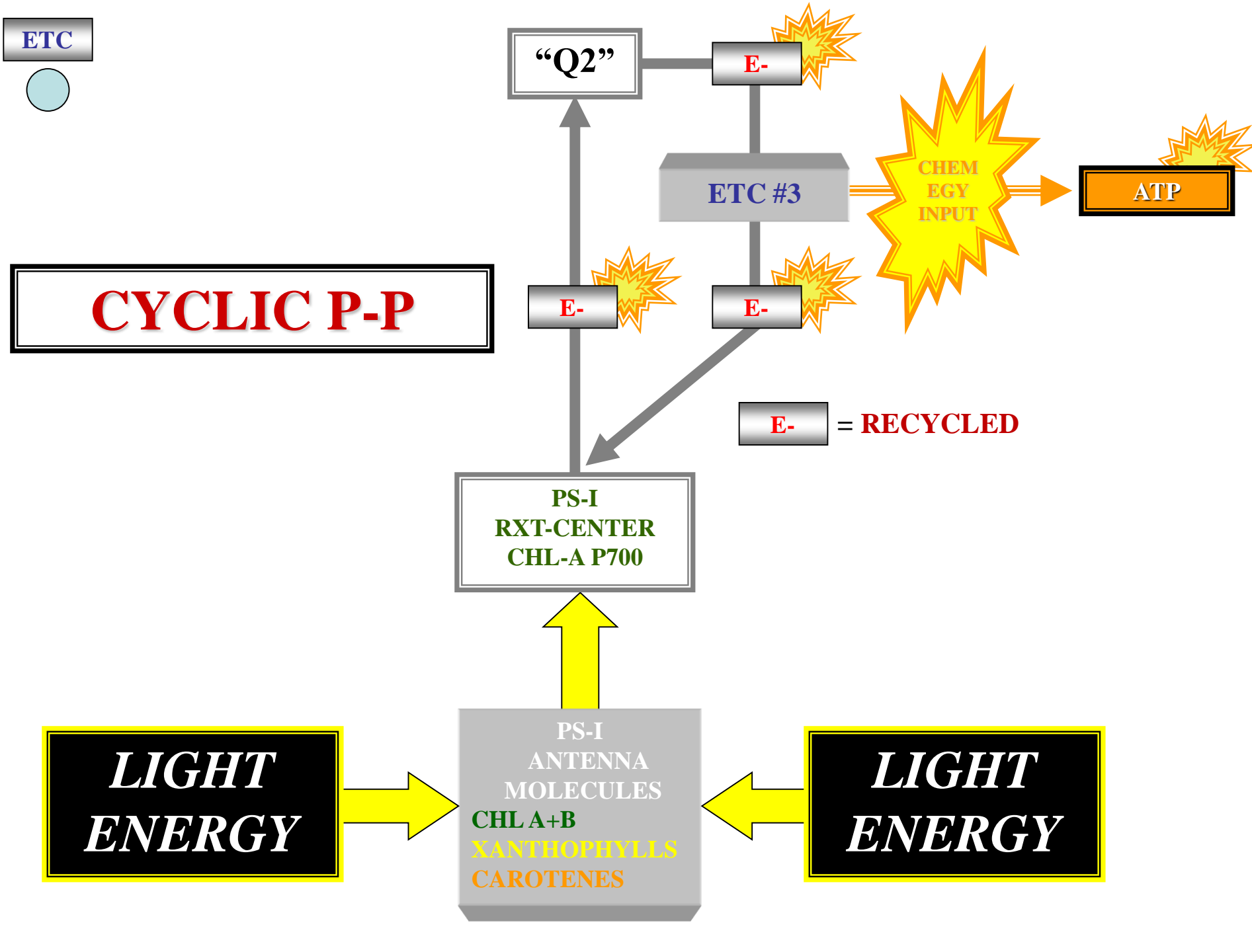
E- = RECYCLED

PS-I
RXT-CENTER
CHL-A P700

**LIGHT
ENERGY**

PS-I
ANTENNA
MOLECULES
CHL A+B
XANTHOPHYLLS
CAROTENES

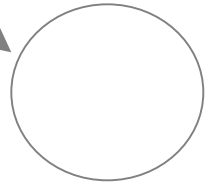
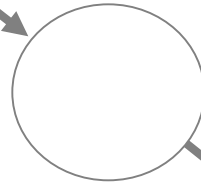
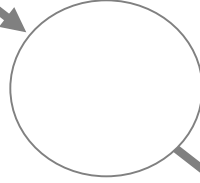
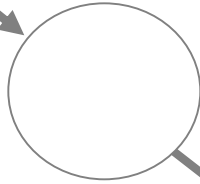
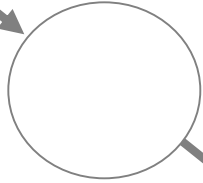
**LIGHT
ENERGY**



ELECTRON TRANSPORT CHAIN #3



THYLAKOID GRANUM



 = ELECTRON TRANSPORT CHAIN COMPONENT

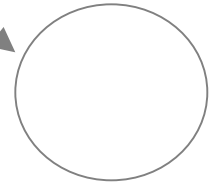
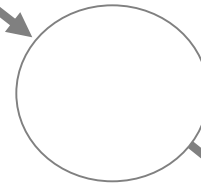
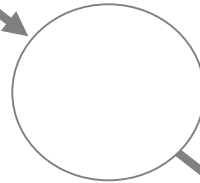
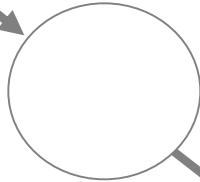
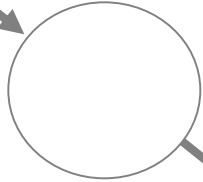
 = CHEMICAL ENERGY

 = DISSIPATED HEAT ENERGY

ELECTRON TRANSPORT CHAIN #3



THYLAKOID GRANUM



REDOX RXTS



= CHEMICAL ENERGY

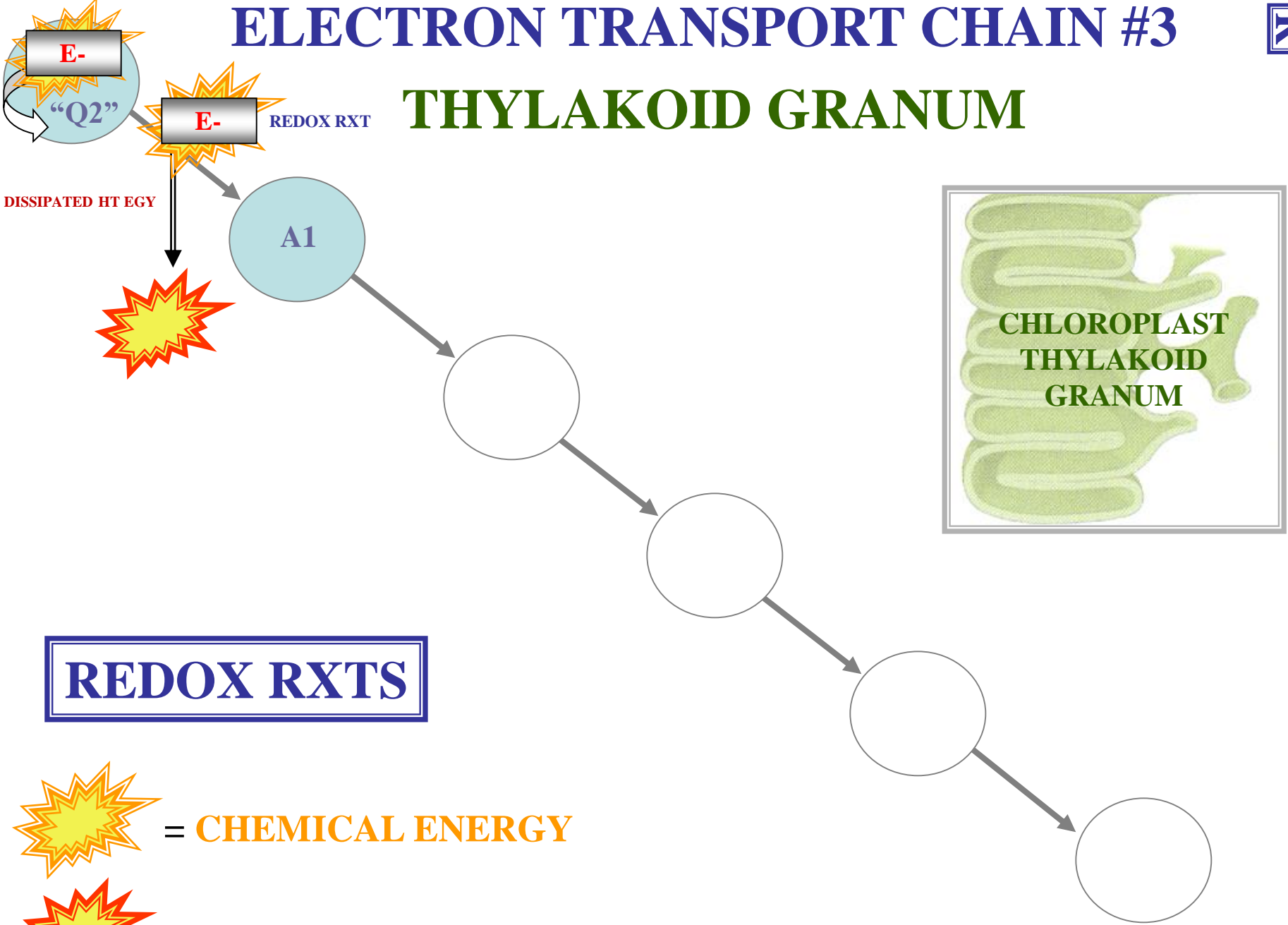


= DISSIPATED HEAT ENERGY

ELECTRON TRANSPORT CHAIN #3



THYLAKOID GRANUM



REDOX RXTS

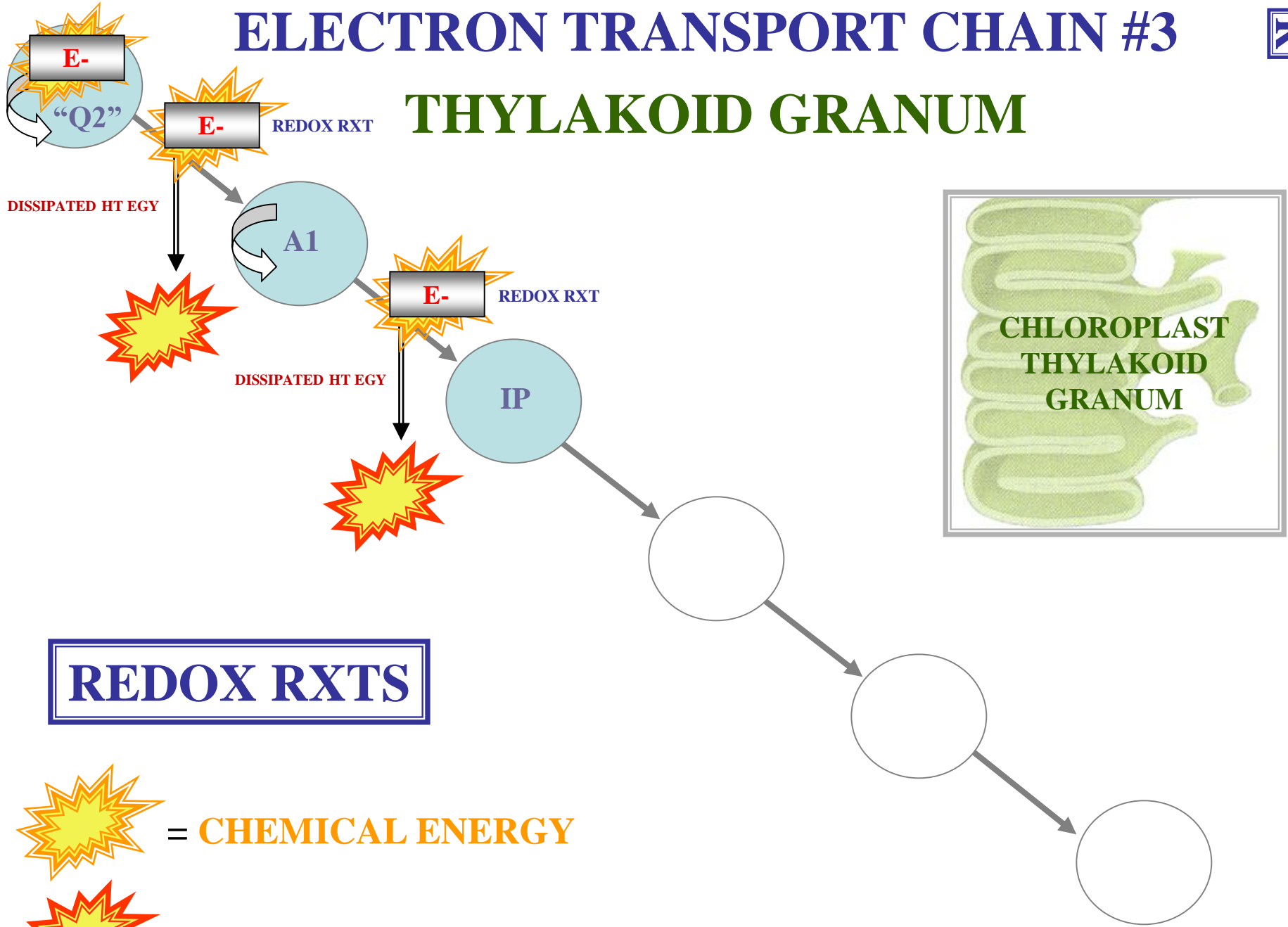
 = CHEMICAL ENERGY

 = DISSIPATED HEAT ENERGY

ELECTRON TRANSPORT CHAIN #3



THYLAKOID GRANUM



REDOX RXTS

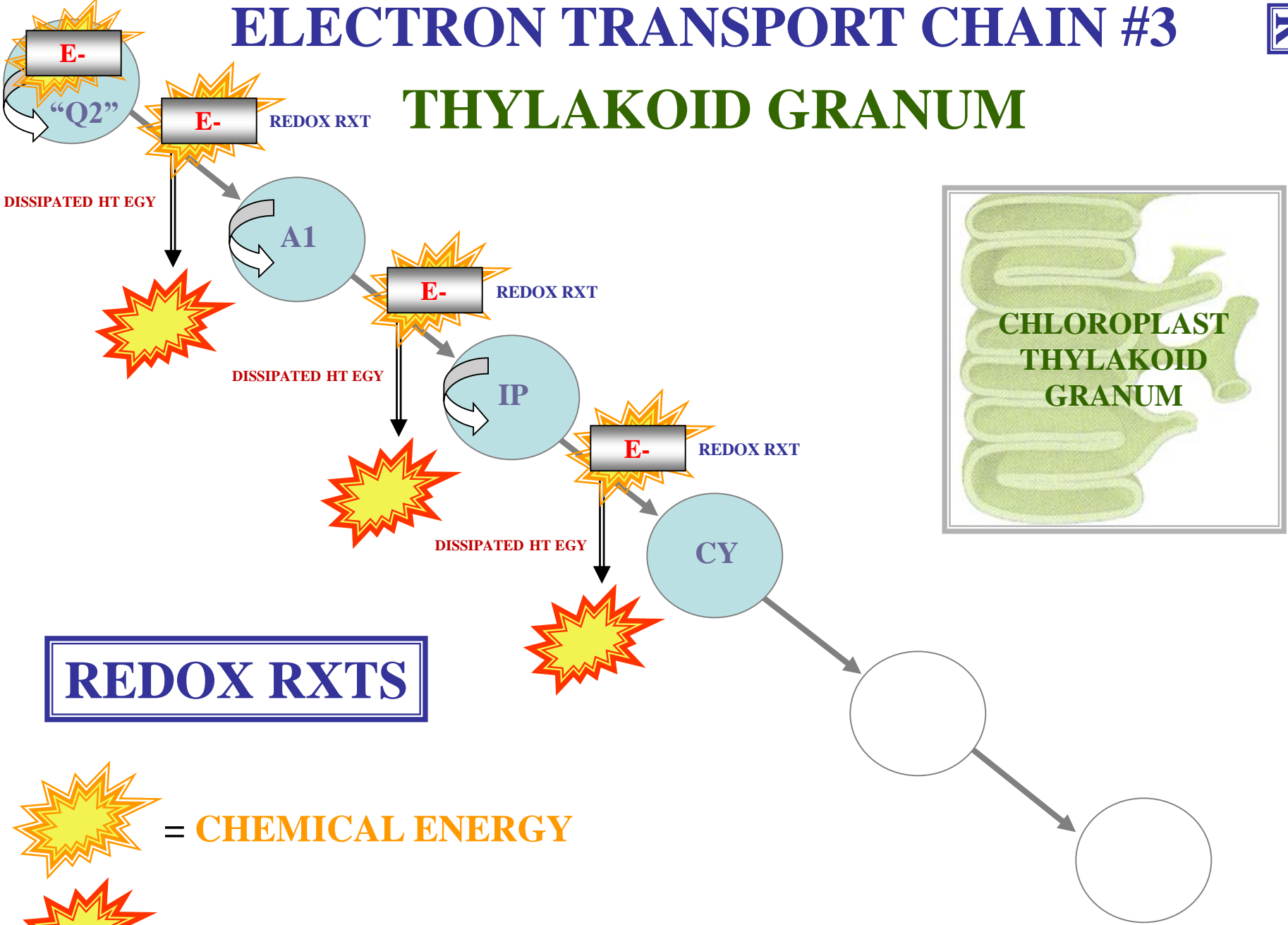
 = **CHEMICAL ENERGY**

 = **DISSIPATED HEAT ENERGY**

ELECTRON TRANSPORT CHAIN #3



THYLAKOID GRANUM



REDOX RXTS

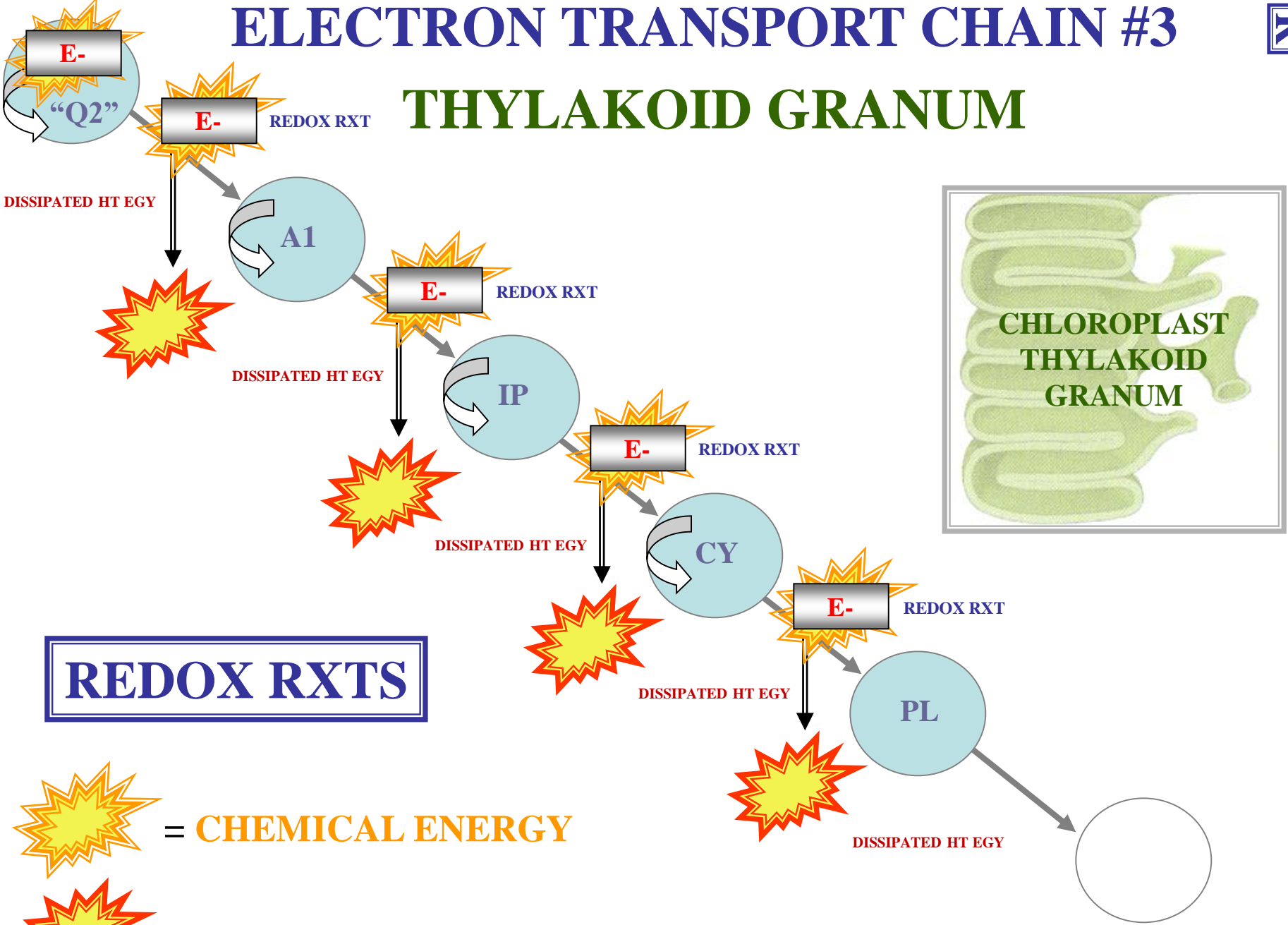
 = CHEMICAL ENERGY

 = DISSIPATED HEAT ENERGY

ELECTRON TRANSPORT CHAIN #3



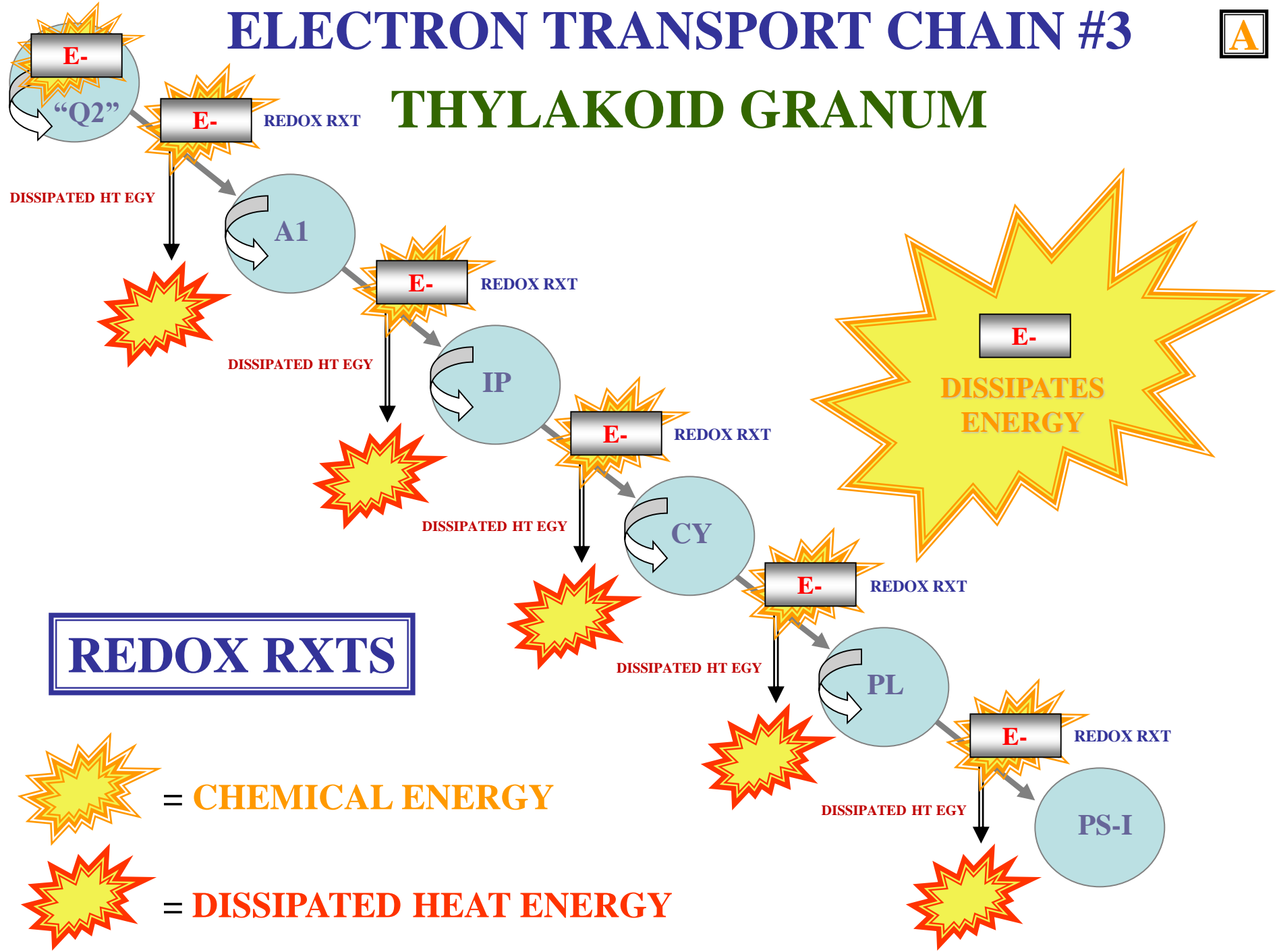
THYLAKOID GRANUM



ELECTRON TRANSPORT CHAIN #3



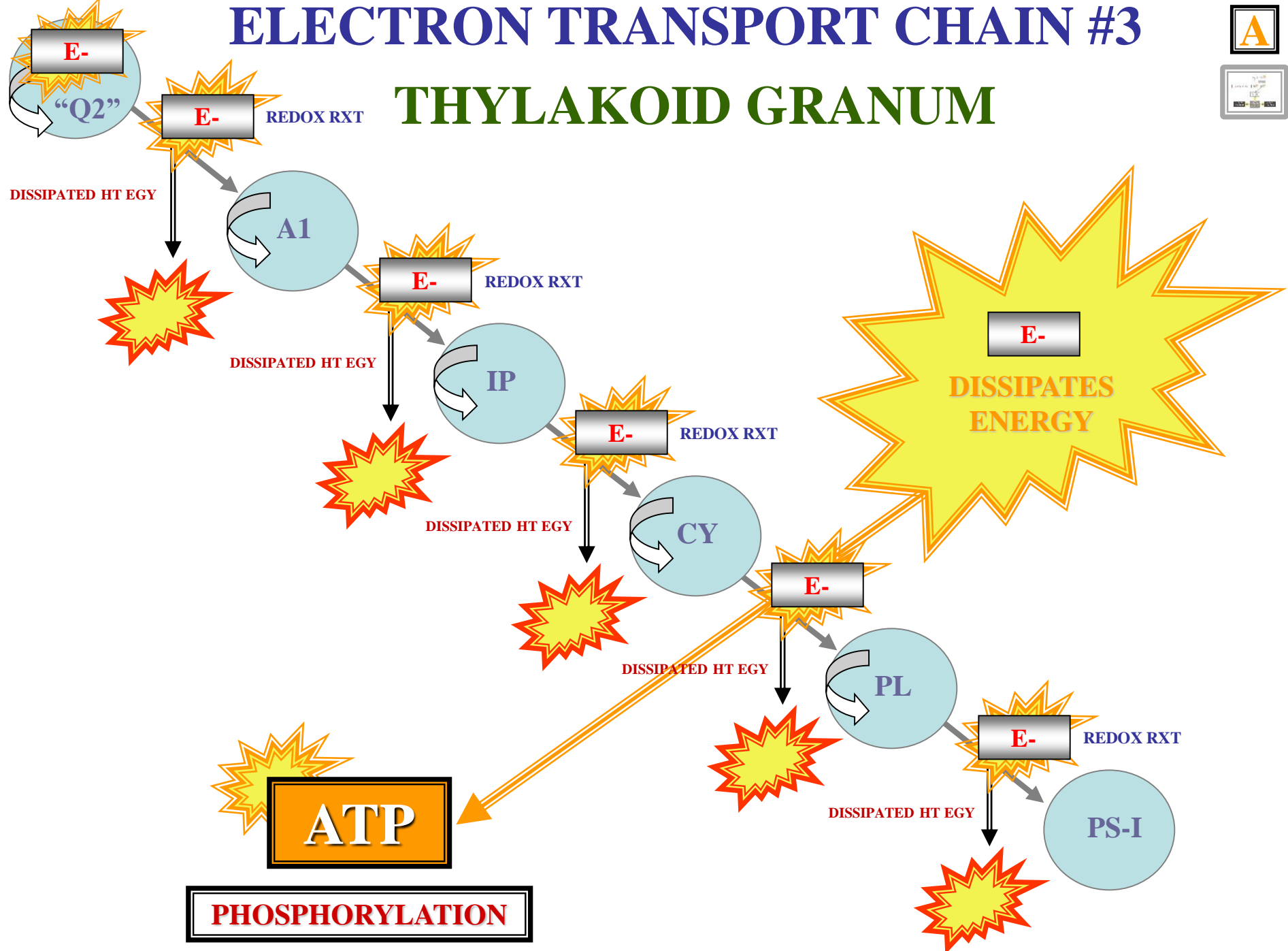
THYLAKOID GRANUM



ELECTRON TRANSPORT CHAIN #3



THYLAKOID GRANUM





CYCLIC P-P

LIGHT ENERGY

PS-I
ANTENNA
MOLECULES
CHL A+B
XANTHOPHYLLS
CAROTENES

LIGHT ENERGY

PS-I
RXT-CENTER
CHL-A P700

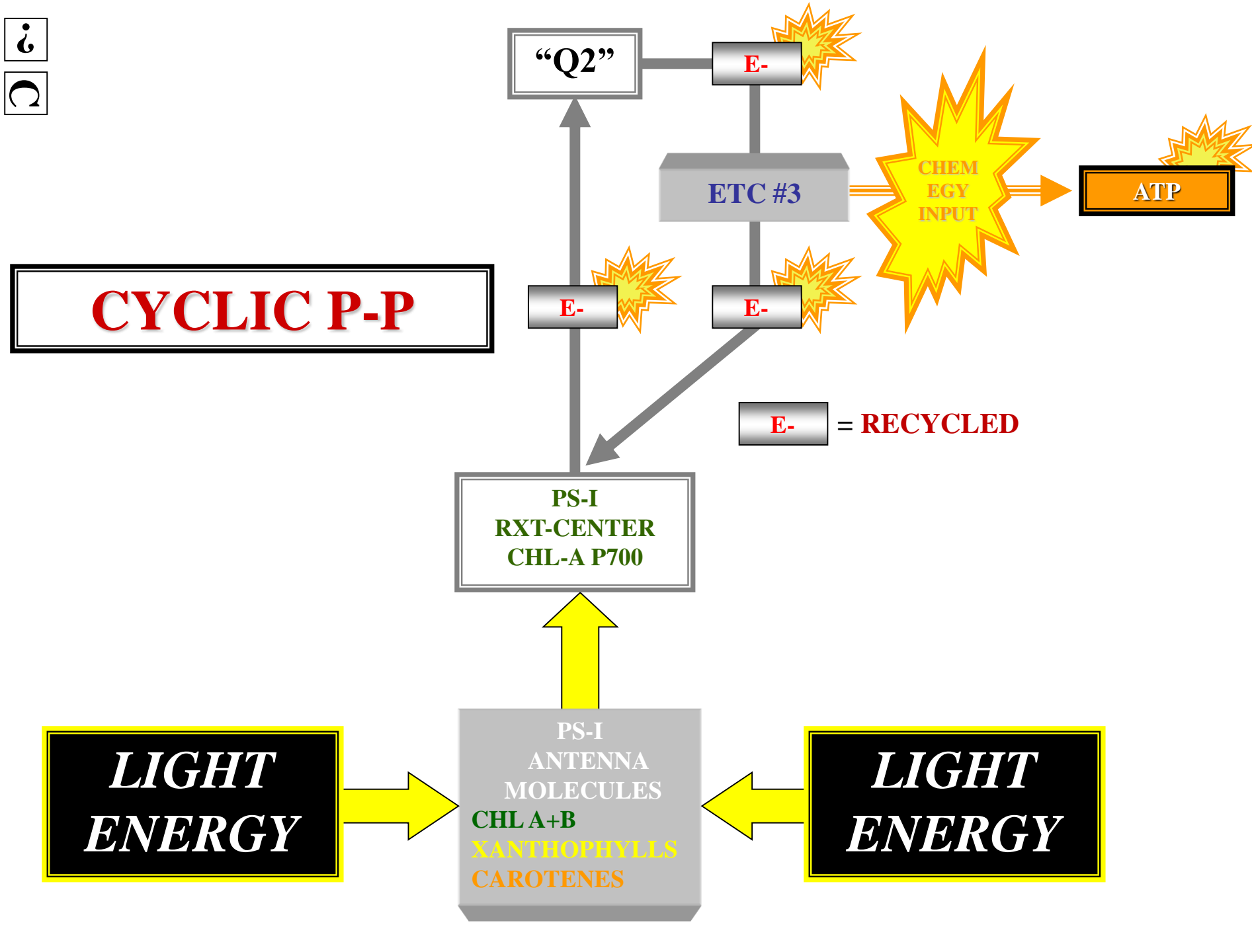
“Q2”

ETC #3

CHEM
EGY
INPUT

ATP

E- = RECYCLED






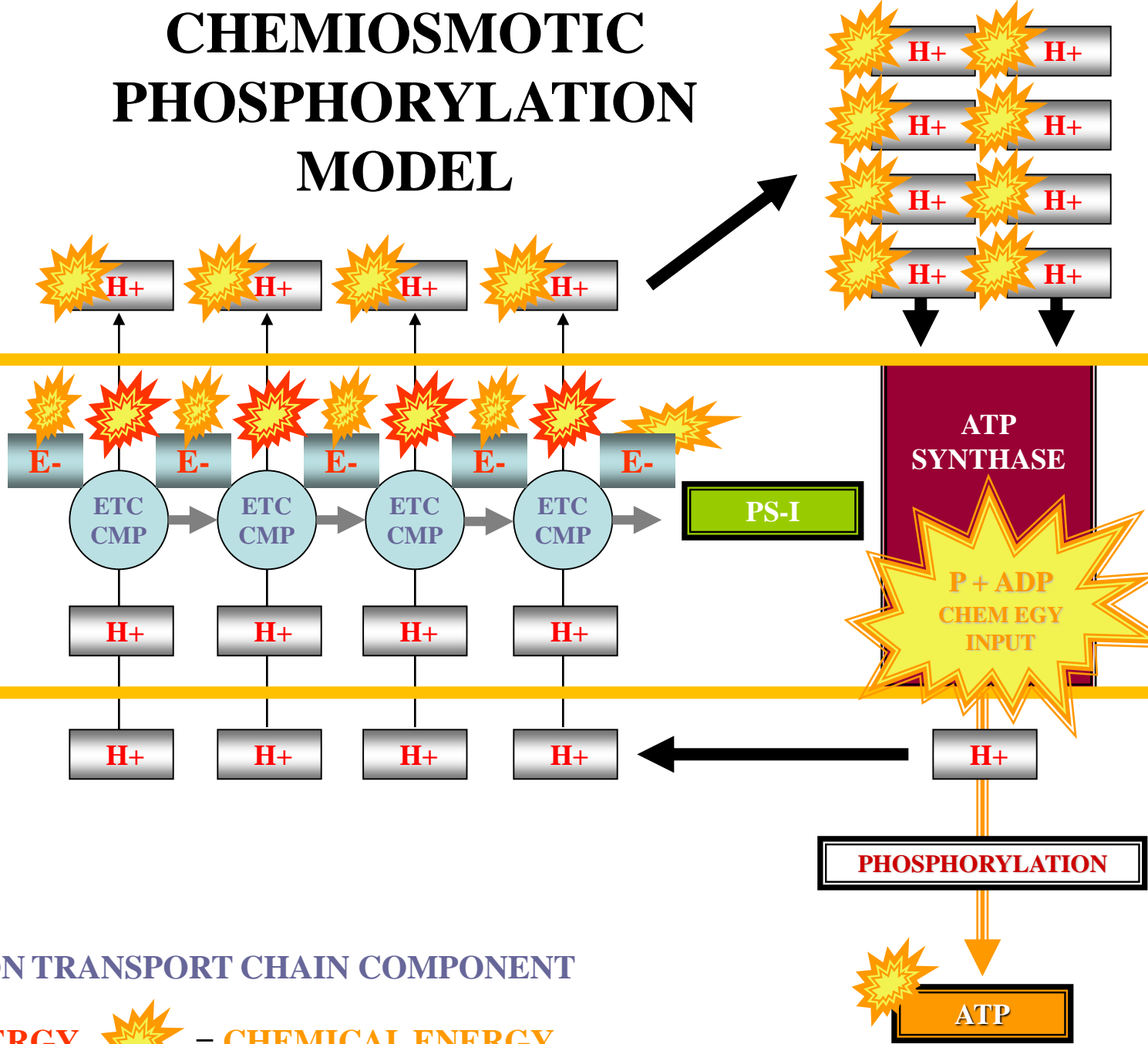
CHEMIOSMOTIC PHOSPHORYLATION MODEL

^ N PS
CHLOROPLAST THYLAKOID SPACE

PS-II / PS-I
CHLOROPLAST THYLAKOID MEMBRANE

CHLOROPLAST STROMA

 = ELECTRON TRANSPORT CHAIN COMPONENT
 = HEAT ENERGY  = CHEMICAL ENERGY



CYCLIC P-P

“Q2”

E-

ETC #3

E-

E-

CHEM
EGY
INPUT

ATP

PS

E- = RECYCLED

PS-I
RXT-CENTER
CHL-A P700

LIGHT
ENERGY

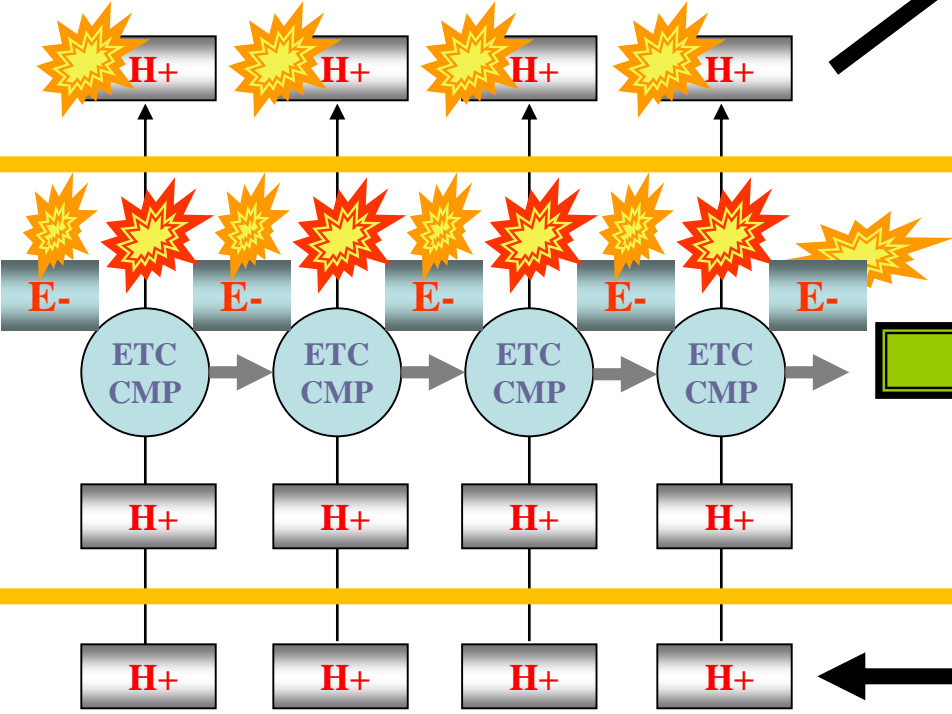
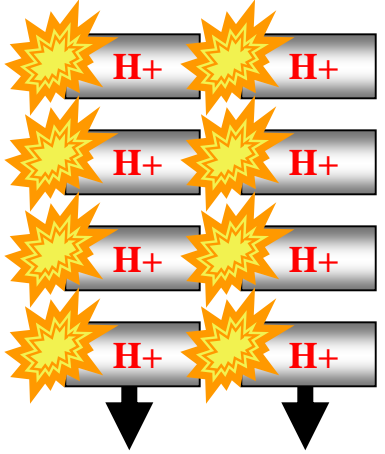
PS-I
ANTENNA
MOLECULES
CHL A+B
XANTHOPHYLLS
CAROTENES

LIGHT
ENERGY

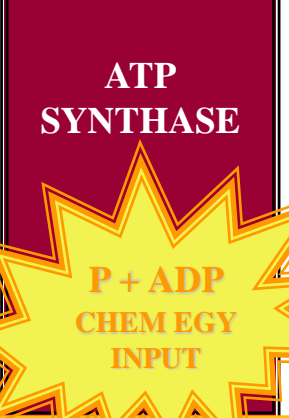
PS

CHLOROPLAST THYLAKOID SPACE

CHEMIOSMOTIC PHOSPHORYLATION MODEL






CHLOROPLAST THYLAKOID MEMBRANE



CHLOROPLAST STROMA

PHOSPHORYLATION



 = ELECTRON TRANSPORT CHAIN COMPONENT
 = HEAT ENERGY  = CHEMICAL ENERGY

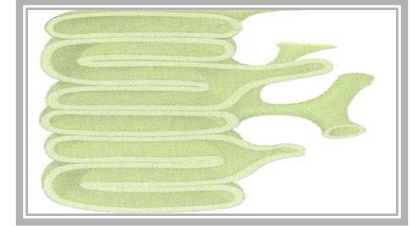
CHLOROPLAST

PS

THYLAKOID



**ANTENNA
MOLECULES**



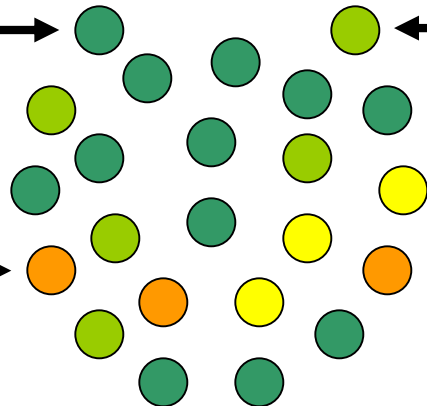
PHOTOSYSTEM

CHLOROPHYLL A

CHLOROPHYLL B

CAROTENES

XANTHOPHYLLS



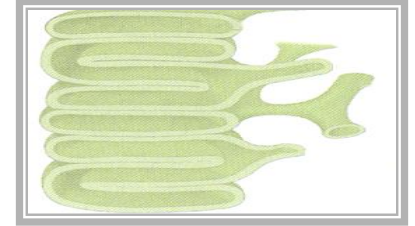
CHLOROPLAST

PS

THYLAKOID

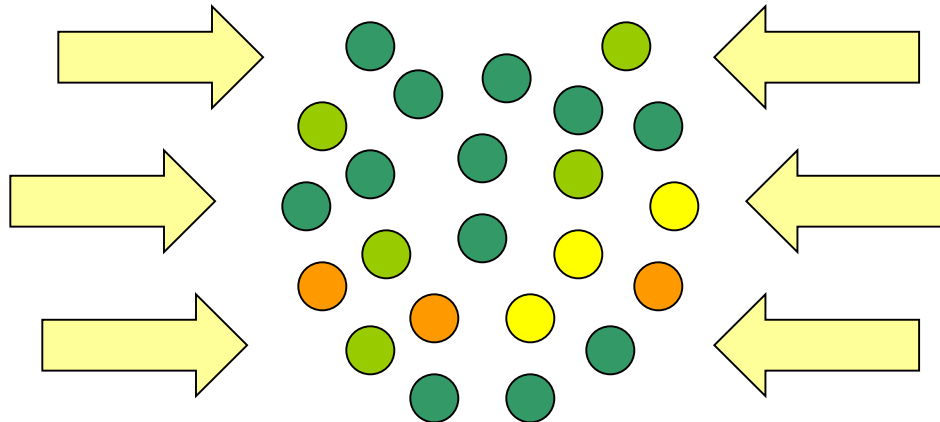


**ANTENNA
MOLECULES**



PHOTOSYSTEM

LTEGY



LTEGY

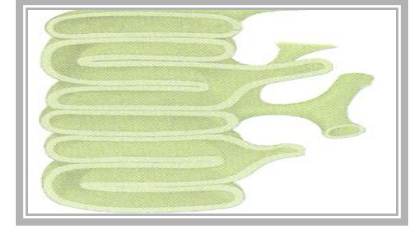
CHLOROPLAST

PS

THYLAKOID



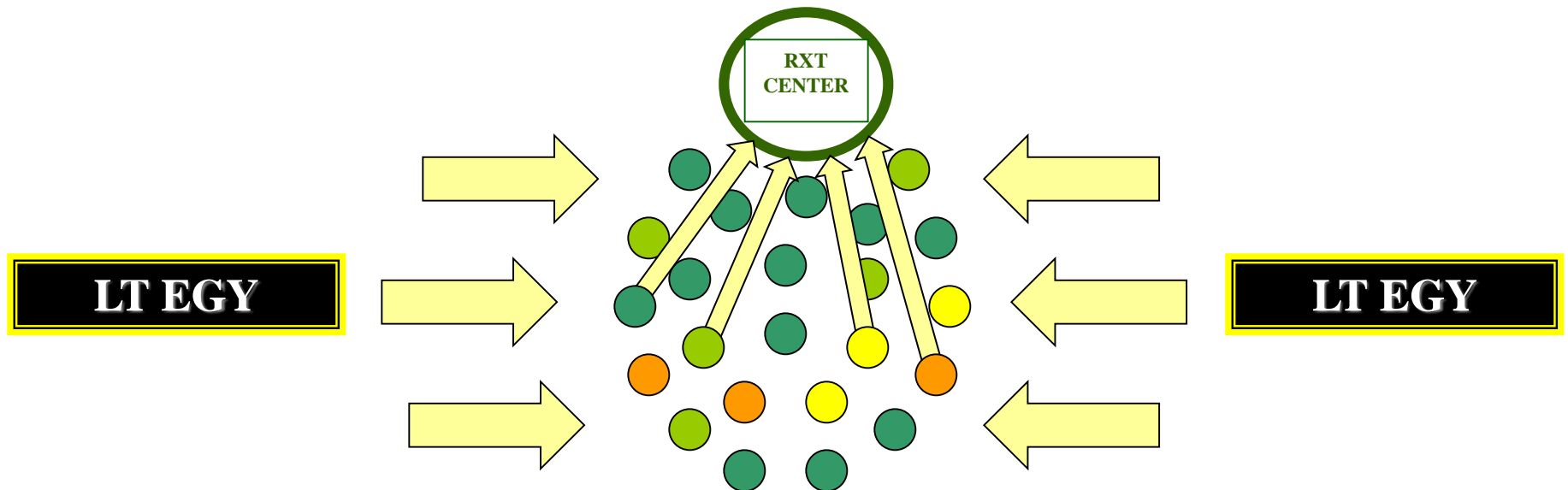
**ANTENNA
MOLECULES**



E-



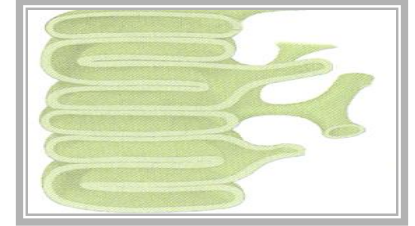
REACTION CENTER: ABSORBS SUFFICIENT LIGHT ENERGY



CHLOROPLAST

PS

THYLAKOID



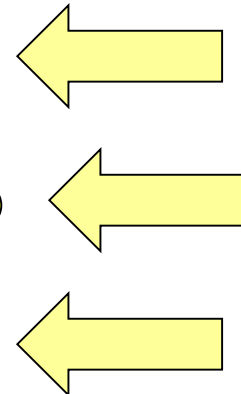
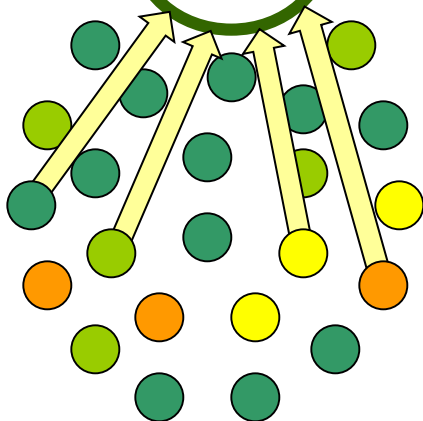
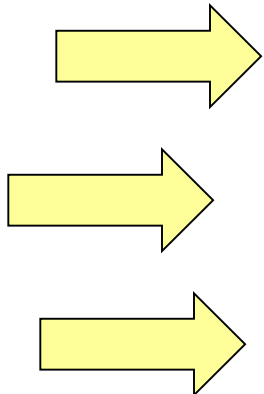
ENERGIZED E-

AC

 = ENERGY



LTEGY



LTEGY

CHLOROPLAST

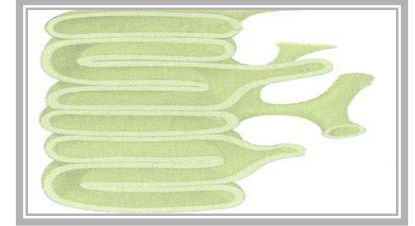


E- ACCEPTOR



LEGY

THYLAKOID



E- ACCEPTOR: ACCEPTS ENERGIZED E-

C

 = ENERGY

