PHOTOSYNTHESIS

!

¿

WATER

CO2

LIGHT EGY

PHOTO

ATMOSPHERE

E-

PHOTOLYSIS

LT RXT

THYLAKOID
GRANUM

ATP

DK RXT

STROMA

SYNTHESIS

CHEM EGY
INPUT

CHLOROPLAST

ATMOSPHERE

OXYGEN

GLUCOSE

LR

DR

+

DARK RXT SYNTHESIS REACTION

PHOTOSYNTHESIS

?

WATER

CO2

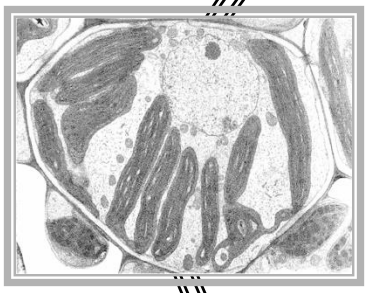
LIGHT EGY

PHOTO

ATMOSPHERE

E-

PHOTOLYSIS



LT RXT

THYLAKOID
GRANUM

CHEMICAL
ENERGY

DK RXT

STROMA

SYNTHESIS

CHEM EGY
INPUT

CHLOROPLAST

ATMOSPHERE

OXYGEN

GLUCOSE

LIGHT REACTION & DARK REACTION ?

CATABOLIC METABOLISM & ANABOLIC METABOLISM ?

EXERGONIC REACTIONS & ENDERGONIC REACTIONS ?

^
+

LIGHT REACTION & DARK REACTION ?

CP

LIGHT REACTION & DARK REACTION

!!!COUPLED!!!

PHOTOSYNTHESIS

E

WATER

CO2

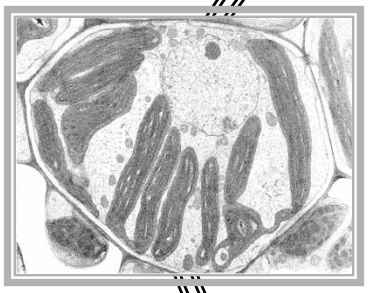
LIGHT EGY

PHOTO

ATMOSPHERE

E-

PHOTOLYSIS



LT RXT

THYLAKOID GRANUM

CHEMICAL ENERGY

DK RXT

STROMA

SYNTHESIS

CHEM EGY INPUT

CHLOROPLAST

ATMOSPHERE

OXYGEN

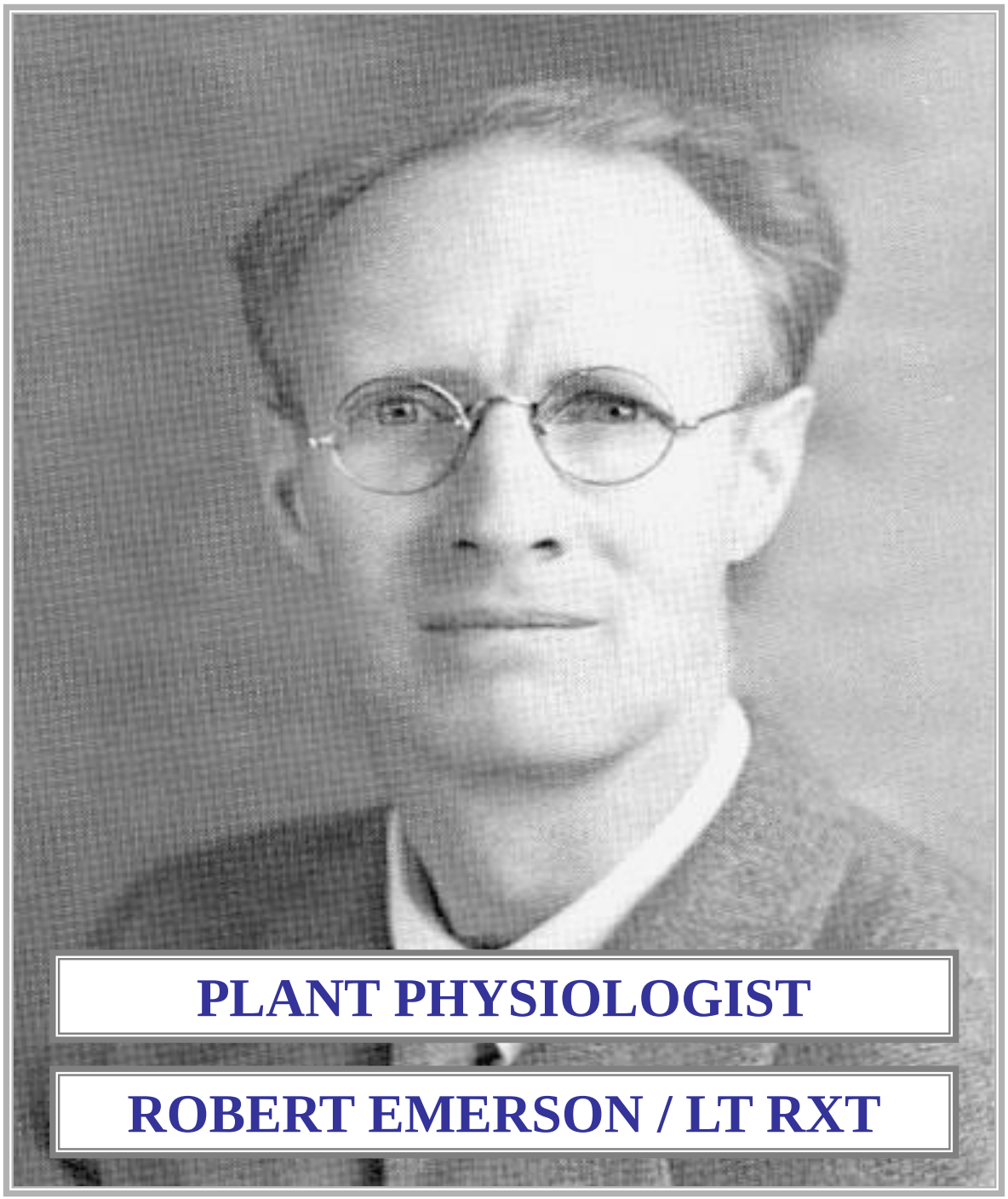
GLUCOSE

CHEMICAL ENERGY

LIGHT REACTION & DARK REACTION

!!!COUPLED!!!

LIGHT REACTION SPECIFICS



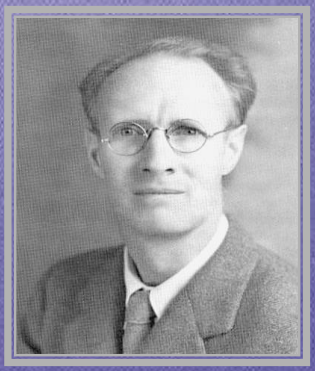
PLANT PHYSIOLOGIST

ROBERT EMERSON / LT RXT

PHOTOSYNTHESIS

L

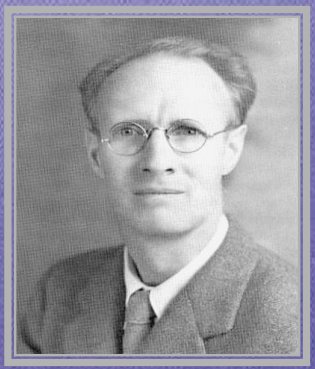
LIGHT REACTION



PHOTOSYNTHESIS

E

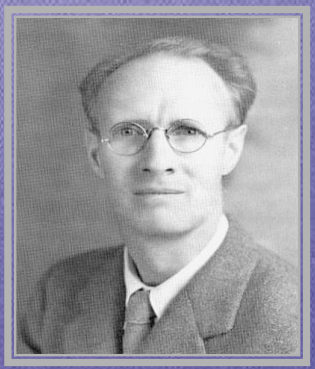
LIGHT RXT
LIGHT DEPENDENT REACTION



PHOTOSYNTHESIS

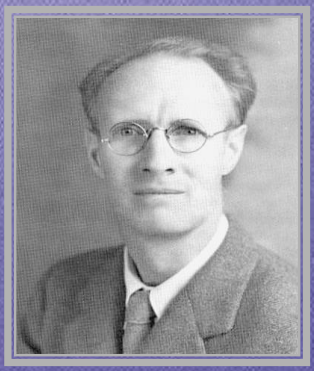
R

LIGHT RXT ENERGY CAPTURING REACTION

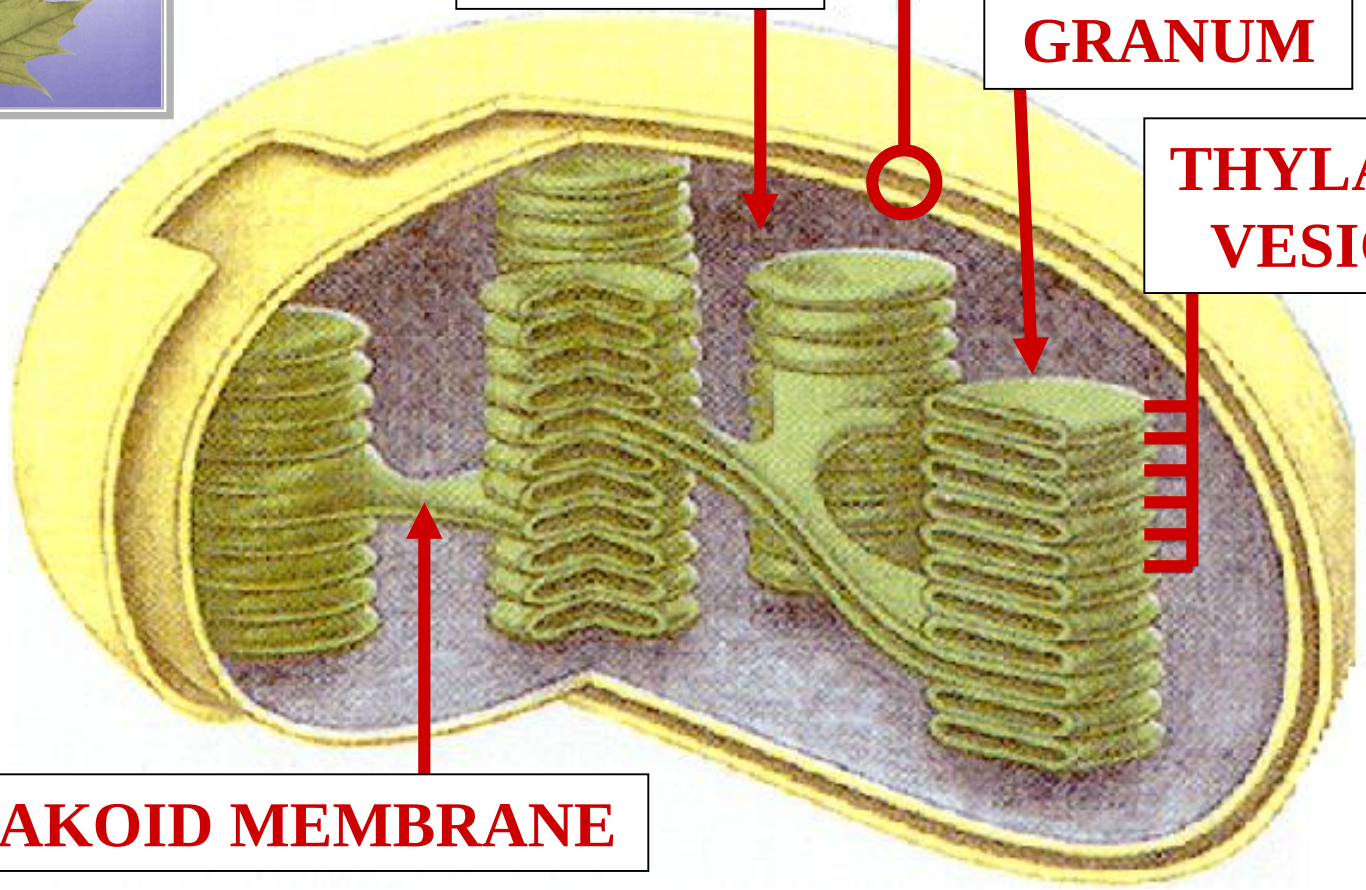


PHOTOSYNTHESIS

LIGHT RXT CONSISTS MOSTLY REDOX REACTIONS

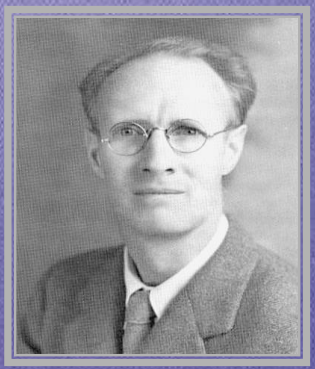


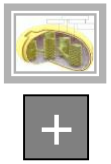
CHLOROPLAST ULTRASTRUCTURE



PHOTOSYNTHESIS

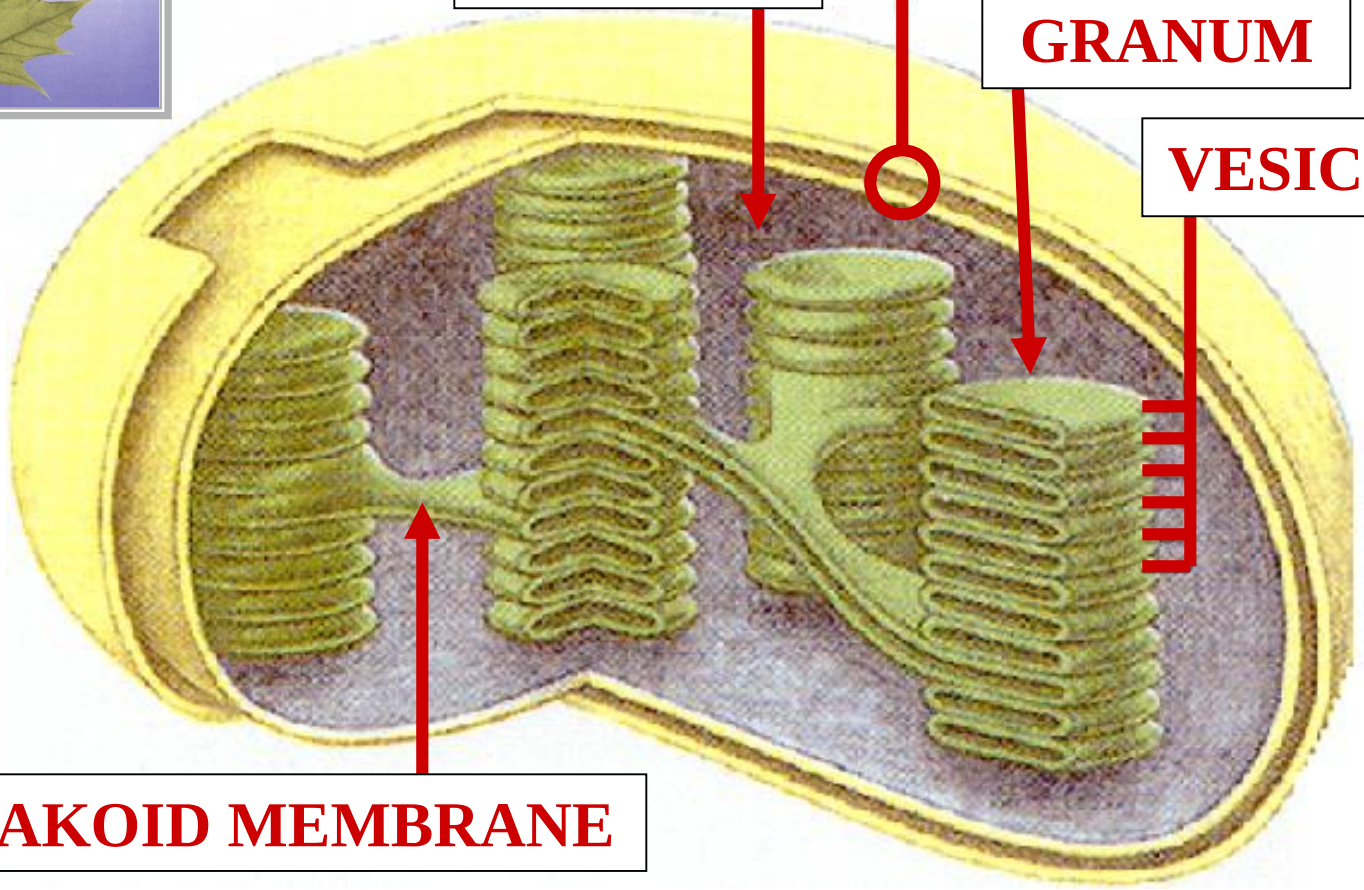
LIGHT RXT OCCURS ALONG THYLAKOID



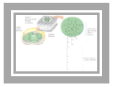


CHLOROPLAST THYLAKOID

CHLOROPLAST ULTRASTRUCTURE



THYLAKOID MEMBRANE



THYLAKOID MEMBRANE

BEARS NUMEROUS PHOTOSYSTEMS

THYLAKOID MEMBRANE

P

CHLOROPLAST
THYLAKOID GRANUM

PHOTOSYSTEM

THYLAKOID

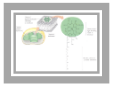
GRANUM
VESICLE

CHLOROPLAST

LEAF

PIGMENT
MOLECULES

PHOTOSYSTEM



PHOTOSYSTEM

CLUSTER
PIGMENT MOLECULES

PHOTOSYSTEM

P

CHLOROPLAST
THYLAKOID GRANUM

PHOTOSYSTEM

THYLAKOID

GRANUM
VESICLE

CHLOROPLAST

PIGMENT
MOLECULES

PIGMENT

PIGMENT

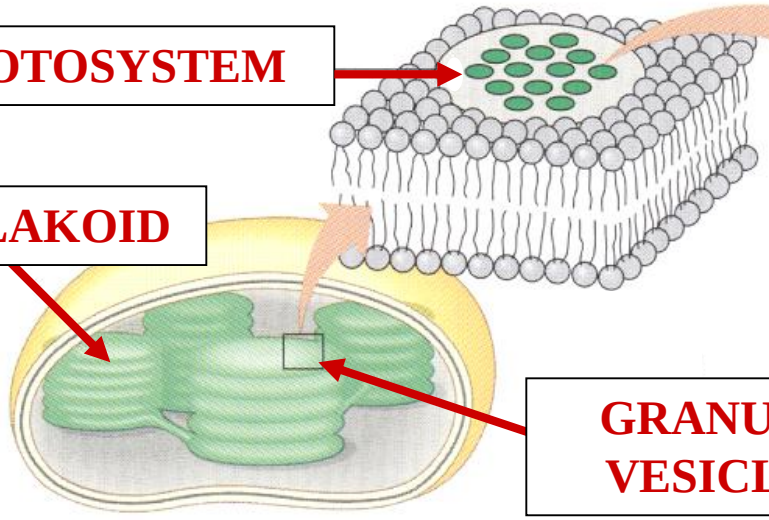
SUBSTANCE ABSORBS LIGHT & REFLECTS LIGHT

PIGMENT

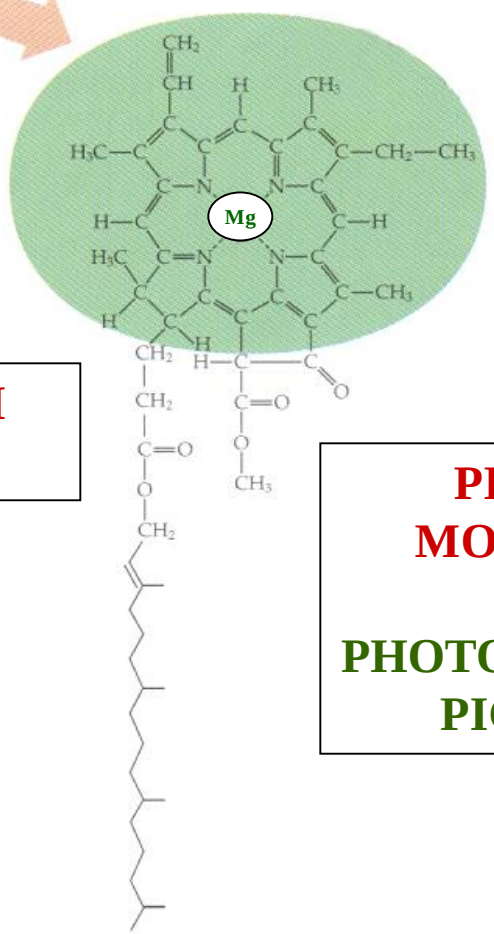
CHLOROPLAST
THYLAKOID GRANUM

PHOTOSYSTEM

THYLAKOID



GRANUM
VESICLE



PIGMENT MOLECULES
=
PHOTOSYNTHETIC PIGMENTS

CHLOROPLAST

PHOTOSYNTHETIC PIGMENTS

PHOTOSYNTHETIC PIGMENT TYPES

PHOTOSYNTHETIC PIGMENTS TYPES

CHLOROPHYLLS

PHOTOSYNTHETIC PIGMENTS TYPES

PHOTOSYNTHETIC PIGMENTS

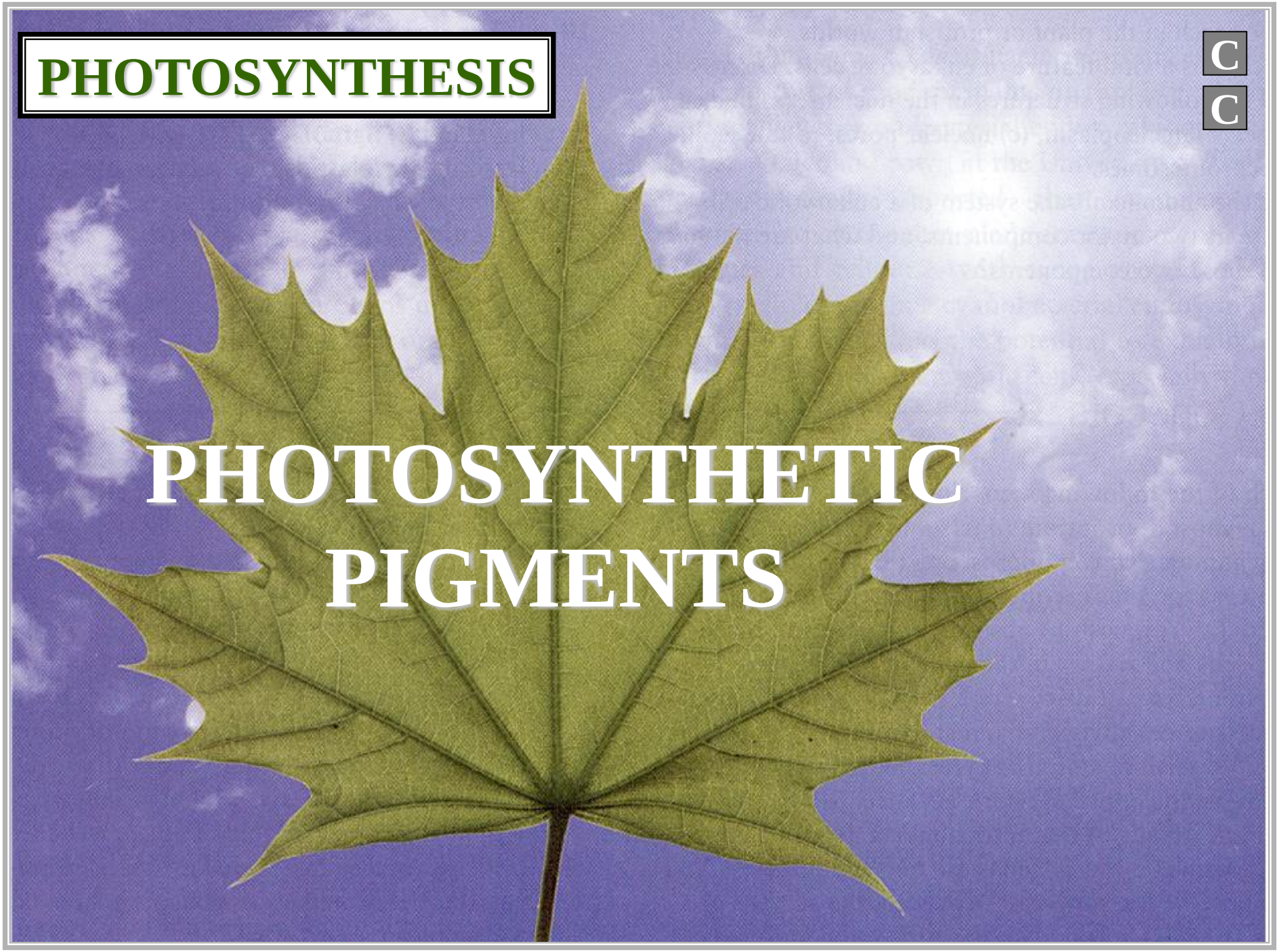
TYPES

CHLOROPHYLLS

CAROTENOIDS

PHOTOSYNTHETIC PIGMENTS

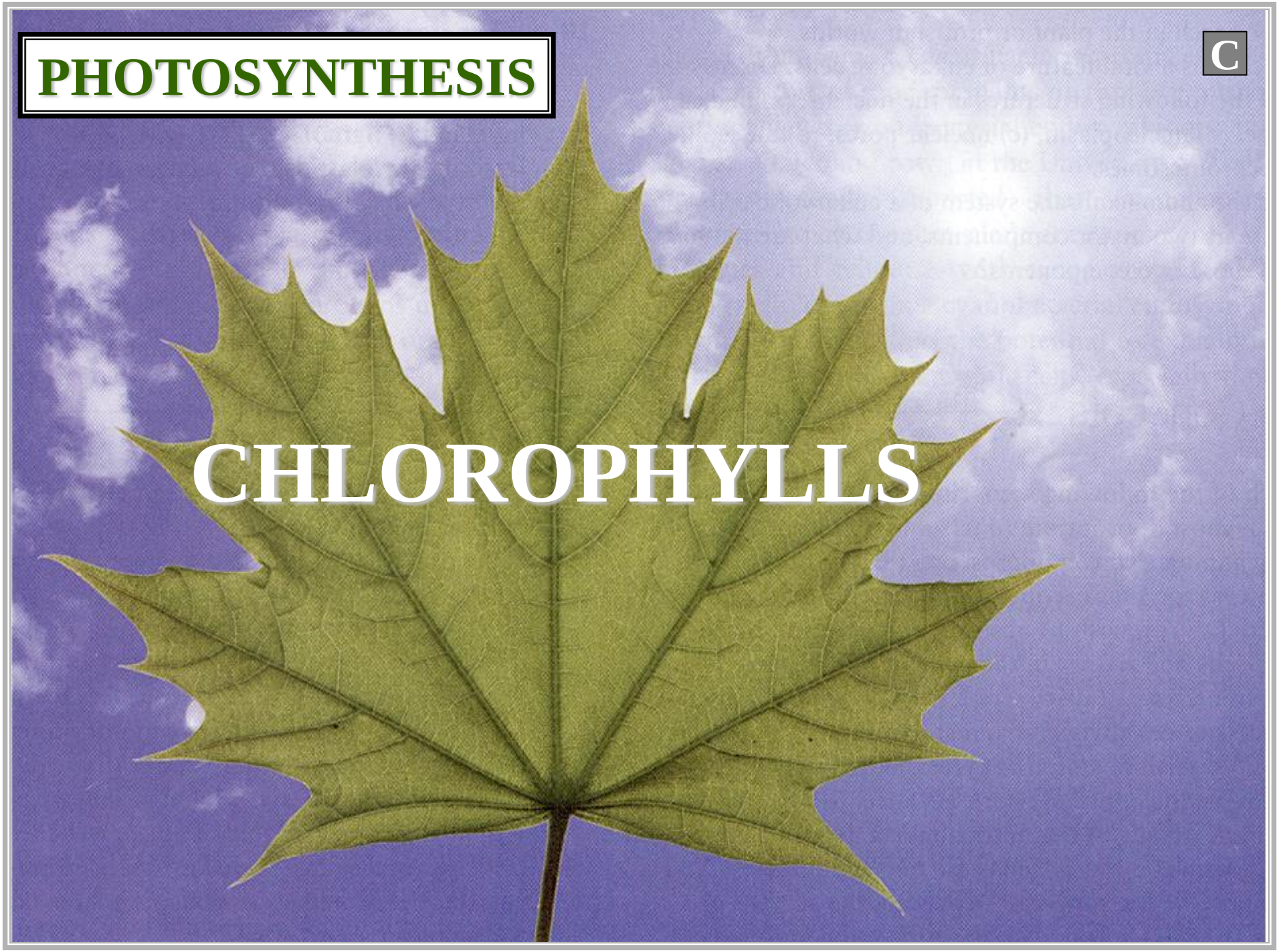
TYPES



PHOTOSYNTHETIC PIGMENTS

PHOTOSYNTHESIS

C



CHLOROPHYLLS

PHOTOSYNTHESIS

CHLOROPHYLLS & CAROTENOIDS

CHLOROPHYLLS

CHLOROPHYLL TYPES

PHOTOSYNTHETIC PIGMENTS CHLOROPHYLLS

CHLOROPHYLL A

PHOTOSYNTHETIC PIGMENTS CHLOROPHYLLS

PHOTOSYNTHETIC PIGMENTS CHLOROPHYLLS

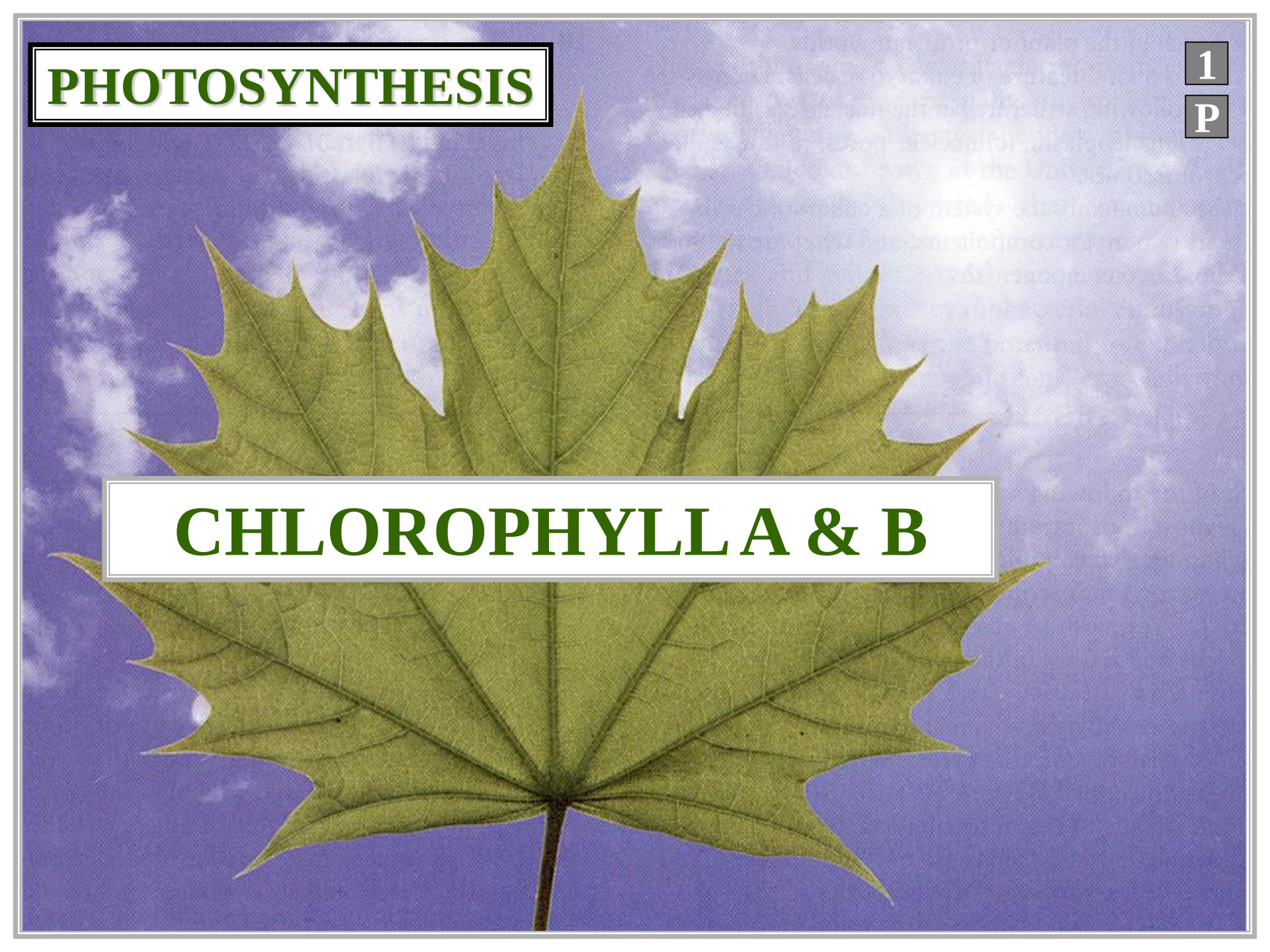
CHLOROPHYLL A
CHLOROPHYLL B

PHOTOSYNTHETIC PIGMENTS CHLOROPHYLLS

PHOTOSYNTHESIS

1

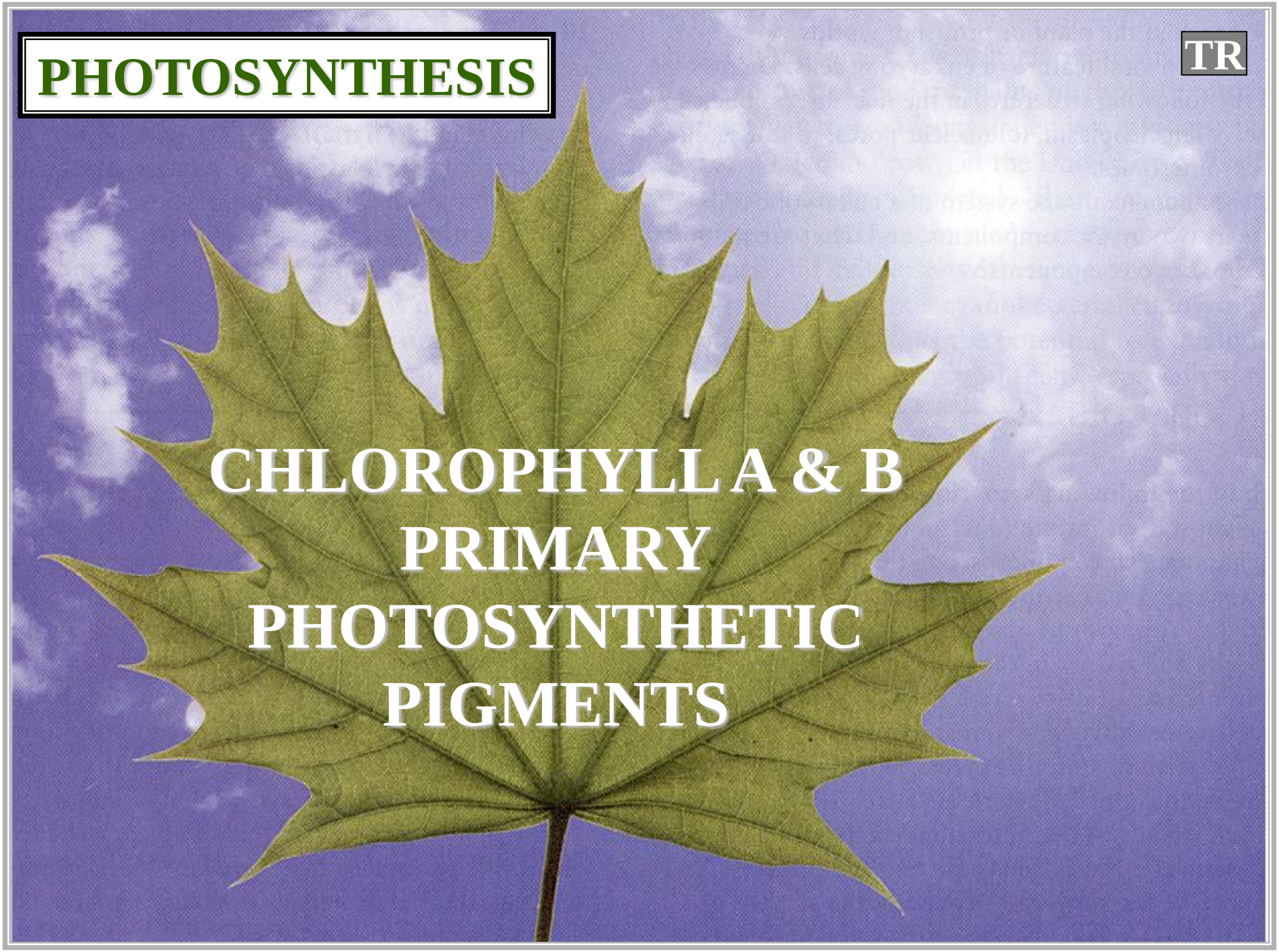
P



CHLOROPHYLL A & B

PHOTOSYNTHESIS

TR



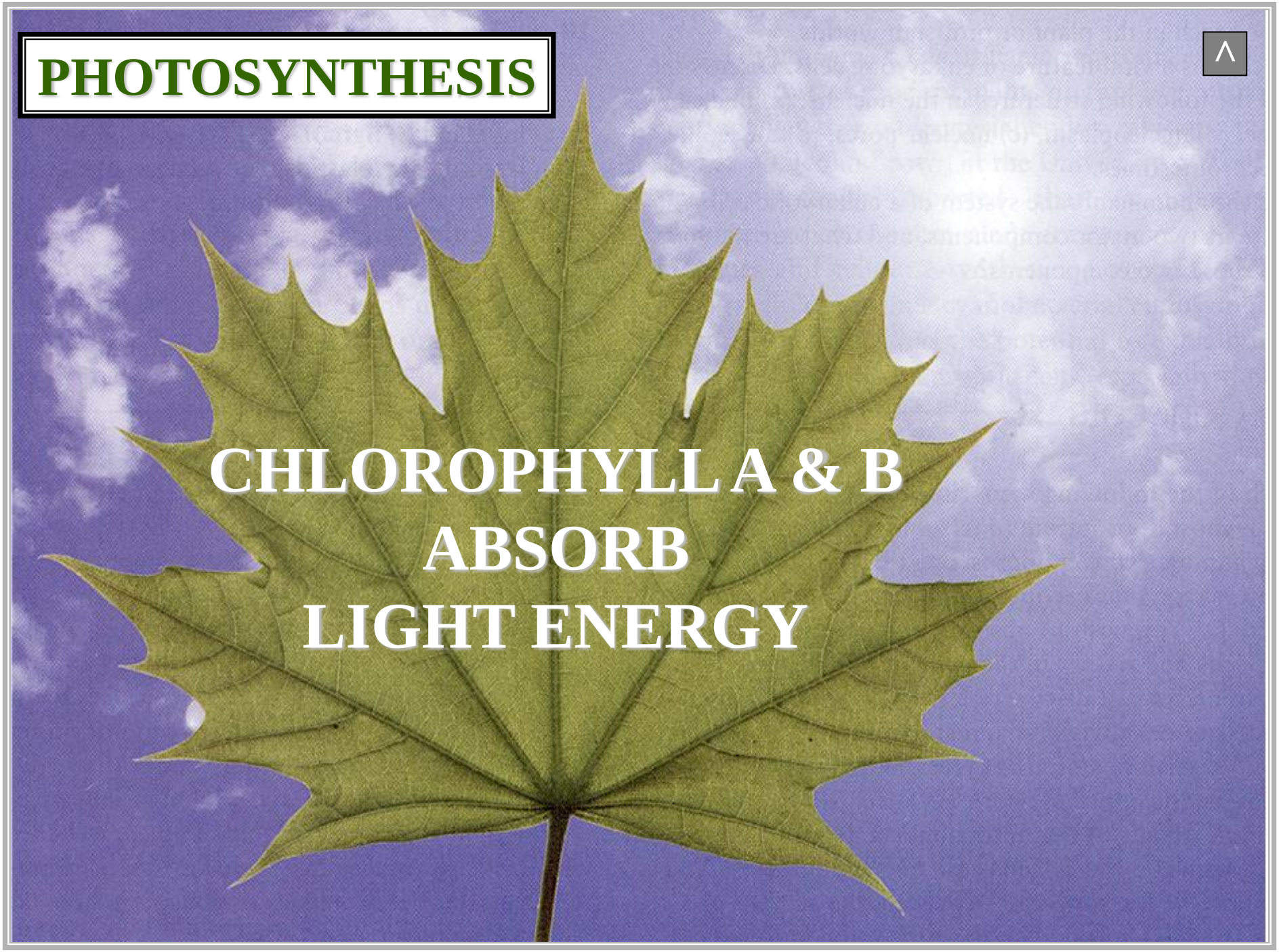
CHLOROPHYLL A & B
PRIMARY
PHOTOSYNTHETIC
PIGMENTS

PHOTOSYNTHESIS

A

ALL TRUE PLANTS
POSSESS
CHLOROPHYLL A & B

PHOTOSYNTHESIS



CHLOROPHYLL A & B
ABSORB
LIGHT ENERGY

CAROTENOIDS

CAROTENOID TYPES

PHOTOSYNTHETIC PIGMENTS CAROTENOIDS

CAROTENES

PHOTOSYNTHETIC PIGMENTS CAROTENOIDS

PHOTOSYNTHETIC PIGMENTS CAROTENOIDS

C

CAROTENES

XANTHOPHYLLS

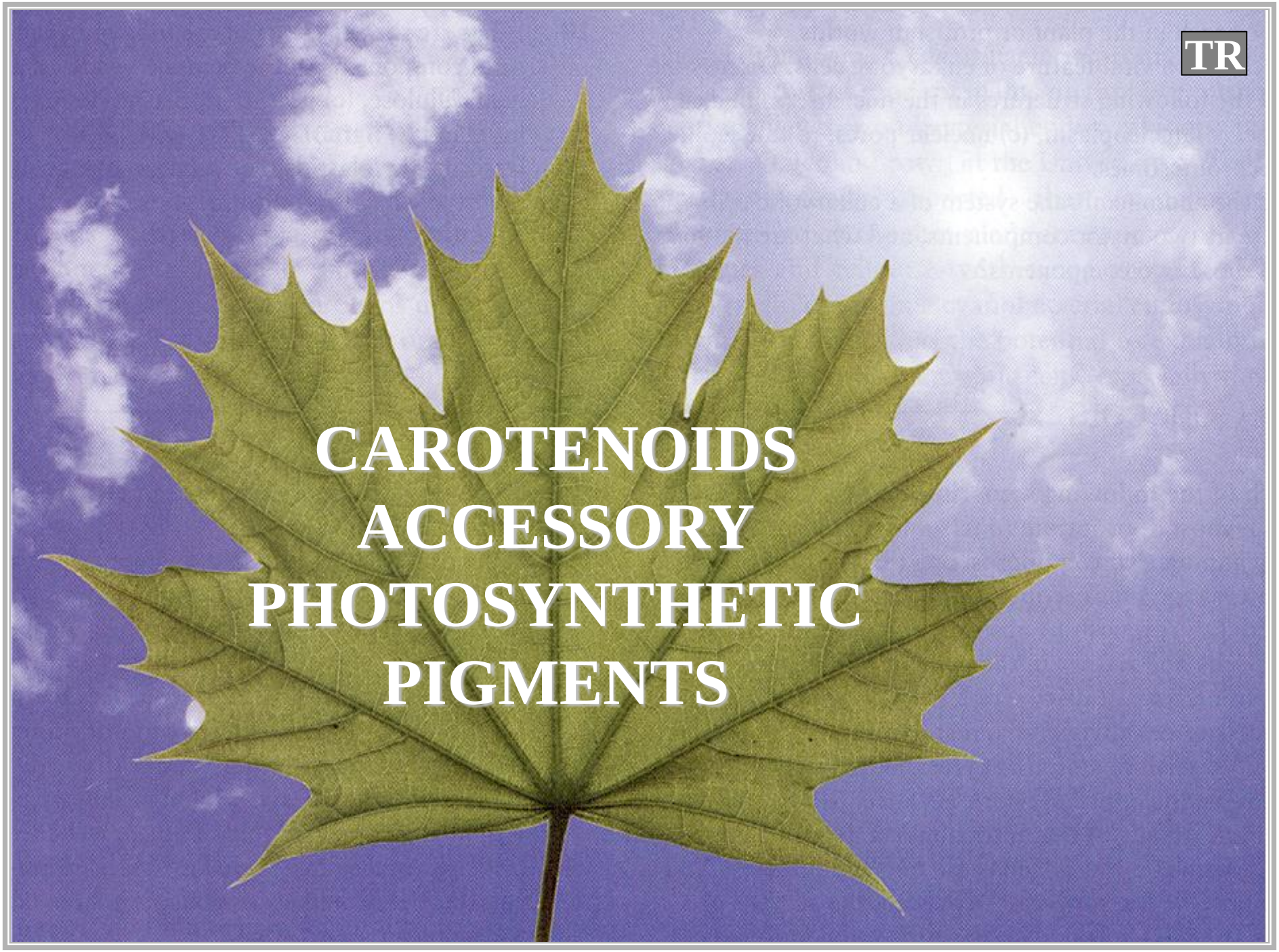
PHOTOSYNTHETIC PIGMENTS CAROTENOIDS

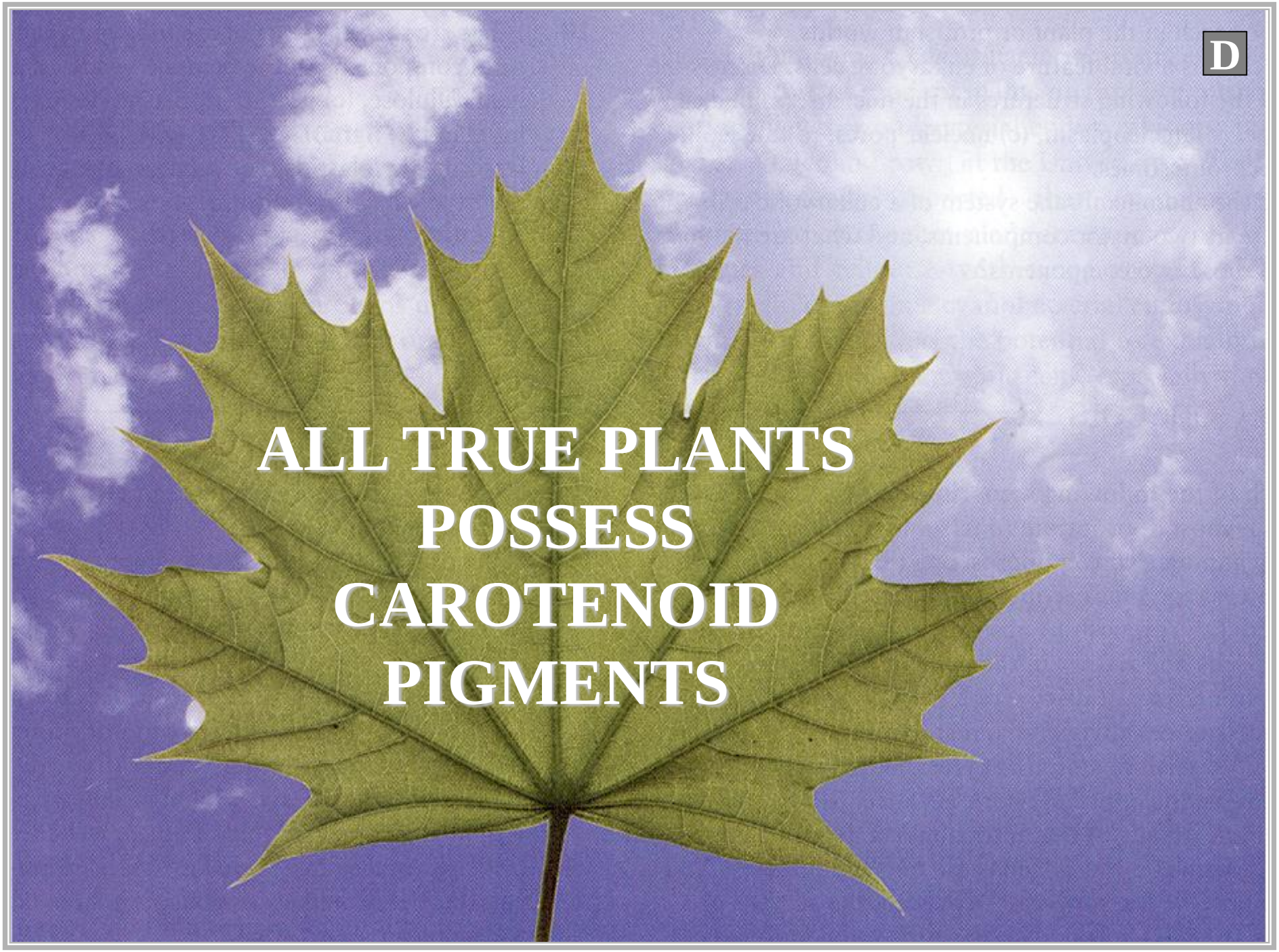
CAROTENES

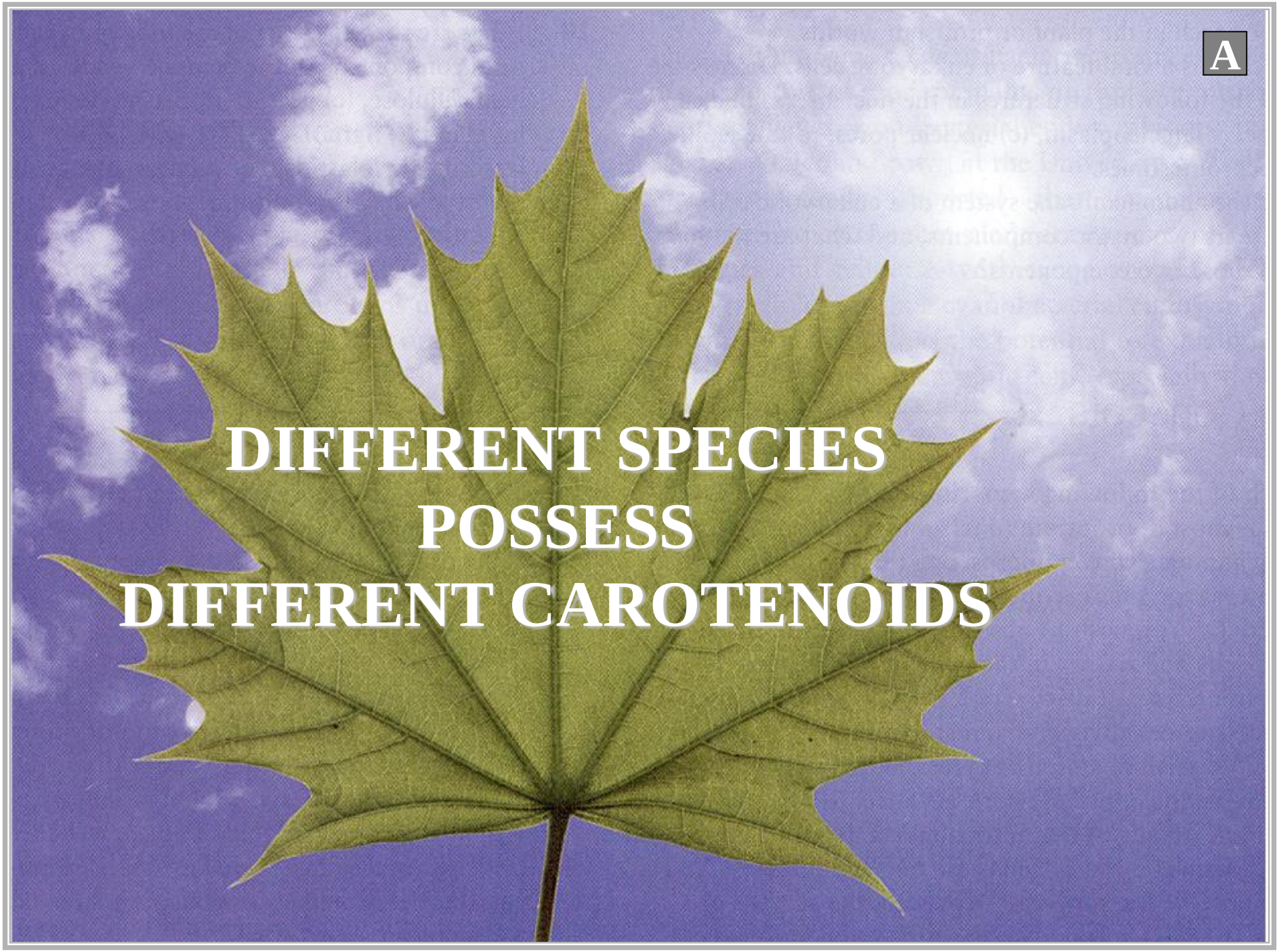

X
CAROTENES

XANTHOPHYLLS


2
A
XANTHOPHYLLS

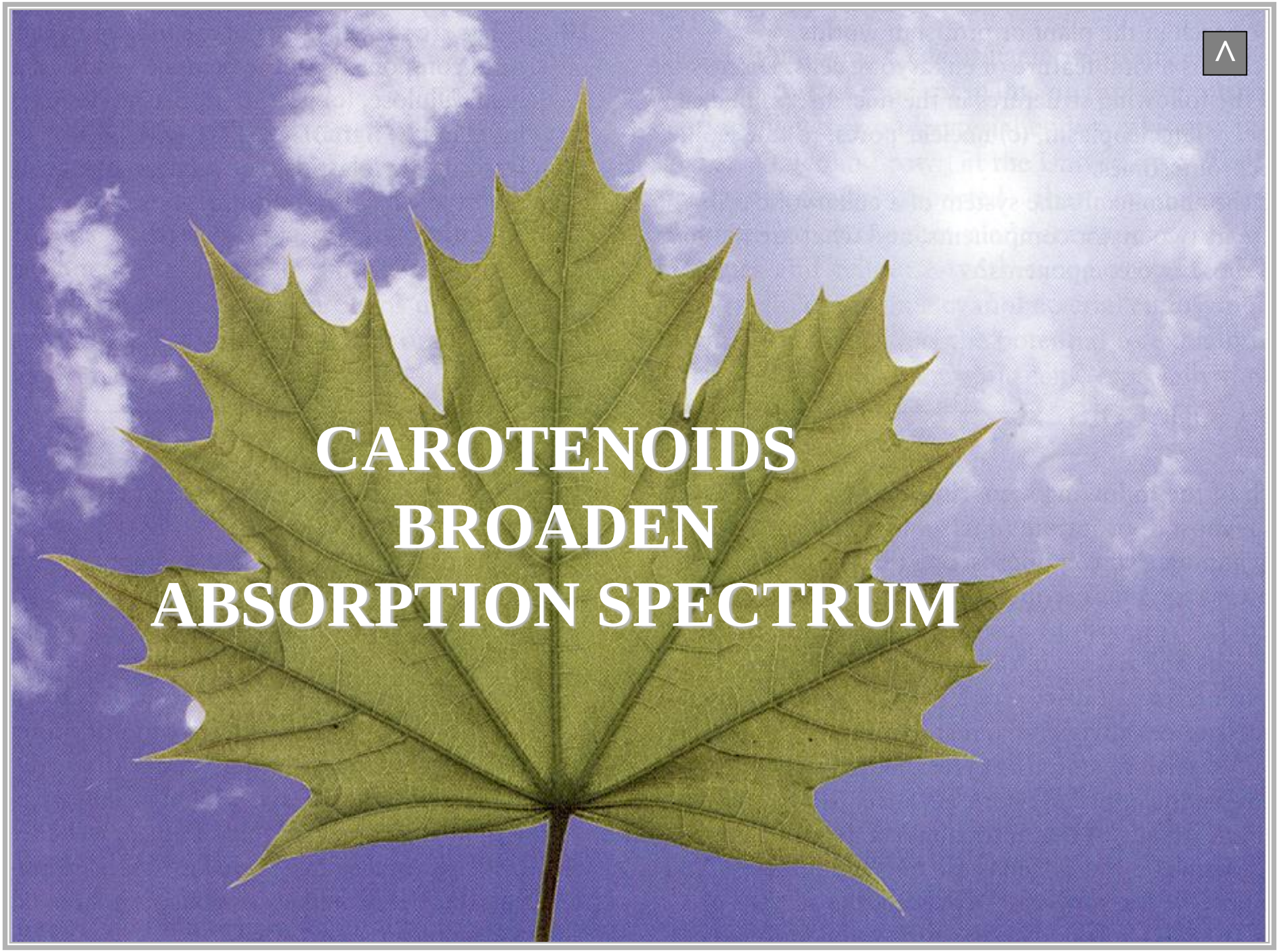

TR
CAROTENOIDS
ACCESSORY
PHOTOSYNTHETIC
PIGMENTS


D
ALL TRUE PLANTS
POSSESS
CAROTENOID
PIGMENTS


A
DIFFERENT SPECIES
POSSESS
DIFFERENT CAROTENOIDS

B

CAROTENOIDS ABSORB DIFFERENT LIGHT ENERGY THAN CHL A & B


CAROTENOIDS
BROADEN
ABSORPTION SPECTRUM

A

ABSORPTION SPECTRUM

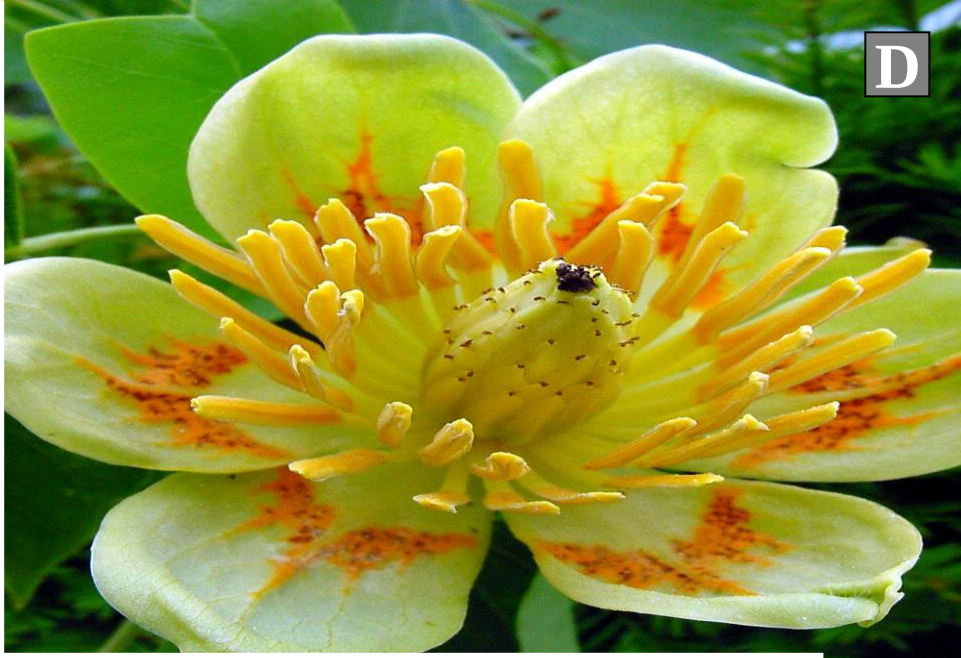
ABSORPTION SPECTRUM

ABSORPTION SPECTRUM

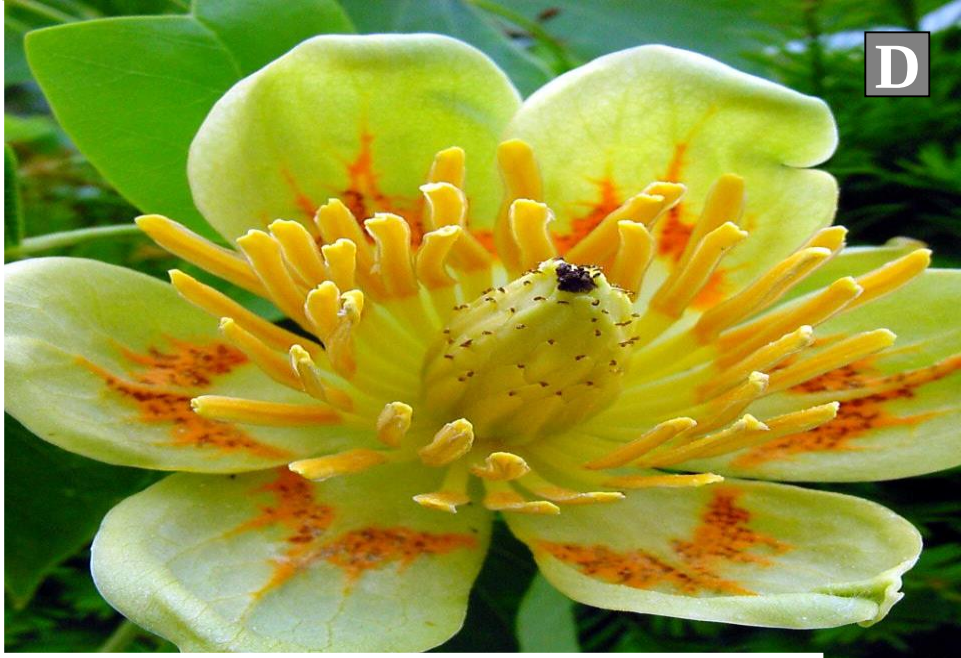
D

ALL ABSORBED PHOTOSYNTHESIS LIGHT WAVELENGHTS

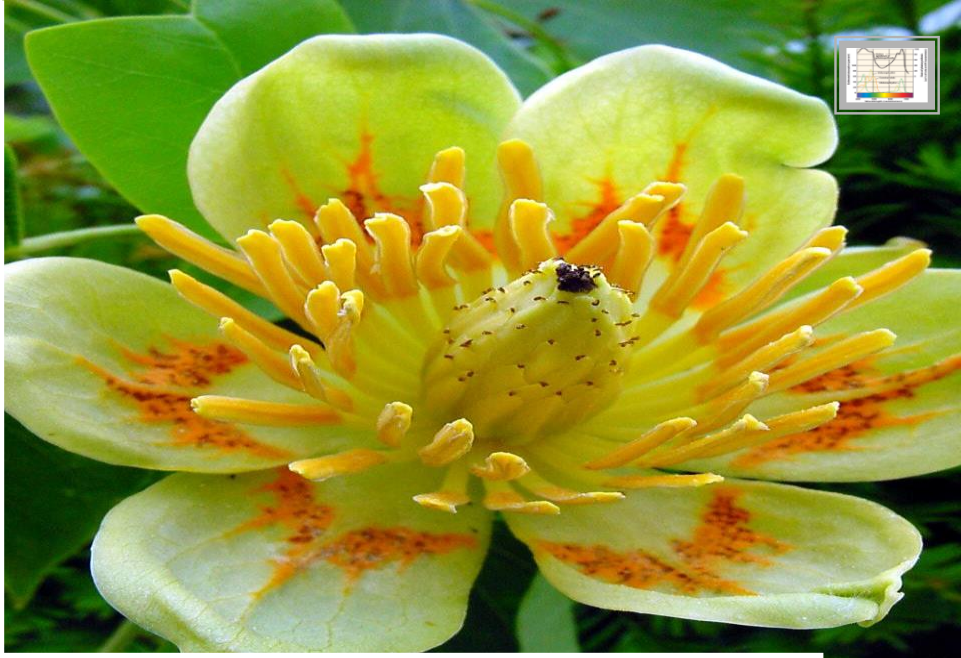
ABSORPTION SPECTRUM



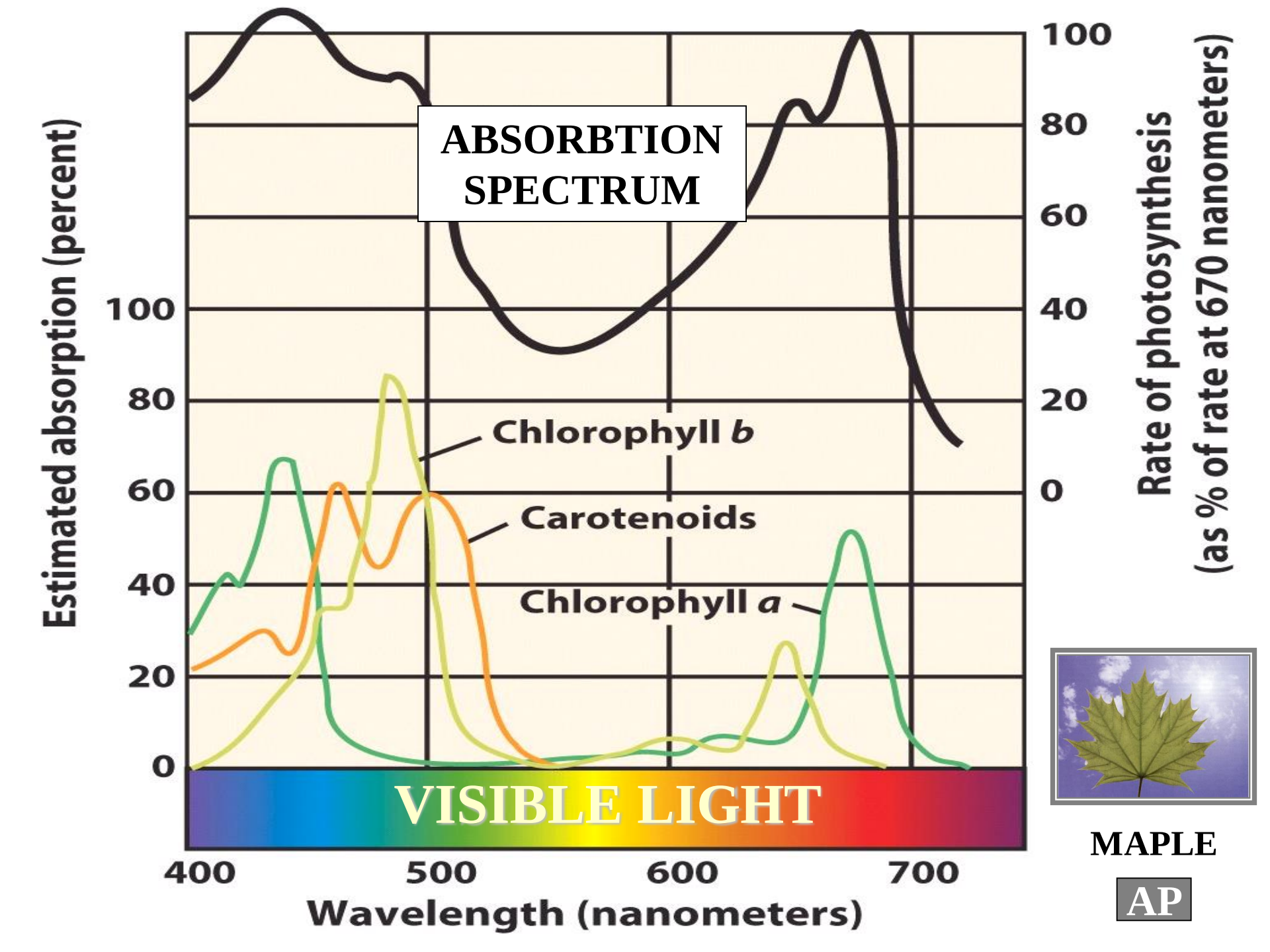
DIFFERENT SPECIES



DIFFERENT CAROTENOIDS



DIFFERENT ABSORPTION SPECTRUM

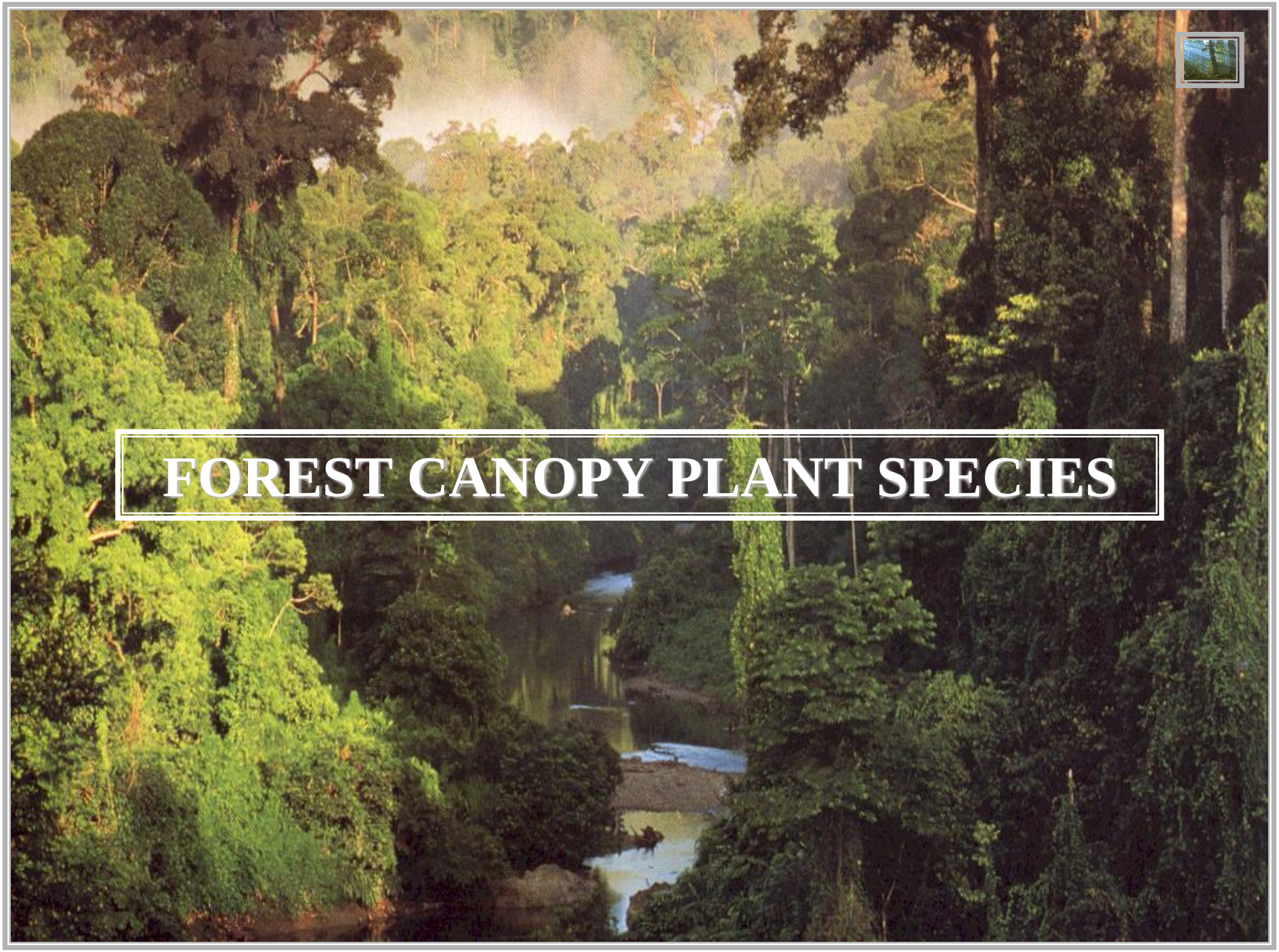

ABSORBTION SPECTRUM
Estimated absorption (percent)
Rate of photosynthesis (as % of rate at 670 nanometers)
100
80
60
40
20
0
Chlorophyll b
Carotenoids
Chlorophyll a
VISIBLE LIGHT
400
500
600
700
Wavelength (nanometers)

MAPLE

AP

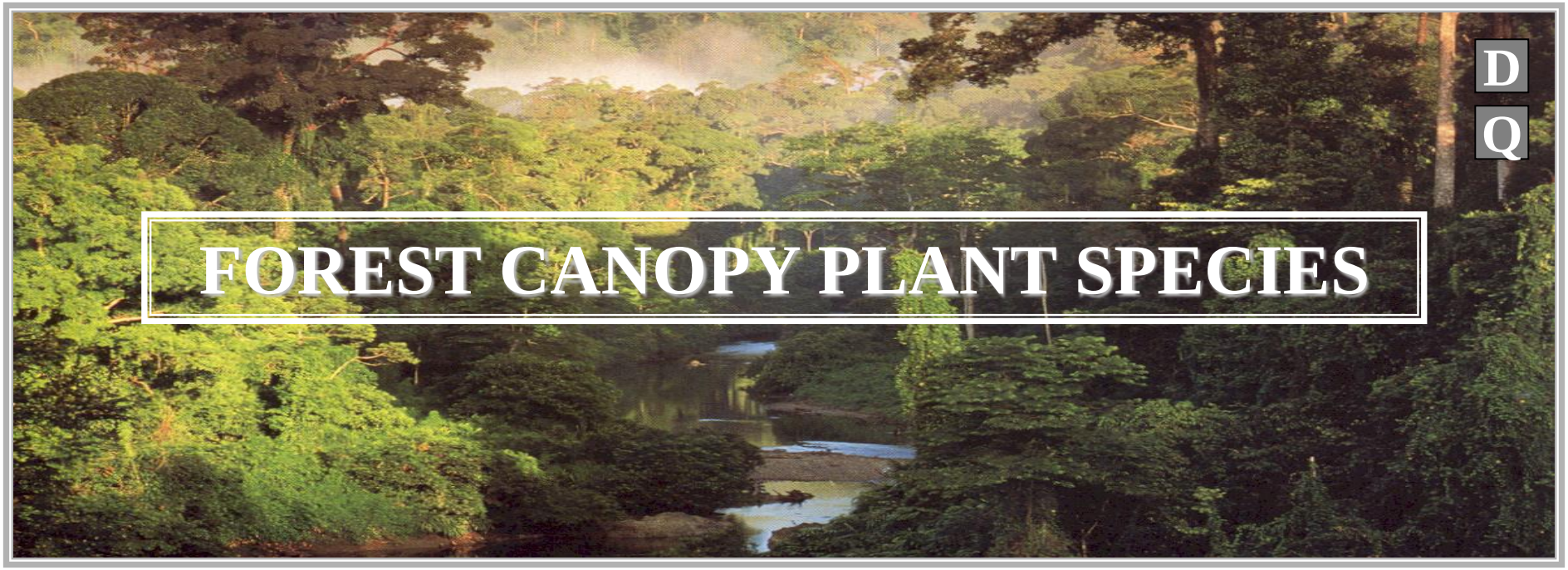
ABSORPTION SPECTRUM

APPLIED



FOREST CANOPY PLANT SPECIES

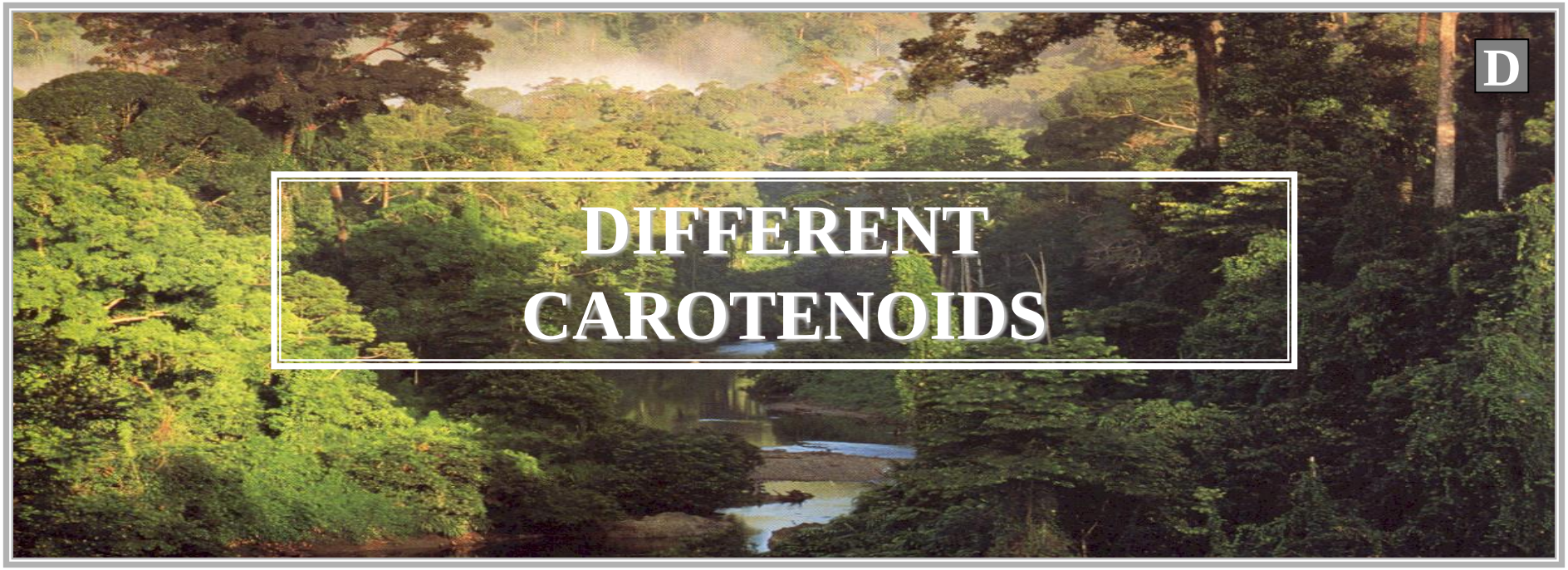
FOREST FLOOR PLANT SPECIES

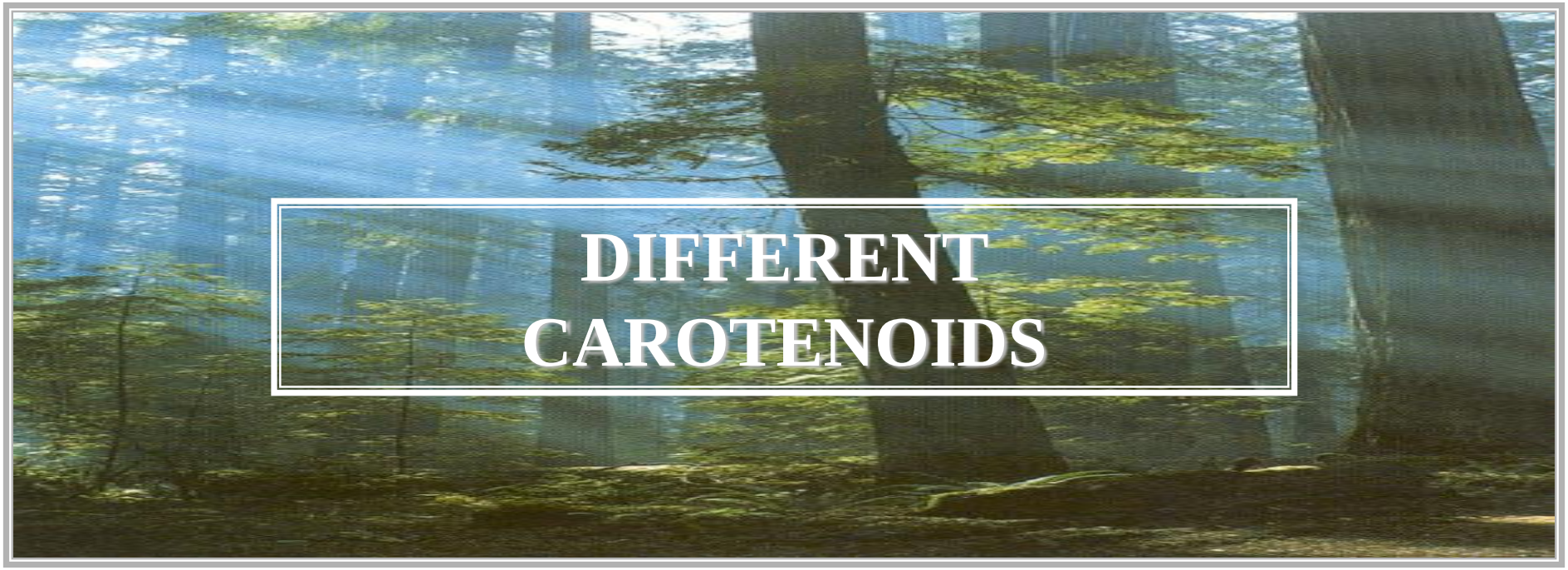

D
Q
FOREST CANOPY PLANT SPECIES


FOREST FLOOR PLANT SPECIES


D
DIFFERENT
LIGHT QUALITY


DIFFERENT
LIGHT QUALITY


D
DIFFERENT
CAROTENOIDS

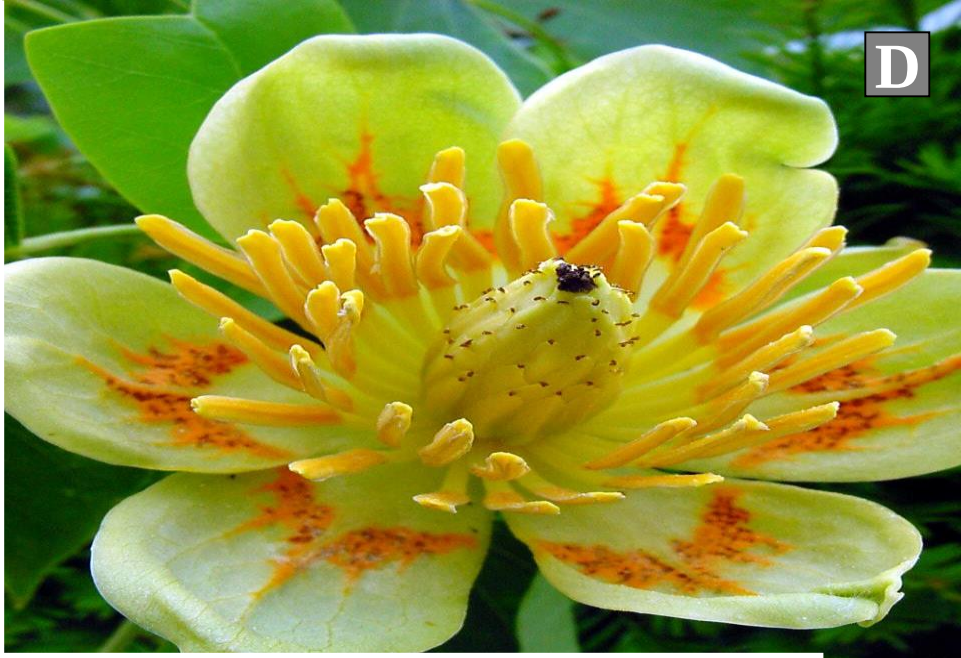

DIFFERENT
CAROTENOIDS


$
DIFFERENT
ABSORPTION SPECTRUM

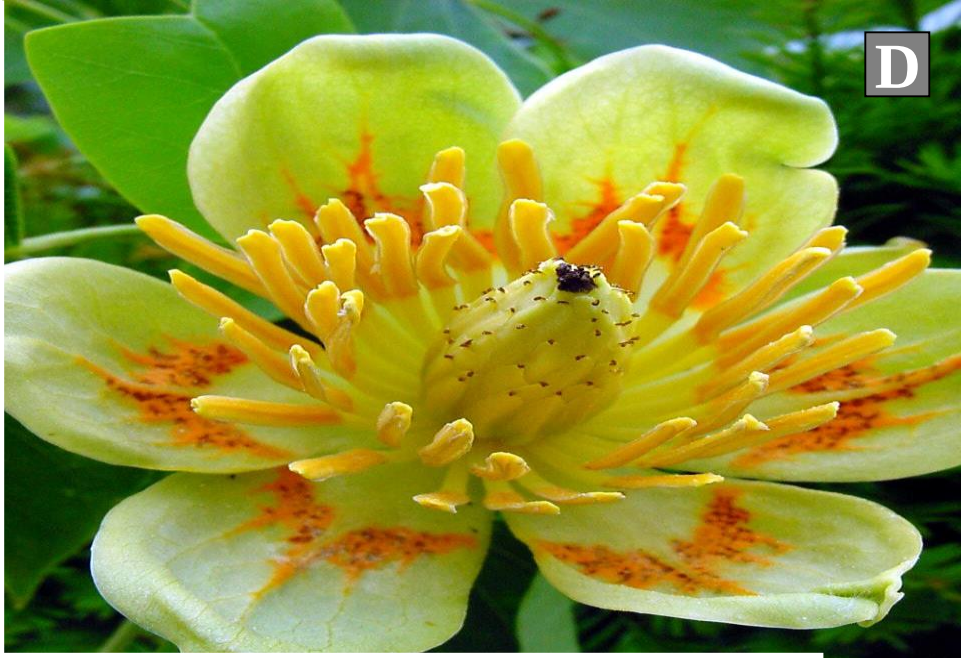

DIFFERENT
ABSORPTION SPECTRUM

ABSORPTION SPECTRUM

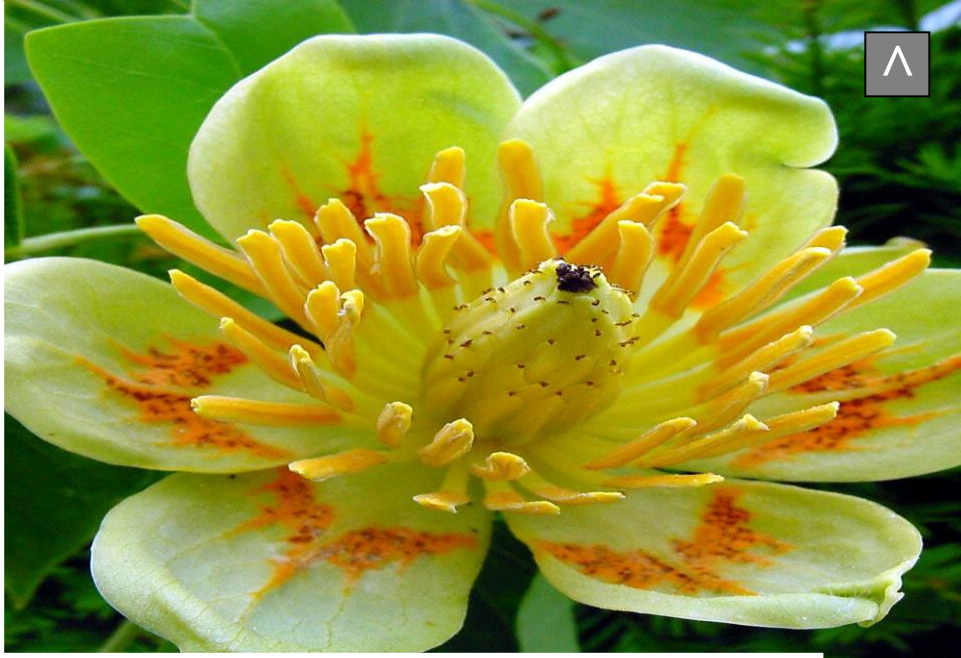
SUMMARY



DIFFERENT SPECIES



DIFFERENT CAROTENOIDS



DIFFERENT ABSORPTION SPECTRUM

>

WAVELENGHT EFFICIENCY

ELECTROMAGNETIC SPECTRUM

FR

SUN

ELECTROMAGNETIC SPECTRUM

HYDROGEN FUSION REACTIONS

SUN

HYDROGEN FUSION REACTIONS

E

ELECTROMAGNETIC SPECTRUM

HYDROGEN FUSION REACTIONS

SUN

HYDROGEN FUSION REACTIONS

*

ELECTROMAGNETIC SPECTRUM PHOTONS

HIGH ENERGY

LOW ENERGY

Gamma rays | X rays | Ultraviolet | Visible | Near infrared | Infrared | Radio waves

SHORT WAVELENGTH

LONG WAVELENGTH

ELECTROMAGNETIC SPECTRUM

HYDROGEN FUSION REACTIONS

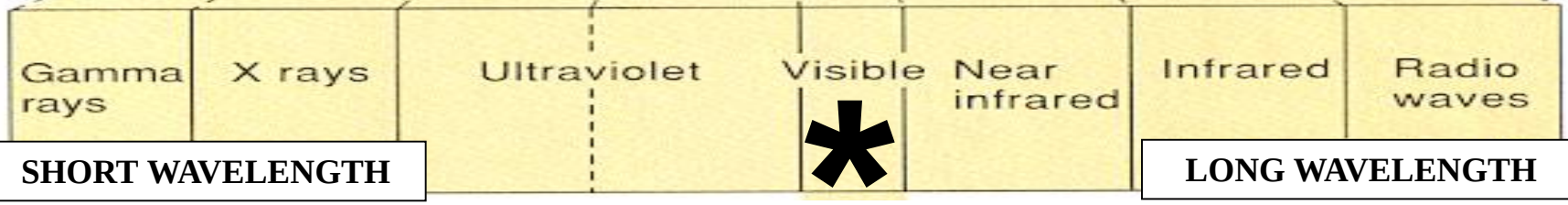
SUN

HYDROGEN FUSION REACTIONS

ELECTROMAGNETIC SPECTRUM PHOTONS

HIGH ENERGY

LOW ENERGY



SHORT WAVELENGTH

LONG WAVELENGTH

PHOTOSYNTHESIS

PHOTOSYNTHESIS

PHOTOSYNTHESIS

PHOTOSYNTHESIS

VISIBLE LIGHT

PRISM

VISIBLE LIGHT SPECTRUM

400 500 600 700

WAVELENGHT EFFICIENCY

GL

VISIBLE LIGHT →

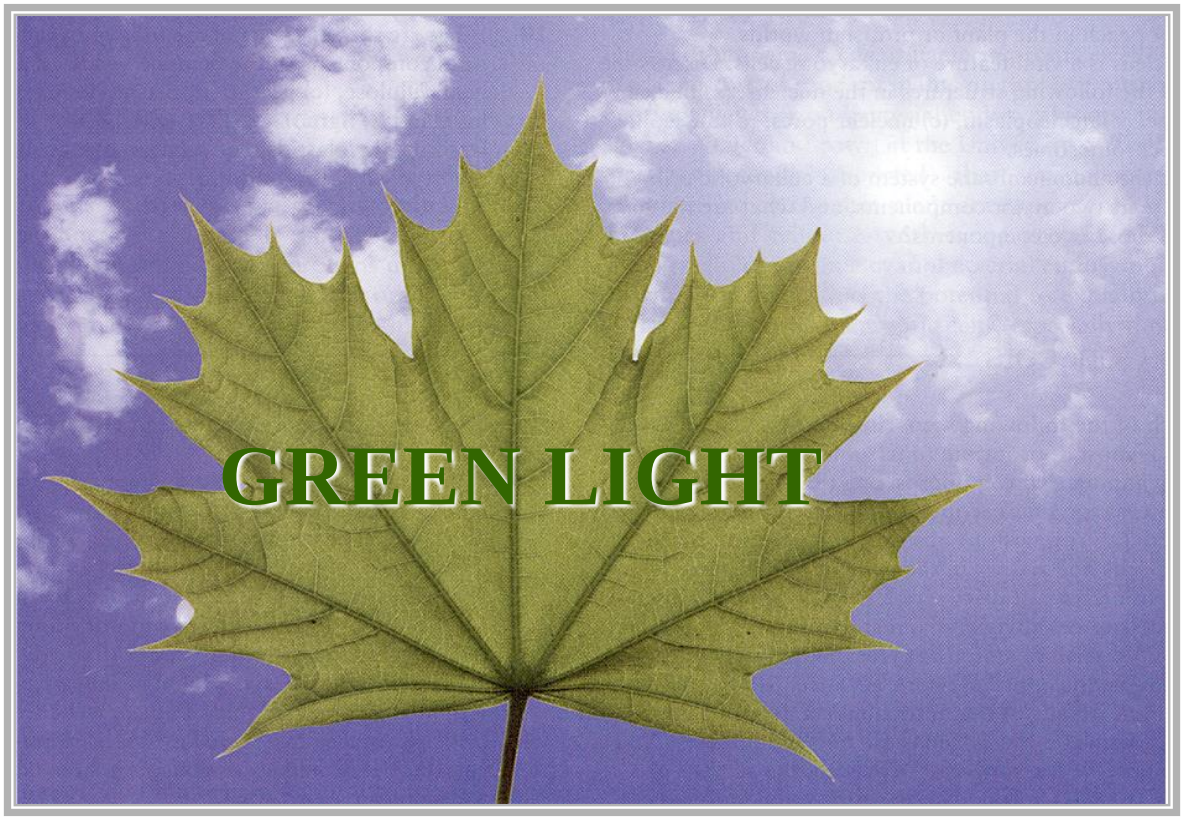
BLUE LT
GREEN LT
YELLOW LT
ORANGE LT
RED LT

CHLOROPHYLL

WAVELENGHT EFFICIENCY

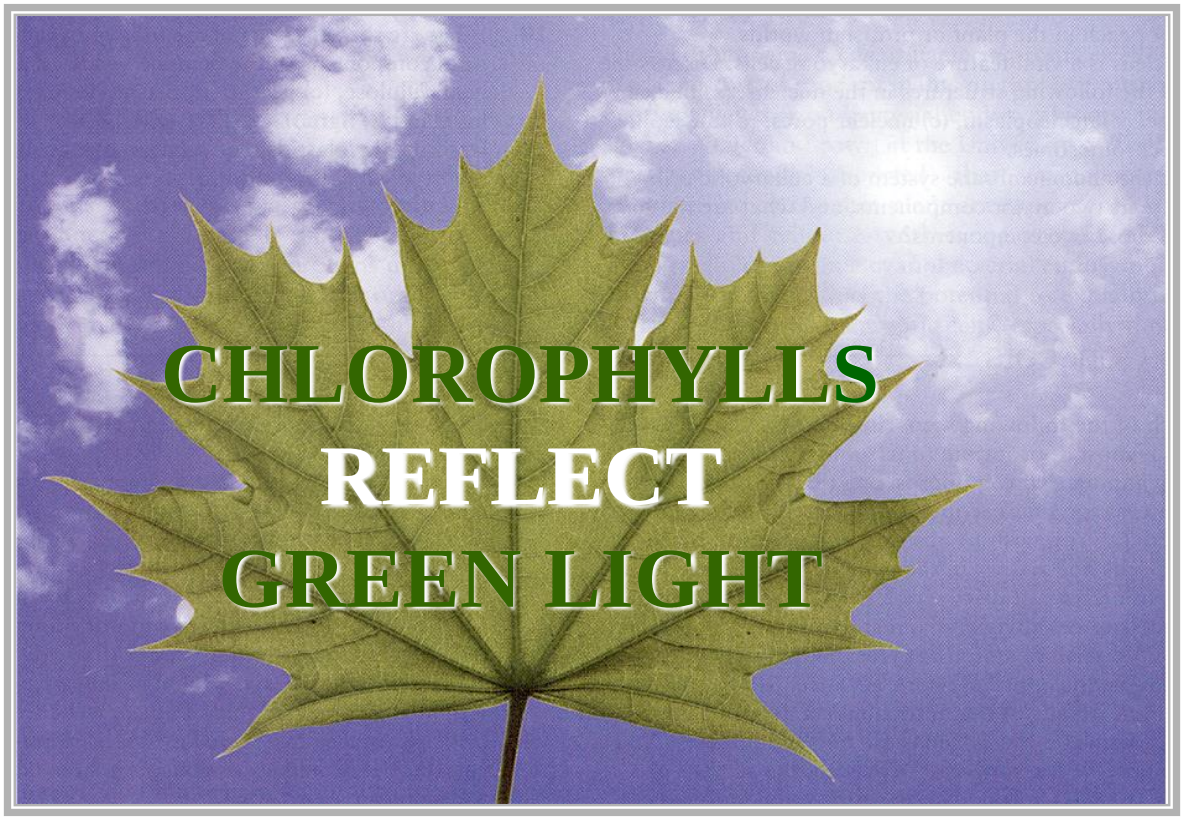
WAVELENGHT EFFICIENCY

VISIBLE LIGHT SPECTRUM



WAVELENGHT EFFICIENCY

VISIBLE LIGHT SPECTRUM



WAVELENGHT EFFICIENCY

PHOTOSYNTHESIS

GREEN LT

VERY

INEFFICIENT

WAVELENGHT EFFICIENCY

BLUE LT

VISIBLE LIGHT → YELLOW LT
ORANGE LT
RED LT

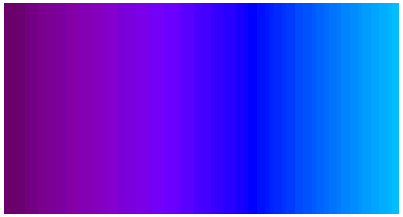
XANTHOPHYLLS

WAVELENGHT EFFICIENCY

WAVELENGHT EFFICIENCY

WAVELENGHT EFFICIENCY

WAVELENGHT EFFICIENCY



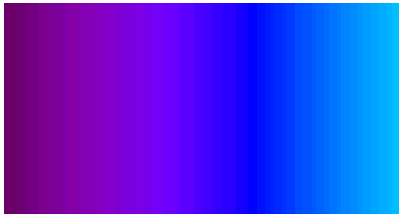
PHOTOSYNTHESIS

YELLOW LT

VERY

INEFFICIENT

WAVELENGHT EFFICIENCY



BLUE LT

VISIBLE LIGHT →

ORANGE LT

RED LT

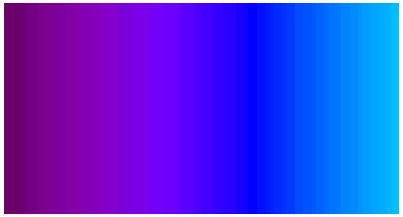
CAROTENES

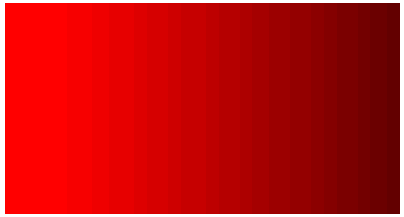
WAVELENGHT EFFICIENCY

WAVELENGHT EFFICIENCY

WAVELENGHT EFFICIENCY

WAVELENGHT EFFICIENCY





PHOTOSYNTHESIS

ORANGE LT

VERY

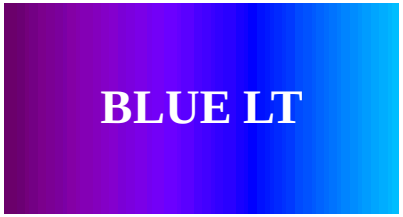
INEFFICIENT

QUESTION

WHAT VISIBLE LT WAVELENGHTS ARE ABSORBED MOST EFFICIENTLY FOR PHOTOSYNTHESIS?

QUESTION

WAVELENGHT EFFICIENCY



WHAT VISIBLE LT WAVELENGHTS ARE ABSORBED MOST EFFICIENTLY FOR PHOTOSYNTHESIS?

WAVELENGHT EFFICIENCY

BLUE LT

RED LT

PHOTOSYNTHESIS

BLUE LT & RED LT

ABSORBED MOST EFFICIENTLY

WAVELENGHT EFFICIENCY

BLUE LT

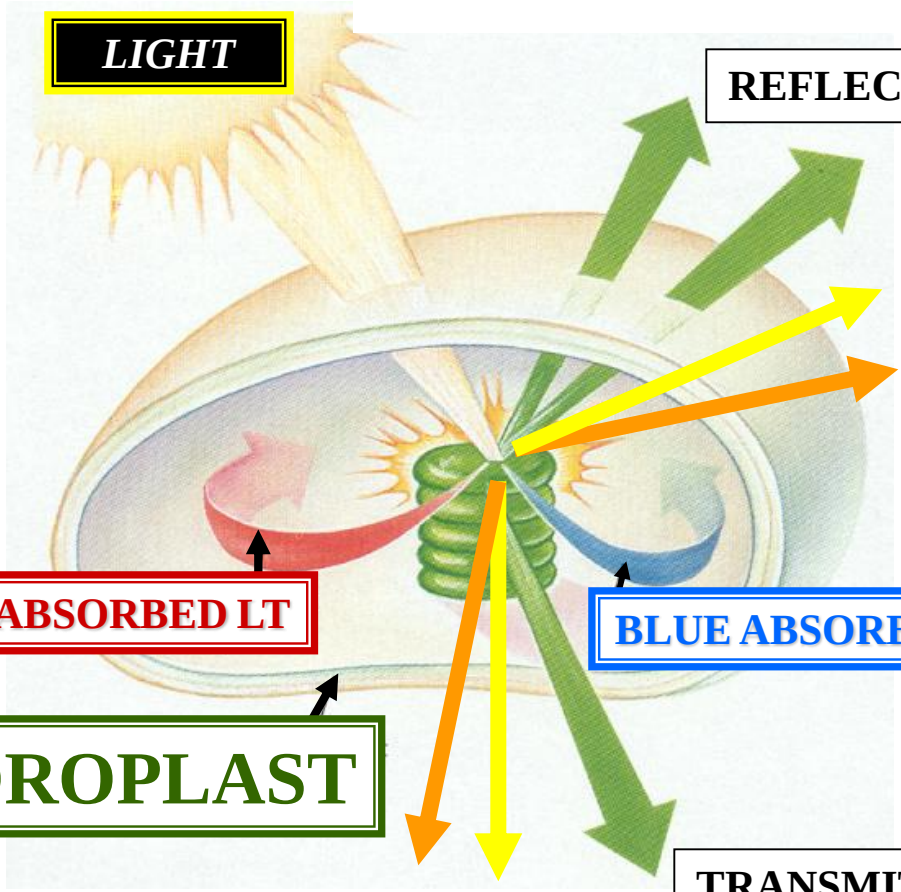
RED LT

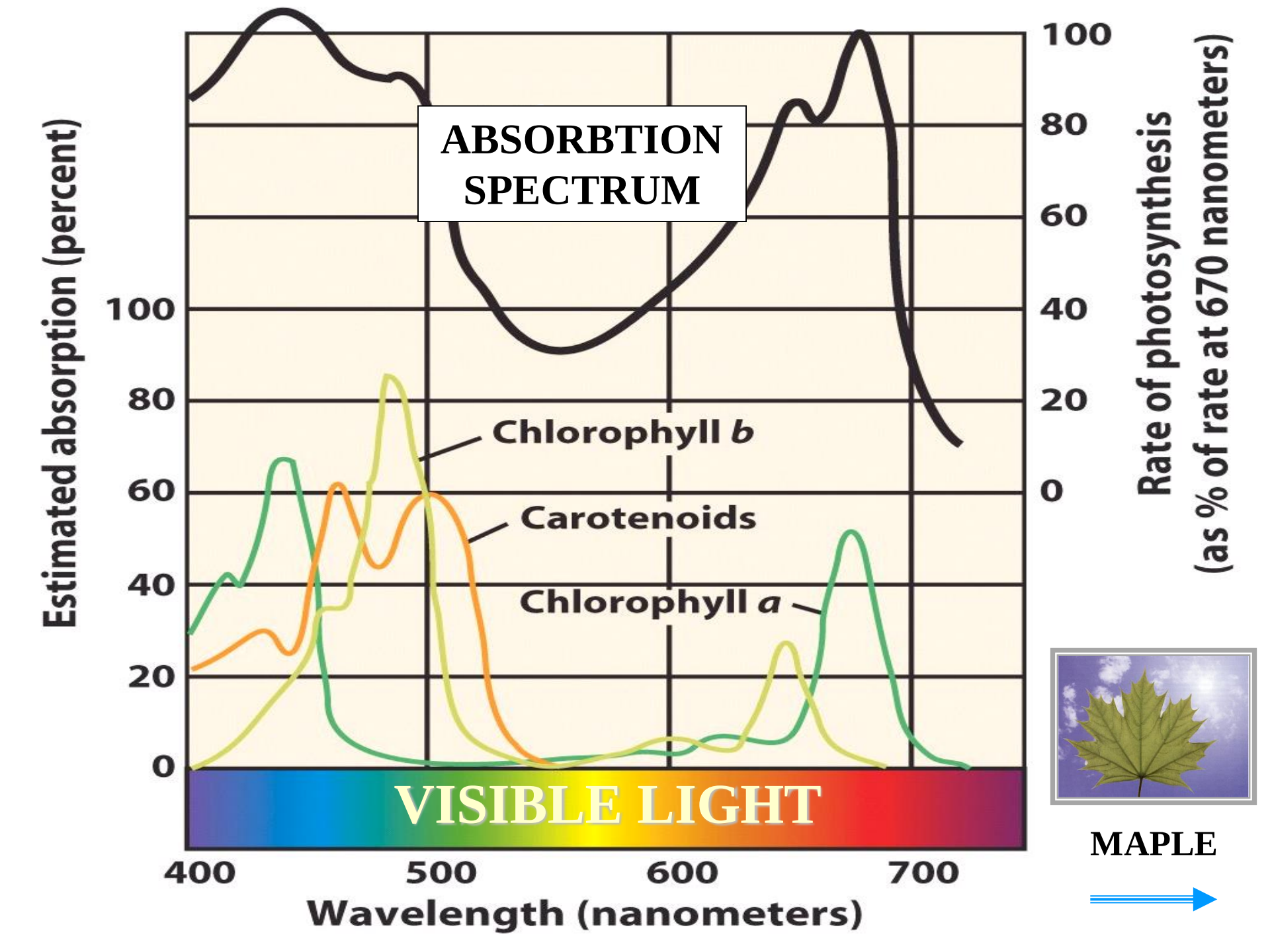
BLUE LT & RED LT MOST EFFICIENT PHOTOSYNTHESIS WAVELENGHTS

WAVELENGHT EFFICIENCY

BLUE LT

RED LT




ABSORBTION SPECTRUM
Estimated absorption (percent)
Rate of photosynthesis (as % of rate at 670 nanometers)
100
80
60
40
20
0
Chlorophyll b
Carotenoids
Chlorophyll a
VISIBLE LIGHT
400
500
600
700
Wavelength (nanometers)
MAPLE