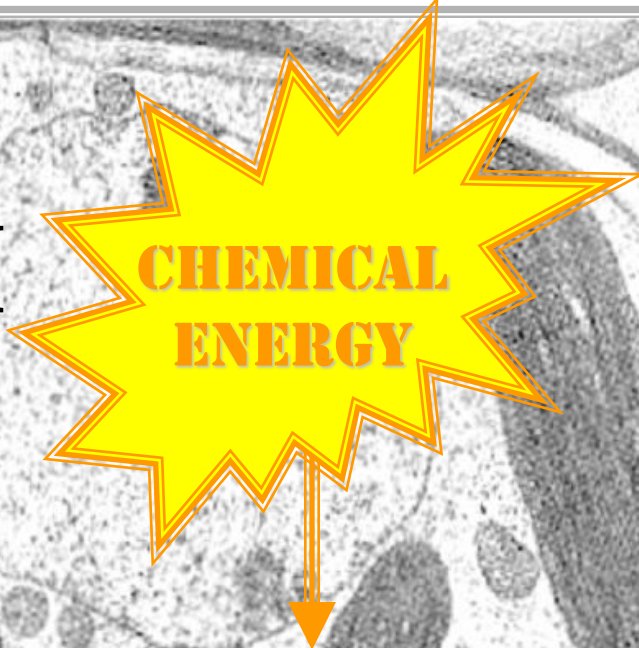


CELL METABOLISM



ENDERGONIC BIOCHEMICAL REACTIONS

CELL METABOLISM



**CHEMICAL
ENERGY**



**CHEMICAL ENERGY
DRIVES
ENDERGONIC REACTIONS
TO A PRODUCT**

PHOTOSYNTHESIS



*EFFICIENT
METABOLISM*

PHOTOSYNTHESIS

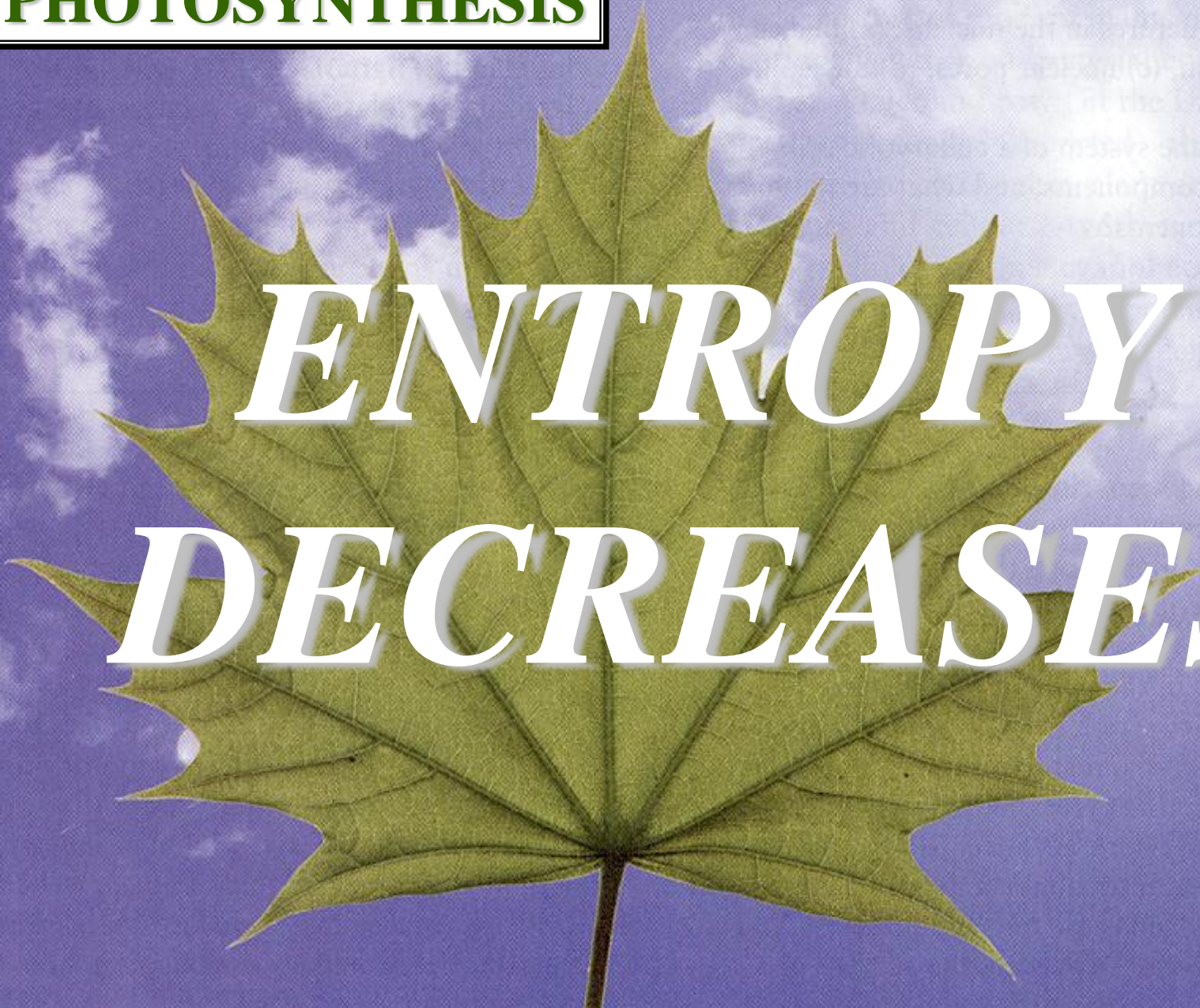


*ORGANIZATION
INCREASES*

PHOTOSYNTHESIS

H

*ENTROPY
DECREASES*



PHOTOSYNTHESIS

^

HOMEOSTASIS



C3

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



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

PHOSPHOGLYCERATE / (PGA)

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

ATP

ATP

R

BIPHOSPHOGLYCERATE / (BIPGA)

BIPHOSPHOGLYCERATE / (BIPGA)

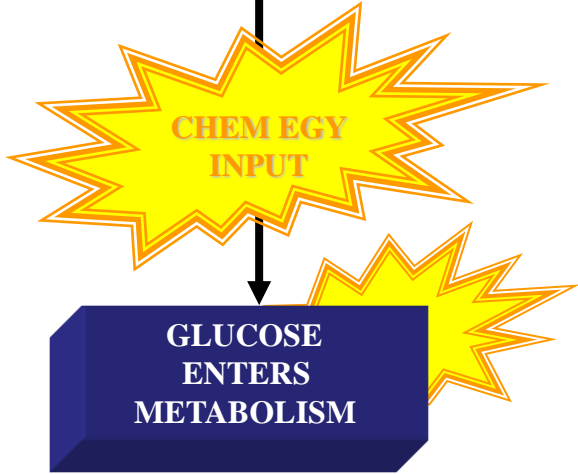
NADPH

NADPH

PHOSPHOGLYCERALDEHYDE / (PGAL)

PHOSPHOGLYCERALDEHYDE / (PGAL)

**ALL RXTS
REQUIRE
A SPECIFIC
ENZYME**



C3 PATHWAY CALVIN CYCLE

C3

CO₂ + RIBULOSE BIPHOSPHATE / (RUBP)



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

PHOSPHOGLYCERATE / (PGA)

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

ATP

ATP

A

BIPHOSPHOGLYCERATE / (BIPGA)

BIPHOSPHOGLYCERATE / (BIPGA)

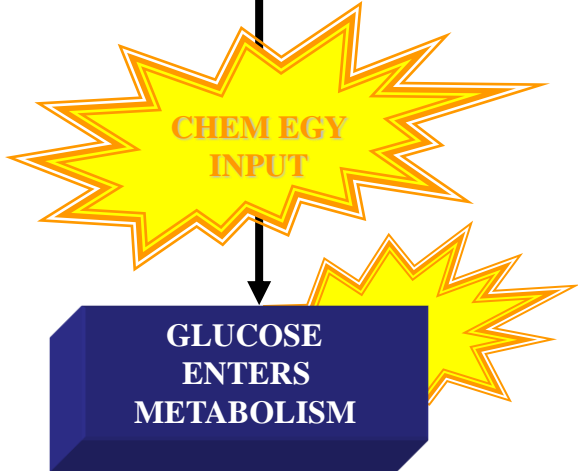
NADPH

NADPH

**ALL RXTS
REQUIRE
A SPECIFIC
ENZYME**

PHOSPHOGLYCERALDEHYDE / (PGAL)

PHOSPHOGLYCERALDEHYDE / (PGAL)



**COMPLEX SERIES
CHEMICAL RXTS
(CSCR)**

RIBULOSE BIPHOSPHATE / (RUBP)

C3 PATHWAY CALVIN CYCLE

C3

CO₂ + RIBULOSE BISPHOEPHATE / (RUBP)



RIBULOSE BISPHOEPHATE
CARBOXYLASE
(RUBP-CARBOXYLASE)

PHOSPHOGLYCERATE / (PGA)

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

ATP

ATP

LR



BISPHOEPHOGLYCERATE / (BIPGA)

BISPHOEPHOGLYCERATE / (BIPGA)

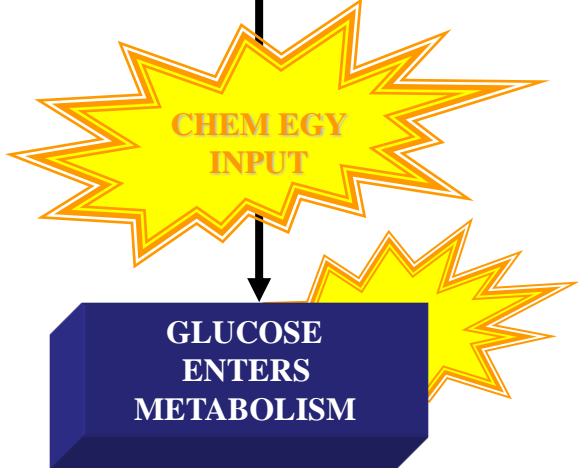
NADPH

NADPH

ALL RXTS
REQUIRE
A SPECIFIC
ENZYME

PHOSPHOGLYCERALDEHYDE / (PGAL)

PHOSPHOGLYCERALDEHYDE / (PGAL)



COMPLEX SERIES
CHEMICAL RXTS
(C3CR)

ATP

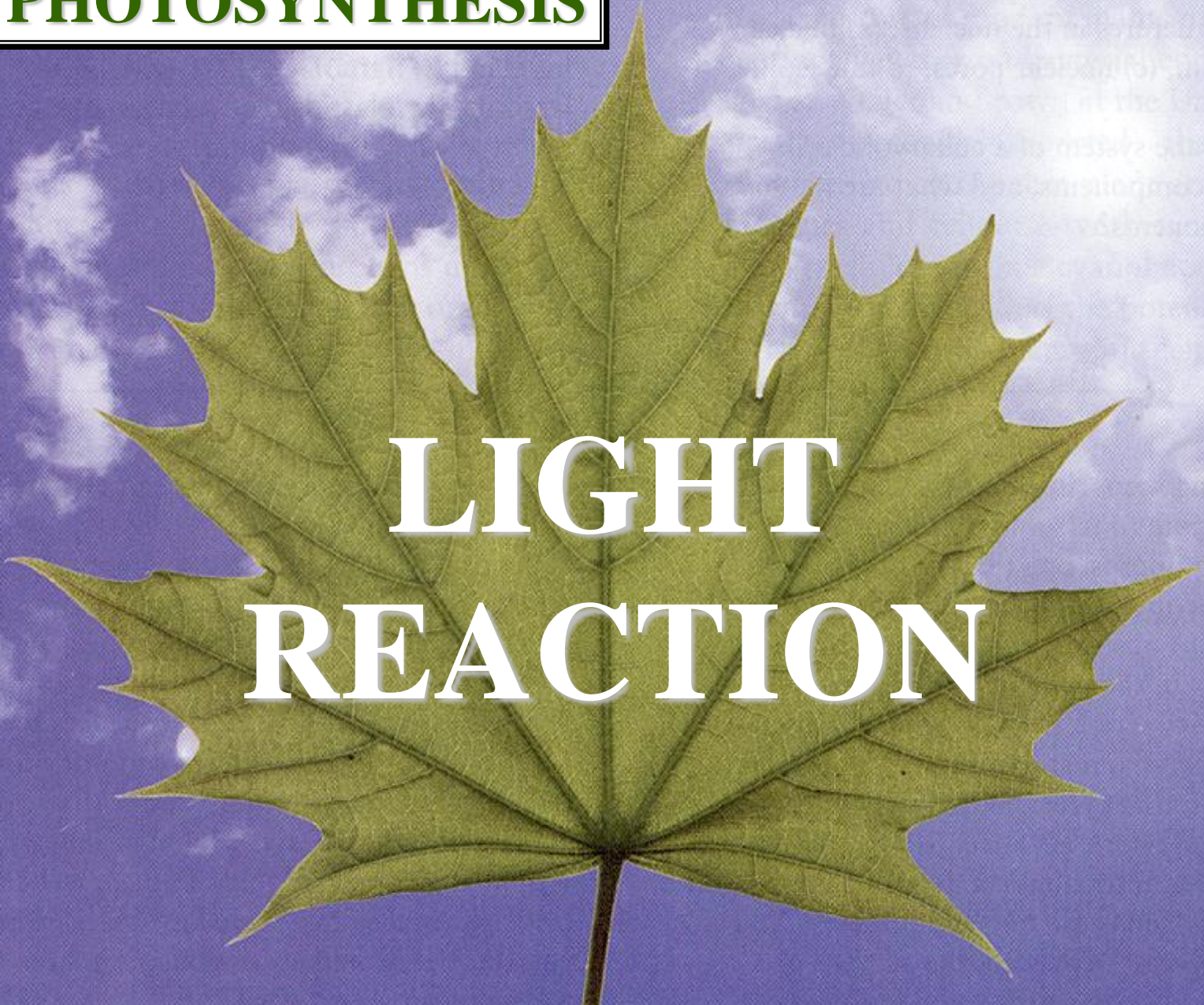
RIBULOSE BISPHOEPHATE / (RUBP)

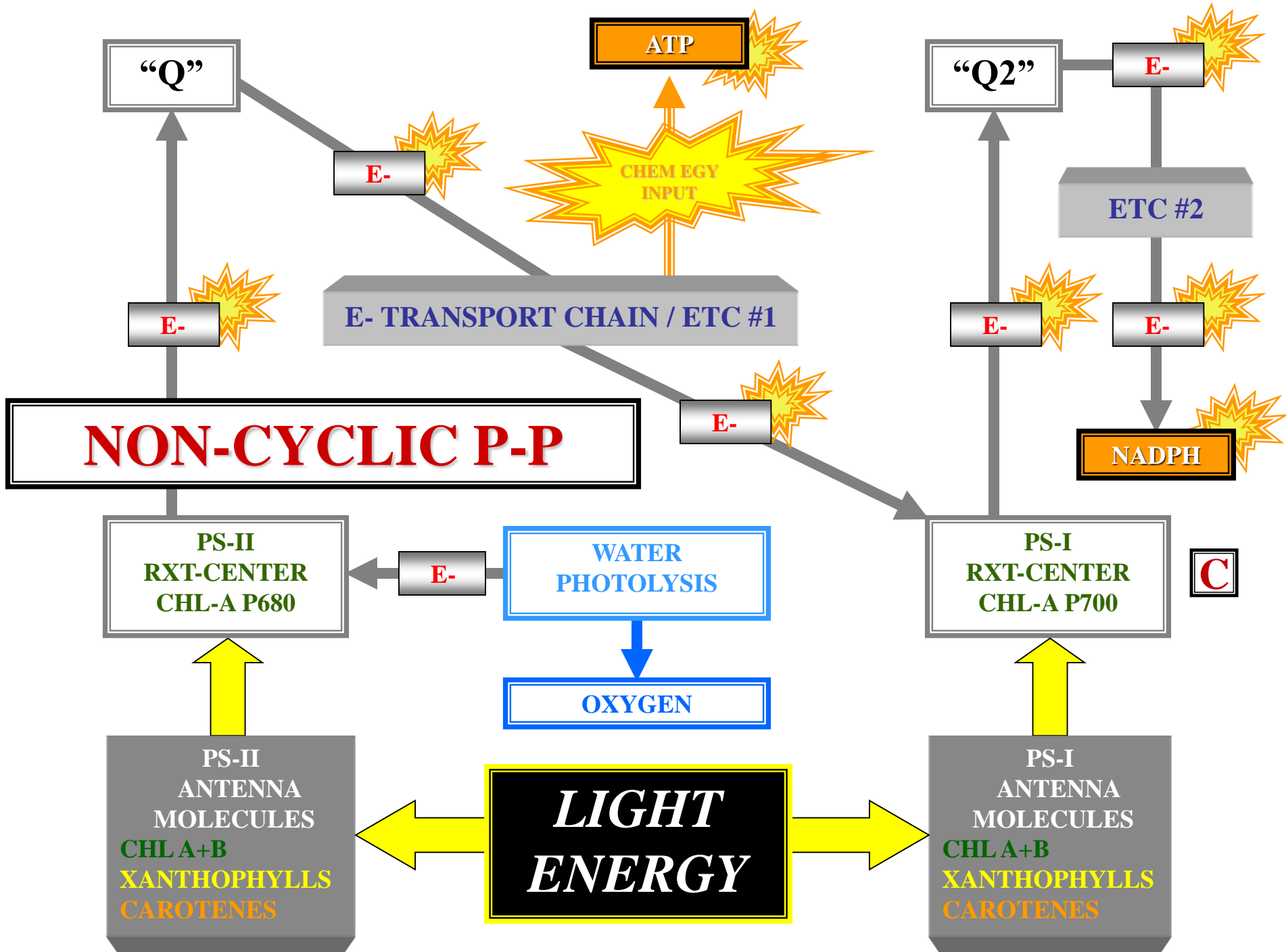
C3 PATHWAY CALVIN CYCLE

PHOTOSYNTHESIS



LIGHT REACTION





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

i R

C3

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



RIBULOSE BISPHOSEPHATE CARBOXYLASE (RUBP-CARBOXYLASE)

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

PHOSPHOGLYCERATE / (PGA)

ATP

ATP

RE

BISPHOSEPHOGLYCERATE / (BIPGA)

BISPHOSEPHOGLYCERATE / (BIPGA)

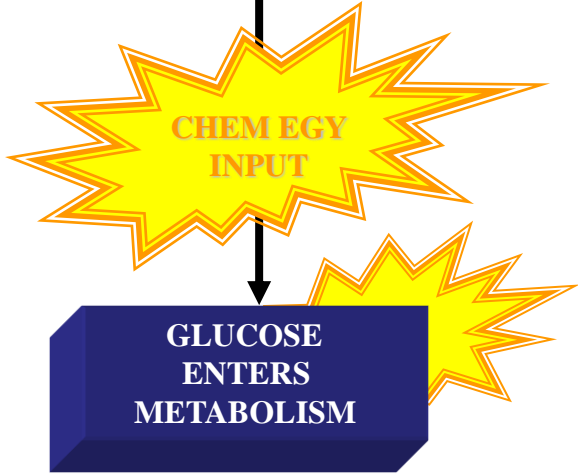
NADPH

NADPH

ALL RXTS REQUIRE A SPECIFIC ENZYME

PHOSPHOGLYCERALDEHYDE / (PGAL)

PHOSPHOGLYCERALDEHYDE / (PGAL)



COMPLEX SERIES CHEMICAL RXTS (CSCR)

ATP

RIBULOSE BISPHOSEPHATE / (RUBP)

C3 PATHWAY CALVIN CYCLE

C3

CO₂ + RIBULOSE BISPHOSEPHATE / (RUBP)

REGENERATED

RIBULOSE BISPHOSEPHATE CARBOXYLASE (RUBP-CARBOXYLASE)

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

PHOSPHOGLYCERATE / (PGA)

ATP

ATP

BISPHOSEPHOGLYCERATE / (BIPGA)

BISPHOSEPHOGLYCERATE / (BIPGA)

NADPH

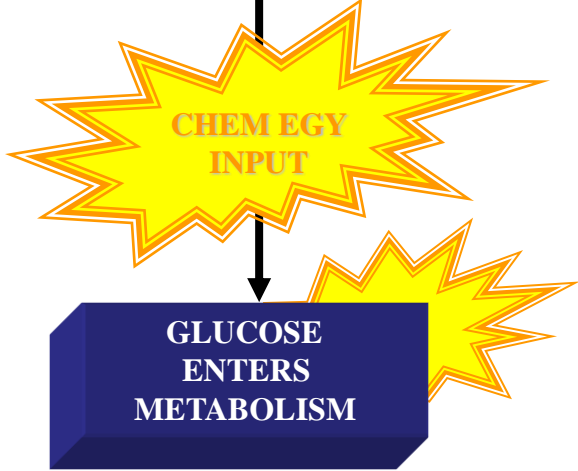
NADPH

PHOSPHOGLYCERALDEHYDE / (PGAL)

PHOSPHOGLYCERALDEHYDE / (PGAL)

ALL RXTS REQUIRE A SPECIFIC ENZYME

COMPLEX SERIES CHEMICAL RXTS (CSCR)

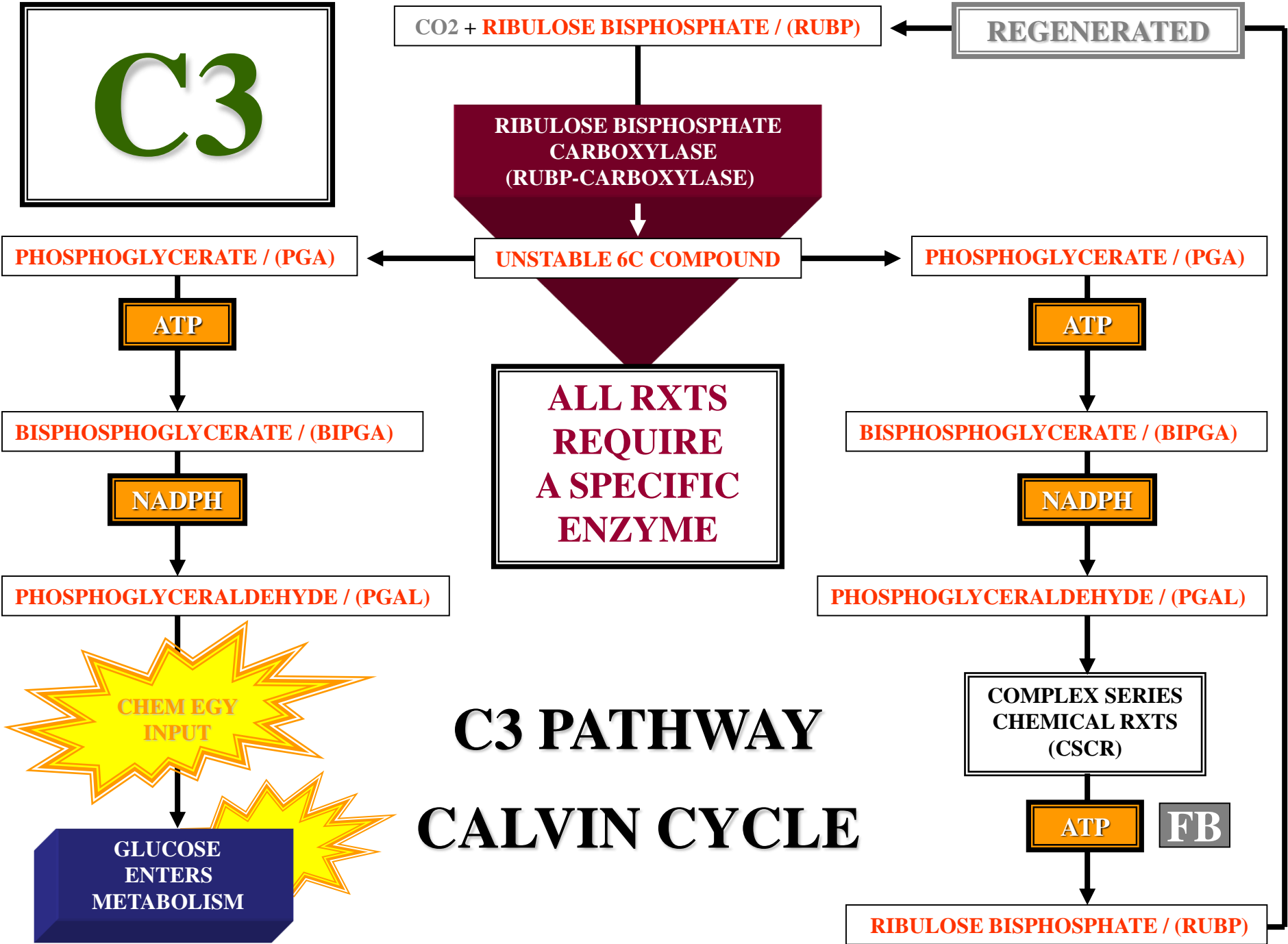


C3 PATHWAY CALVIN CYCLE

ATP

FB

RIBULOSE BISPHOSEPHATE / (RUBP)



C3

CO₂ + RIBULOSE BISPHOSEPHATE / (RUBP)

FEEDBACK

RIBULOSE BISPHOSEPHATE CARBOXYLASE (RUBP-CARBOXYLASE)

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

PHOSPHOGLYCERATE / (PGA)

ATP

ATP

BISPHOGLYCERATE / (BIPGA)

BISPHOGLYCERATE / (BIPGA)

NADPH

NADPH

PHOSPHOGLYCERALDEHYDE / (PGAL)

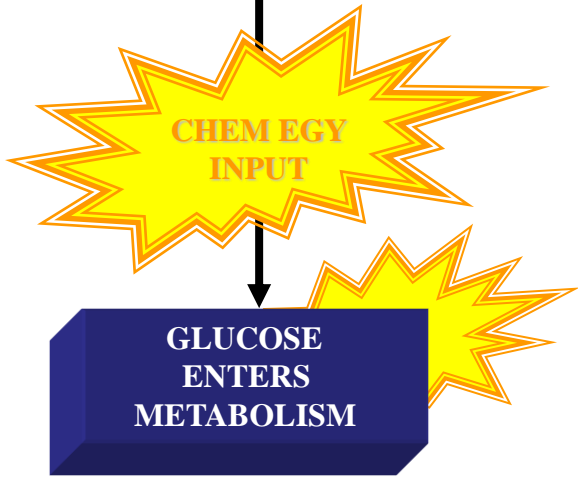
PHOSPHOGLYCERALDEHYDE / (PGAL)

ALL RXTS REQUIRE A SPECIFIC ENZYME

COMPLEX SERIES CHEMICAL RXTS (CSCR)

ATP

RIBULOSE BISPHOSEPHATE / (RUBP)



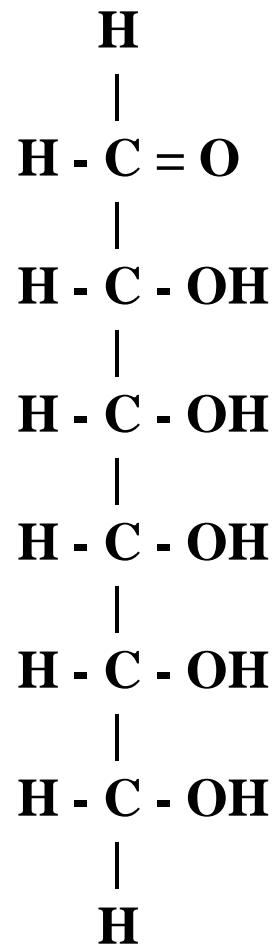
C3 PATHWAY CALVIN CYCLE

C3

PATHWAY

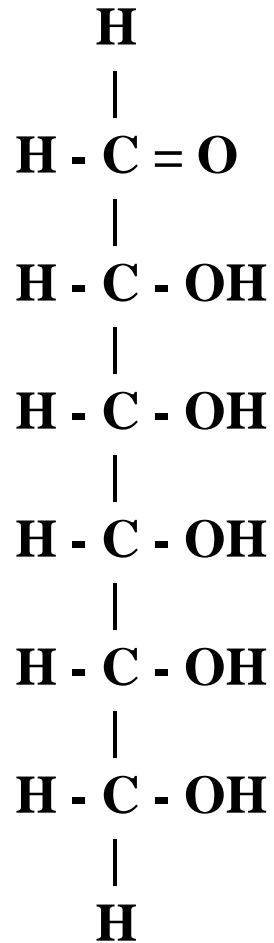
ENERGY COST

GLUCOSE



GLUCOSE

GLUCOSE
6C
SUGAR



GLUCOSE
6C
SUGAR



QUESTION



WHAT COMPOUND
CONTRIBUTES C ATOMS
TO THE SYNTHESIS OF
GLUCOSE?

QUESTION

C3

CO₂ + RIBULOSE BISPHOSEPHATE / (RUBP)

FEEDBACK

RIBULOSE BISPHOSEPHATE CARBOXYLASE (RUBP-CARBOXYLASE)

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

PHOSPHOGLYCERATE / (PGA)

ATP

ATP

BISPHOSEPHOGLYCERATE / (BIPGA)

BISPHOSEPHOGLYCERATE / (BIPGA)

NADPH

NADPH

PHOSPHOGLYCERALDEHYDE / (PGAL)

PHOSPHOGLYCERALDEHYDE / (PGAL)

CHEM EGY INPUT
GLUCOSE 6 CARBON SUGAR

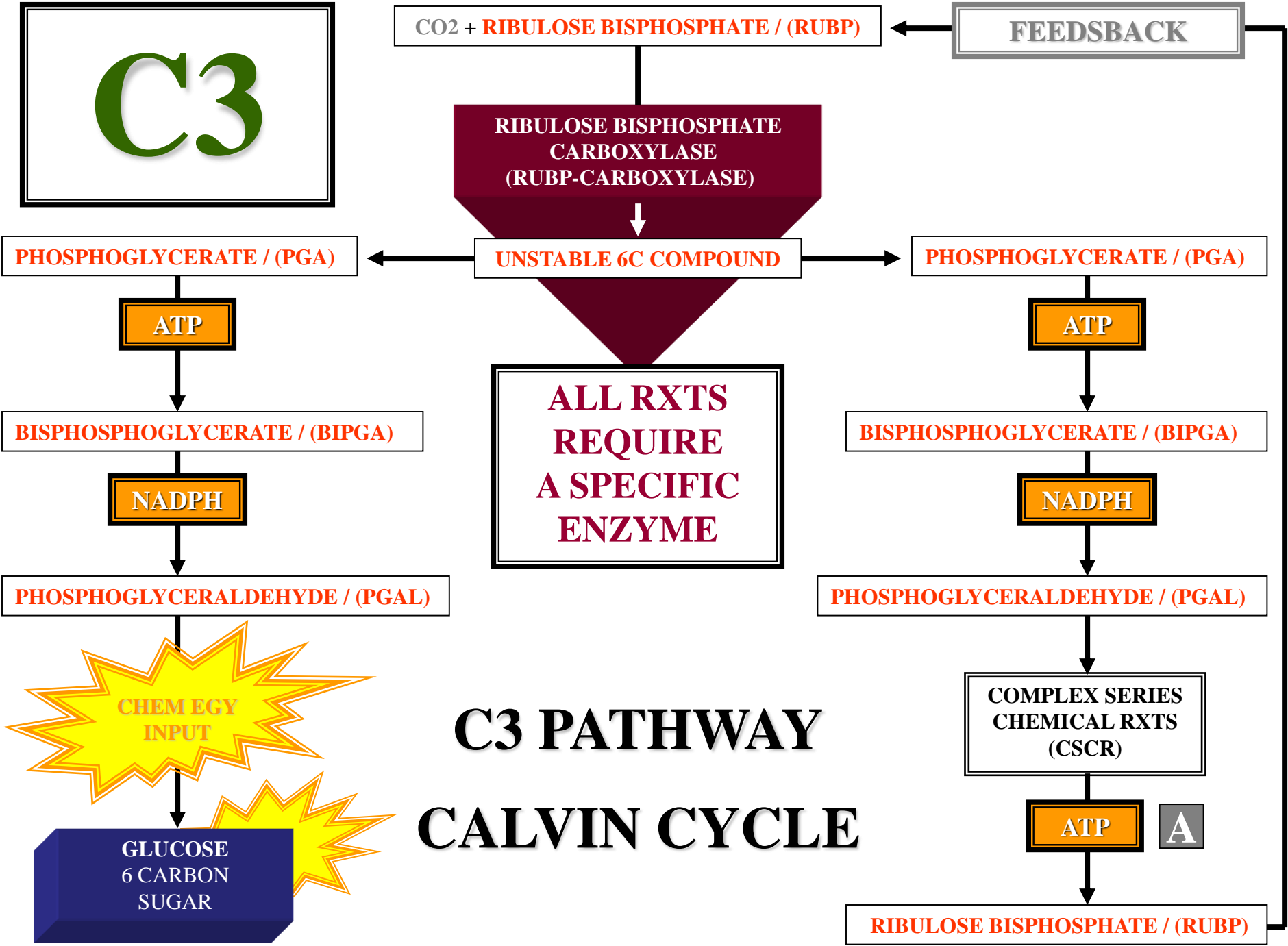
ALL RXTS REQUIRE A SPECIFIC ENZYME

COMPLEX SERIES CHEMICAL RXTS (CSCR)

ATP A

RIBULOSE BISPHOSEPHATE / (RUBP)

C3 PATHWAY CALVIN CYCLE





ANSWER

CO2

ANSWER



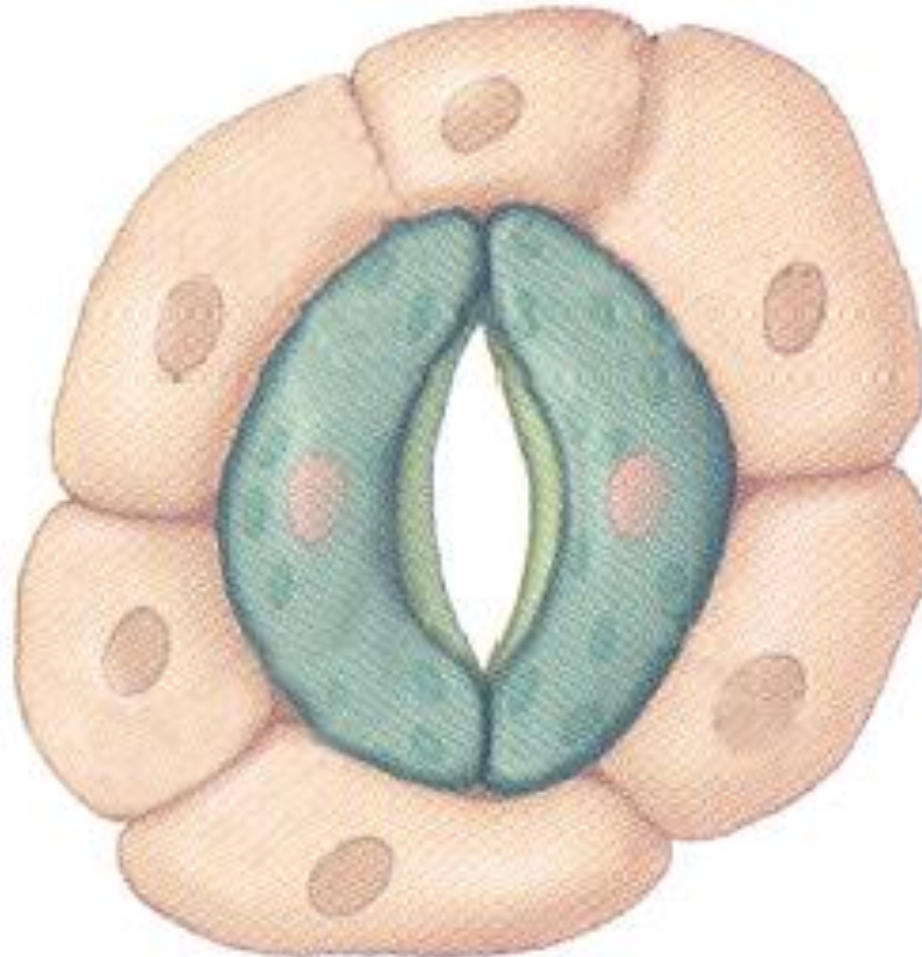
ATMOSPHERE

LEAF STOMATE

ATMOSPHERE

CO₂

CO₂



CO₂

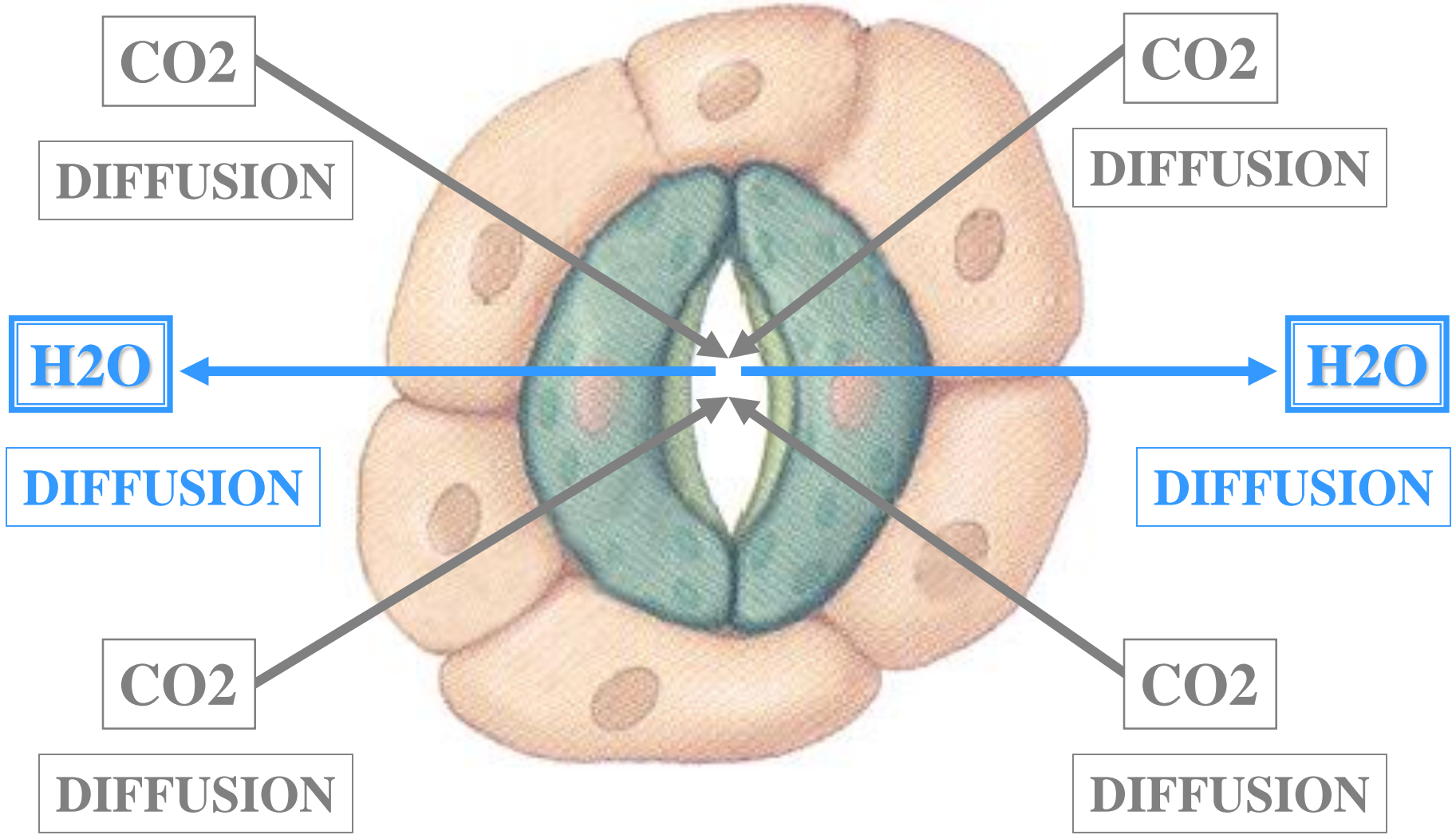
CO₂

 CO₂

LEAF STOMATE

ATMOSPHERE

ATMOSPHERE



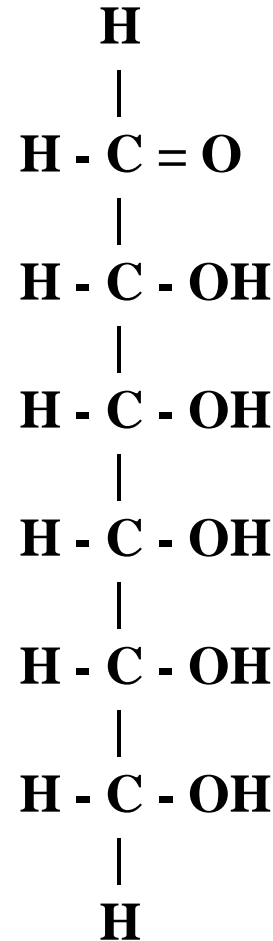
PHOTOSYNTHESIS



CO₂
CO₂
CO₂
CO₂
CO₂
CO₂



SYNTHESIZE



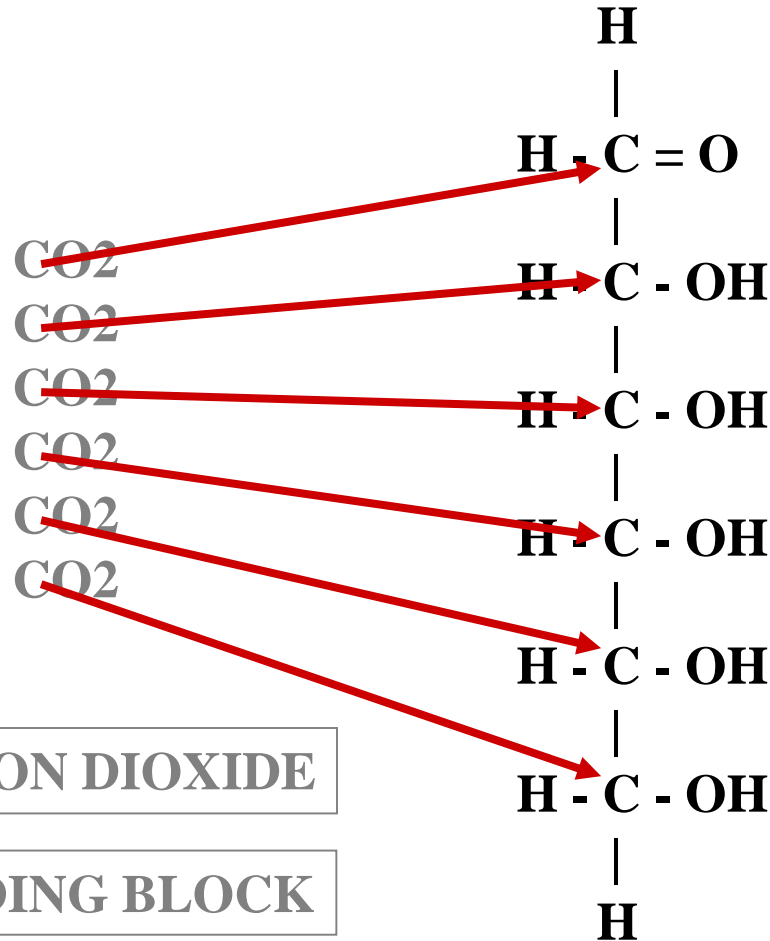
CARBON DIOXIDE

BUILDING BLOCK

C₆H₁₂O₆

GLUCOSE

PHOTOSYNTHESIS



CARBON DIOXIDE

BUILDING BLOCK



GLUCOSE

C3

CO₂ + RIBULOSE BISPHOSEPHATE / (RUBP)

FEEDBACK

C
1
+

RIBULOSE BISPHOSEPHATE
CARBOXYLASE
(RUBP-CARBOXYLASE)

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

PHOSPHOGLYCERATE / (PGA)

ATP

ATP

BISPHOGLYCERATE / (BIPGA)

BISPHOGLYCERATE / (BIPGA)

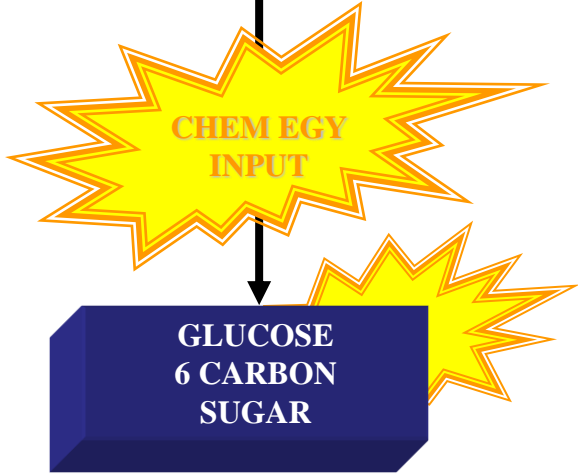
NADPH

NADPH

PHOSPHOGLYCERALDEHYDE / (PGAL)

PHOSPHOGLYCERALDEHYDE / (PGAL)

ALL RXTS
REQUIRE
A SPECIFIC
ENZYME

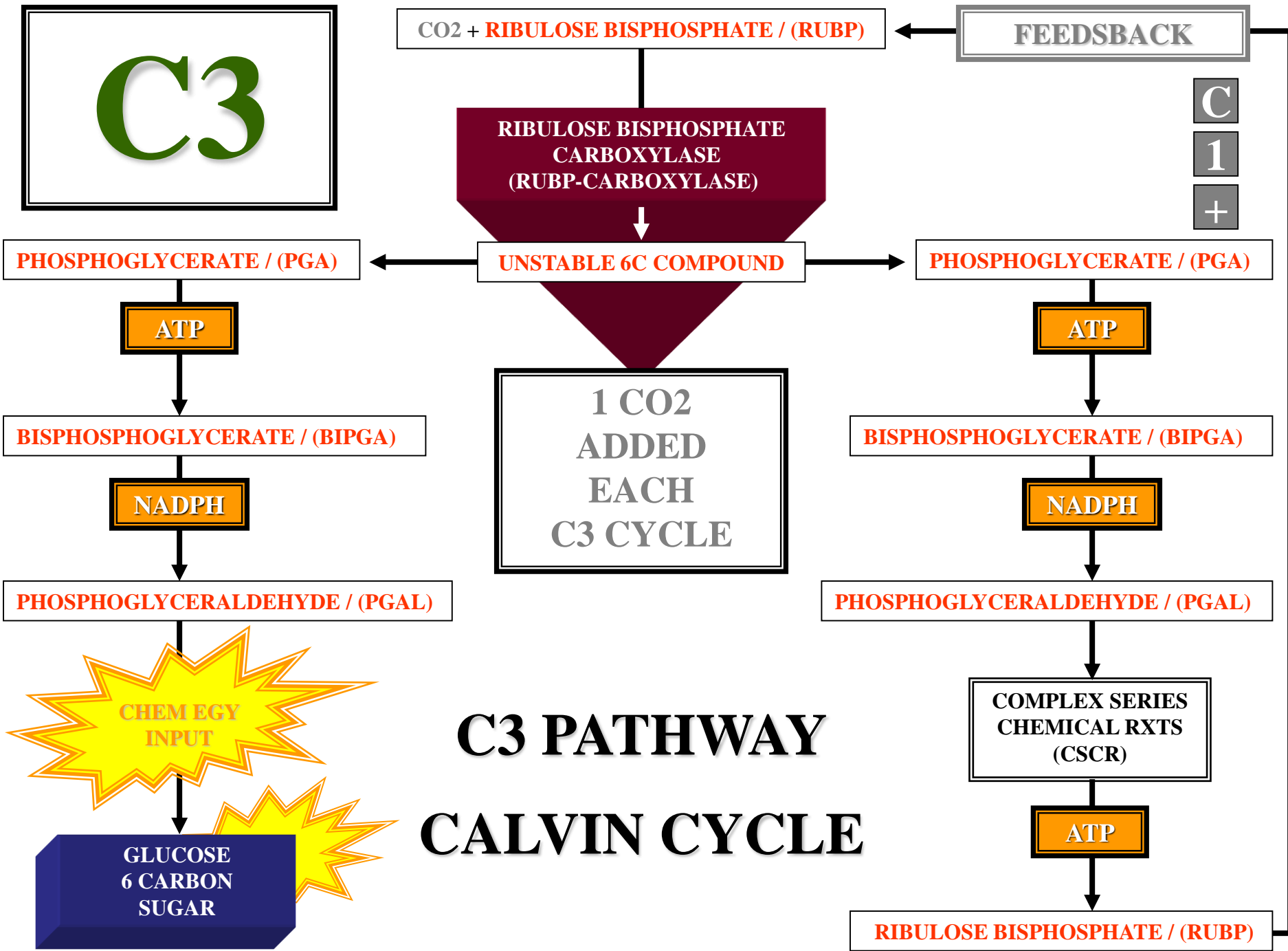


C3 PATHWAY CALVIN CYCLE

COMPLEX SERIES
CHEMICAL RXTS
(CSCR)

ATP

RIBULOSE BISPHOSEPHATE / (RUBP)



C3

CO₂ + RIBULOSE BIPHOSPHATE / (RUBP)

FEEDBACK

6X

RIBULOSE BIPHOSPHATE
CARBOXYLASE
(RUBP-CARBOXYLASE)

PHOSPHOGLYCERATE / (PGA)

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

ATP

ATP

BIPHOSPHOGLYCERATE / (BIPGA)

BIPHOSPHOGLYCERATE / (BIPGA)

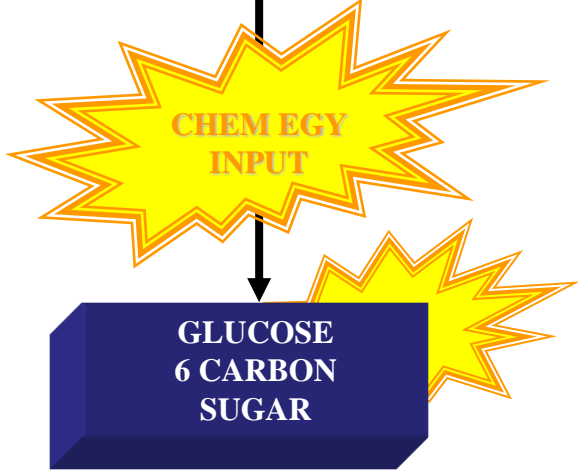
NADPH

NADPH

1 C ATOM
ADDED
EACH
C3 CYCLE

PHOSPHOGLYCERALDEHYDE / (PGAL)

PHOSPHOGLYCERALDEHYDE / (PGAL)

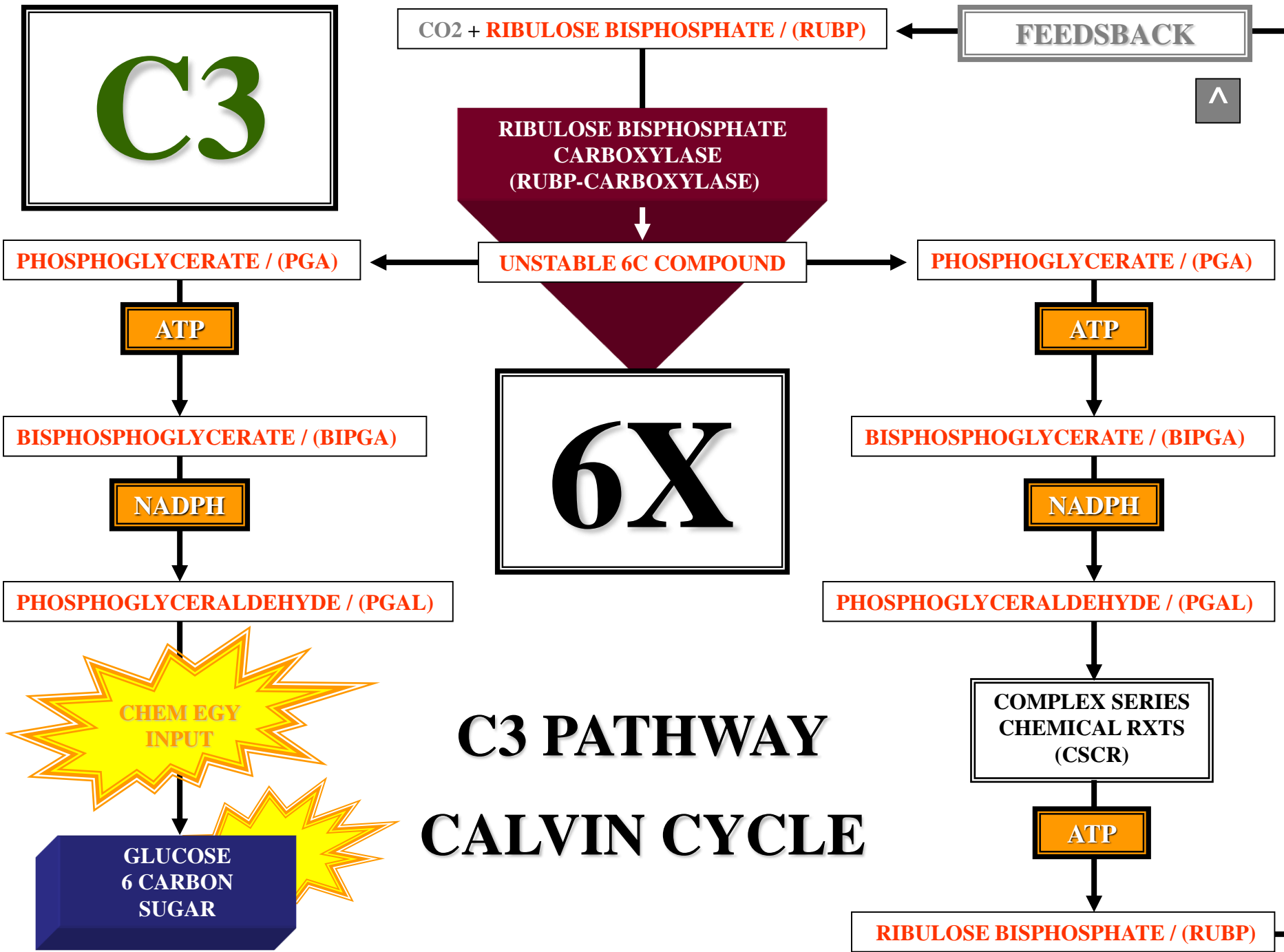


COMPLEX SERIES
CHEMICAL RXTS
(CSCR)

ATP

RIBULOSE BIPHOSPHATE / (RUBP)

C3 PATHWAY CALVIN CYCLE





ENERGY EXPENSE

PHOTOSYNTHESIS

A



WATER

LIGHT ENERGY

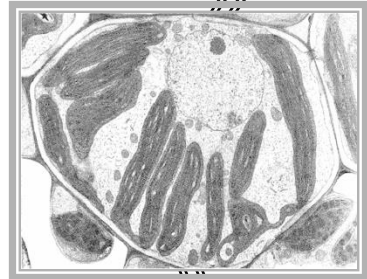
E-

PHOTOLYSIS

LT RXT

THYLAKOID
GRANUM

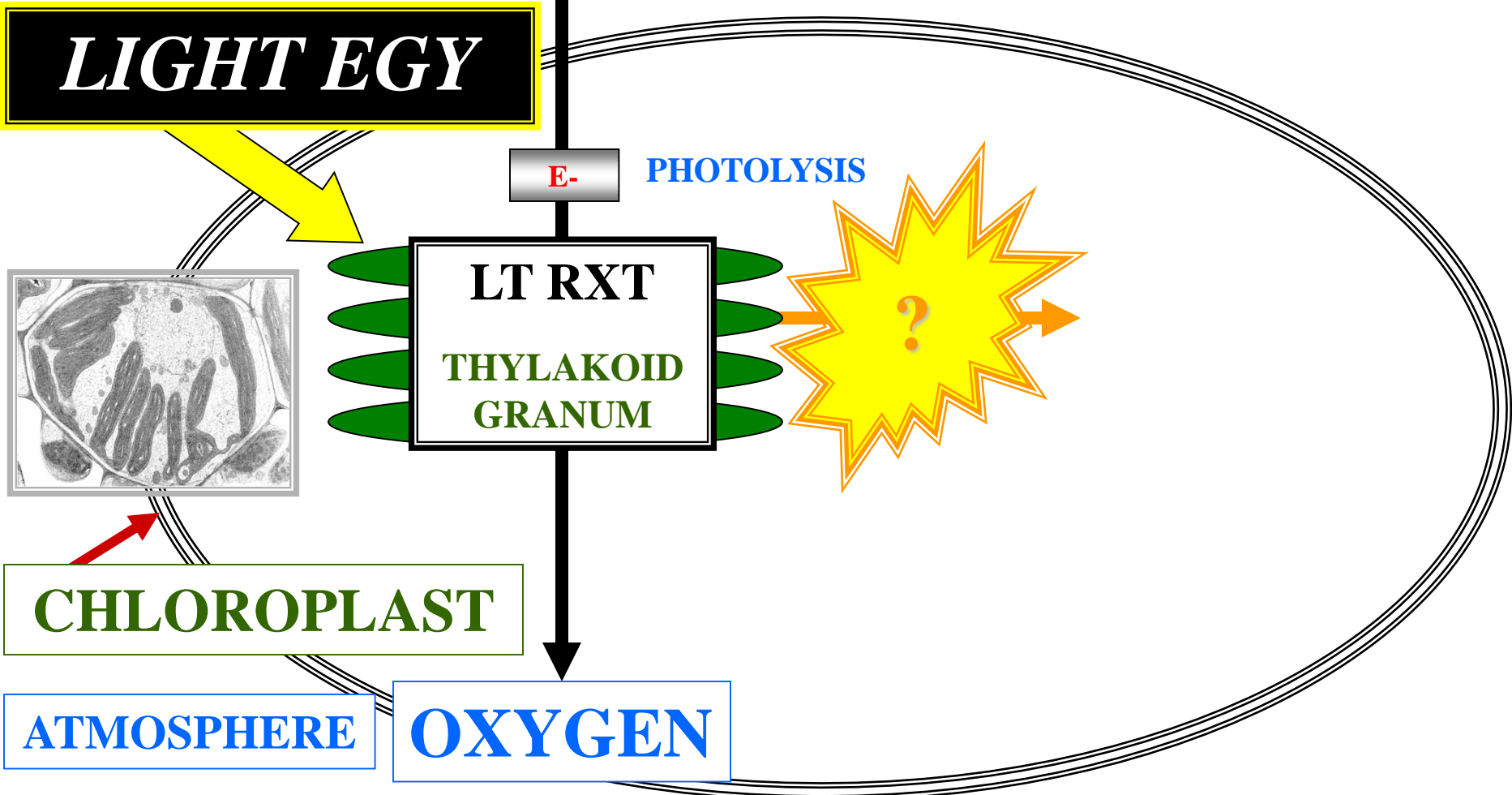
?



CHLOROPLAST

ATMOSPHERE

OXYGEN



PHOTOSYNTHESIS

N



WATER

LIGHT ENERGY

E- PHOTOLYSIS

**LT RXT
THYLAKOID
GRANUM**

ATP

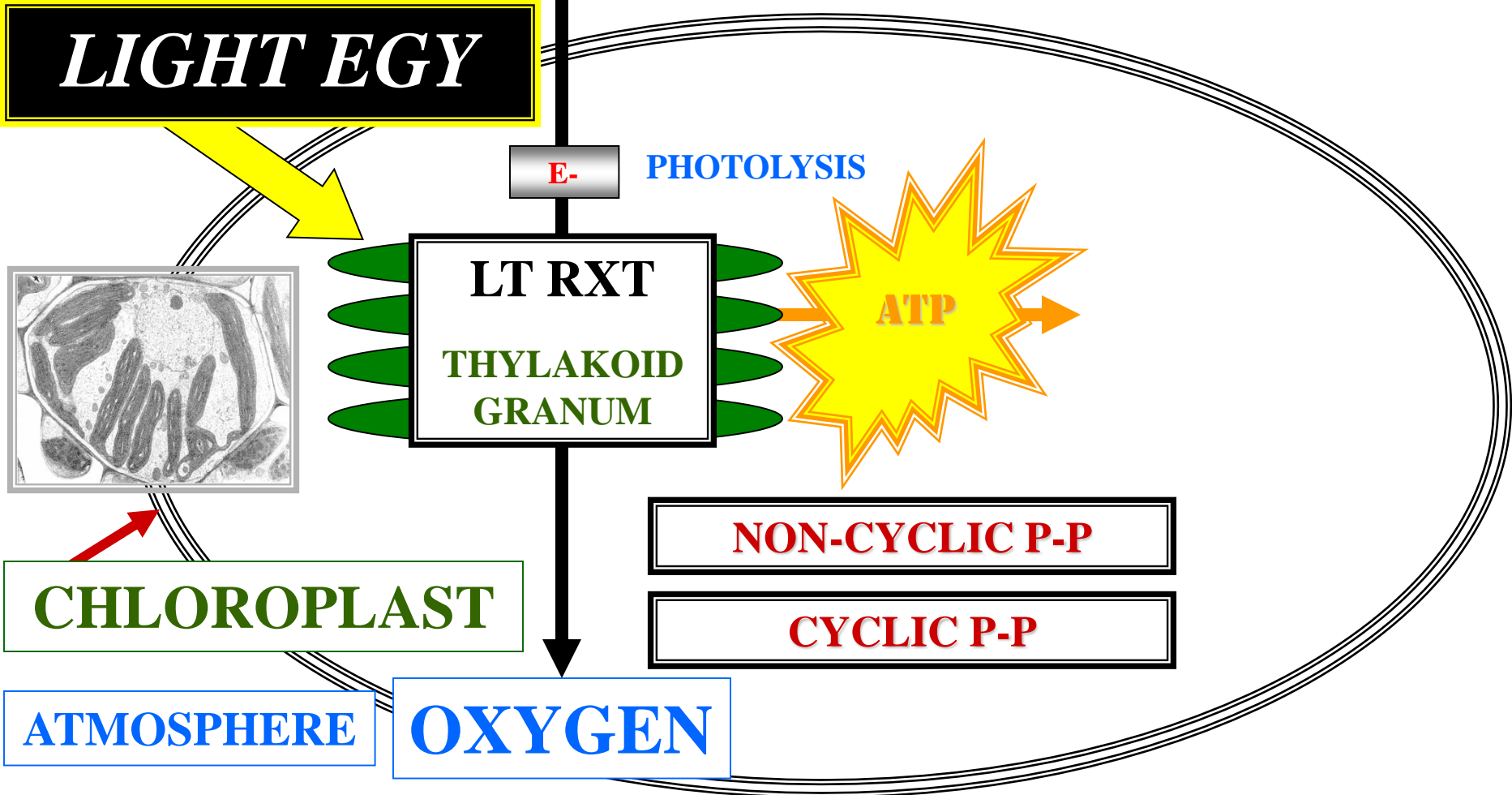
NON-CYCLIC P-P

CYCLIC P-P

CHLOROPLAST

ATMOSPHERE

OXYGEN



PHOTOSYNTHESIS



WATER

LIGHT ENERGY

E-

PHOTOLYSIS

LT RXT

THYLAKOID
GRANUM

DK RXT

STROMA
ENZYMES

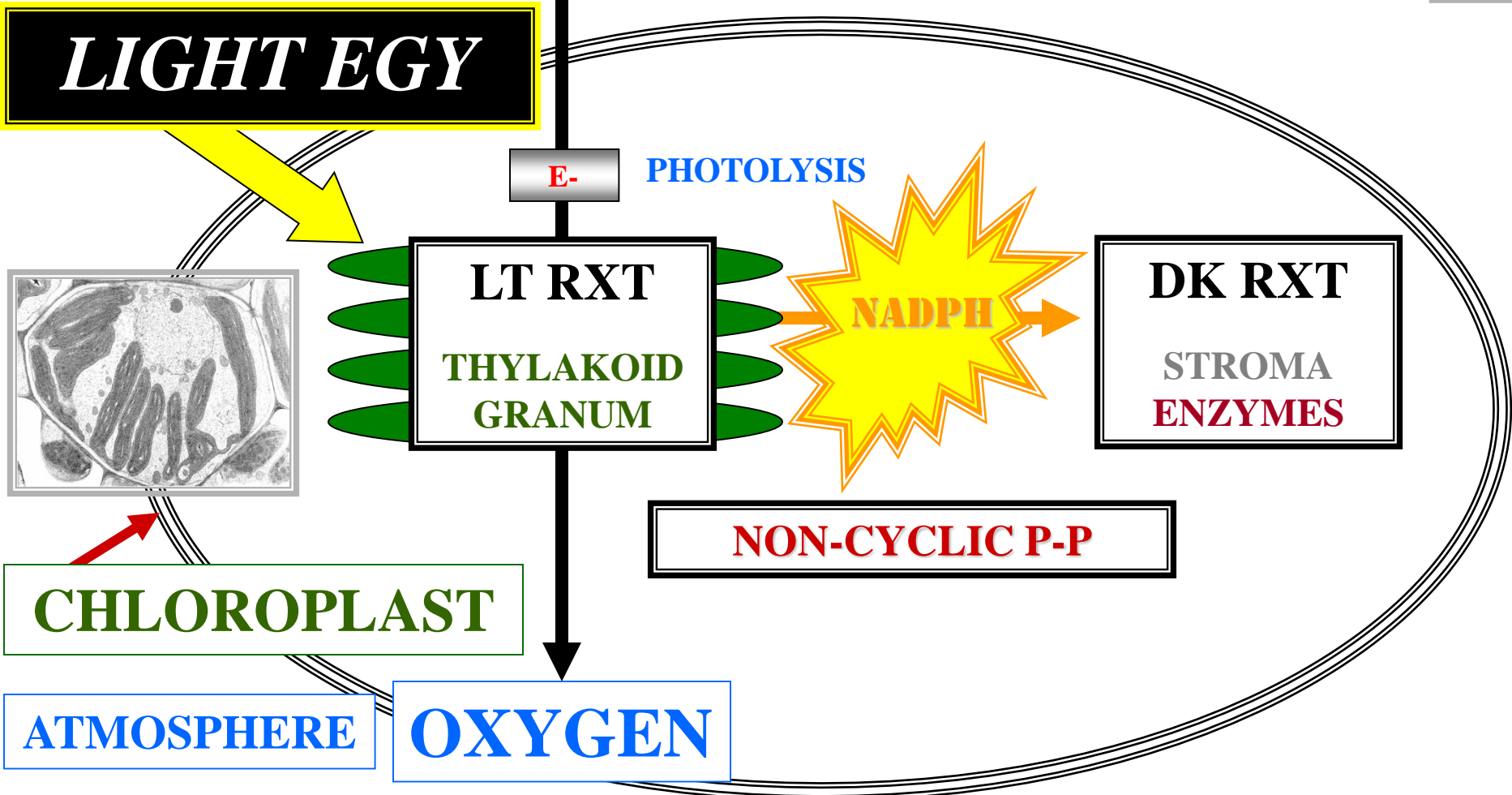
NADPH

NON-CYCLIC P-P

CHLOROPLAST

ATMOSPHERE

OXYGEN



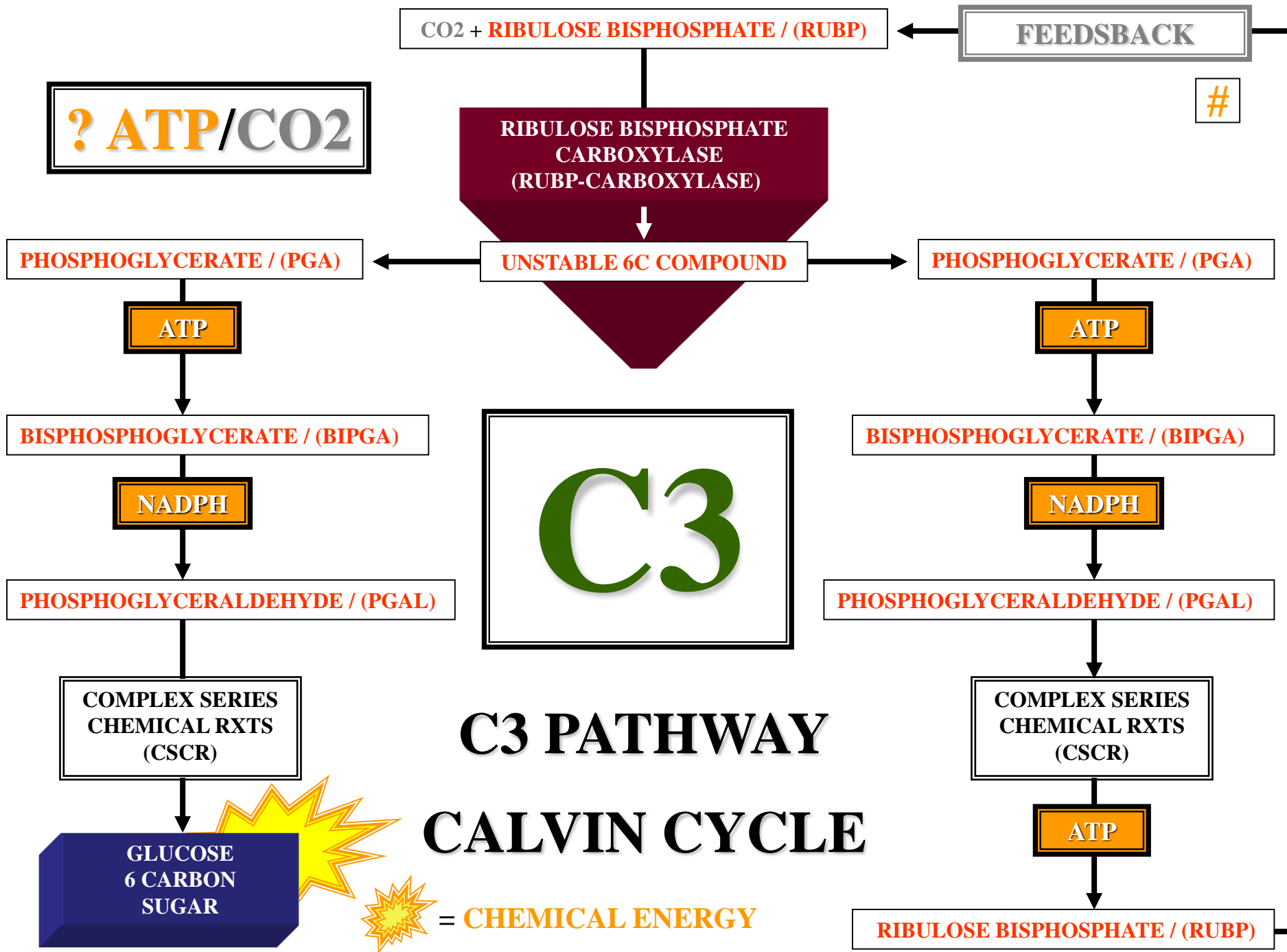


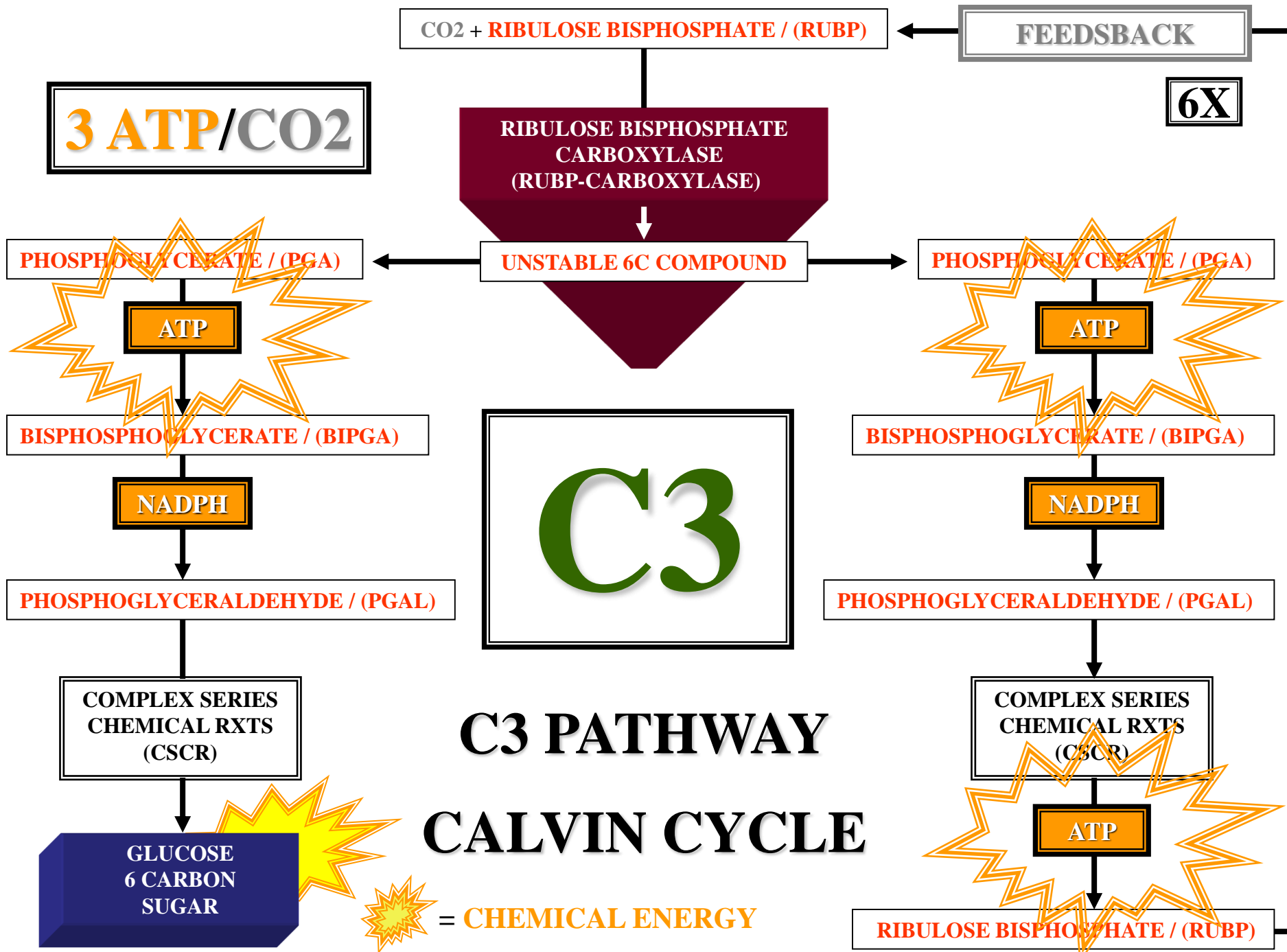
ATP

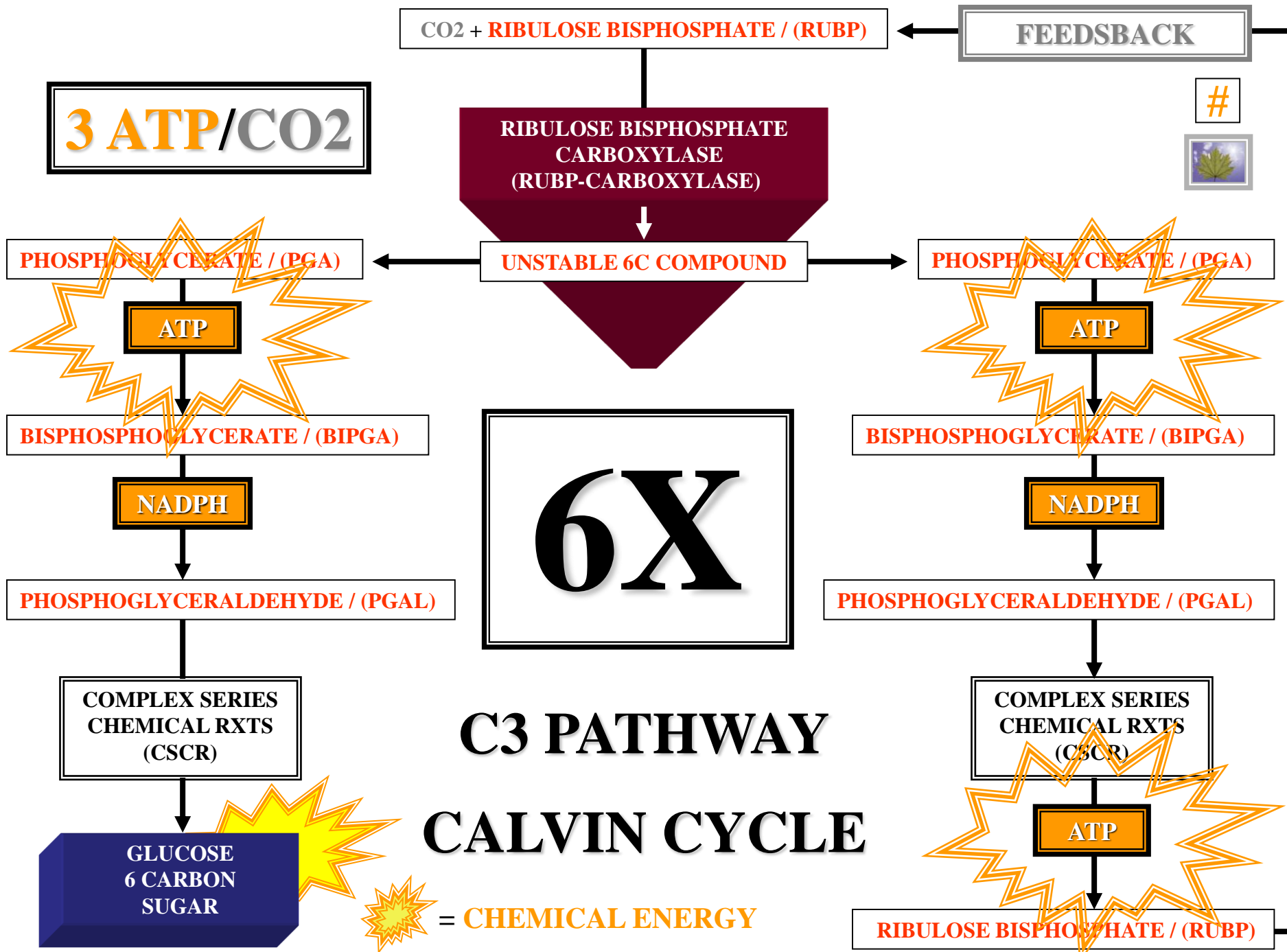
ENERGY EXPENSE

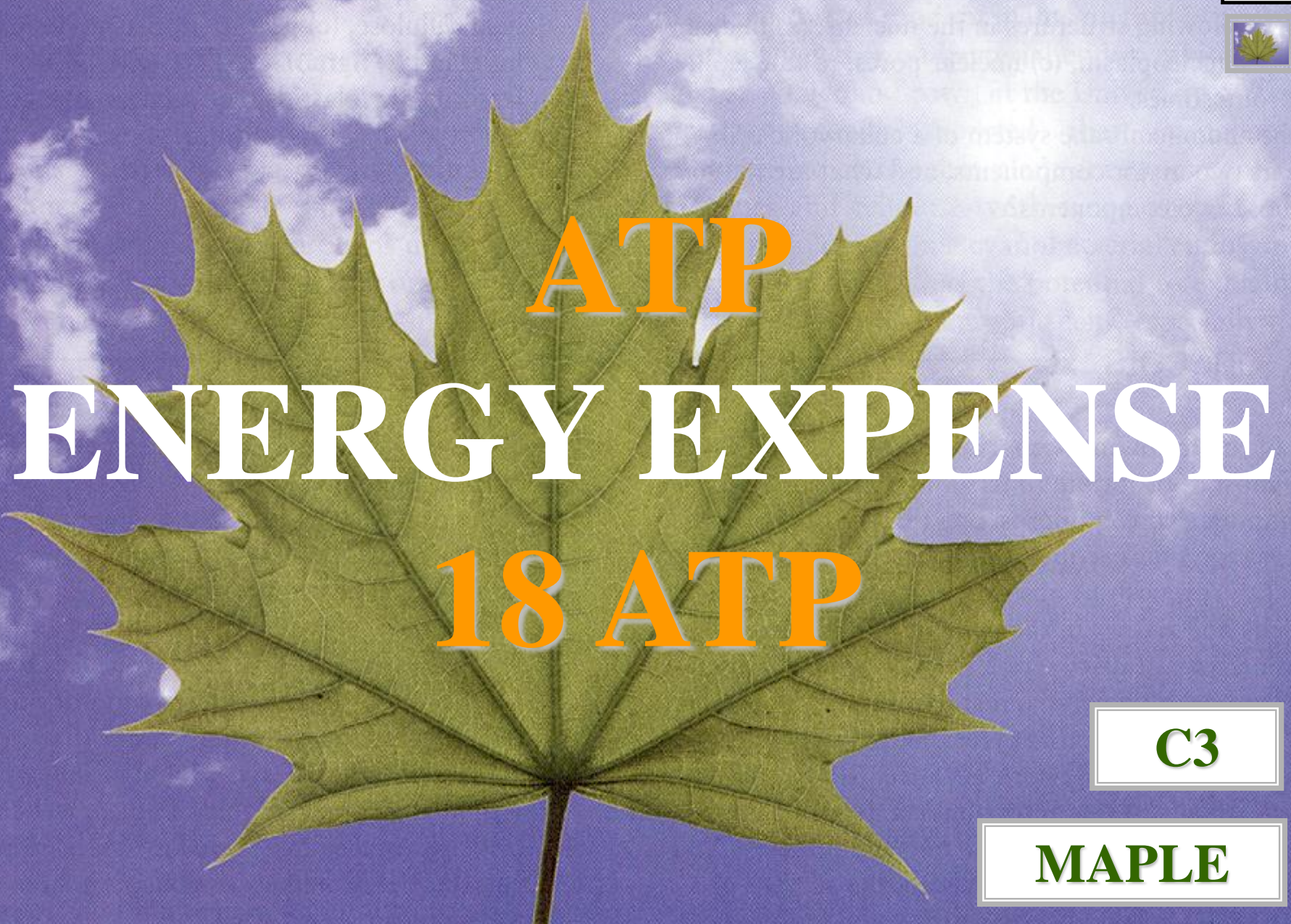
C3

MAPLE







A large, detailed image of a green maple leaf with prominent veins, centered against a blue sky with white clouds. The leaf is the central focus of the slide.

ATP
ENERGY EXPENSE
18 ATP

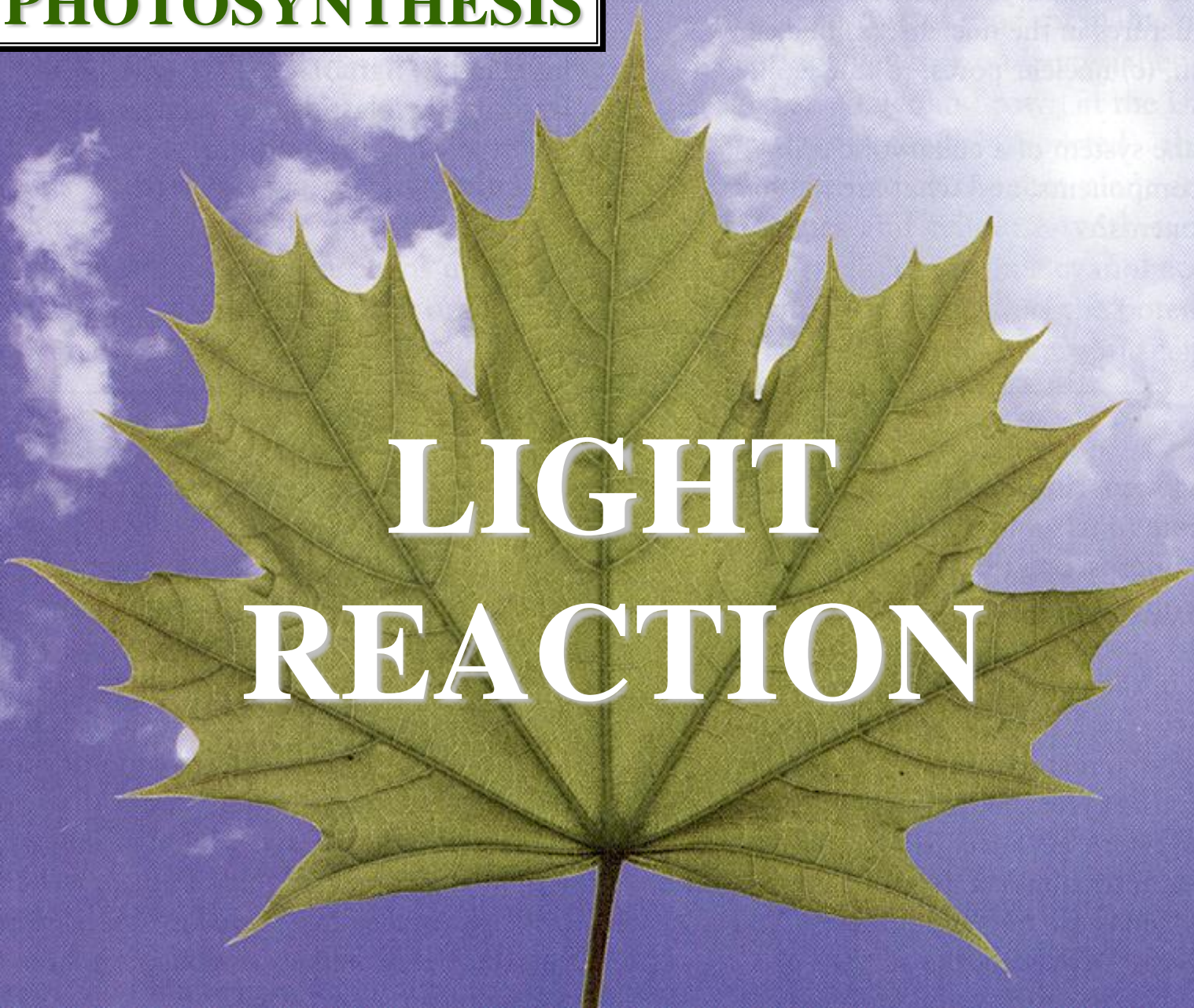
C3

MAPLE

PHOTOSYNTHESIS



LIGHT REACTION



CYCLIC P-P

“Q2”

E-

ETC #3

E-

E-

CHEM
EGY
INPUT

ATP

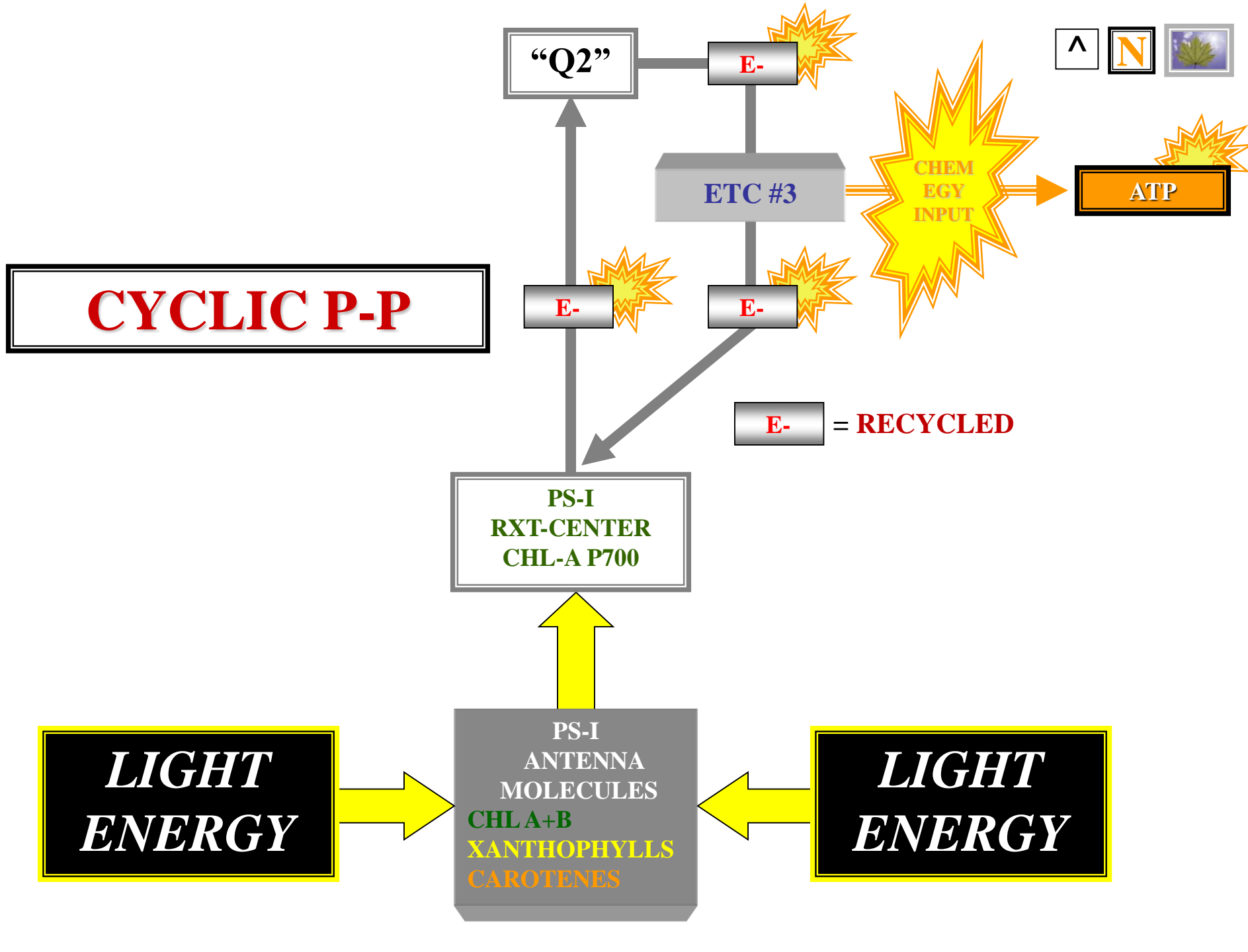
E- = RECYCLED

PS-I
RXT-CENTER
CHL-A P700

LIGHT
ENERGY

PS-I
ANTENNA
MOLECULES
CHL A+B
XANTHOPHYLLS
CAROTENES

LIGHT
ENERGY



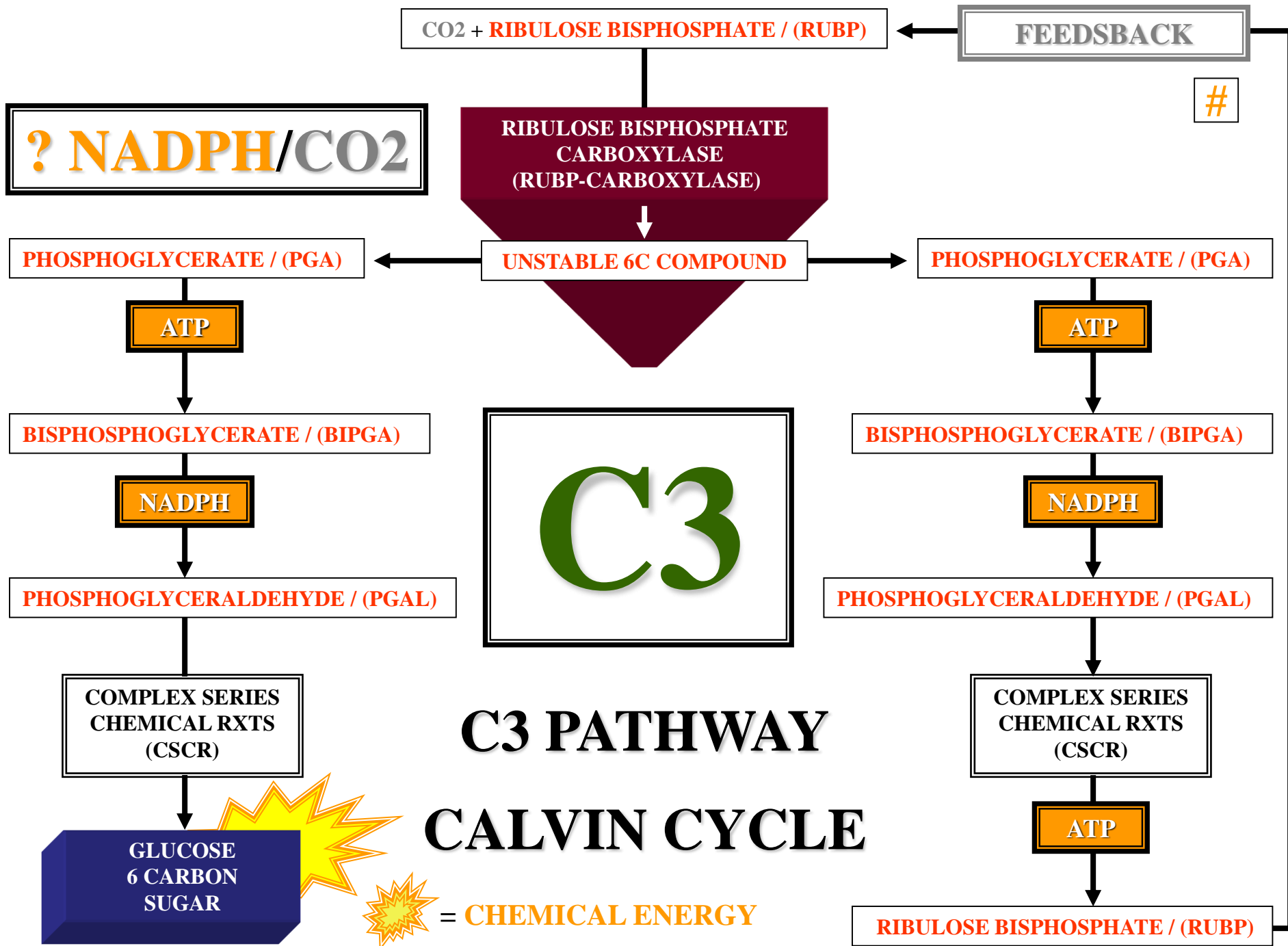


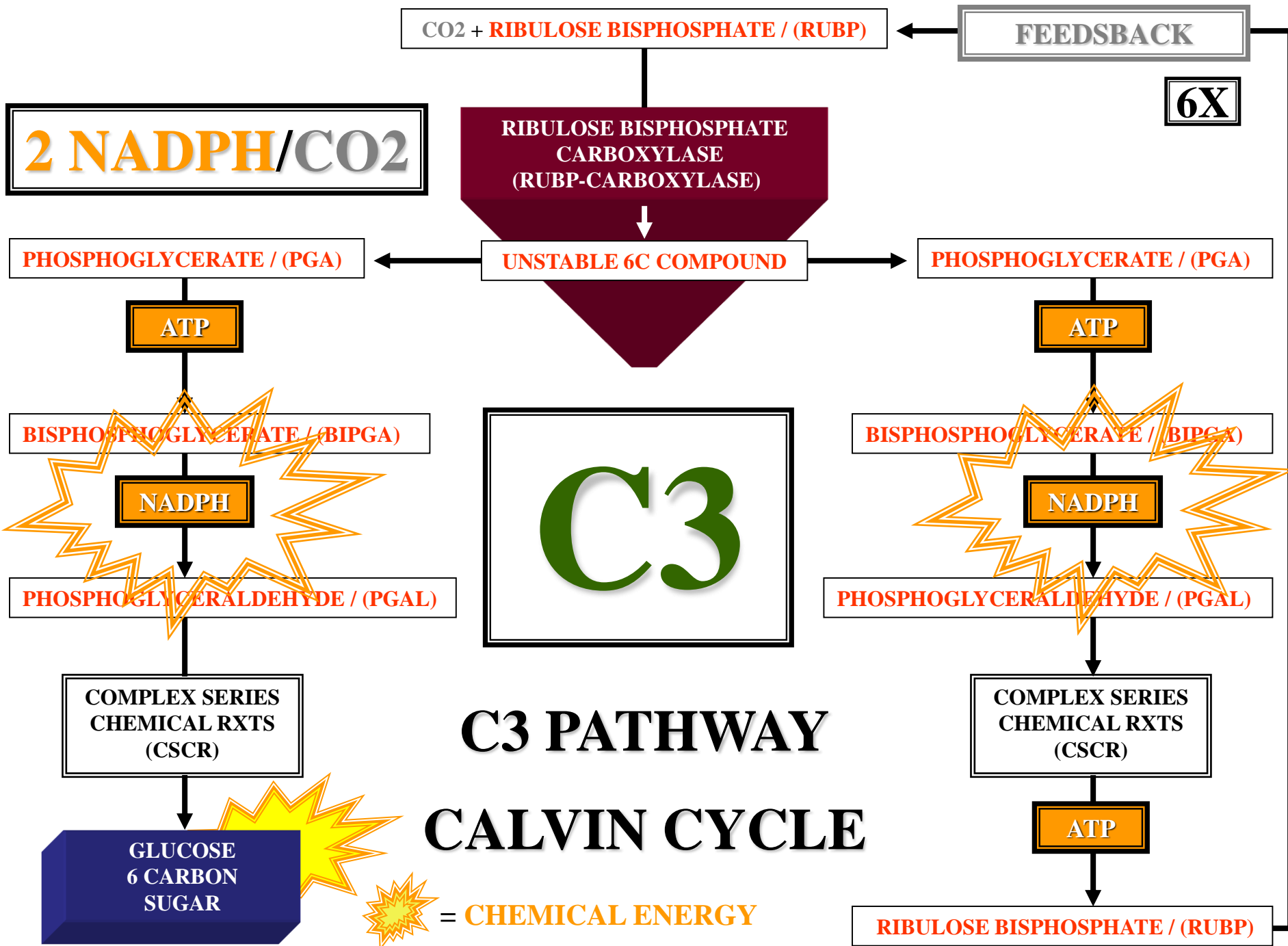
NADPH

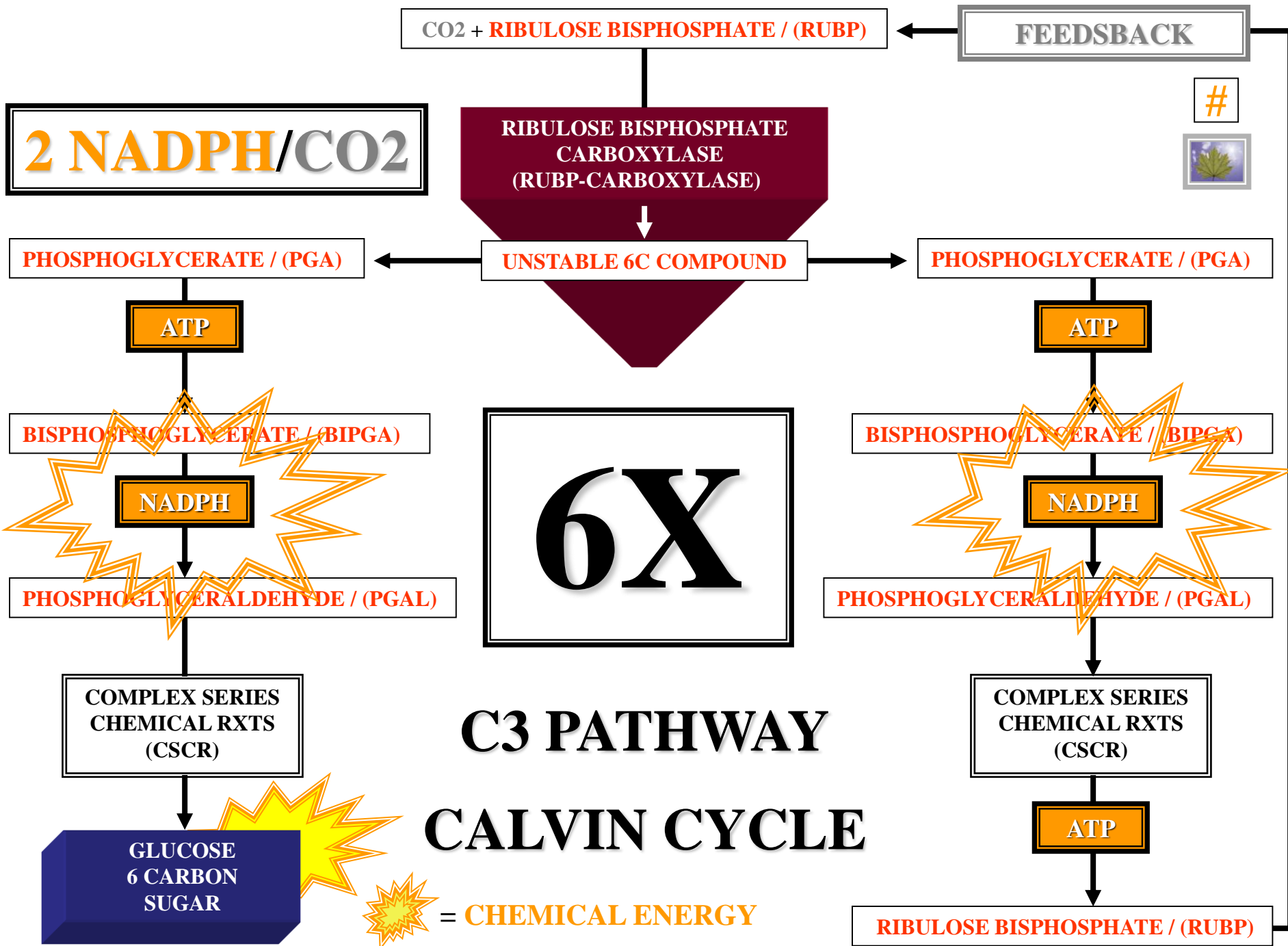
ENERGY EXPENSE

C3

MAPLE









NADPH

ENERGY EXPENSE

12 NADPH

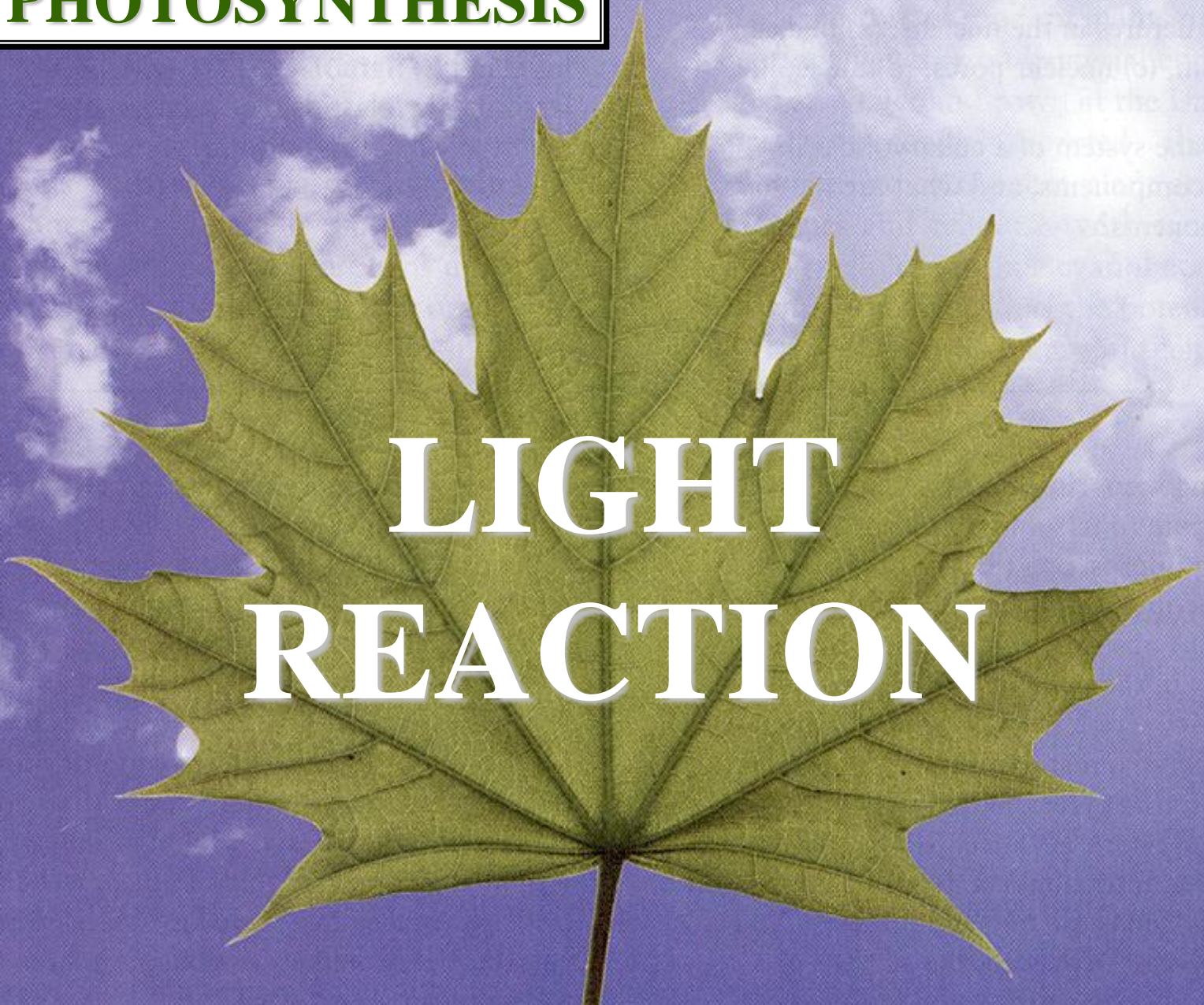
C3

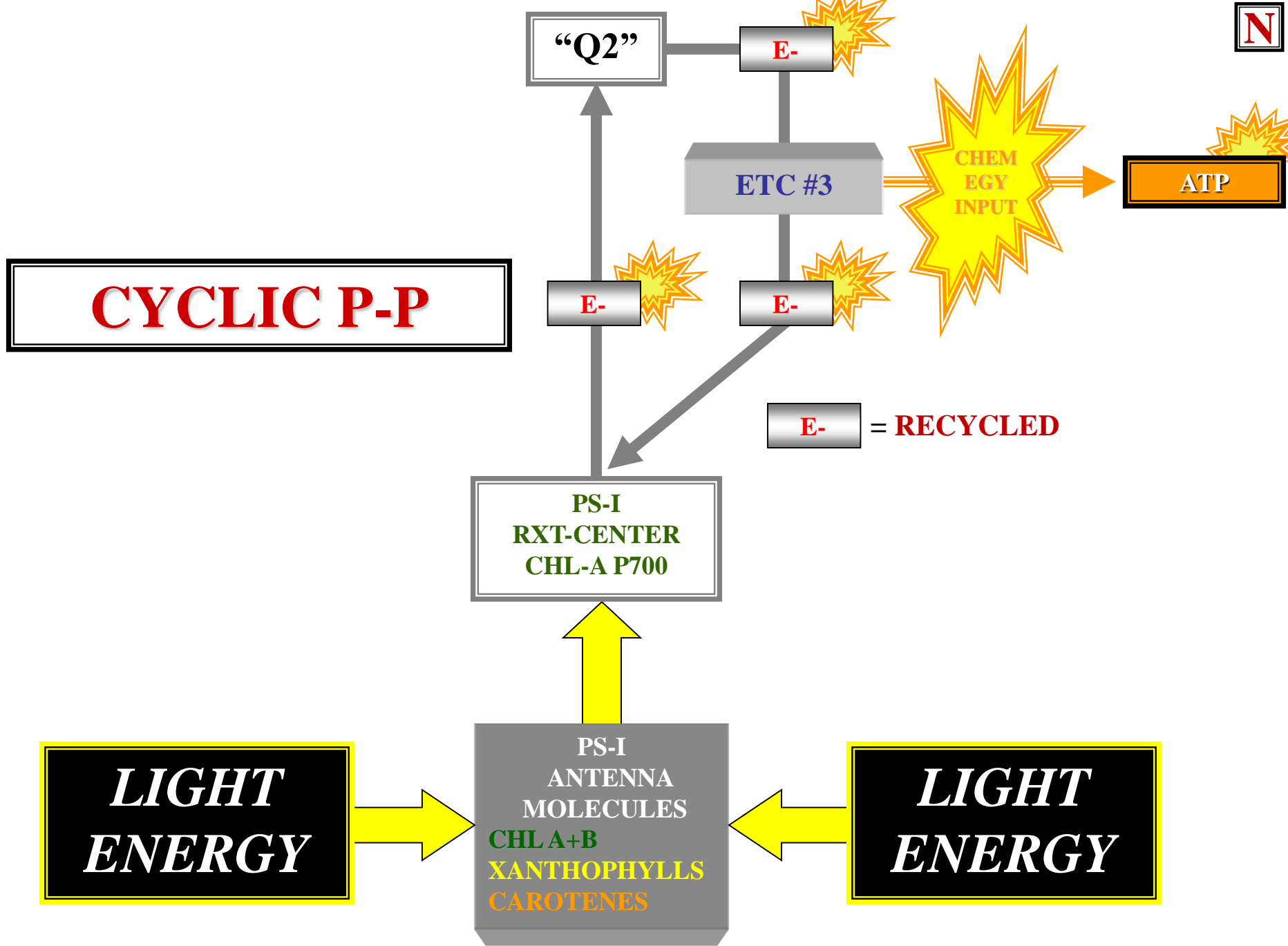
MAPLE

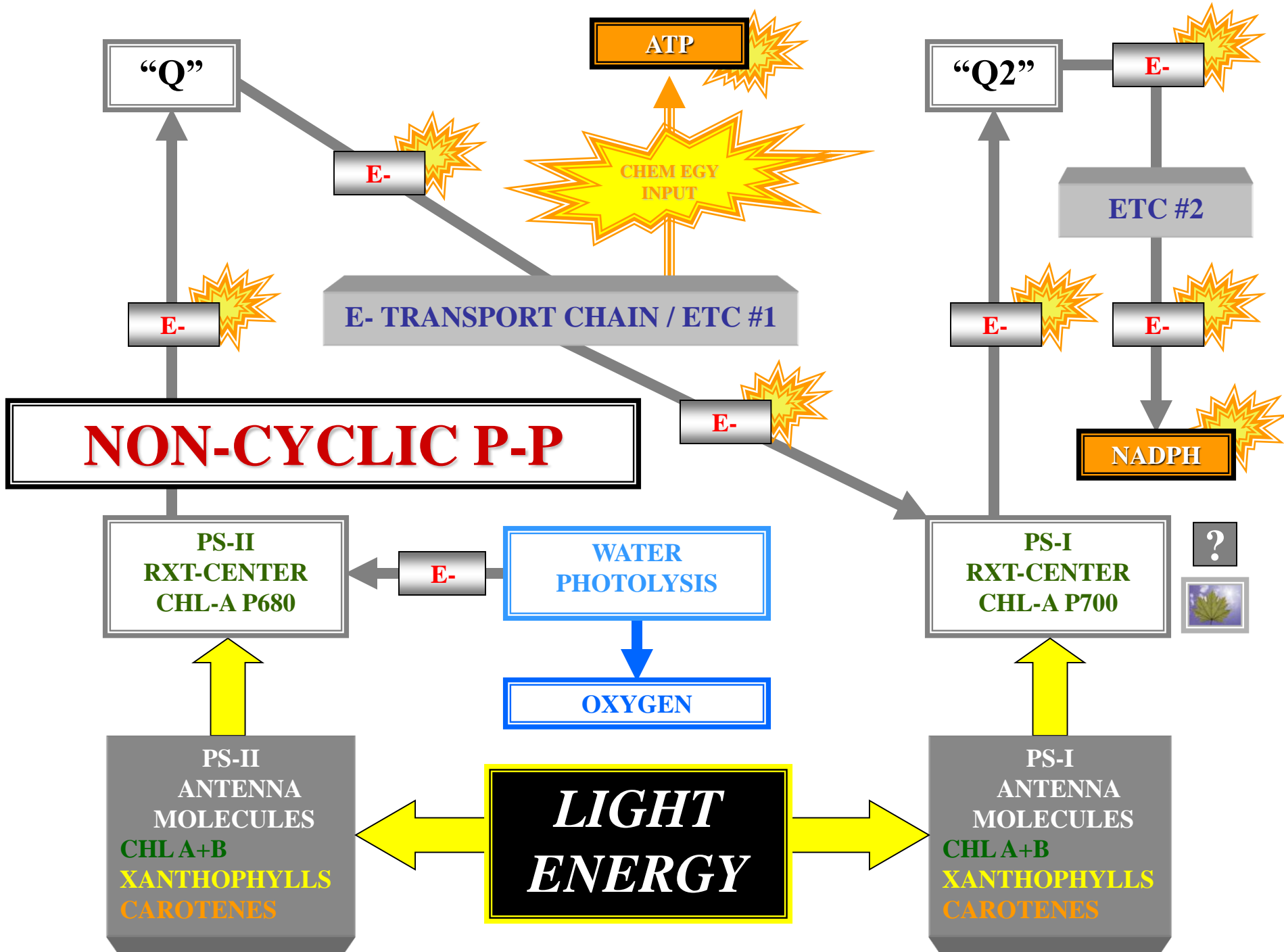
PHOTOSYNTHESIS

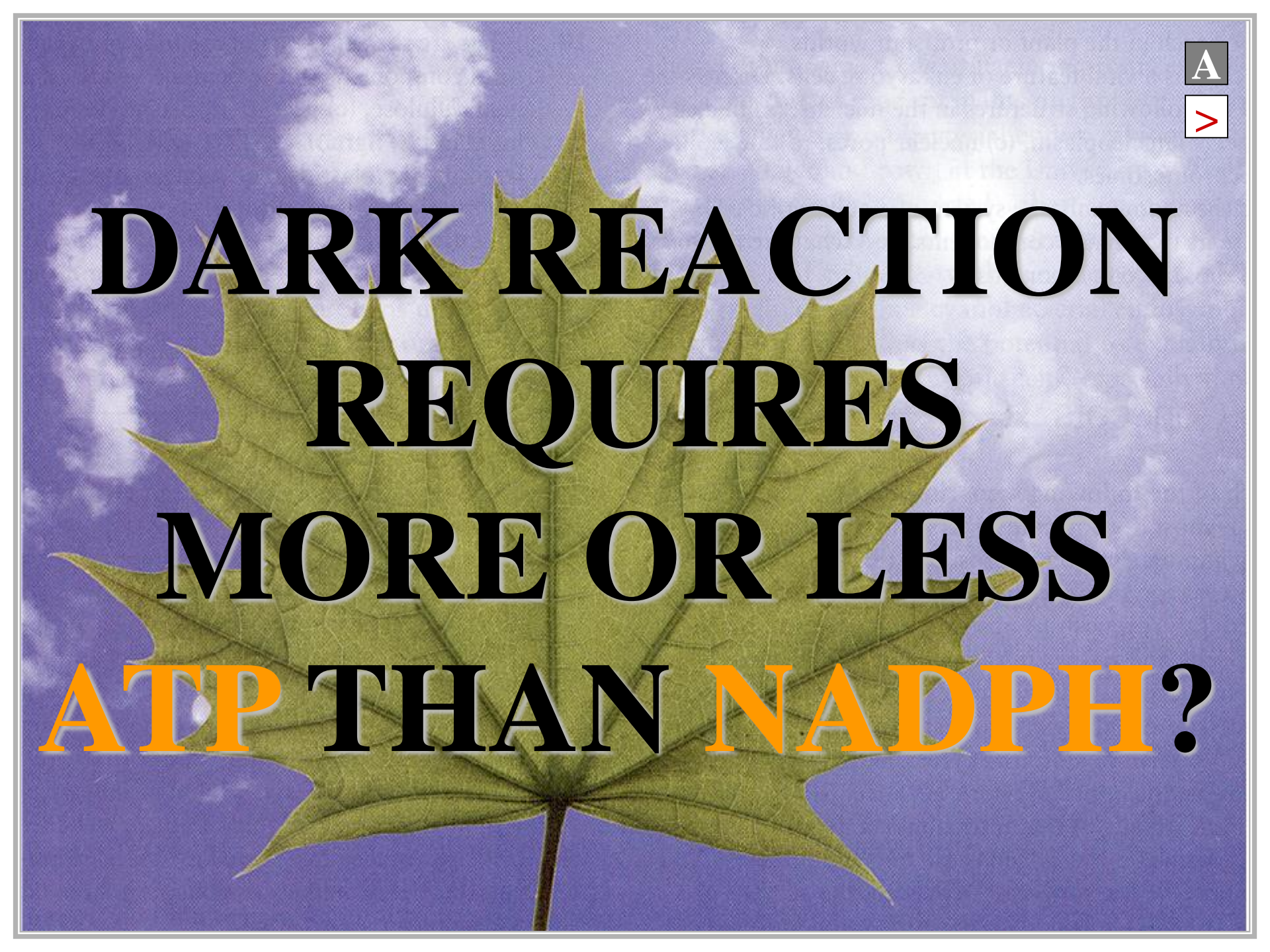


LIGHT REACTION

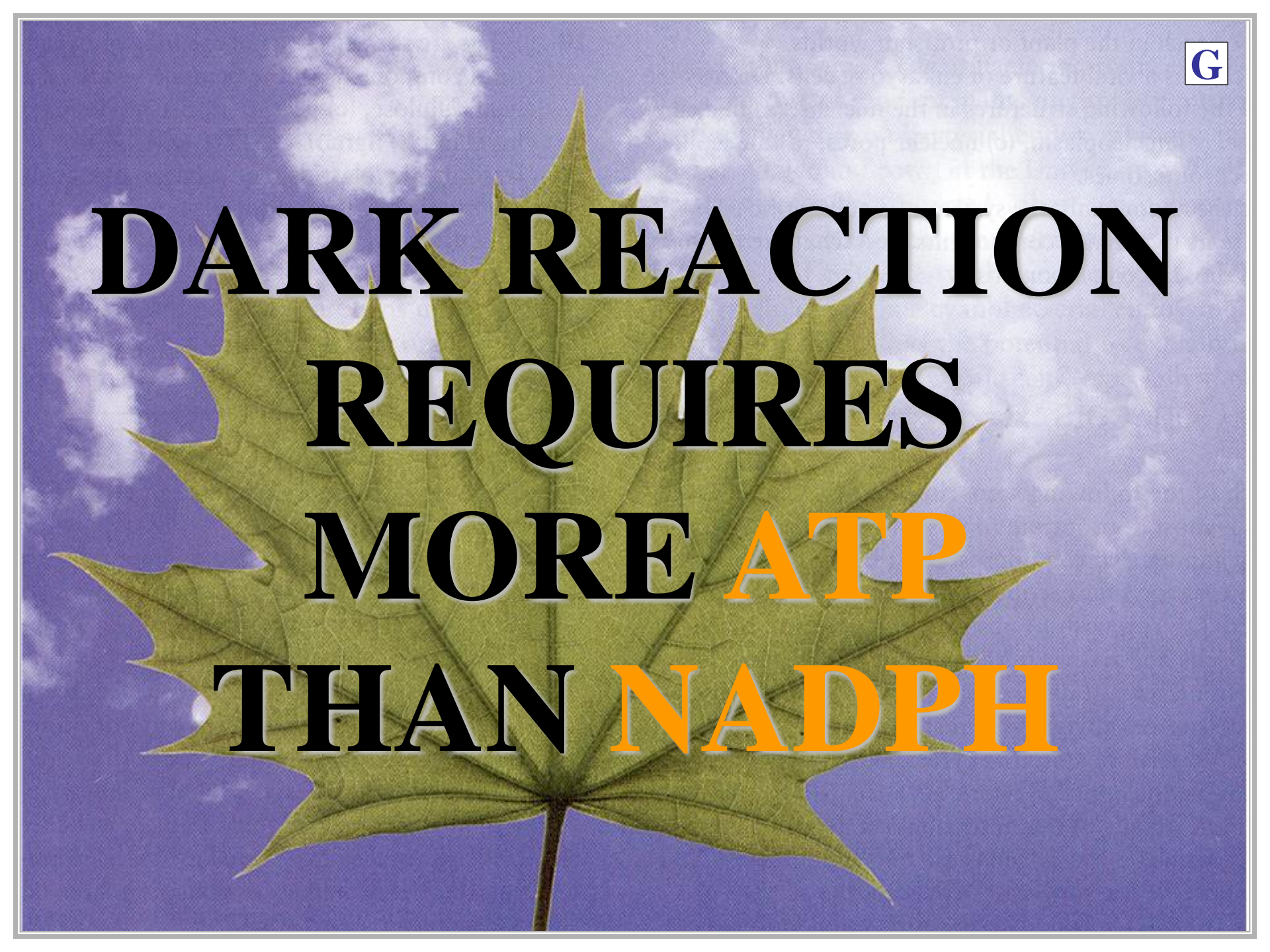








**DARK REACTION
REQUIRES
MORE OR LESS
ATP THAN NADPH?**



**DARK REACTION
REQUIRES
MORE ATP
THAN NADPH**



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

FEEDBACK

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



PHOSPHOGLYCERATE / (PGA)

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

ATP

ATP

BISPHOSEPHOGLYCERATE / (BIPGA)

BISPHOSEPHOGLYCERATE / (BIPGA)

NADPH

NADPH

PHOSPHOGLYCERALDEHYDE / (PGAL)

PHOSPHOGLYCERALDEHYDE / (PGAL)

**COMPLEX SERIES
CHEMICAL RXTS
(CSCR)**

**COMPLEX SERIES
CHEMICAL RXTS
(CSCR)**

GLUCOSE

**C₃ PATHWAY
CALVIN CYCLE**

ATP

RIBULOSE BISPHOSEPHATE / (RUBP)

= CHEMICAL ENERGY

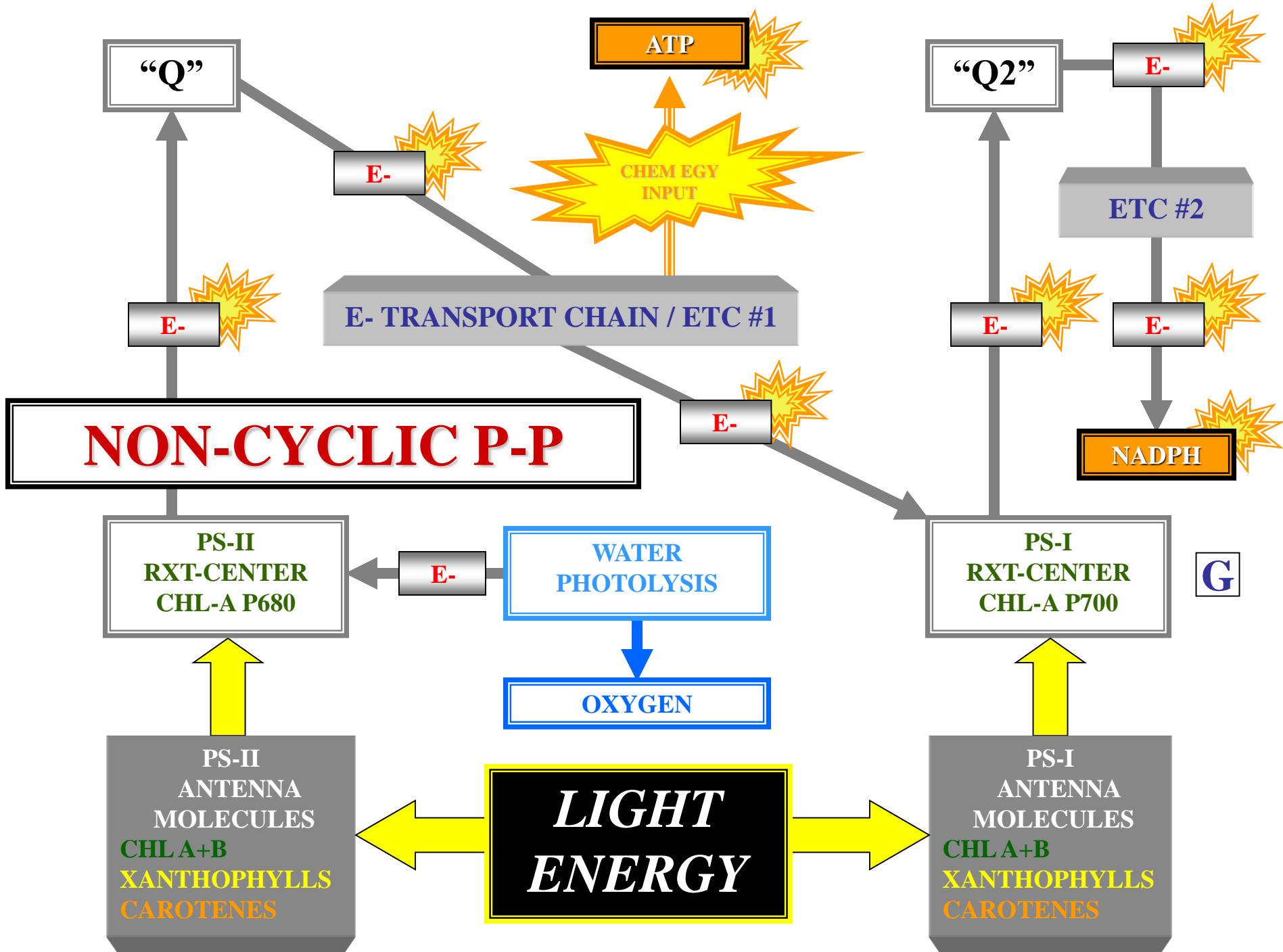




**WHAT DO PLANTS
PREFER
NON-CYCLIC P-P
OR
CYCLIC P-P?**



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





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

FEEDBACK

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



2

R



PHOSPHOGLYCERATE / (PGA)

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

ATP

ATP

BIPHOSPHOGLYCERATE / (BIPGA)

BIPHOSPHOGLYCERATE / (BIPGA)

NADPH

NADPH

PHOSPHOGLYCERALDEHYDE / (PGAL)

PHOSPHOGLYCERALDEHYDE / (PGAL)

C₃

**COMPLEX SERIES
CHEMICAL RXTS
(CSCR)**

**COMPLEX SERIES
CHEMICAL RXTS
(CSCR)**

GLUCOSE

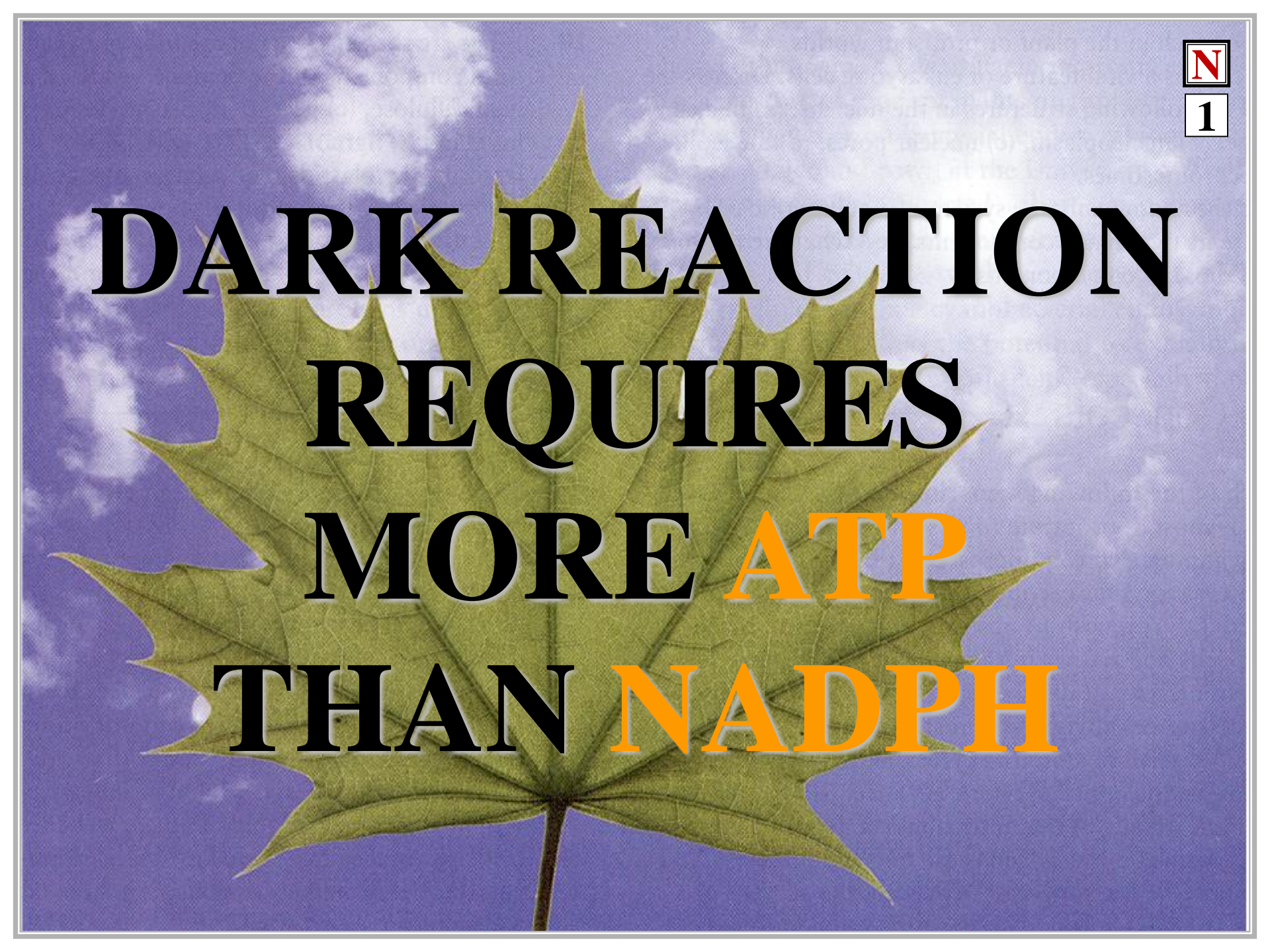
C₃ PATHWAY CALVIN CYCLE

ATP

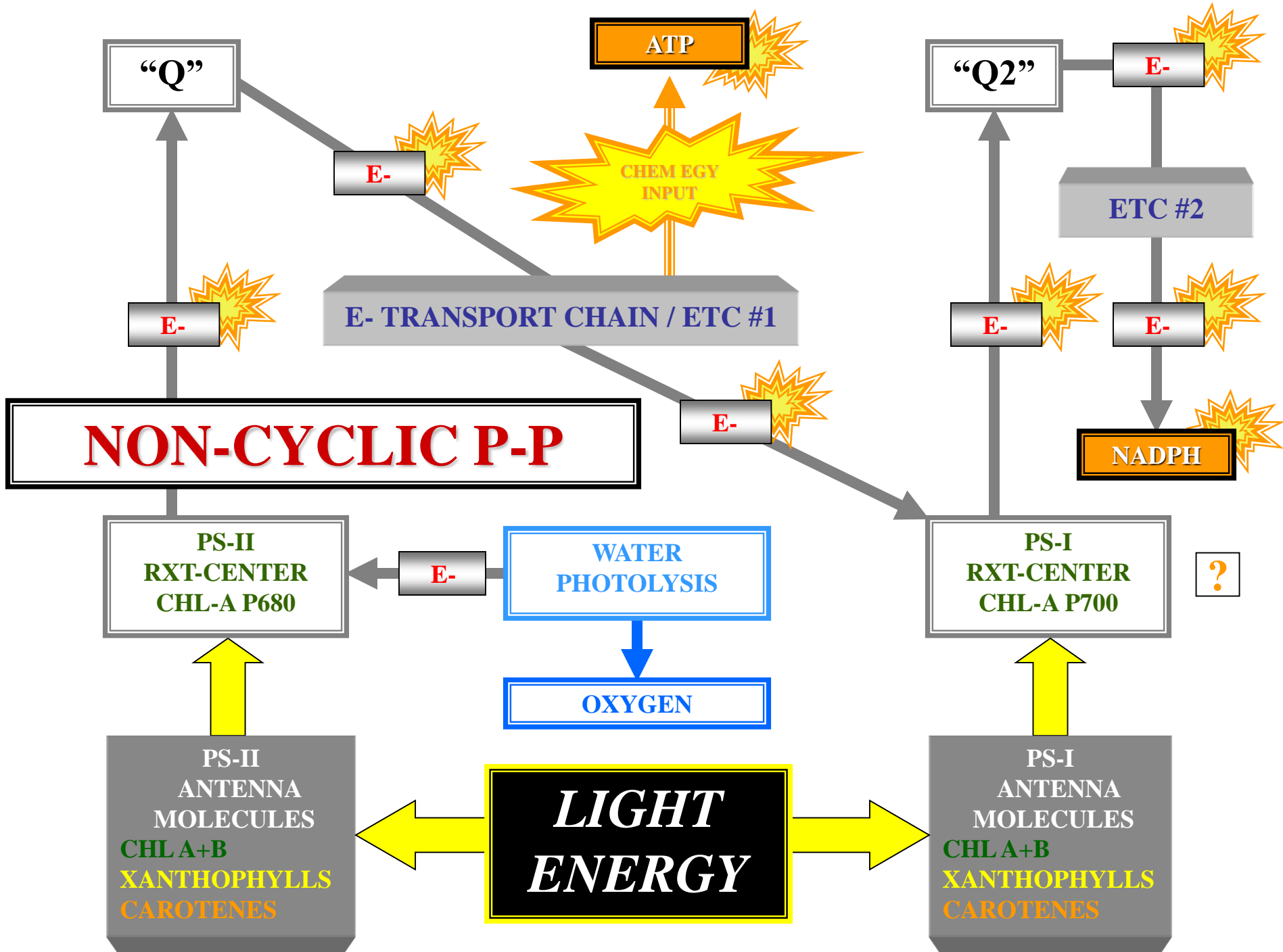
RIBULOSE BIPHOSPHATE / (RUBP)

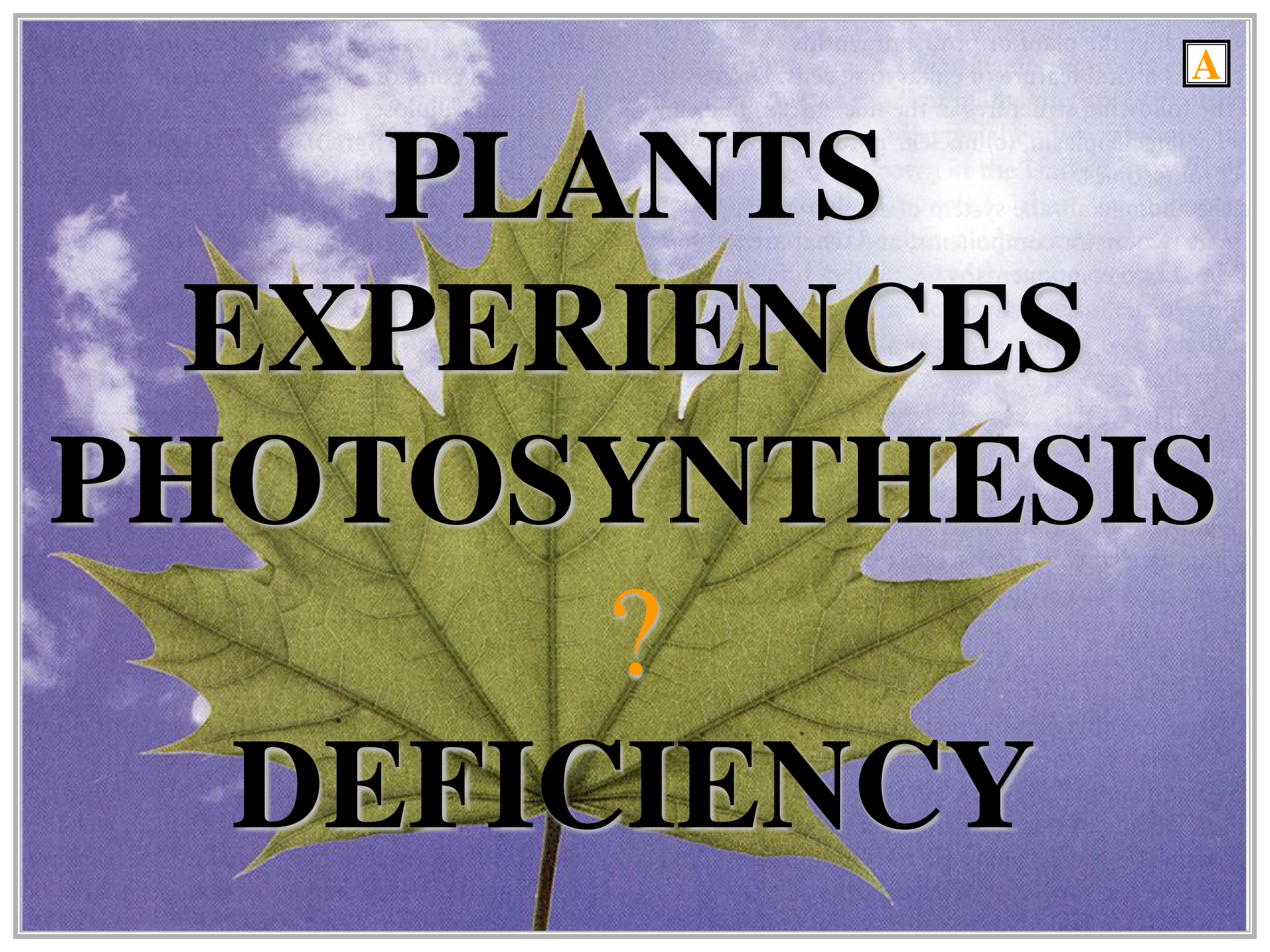
= CHEMICAL ENERGY



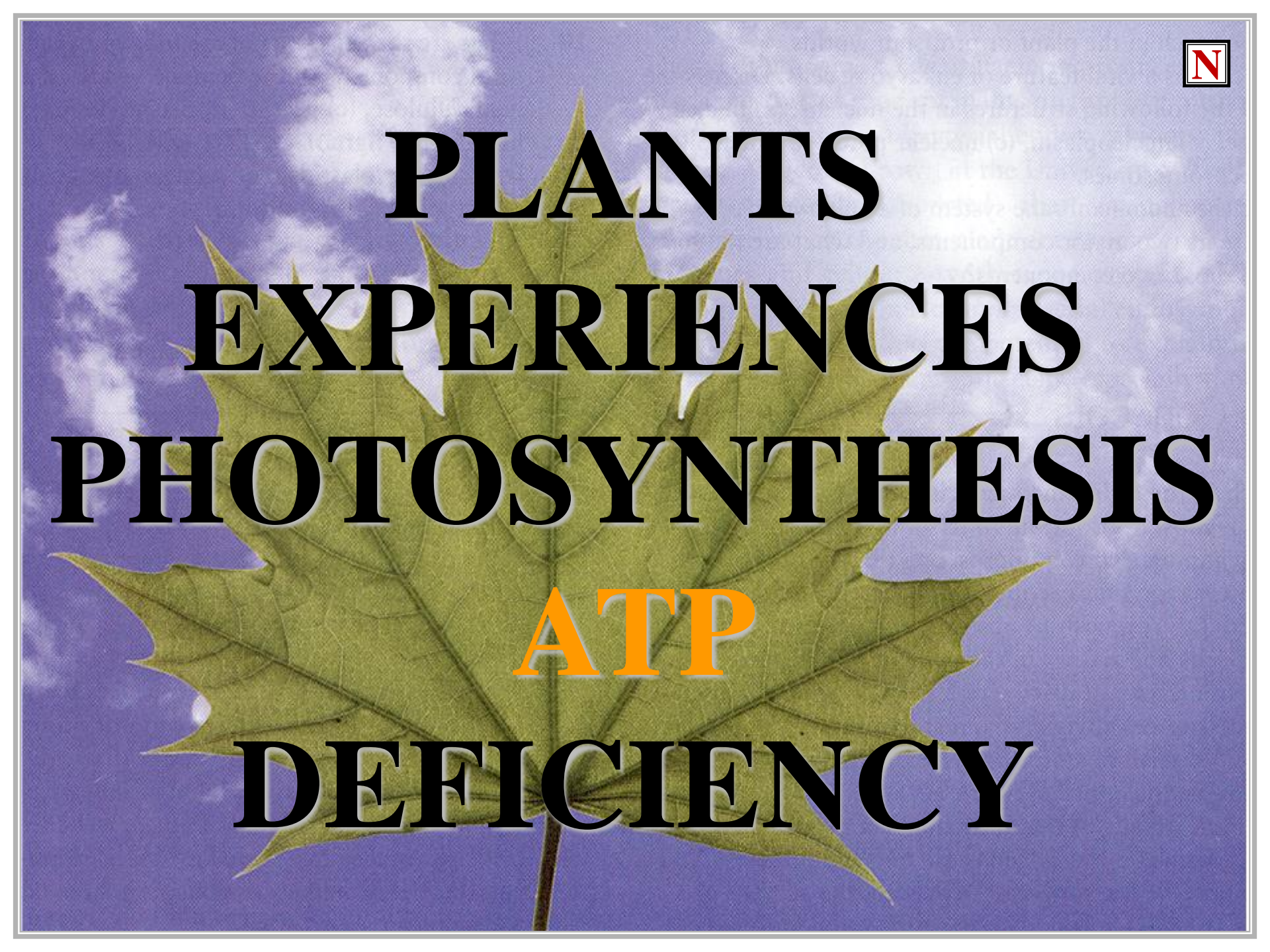


**DARK REACTION
REQUIRES
MORE ATP
THAN NADPH**

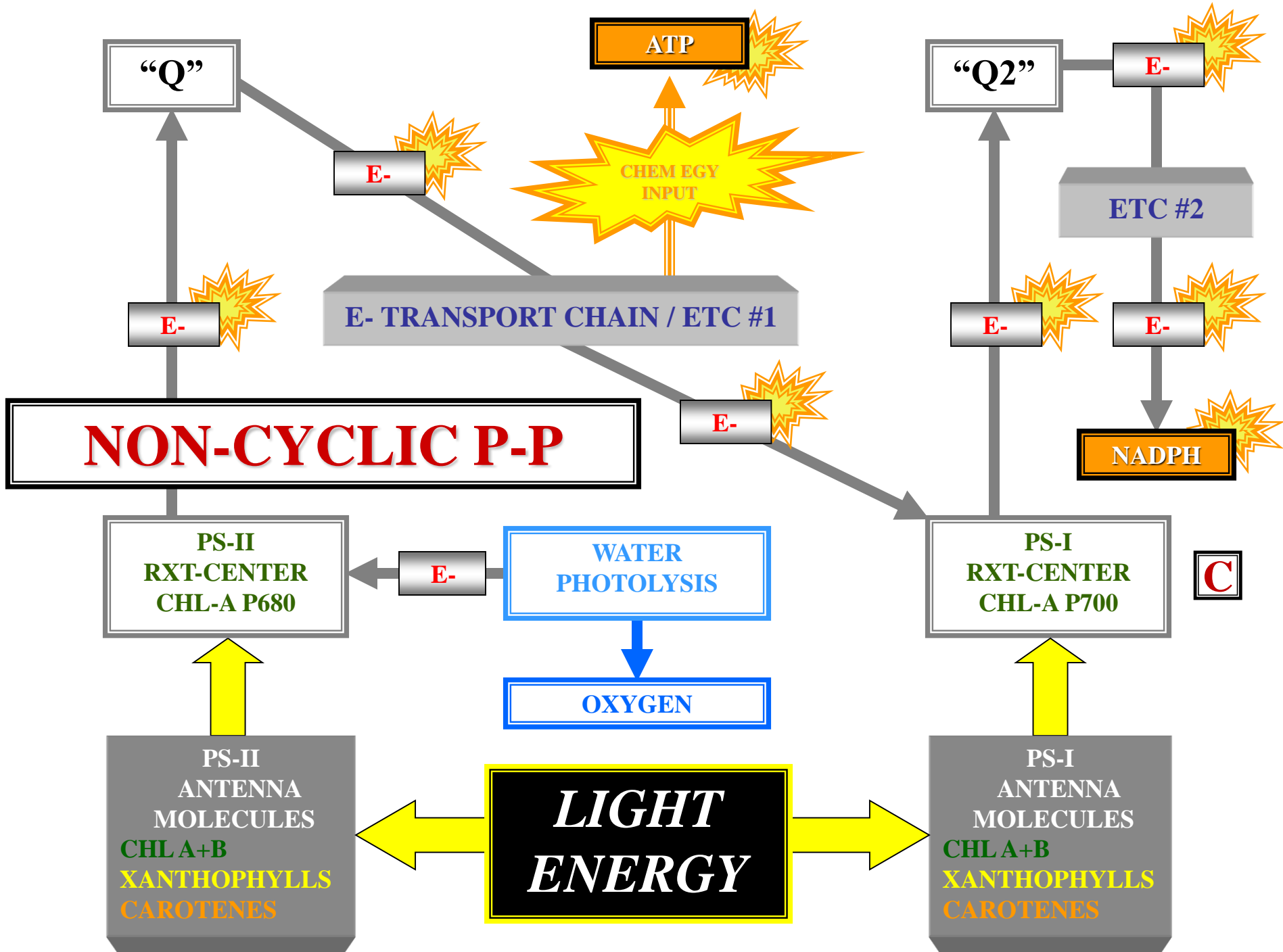


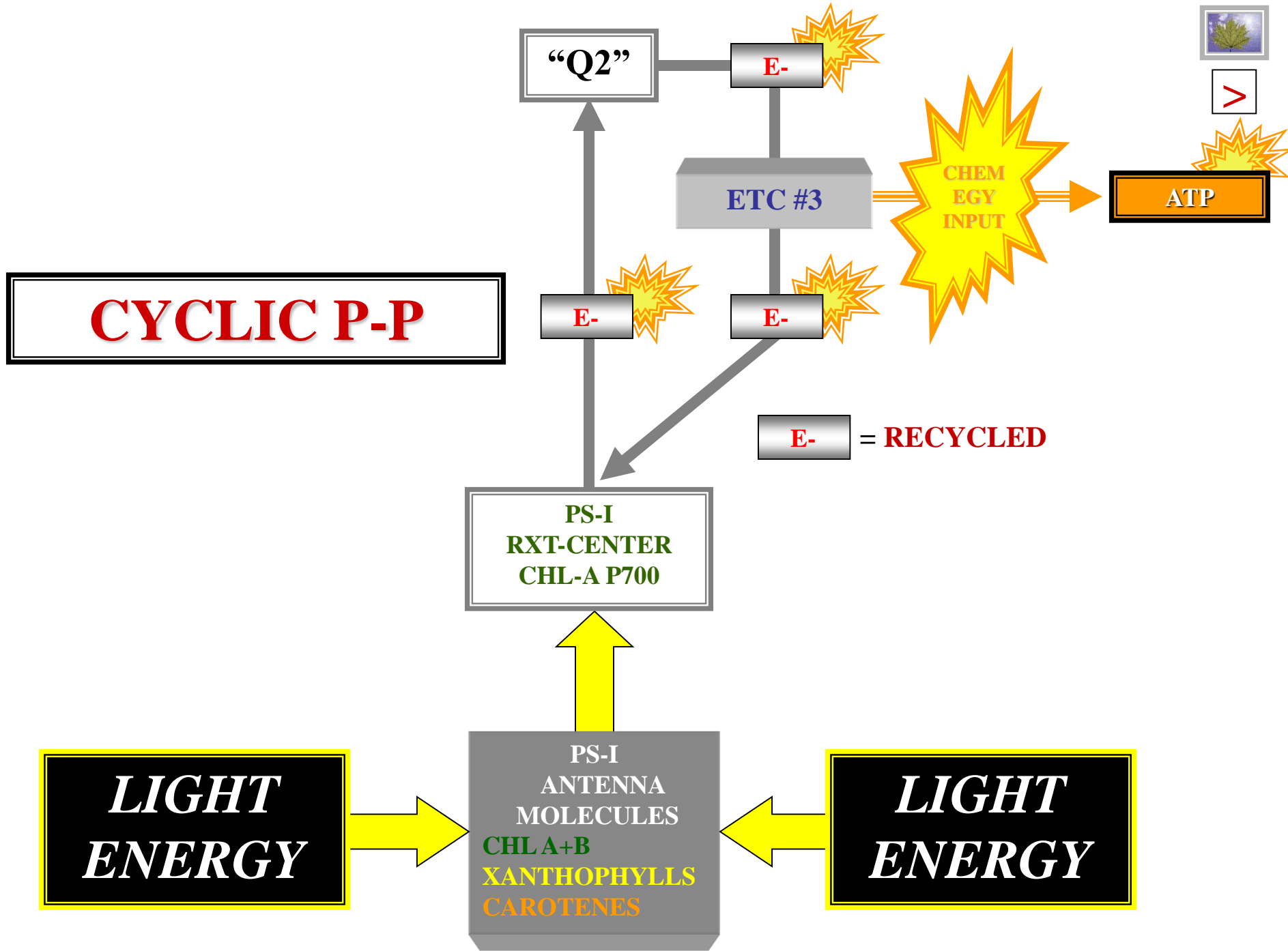


PLANTS
EXPERIENCES
PHOTOSYNTHESIS
?
DEFICIENCY



PLANTS
EXPERIENCES
PHOTOSYNTHESIS
ATP
DEFICIENCY







PLANTS RELY

CYCLIC P-P

ELIMINATE

ATP

DEFICIENCY

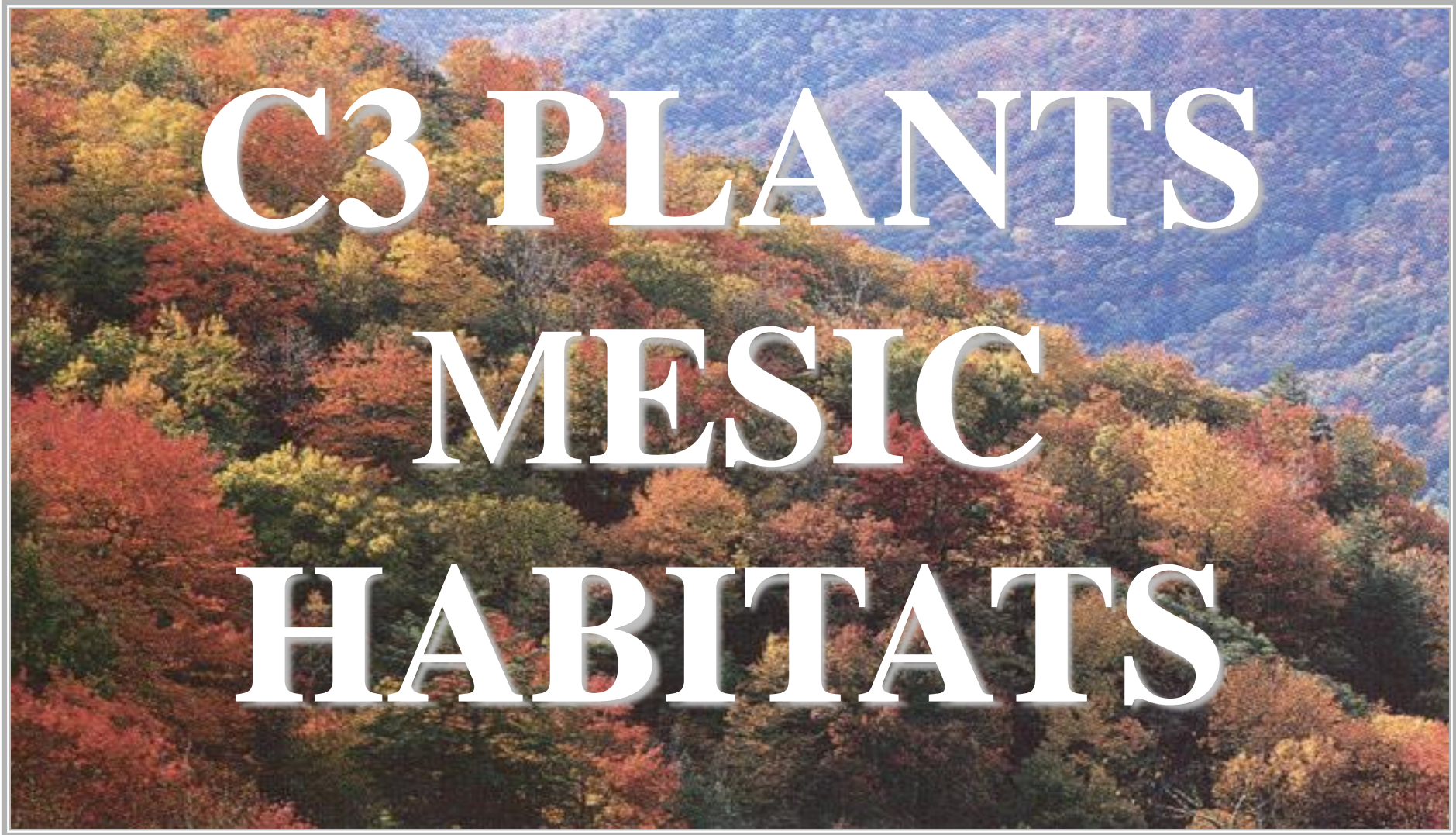


C3

PATHWAY

ECOLOGY

C3 ECOLOGY

A large photograph of a forest with vibrant autumn foliage in shades of red, orange, yellow, and green, covering rolling hills. The text is overlaid on this image.

C3 PLANTS MESIC HABITATS

MESIC HABITATS

C3 ECOLOGY

EG



ADEQUATE
WATER

MESIC HABITATS

C3 ECOLOGY

?

EZ



ALABAMA FORESTS

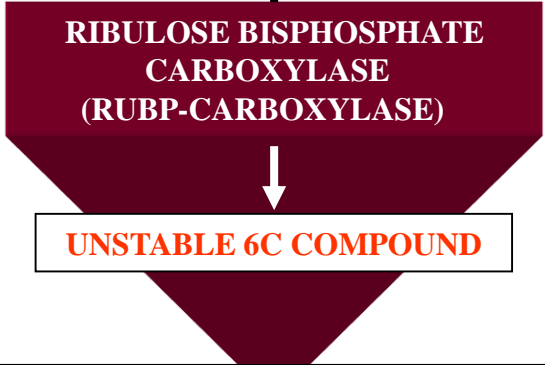
MESIC HABITATS

C3

CO₂
ENTERS
STROMA



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



I

UNSTABLE 6C COMPOUND

?

ENZYME

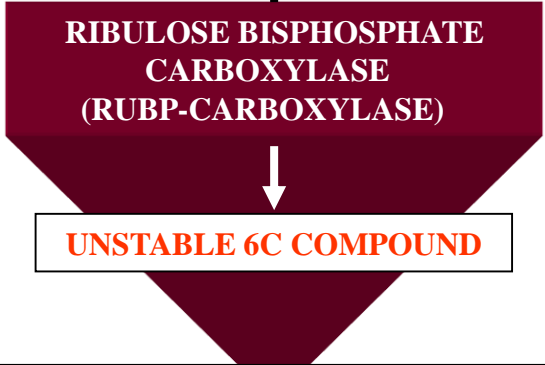
C3 CO₂ FIXATION ENZYME

C3

CO₂
ENTERS
STROMA



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



**INEFFICIENT
ENZYME**

C3 CO₂ FIXATION ENZYME



ATMOSPHERE

LEAF STOMATE

ATMOSPHERE

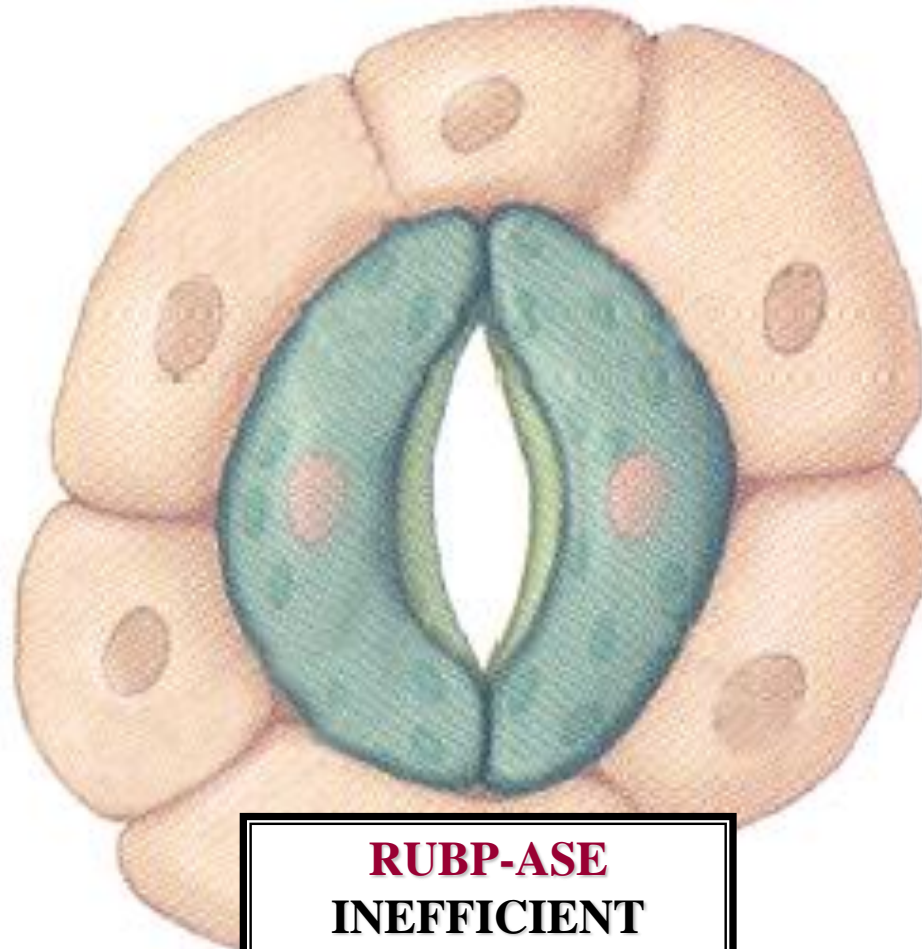
CO₂

CO₂



CO₂

CO₂



RUBP-ASE
INEFFICIENT
ENZYME



LEAF STOMATE

ATMOSPHERE

ATMOSPHERE

CO₂

CO₂

DIFFUSION

DIFFUSION

H₂O

H₂O

DIFFUSION

DIFFUSION

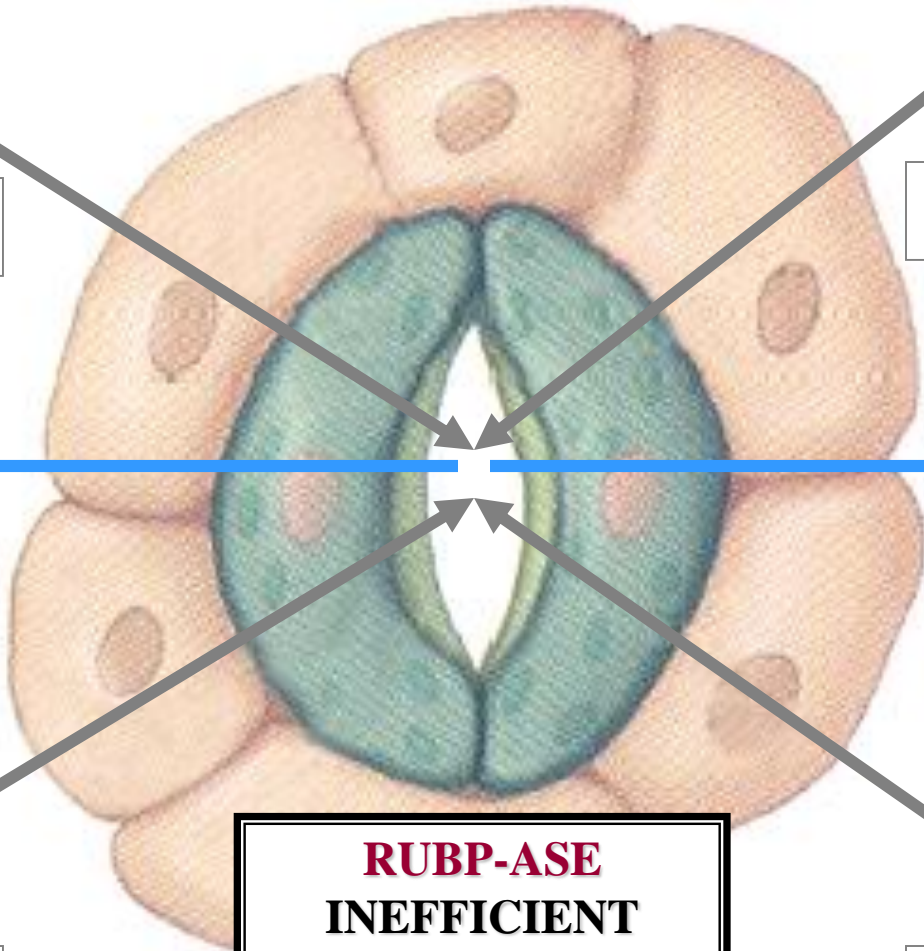
CO₂

CO₂

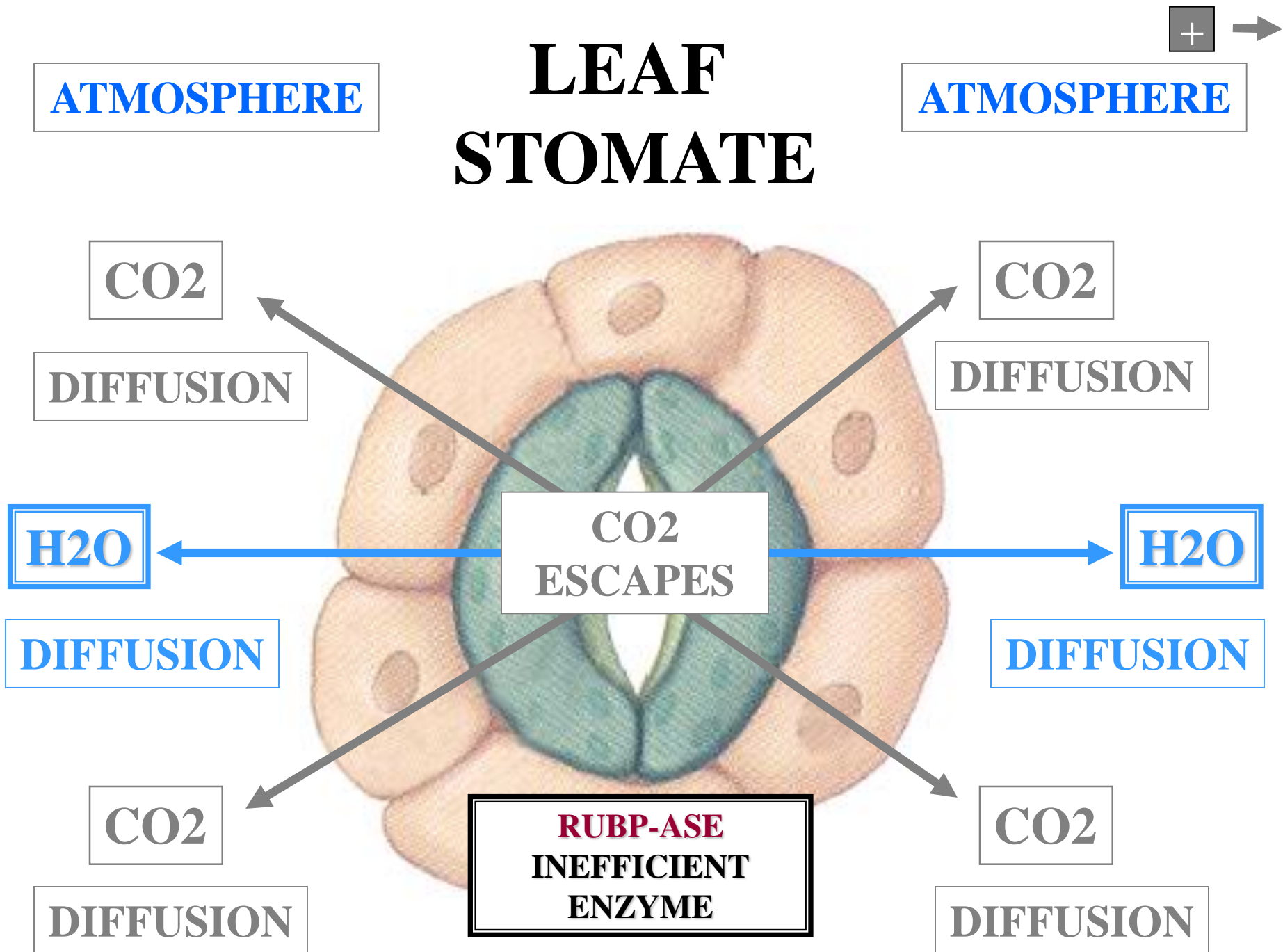
DIFFUSION

DIFFUSION

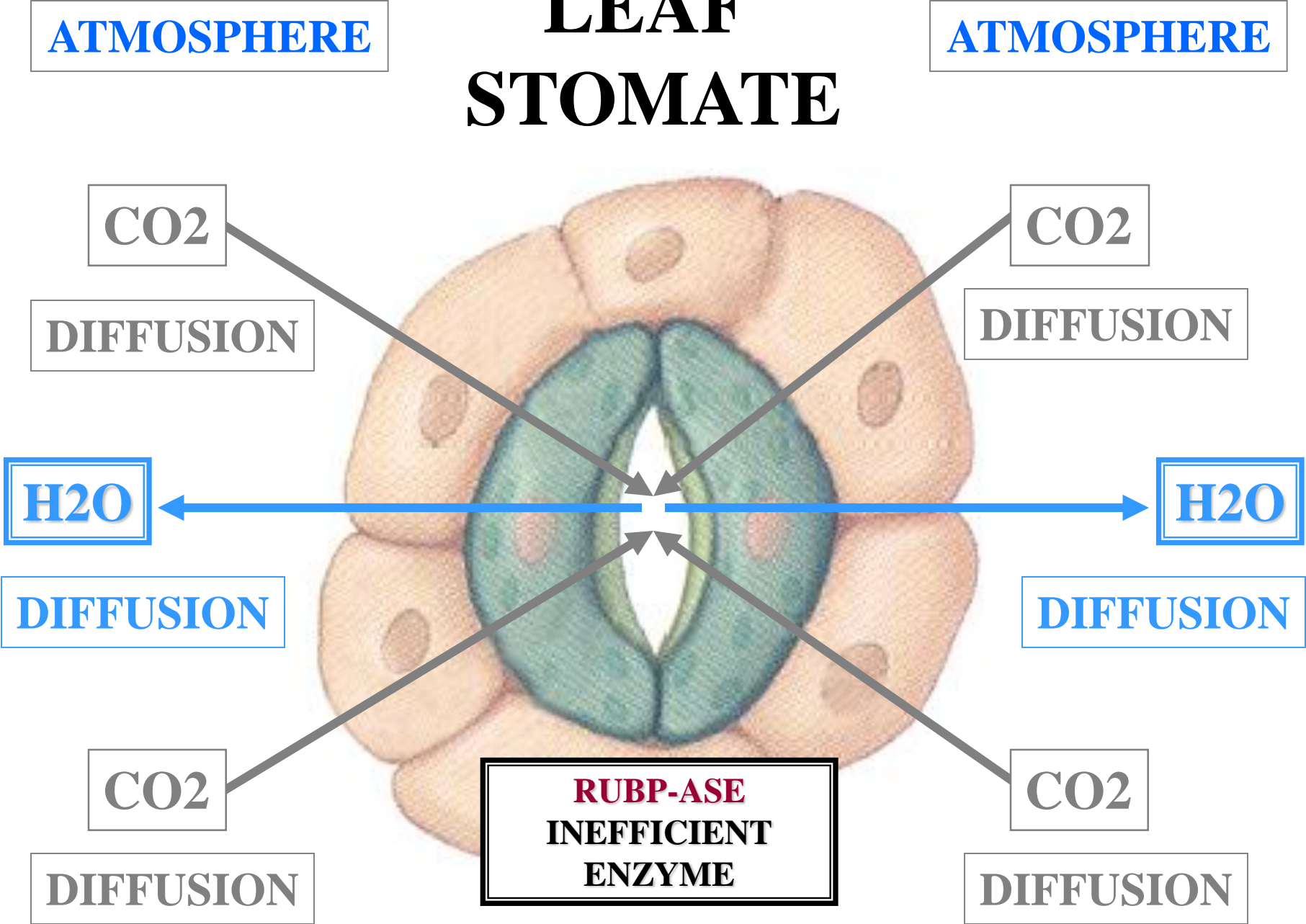
RUBP-ASE
INEFFICIENT
ENZYME



LEAF STOMATE



LEAF STOMATE



ATMOSPHERE

ATMOSPHERE

LEAF STOMATE

CO₂

CO₂

OPEN LONG PERIODS

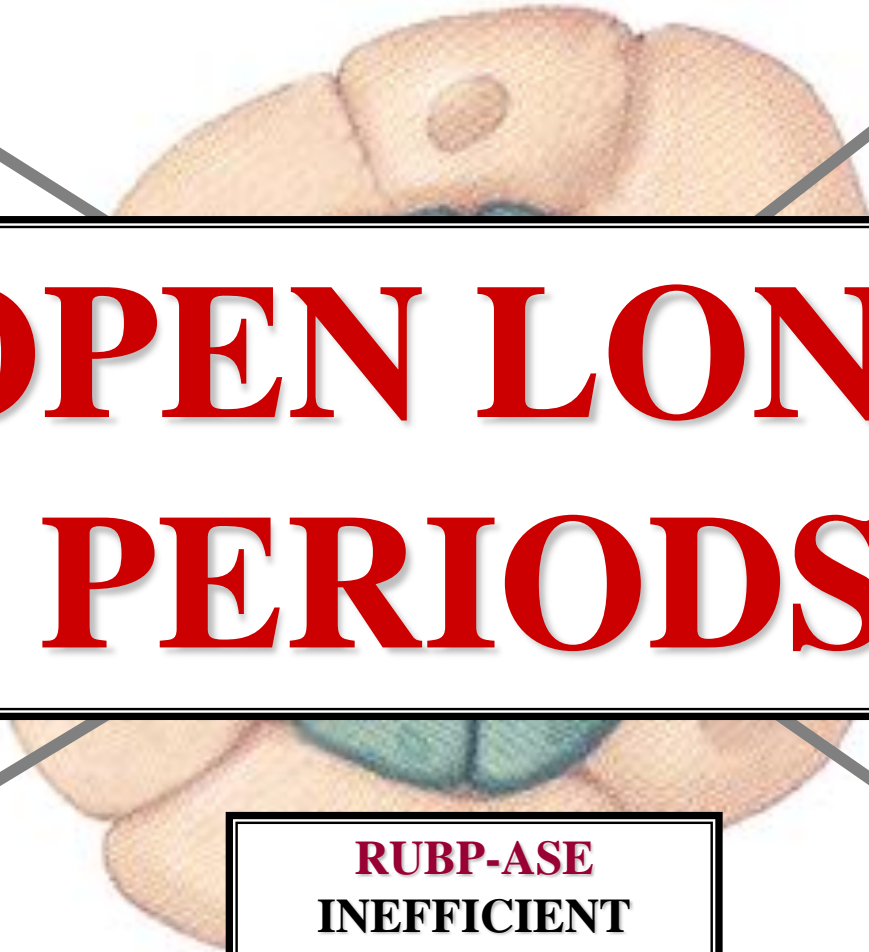
C₃

C₃

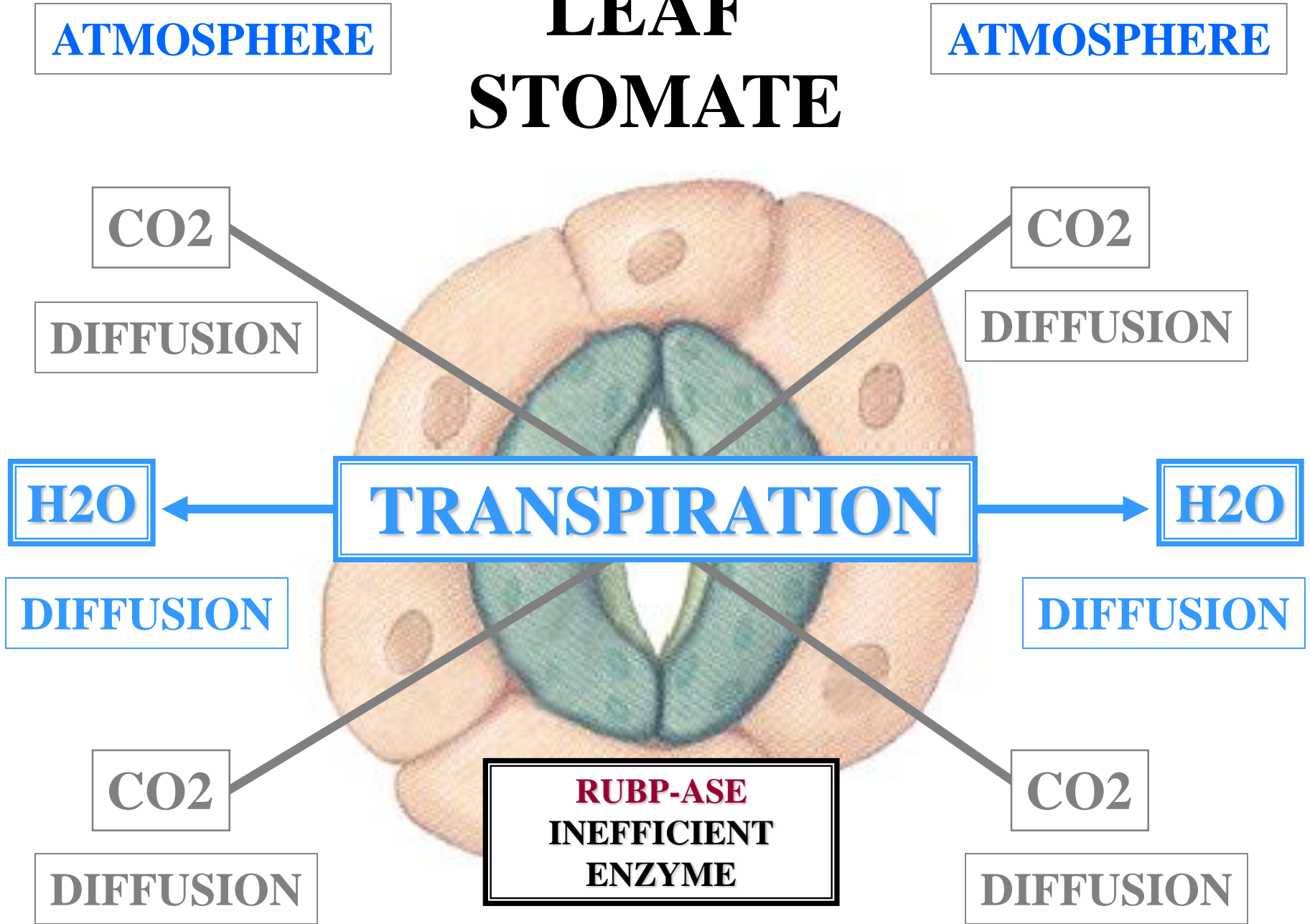
CO₂

CO₂

**RUBP-ASE
INEFFICIENT
ENZYME**



LEAF STOMATE



ATMOSPHERE

LEAF STOMATE

ATMOSPHERE

CO₂

CO₂

C₃

HIGH

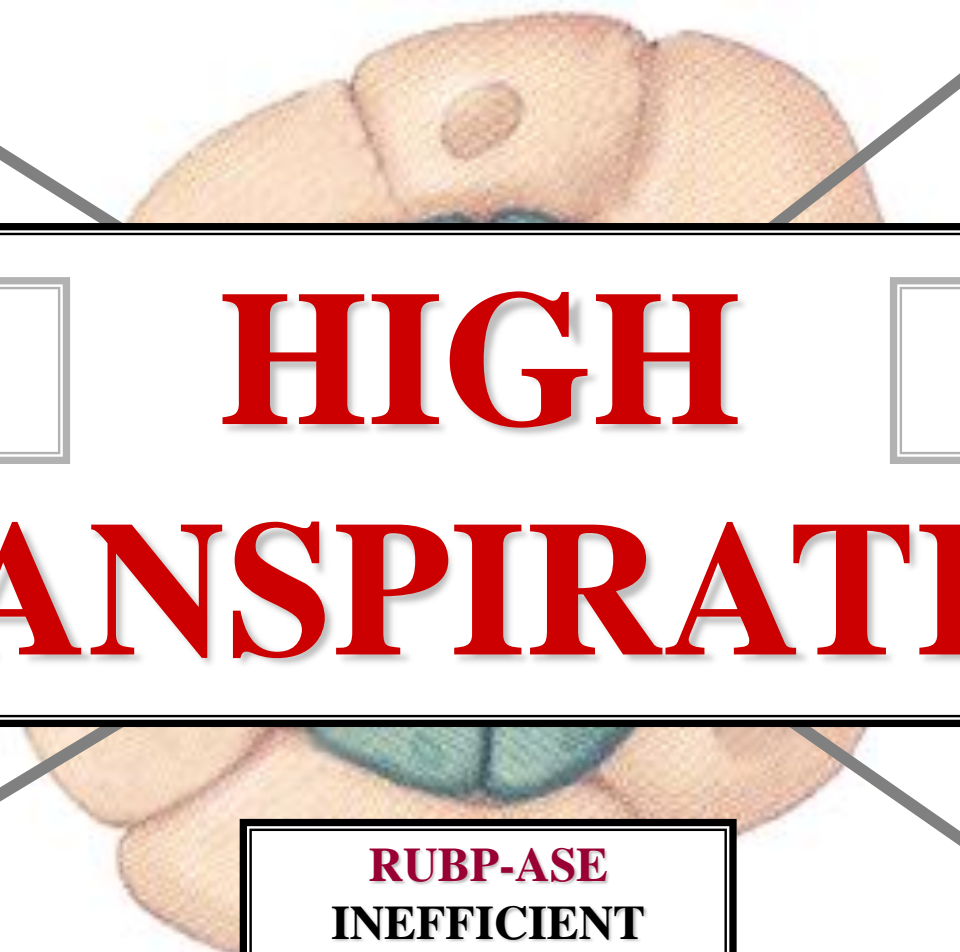
C₃

TRANSPIRATION

CO₂

CO₂

RUBP-ASE
INEFFICIENT
ENZYME



C3 ECOLOGY

MH



ADEQUATE
WATER

MESIC HABITATS

C3 ECOLOGY



MESIC HABITATS

MESIC HABITATS

C3 ECOLOGY



ALABAMA FORESTS

MESIC HABITATS



DARK REACTION

**HATCH & SLACK
CYCLE**



HATCH & SLACK CYCLE

SYNONYMOUS

C4 PATHWAY

HATCH & SLACK AUSTRALIAN PLANT PHYSIOLOGISTS

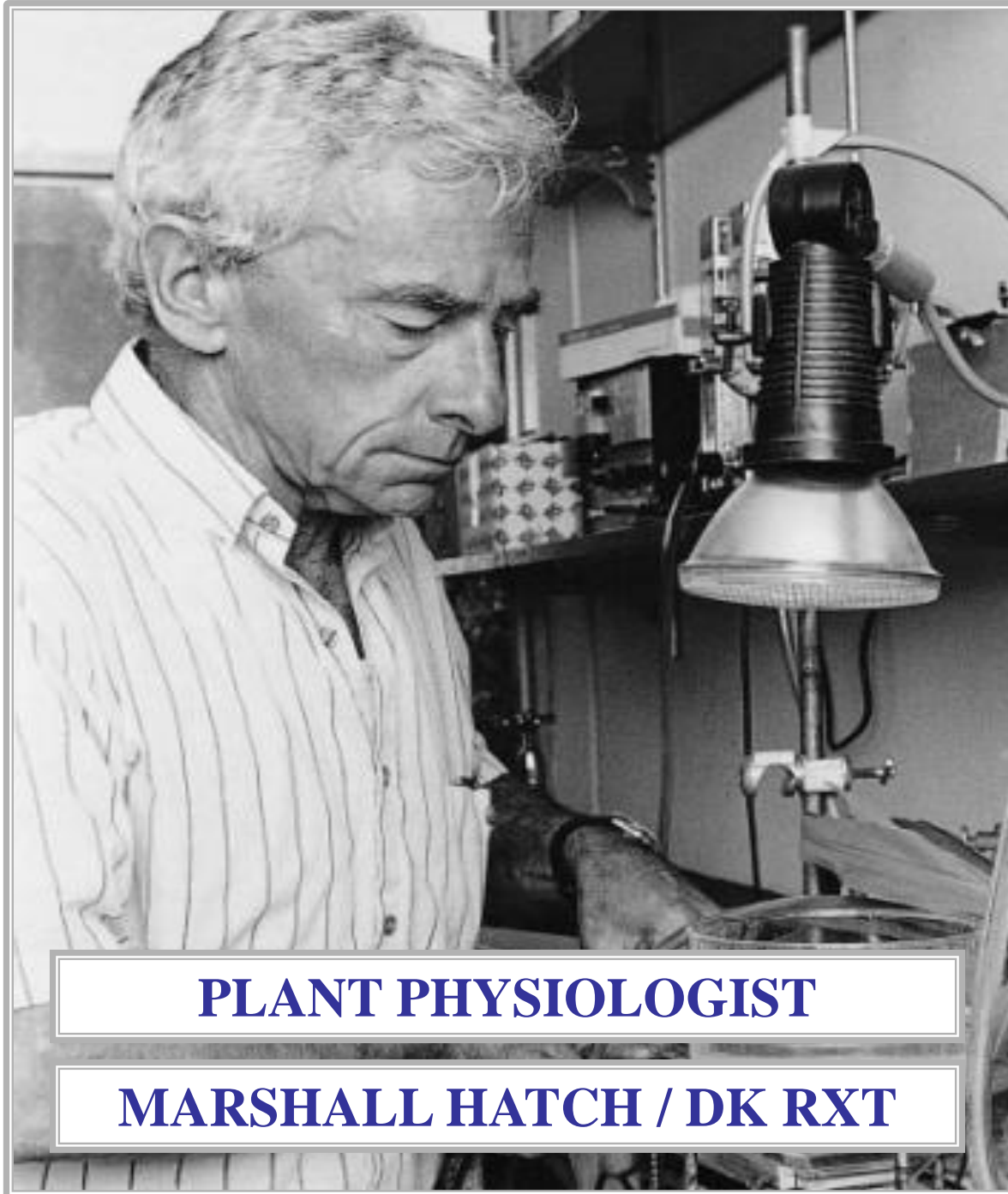
EL

AUSTRALIA

A map of the Pacific region, centered on Australia. The landmasses are colored in a light olive green, while the surrounding water is light blue. Labels for various regions and islands are placed in black text. A white box with a black border is superimposed over the continent of Australia, containing the word 'AUSTRALIA' in black, all-caps, serif font. In the top right corner of the map area, there is a smaller white box with a black border containing the letters 'EL' in black, all-caps, serif font. The labels include 'Asia' (top left), 'Northern Marianas' (top center), 'Philippines' (middle left), 'Micronesia' (middle center), 'Indonesia' (bottom left), 'Papua New Guinea' (center), 'Solomon Islands' (center right), 'Vanuatu' (right), 'Fiji Islands' (bottom right), 'New Caledonia' (center right), and 'New Zealand' (bottom right).

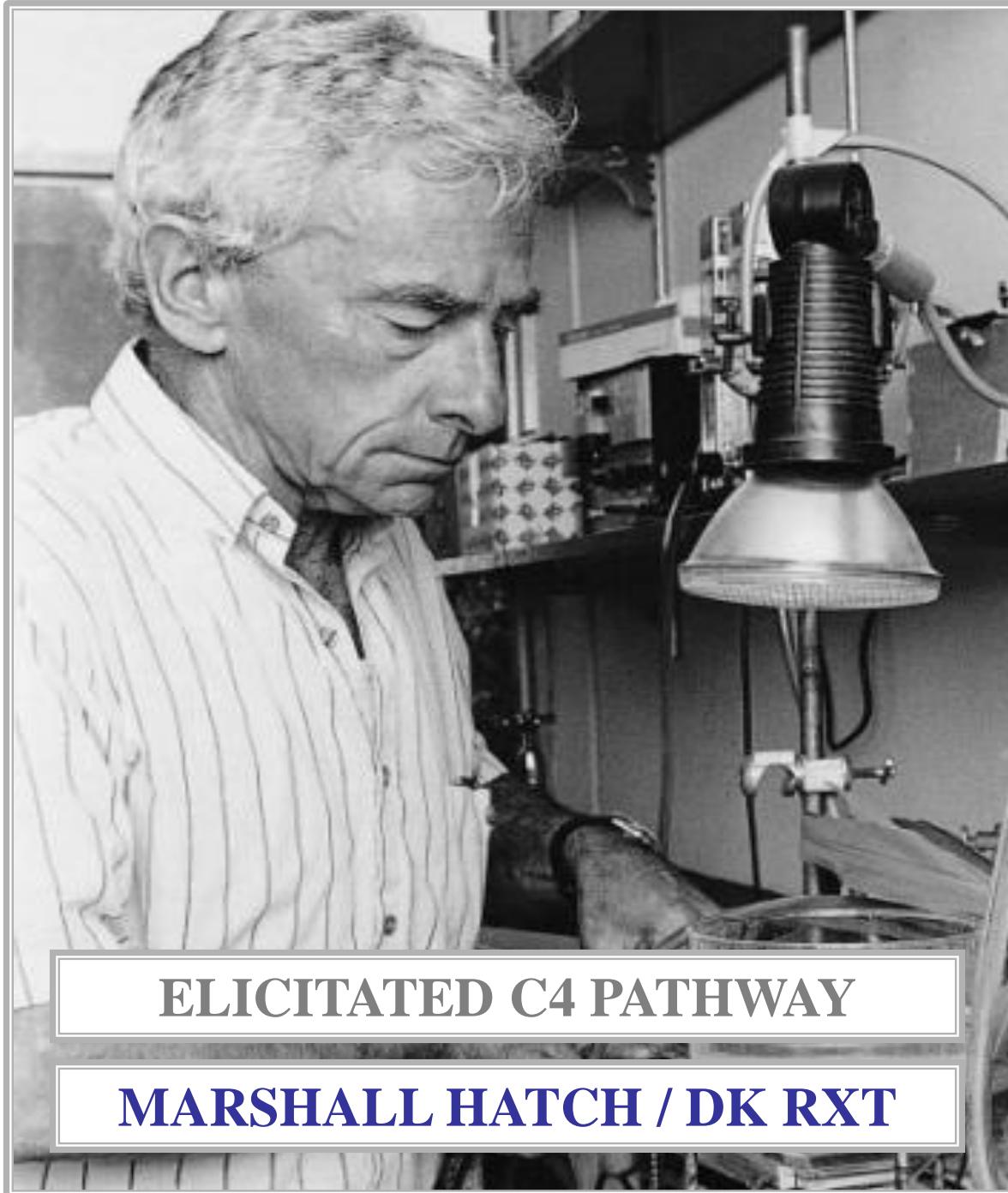
HATCH & SLACK ELICITATED C4 PATHWAY





PLANT PHYSIOLOGIST

MARSHALL HATCH / DK RXT



ELICITED C4 PATHWAY

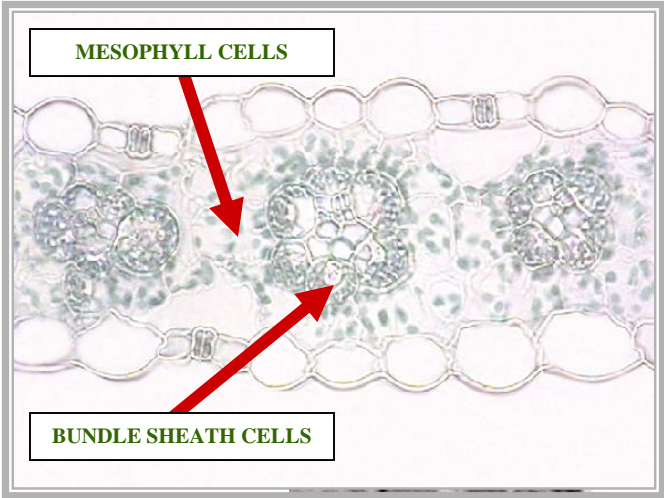
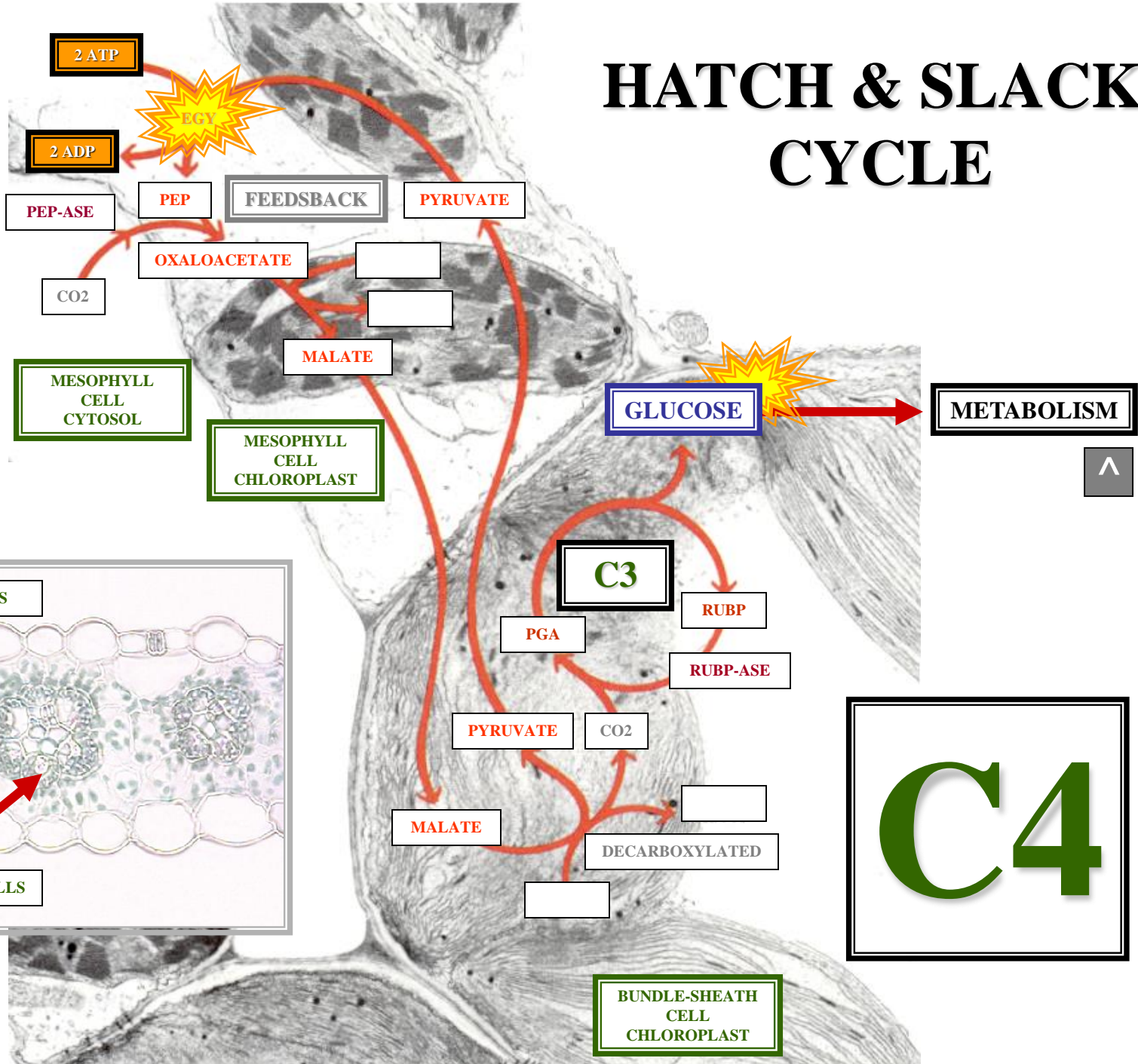
MARSHALL HATCH / DK RXT



HATCH & SLACK CYCLE



CORN



C4

C4
PATHWAY
ACRONYM

C4 ACRONYM



PEP = PHOSPHOENOLPYRUVATE

C4 ACRONYM



C4 PLANT
MODIFIED
C3 PLANT



C4 KRANTZ LEAF ANATOMY

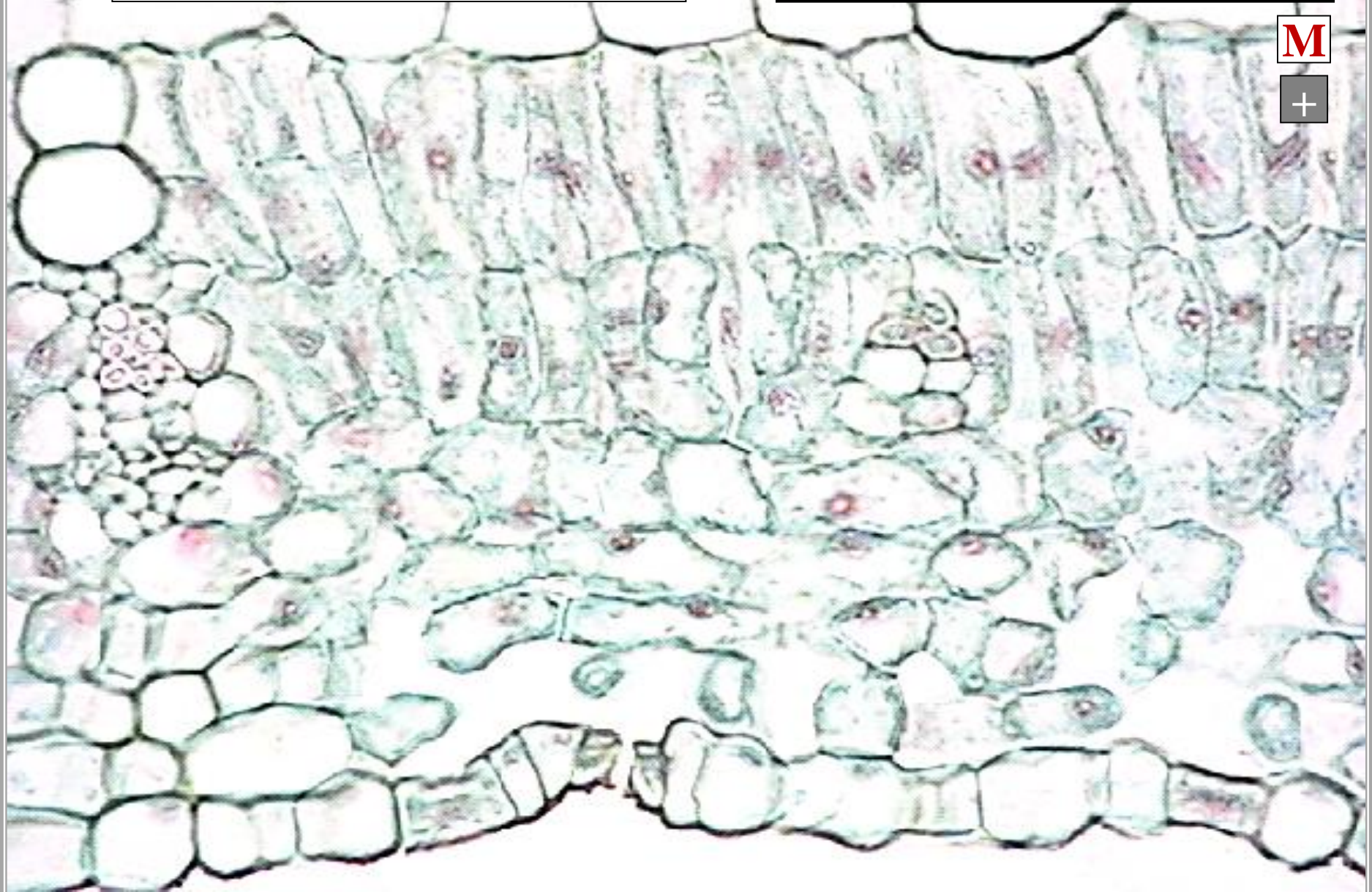
**C4
LEAF
MESOPHYLL**

MESOPHYLL

C3 LEAF

M

+



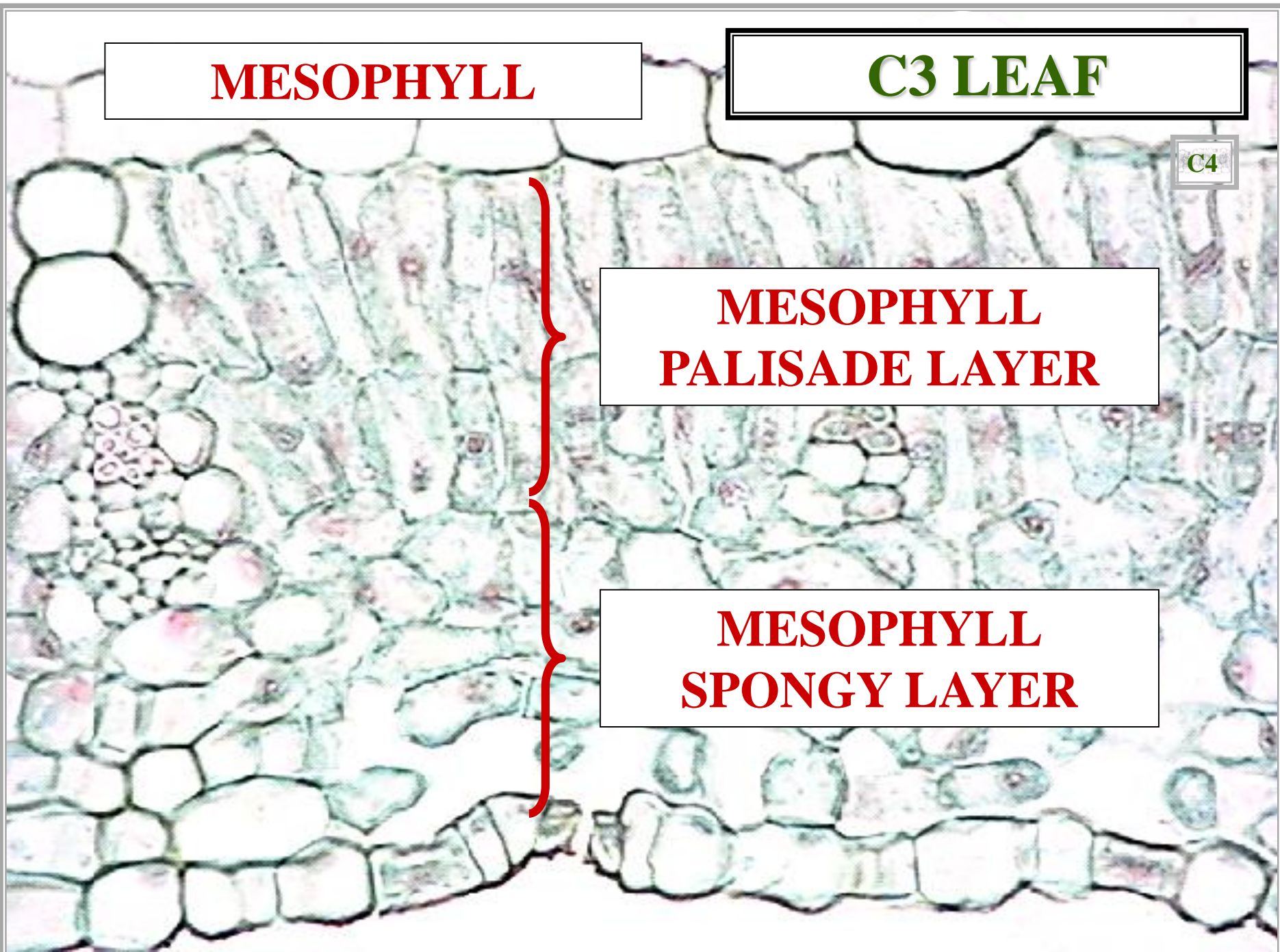
MESOPHYLL

C3 LEAF

C4

**MESOPHYLL
PALISADE LAYER**

**MESOPHYLL
SPONGY LAYER**



MESOPHYLL

C4 LEAF

PL

+

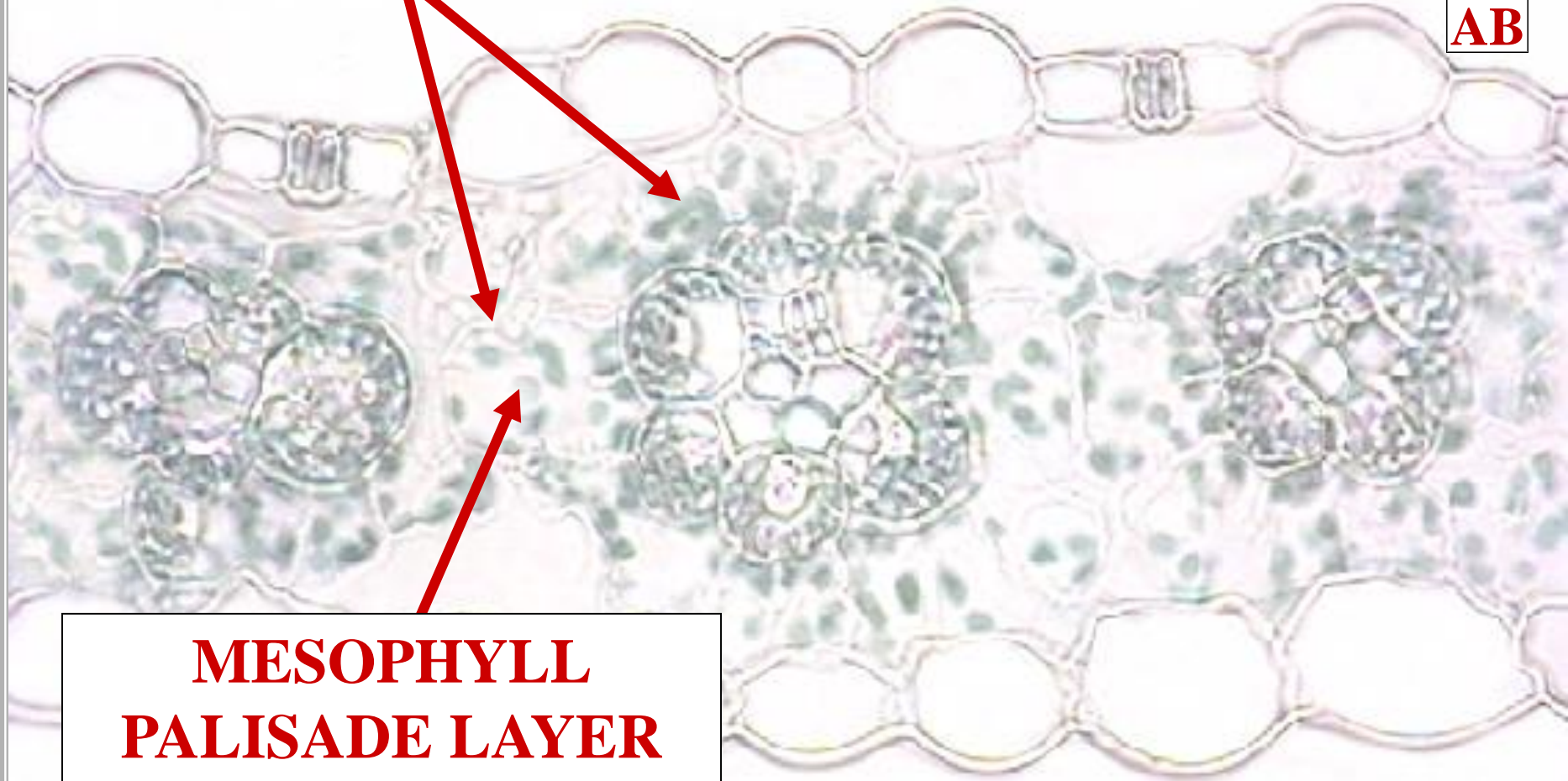


KRANTZ C4 LEAF ANATOMY

MESOPHYLL

C4 LEAF

AB



**MESOPHYLL
PALISADE LAYER**

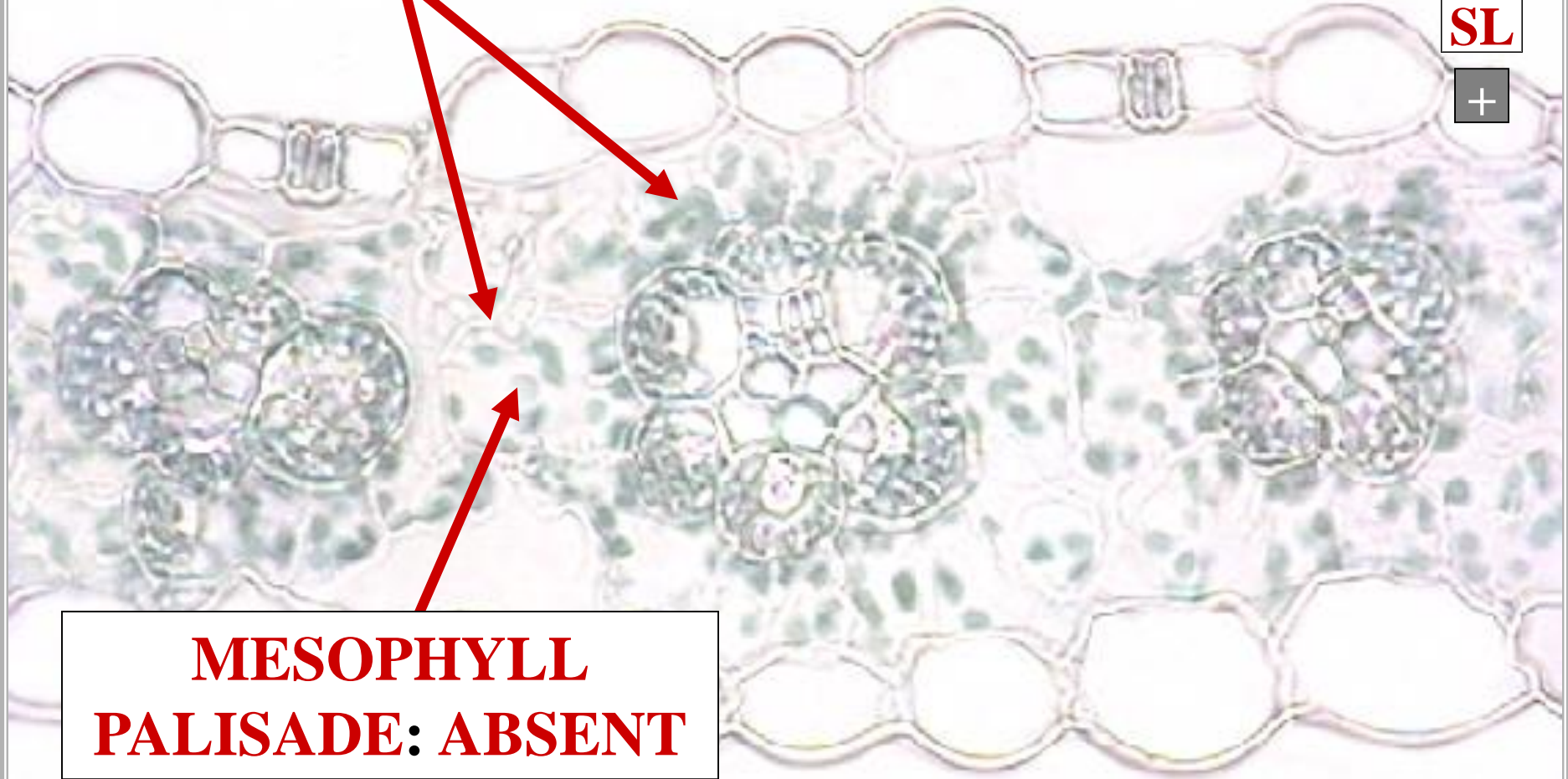
KRANTZ C4 LEAF ANATOMY

MESOPHYLL

C4 LEAF

SL

+



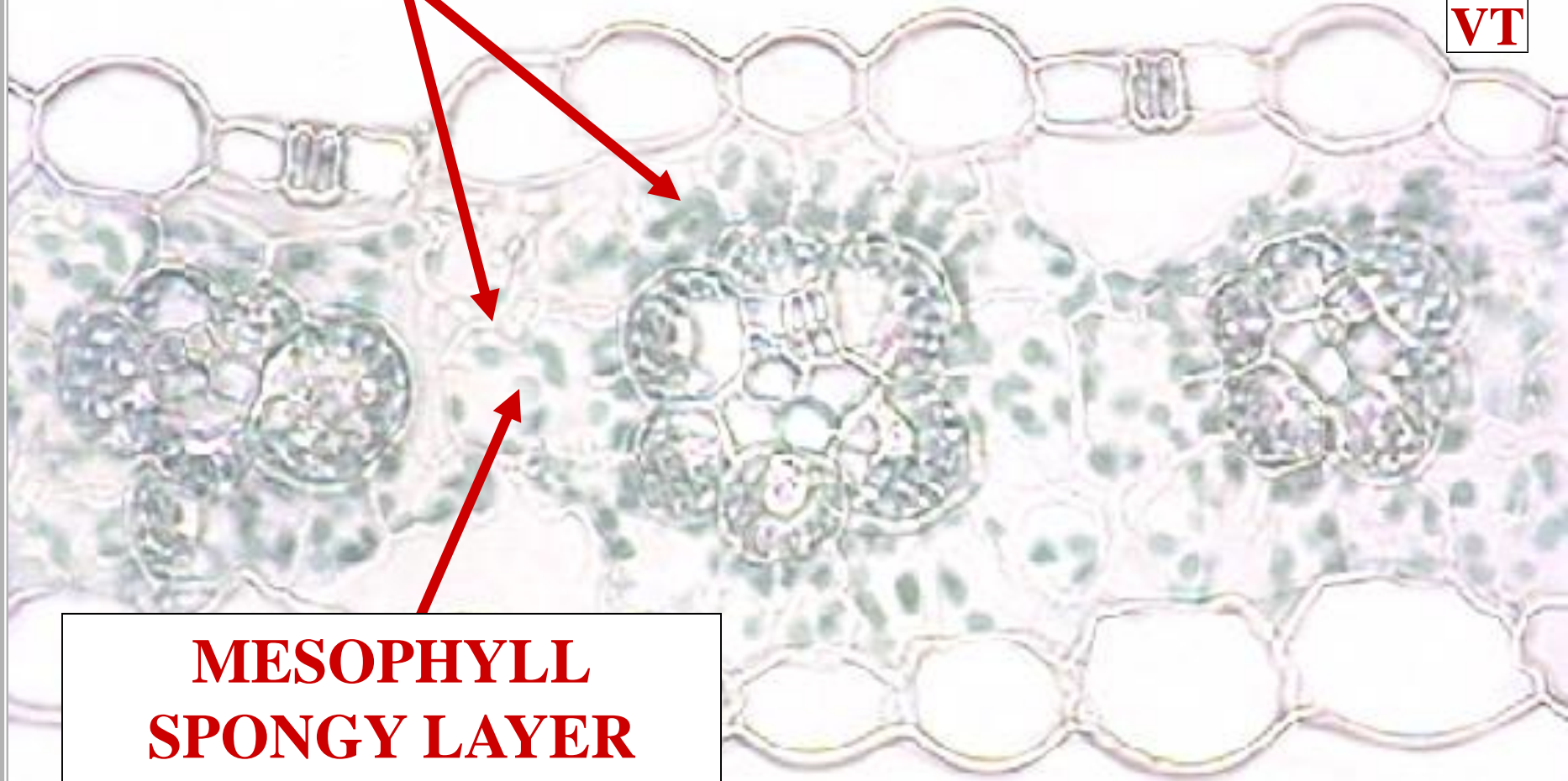
**MESOPHYLL
PALISADE: ABSENT**

KRANTZ C4 LEAF ANATOMY

MESOPHYLL

C4 LEAF

VT



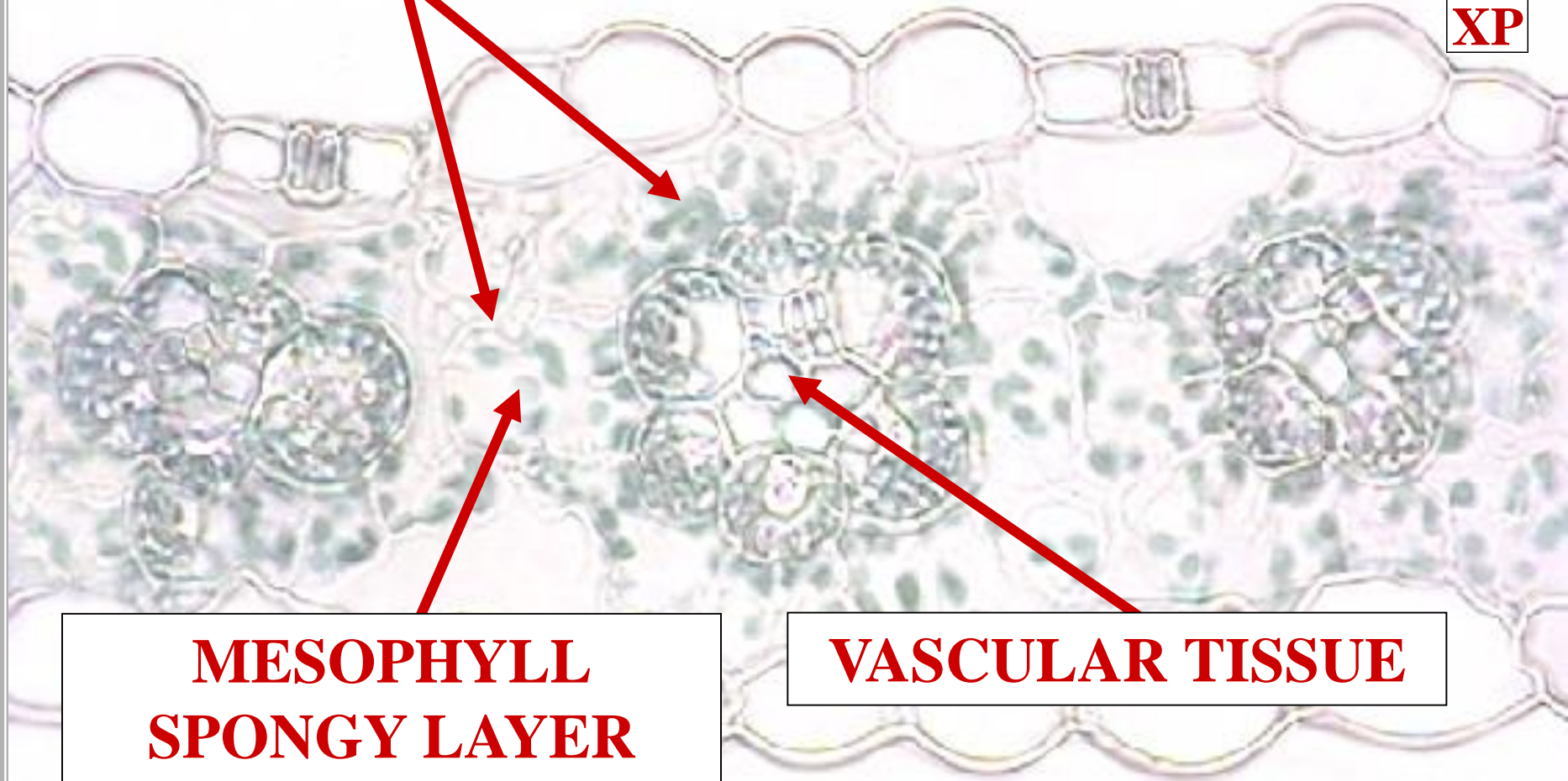
**MESOPHYLL
SPONGY LAYER**

KRANTZ C4 LEAF ANATOMY

MESOPHYLL

C4 LEAF

XP



**MESOPHYLL
SPONGY LAYER**

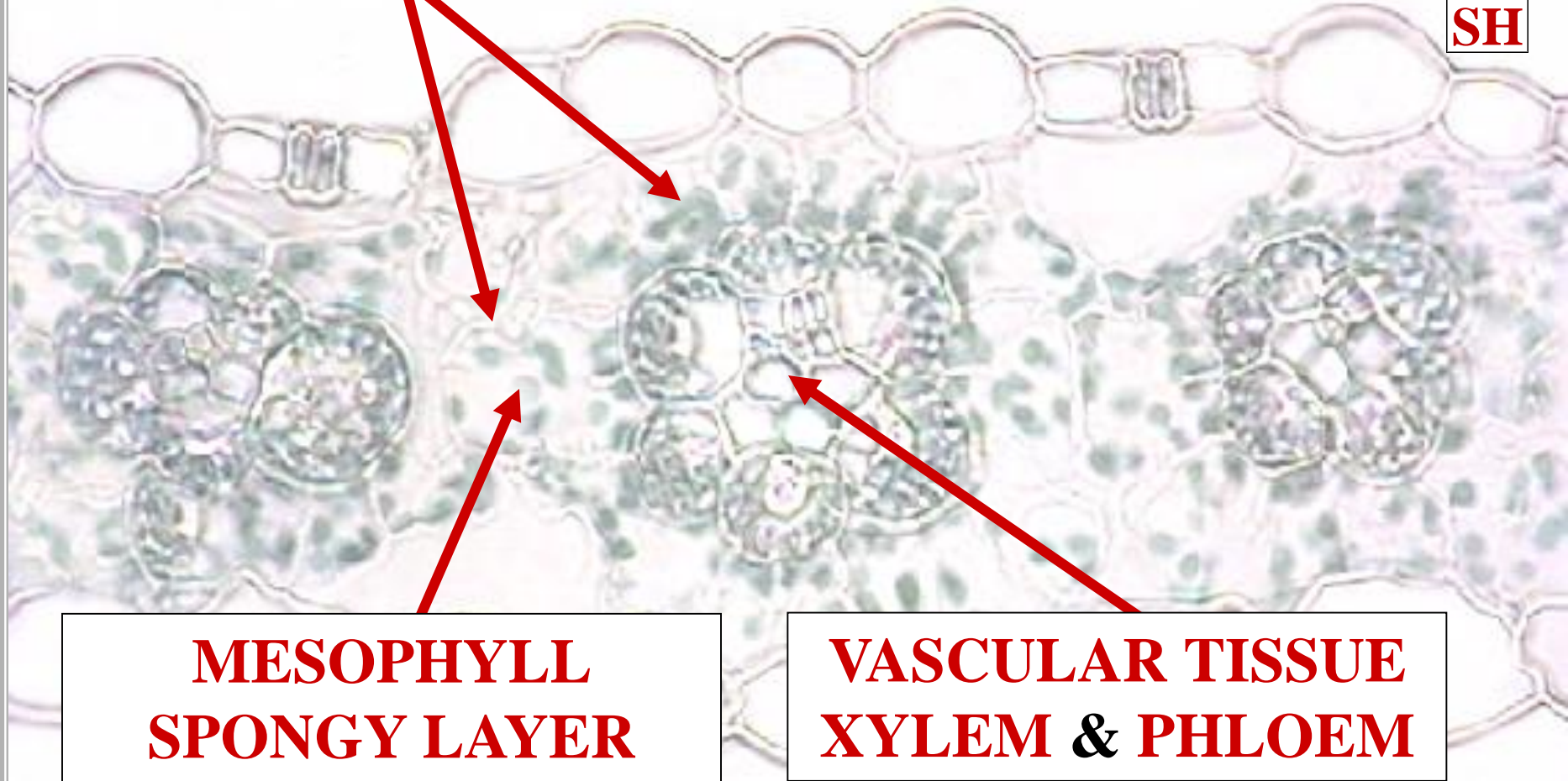
VASCULAR TISSUE

KRANTZ C4 LEAF ANATOMY

MESOPHYLL

C4 LEAF

SH



**MESOPHYLL
SPONGY LAYER**

**VASCULAR TISSUE
XYLEM & PHLOEM**

KRANTZ C4 LEAF ANATOMY

MESOPHYLL

C4 LEAF

“W”

VASCULAR TISSUE

**MESOPHYLL
SPONGY LAYER**

**BUNDLE SHEATH
CELLS: PRESENT**

KRANTZ C4 LEAF ANATOMY

