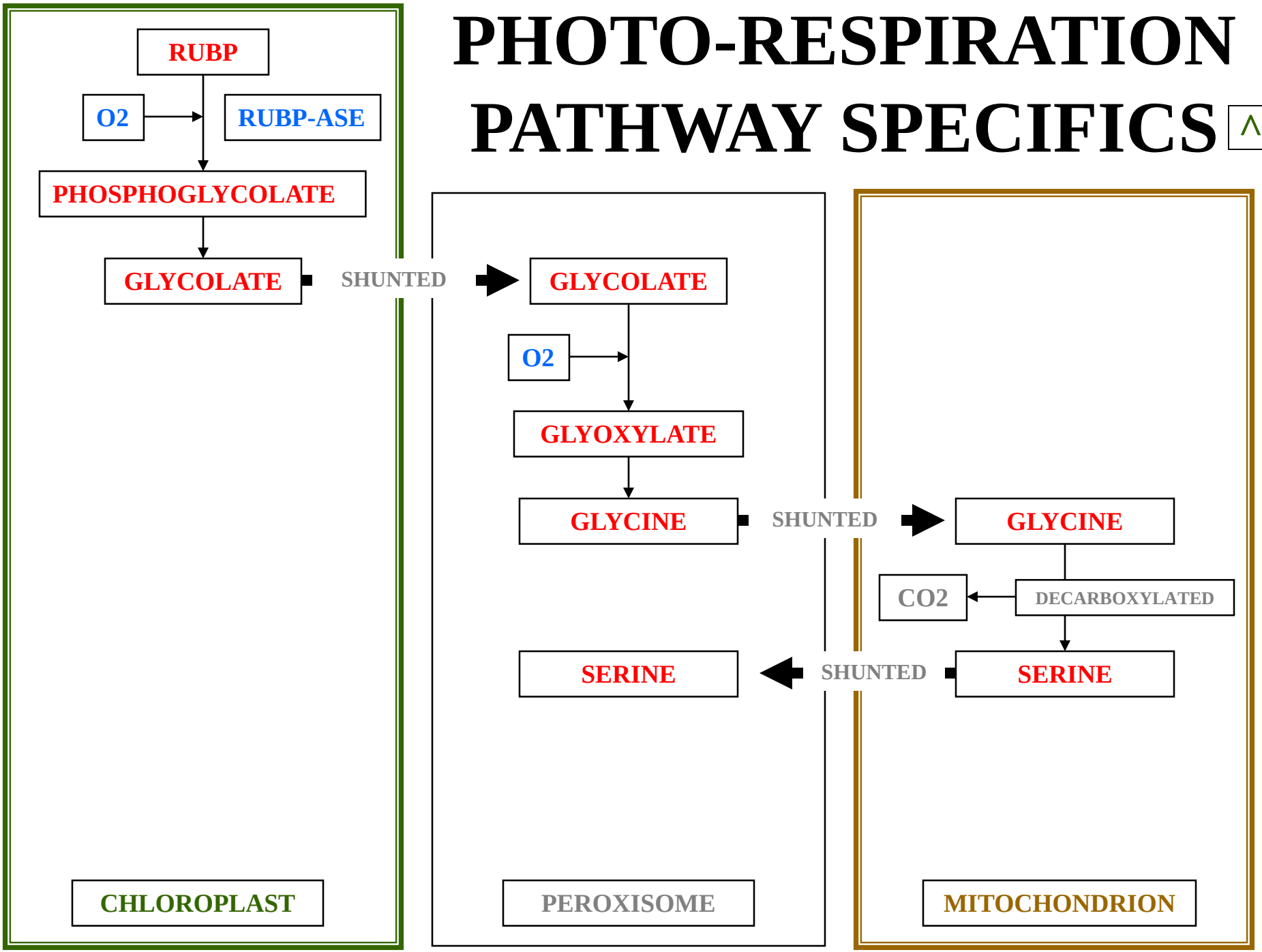
PHOTO-RESPIRATION PATHWAY SPECIFICS



MESOPHYLL CELL PEROXISOME

PHOTO-RESPIRATION PATHWAY SPECIFICS

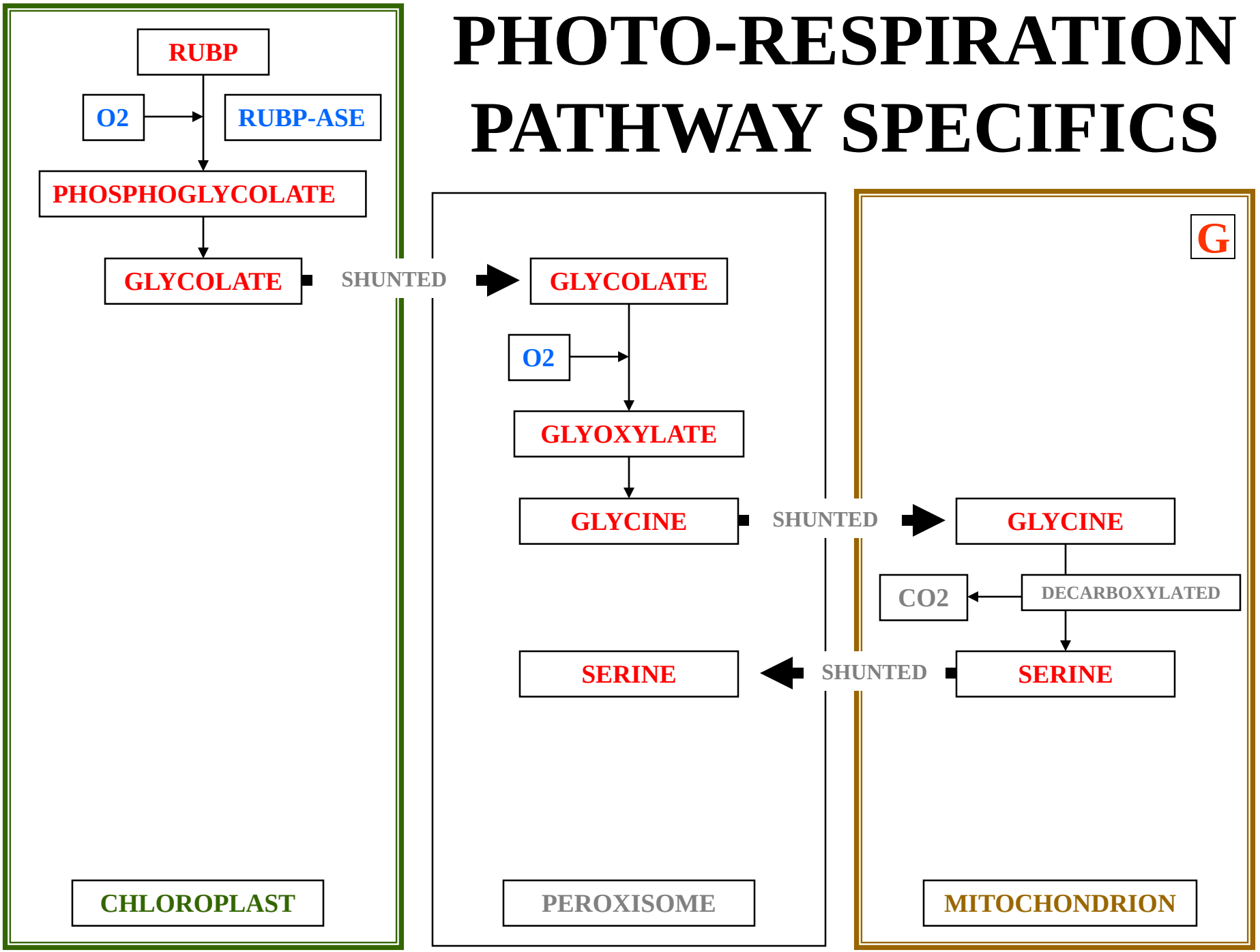


PHOTO-RESPIRATION PATHWAY SPECIFICS

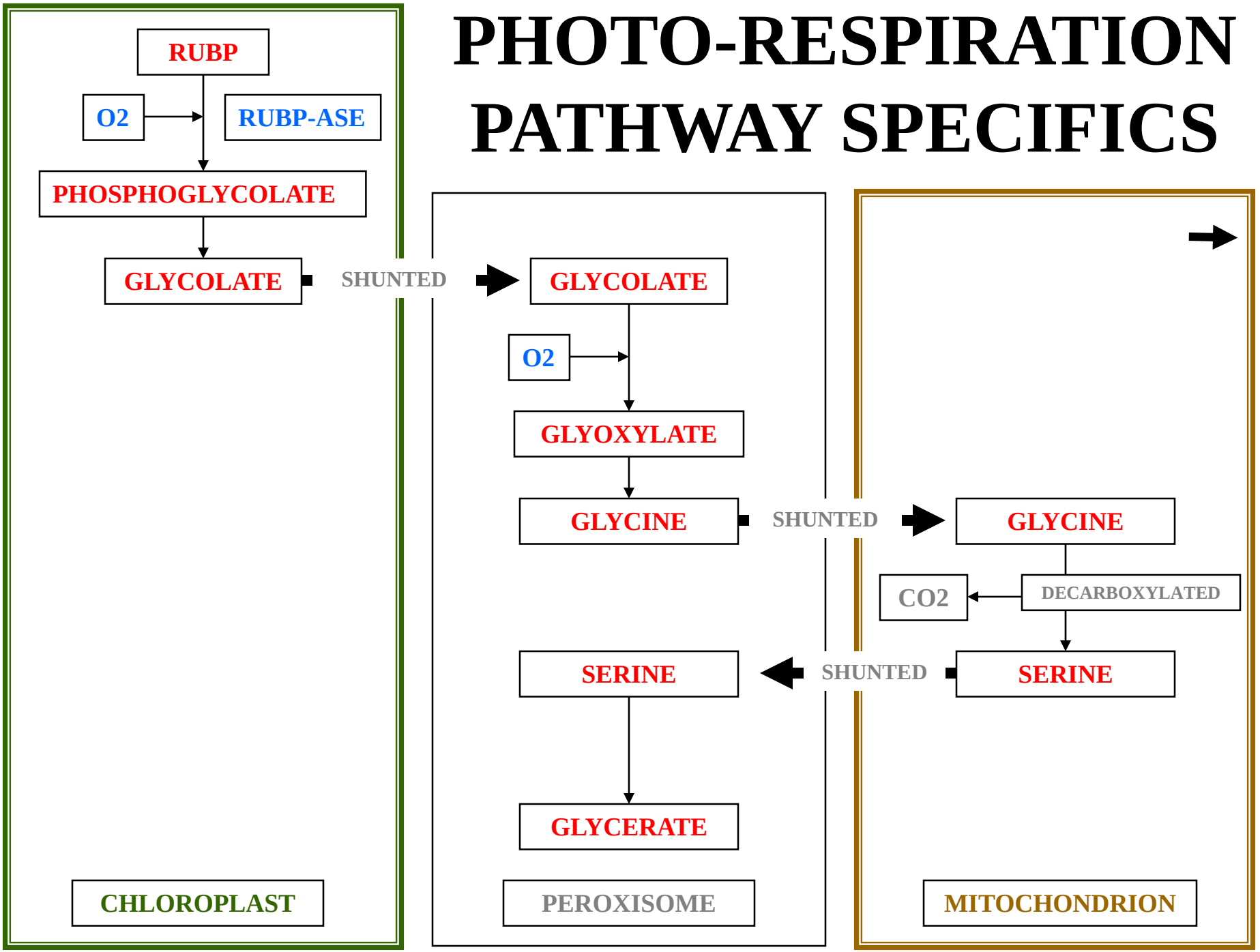
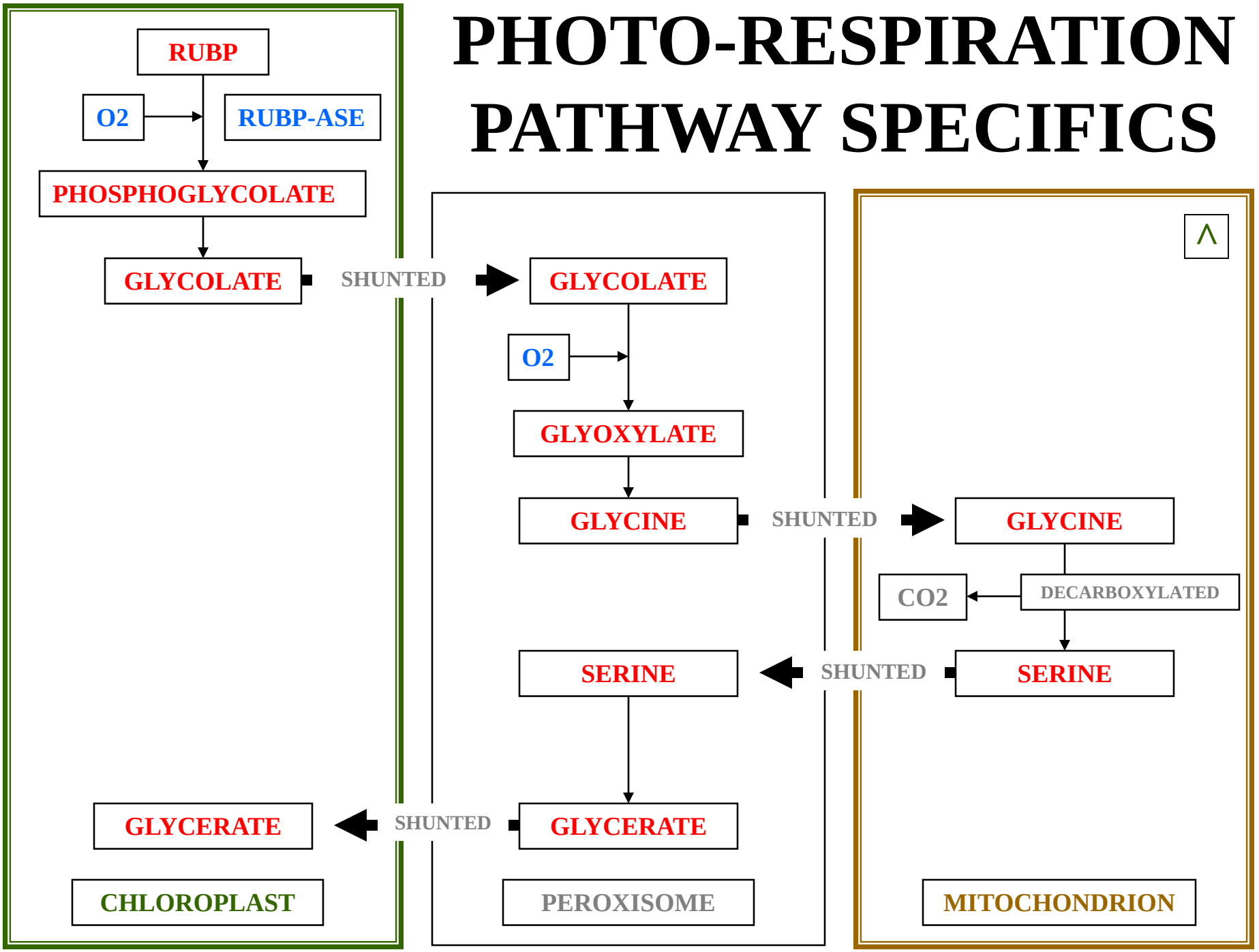


PHOTO-RESPIRATION PATHWAY SPECIFICS



MESOPHYLL CELL CHLOROPLAST

PHOTO-RESPIRATION PATHWAY SPECIFICS

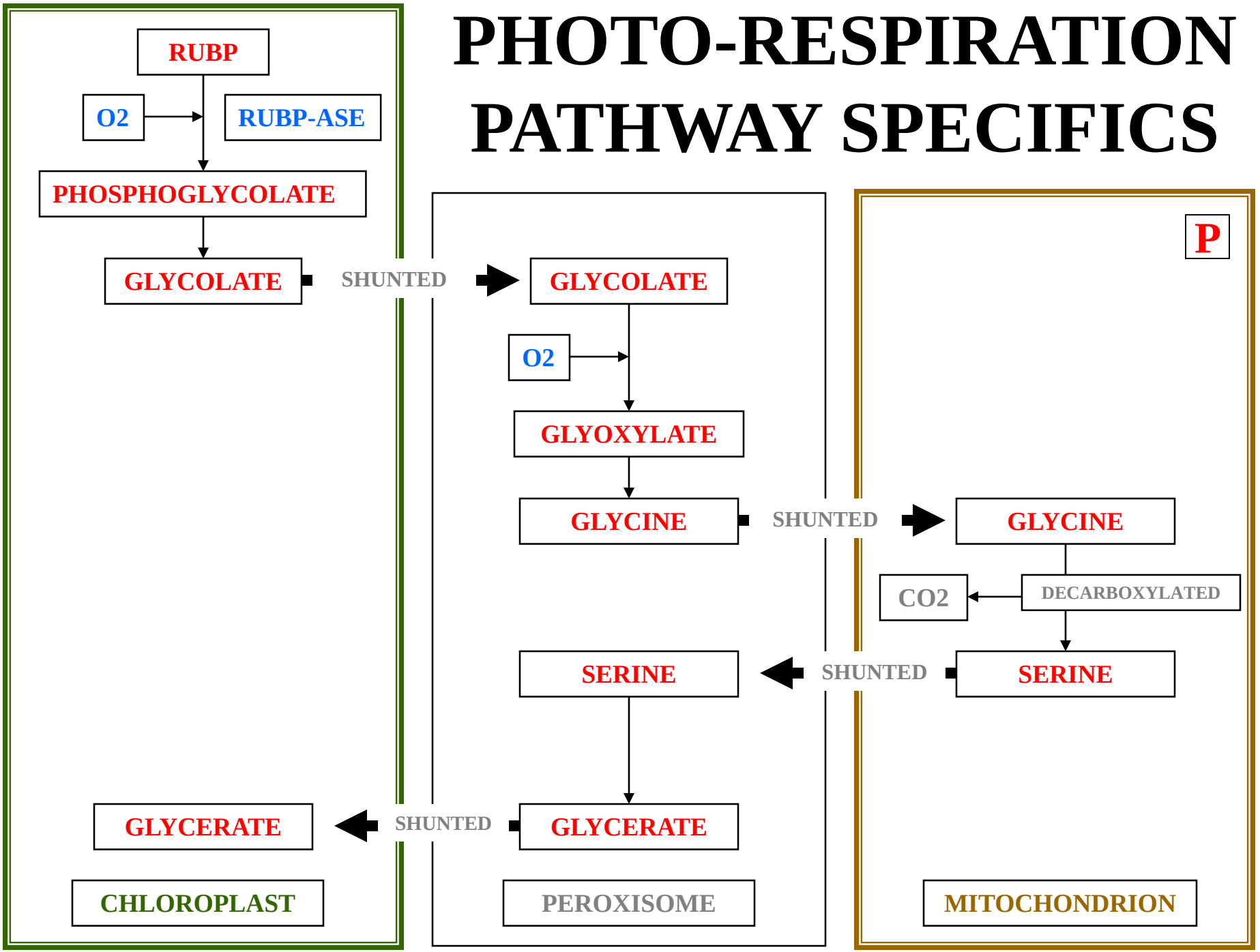


PHOTO-RESPIRATION PATHWAY SPECIFICS

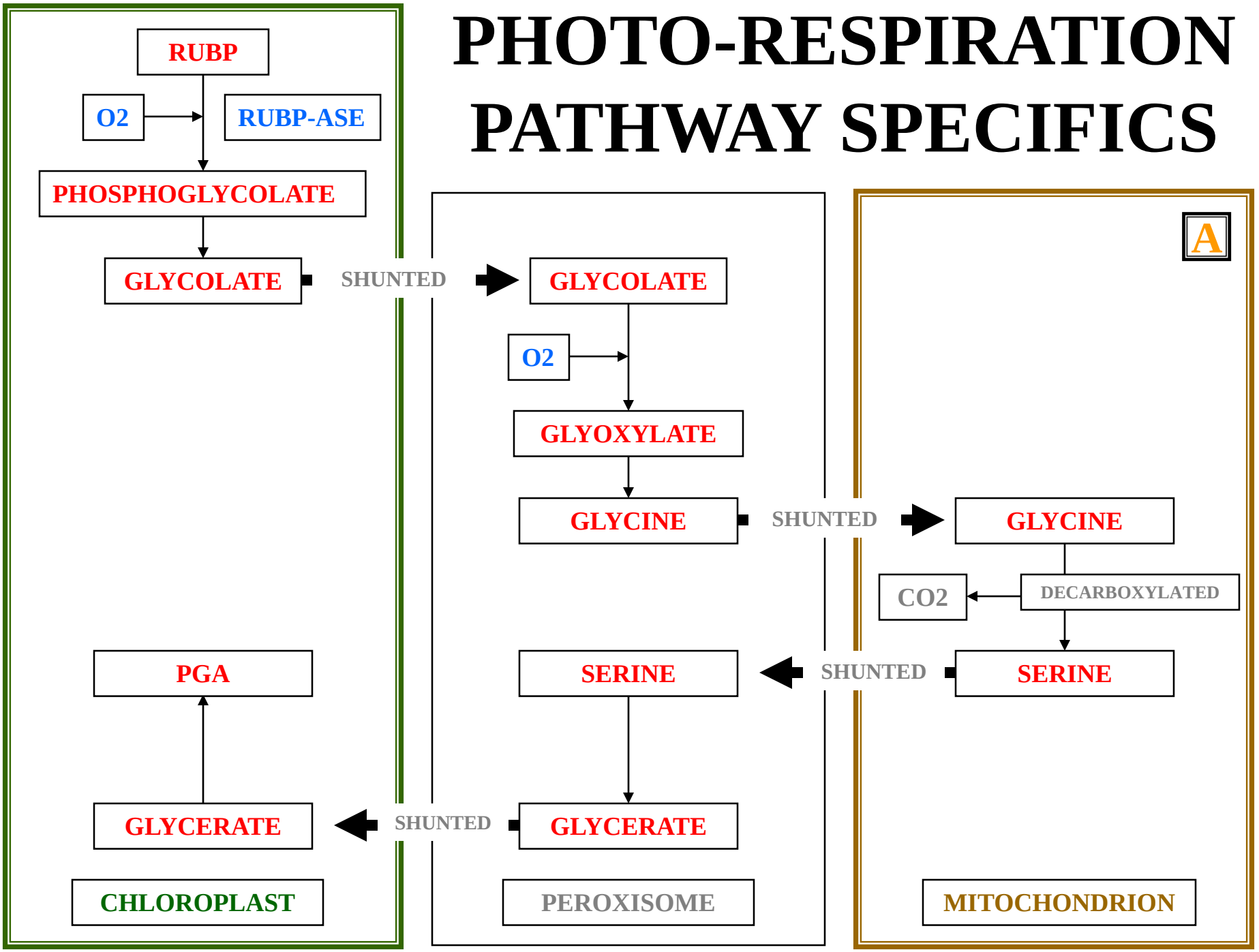
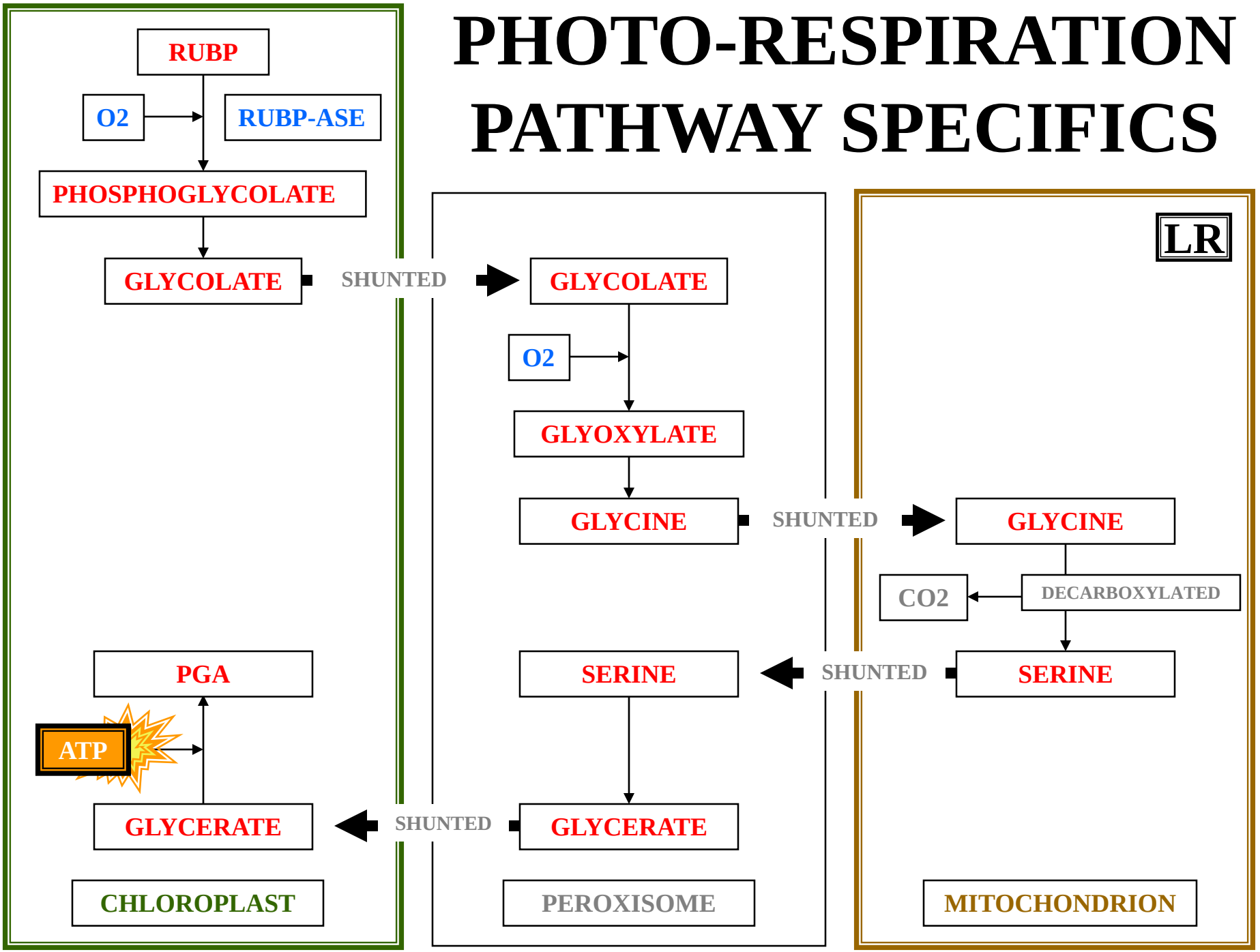


PHOTO-RESPIRATION PATHWAY SPECIFICS



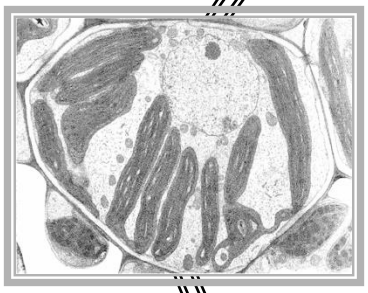
PHOTOSYNTHESIS

WATER

LIGHT EGY

E-

PHOTOLYSIS

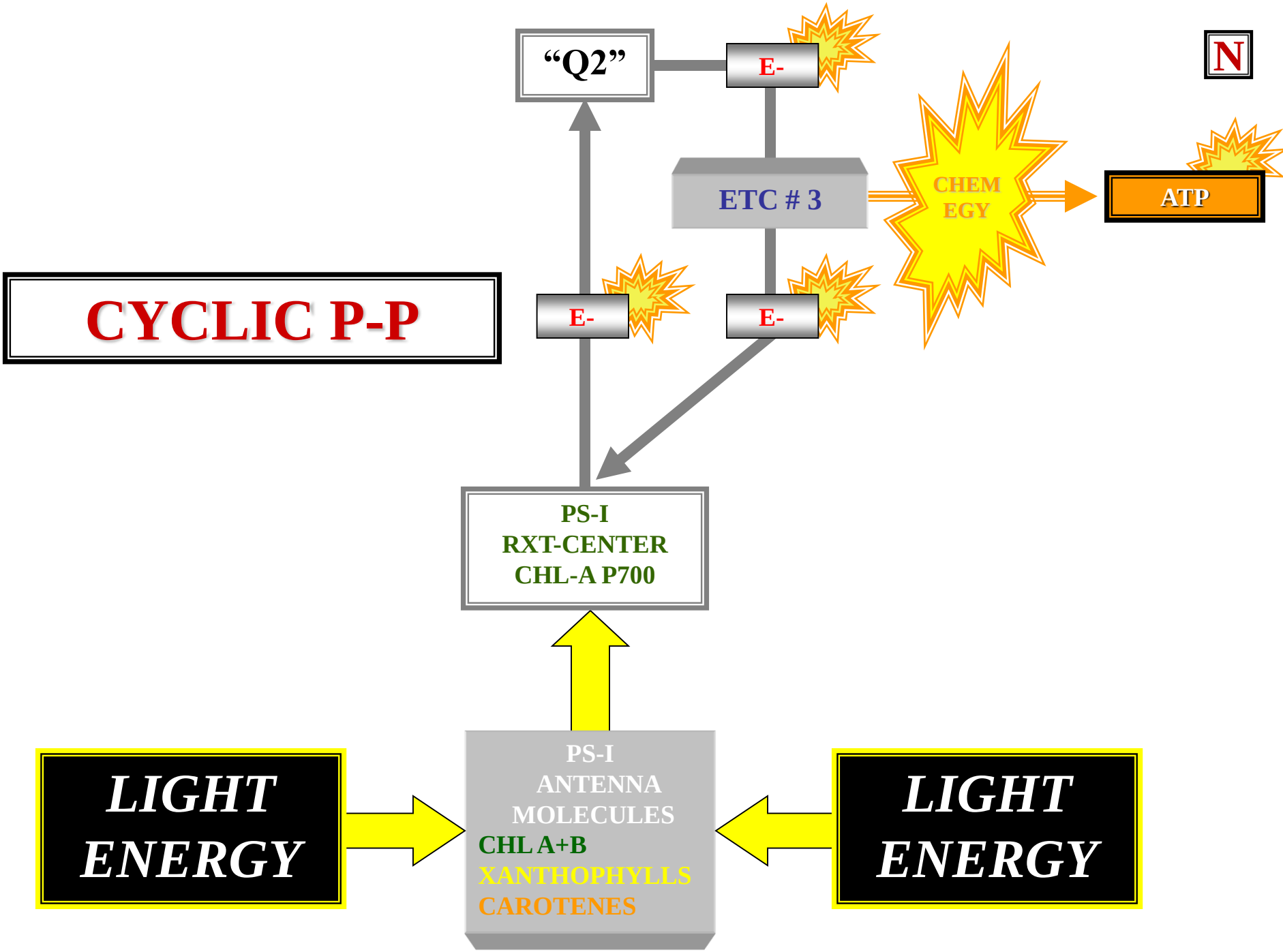


LT RXT

THYLAKOID
GRANUM

CHLOROPLAST

OXYGEN


"Q2"
E-
N
ETC # 3
CHEM
EGY
ATP
CYCLIC P-P
E-
E-
PS-I
RXT-CENTER
CHL-A P700
PS-I
ANTENNA
MOLECULES
CHL A+B
XANTHOPHYLLS
CAROTENES
LIGHT
ENERGY
LIGHT
ENERGY

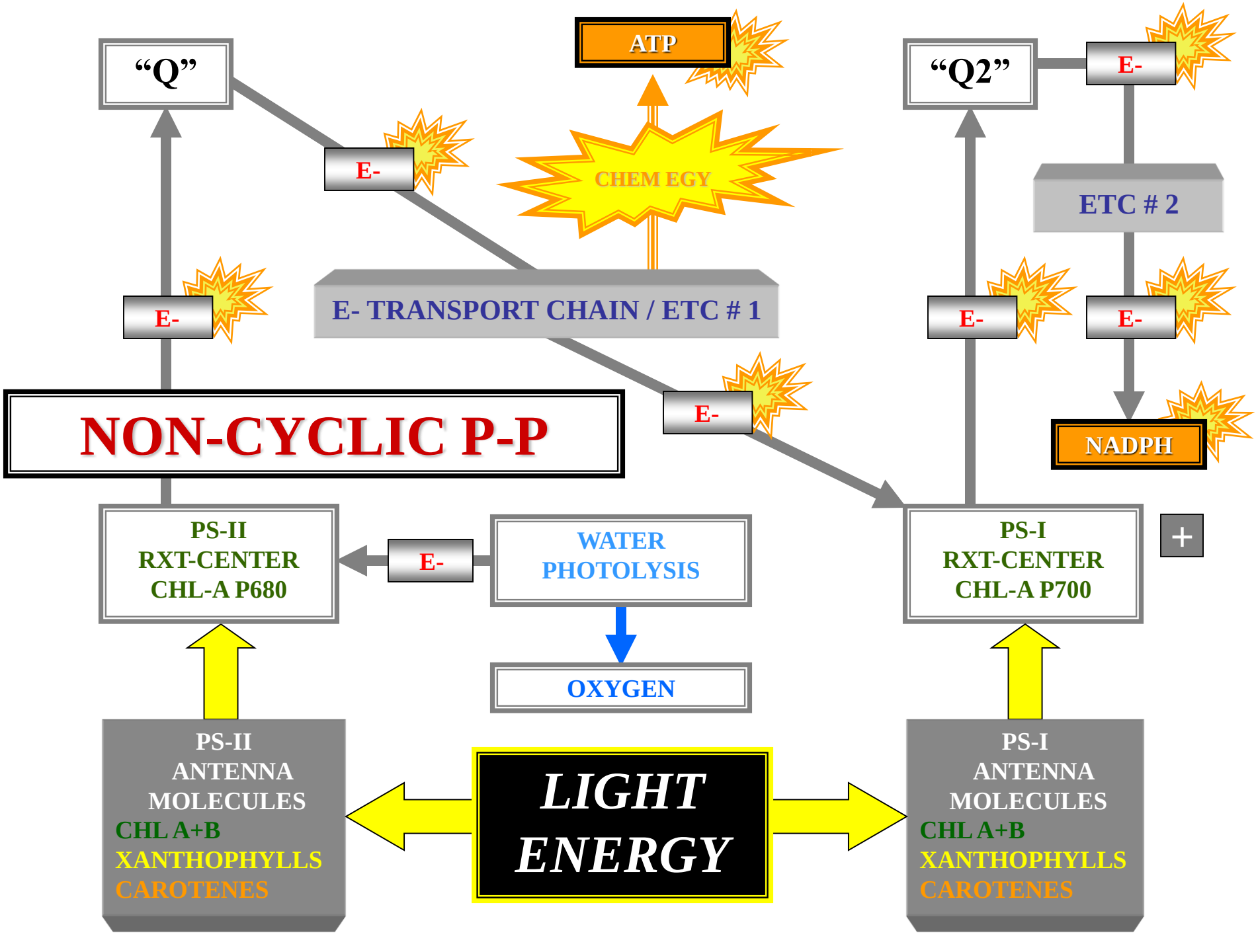
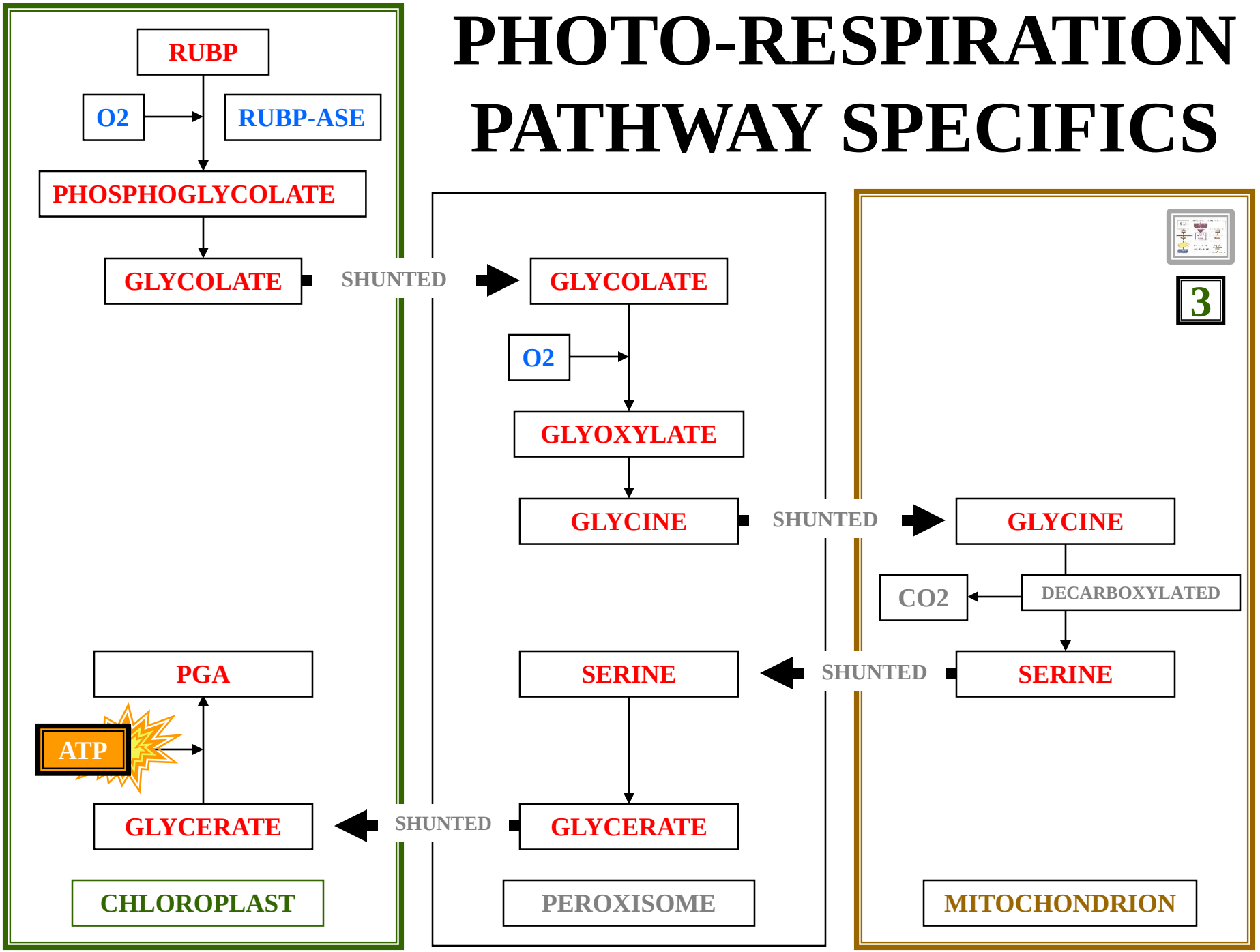

"Q"
ATP
"Q2"
E-
CHEM EGY
ETC # 2
E-
E- TRANSPORT CHAIN / ETC # 1
E-
E-
E-
NON-CYCLIC P-P
NADPH
PS-II
RXT-CENTER
CHL-A P680
E-
WATER
PHOTOLYSIS
PS-I
RXT-CENTER
CHL-A P700
+
OXYGEN
PS-II
ANTENNA
MOLECULES
CHL A+B
XANTHOPHYLLS
CAROTENES
LIGHT
ENERGY
PS-I
ANTENNA
MOLECULES
CHL A+B
XANTHOPHYLLS
CAROTENES

PHOTO-RESPIRATION PATHWAY SPECIFICS



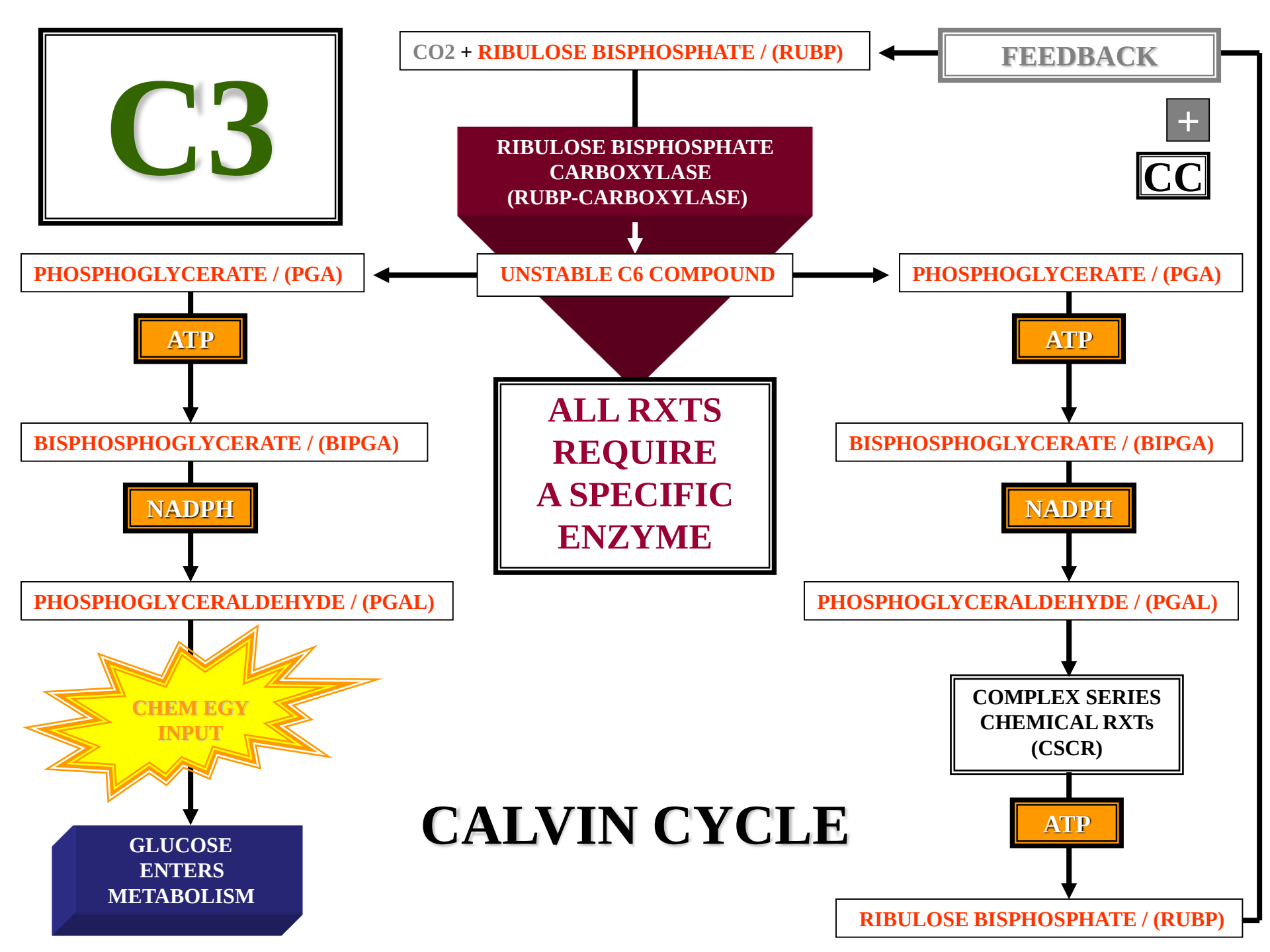

C3
CO2 + RIBULOSE BISPHOSPHATE / (RUBP)
FEEDBACK
+
CC
RIBULOSE BISPHOSPHATE CARBOXYLASE (RUBP-CARBOXYLASE)
PHOSPHOGLYCERATE / (PGA)
UNSTABLE C6 COMPOUND
PHOSPHOGLYCERATE / (PGA)
ATP
ATP
ALL RXTS REQUIRE A SPECIFIC ENZYME
BISPHOSPHOGLYCERATE / (BIPGA)
BISPHOSPHOGLYCERATE / (BIPGA)
NADPH
NADPH
PHOSPHOGLYCERALDEHYDE / (PGAL)
PHOSPHOGLYCERALDEHYDE / (PGAL)
CHEM EGY INPUT
COMPLEX SERIES CHEMICAL RXTs (CSCR)
ATP
GLUCOSE ENTERS METABOLISM
RIBULOSE BISPHOSPHATE / (RUBP)
CALVIN CYCLE

PHOTO-RESPIRATION PATHWAY SPECIFICS

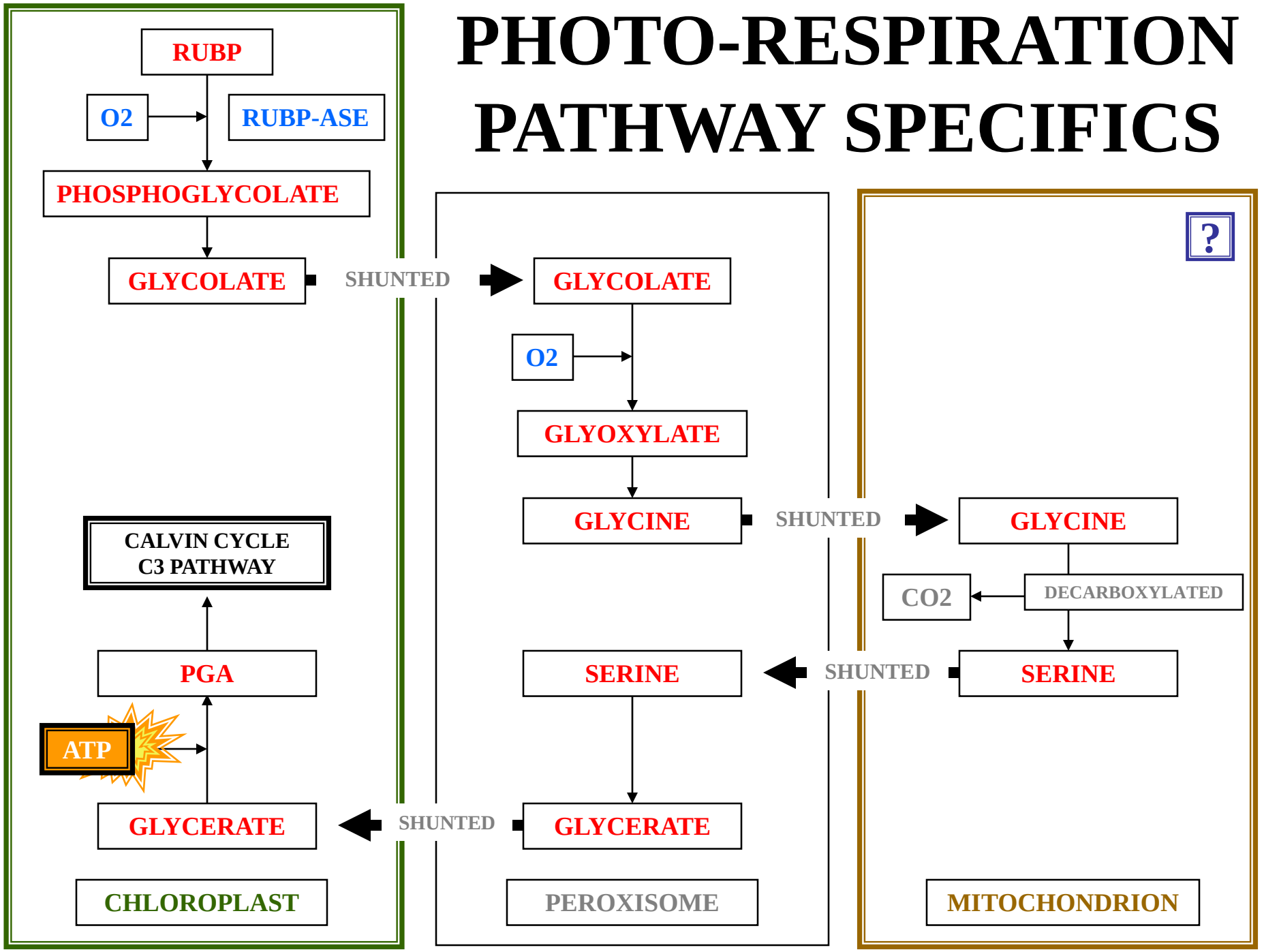


PHOTO-RESPIRATION PATHWAY SPECIFICS

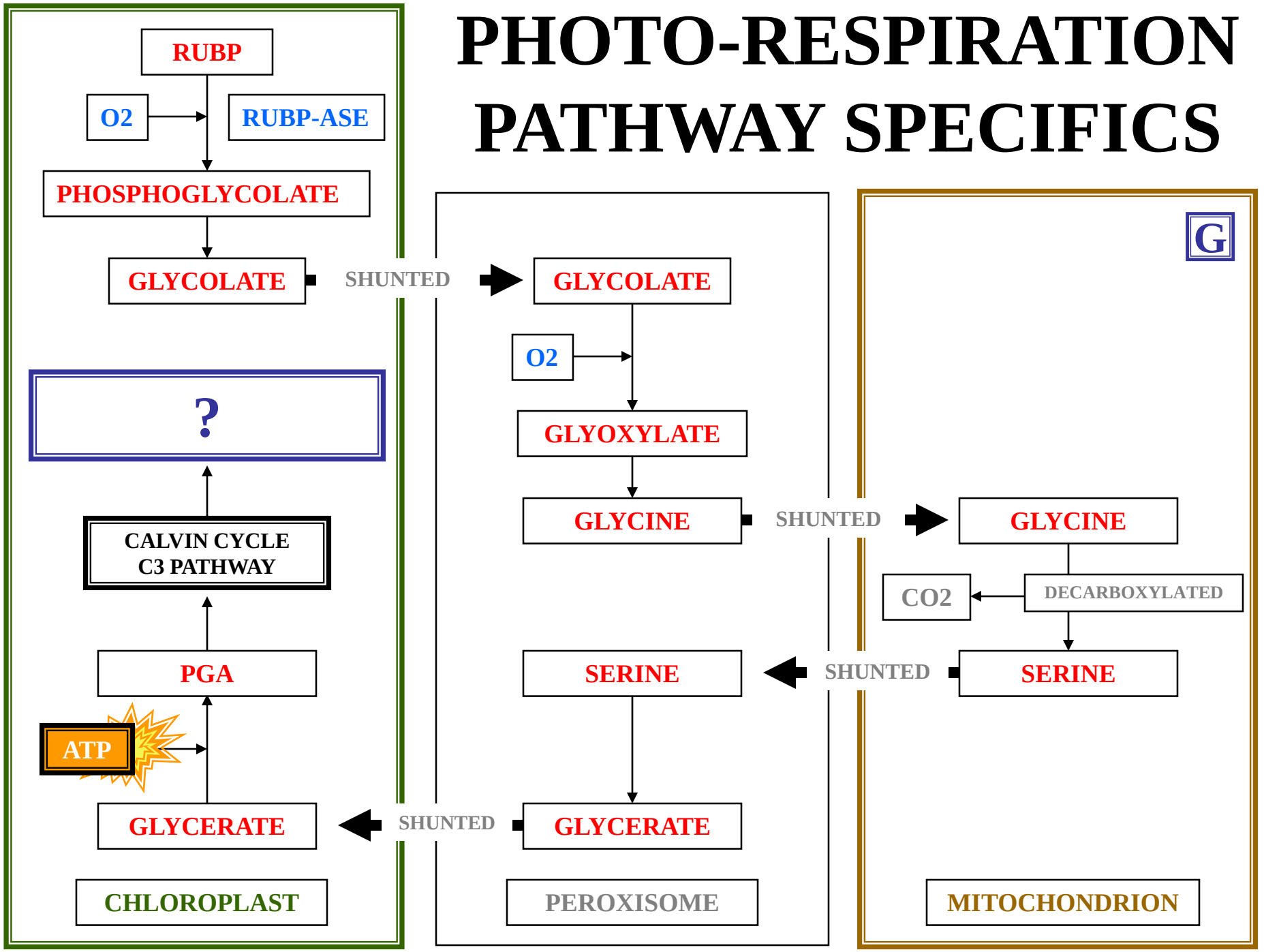
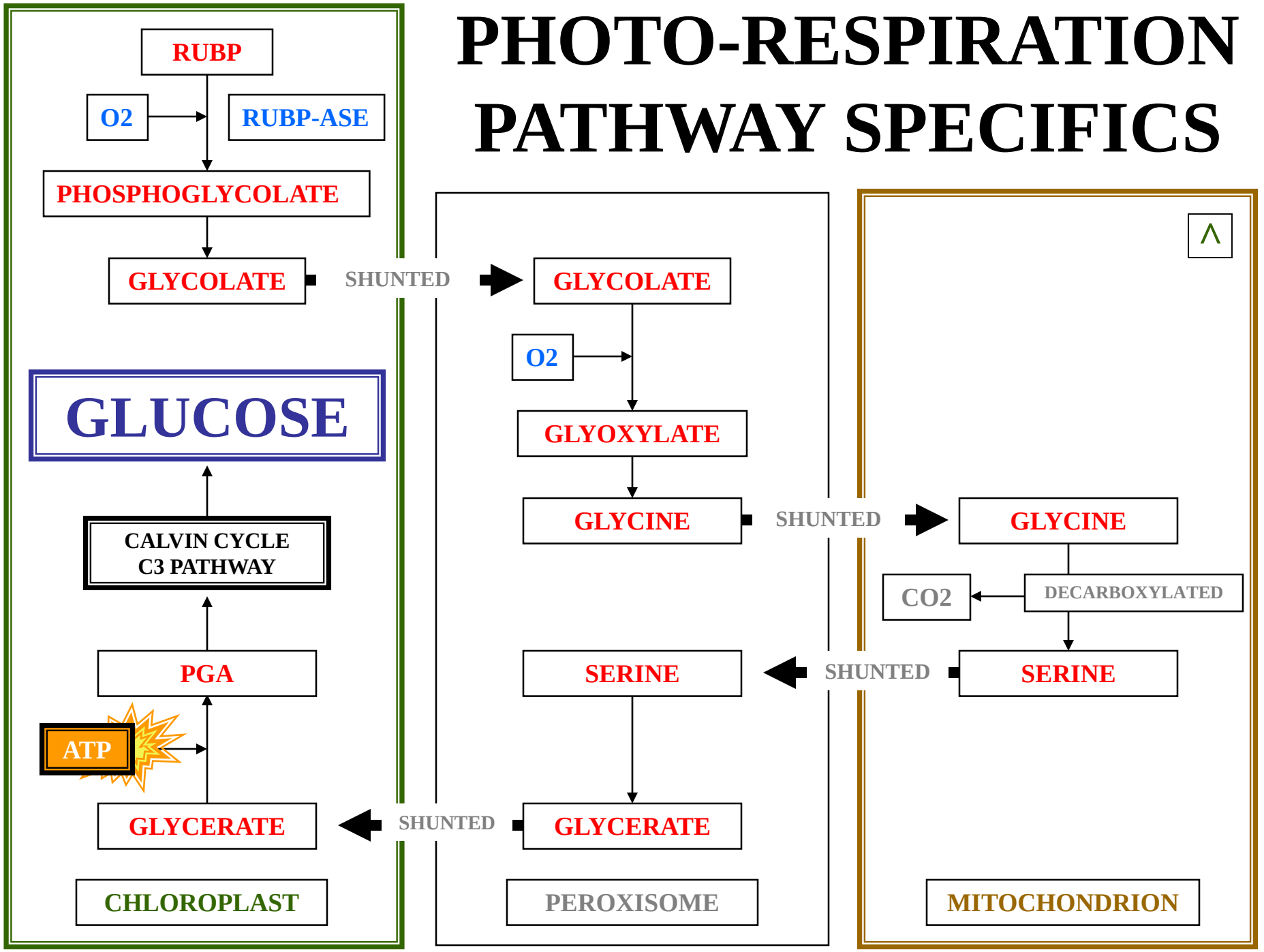


PHOTO-RESPIRATION PATHWAY SPECIFICS



MESOPHYLL
CELL
MITOCHONDRION

PHOTO-RESPIRATION PATHWAY SPECIFICS

D

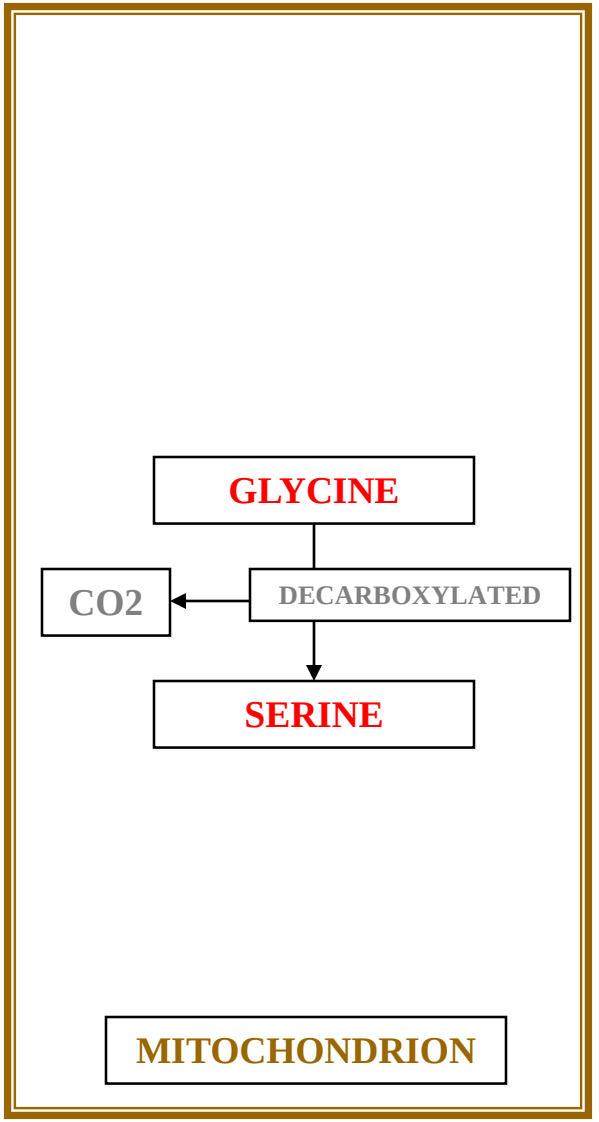


PHOTO-RESPIRATION PATHWAY SPECIFICS

3

GLYCINE

DECARBOXYLATED

SERINE

CO2

DIFFUSION

CO2

CHLOROPLAST

MITOCHONDRION

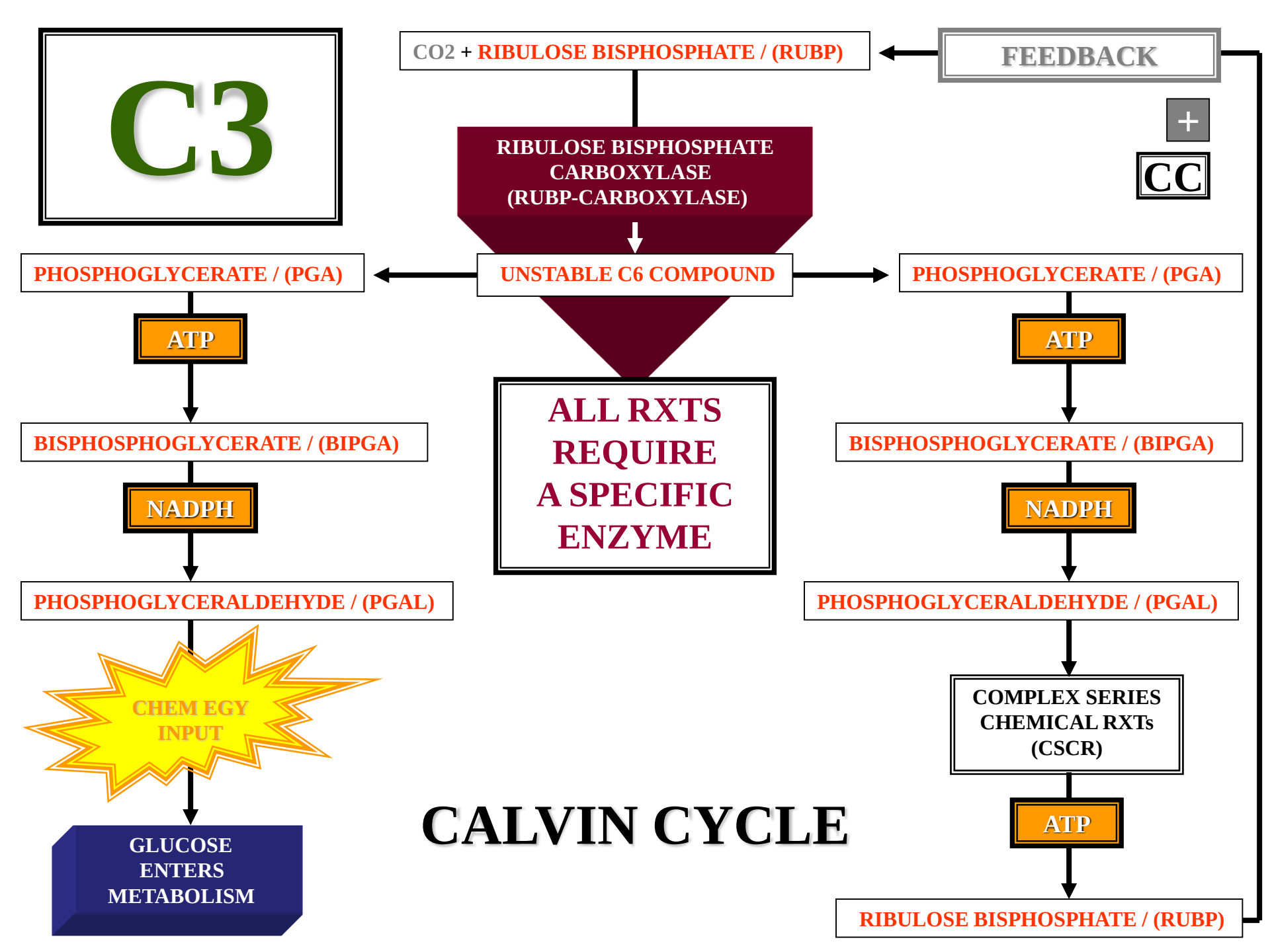

C3
CO2 + RIBULOSE BISPHOSPHATE / (RUBP)
FEEDBACK
+
CC
RIBULOSE BISPHOSPHATE CARBOXYLASE (RUBP-CARBOXYLASE)
PHOSPHOGLYCERATE / (PGA)
UNSTABLE C6 COMPOUND
PHOSPHOGLYCERATE / (PGA)
ATP
ATP
ALL RXTS REQUIRE A SPECIFIC ENZYME
BISPHOSPHOGLYCERATE / (BIPGA)
BISPHOSPHOGLYCERATE / (BIPGA)
NADPH
NADPH
PHOSPHOGLYCERALDEHYDE / (PGAL)
PHOSPHOGLYCERALDEHYDE / (PGAL)
CHEM EGY INPUT
COMPLEX SERIES CHEMICAL RXTs (CSCR)
ATP
GLUCOSE ENTERS METABOLISM
RIBULOSE BISPHOSPHATE / (RUBP)
CALVIN CYCLE

PHOTO-RESPIRATION PATHWAY SPECIFICS

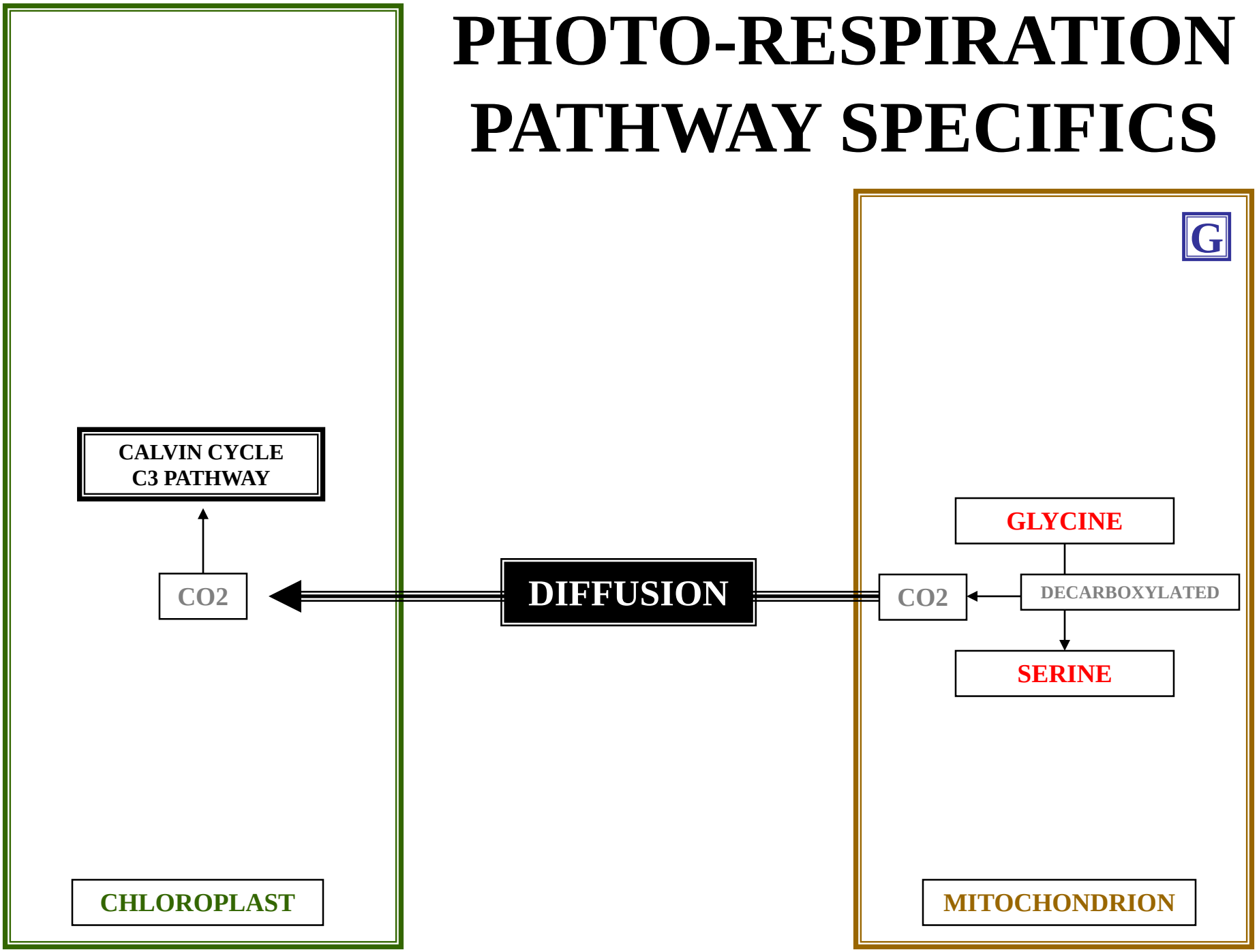


PHOTO-RESPIRATION PATHWAY SPECIFICS

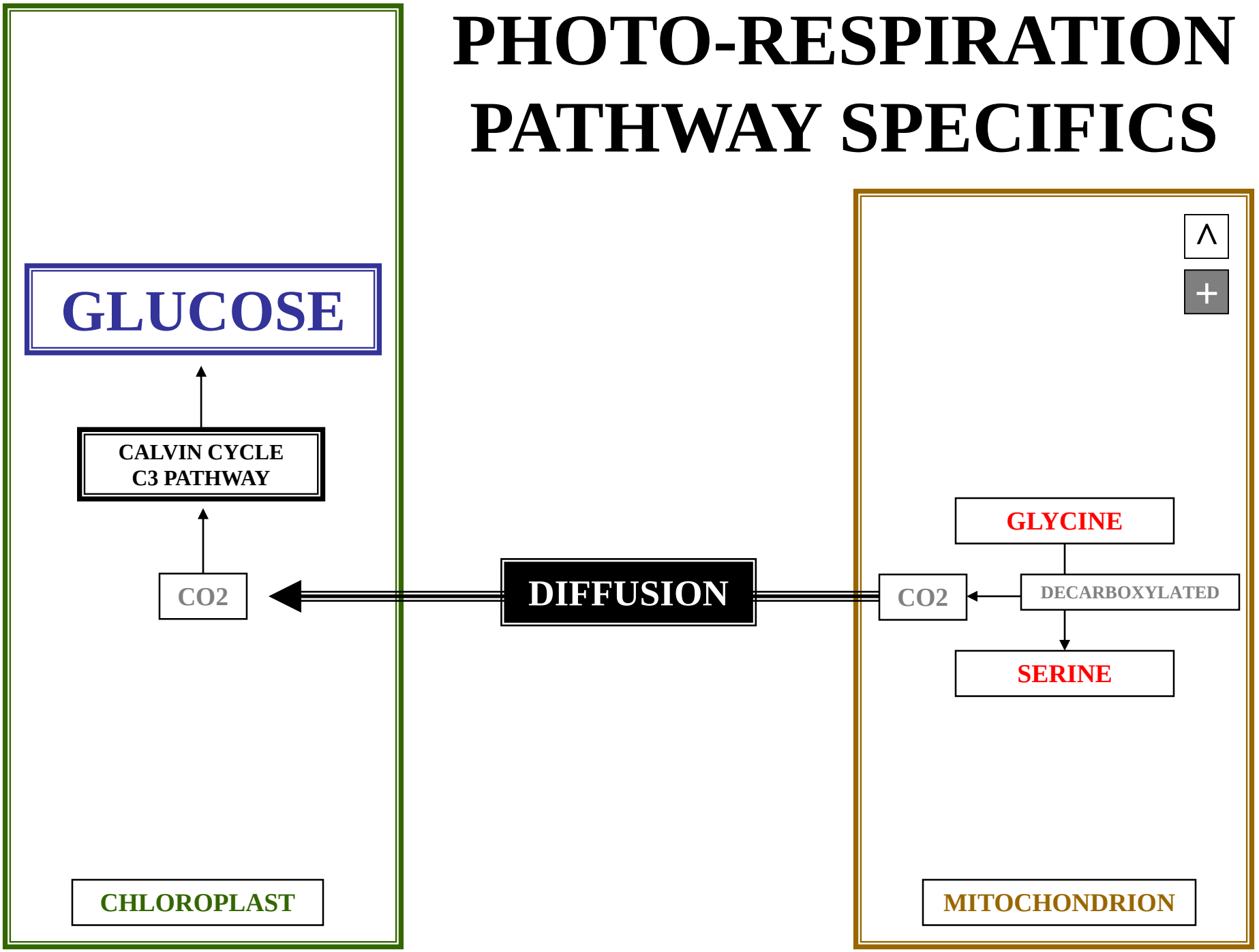


PHOTO-RESPIRATION PATHWAY SPECIFICS

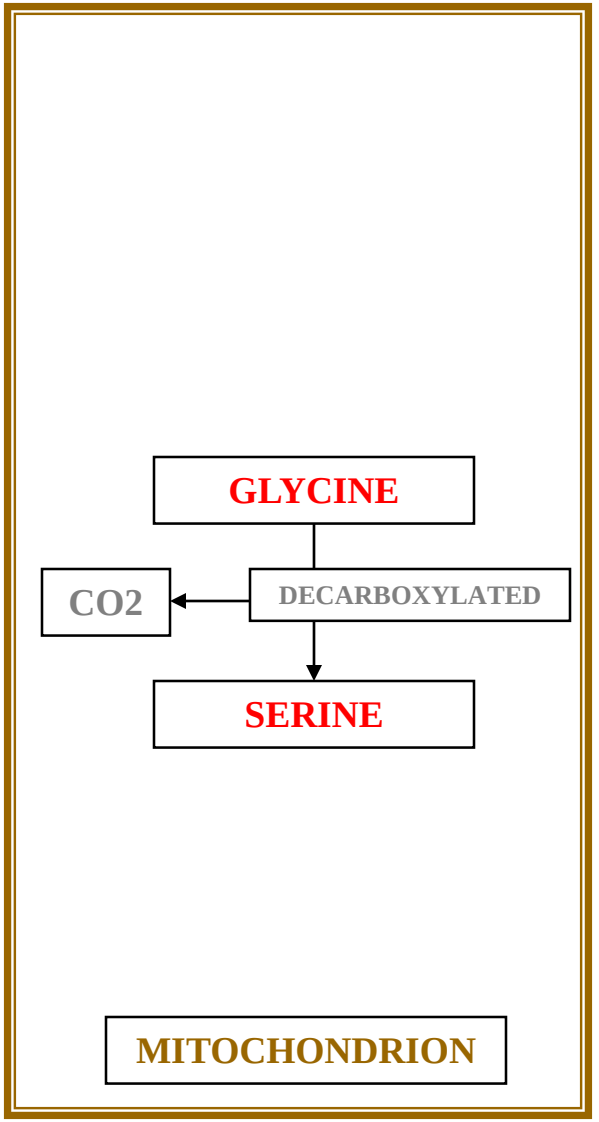
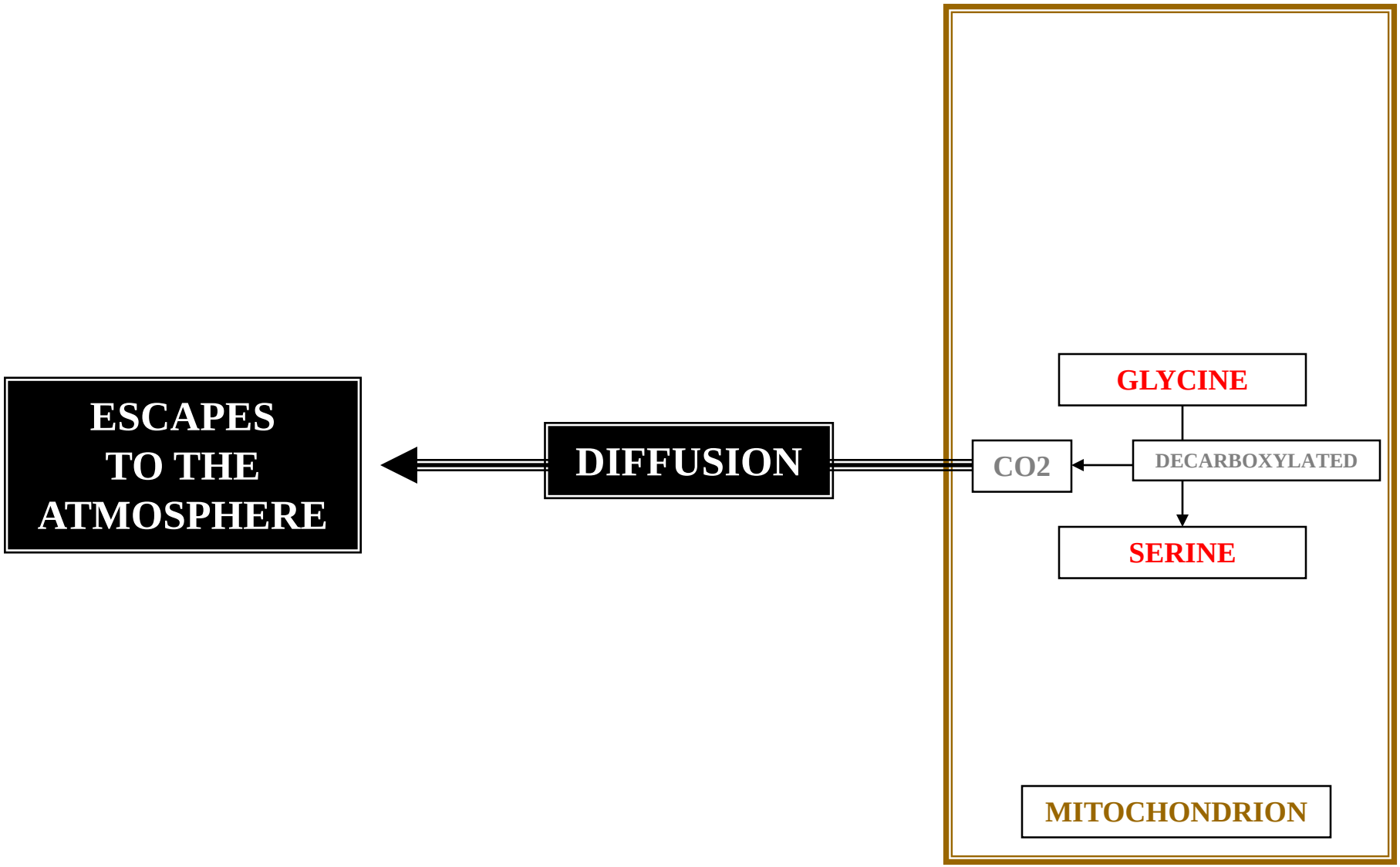


PHOTO-RESPIRATION PATHWAY SPECIFICS

EZ



C3

CO2
ENTERS
CHLOROPLAST STROMA

↓

CO2 + RIBULOSE BISPHOSPHATE / (RUBP)

RIBULOSE BISPHOSPHATE
CARBOXYLASE
(RUBP-CARBOXYLASE)

↓

UNSTABLE 6C COMPOUND

I

RIBULOSE BISPHOSPHATE CARBOXYLASE (RUBP-ASE)

C3

CO_2
ENTERS
CHLOROPLAST STROMA

↓

CO_2 + RIBULOSE BISPHOSPHATE / (RUBP)

↓

RIBULOSE BISPHOSPHATE
CARBOXYLASE
(RUBP-CARBOXYLASE)

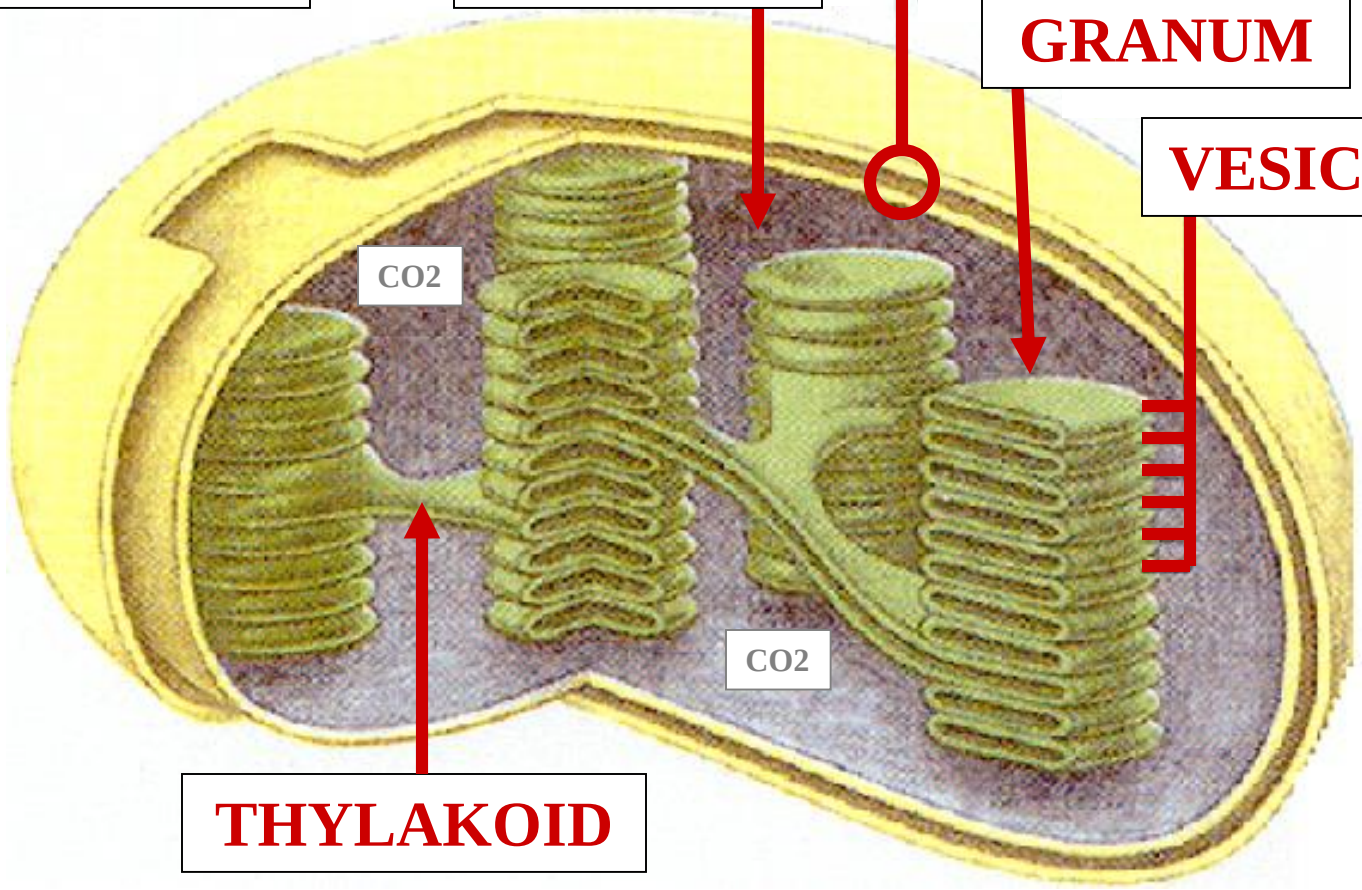
↓

UNSTABLE 6C COMPOUND

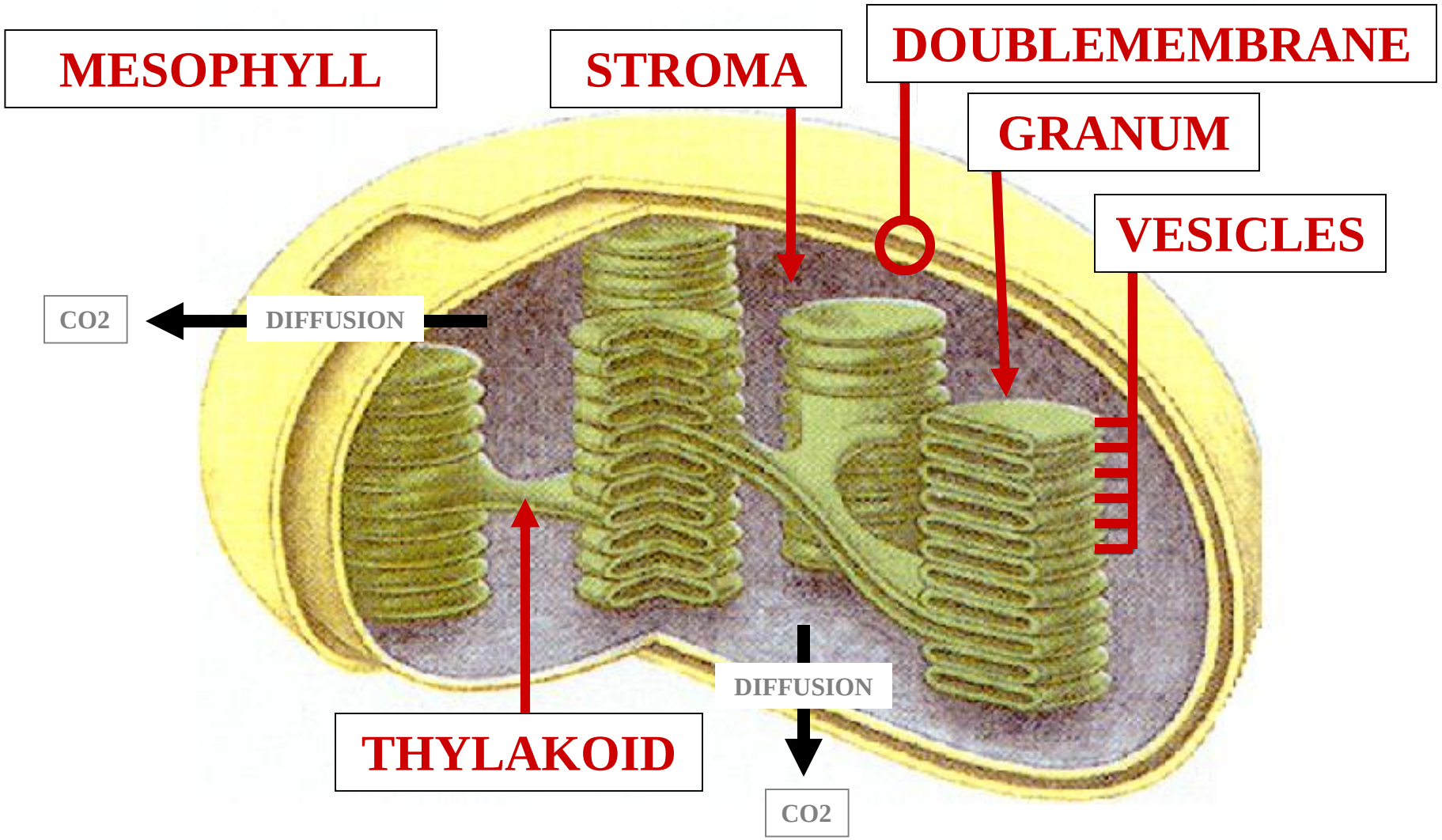
INEFFICIENT ENZYME

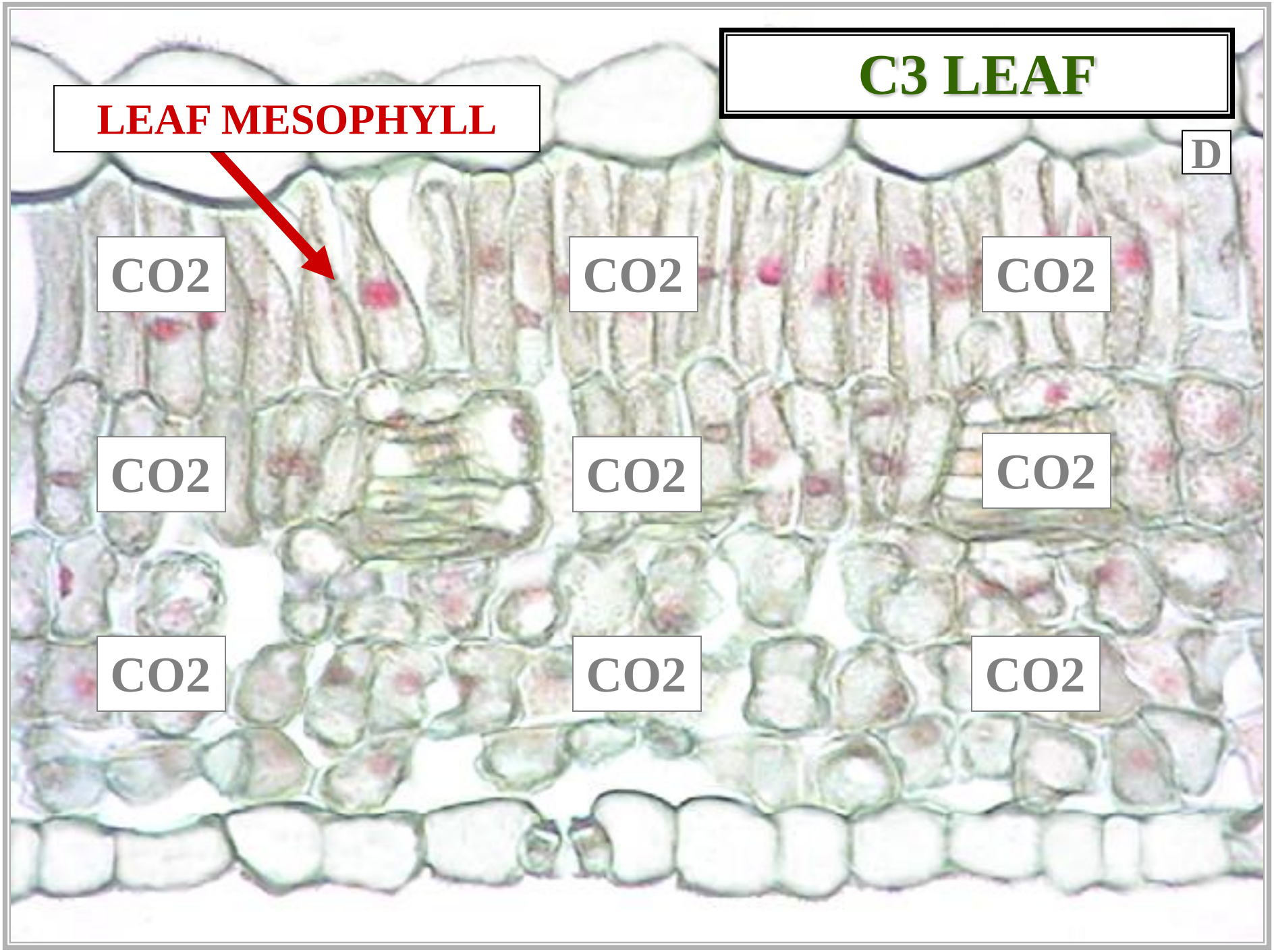
D

CHLOROPLAST ULTRASTRUCTURE



CHLOROPLAST ULTRASTRUCTURE




C3 LEAF
D
LEAF MESOPHYLL
CO2
CO2
CO2
CO2
CO2
CO2
CO2
CO2
CO2

C3 LEAF

LEAF MESOPHYLL

CO2 CO2 CO2

DIFFUSION DIFFUSION DIFFUSION

CO2 CO2 CO2

DIFFUSION DIFFUSION DIFFUSION

CO2 CO2 CO2

DIFFUSION DIFFUSION DIFFUSION

LEAF STOMATE

ATMOSPHERE

ATMOSPHERE

CO2

DIFFUSION

CO2

DIFFUSION

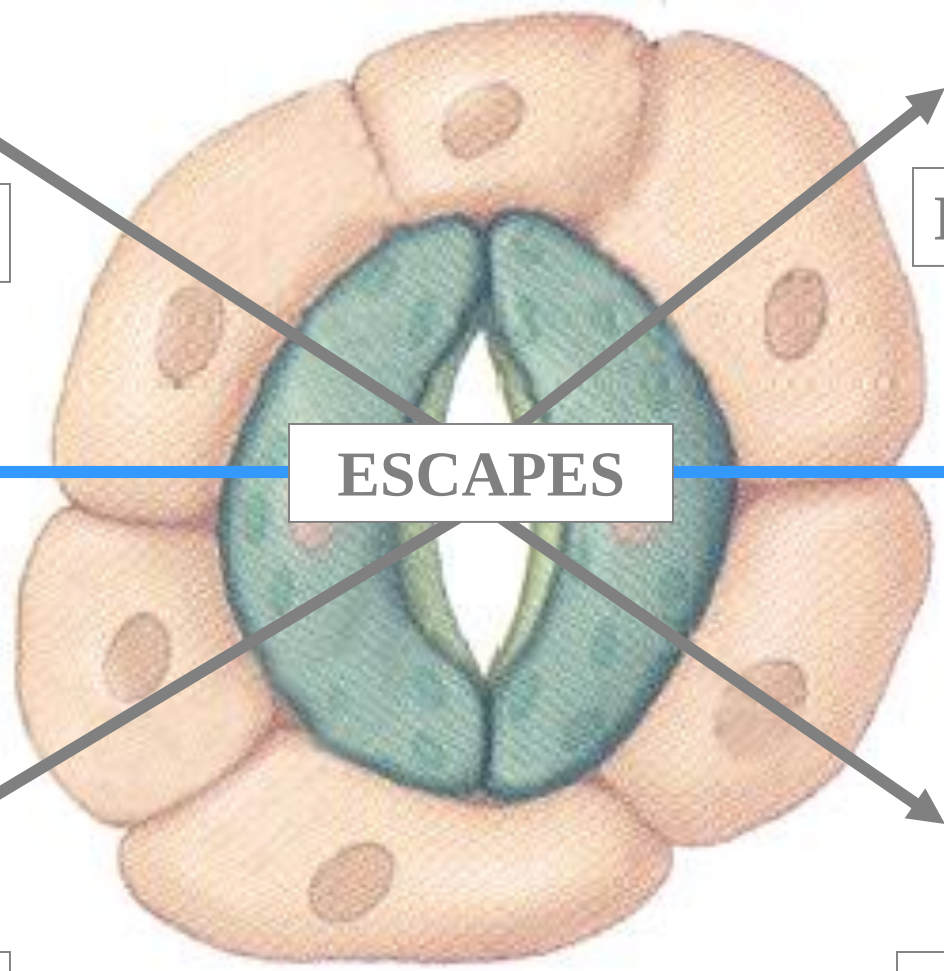
H2O

DIFFUSION

ESCAPES

H2O

DIFFUSION



CO2

DIFFUSION

CO2

DIFFUSION

PHOTO-RESPIRATION PATHWAY SPECIFICS

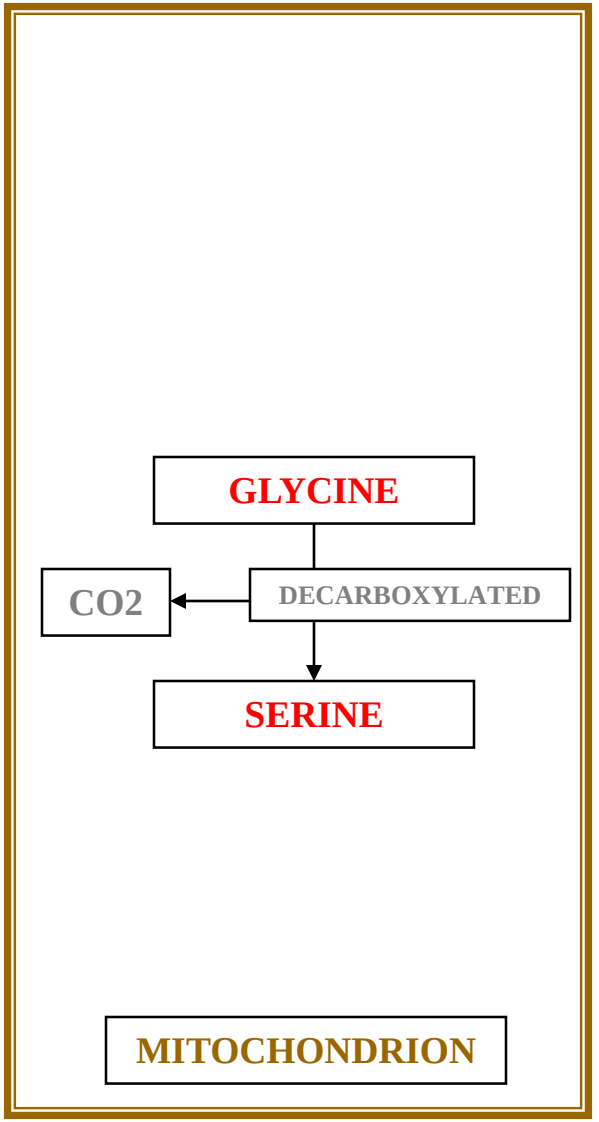
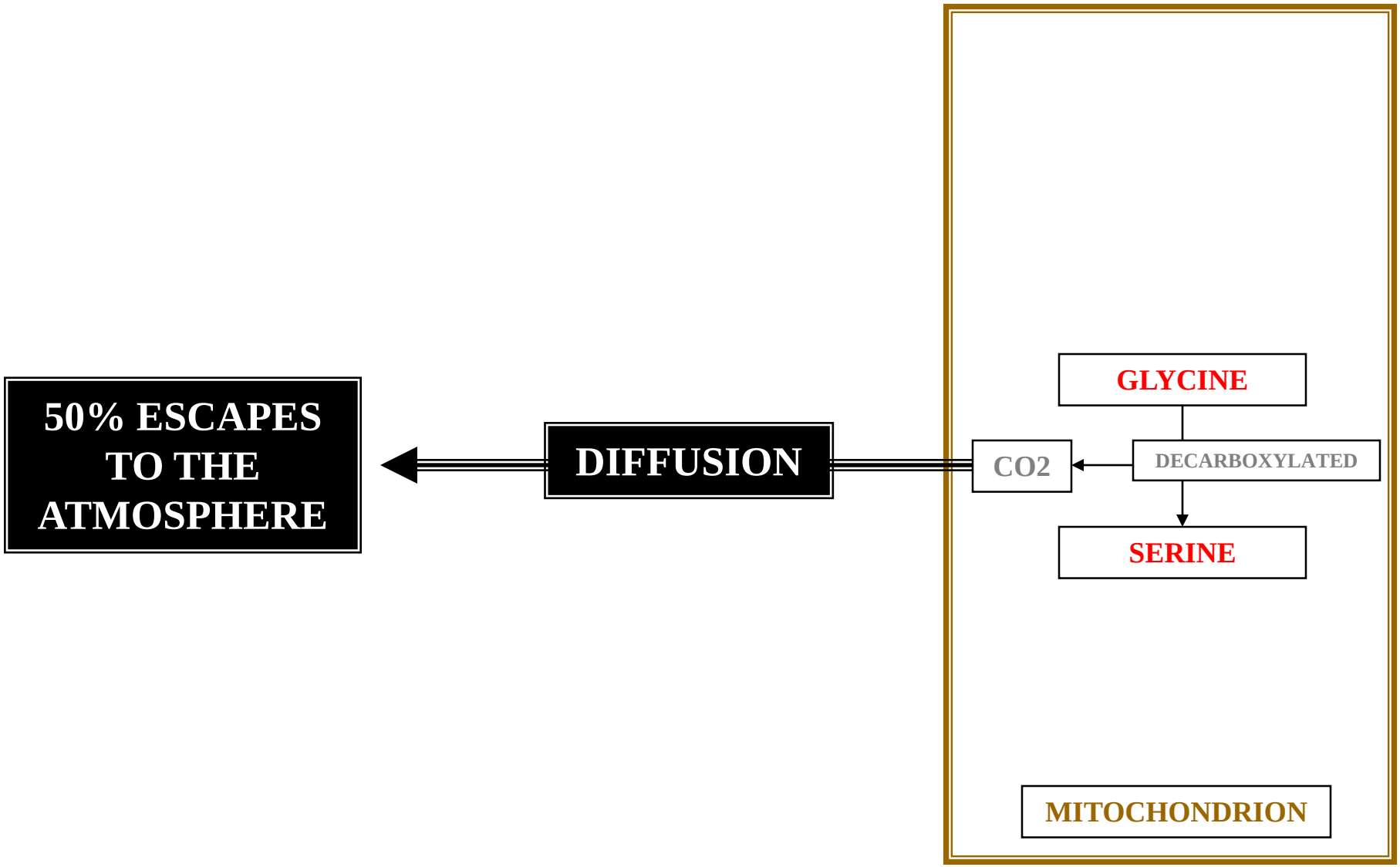


PHOTO-RESPIRATION PATHWAY SPECIFICS

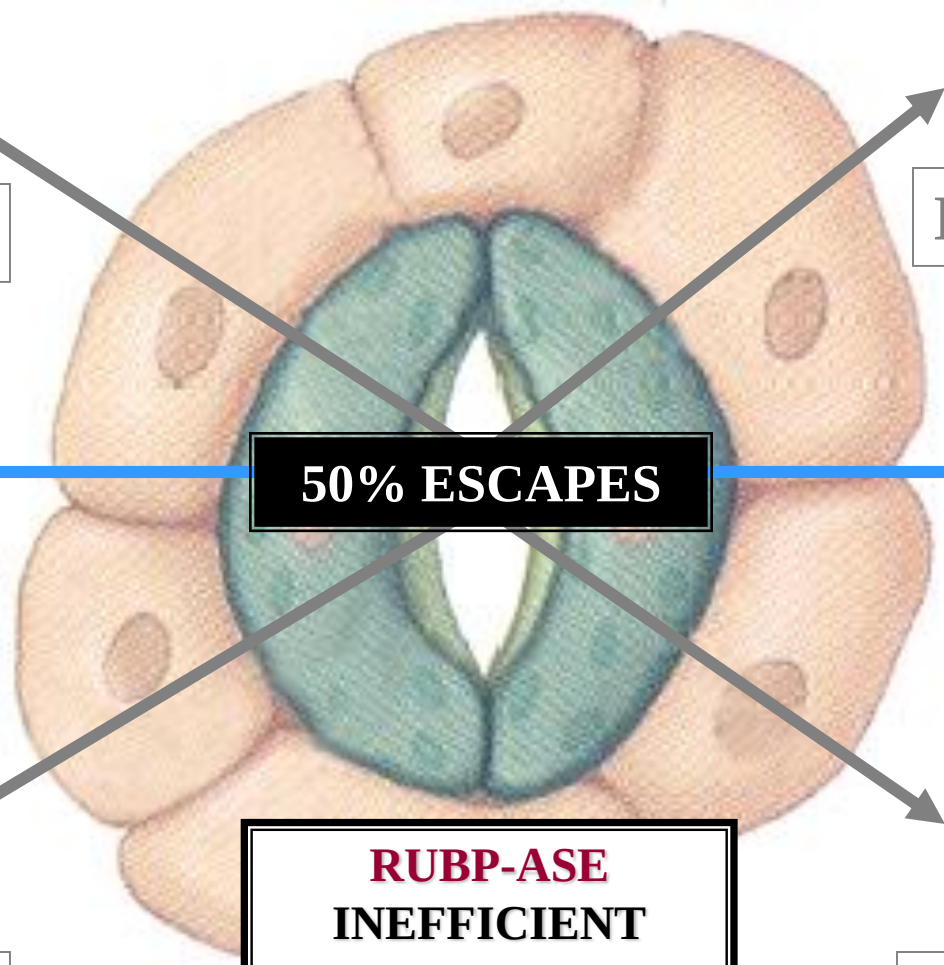


L

LEAF STOMATE

ATMOSPHERE

ATMOSPHERE



CO2

DIFFUSION

CO2

DIFFUSION

H2O

DIFFUSION

50% ESCAPES

H2O

DIFFUSION

CO2

DIFFUSION

RUBP-ASE
INEFFICIENT
ENZYME

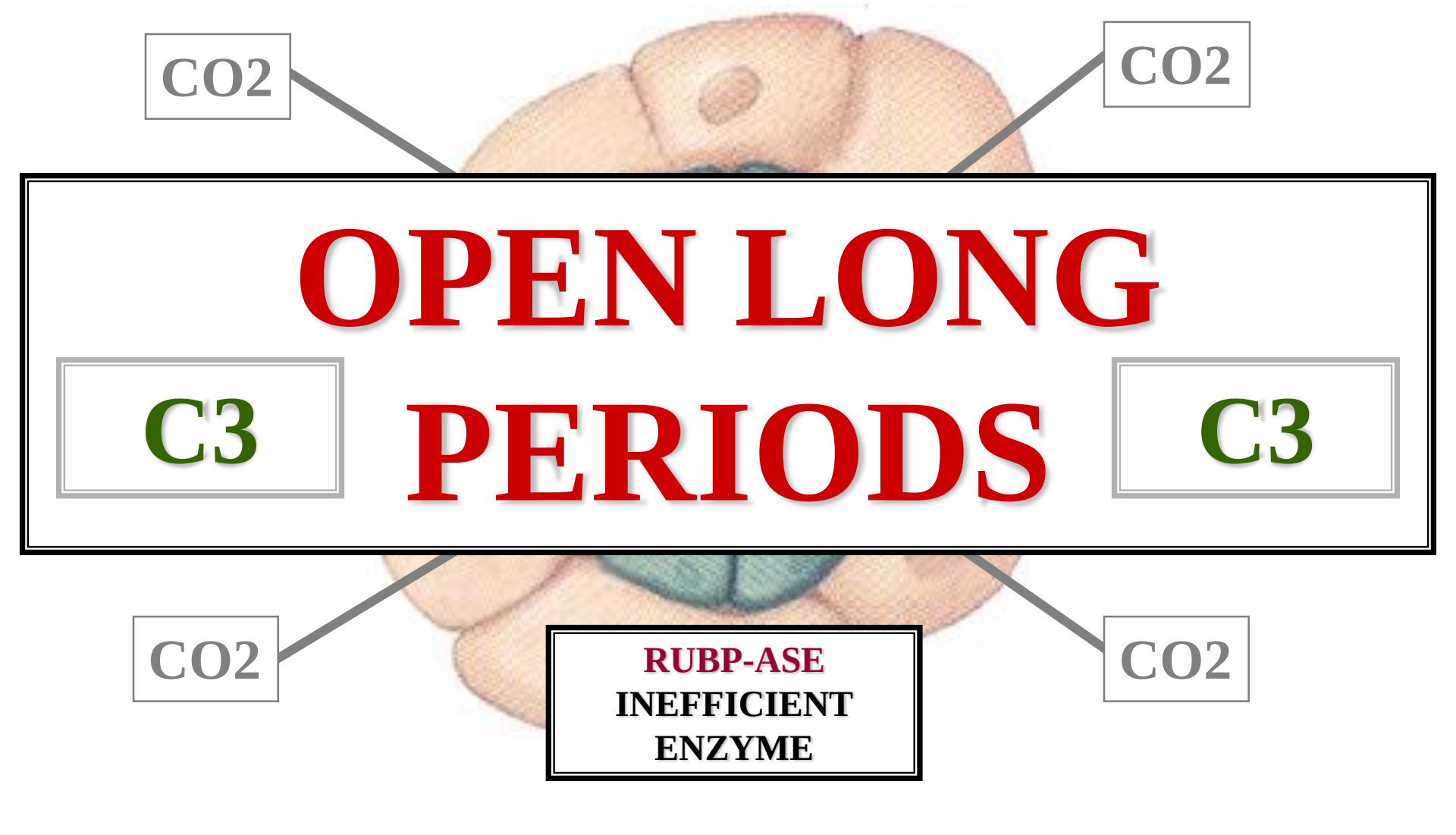
CO2

DIFFUSION

ATMOSPHERE

LEAF STOMATE

ATMOSPHERE



CO2

CO2

OPEN LONG PERIODS

C3

C3

CO2

CO2

RUBP-ASE
INEFFICIENT ENZYME

LEAF STOMATE

ATMOSPHERE

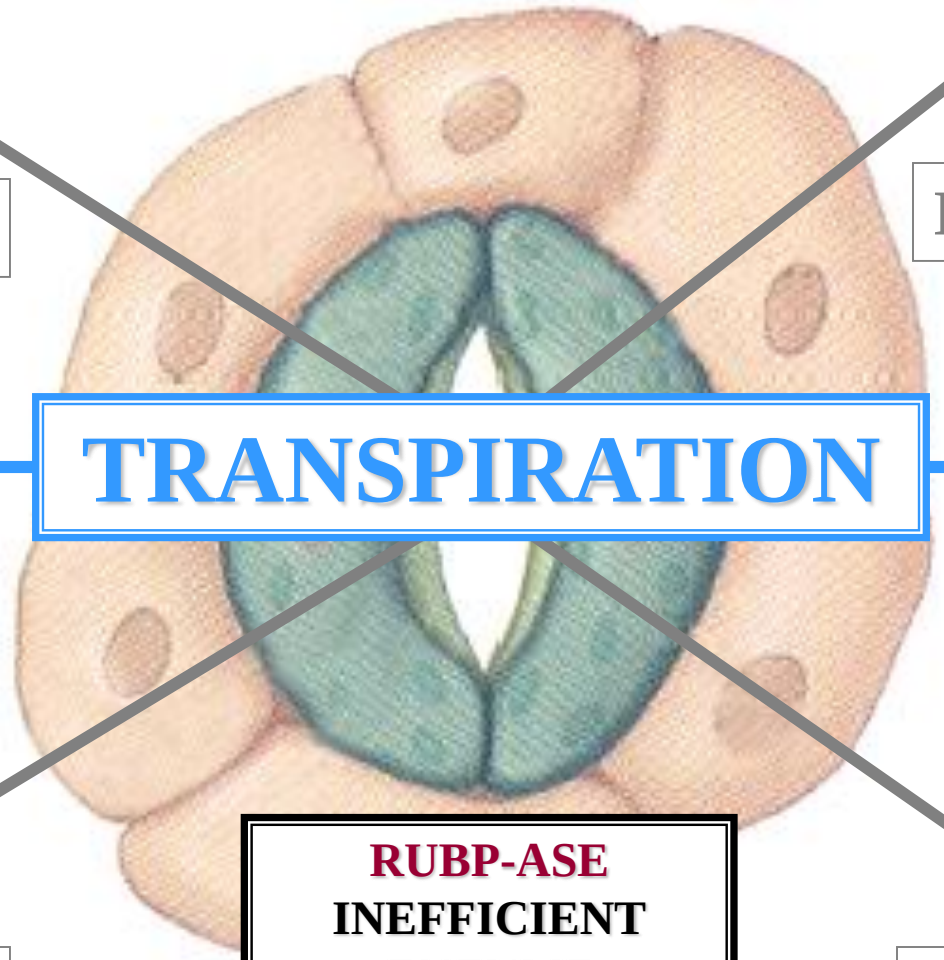
ATMOSPHERE

CO2

DIFFUSION

CO2

DIFFUSION



H2O

TRANSPIRATION

H2O

DIFFUSION

DIFFUSION

CO2

DIFFUSION

CO2

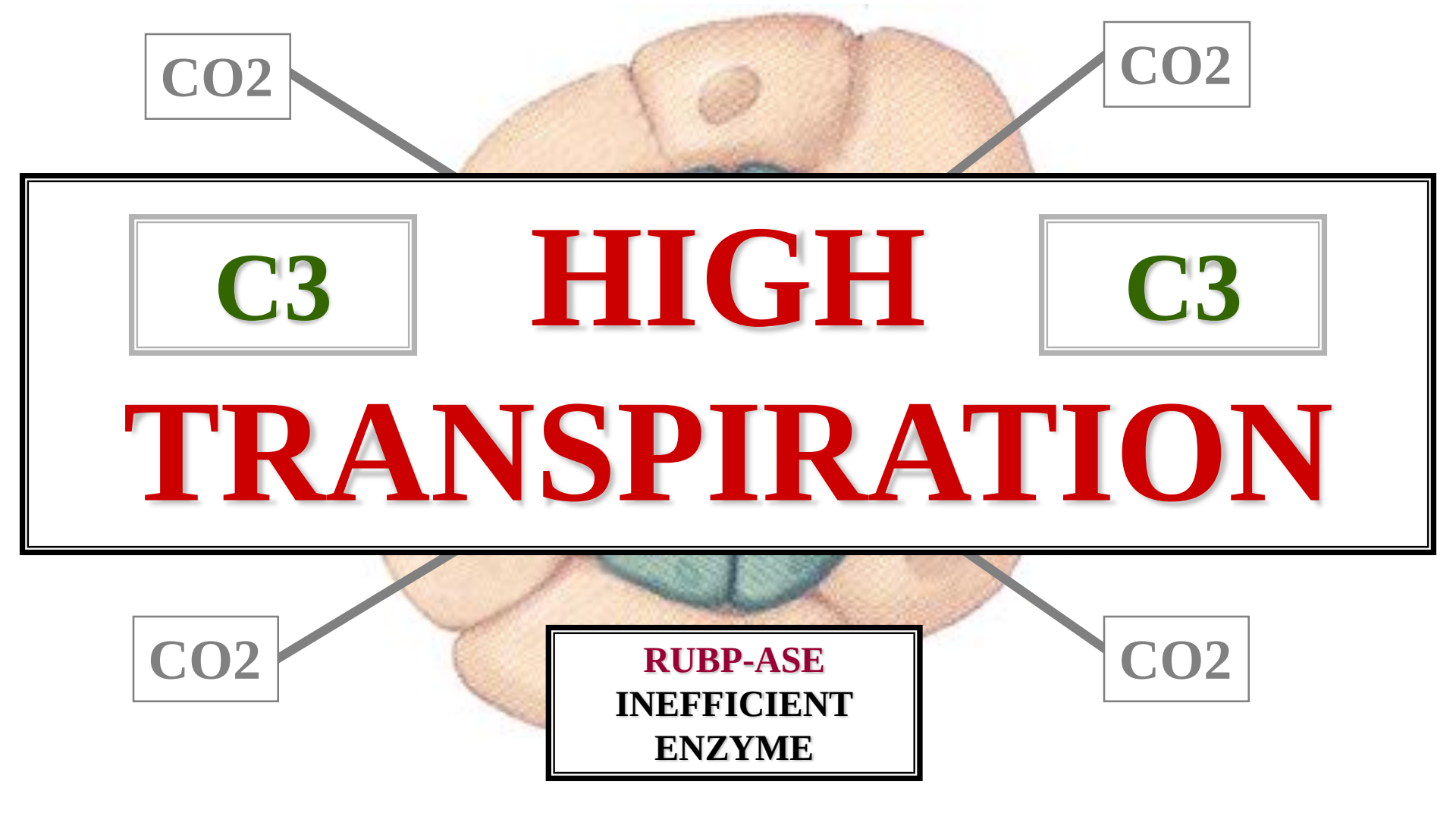
DIFFUSION

RUBP-ASE
INEFFICIENT
ENZYME

ATMOSPHERE

LEAF STOMATE

ATMOSPHERE



CO2

CO2

C3

HIGH TRANSPIRATION

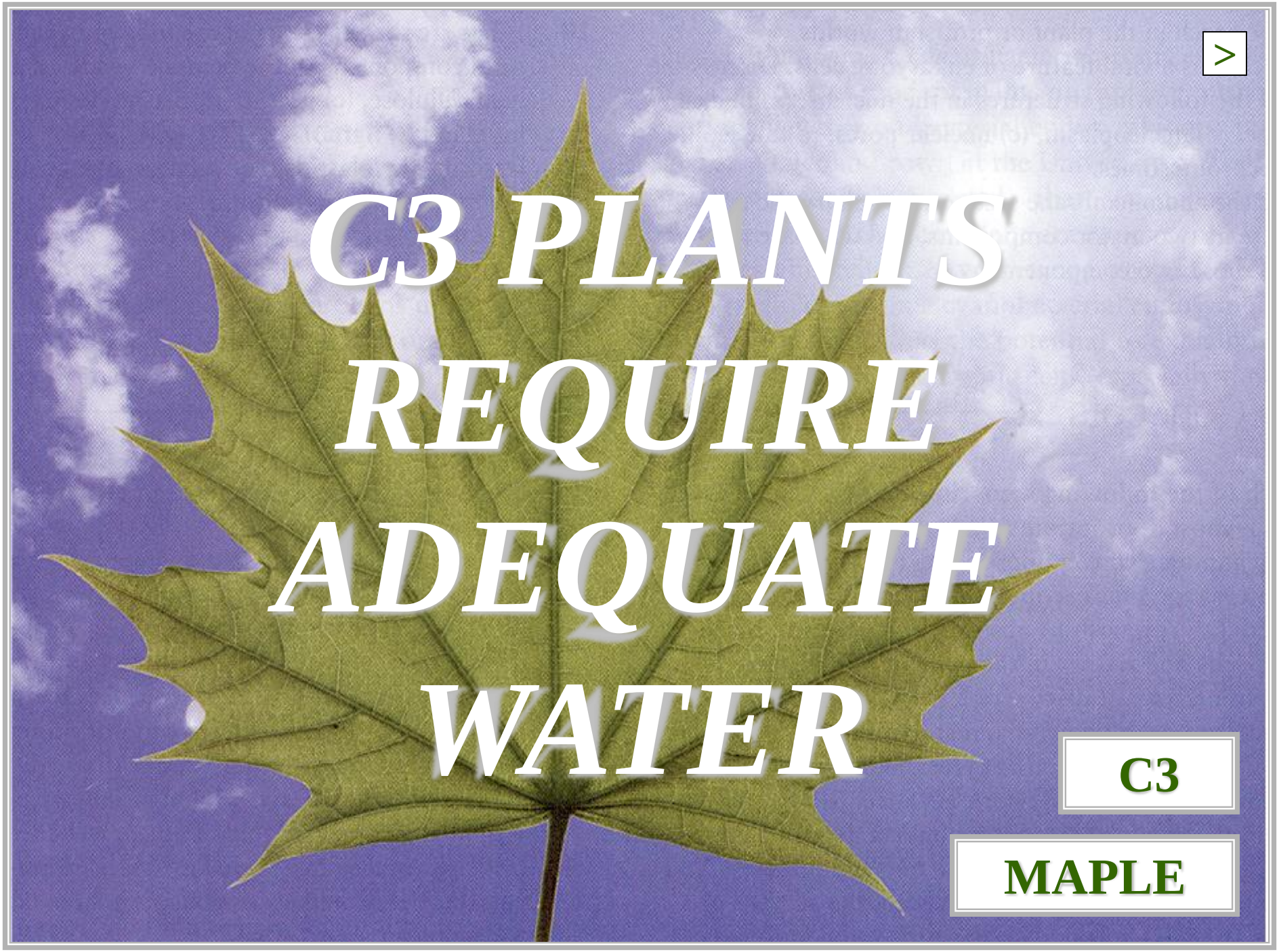
C3

CO2

CO2

RUBP-ASE
INEFFICIENT ENZYME


C3
MAPLE


C3 PLANTS REQUIRE ADEQUATE WATER
>
C3
MAPLE

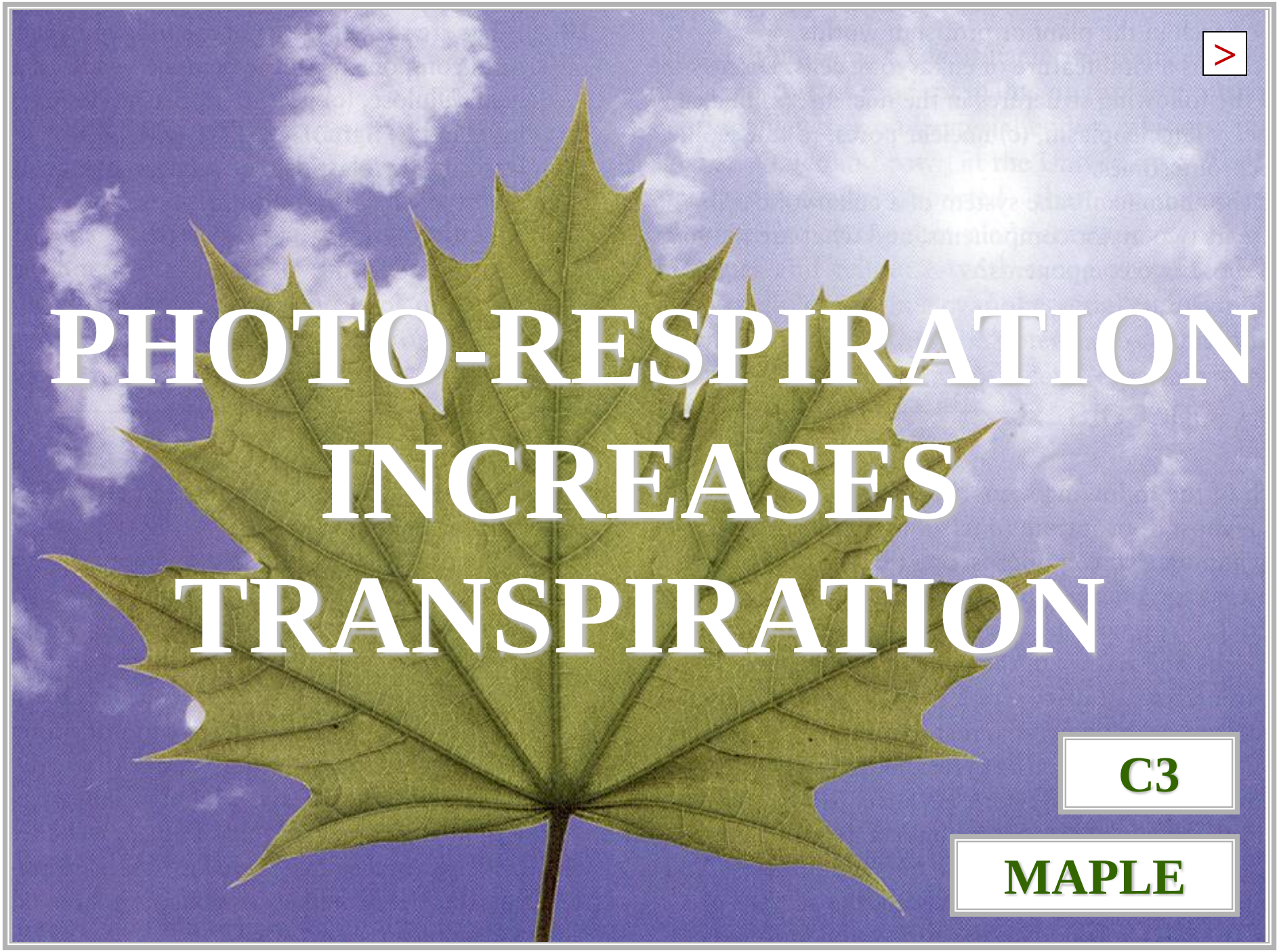

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PHOTO-RESPIRATION
INCREASES
TRANSPIRATION
C3
MAPLE

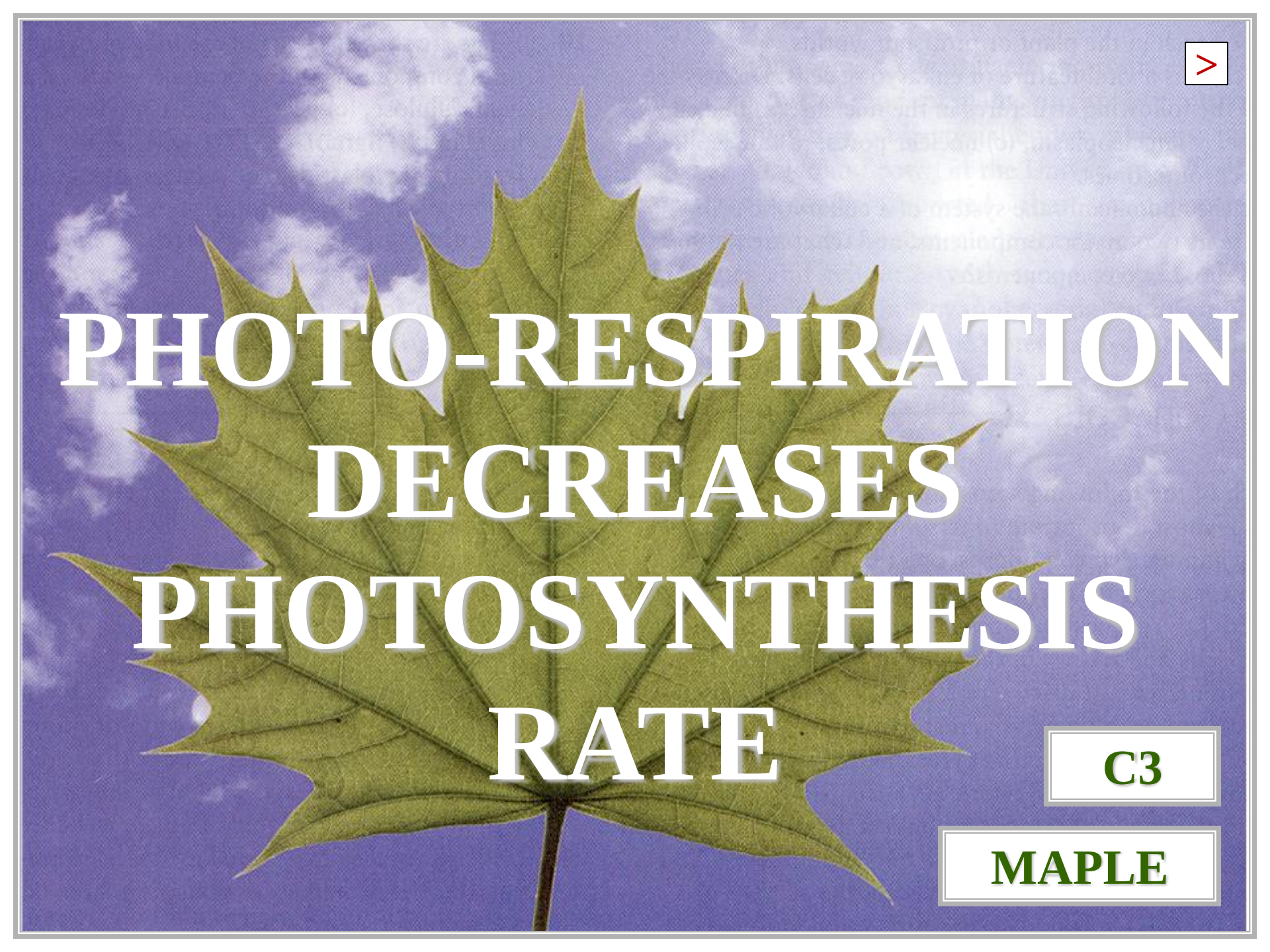


PHOTO-RESPIRATION
DECREASES
PHOTOSYNTHESIS
RATE
C3
MAPLE

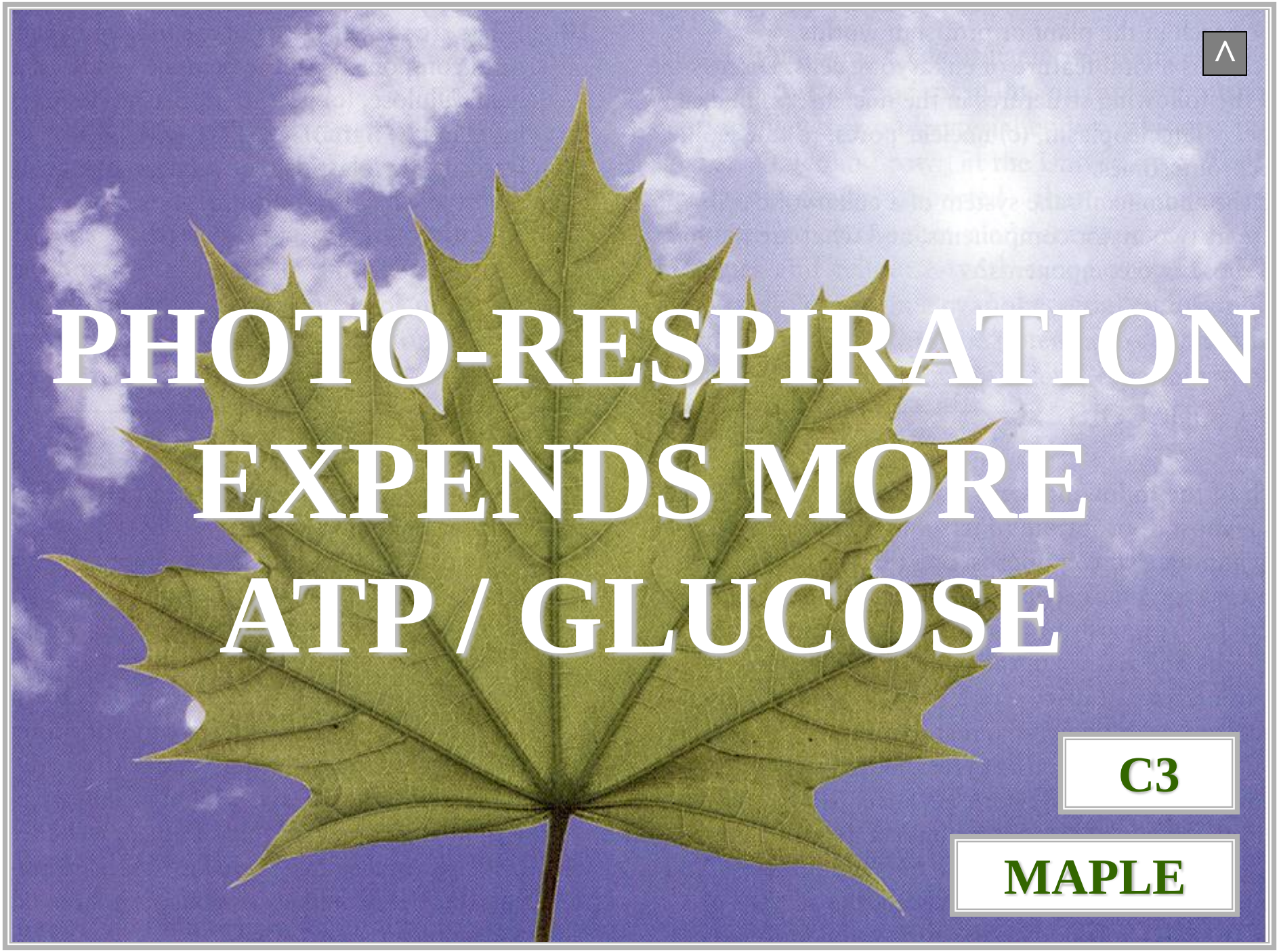


PHOTO-RESPIRATION
EXPENDS MORE
ATP / GLUCOSE
C3
MAPLE

PHOTO-RESPIRATION ENERGY COST

C

PHOTO-RESPIRATION & PHOTOSYNTHESIS ?

C3

MAPLE

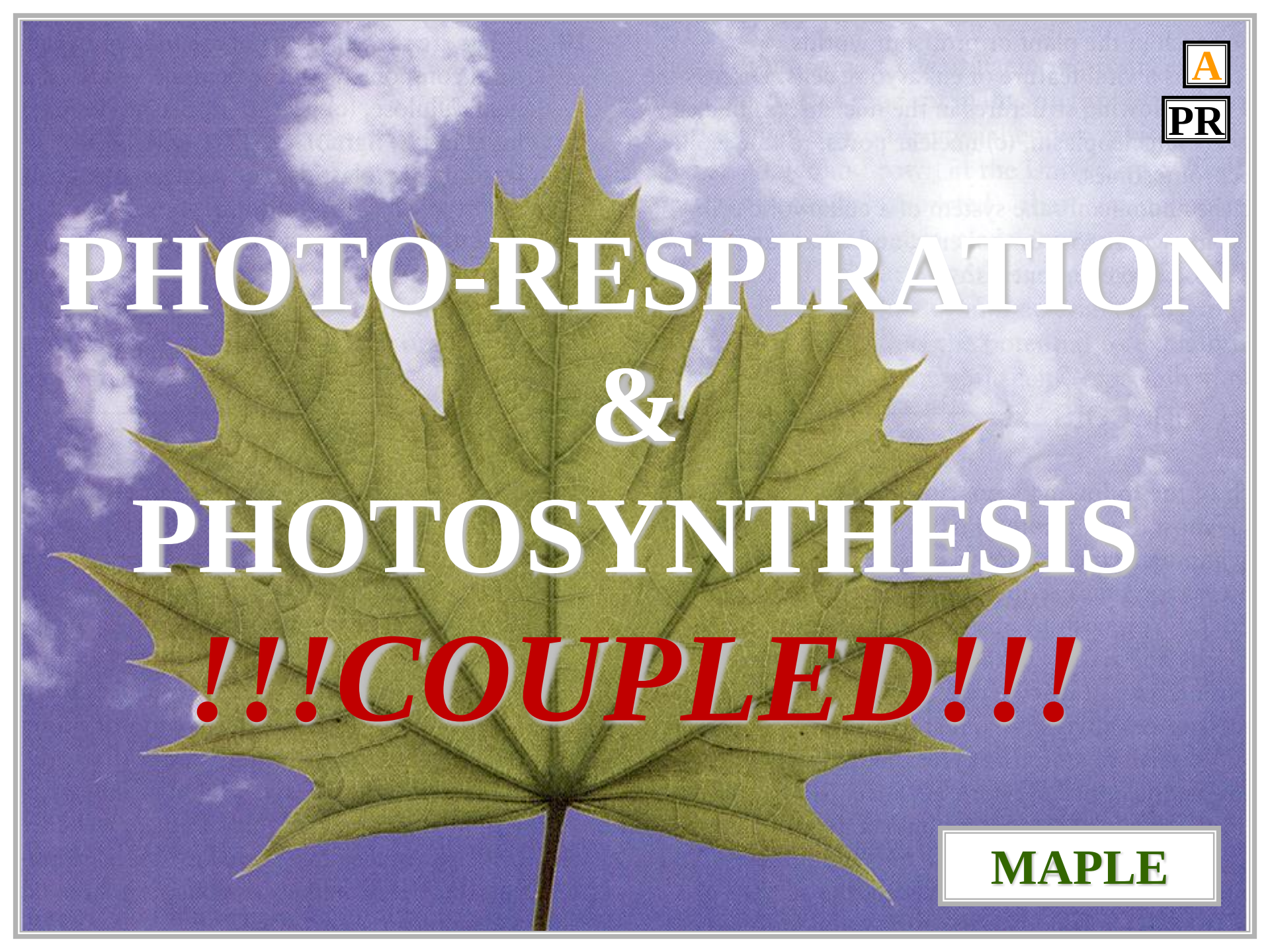
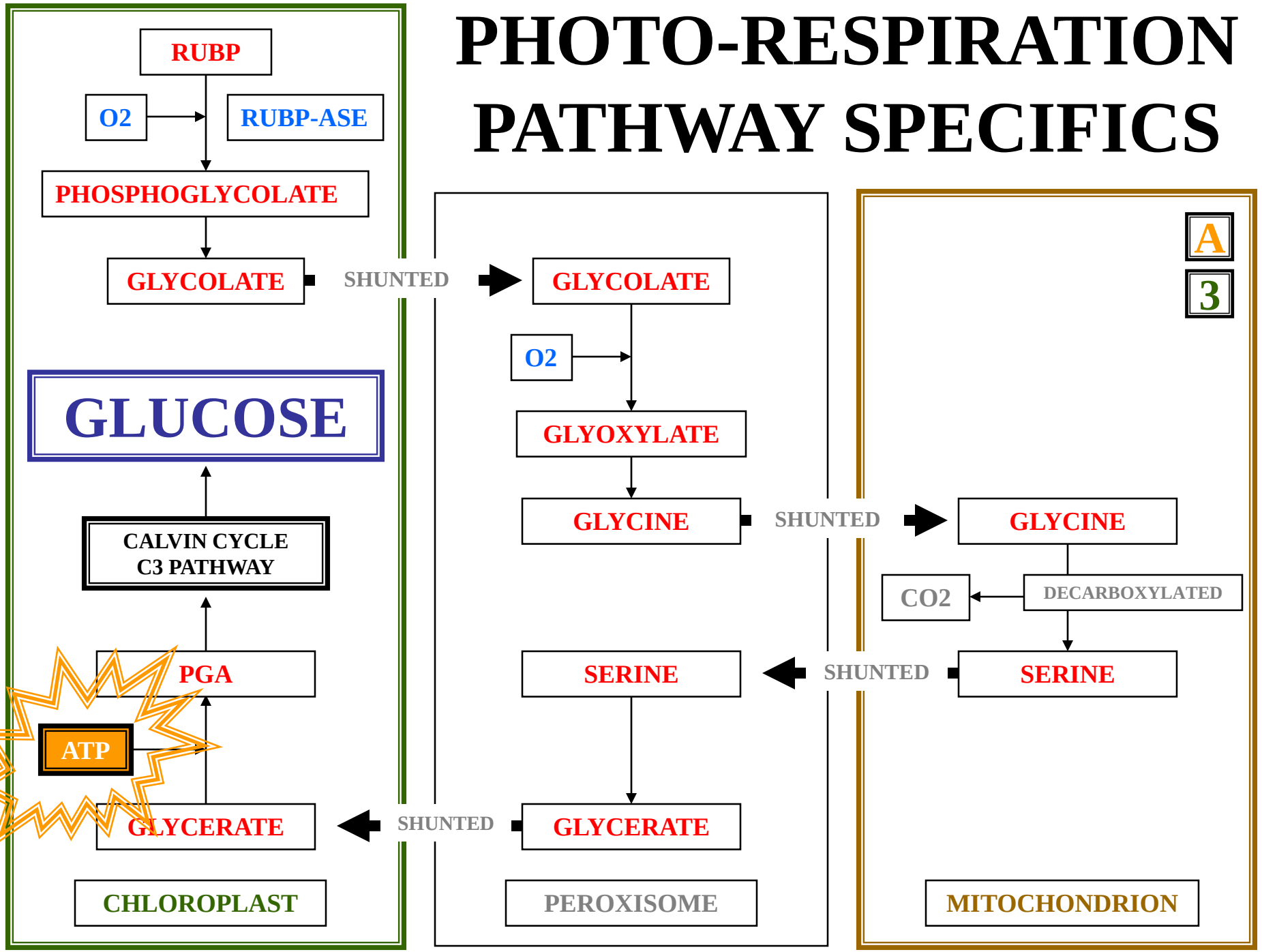

A
PR
PHOTO-RESPIRATION
&
PHOTOSYNTHESIS
!!!COUPLED!!!
MAPLE

PHOTO-RESPIRATION PATHWAY SPECIFICS



C3

CO_2 + RIBULOSE BISPHOSPHATE / (RUBP)

RIBULOSE BISPHOSPHATE CARBOXYLASE (RUBP-CARBOXYLASE)

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

ATP

BISPHOSPHOGLYCERATE / (BIPGA)

NADPH

PHOSPHOGLYCERALDEHYDE / (PGAL)

COMPLEX SERIES CHEMICAL RXTS (CSCR)

GLUCOSE

ALL RXTS REQUIRE A SPECIFIC ENZYME

PHOSPHOGLYCERATE / (PGA)

ATP

BISPHOSPHOGLYCERATE / (BIPGA)

NADPH

Λ

PHOSPHOGLYCERALDEHYDE / (PGAL)

COMPLEX SERIES CHEMICAL RXTS (CSCR)

ATP

RIBULOSE BISPHOSPHATE / (RUBP)

CALVIN CYCLE

PHOTO-RESPIRATION
ENERGY EXPENSE

?

ATP

ENERGY EXPENSE

C3

MAPLE

PHOTO-RESPIRATION PATHWAY SPECIFICS

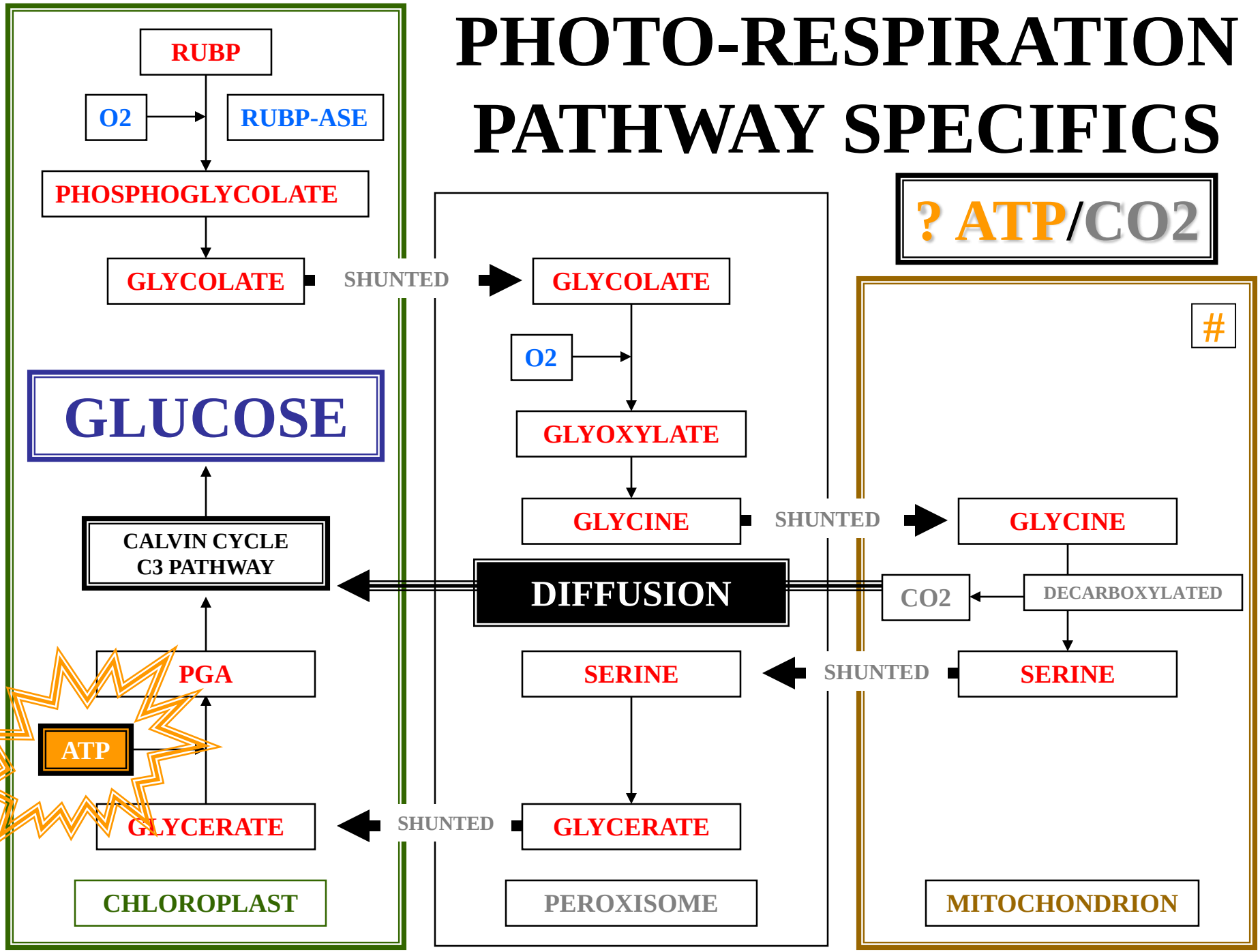
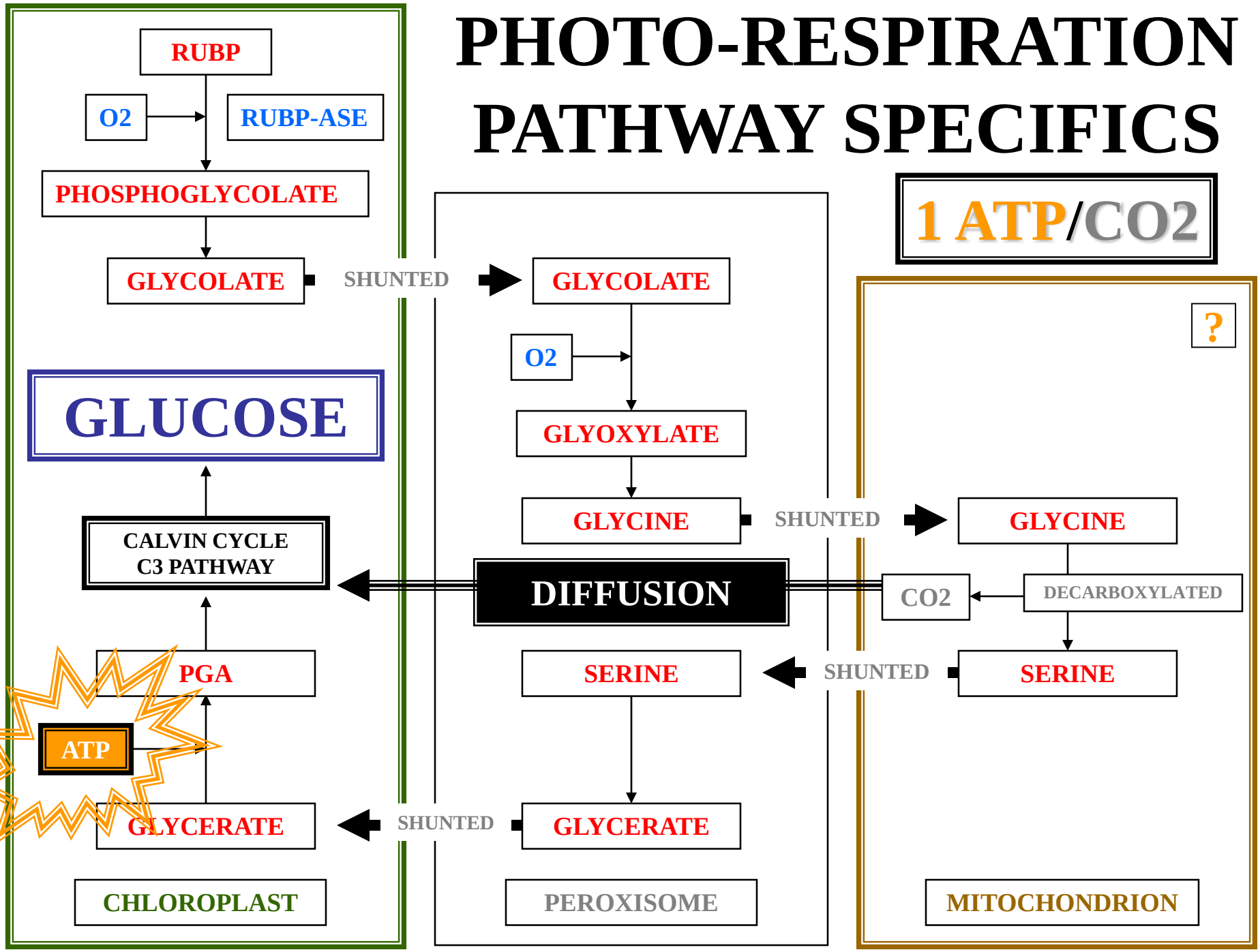
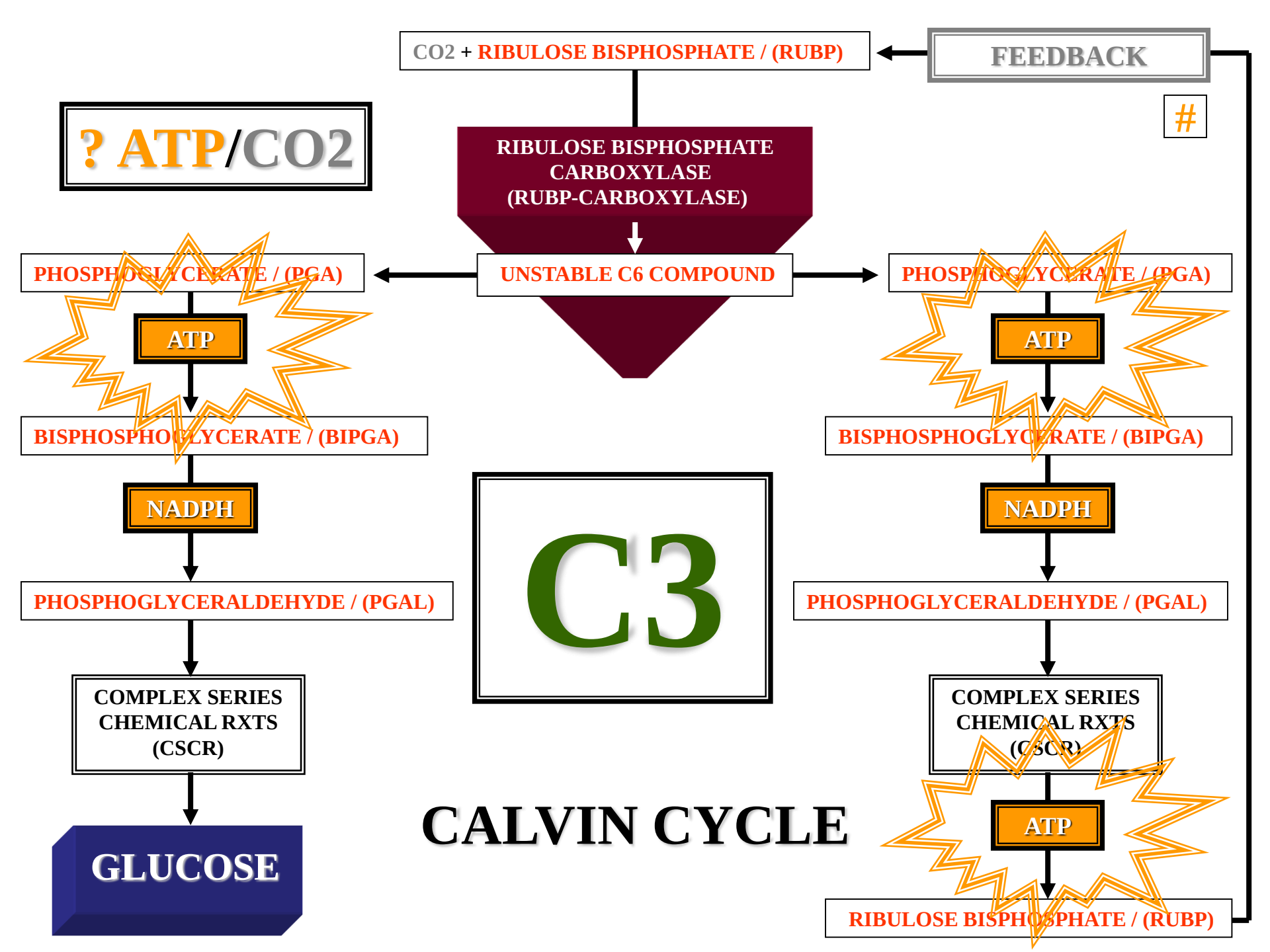
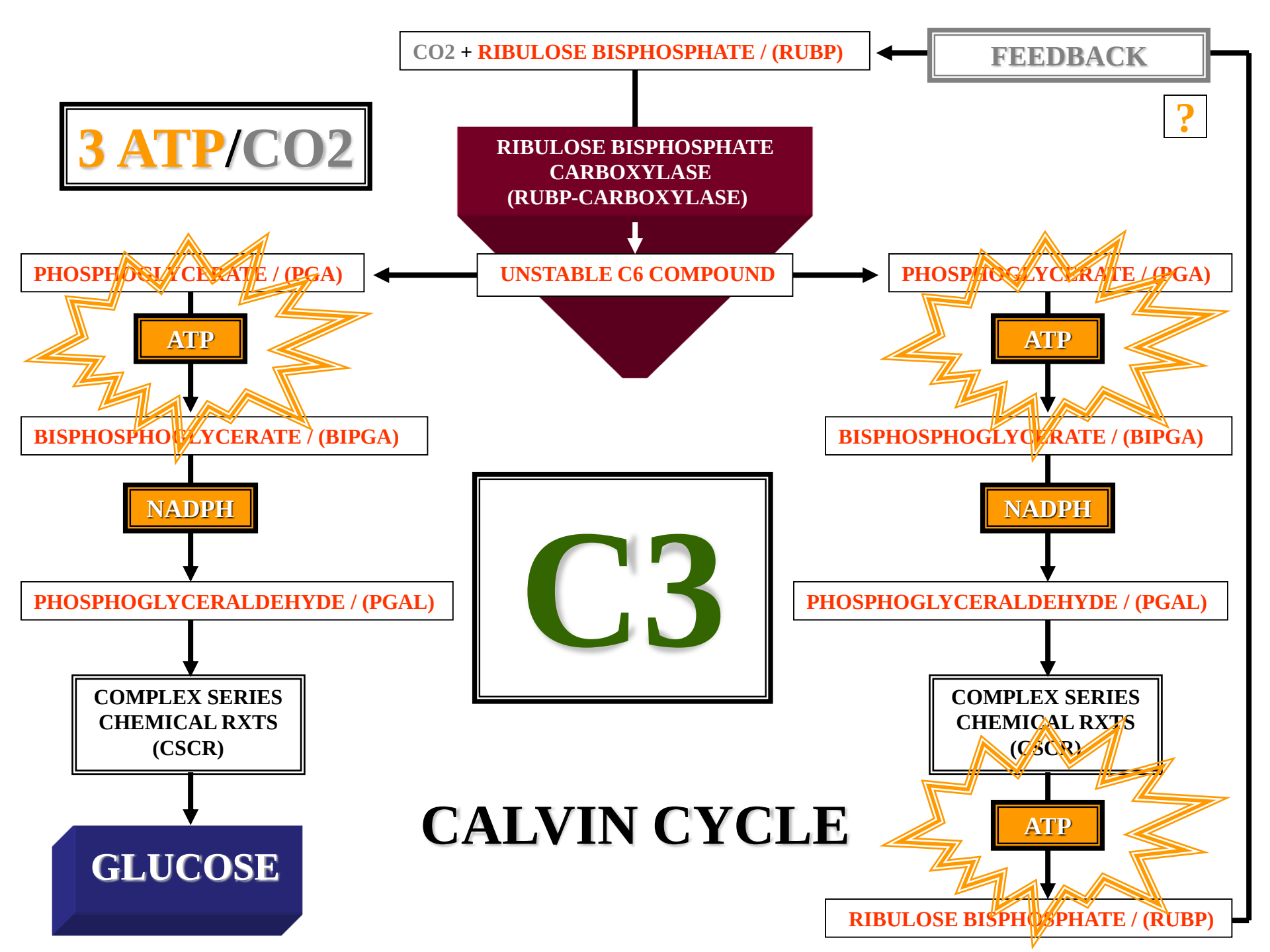


PHOTO-RESPIRATION PATHWAY SPECIFICS




CO2 + RIBULOSE BISPHOSPHATE / (RUBP)
FEEDBACK
#
? ATP/CO2
RIBULOSE BISPHOSPHATE CARBOXYLASE (RUBP-CARBOXYLASE)
UNSTABLE C6 COMPOUND
PHOSPHOGLYCERATE / (PGA)
PHOSPHOGLYCERATE / (PGA)
ATP
ATP
BISPHOSPHOGLYCERATE / (BIPGA)
BISPHOSPHOGLYCERATE / (BIPGA)
NADPH
NADPH
C3
PHOSPHOGLYCERALDEHYDE / (PGAL)
PHOSPHOGLYCERALDEHYDE / (PGAL)
COMPLEX SERIES CHEMICAL RXTS (CSCR)
COMPLEX SERIES CHEMICAL RXTS (CSCR)
CALVIN CYCLE
ATP
GLUCOSE
RIBULOSE BISPHOSPHATE / (RUBP)


CO2 + RIBULOSE BISPHOSPHATE / (RUBP)
FEEDBACK
?
3 ATP/CO2
RIBULOSE BISPHOSPHATE CARBOXYLASE (RUBP-CARBOXYLASE)
UNSTABLE C6 COMPOUND
PHOSPHOGLYCERATE / (PGA)
PHOSPHOGLYCERATE / (PGA)
ATP
ATP
BISPHOSPHOGLYCERATE / (BIPGA)
BISPHOSPHOGLYCERATE / (BIPGA)
NADPH
NADPH
C3
PHOSPHOGLYCERALDEHYDE / (PGAL)
PHOSPHOGLYCERALDEHYDE / (PGAL)
COMPLEX SERIES CHEMICAL RXTS (CSCR)
COMPLEX SERIES CHEMICAL RXTS (CSCR)
CALVIN CYCLE
ATP
GLUCOSE
RIBULOSE BISPHOSPHATE / (RUBP)

#

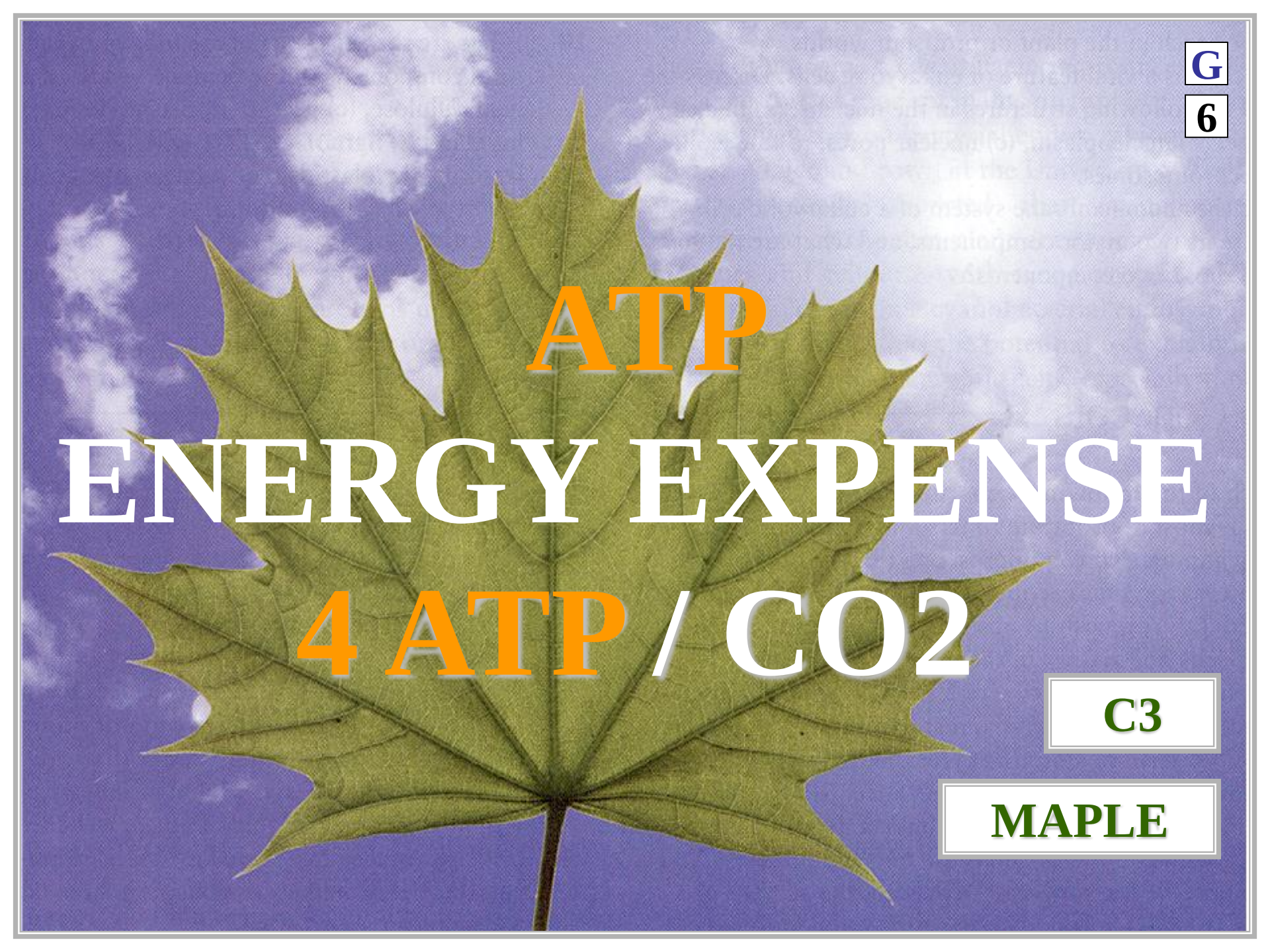
ATP

ENERGY EXPENSE

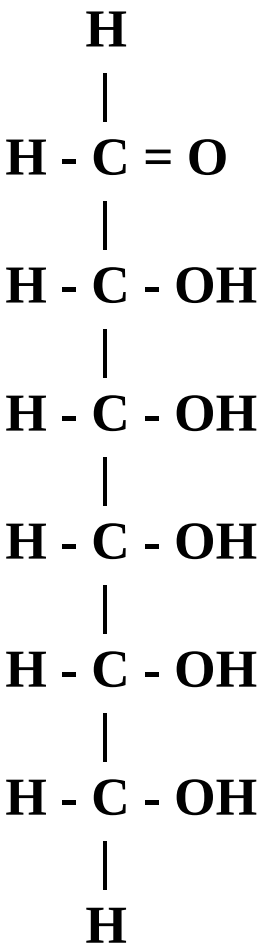
? ATP / CO2

C3

MAPLE


G
6
ATP
ENERGY EXPENSE
4 ATP / CO2
C3
MAPLE

GLUCOSE



C6H12O6

GLUCOSE
6C
SUGAR

GLUCOSE
6C
SUGAR

PR

PHOTO-RESPIRATION PATHWAY SPECIFICS X

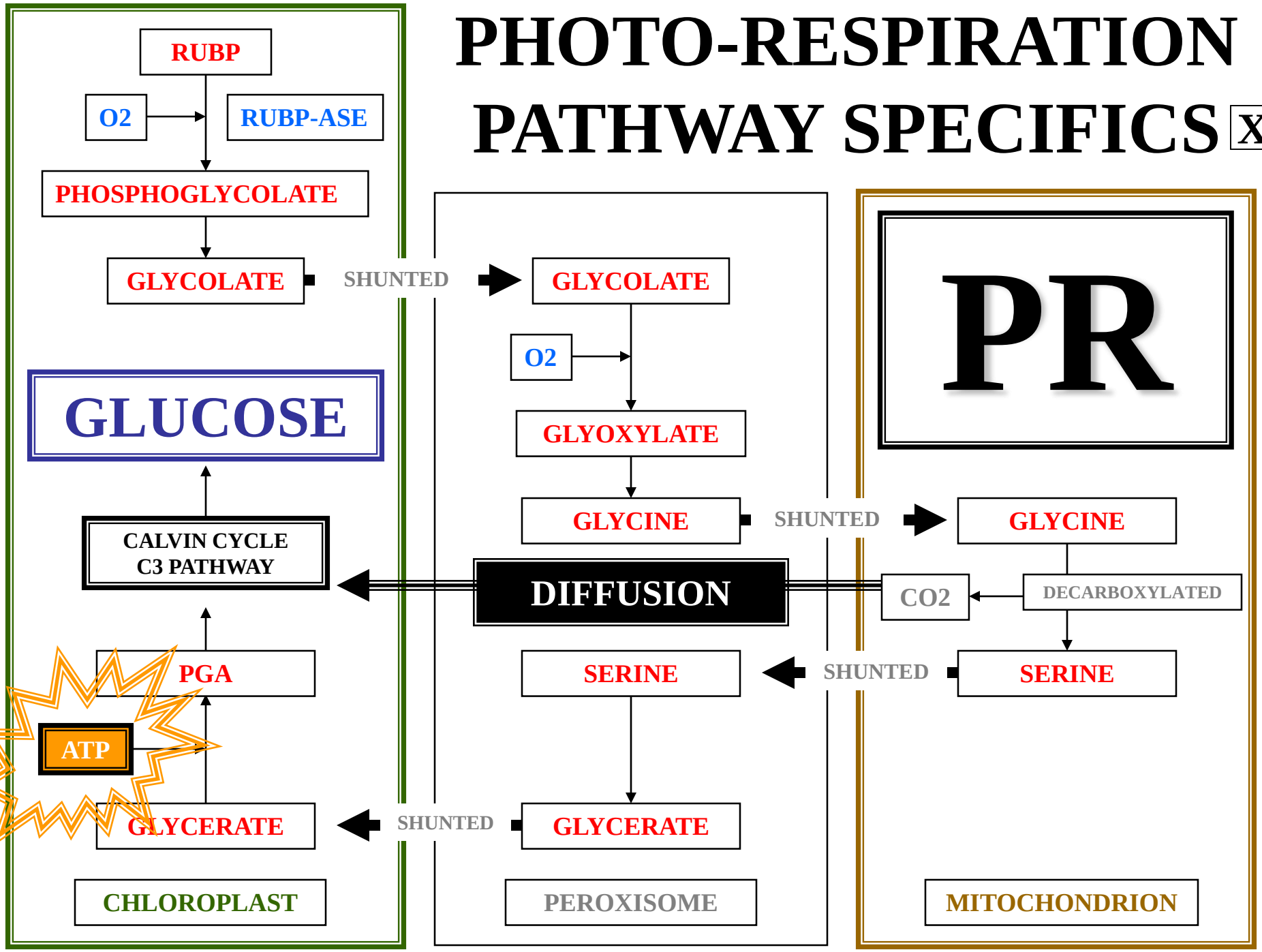
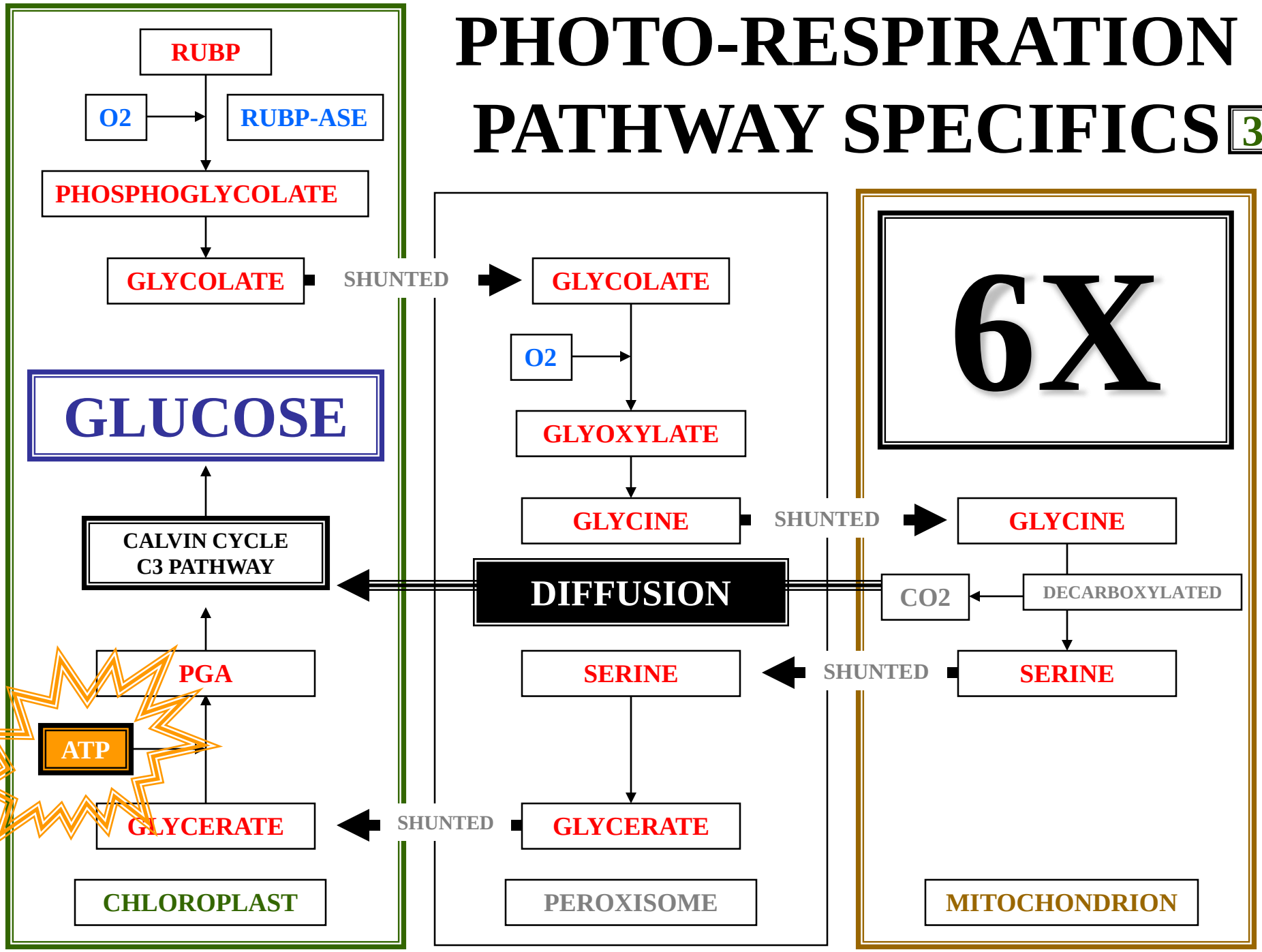
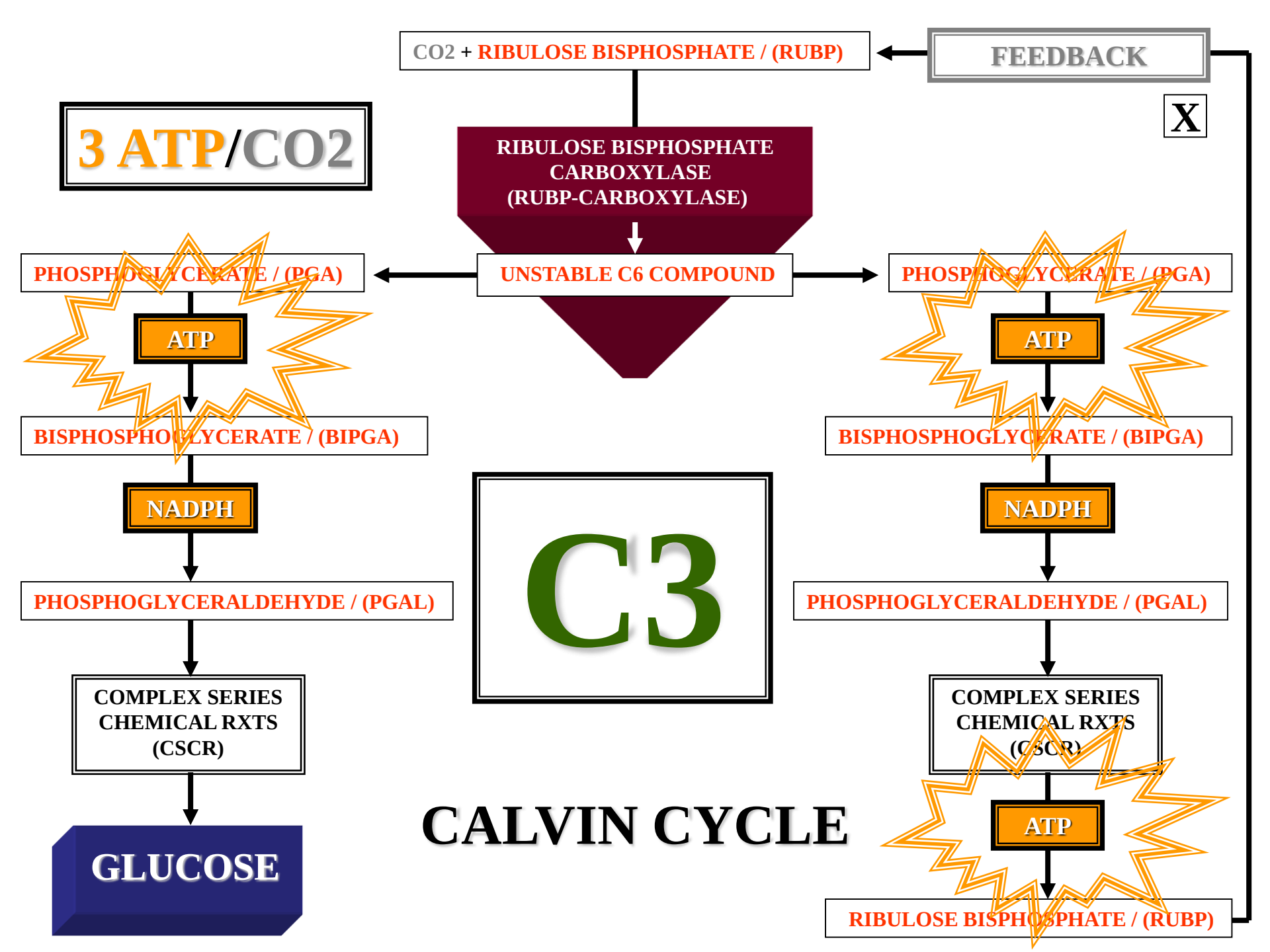
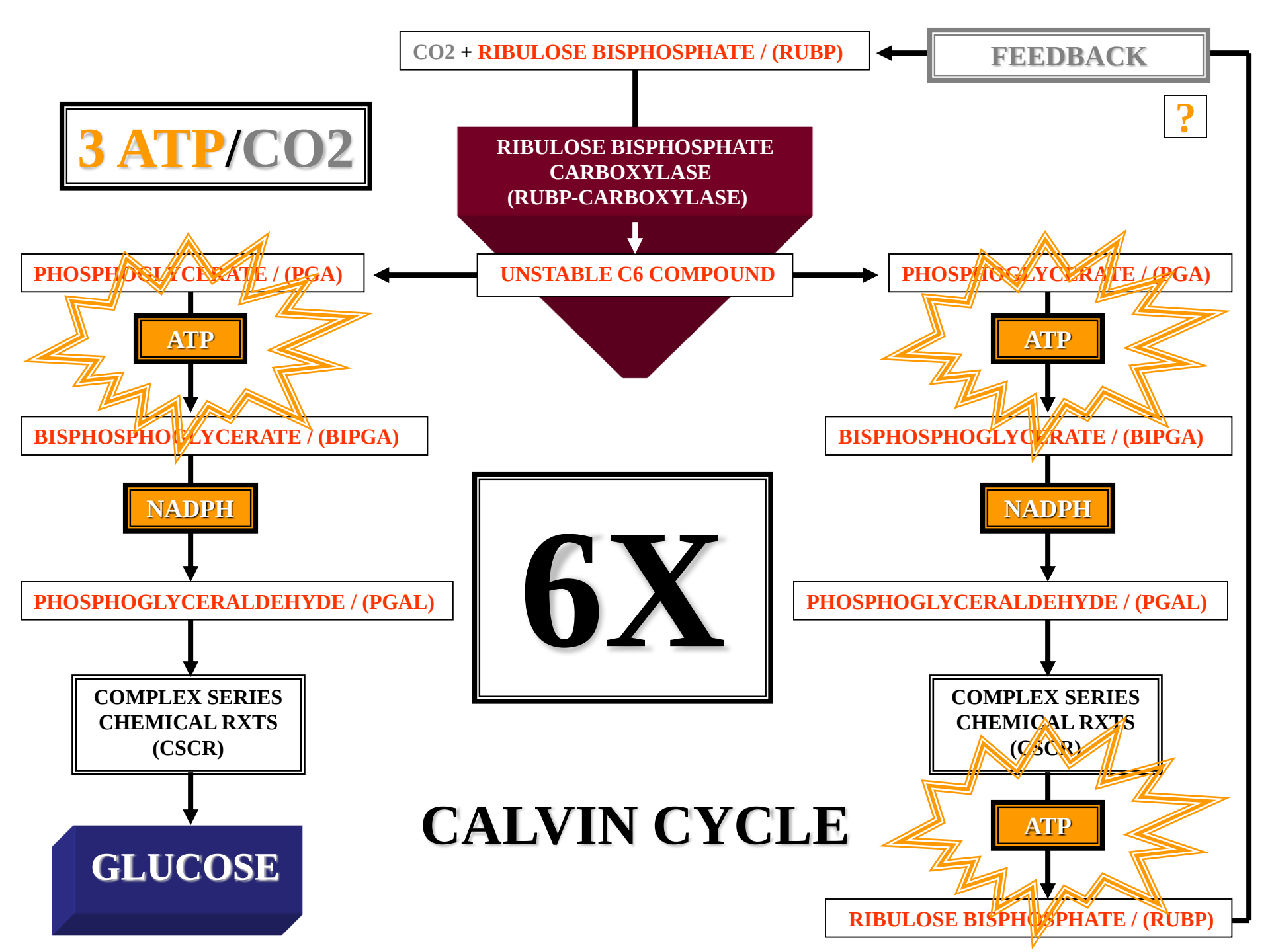


PHOTO-RESPIRATION PATHWAY SPECIFICS 3



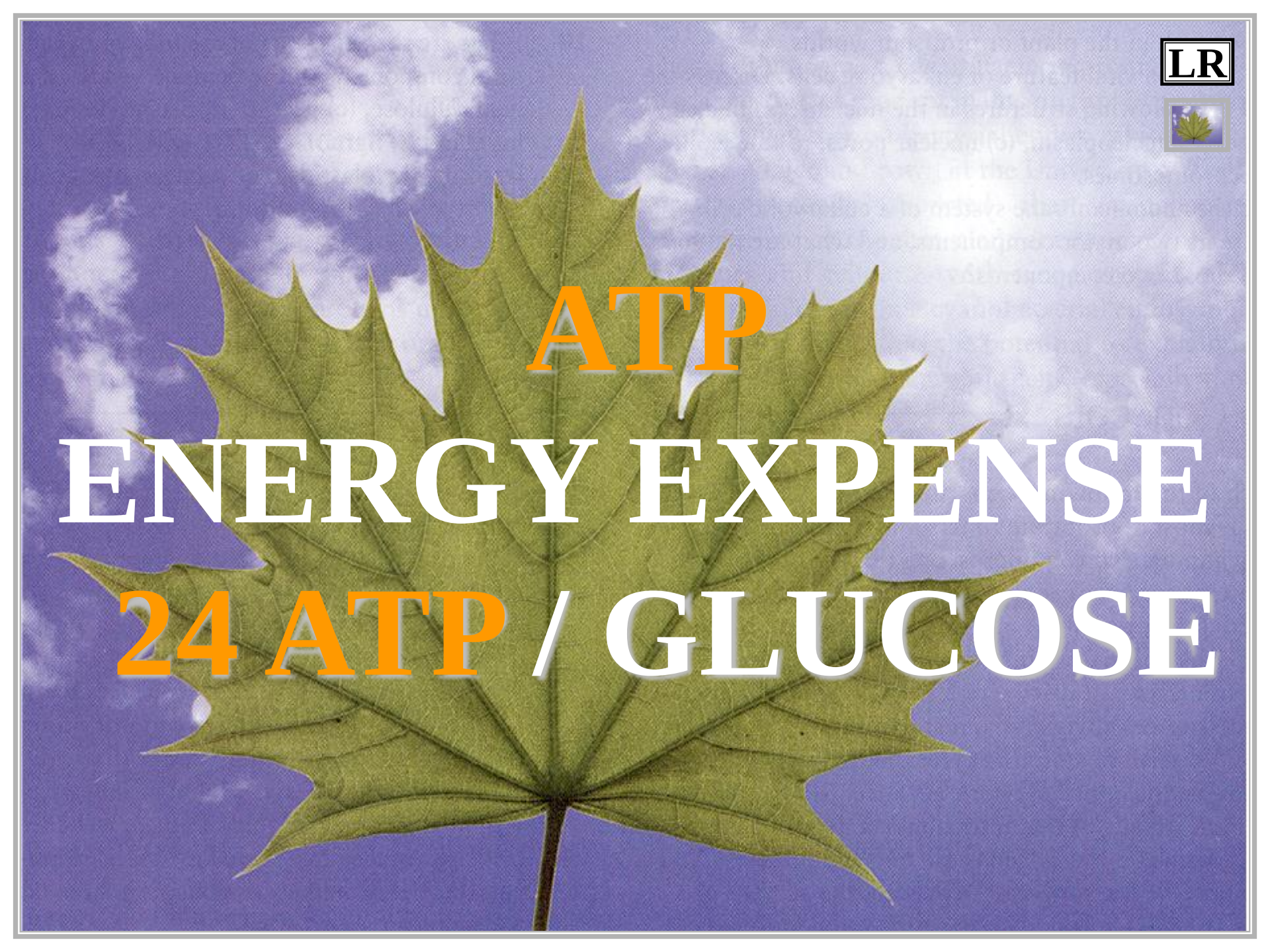

CO2 + RIBULOSE BISPHOSPHATE / (RUBP)
FEEDBACK
X
3 ATP/CO2
RIBULOSE BISPHOSPHATE CARBOXYLASE (RUBP-CARBOXYLASE)
UNSTABLE C6 COMPOUND
PHOSPHOGLYCERATE / (PGA)
PHOSPHOGLYCERATE / (PGA)
ATP
ATP
BISPHOSPHOGLYCERATE / (BIPGA)
BISPHOSPHOGLYCERATE / (BIPGA)
NADPH
NADPH
C3
PHOSPHOGLYCERALDEHYDE / (PGAL)
PHOSPHOGLYCERALDEHYDE / (PGAL)
COMPLEX SERIES CHEMICAL RXTS (CSCR)
COMPLEX SERIES CHEMICAL RXTS (CSCR)
CALVIN CYCLE
ATP
GLUCOSE
RIBULOSE BISPHOSPHATE / (RUBP)

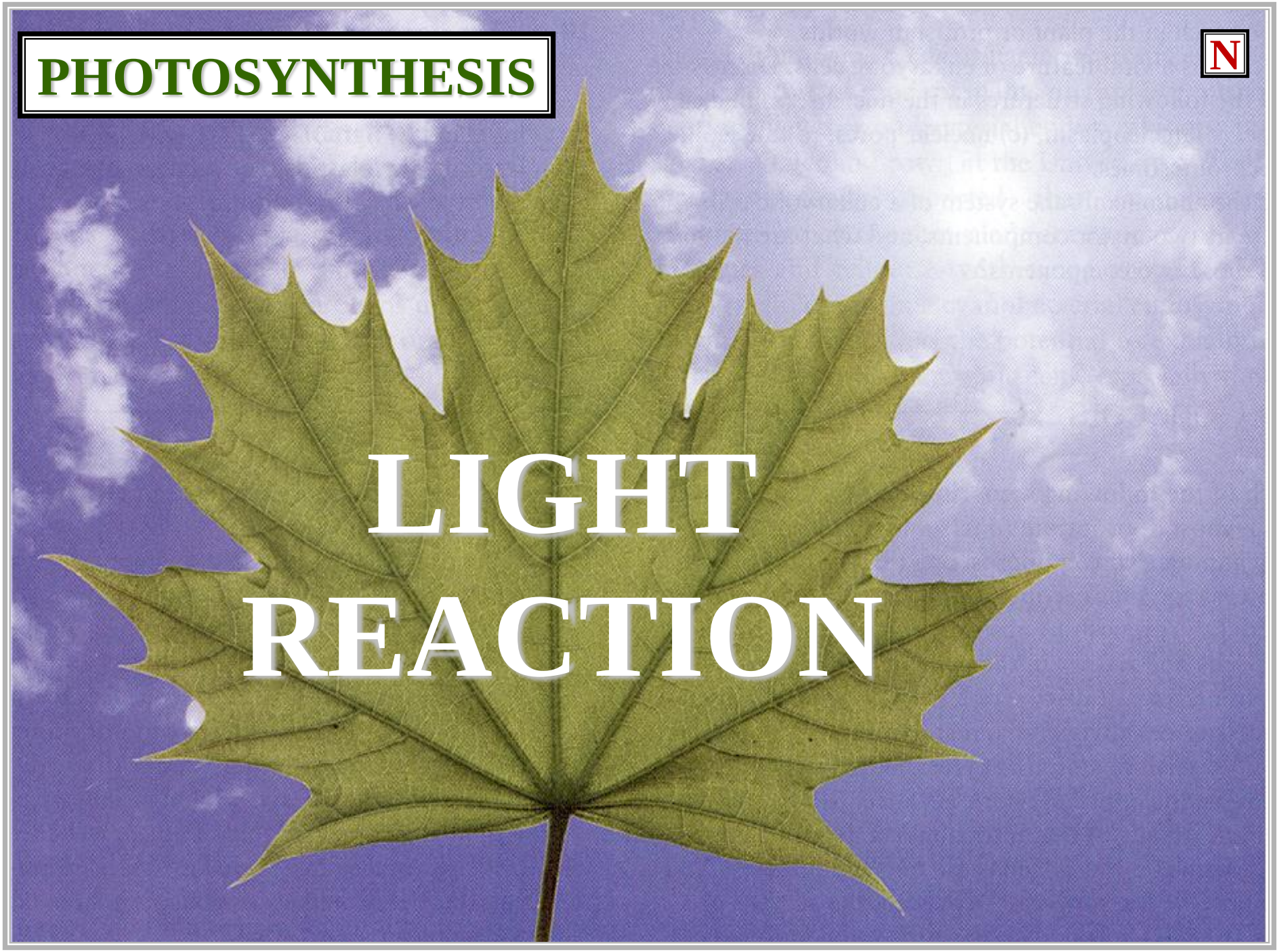

CO2 + RIBULOSE BISPHOSPHATE / (RUBP)
FEEDBACK
?
3 ATP/CO2
RIBULOSE BISPHOSPHATE CARBOXYLASE (RUBP-CARBOXYLASE)
UNSTABLE C6 COMPOUND
PHOSPHOGLYCERATE / (PGA)
PHOSPHOGLYCERATE / (PGA)
ATP
ATP
BISPHOSPHOGLYCERATE / (BIPGA)
BISPHOSPHOGLYCERATE / (BIPGA)
NADPH
NADPH
6X
PHOSPHOGLYCERALDEHYDE / (PGAL)
PHOSPHOGLYCERALDEHYDE / (PGAL)
COMPLEX SERIES CHEMICAL RXTS (CSCR)
COMPLEX SERIES CHEMICAL RXTS (CSCR)
CALVIN CYCLE
ATP
GLUCOSE
RIBULOSE BISPHOSPHATE / (RUBP)

ATP

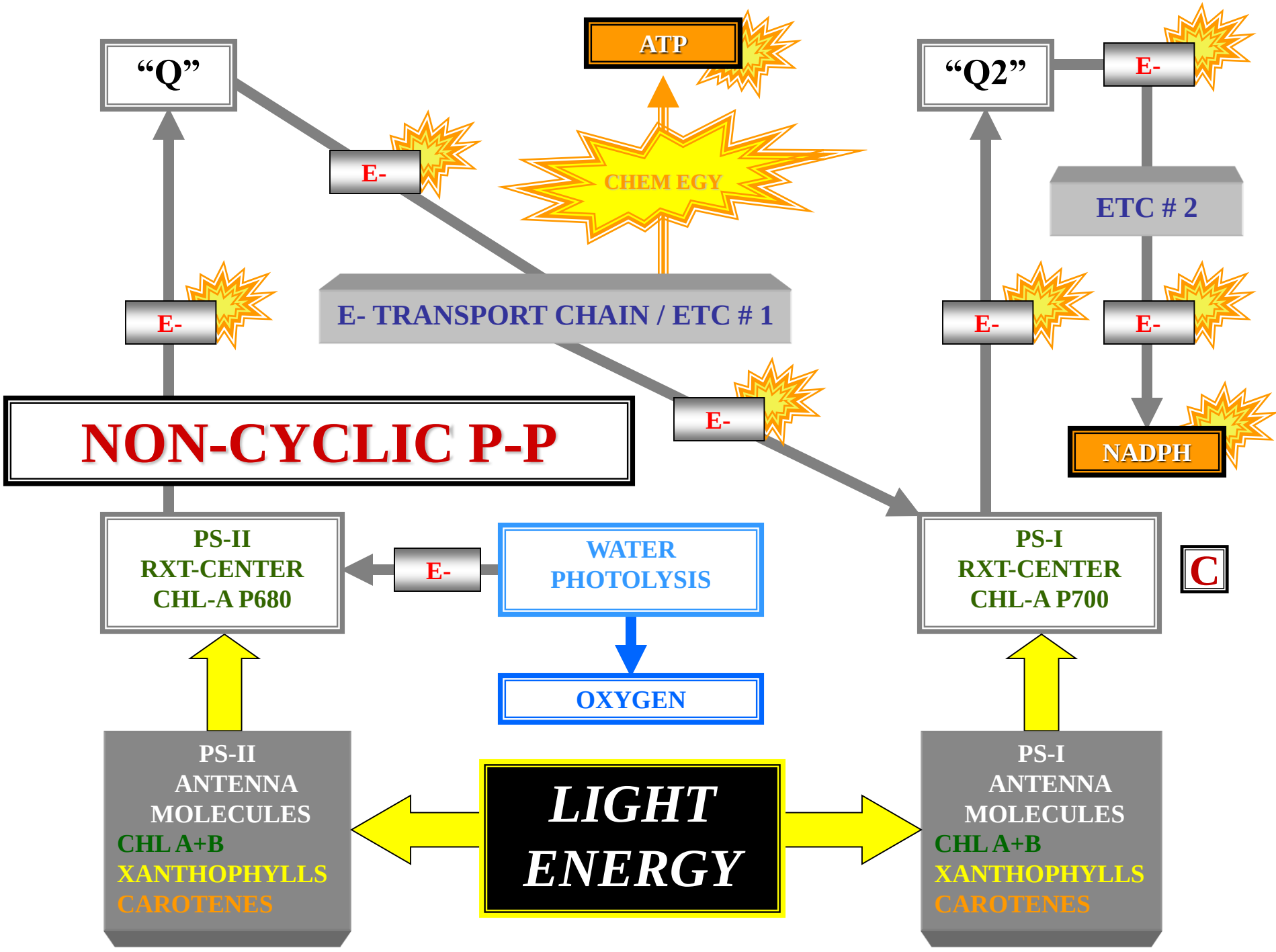
ENERGY EXPENSE

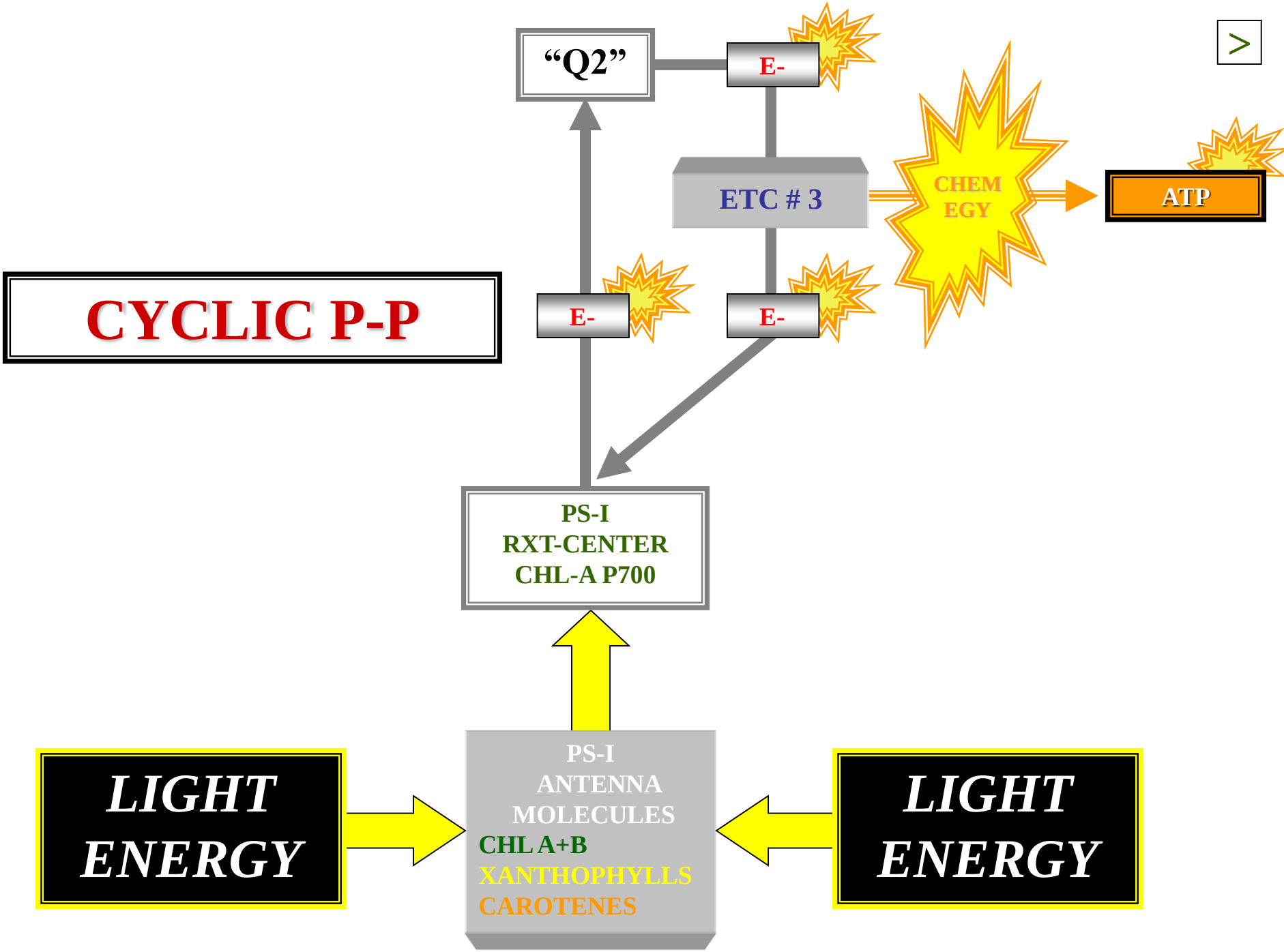
? ATP / GLUCOSE


LR
ATP
ENERGY EXPENSE
24 ATP / GLUCOSE



LIGHT REACTION


"Q"
ATP
"Q2"
E-
CHEM EGY
ETC # 2
E- TRANSPORT CHAIN / ETC # 1
NON-CYCLIC P-P
NADPH
PS-II
RXT-CENTER
CHL-A P680
WATER
PHOTOLYSIS
PS-I
RXT-CENTER
CHL-A P700
C
OXYGEN
PS-II
ANTENNA
MOLECULES
CHL A+B
XANTHOPHYLLS
CAROTENES
LIGHT
ENERGY
PS-I
ANTENNA
MOLECULES
CHL A+B
XANTHOPHYLLS
CAROTENES


"Q2"
E-
ETC # 3
CHEM
EGY
ATP
CYCLIC P-P
E-
E-
PS-I
RXT-CENTER
CHL-A P700
PS-I
ANTENNA
MOLECULES
CHL A+B
XANTHOPHYLLS
CAROTENES
LIGHT
ENERGY
LIGHT
ENERGY

PHOTOSYNTHESIS WITH PHOTO-RESPIRATION EXPENDS MORE ATP / GLUCOSE

MAPLE

PHOTOSYNTHESIS WITHOUT PHOTO-RESPIRATION

18 ATP / GLUCOSE ENERGY EXPENSE

MAPLE

PHOTOSYNTHESIS WITH PHOTO-RESPIRATION

24 ATP / GLUCOSE ENERGY EXPENSE

MAPLE

PHOTO-RESPIRATION REQUIRES 6 ATP MORE / GLUCOSE

MAPLE

PHOTO-RESPIRATION WASTEFUL PATHWAY

>

PHOTO-RESPIRATION INCREASES TRANSPIRATION

C3

MAPLE

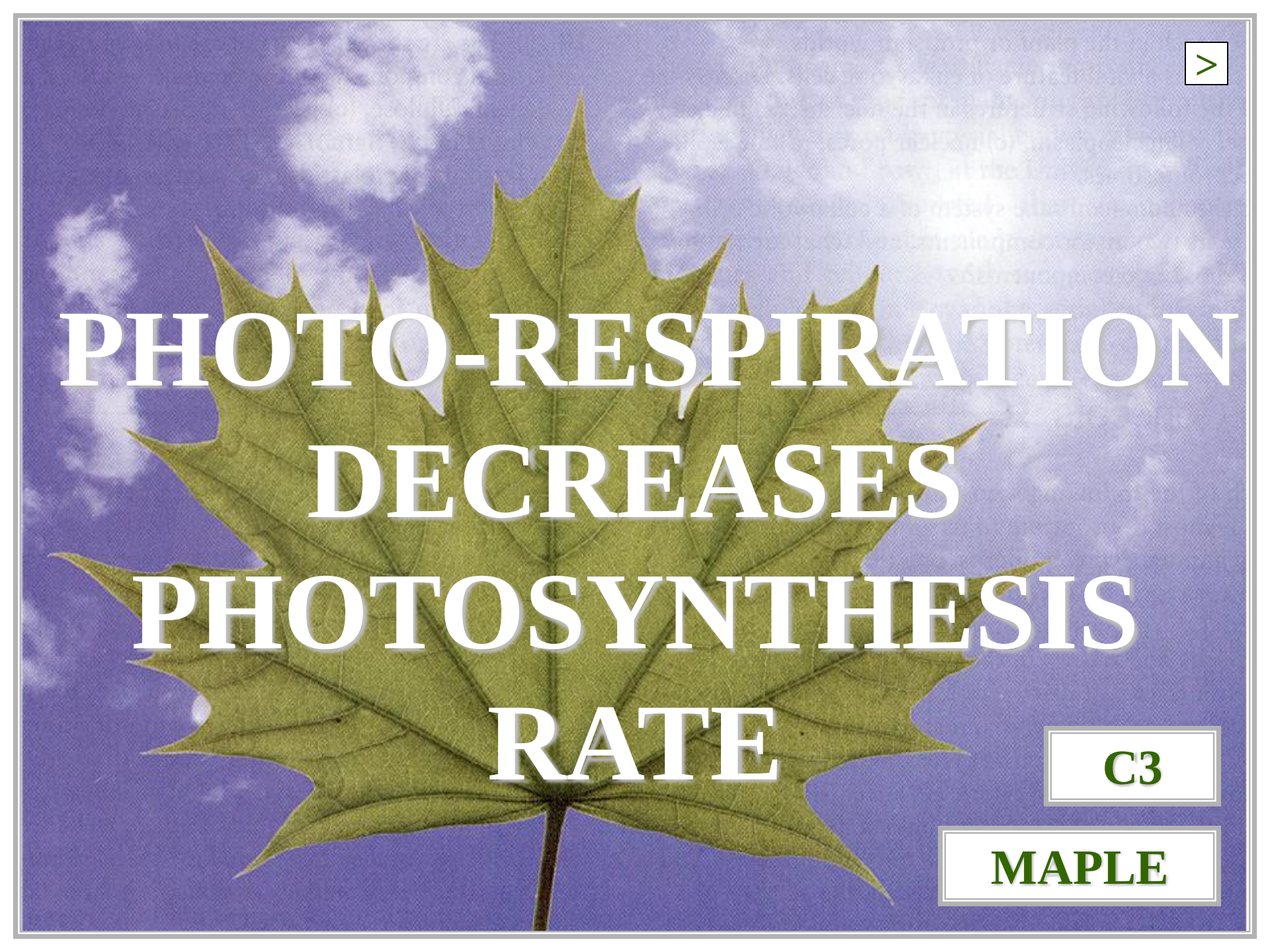


PHOTO-RESPIRATION DECREASES PHOTOSYNTHESIS RATE
C3
MAPLE

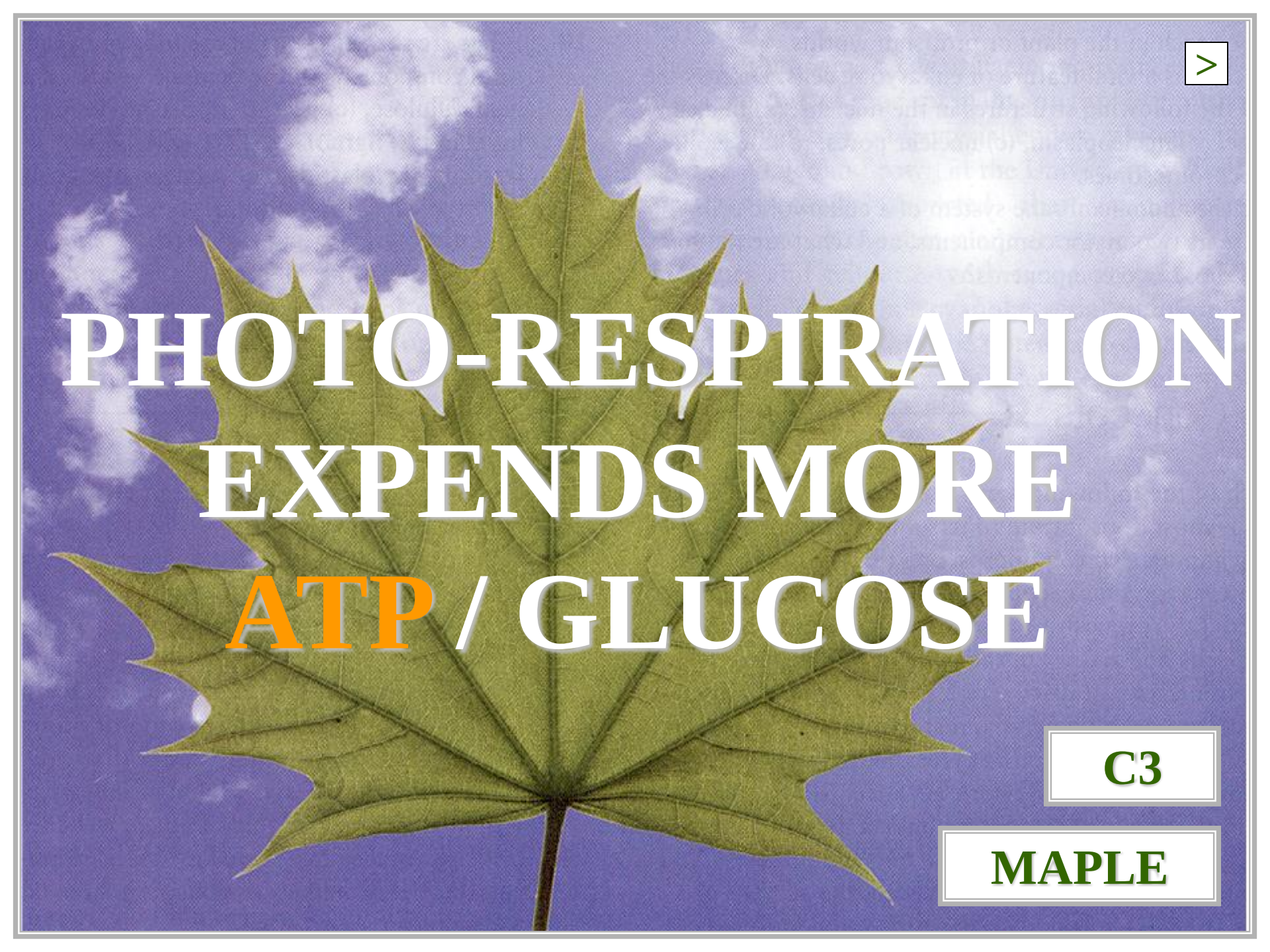
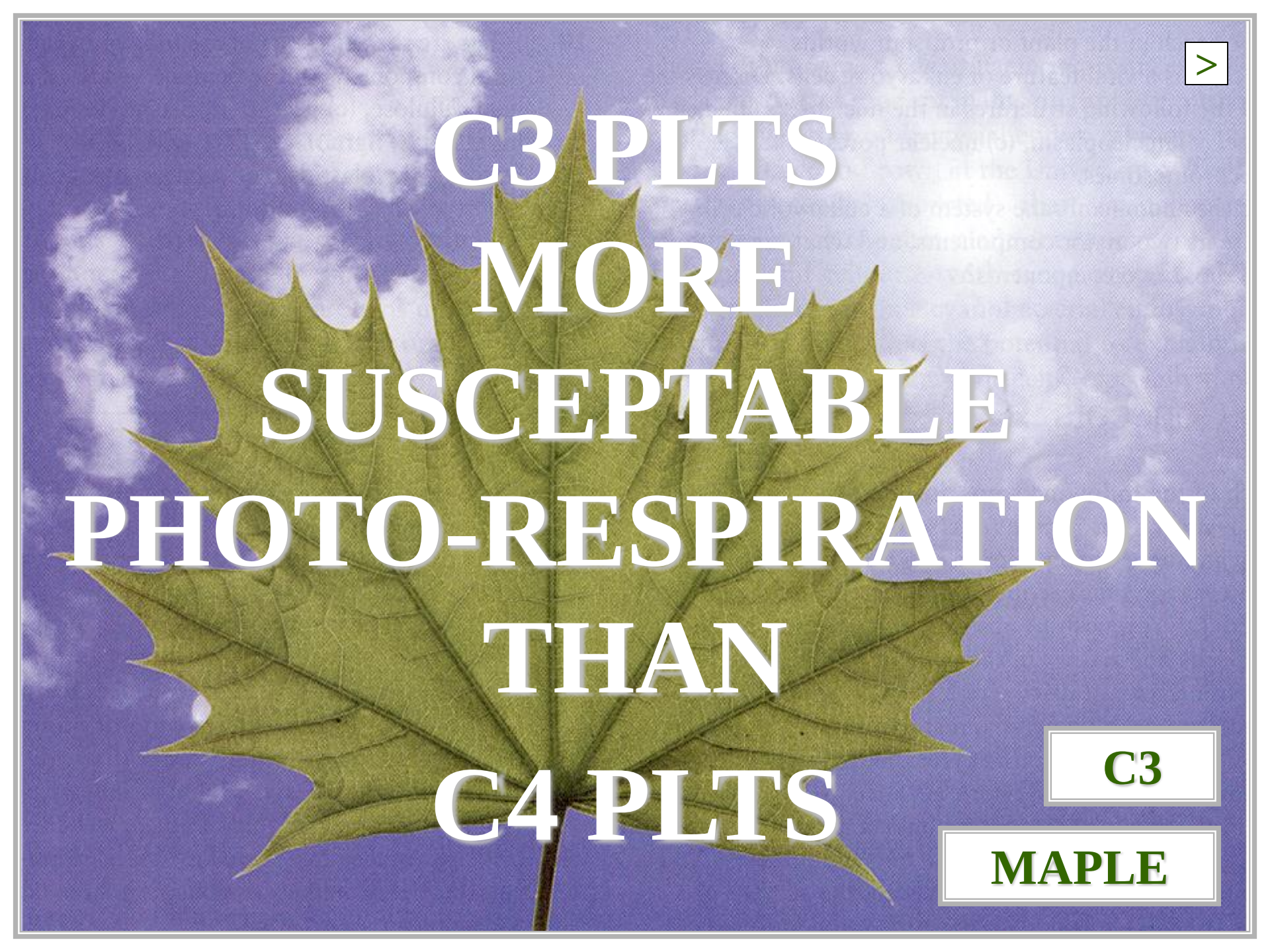
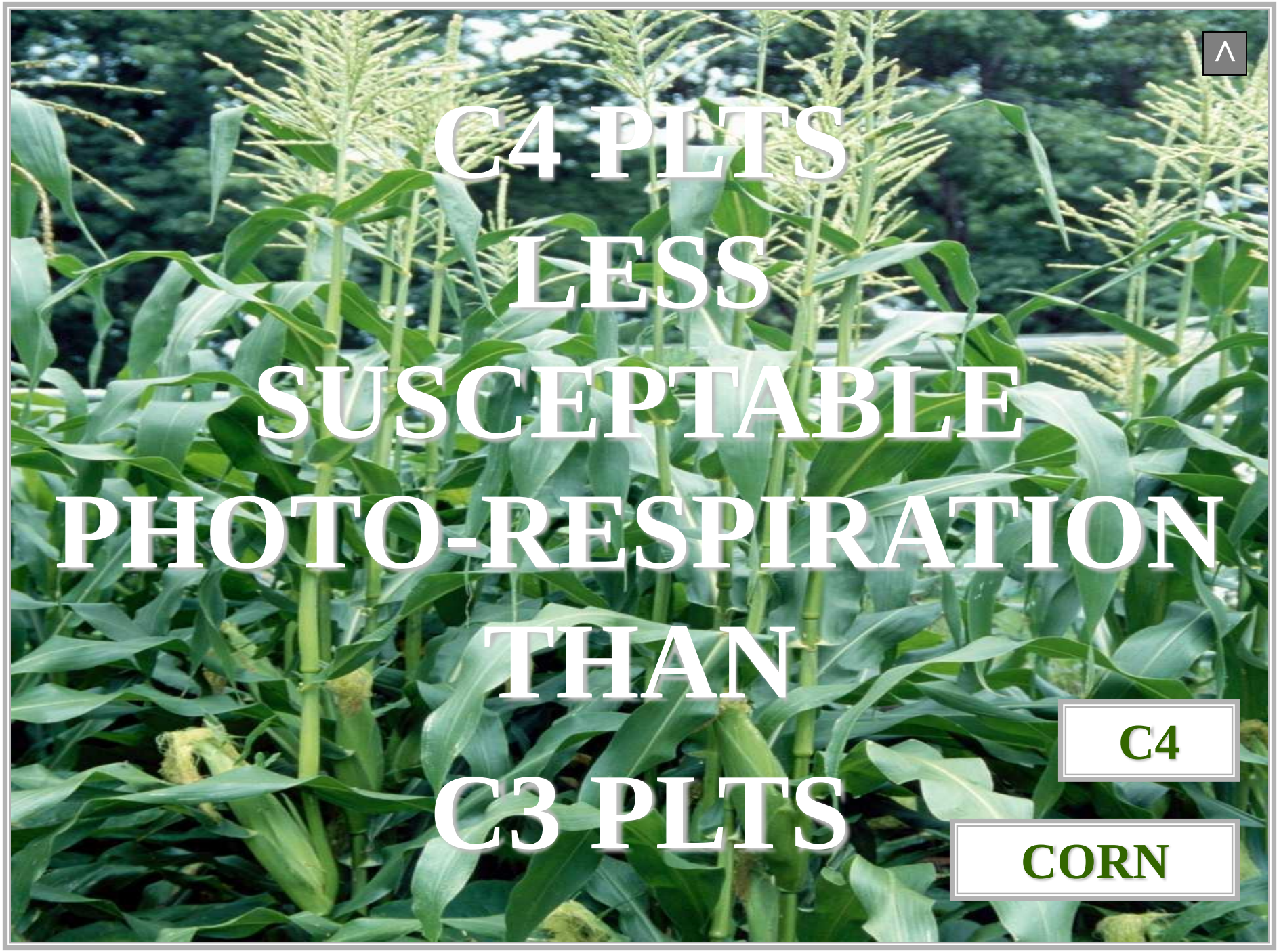


PHOTO-RESPIRATION
EXPENDS MORE
ATP / GLUCOSE
>
C3
MAPLE


C3 PLTS
MORE
SUSCEPTABLE
PHOTO-RESPIRATION
THAN
C4 PLTS
>
C3
MAPLE


C4 PLTS
LESS
SUSCEPTABLE
PHOTO-RESPIRATION
THAN
C3 PLTS
C4
CORN

C4 PLANTS
LESS
SUSCEPTABLE
PHOTO-RESPIRATION

C4
KRANTZ
LEAF ANATOMY

C4
KRANTZ
LEAF ANATOMY

C4

CORN

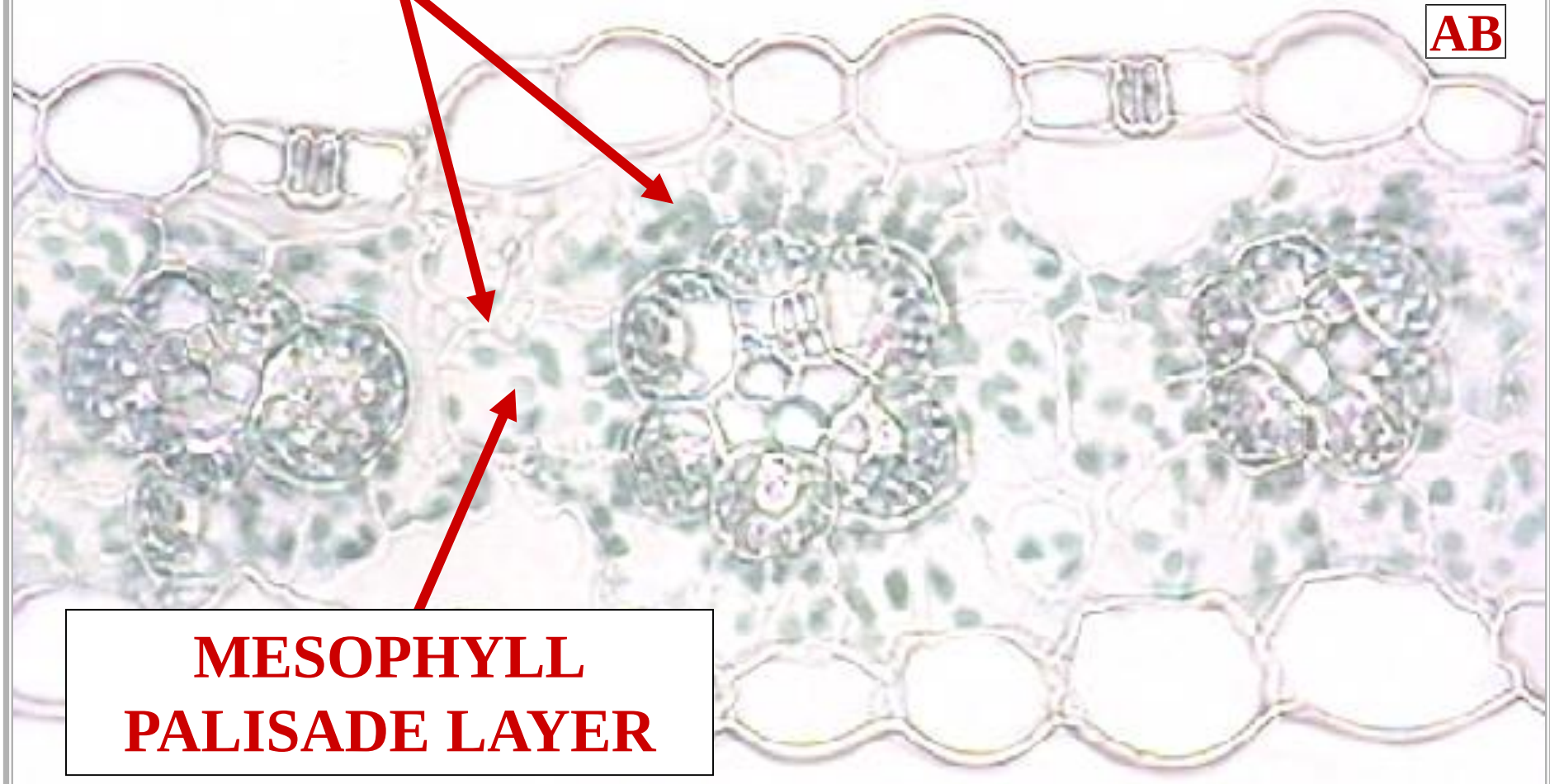
MESOPHYLL

C4 LEAF

PL

+

KRANTZ C4 LEAF ANATOMY



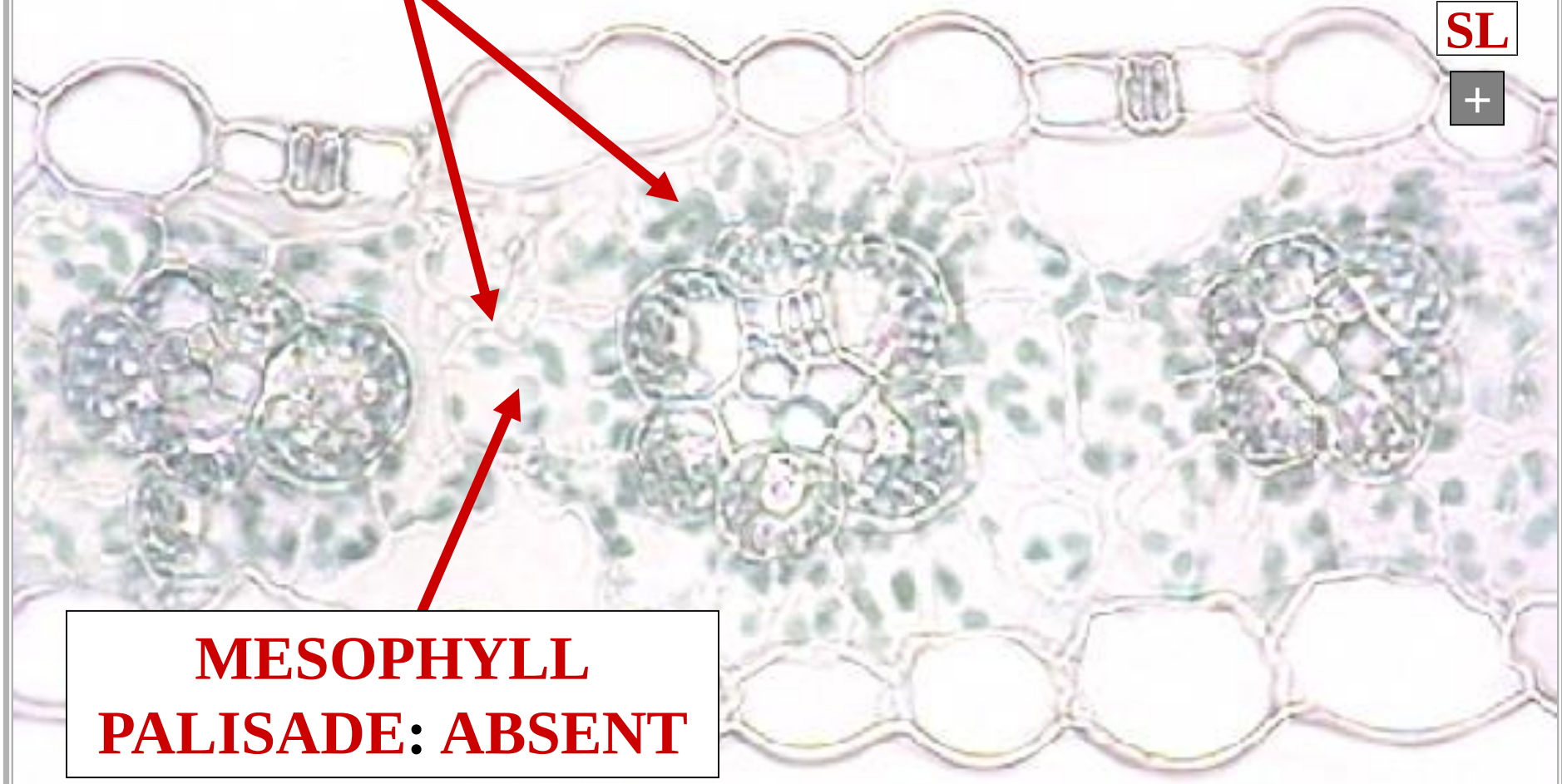
KRANTZ C4 LEAF ANATOMY

MESOPHYLL

C4 LEAF

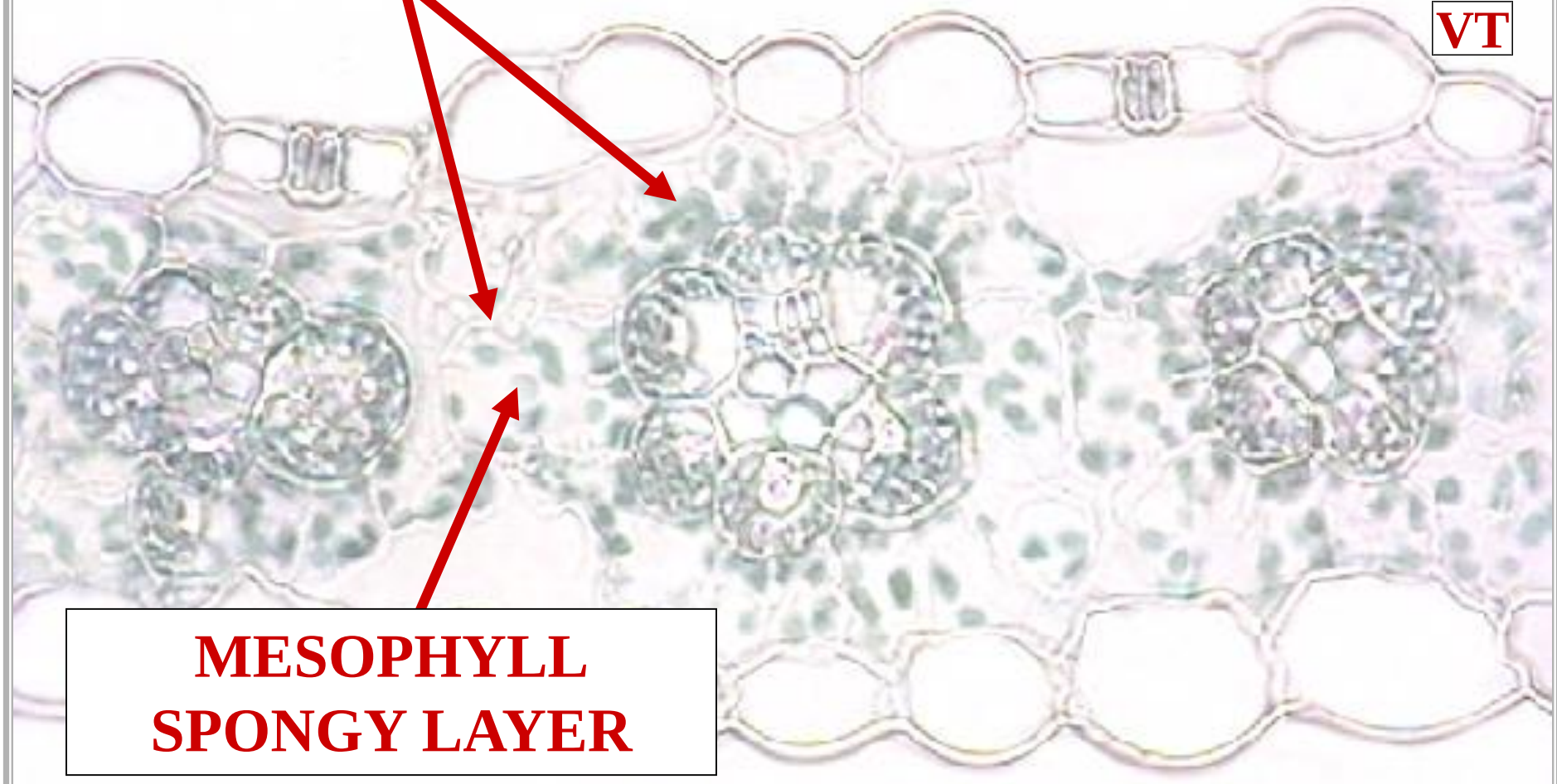
SL

+



MESOPHYLL
PALISADE: ABSENT

KRANTZ C4 LEAF ANATOMY



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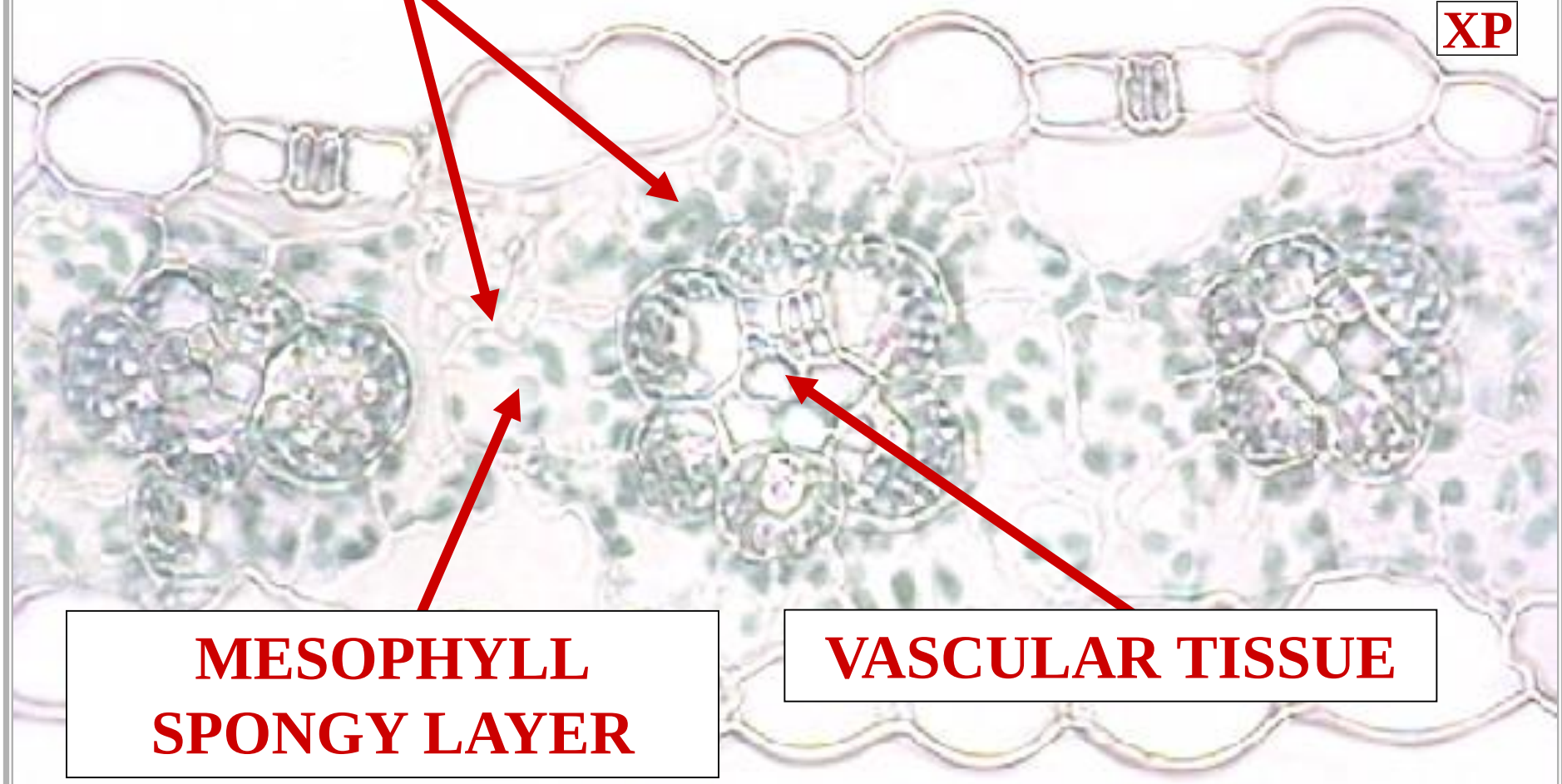

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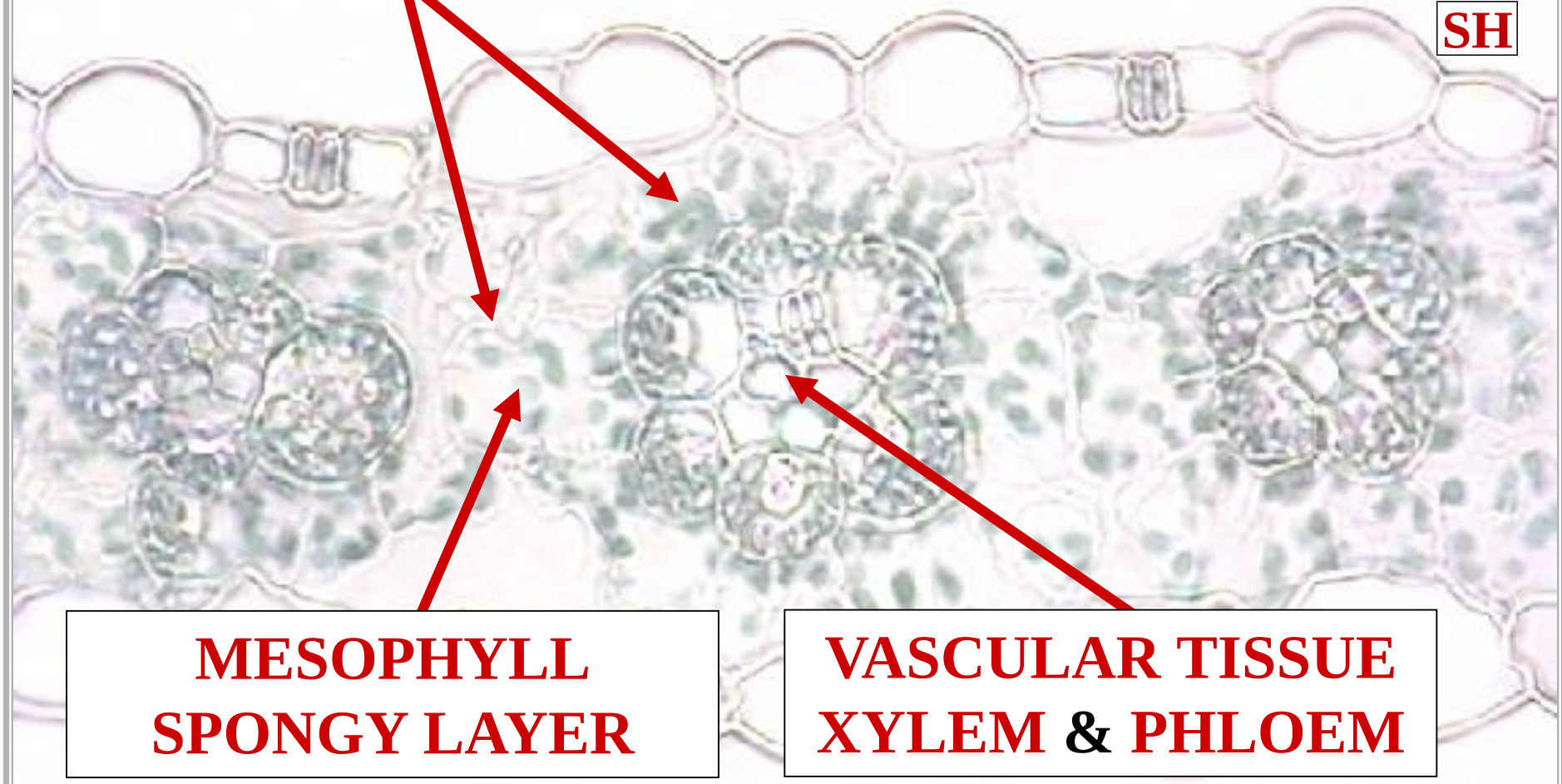

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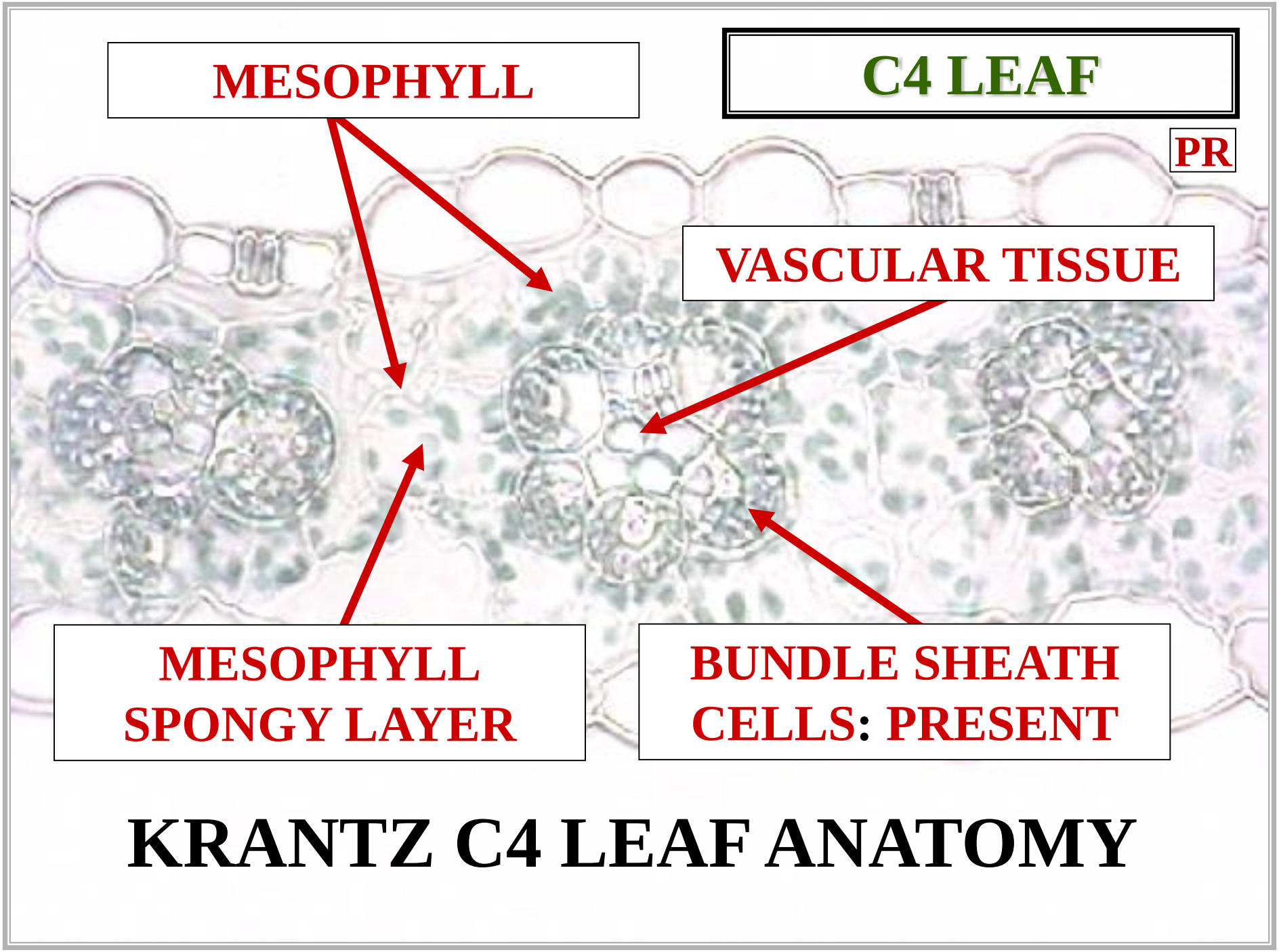

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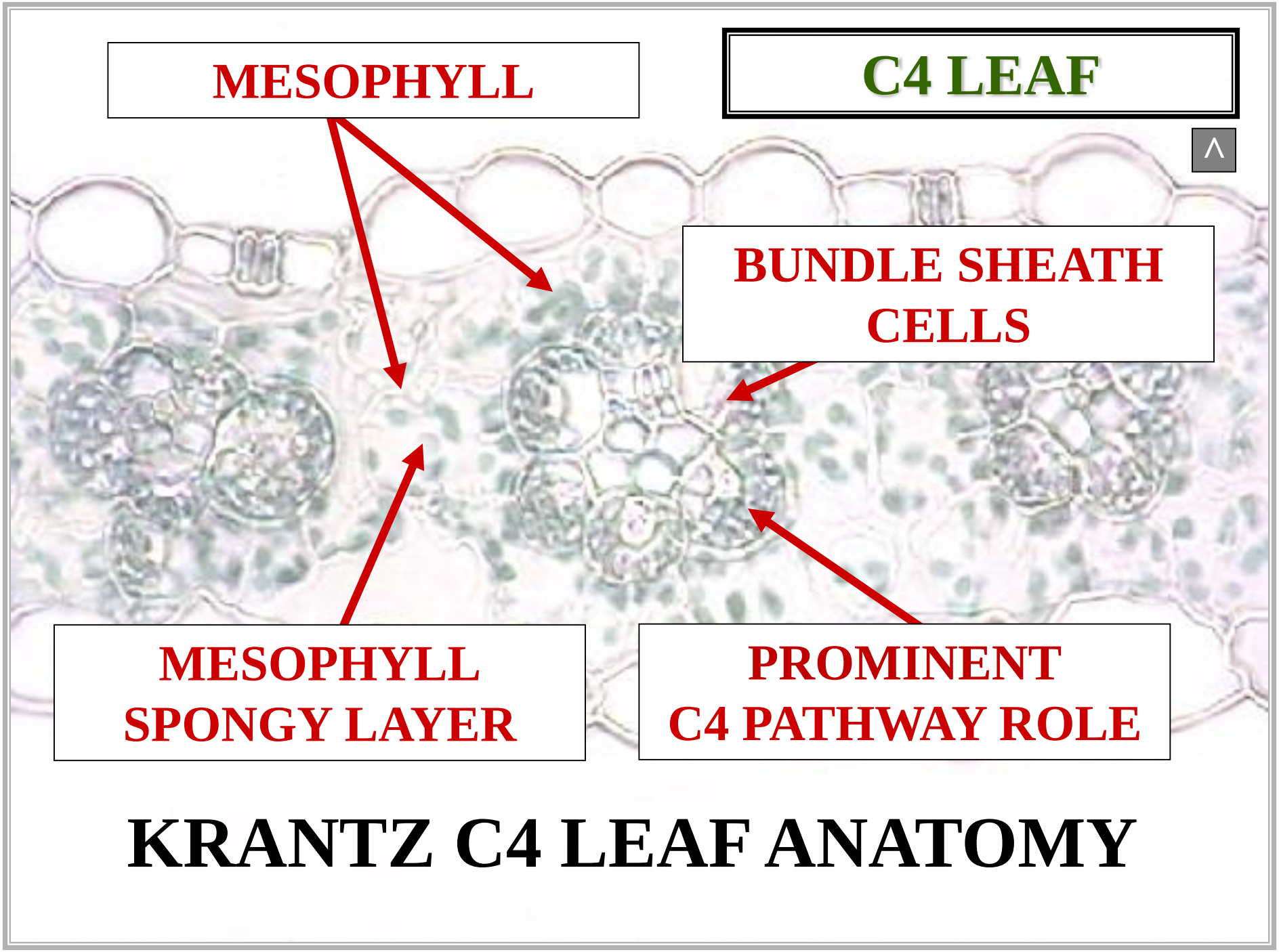


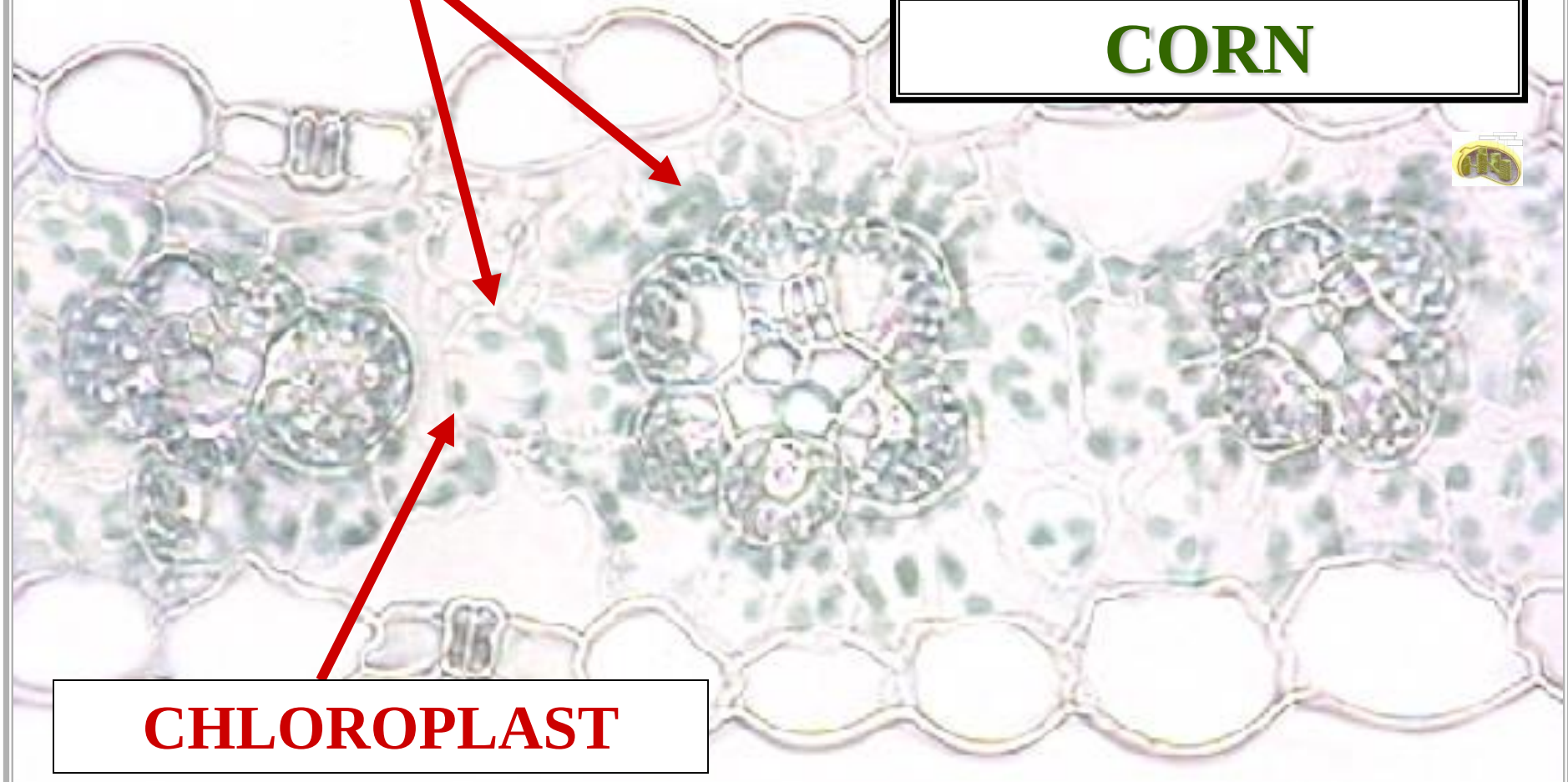
KRANTZ C4 LEAF ANATOMY

C4 MESOPHYLL CELL CHLOROPLAST

MESOPHYLL CELL

C4 LEAF

CORN

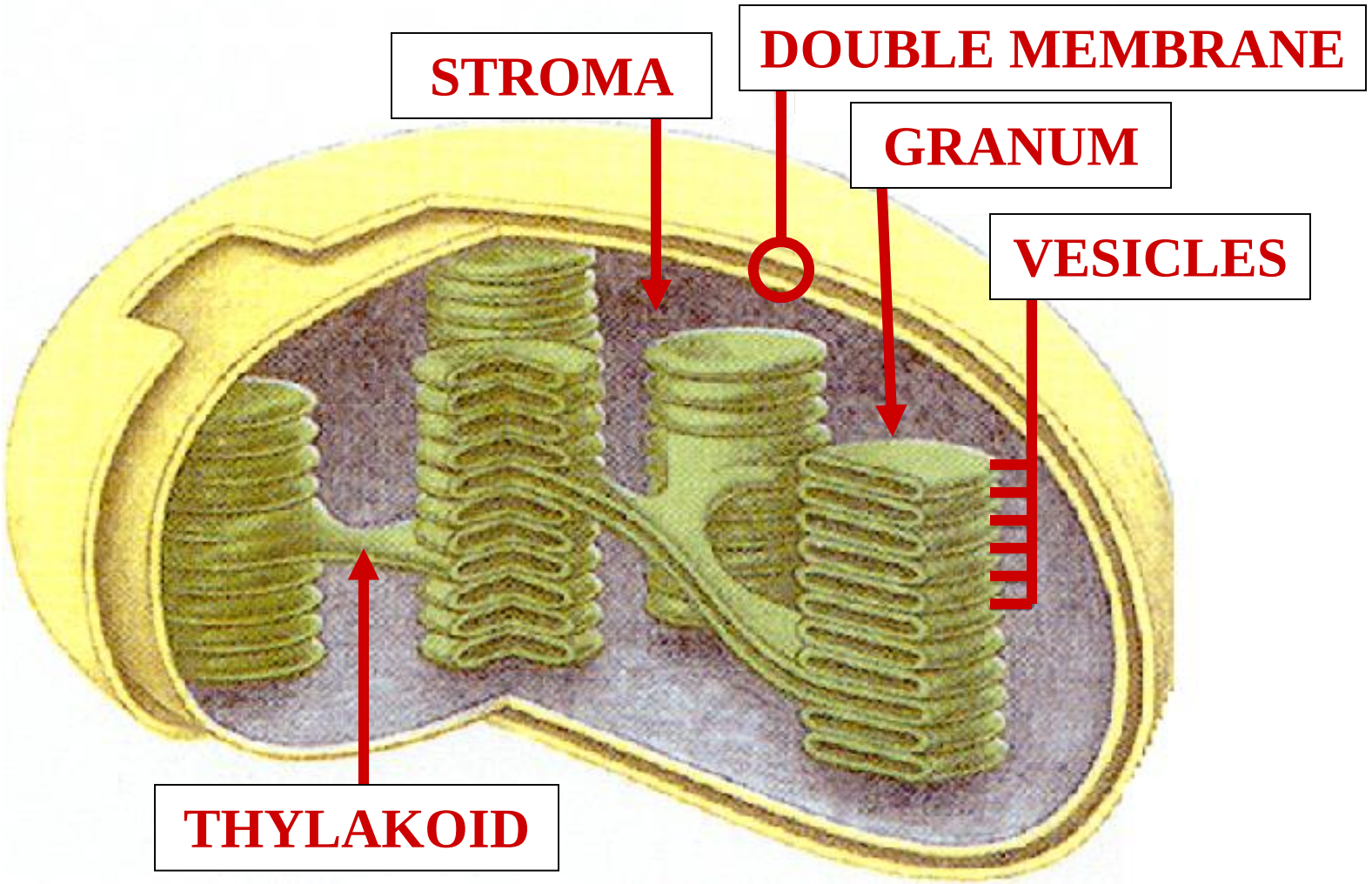


CHLOROPLAST

KRANTZ C4 LEAF ANATOMY

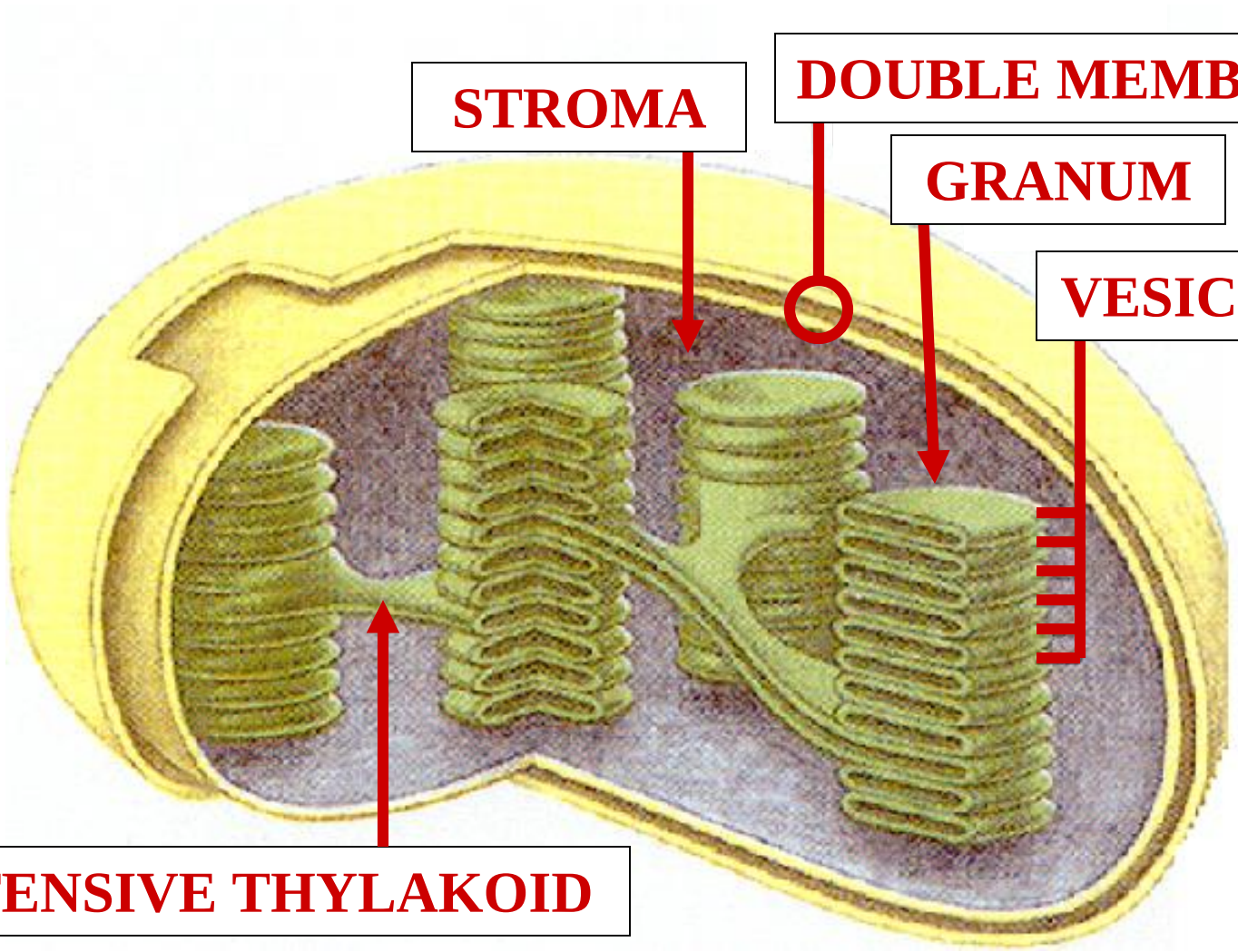
C4 MESOPHYLL CHLOROPLAST ULTRASTRUCTURE

E

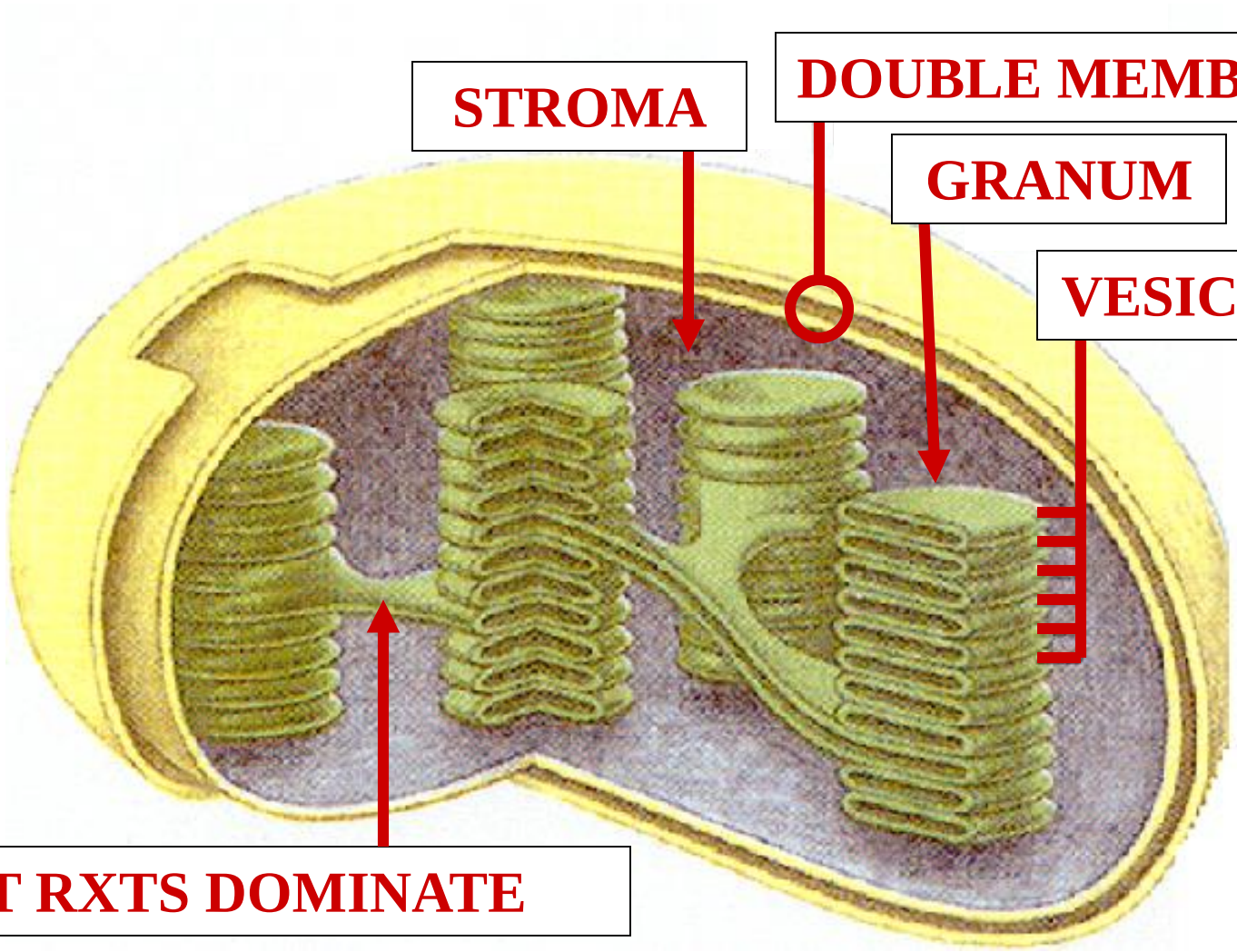


C4 MESOPHYLL CHLOROPLAST ULTRASTRUCTURE

L



C4 MESOPHYLL CHLOROPLAST ULTRASTRUCTURE



PHOTOSYNTHESIS

MS

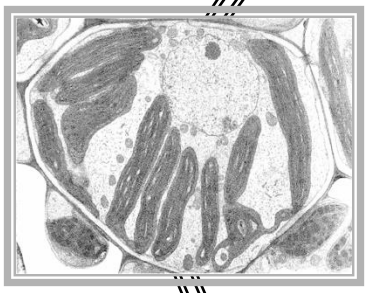
O

WATER

LIGHT EGY

E-

PHOTOLYSIS

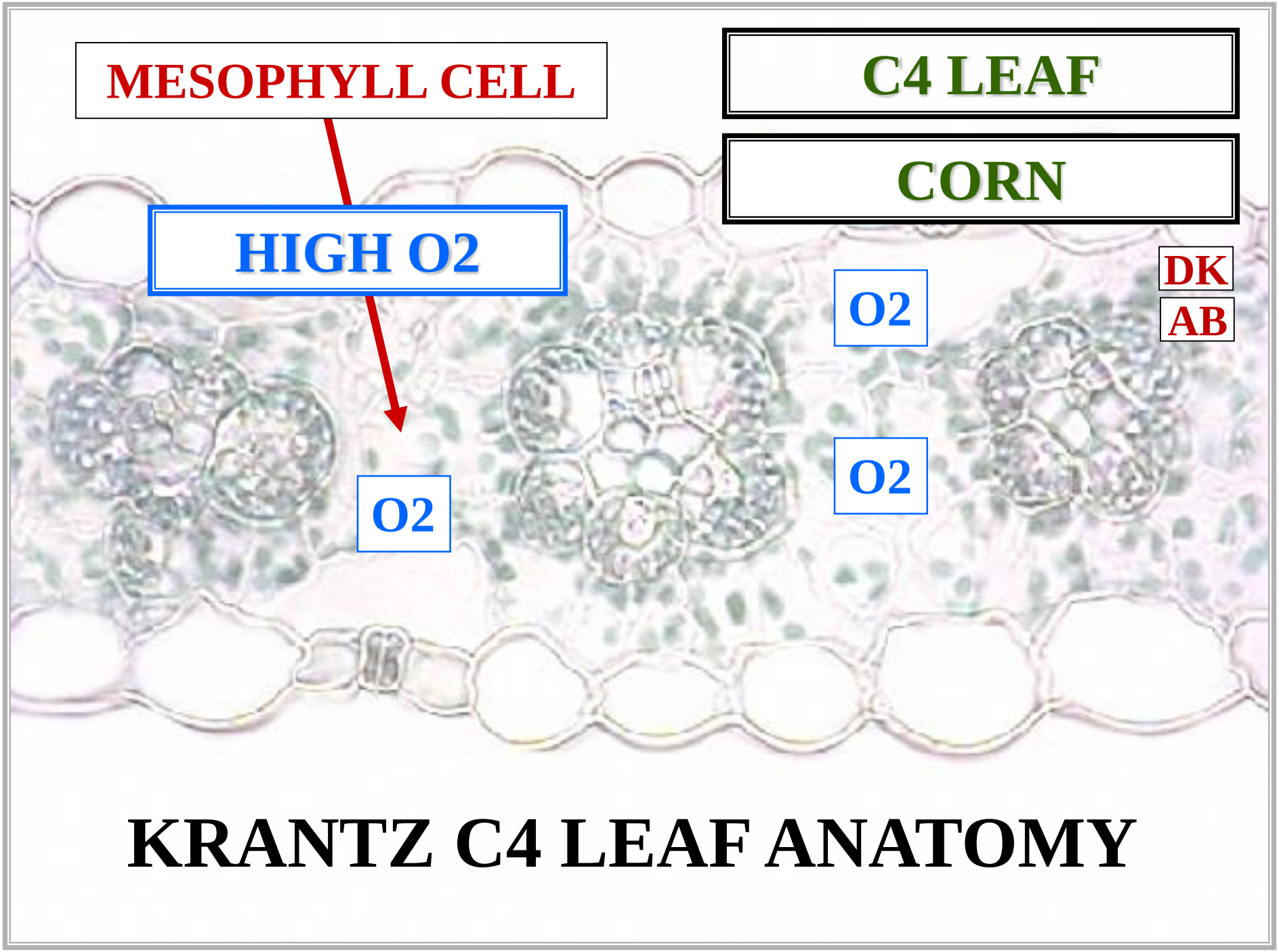


LT RXT

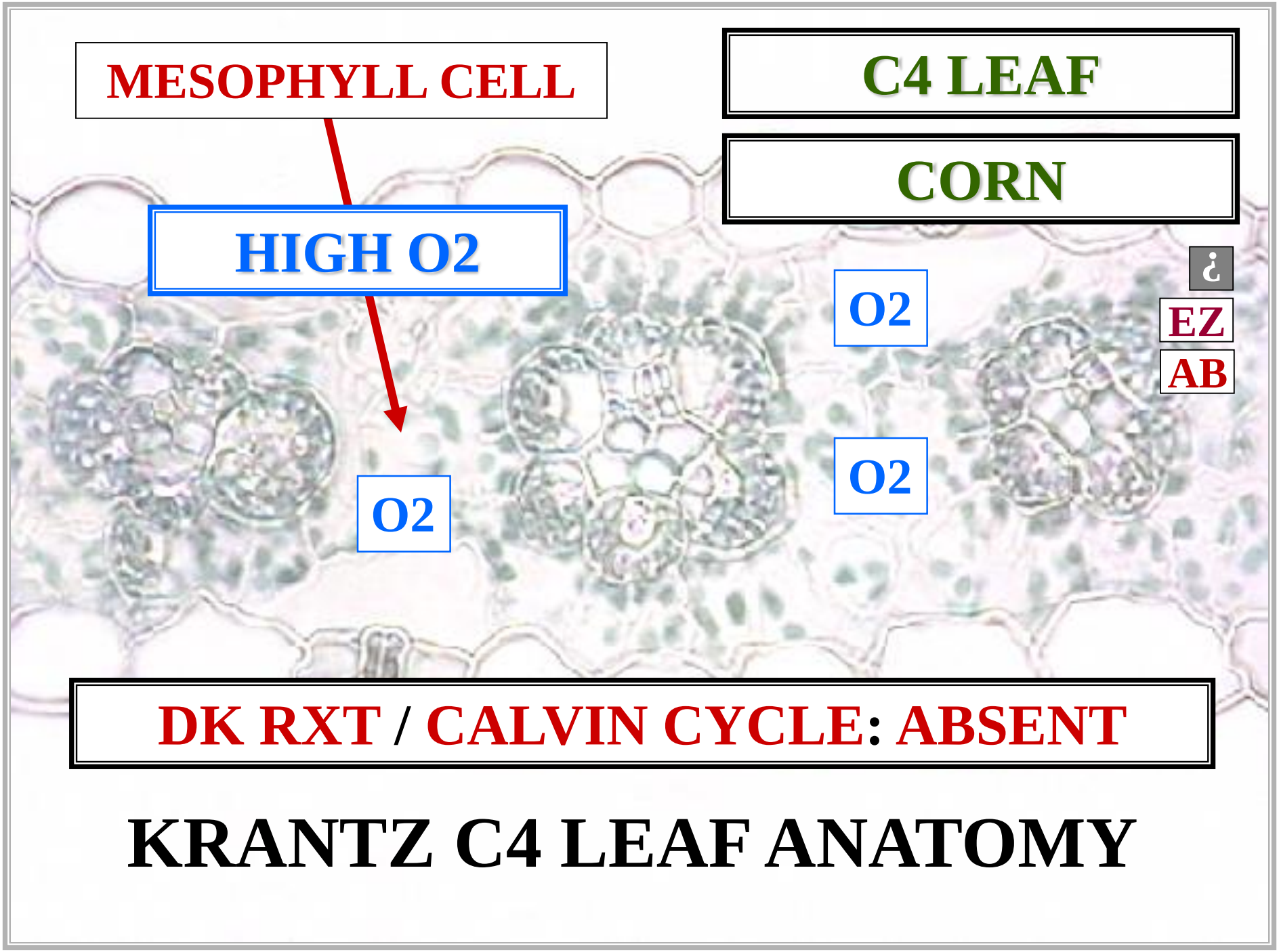
THYLAKOID GRANUM

CHLOROPLAST

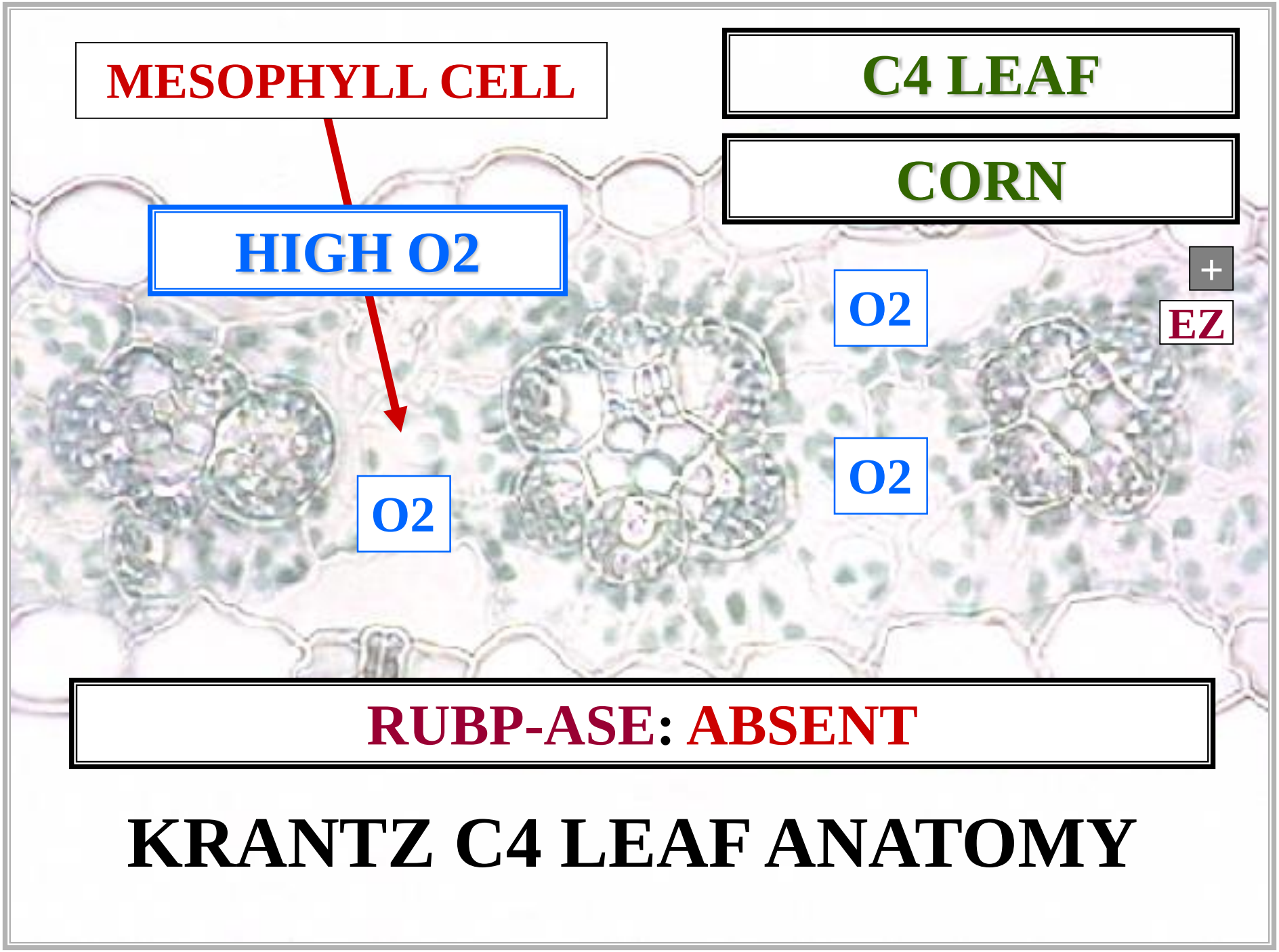
OXYGEN



KRANTZ C4 LEAF ANATOMY



KRANTZ C4 LEAF ANATOMY



KRANTZ C4 LEAF ANATOMY

C4

O2
HIGH CONCENTRATION
CHLOROPLAST STROMA

O2 + RIBULOSE BISPHOSPHATE / (RUBP)

RIBULOSE BISPHOSPHATE ENZYME (RUBP-ASE)

ABSENT

OX

C4

O2
HIGH CONCENTRATION
CHLOROPLAST STROMA

↓

O2 + RIBULOSE BISPHOSPHATE / (RUBP)

RIBULOSE BISPHOSPHATE OXYGENASE (RUBP-OXYGENASE)

ABSENT

¿

PR

O2
HIGH CONCENTRATION
CHLOROPLAST STROMA

O2 + RIBULOSE BISPHOSPHATE / (RUBP)

RIBULOSE BISPHOSPHATE OXYGENASE (RUBP-OXYGENASE)

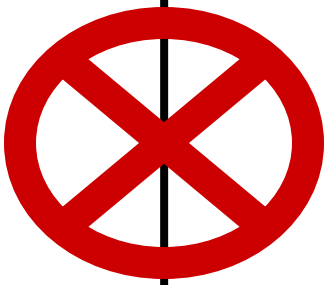
PR

AB

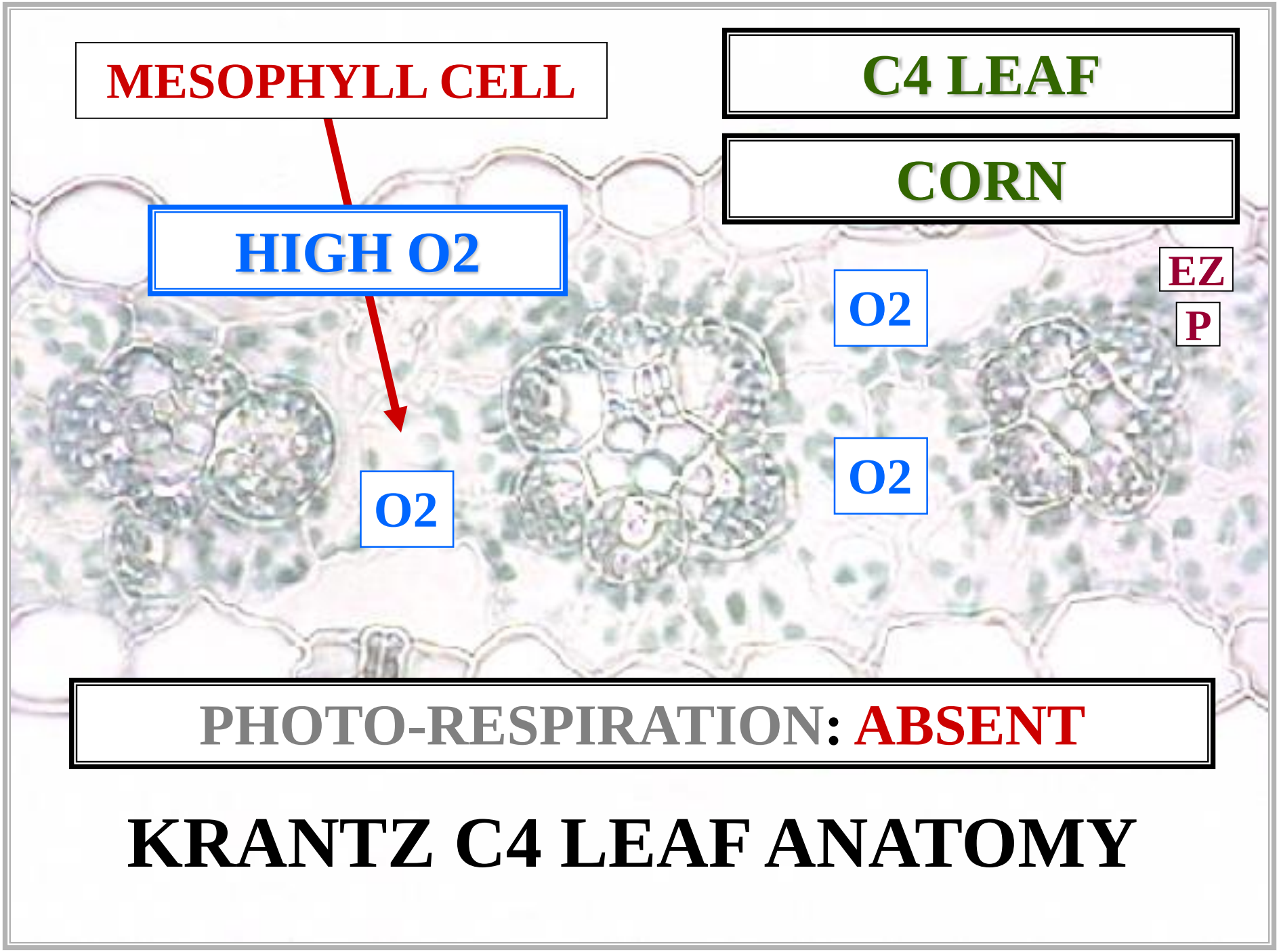
PHOSPHOGLYCERATE / (PGA) ← **ABSENT** → **PHOSPHOGLYCOLATE**

CALVIN CYCLE

GLUCOSE ENTERS METABOLISM



PHOTORESPIRATION



KRANTZ C4 LEAF ANATOMY