




CAM PLANT CONDUCTS C3 AND C4



CAM PLANT MODIFIED C4 PLANT



CAM PLANT
KRANZ LEAF
ANATOMY
ABSENT



MESOPHYLL

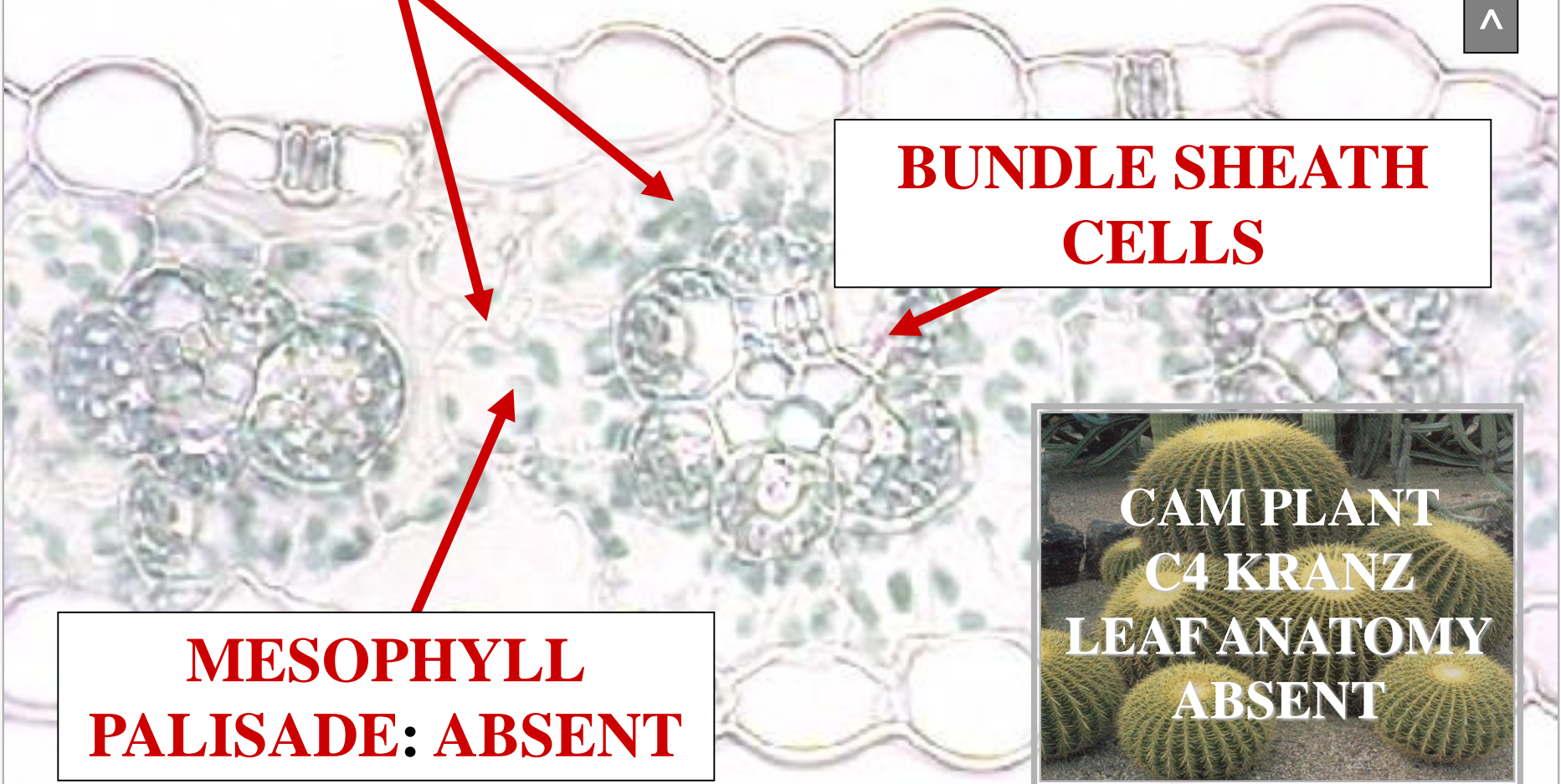
C4 LEAF

**BUNDLE SHEATH
CELLS**

**MESOPHYLL
PALISADE: ABSENT**

**CAM PLANT
C4 KRANZ
LEAF ANATOMY
ABSENT**

KRANZ C4 LEAF ANATOMY





CAM PATHWAY SPECIFICS

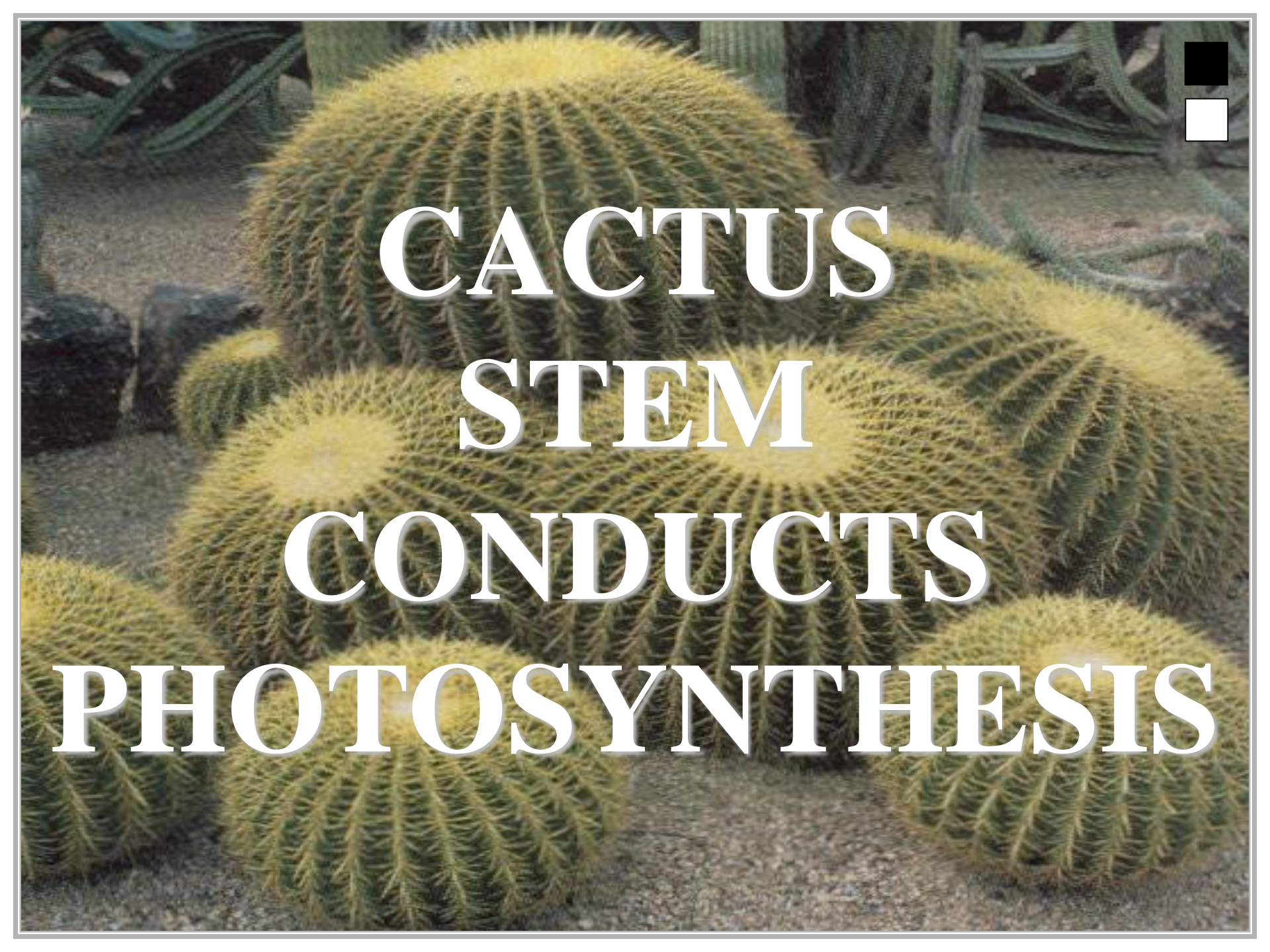


CAM PATHWAY CACTUS PLANT



ST

CACTUS DESERT CAM PLANT



**CACTUS
STEM
CONDUCTS
PHOTOSYNTHESIS**

CAM PATHWAY DARK HOURS



CAM PATHWAY LIGHT HOURS





CAM PATHWAY DARK HOURS

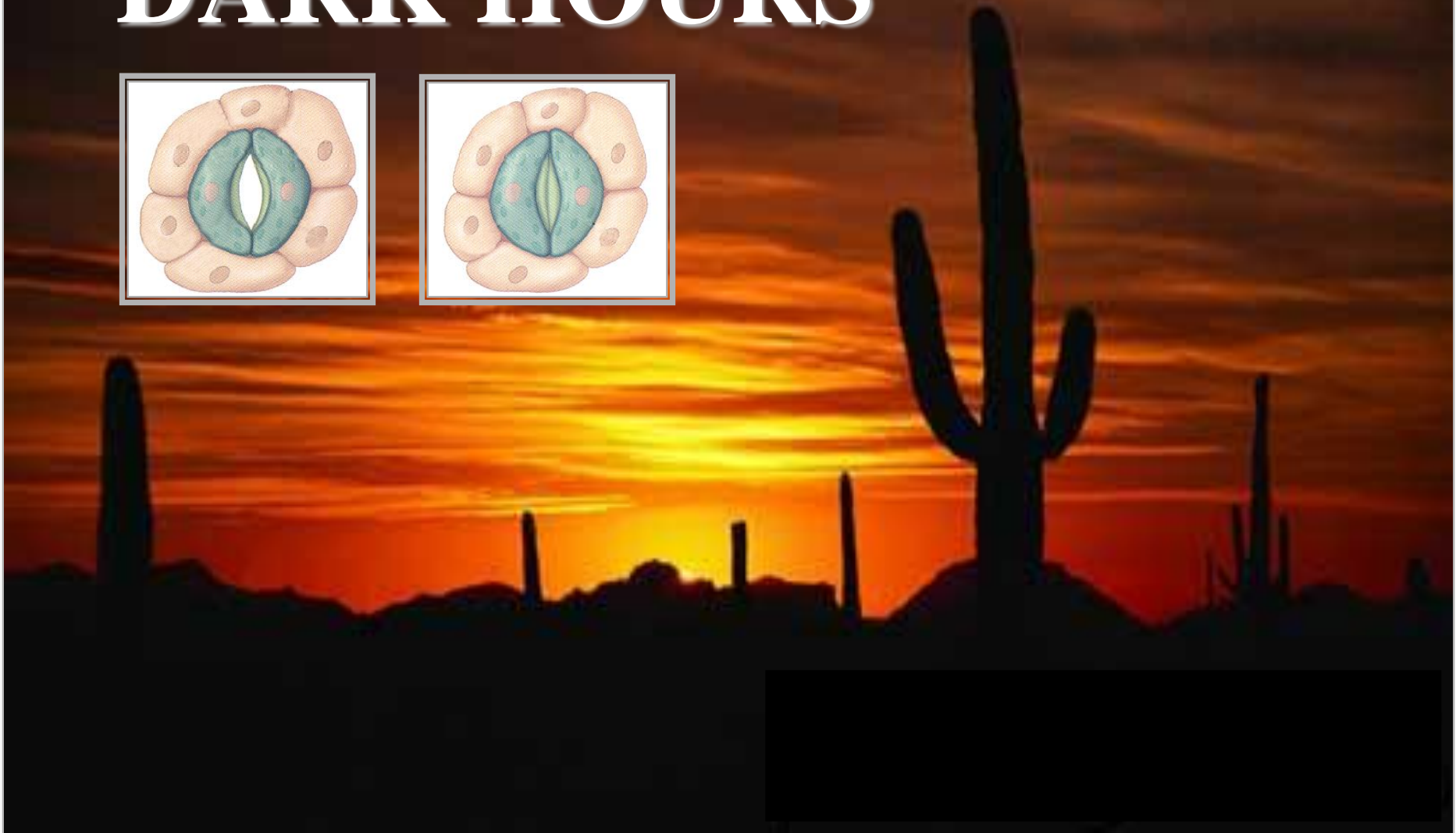
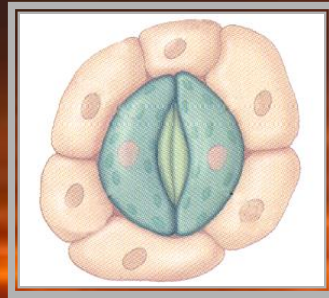
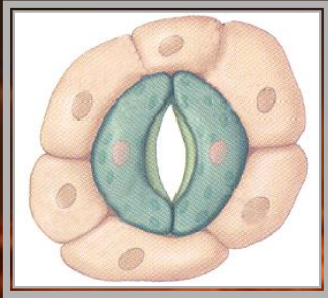
CAM PATHWAY DARK HOURS



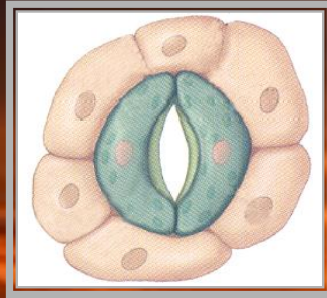


STEM STOMATE

CAM PATHWAY DARK HOURS

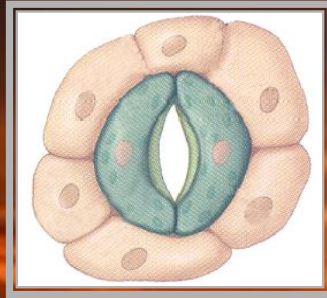


CAM PATHWAY DARK HOURS



**STOMATES
OPEN**

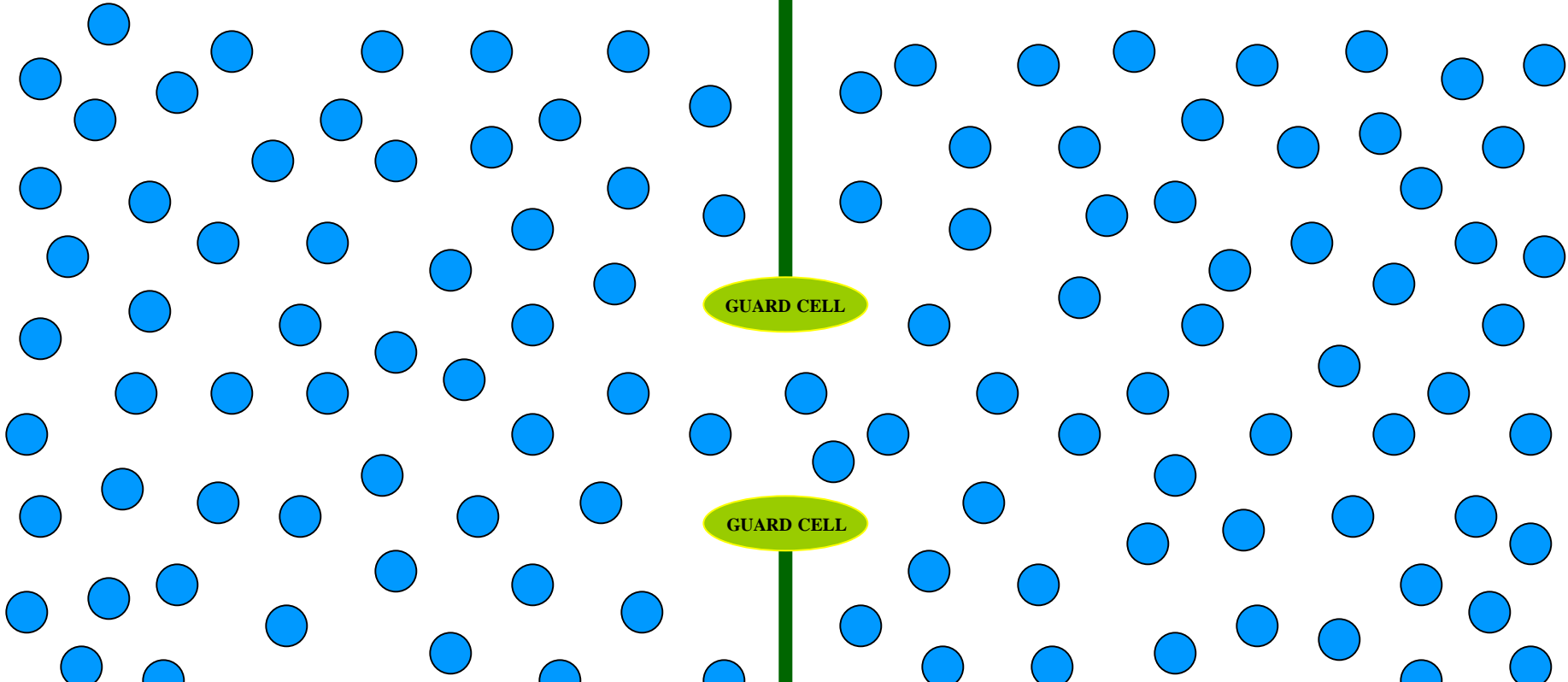
DARK HOURS
HIGH HUMIDITY



STOMATES
OPEN

PLANT

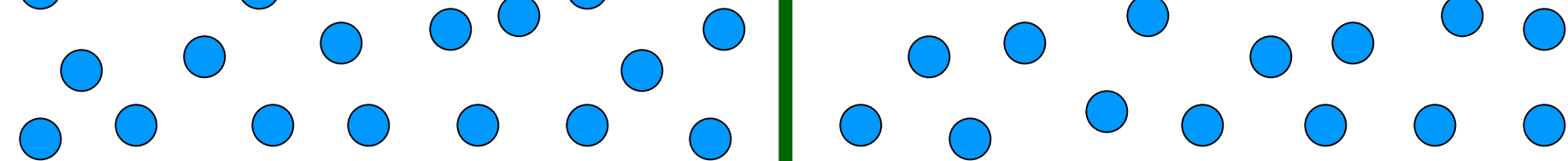
ATMOSPHERE



GUARD CELL

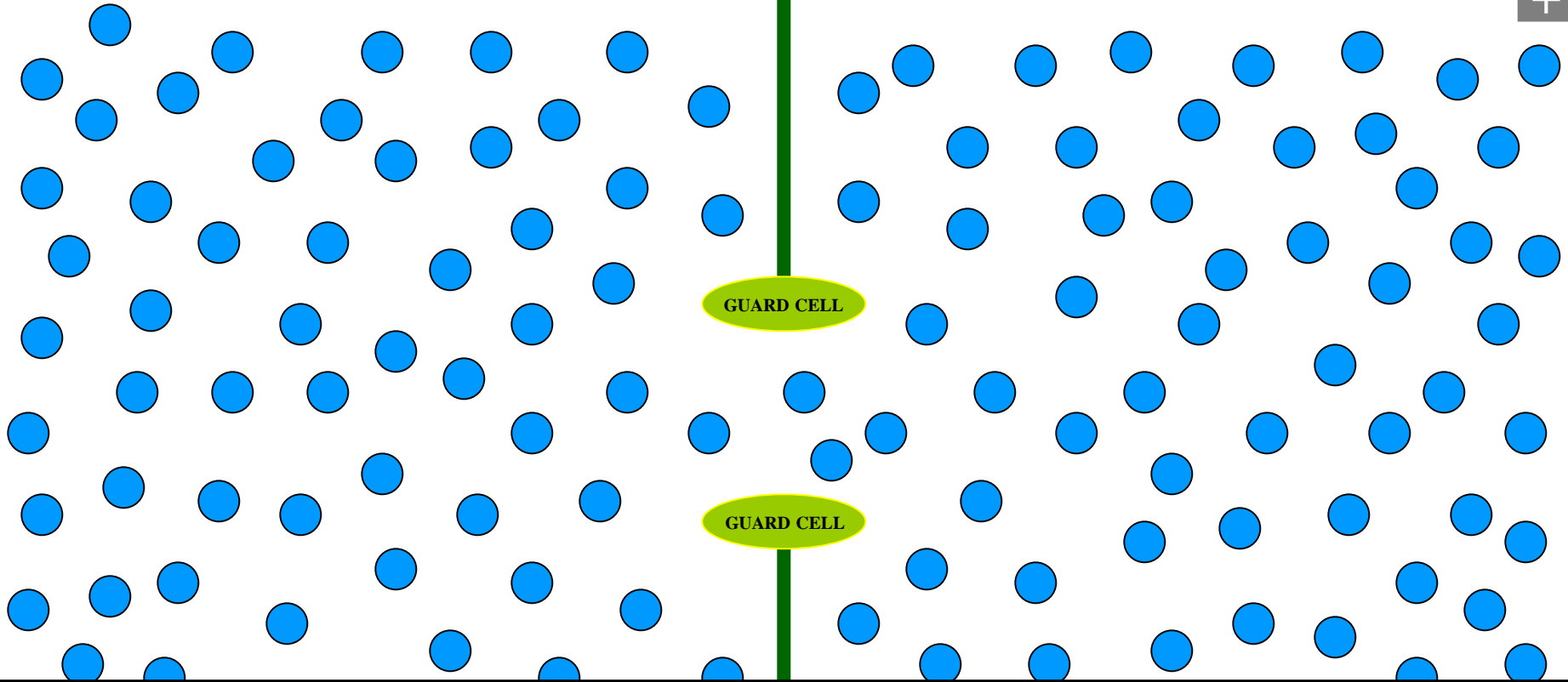
GUARD CELL

● = WATER **DARK HOURS** WATER = ●



PLANT

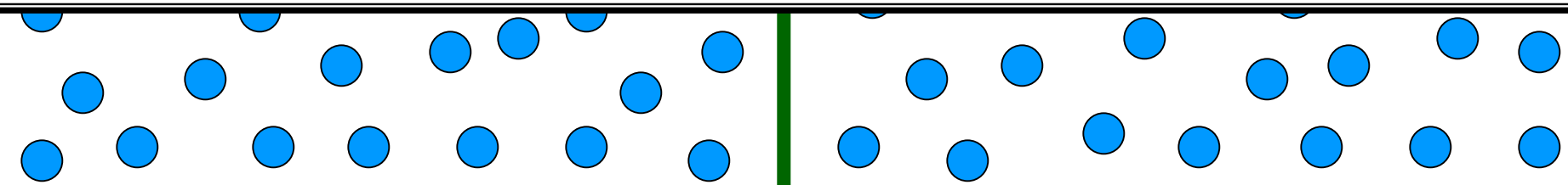
ATMOSPHERE



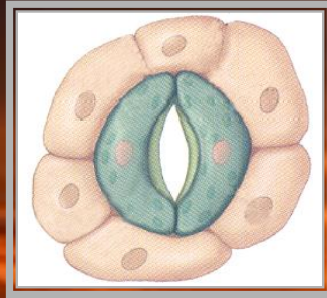
● = WATER

SHALLOW GRADIENT

WATER = ●



CAM PATHWAY DARK HOURS

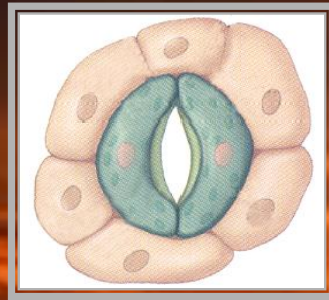


TRANSPIRATION
POTENTIAL

CAM PATHWAY DARK HOURS



0

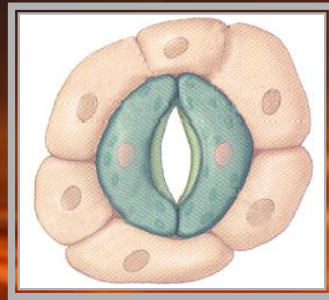


VERY LOW
TRANSPIRATION
POTENTIAL

CAM PATHWAY DARK HOURS



CO₂



STOMATES
OPEN

DARK HOURS

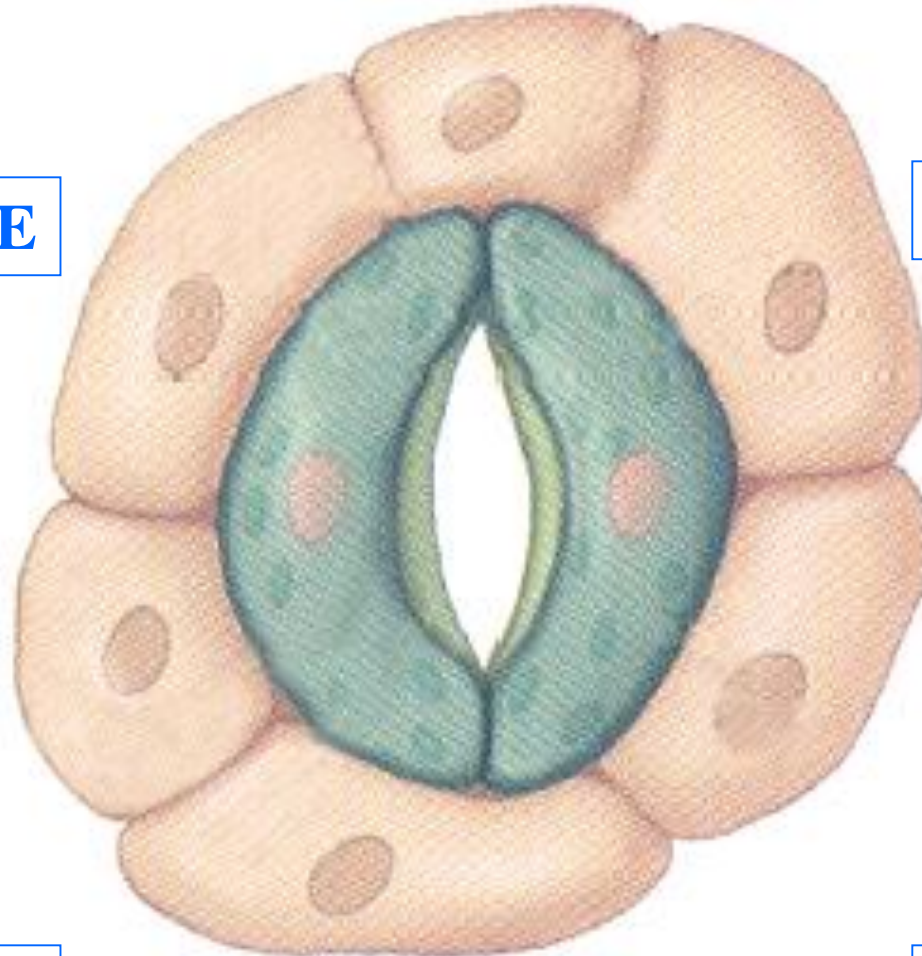
STEM STOMATE

DARK HOURS

D

CO₂

ATMOSPHERE



CO₂

ATMOSPHERE

CO₂

ATMOSPHERE

CO₂

ATMOSPHERE

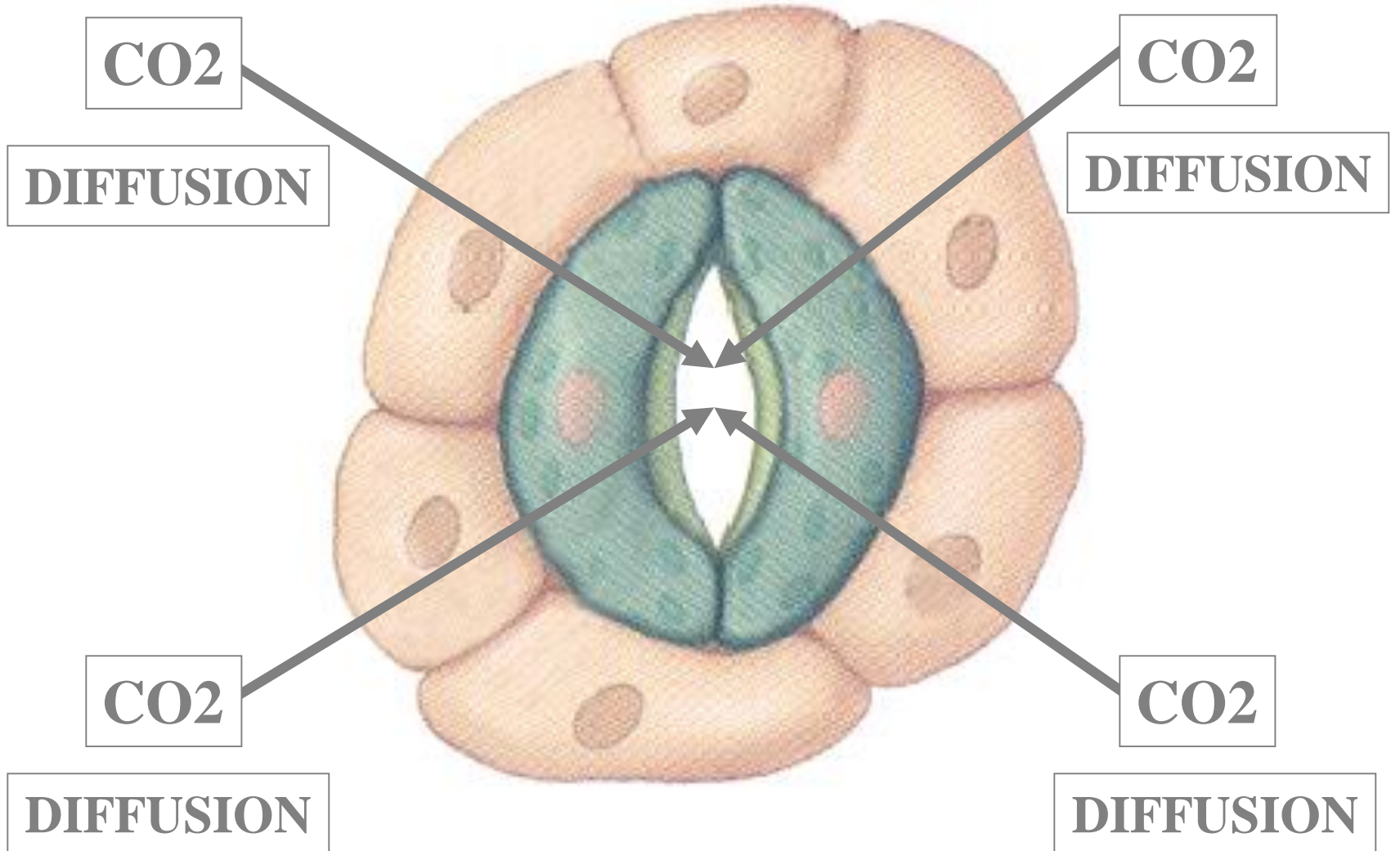
DARK HOURS

STEM STOMATE

DARK HOURS

+

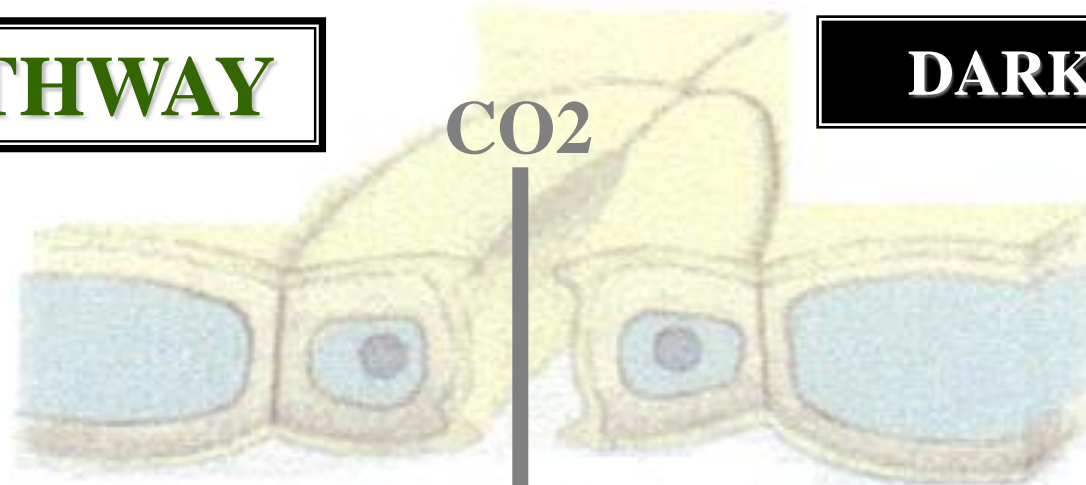
M



CAM PATHWAY

DARK HOURS

ATMOSPHERE



DIFFUSION



CO2

MESOPHYLL CELL / CYTOSOL

^



**STEM
MESOPHYLL
CELL
CYTOSOL**



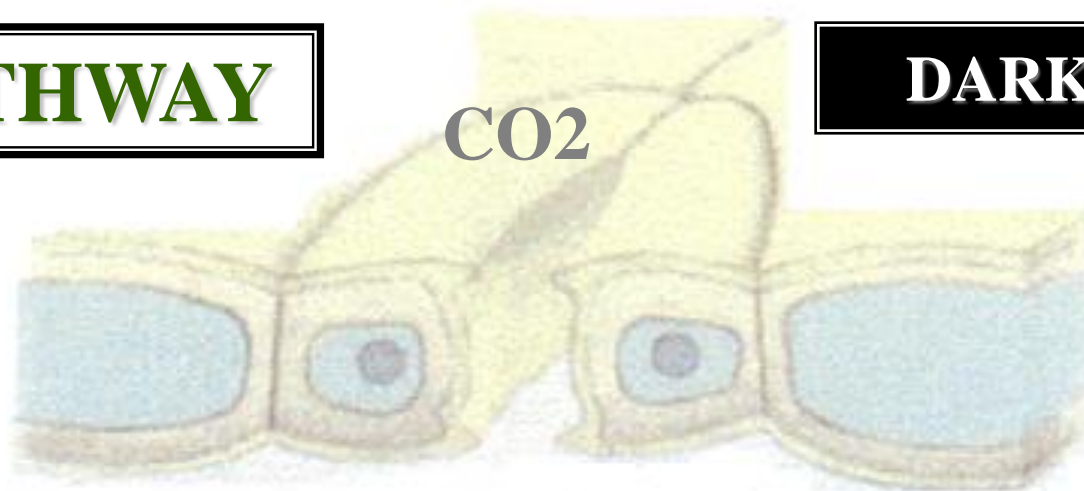
CAM PATHWAY CO₂ FIXATION

CAM PATHWAY

DARK HOURS

CO₂

ATMOSPHERE



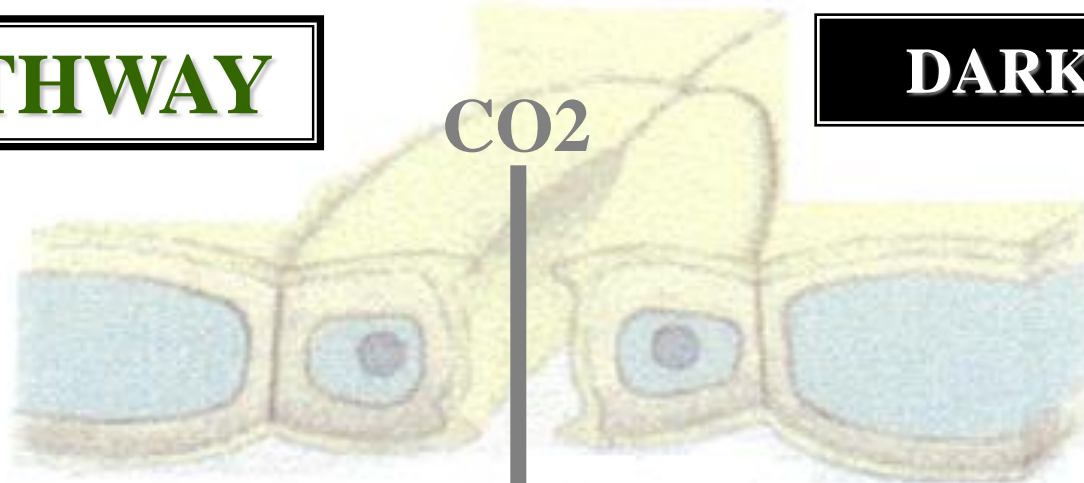
D

MESOPHYLL CELL / CYTOSOL

CAM PATHWAY

DARK HOURS

ATMOSPHERE



DIFFUSION



CO2

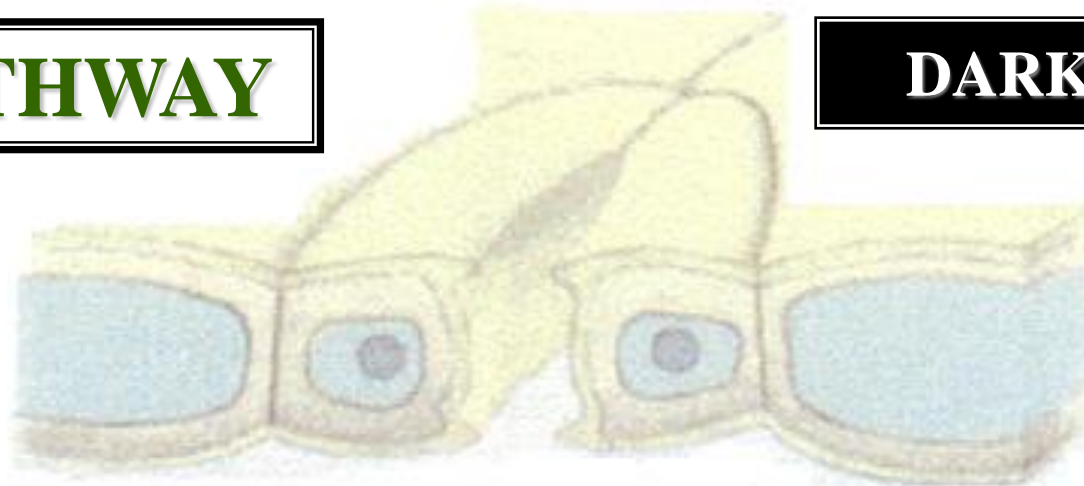
MESOPHYLL CELL / CYTOSOL

P

CAM PATHWAY

DARK HOURS

ATMOSPHERE



$\text{CO}_2 + \text{PEP}$

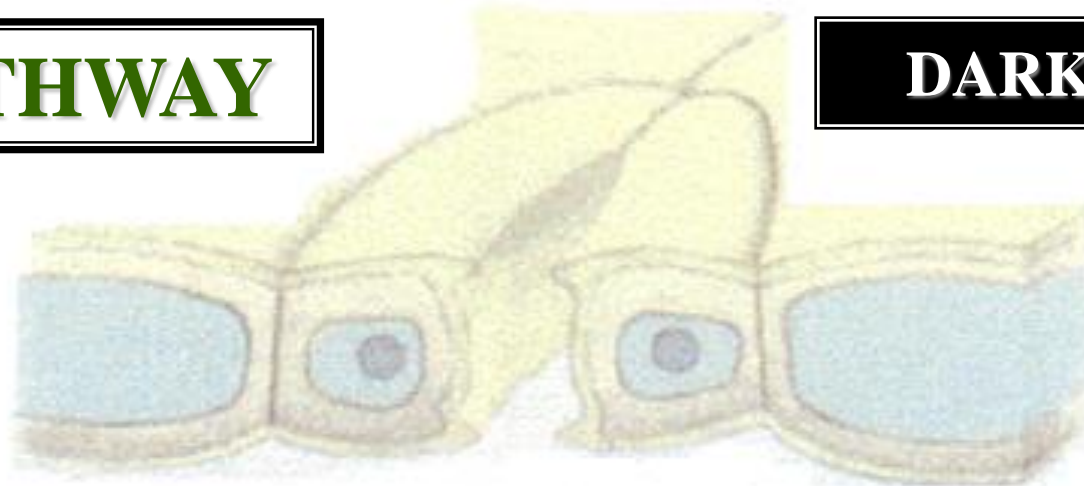
0

MESOPHYLL CELL / CYTOSOL

CAM PATHWAY

DARK HOURS

ATMOSPHERE



EZ

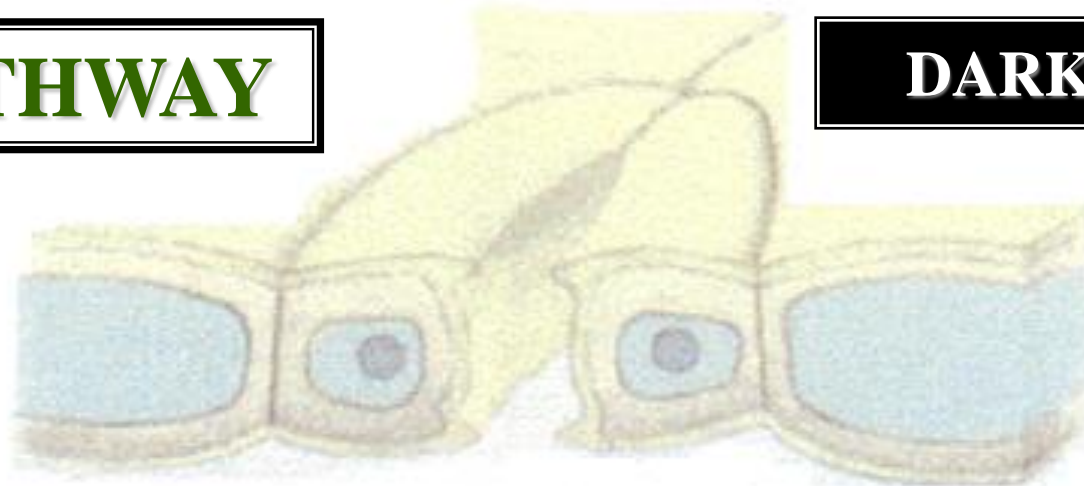


MESOPHYLL CELL / CYTOSOL

CAM PATHWAY

DARK HOURS

ATMOSPHERE



?

2

MESOPHYLL CELL / CYTOSOL

C3

CO₂
ENTERS
STROMA

C3

CO₂ + RIBULOSE BISPHOSEPHATE / (RUBP)

RIBULOSE BISPHOSEPHATE
CARBOXYLASE
(RUBP-CARBOXYLASE)

+

2 PHOSPHOGLYCERATE / (PGA)

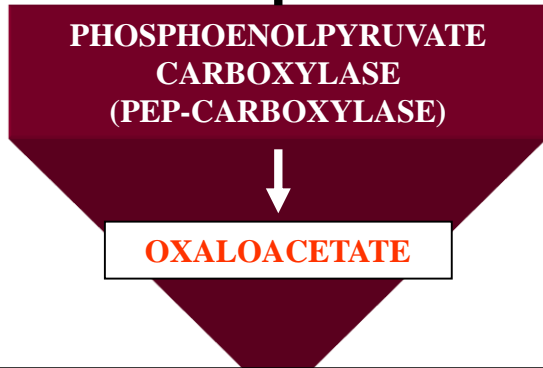
**INEFFICIENT
ENZYME**

C4

**CO₂
ENTERS
MESOPHYLL CYTOSOL**

C4

CO₂ + PHOSPHOENOLPYRUVATE / (PEP)



P

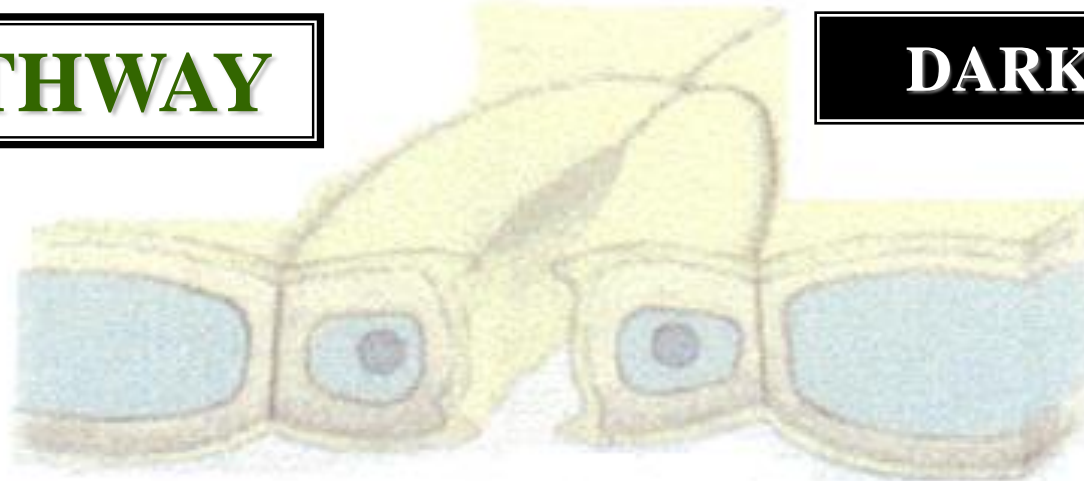
+

**EFFICIENT
ENZYME**

CAM PATHWAY

DARK HOURS

ATMOSPHERE



PHOSPHOENOLPYRUVATE
CARBOXYLASE
(PEP-ASE)

C4 CO2 FIXATION ENZYME

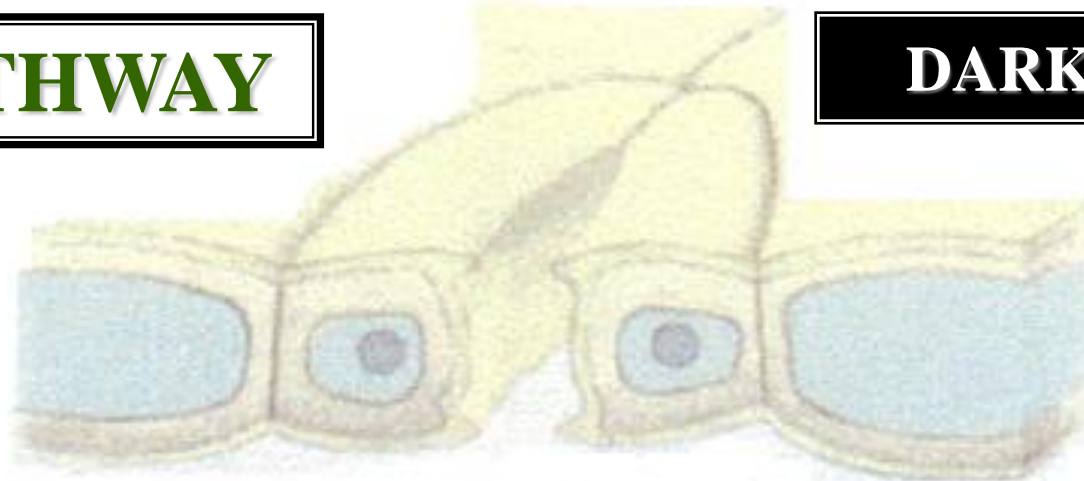
C4 R

MESOPHYLL CELL / CYTOSOL

CAM PATHWAY

DARK HOURS

ATMOSPHERE



PHOSPHOENOLPYRUVATE
CARBOXYLASE
(PEP-ASE)

C4 CO2 FIXATION ENZYME

C4 CO2 FIXATION RXT

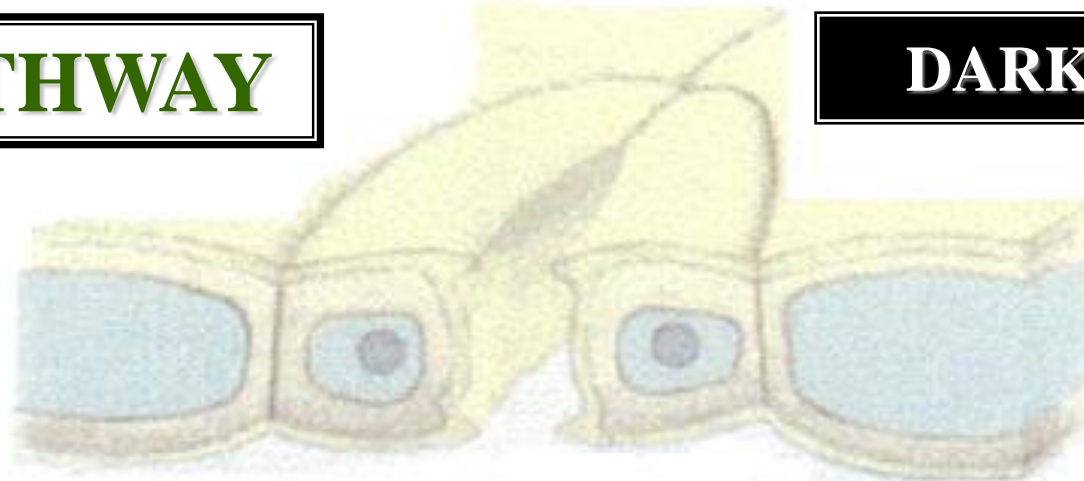
CAM

MESOPHYLL CELL / CYTOSOL

CAM PATHWAY

DARK HOURS

ATMOSPHERE



**PHOSPHOENOLPYRUVATE
CARBOXYLASE
(PEP-ASE)**

CAM CO2 FIXATION ENZYME

C4 CO2 FIXATION RXT

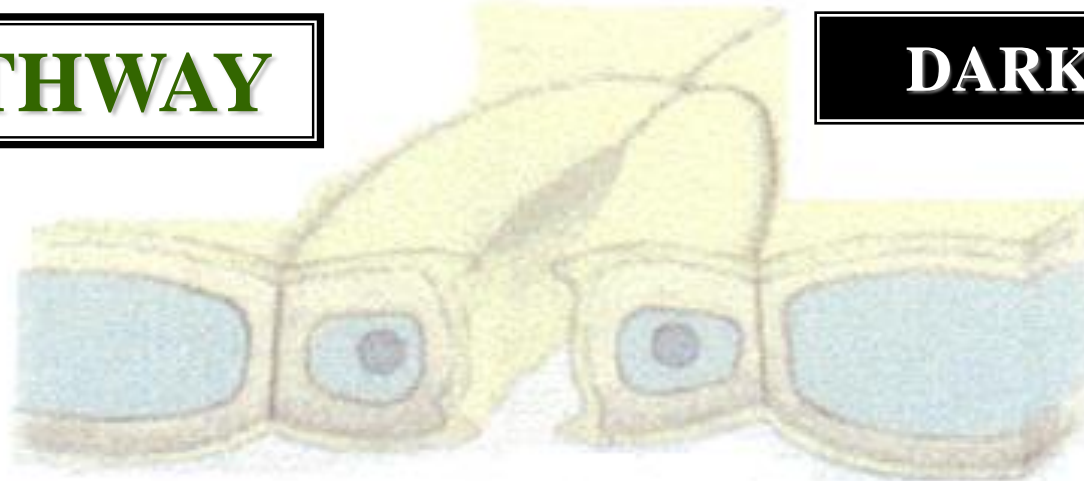
CAM

MESOPHYLL CELL / CYTOSOL

CAM PATHWAY

DARK HOURS

ATMOSPHERE



PHOSPHOENOLPYRUVATE
CARBOXYLASE
(PEP-ASE)

CAM CO₂ FIXATION ENZYME

CAM CO₂ FIXATION RXT

M

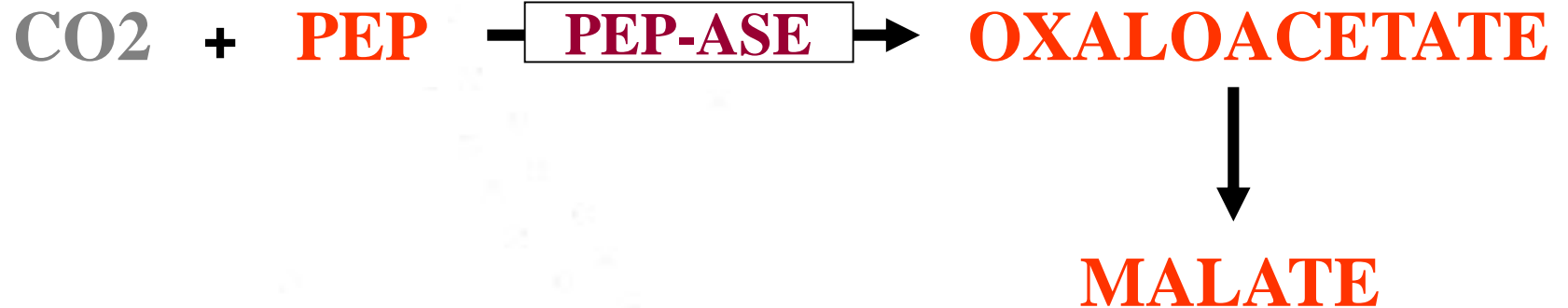
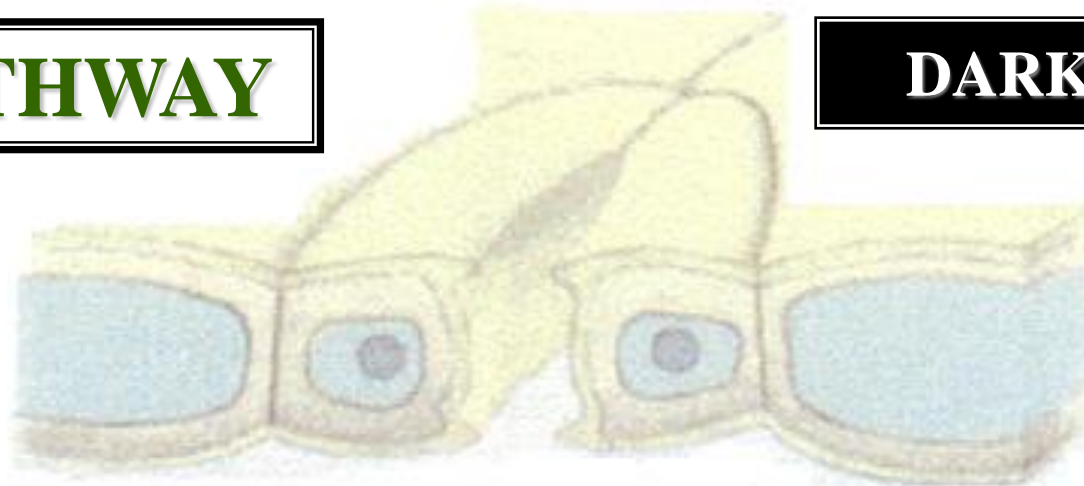


MESOPHYLL CELL / CYTOSOL

CAM PATHWAY

DARK HOURS

ATMOSPHERE

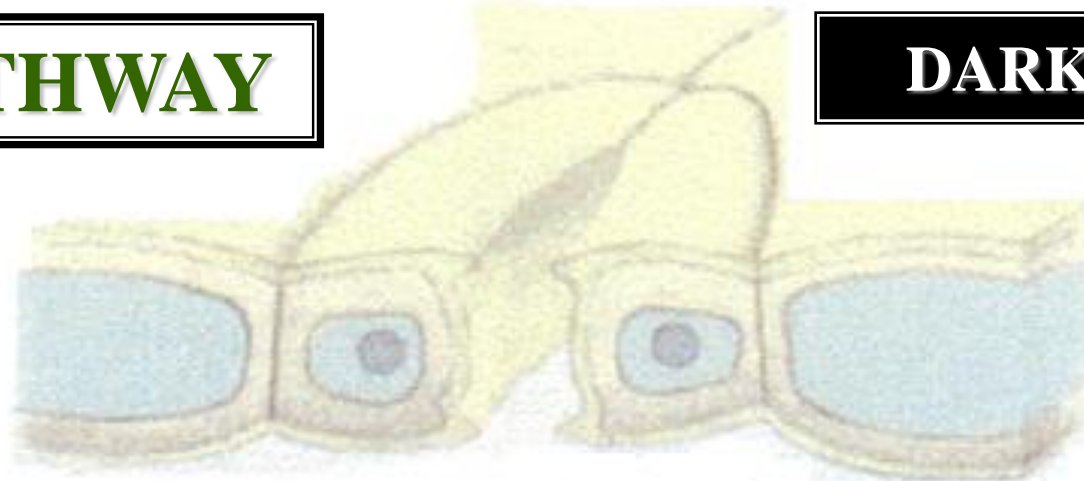


MESOPHYLL CELL / CYTOSOL

CAM PATHWAY

DARK HOURS

ATMOSPHERE



VACUOLE

MESOPHYLL CELL / CYTOSOL

^

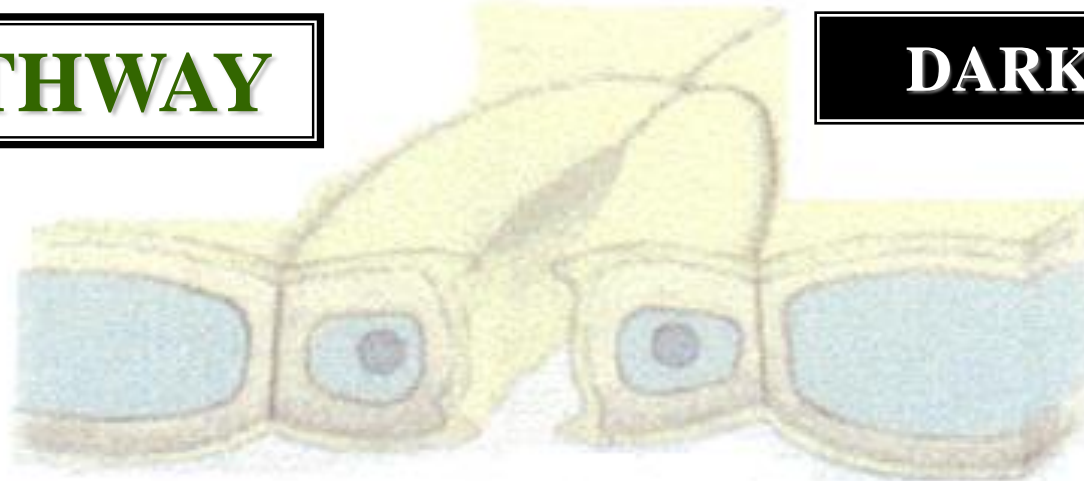


**STEM
MESOPHYLL
CELL
VACUOLE**

CAM PATHWAY

DARK HOURS

ATMOSPHERE



* CO₂



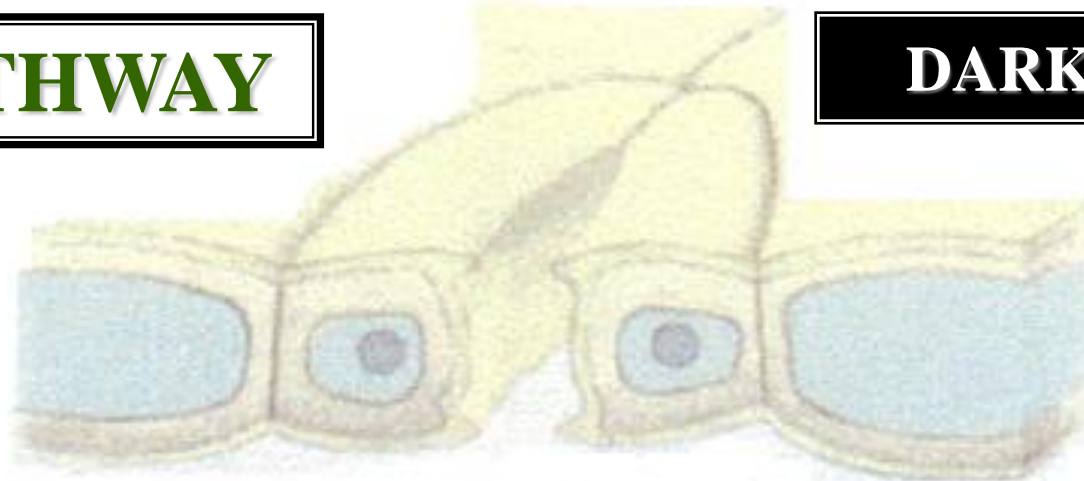
VACUOLE

MESOPHYLL CELL / CYTOSOL

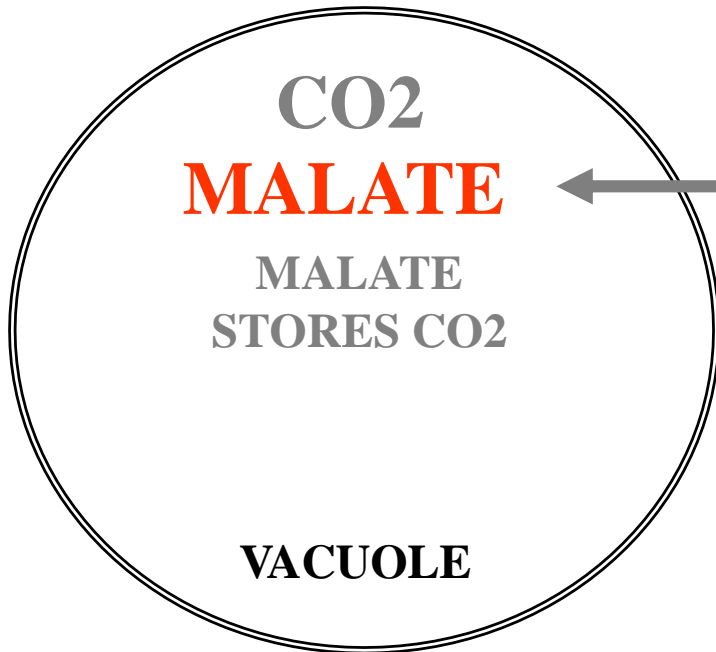
CAM PATHWAY

DARK HOURS

ATMOSPHERE



* **V**



SHUNTED

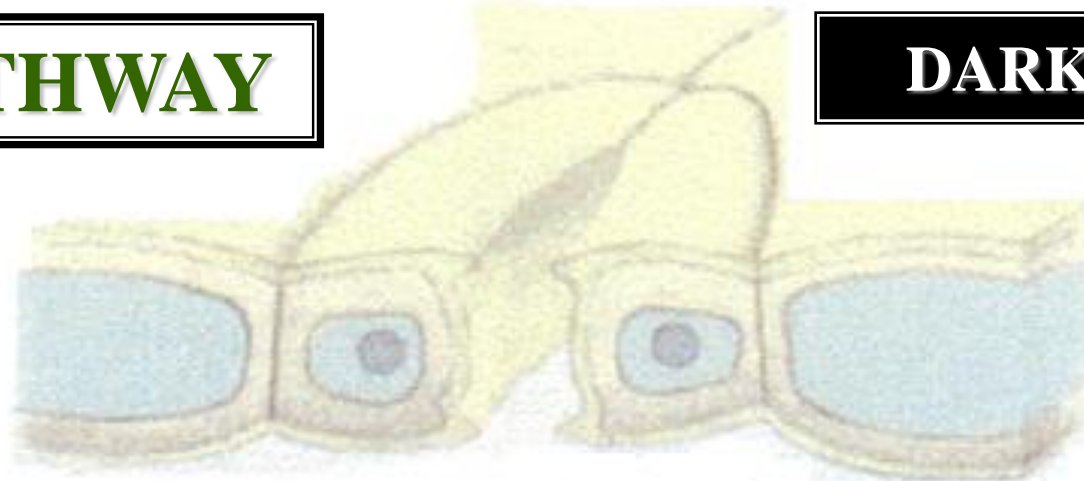
MALATE

MESOPHYLL CELL / CYTOSOL

CAM PATHWAY

DARK HOURS

ATMOSPHERE



CO₂
MALATE
MALATE
STORES CO₂
VACUOLE
STORES MALATE

VACUOLE

MESOPHYLL CELL / CYTOSOL





**CAM PLANTS
FIXATE
CO₂
DURING
DARK HOURS**



**CAM PLANTS
STORE
CO₂ W/IN MALATE
DURING
DARK HOURS**



CAM PATHWAY LIGHT HOURS

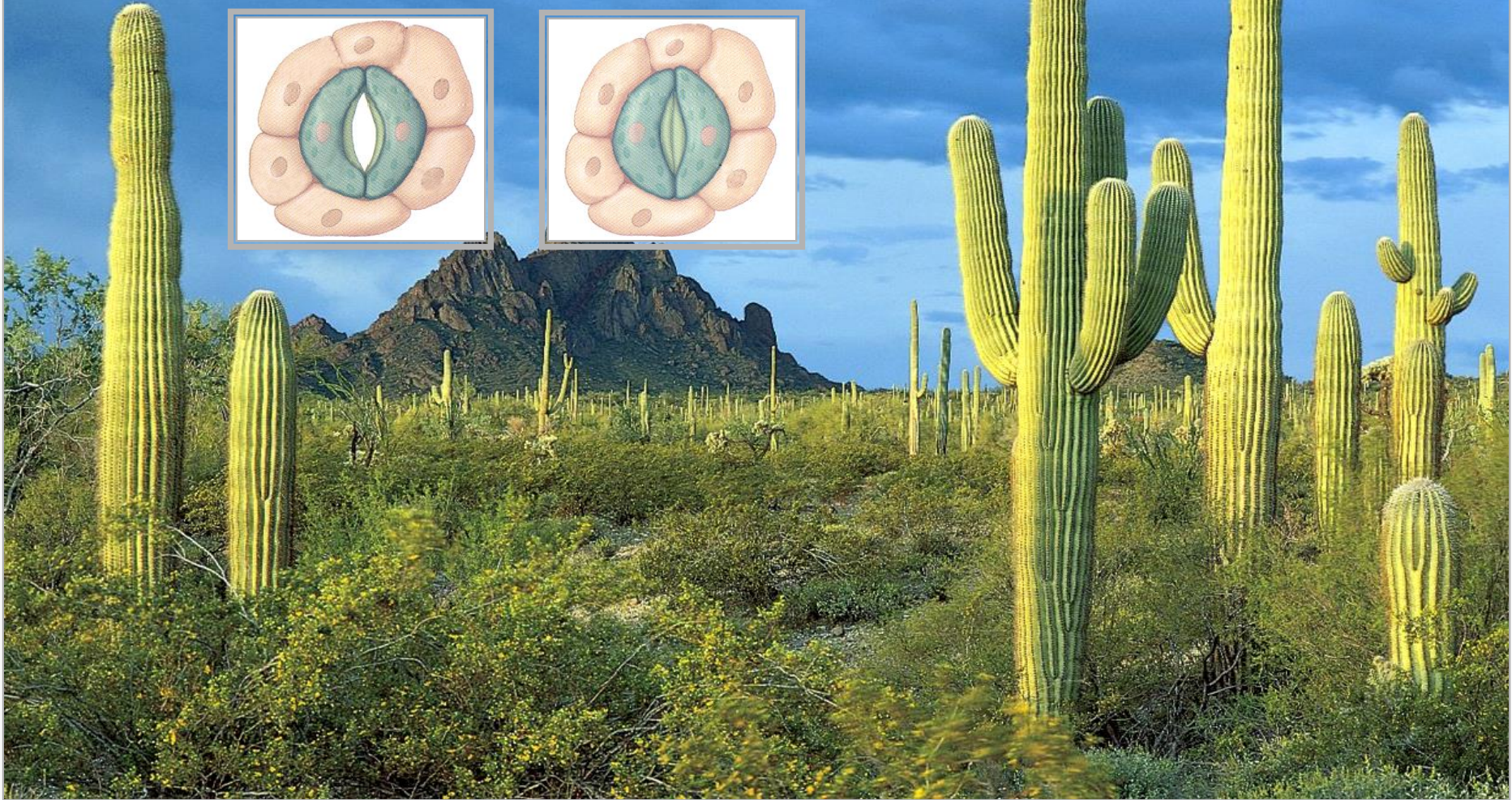
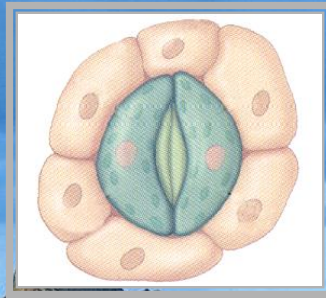
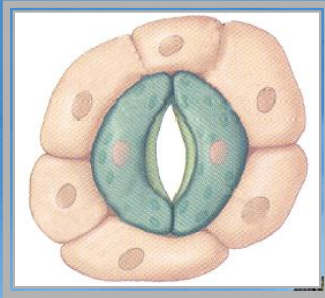
CAM PATHWAY LIGHT HOURS



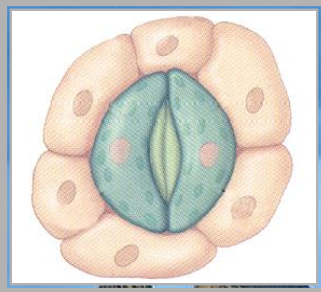


STEM STOMATE

CAM PATHWAY LIGHT HOURS



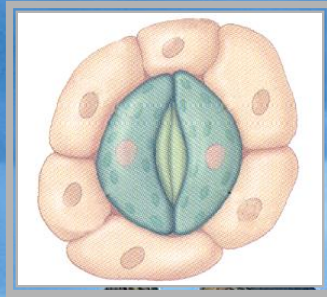
CAM PATHWAY LIGHT HOURS



STOMATES
CLOSE



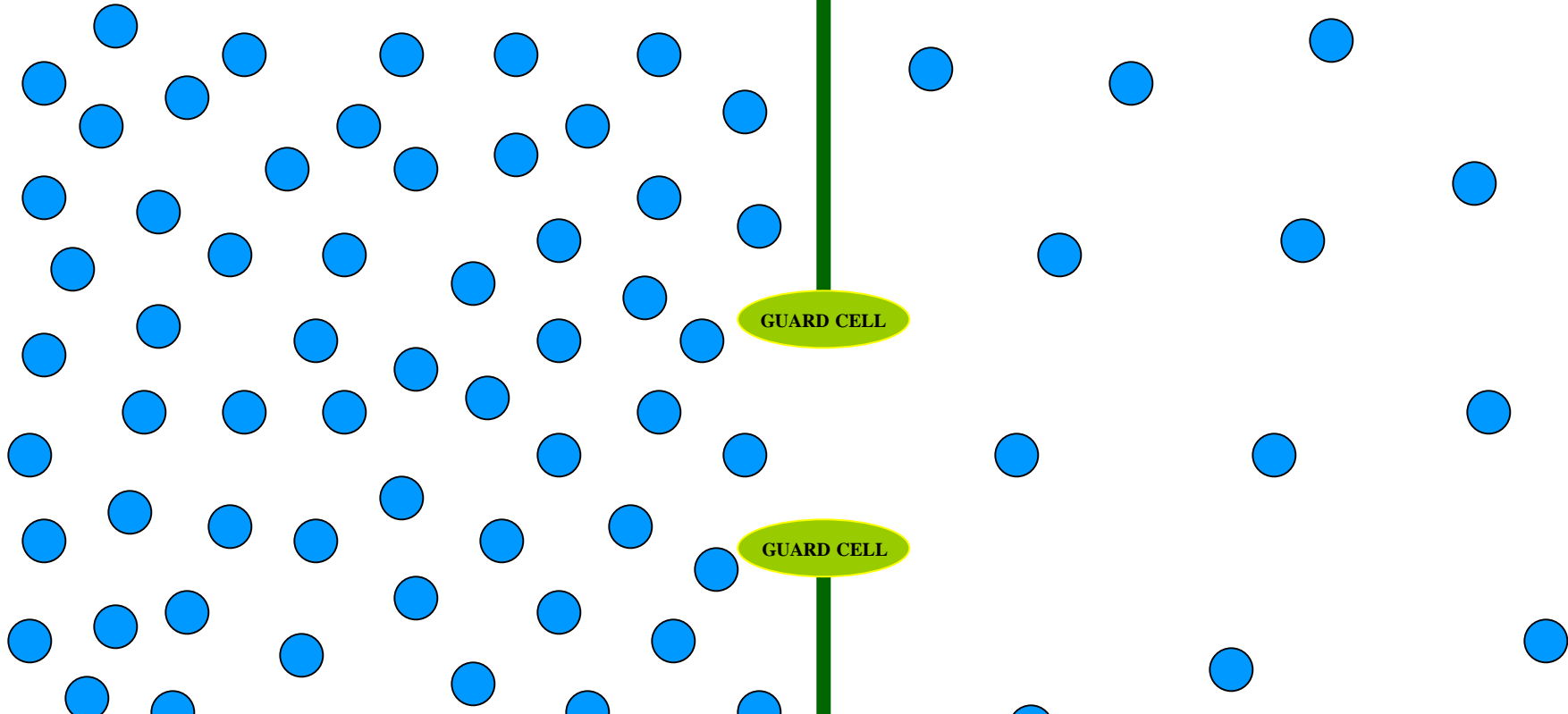
LIGHT HOURS
LOW HUMIDITY



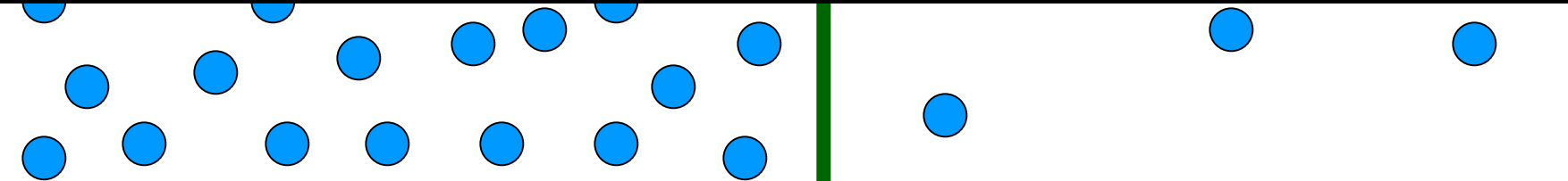
STOMATES
CLOSE

PLANT

ATMOSPHERE



LOW HUMIDITY LIGHT HOURS



PLANT

ATMOSPHERE

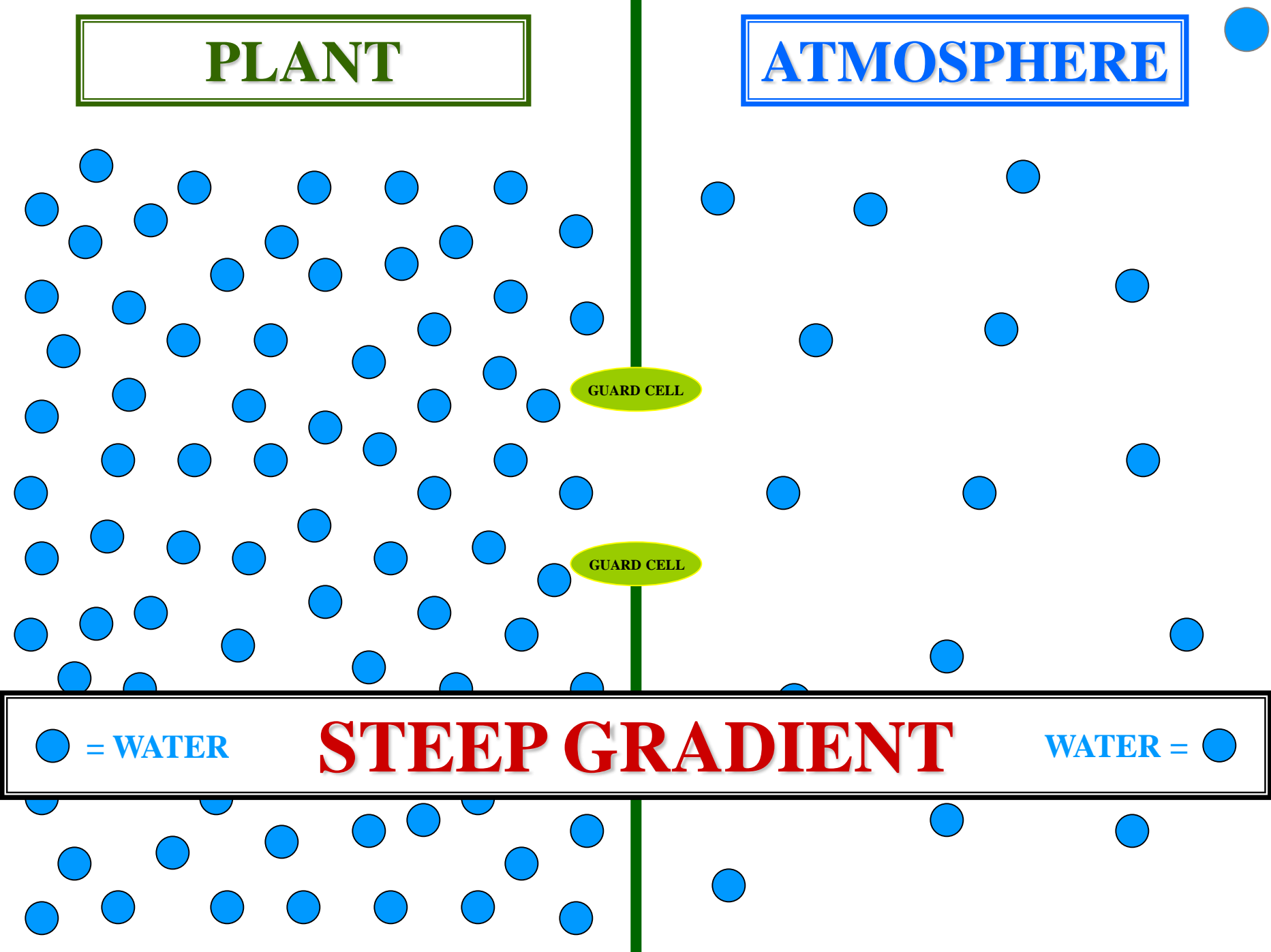
GUARD CELL

GUARD CELL

● = WATER

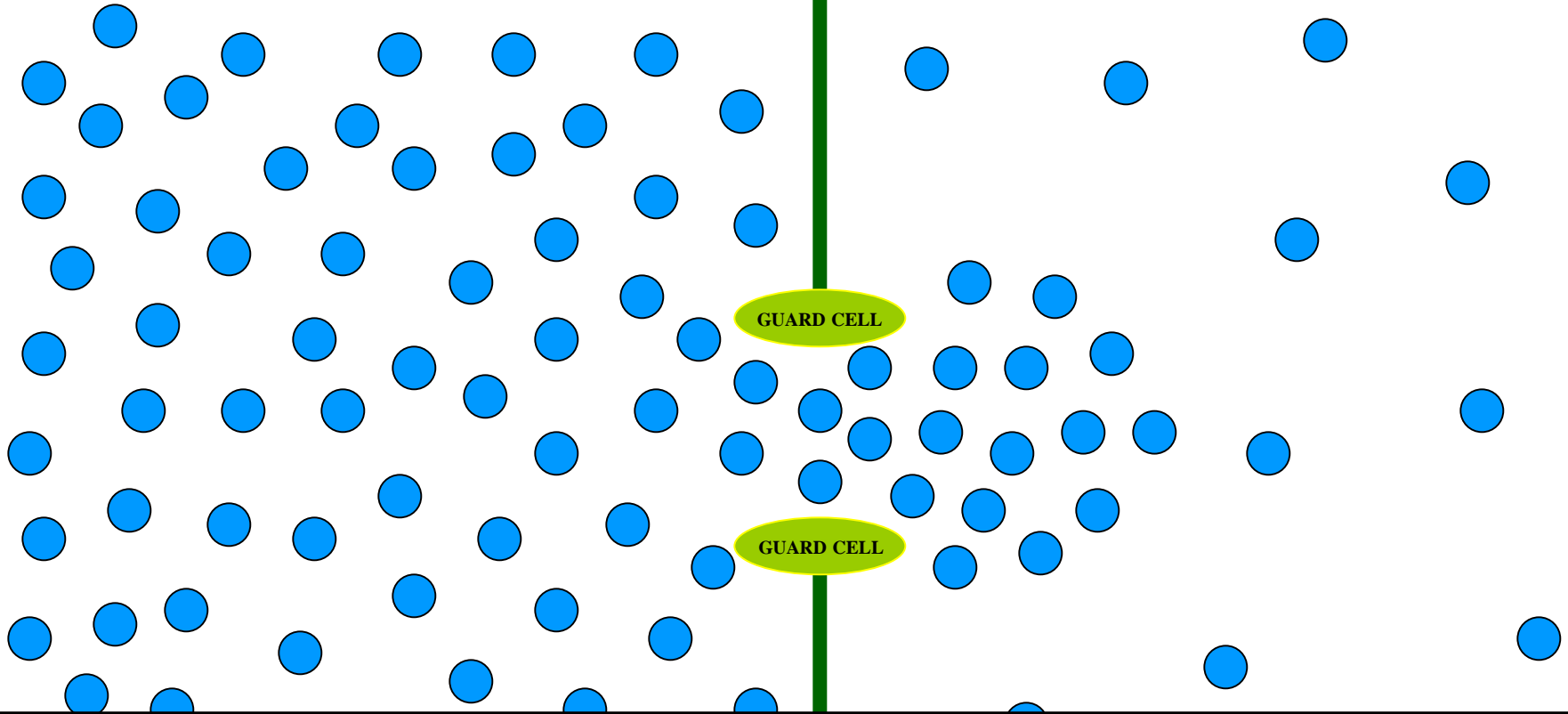
STEEP GRADIENT

WATER = ●



PLANT

ATMOSPHERE



GUARD CELL

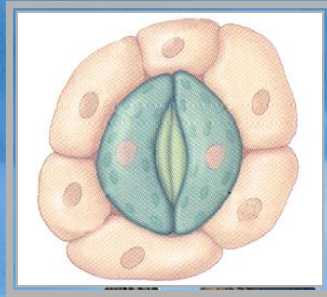
GUARD CELL

● = WATER

STEEP GRADIENT

WATER = ●

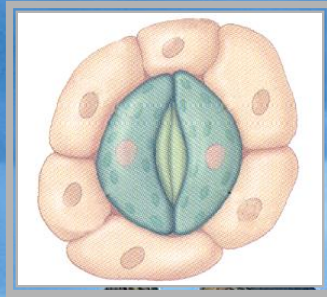
LIGHT HOURS
LOW HUMIDITY



TRANSPIRATION
POTENTIAL



LIGHT HOURS
LOW HUMIDITY



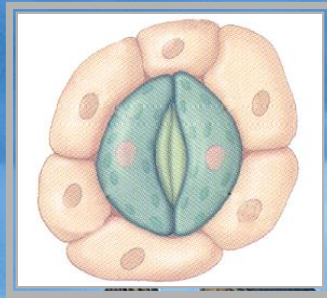
C

VERY HIGH
TRANSPIRATION
POTENTIAL



LIGHT HOURS
LOW HUMIDITY

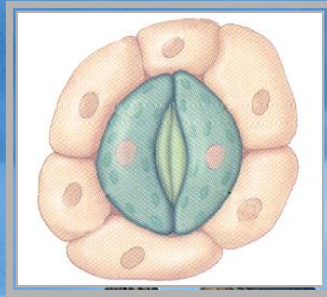
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T



STOMATES
CLOSE



LIGHT HOURS
LOW HUMIDITY

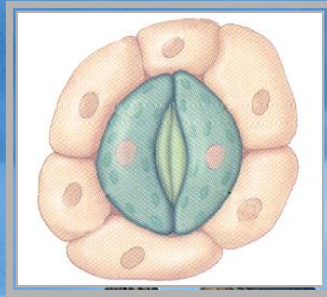


?

TRANSPIRATION

LIGHT HOURS
LOW HUMIDITY

?
C

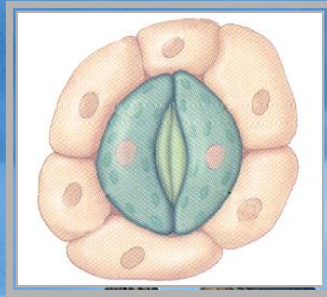


NO

TRANSPIRATION

LIGHT HOURS
LOW HUMIDITY

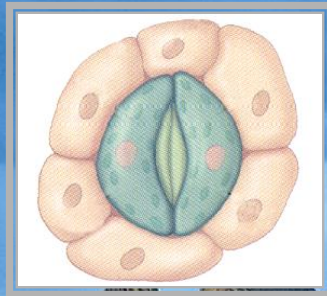
N



?

CO₂ FIXATION

LIGHT HOURS
LOW HUMIDITY



NO
CO₂ FIXATION



QUESTION



**DOES THE CAM PLANT
NEED TO FIXATE CO₂
DURING THE
LIGHT HOURS?**

QUESTION

ANSWER



NO

LIGHT HOURS CO₂

FIXATION NOT

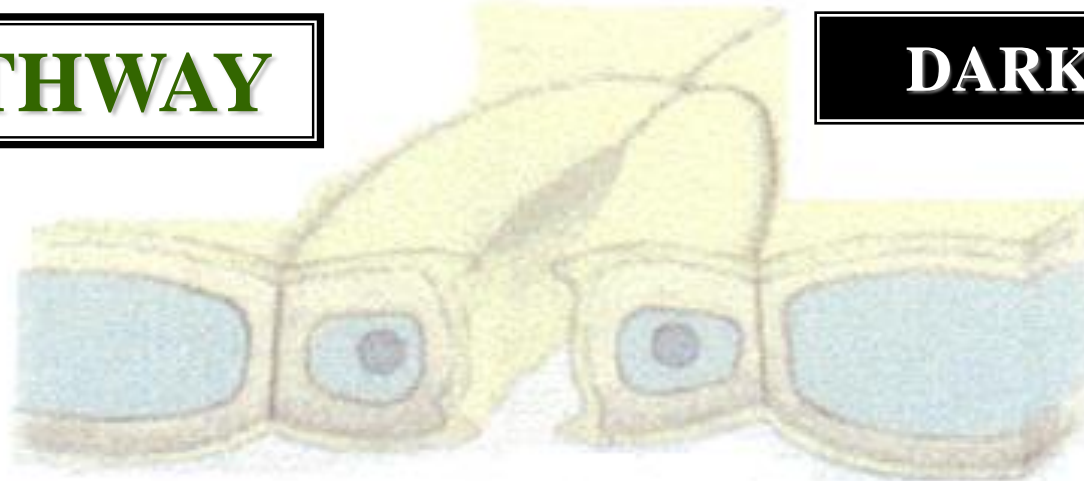
REQUIRED

ANSWER

CAM PATHWAY

DARK HOURS

ATMOSPHERE



CO_2

MALATE

SHUNTED

MALATE

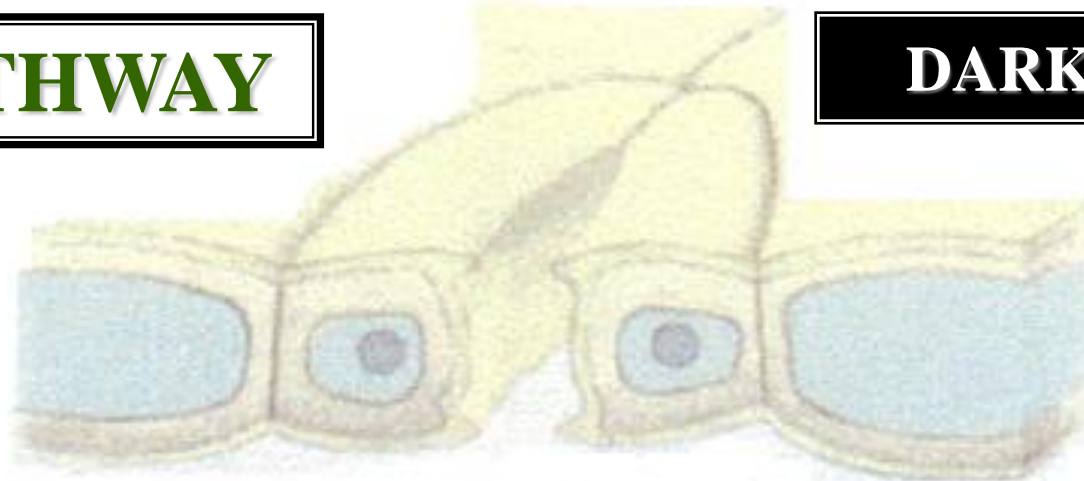
VACUOLE

MESOPHYLL CELL / CYTOSOL

CAM PATHWAY

DARK HOURS

ATMOSPHERE



MALATE STORES CO₂

VACUOLE

MESOPHYLL CELL / CYTOSOL





STEM
MESOPHYLL
CELL
CHLOROPLAST
THYLAKOID

CAM PATHWAY LIGHT HOURS



CAM PATHWAY LIGHT HOURS



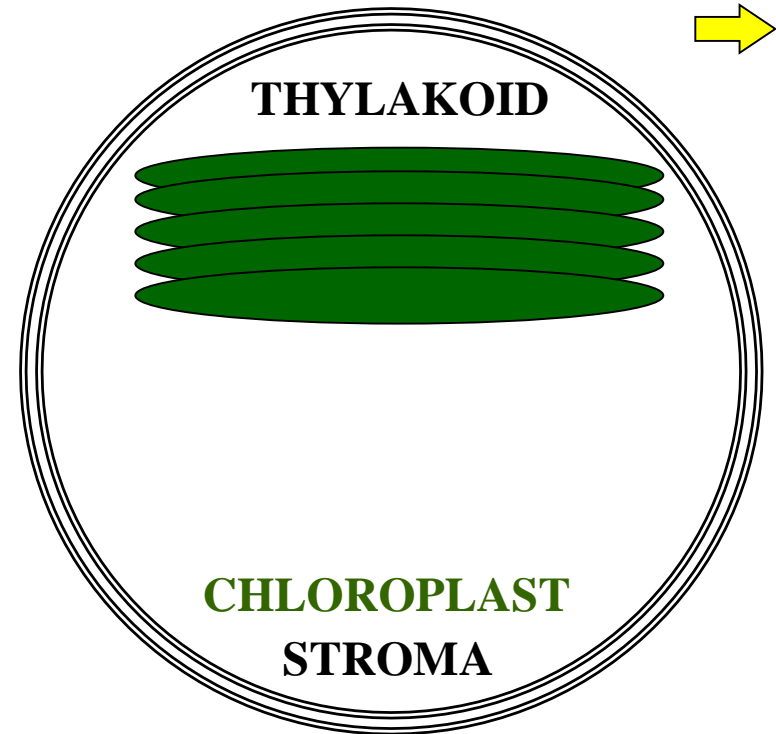
LIGHT REACTION
OCCURS



CAM PATHWAY

LIGHT HOURS

ATMOSPHERE

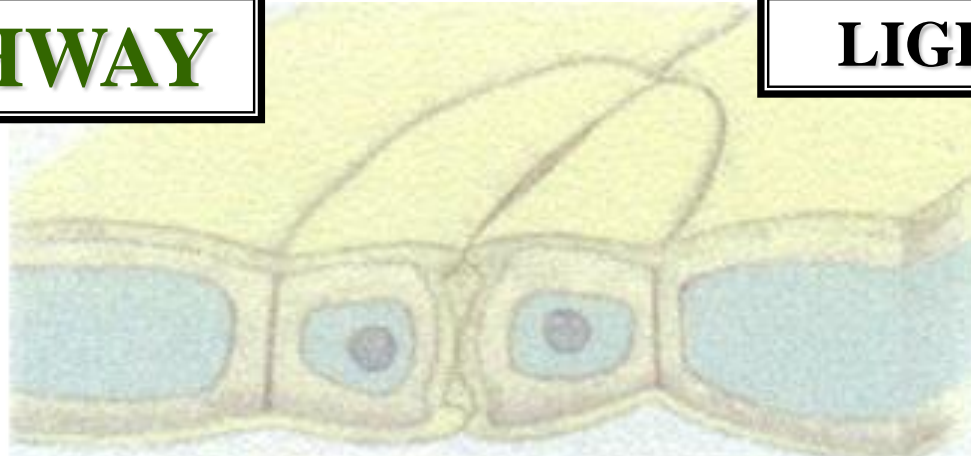


MESOPHYLL CELL / CYTOSOL

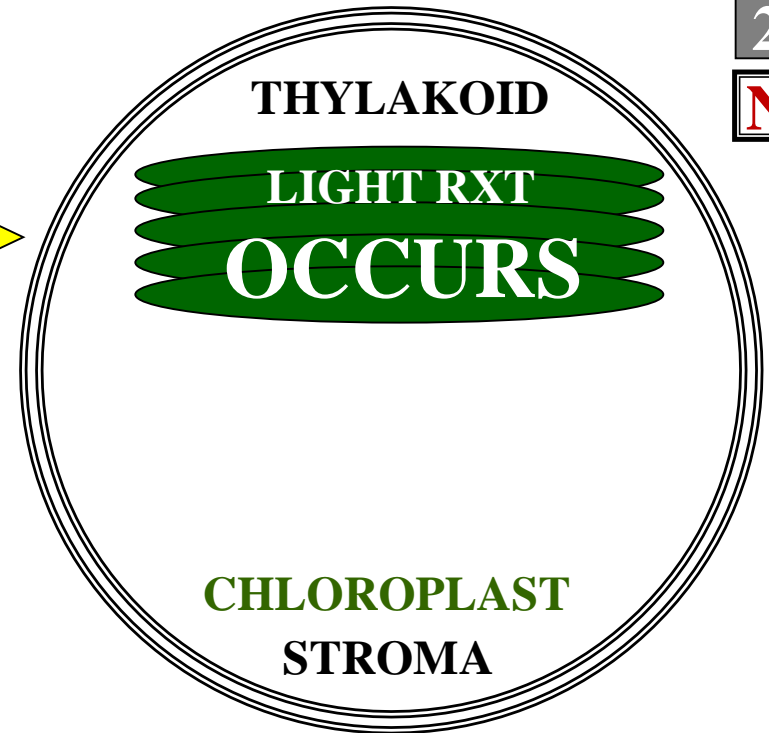
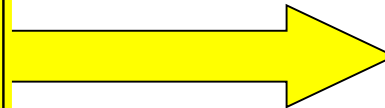
CAM PATHWAY

LIGHT HOURS

ATMOSPHERE



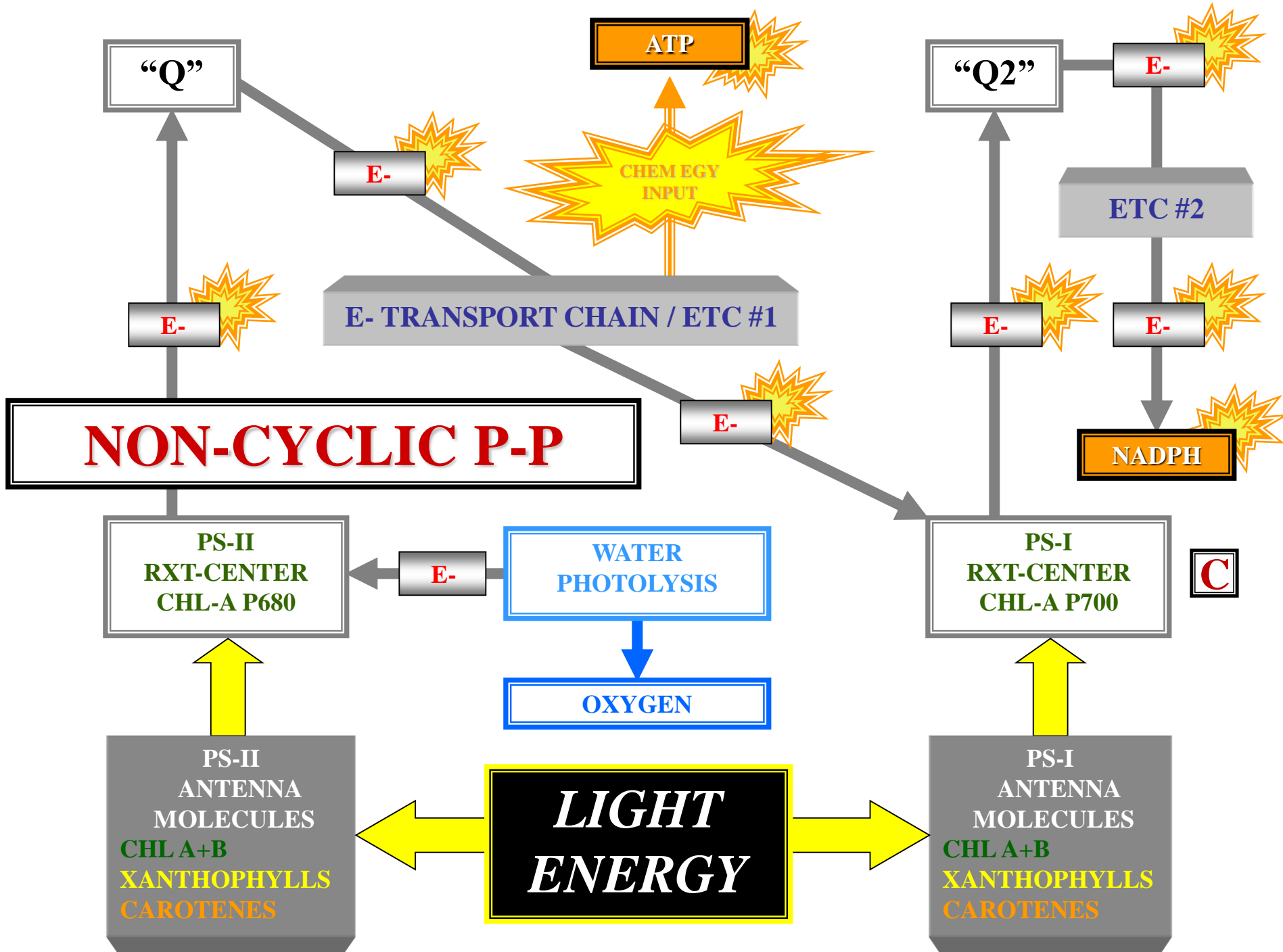
LIGHT



2

N

MESOPHYLL CELL / CYTOSOL



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

?

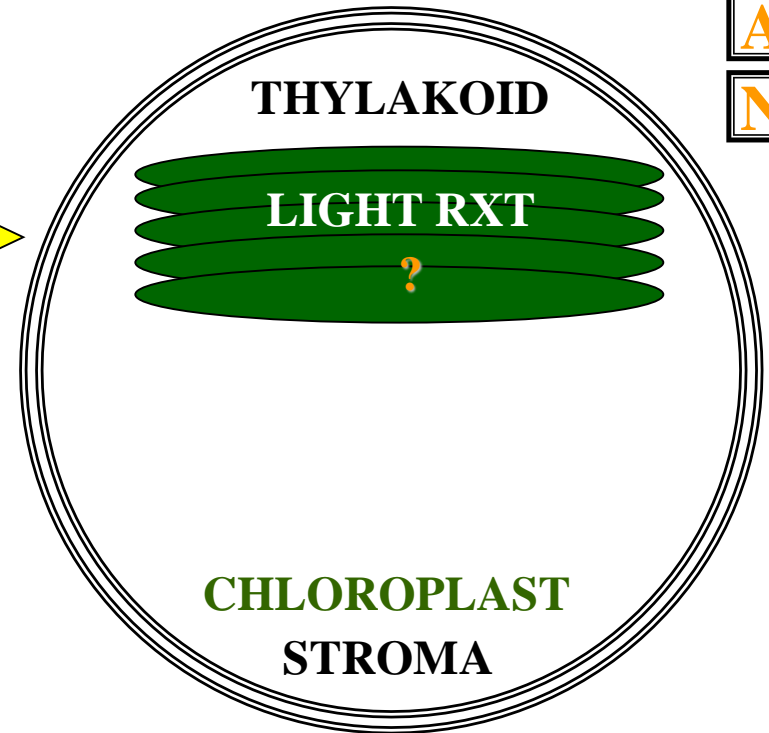
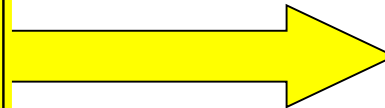
CAM PATHWAY

LIGHT HOURS

ATMOSPHERE



LIGHT



A
N

MESOPHYLL CELL / CYTOSOL

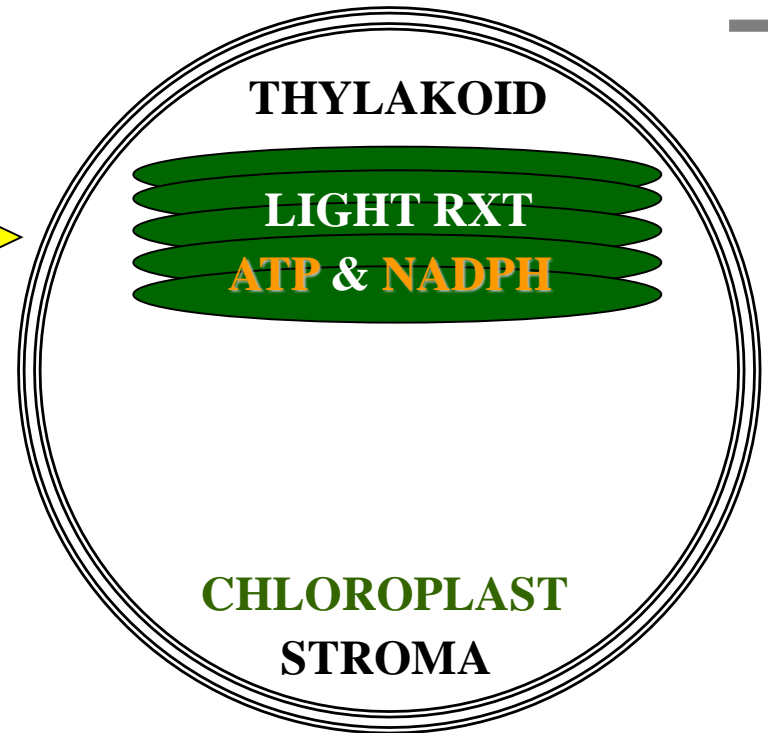
CAM PATHWAY

LIGHT HOURS

ATMOSPHERE



LIGHT →



MESOPHYLL CELL / CYTOSOL

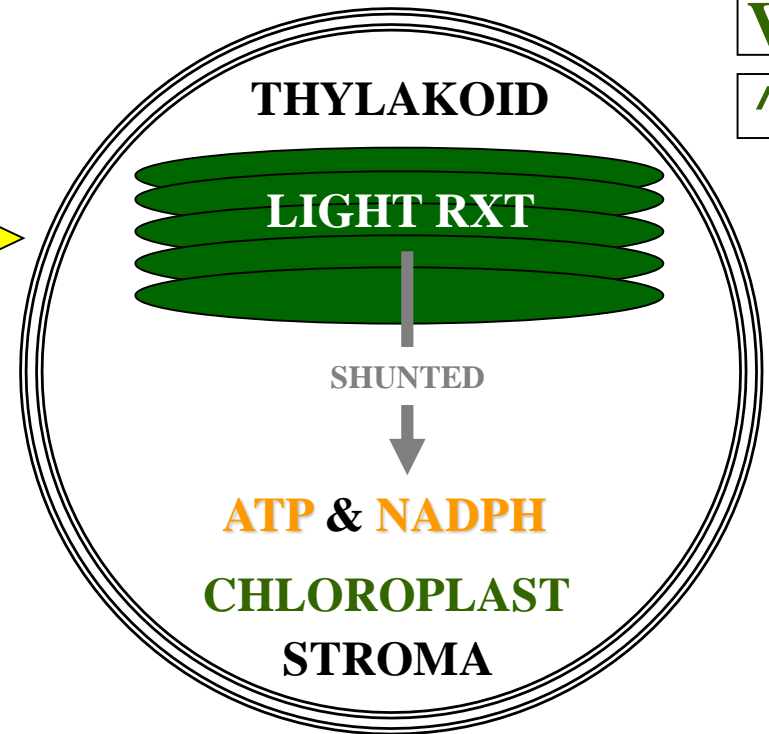
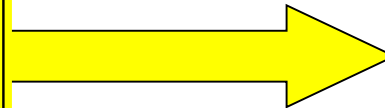
CAM PATHWAY

LIGHT HOURS

ATMOSPHERE



LIGHT EGY



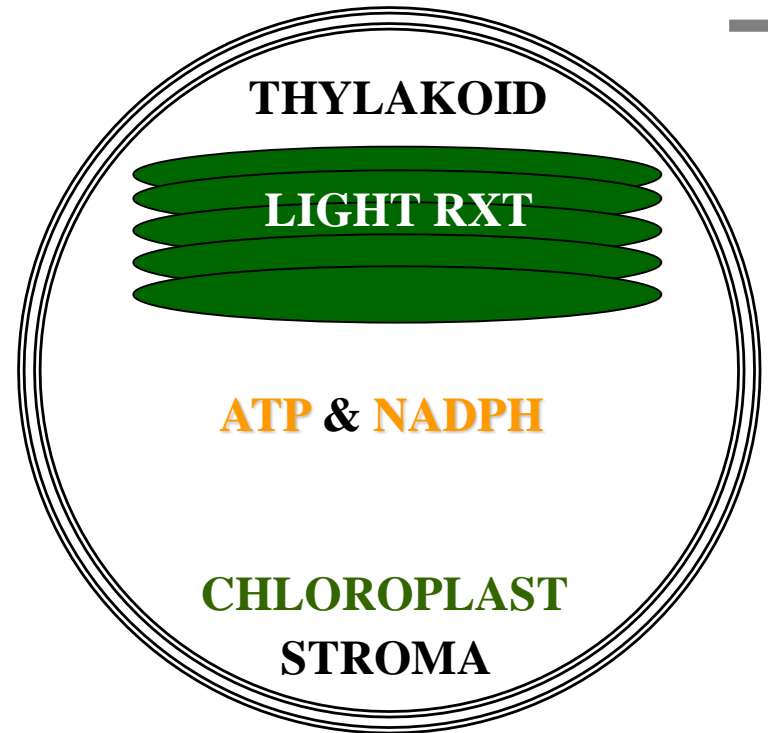
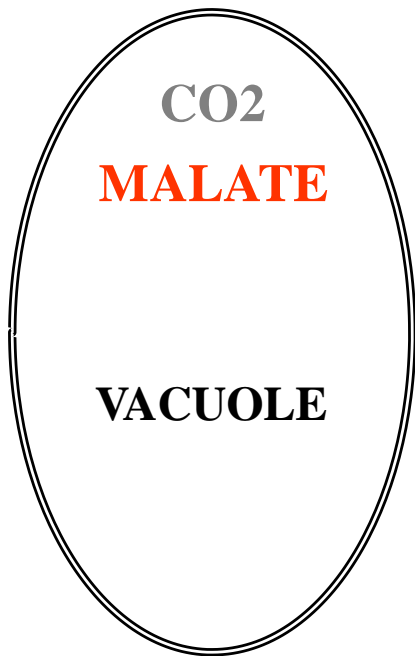
MESOPHYLL CELL / CYTOSOL

**STEM
MESOPHYLL
CELL
VACUOLE**

CAM PATHWAY

LIGHT HOURS

ATMOSPHERE

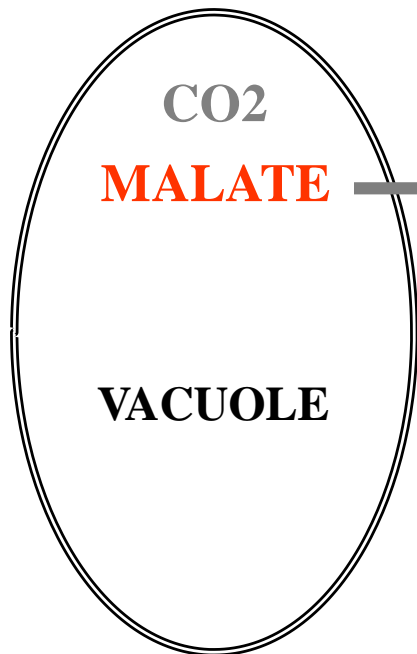


MESOPHYLL CELL / CYTOSOL

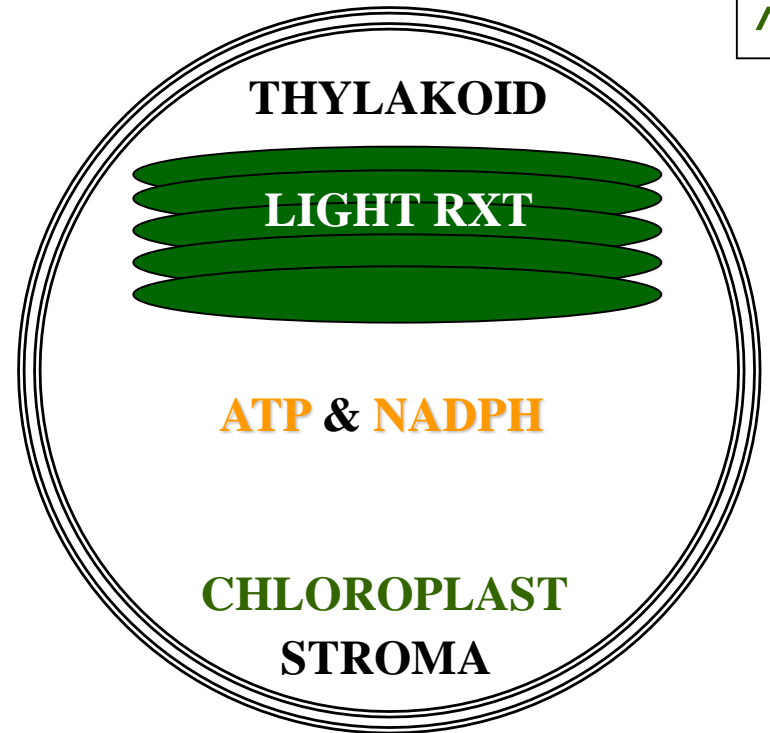
CAM PATHWAY

LIGHT HOURS

ATMOSPHERE



SHUNTED



MESOPHYLL CELL / CYTOSOL



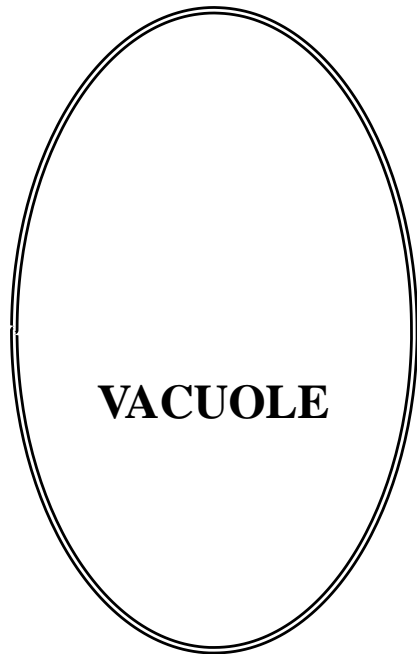
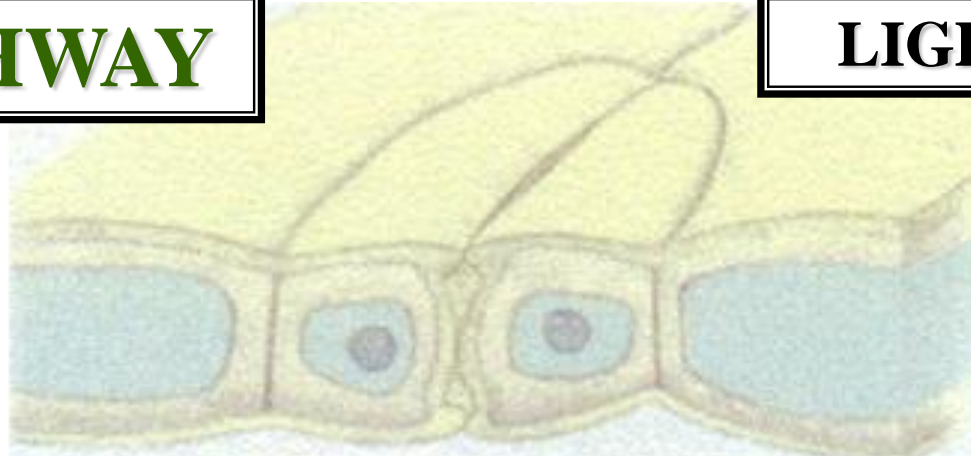


**STEM
MESOPHYLL
CELL
CYTOSOL**

CAM PATHWAY

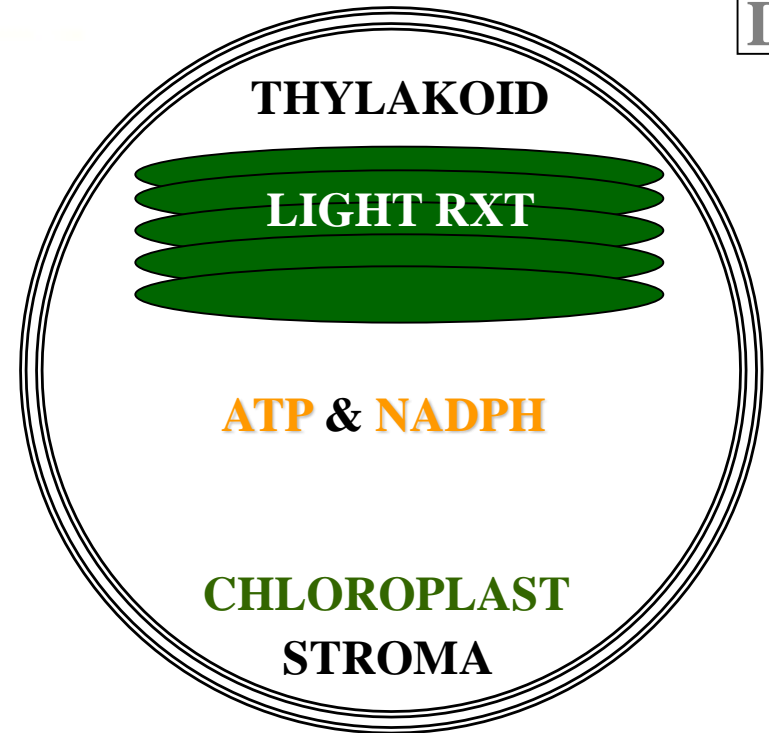
LIGHT HOURS

ATMOSPHERE



VACUOLE

CO₂
MALATE



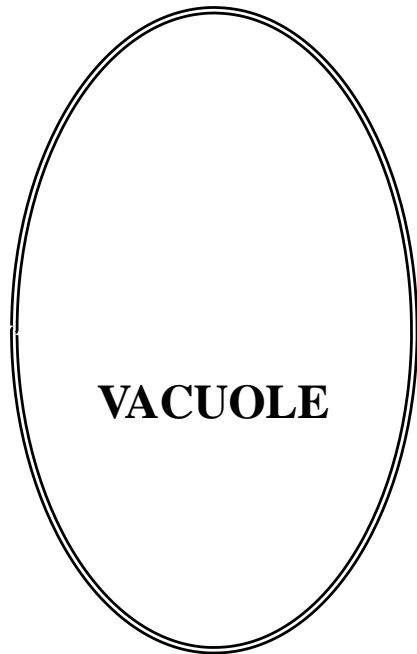
D

MESOPHYLL CELL / CYTOSOL

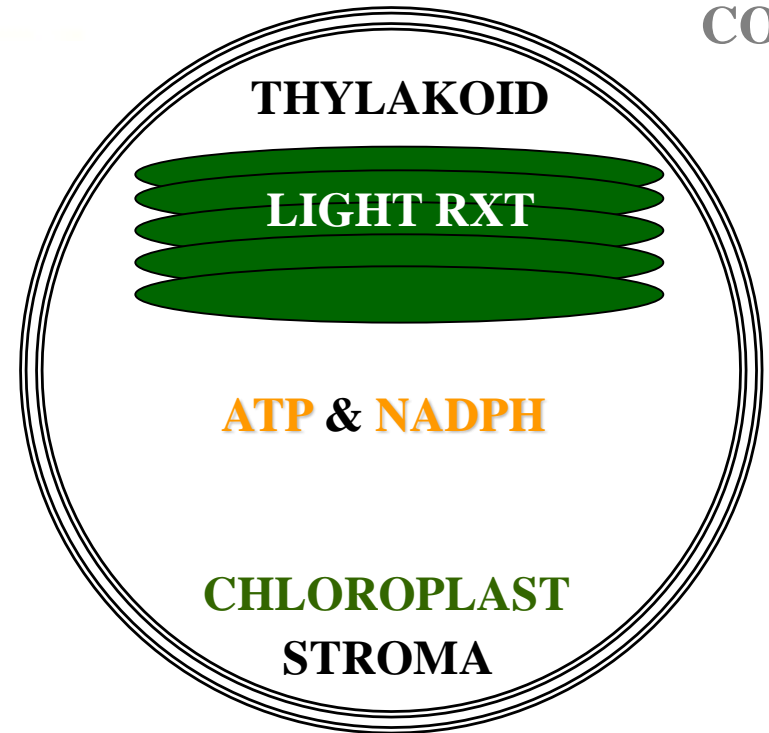
CAM PATHWAY

LIGHT HOURS

ATMOSPHERE



CO₂
MALATE
|
DECARBOXYLATED



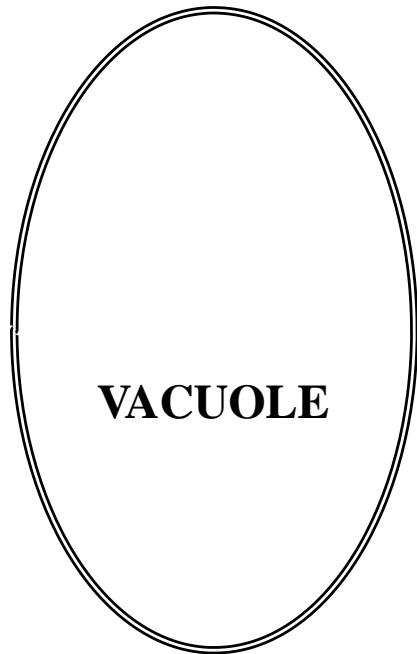
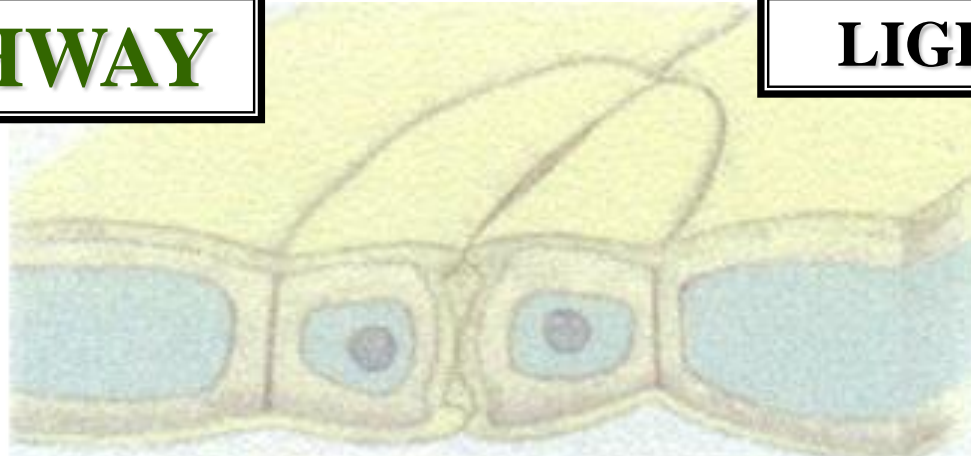
CO₂

MESOPHYLL CELL / CYTOSOL

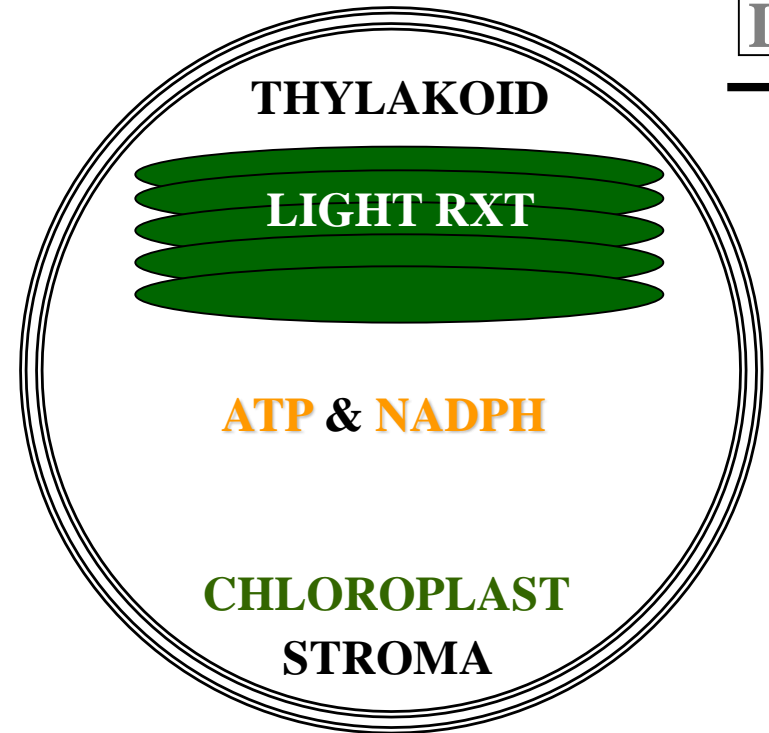
CAM PATHWAY

LIGHT HOURS

ATMOSPHERE



PYRUVATE
↓
DECARBOXYLATED
↓
CO₂
RELEASED



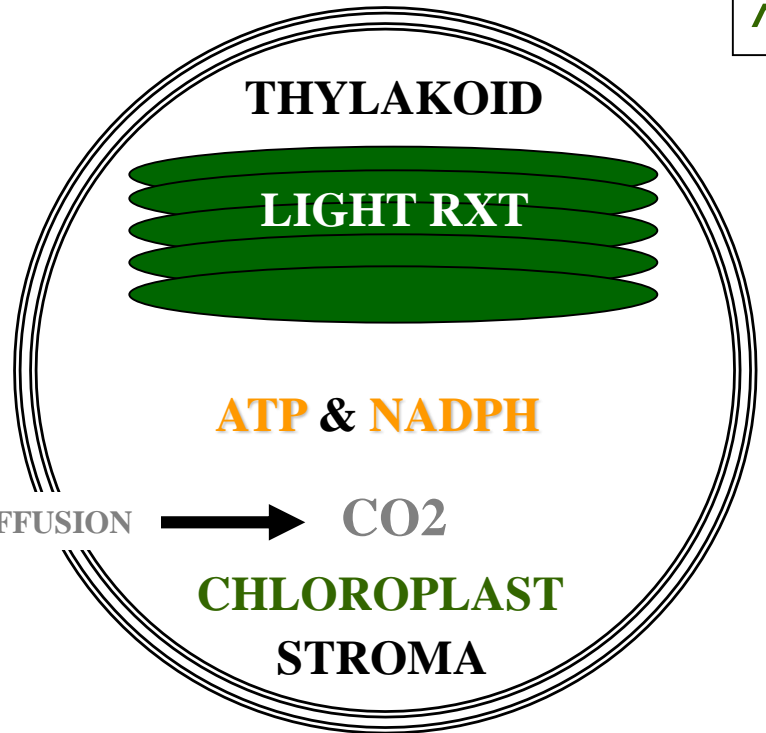
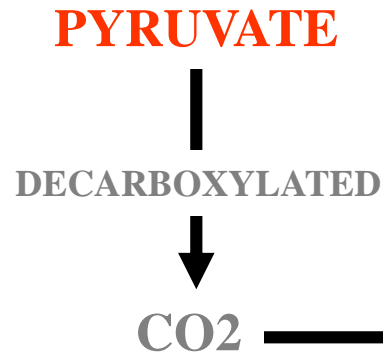
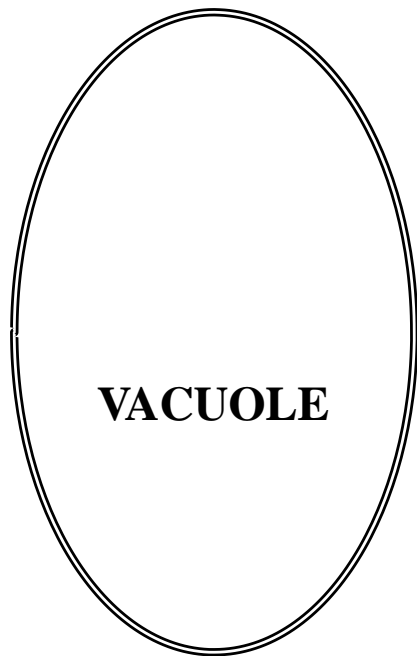
D
→

MESOPHYLL CELL / CYTOSOL

CAM PATHWAY

LIGHT HOURS

ATMOSPHERE



MESOPHYLL CELL / CYTOSOL



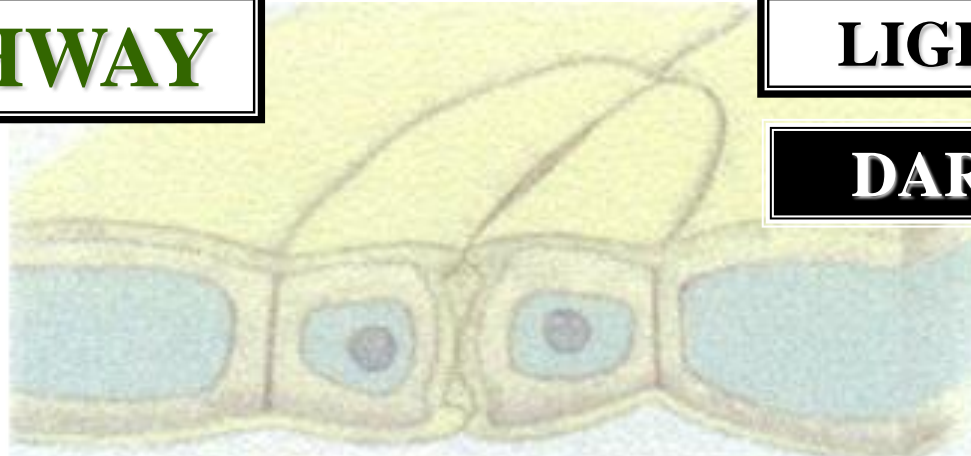


STEM
MESOPHYLL
CELL
CHLOROPLAST
STROMA

CAM PATHWAY

LIGHT HOURS

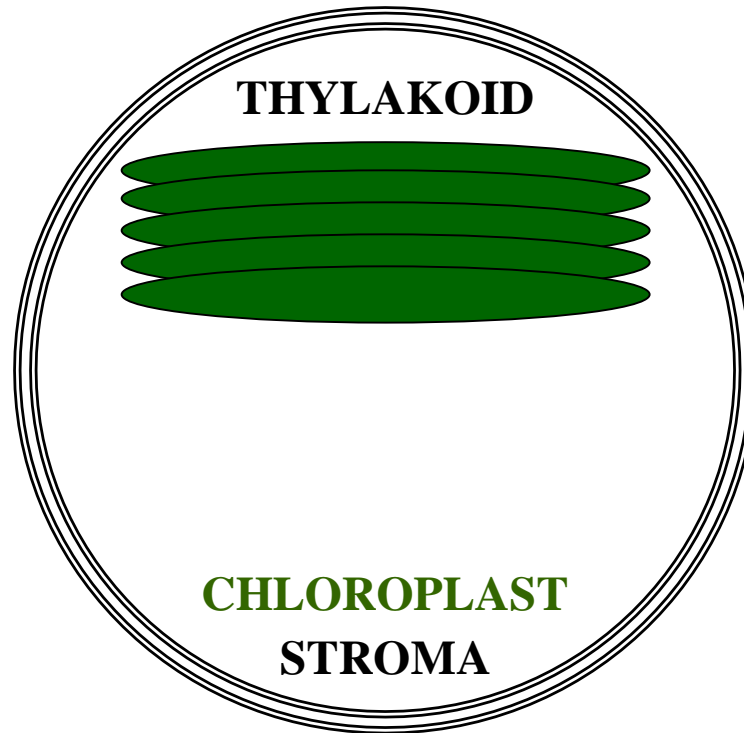
ATMOSPHERE



DARK HOURS



CO₂



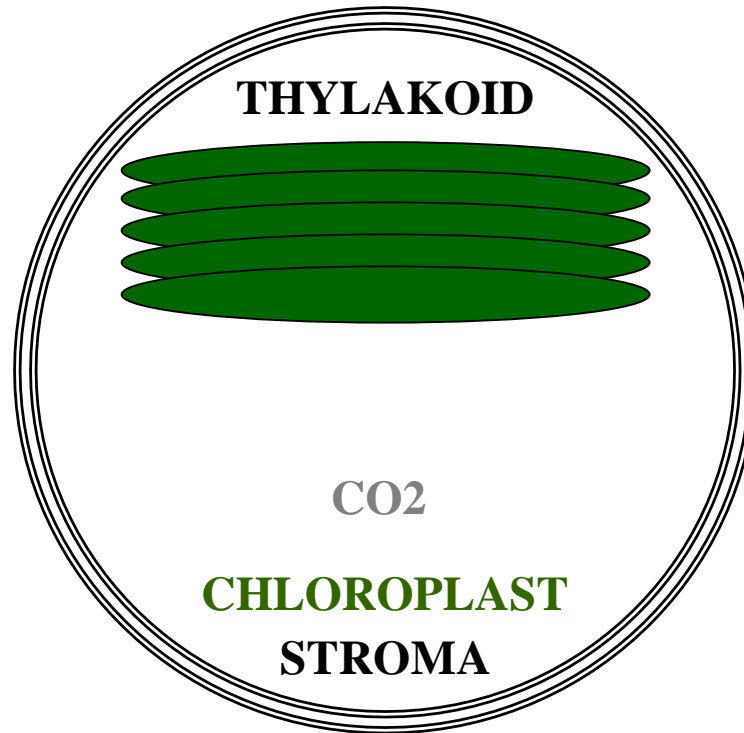
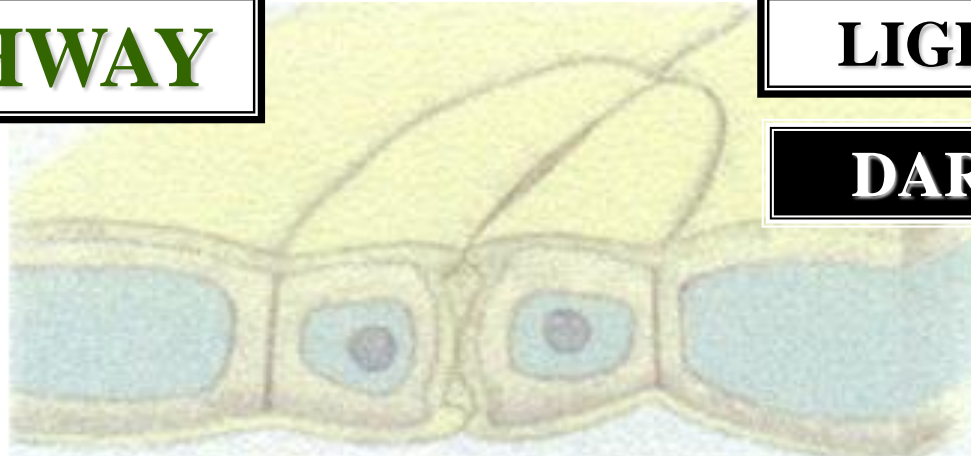
MESOPHYLL CELL / CYTOSOL

CAM PATHWAY

LIGHT HOURS

DARK HOURS

ATMOSPHERE



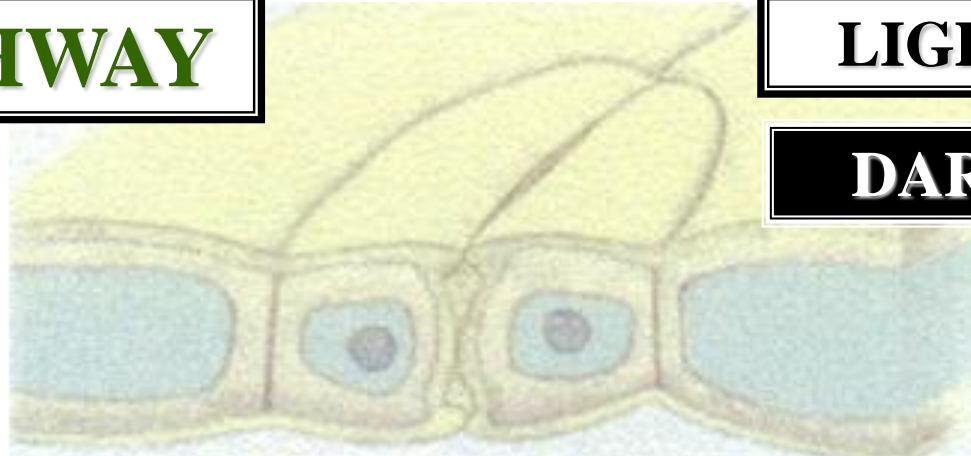
MESOPHYLL CELL / CYTOSOL

CAM PATHWAY

LIGHT HOURS

DARK HOURS

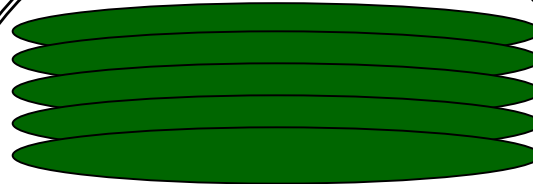
ATMOSPHERE



?

DK

THYLAKOID



ATP & NADPH

CO₂

CHLOROPLAST

STROMA

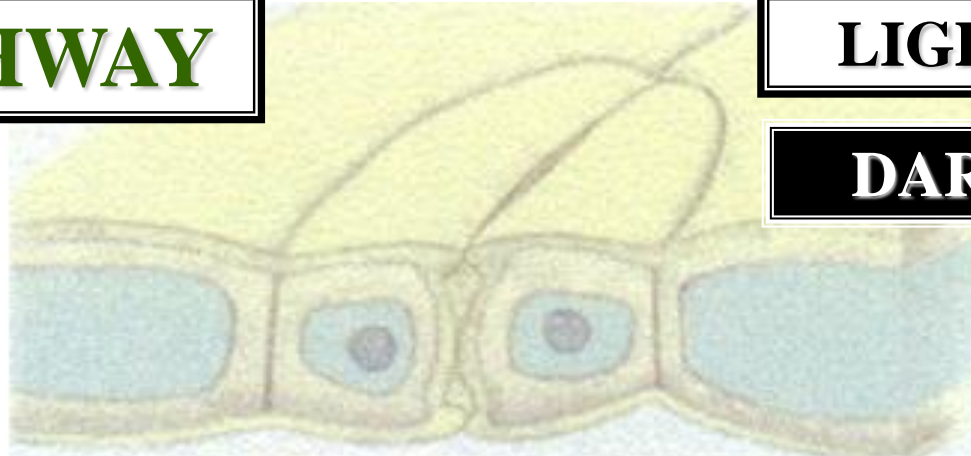
MESOPHYLL CELL / CYTOSOL

CAM PATHWAY

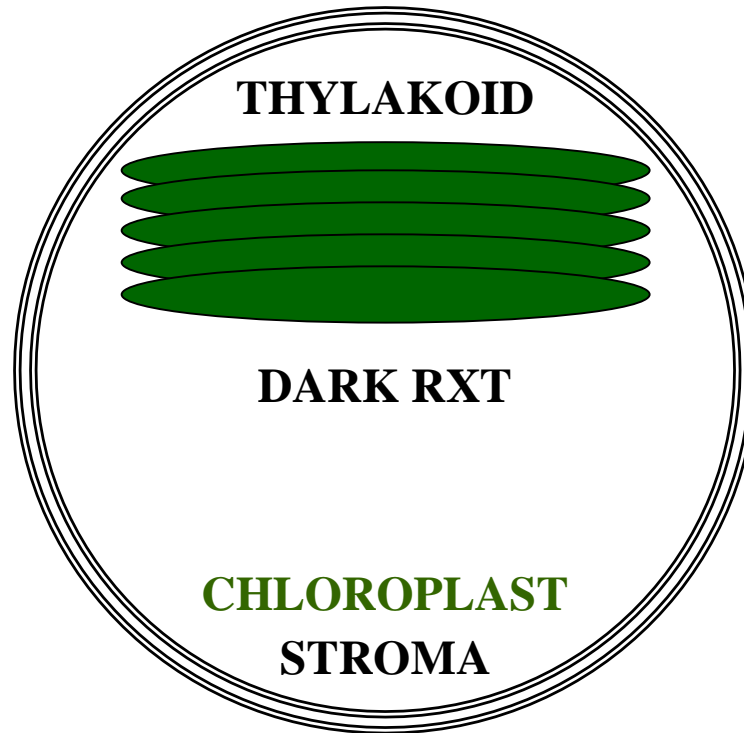
LIGHT HOURS

DARK HOURS

ATMOSPHERE



C3



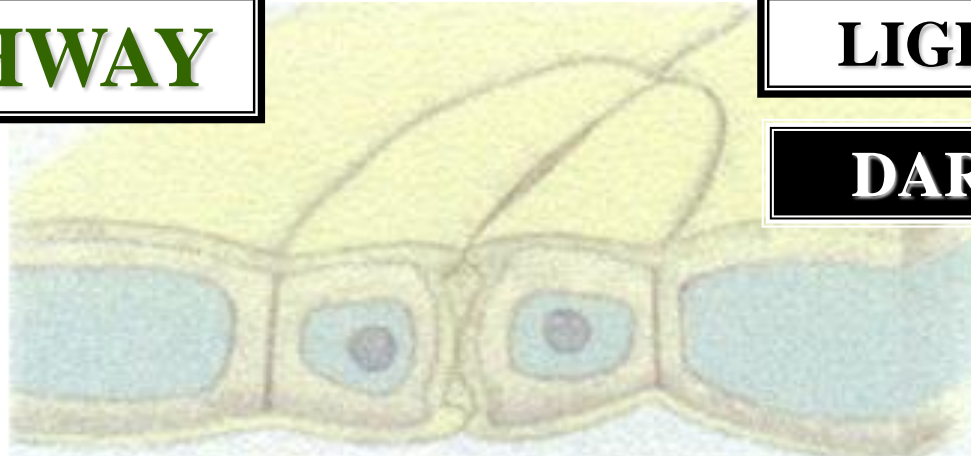
MESOPHYLL CELL / CYTOSOL

CAM PATHWAY

LIGHT HOURS

DARK HOURS

ATMOSPHERE

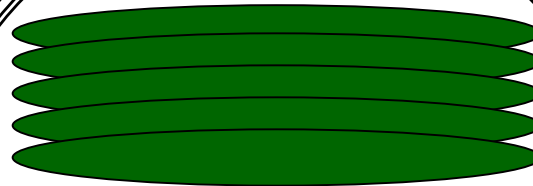


G



+

THYLAKOID



DARK RXT
C3 PATHWAY
CALVIN CYCLE

CHLOROPLAST
STROMA

MESOPHYLL CELL / CYTOSOL



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

FEEDBACK

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

+

G

PHOSPHOGLYCERATE / (PGA)

UNSTABLE 6C COMPOUND

PHOSPHOGLYCERATE / (PGA)

ATP

ATP

BISPHOSEPHOGLYCERATE / (BIPGA)

BISPHOSEPHOGLYCERATE / (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 BISPHOSEPHATE / (RUBP)

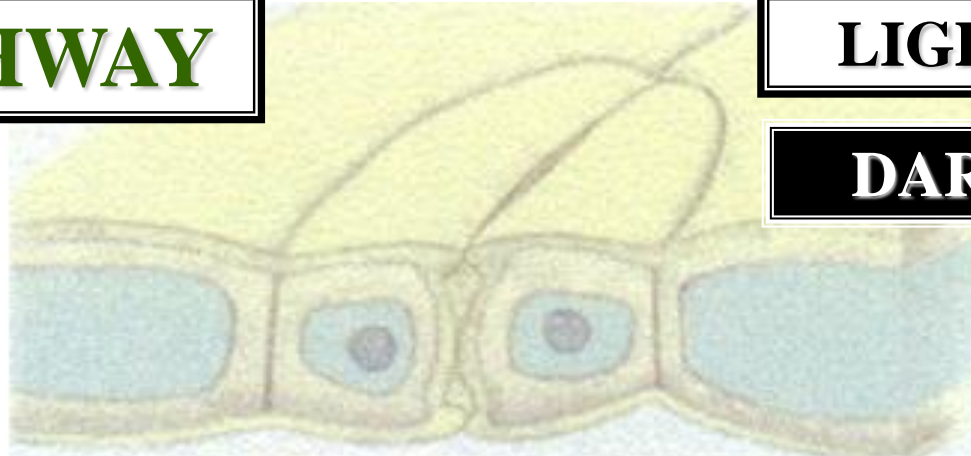
= CHEMICAL ENERGY

CAM PATHWAY

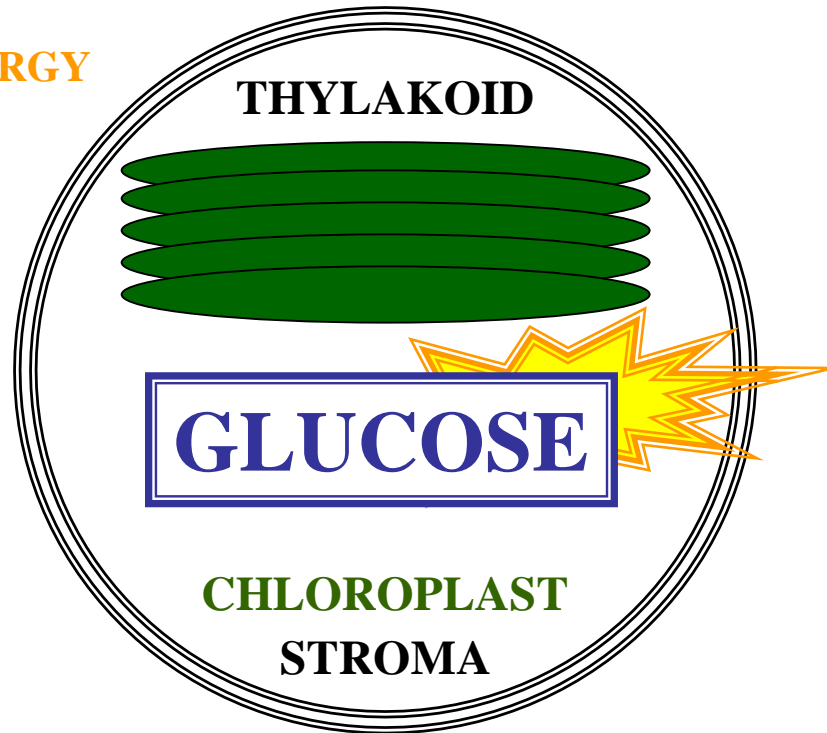
LIGHT HOURS

DARK HOURS

ATMOSPHERE



= CHEMICAL ENERGY



THYLAKOID

GLUCOSE

CHLOROPLAST
STROMA

MESOPHYLL CELL / CYTOSOL

CAM PATHWAY

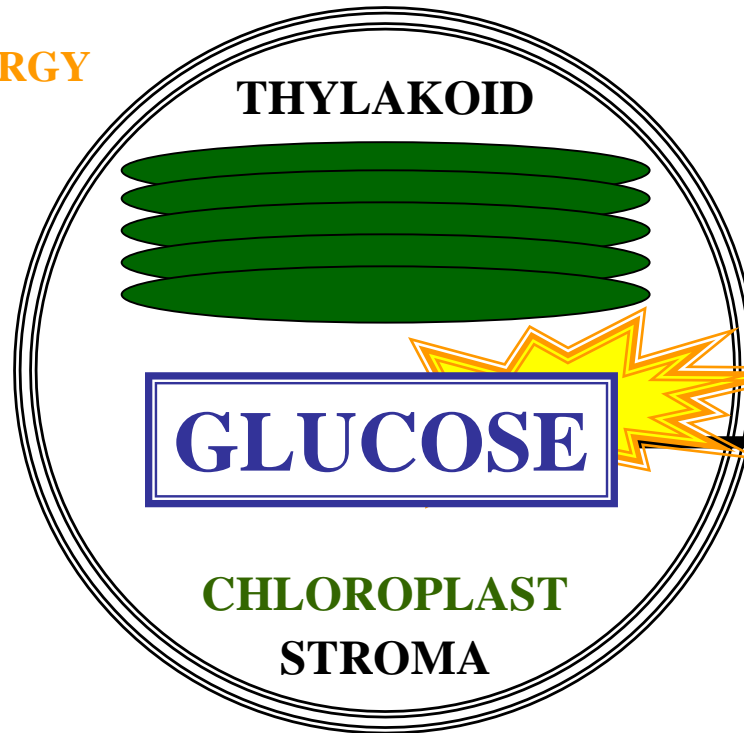
LIGHT HOURS

DARK HOURS

ATMOSPHERE



= CHEMICAL ENERGY



GLUCOSE

METABOLISM

MESOPHYLL CELL / CYTOSOL

**CAM
PATHWAY
ADVANTAGE
OVER
C3 & C4**





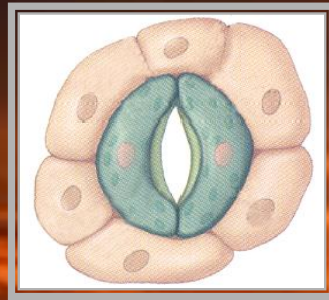
CAM PATHWAY DARK HOURS



CAM PATHWAY LIGHT HOURS

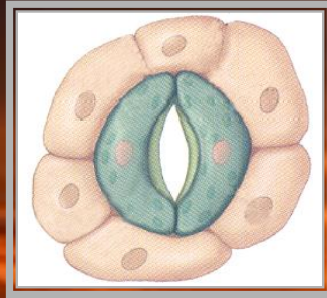


CAM PATHWAY DARK HOURS



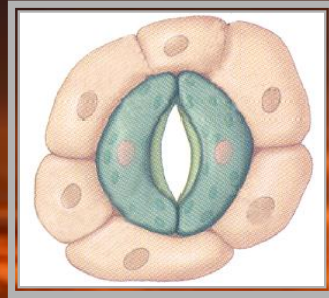
STOMATES
OPEN

CAM PATHWAY DARK HOURS



HIGH
HUMIDITY

CAM PATHWAY DARK HOURS

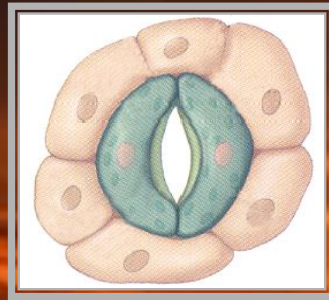


TRANSPIRATION
POTENTIAL

CAM PATHWAY DARK HOURS

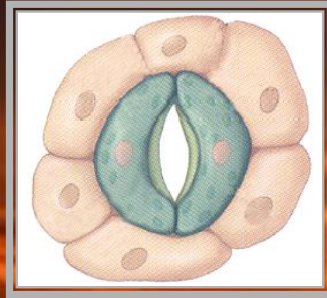
CO₂

F



VERY LOW
TRANSPIRATION
POTENTIAL

CAM PATHWAY DARK HOURS



CAM PLANTS
UNDERGO
CO₂ FIXATION





CAM ADVANTAGE

LESS

TRANSPIRATION

PER GLUCOSE

THAN C3 OR C4



CAM PATHWAY ECOLOGY