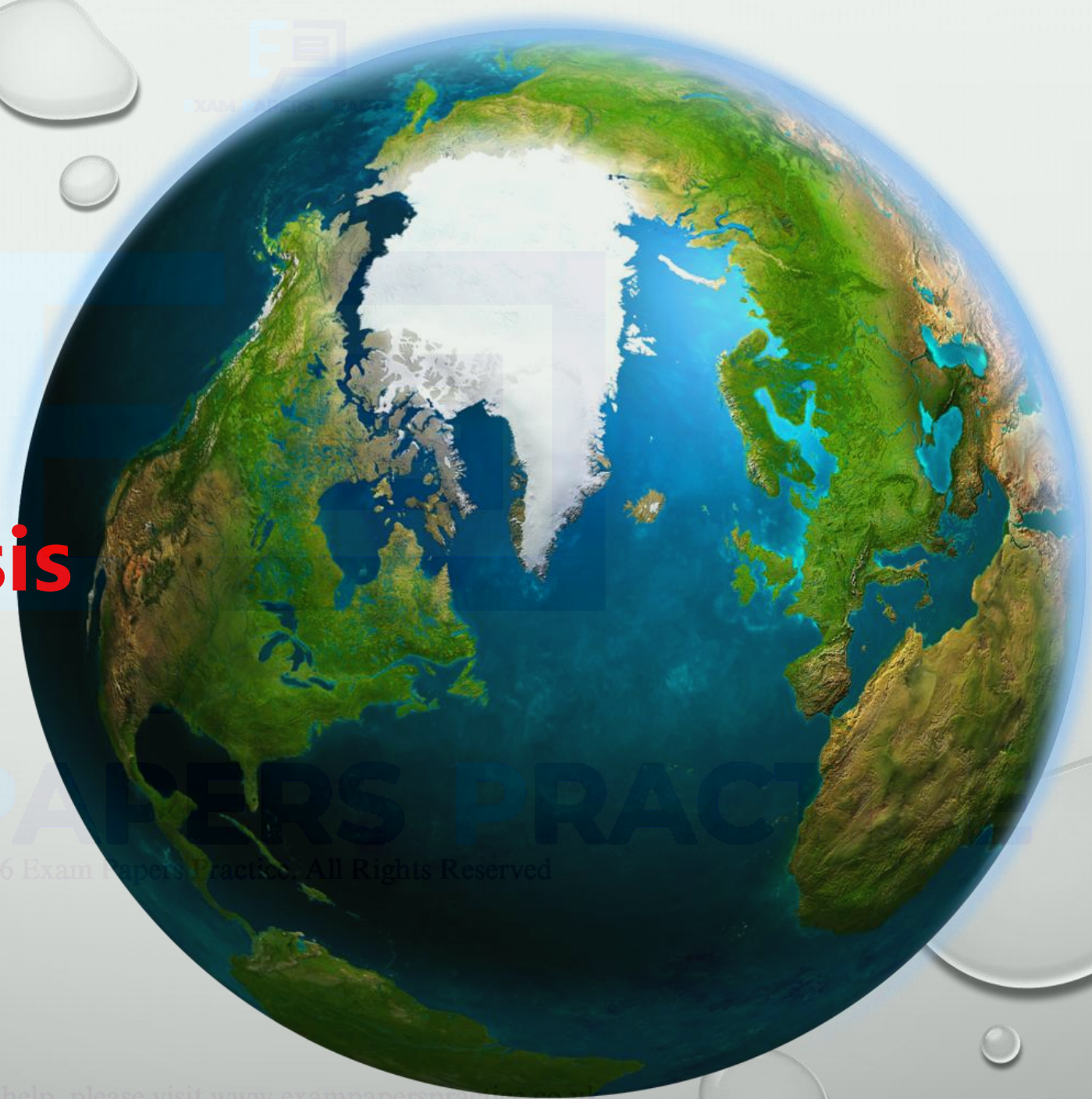


photosynthesis



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Plant nutrition

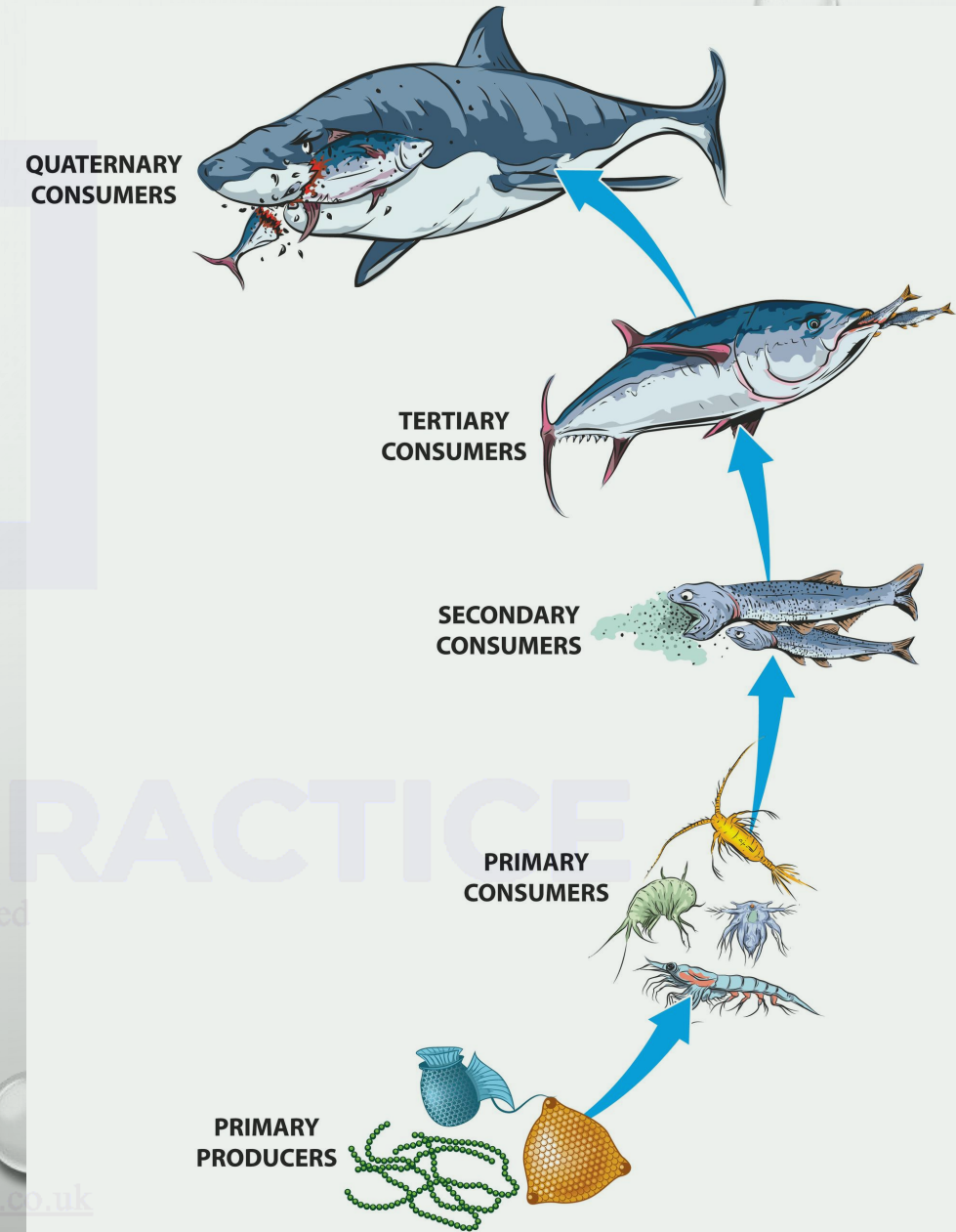
Types of nutrition

Nutrition

Taking in useful substances is called **feeding**, or **nutrition**.

Organic substances	Inorganic substances
Substances made by living things e.g. carbohydrates, lipids, proteins and vitamins	e.g. carbon dioxide, water and minerals

Organic substance 有机物
Inorganic substance 无机物

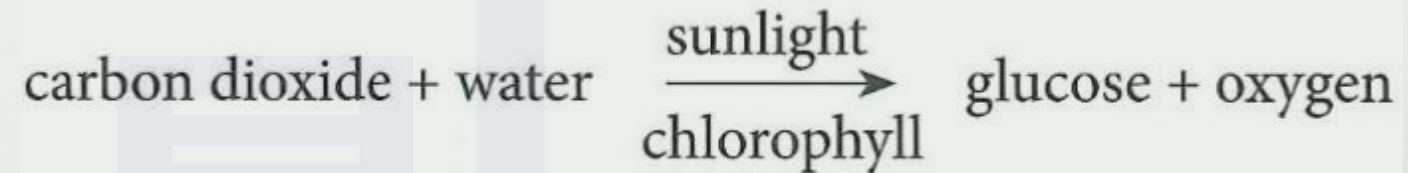


Plant nutrition

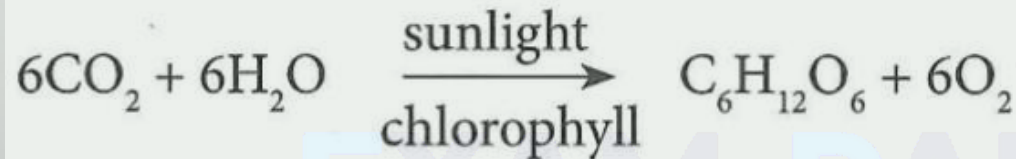
photosynthesis

photosynthesis

The process by which plants manufacture carbohydrates from raw materials using energy from light



Balanced equation for photosynthesis



Chlorophyll is the pigment which makes plants look green. It can absorb solar energy and then release the energy to make carbon dioxide combine with water, with the help inside the chloroplast.

Light energy is transferred to chemical energy

molecular formula 分子式
balanced equation 平衡方程
chemical energy 化学能

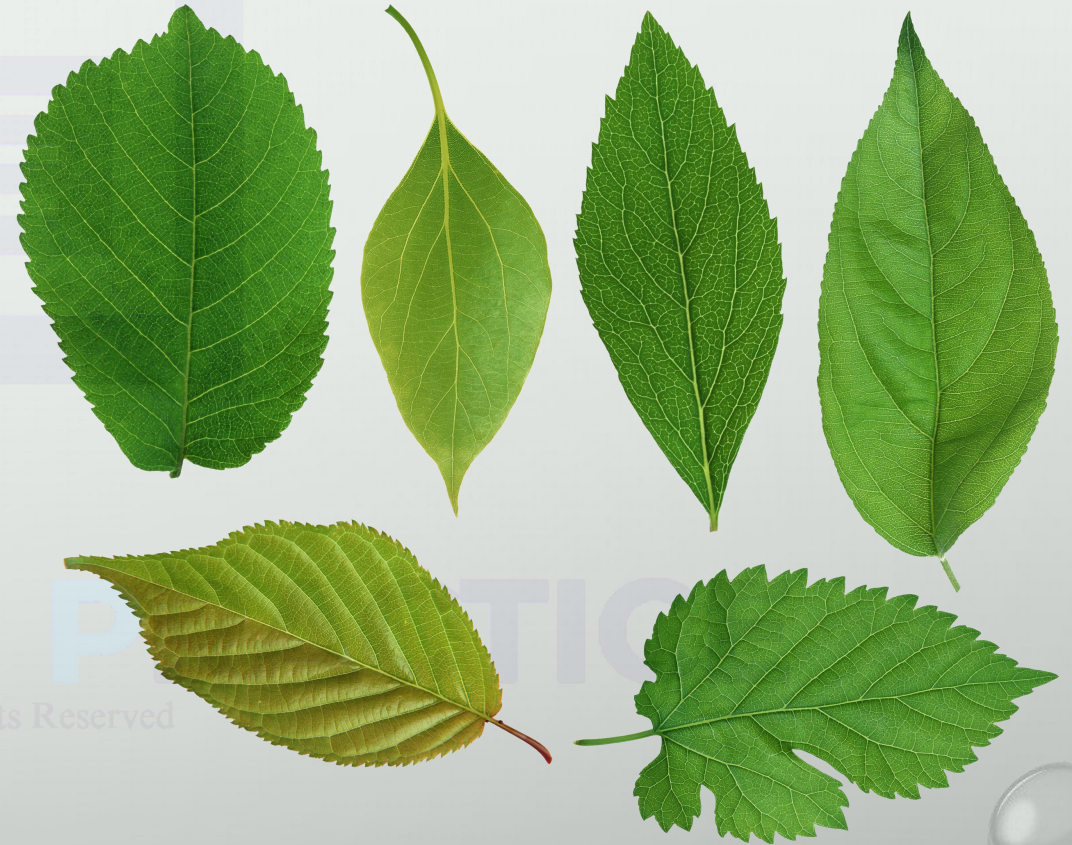
- ♠ give one example of an organic substance.
- ♠ which inorganic substances does a plant use to make carbohydrates?
- ♠ what is chlorophyll, and how does it help the plant?

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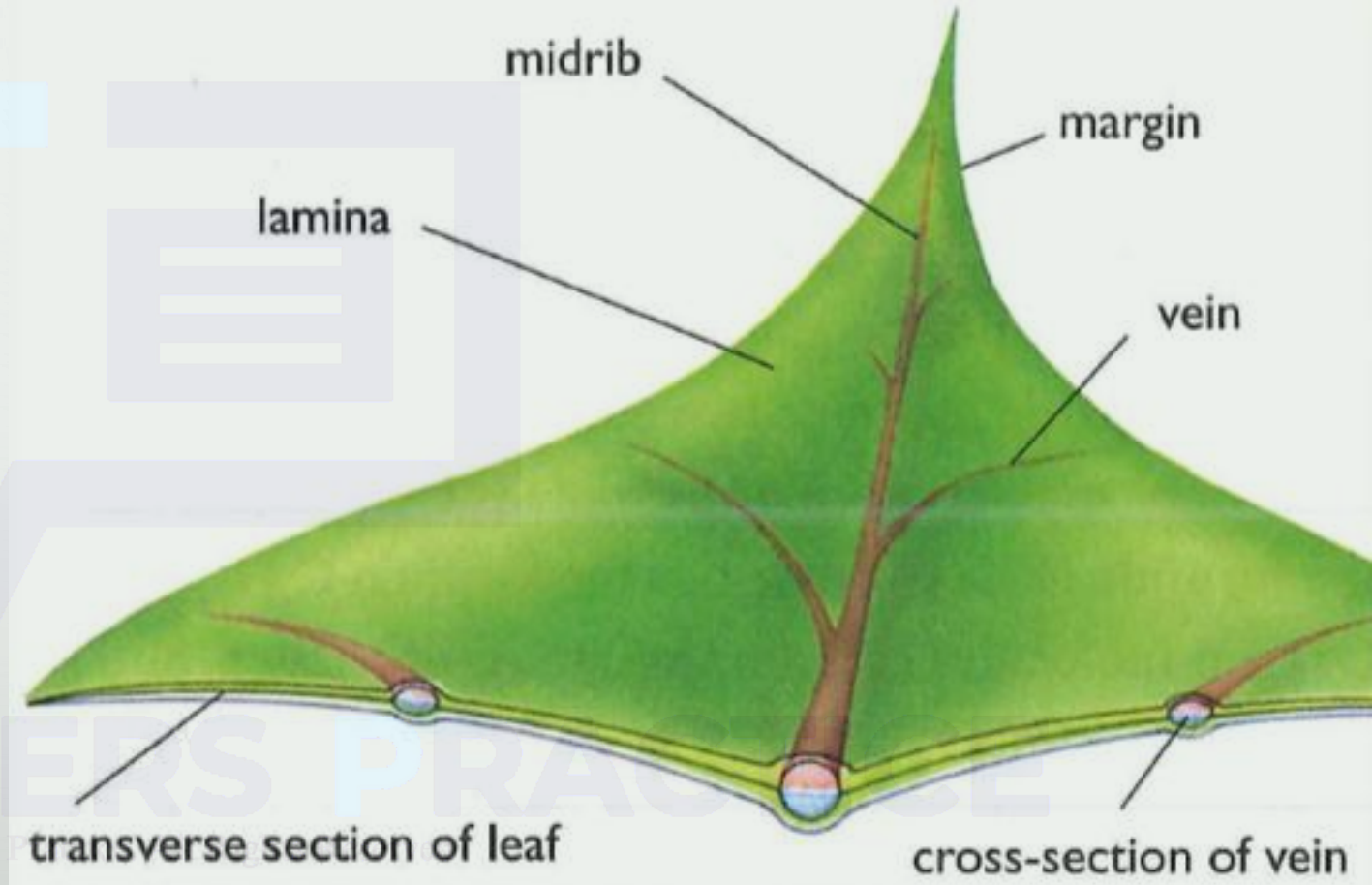
Plant nutrition

photosynthesis



Plant nutrition

photosynthesis



petiole (leaf stalk) 叶柄

lamina 叶片

midrib 中脉

vein 叶脉

margin 边缘

transverse section 横切面

cross-section 横切面

Vascular bundles 维管束

Plant nutrition

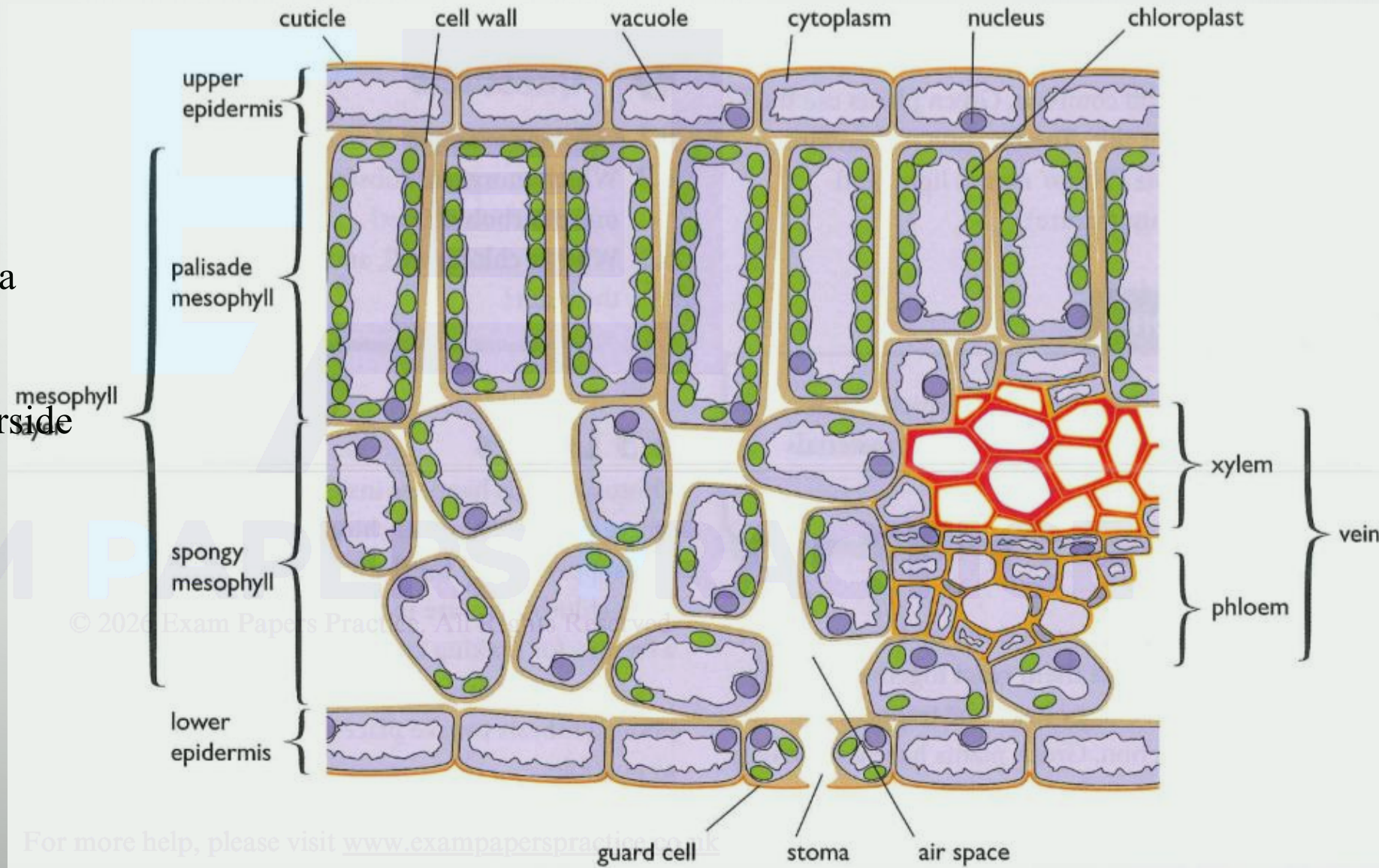
photosynthesis

epidermis

- ◆ upper epidermis + lower epidermis
- ◆ no chloroplasts
- ◆ protect inner layers of cells
- ◆ upper epidermis often secrete a waxy substance (cuticle), to stop water evaporation.

Sometimes a cuticle on the underside of the leaf.

epidermis 表皮
cuticle 角质层
waxy substance 蜡质

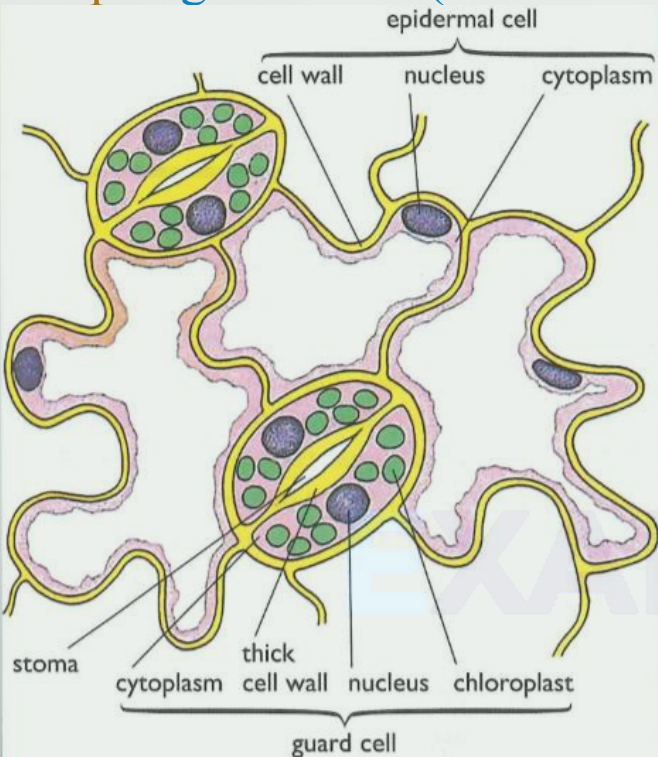


Plant nutrition

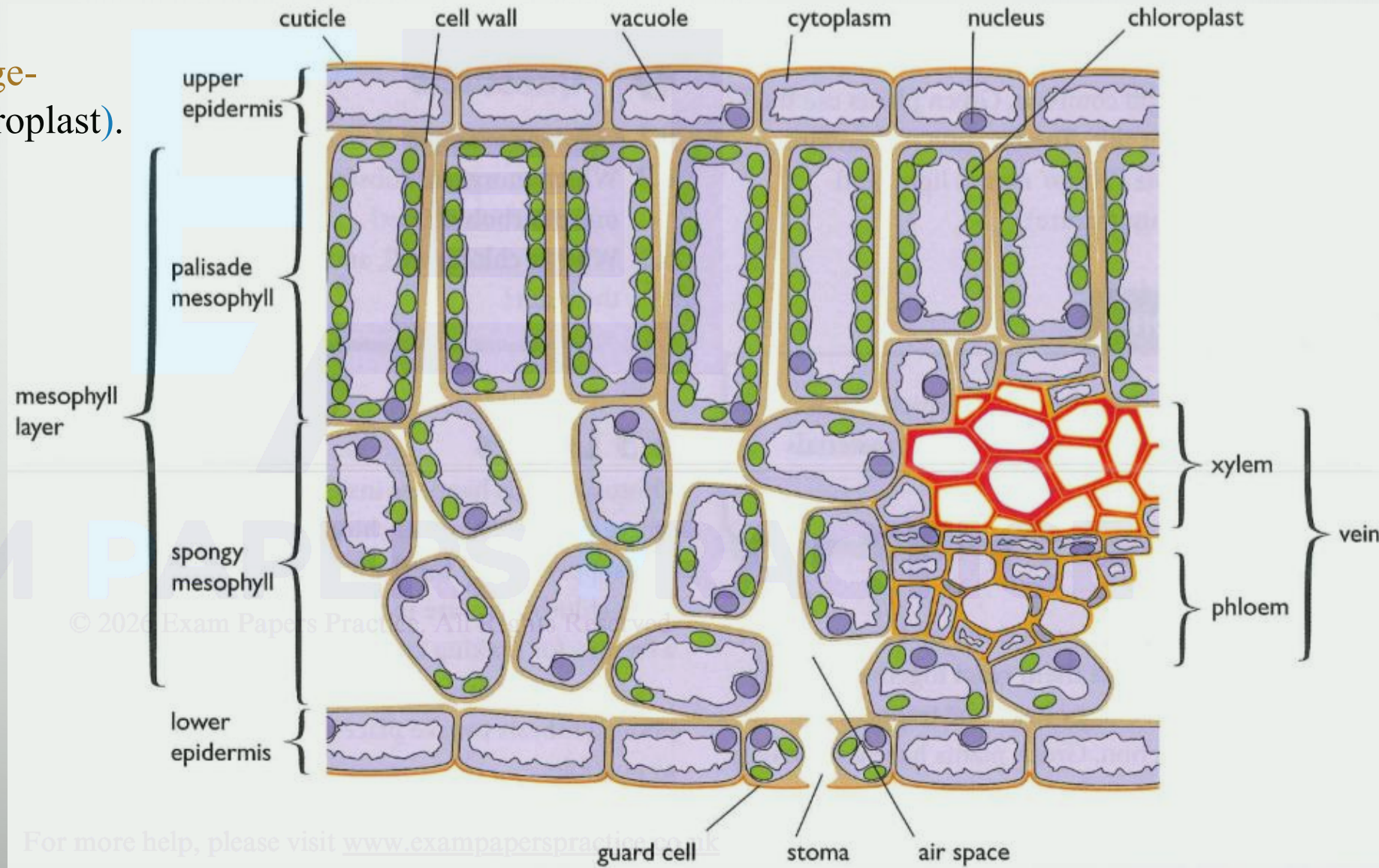
photosynthesis

Stomata (stoma)

- ◆ in the lower epidermis
- ◆ surrounded by a pair of **sausage-shaped guard cells** (contain chloroplast).



stomata(stoma)气孔
guard cell保卫细胞
sausage-shaped香肠状的



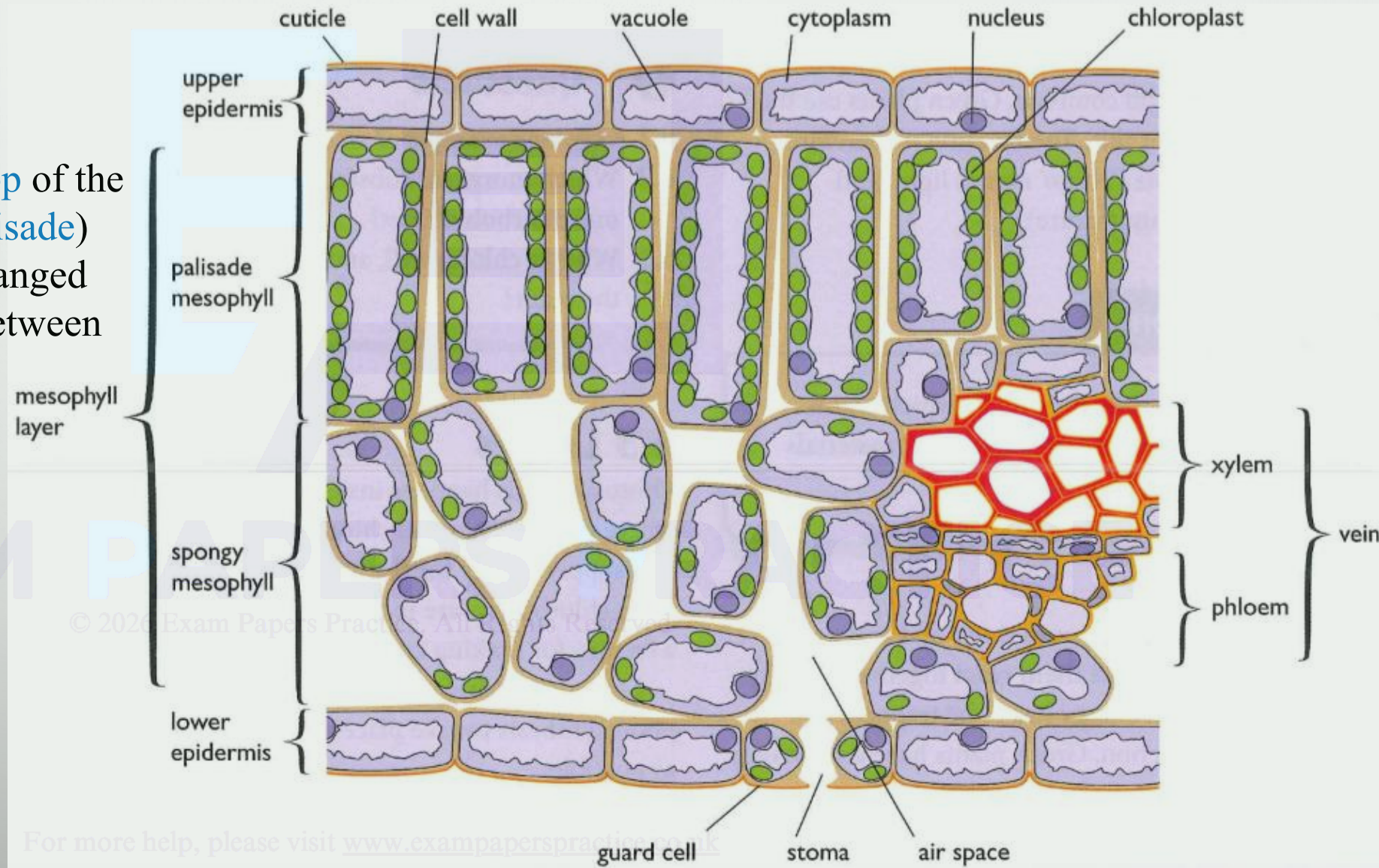
Plant nutrition

photosynthesis

Mesophyll

- ◆ palisade layer + spongy layer
- ◆ contain chloroplast
- ◆ palisade layer (nearer to the top of the leaf, arranged like a fence or palisade)
- ◆ spongy layer (rounder and arranged quite loosely, with large space between them.)

mesophyll 叶肉
palisade layer 栅栏层
spongy layer 海绵层



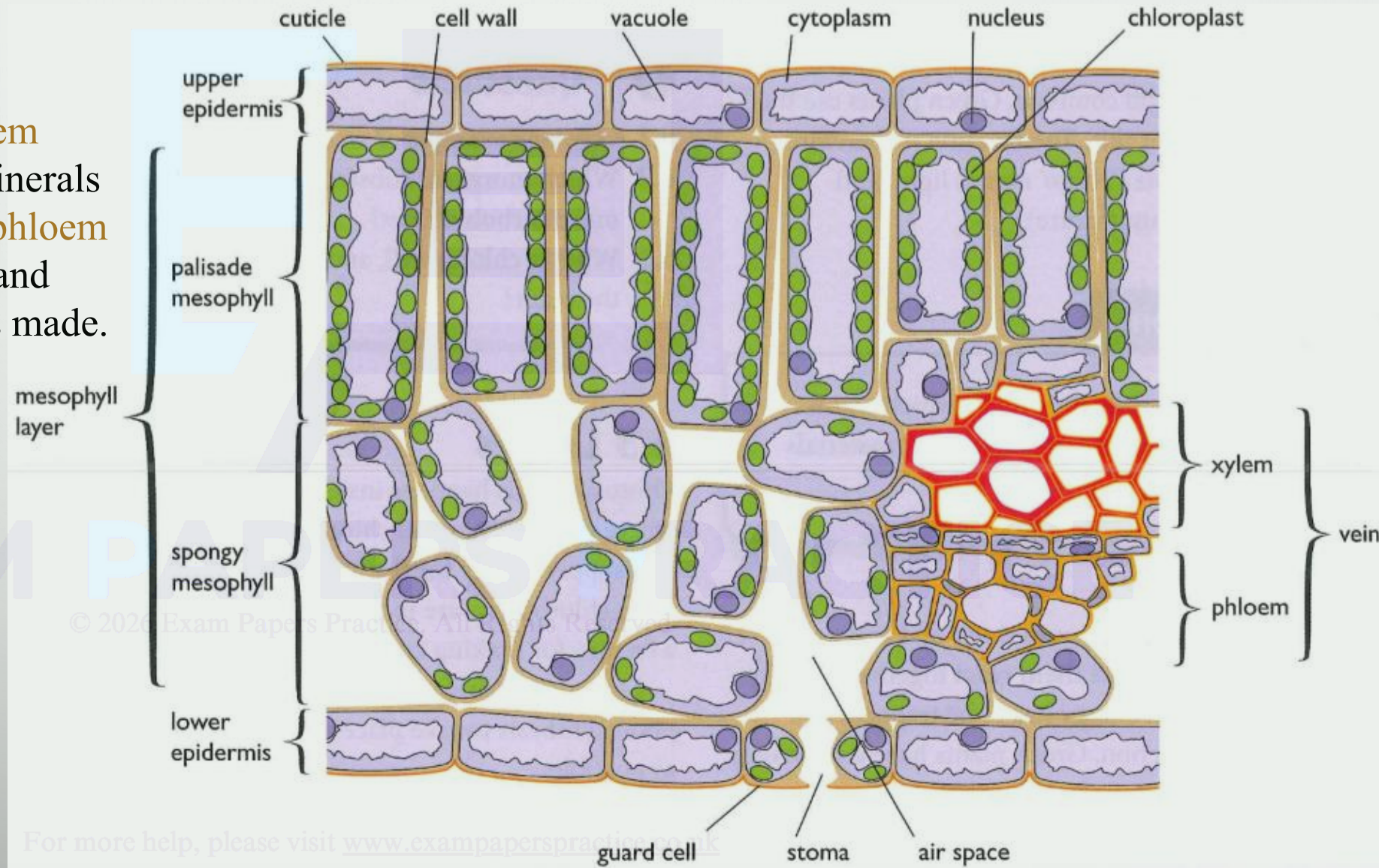
Plant nutrition

photosynthesis

Vascular bundles

- ◆ xylem + phloem
- ◆ xylem (large, thick-walled xylem vessels) → carrying water and minerals
- ◆ phloem (smaller, thin-walled phloem tubes) → carrying away sucrose and other substances that the leaf has made.

vascular bundle 维管束
xylem 木质部
phloem 韧皮部
xylem vessel 木质部导管
phloem tube 韧皮部管道



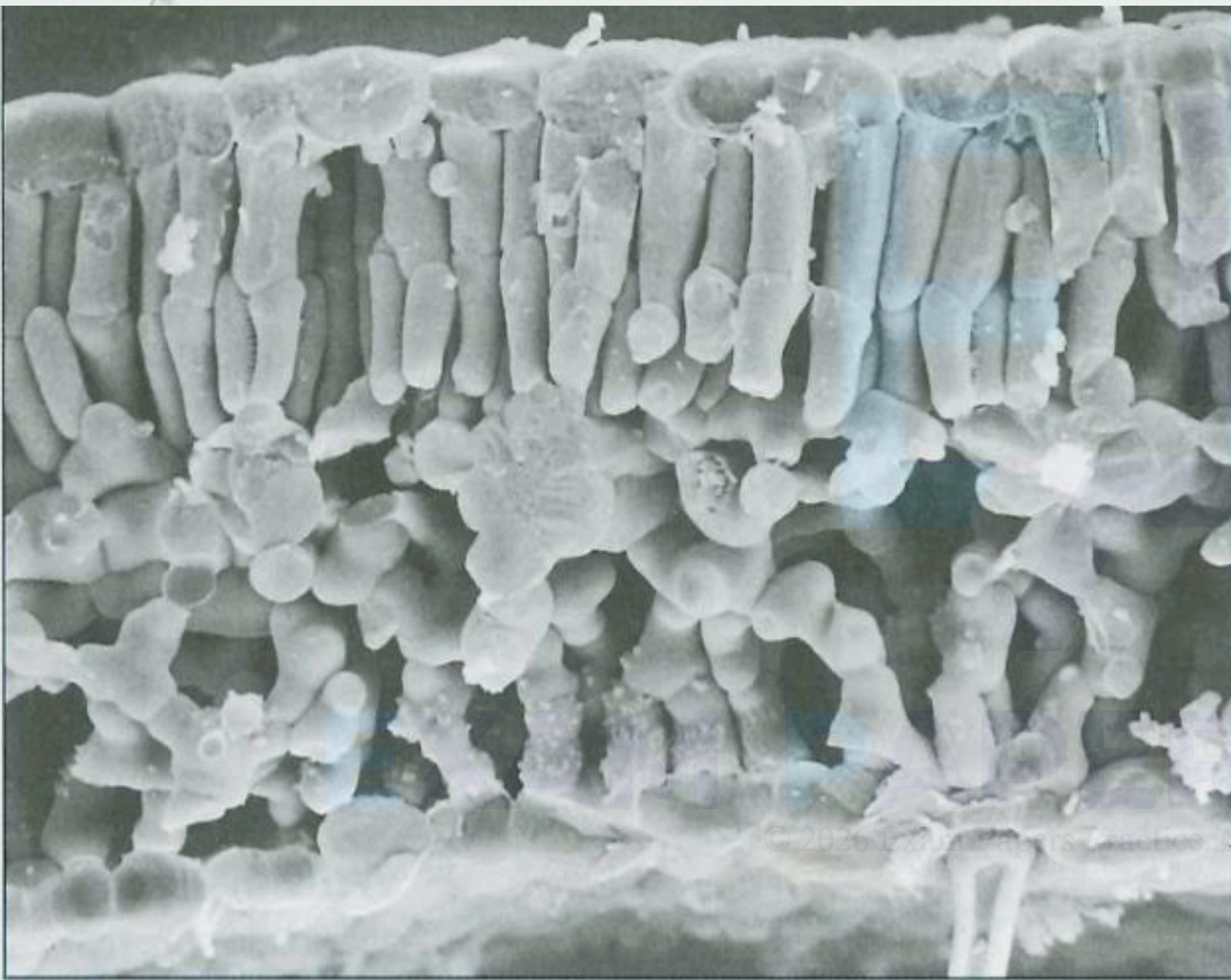


Figure 6.4 A photograph taken with a scanning electron microscope, showing the cells inside a leaf. Scanning electron microscopes provide 3D images. ($\times 400$).

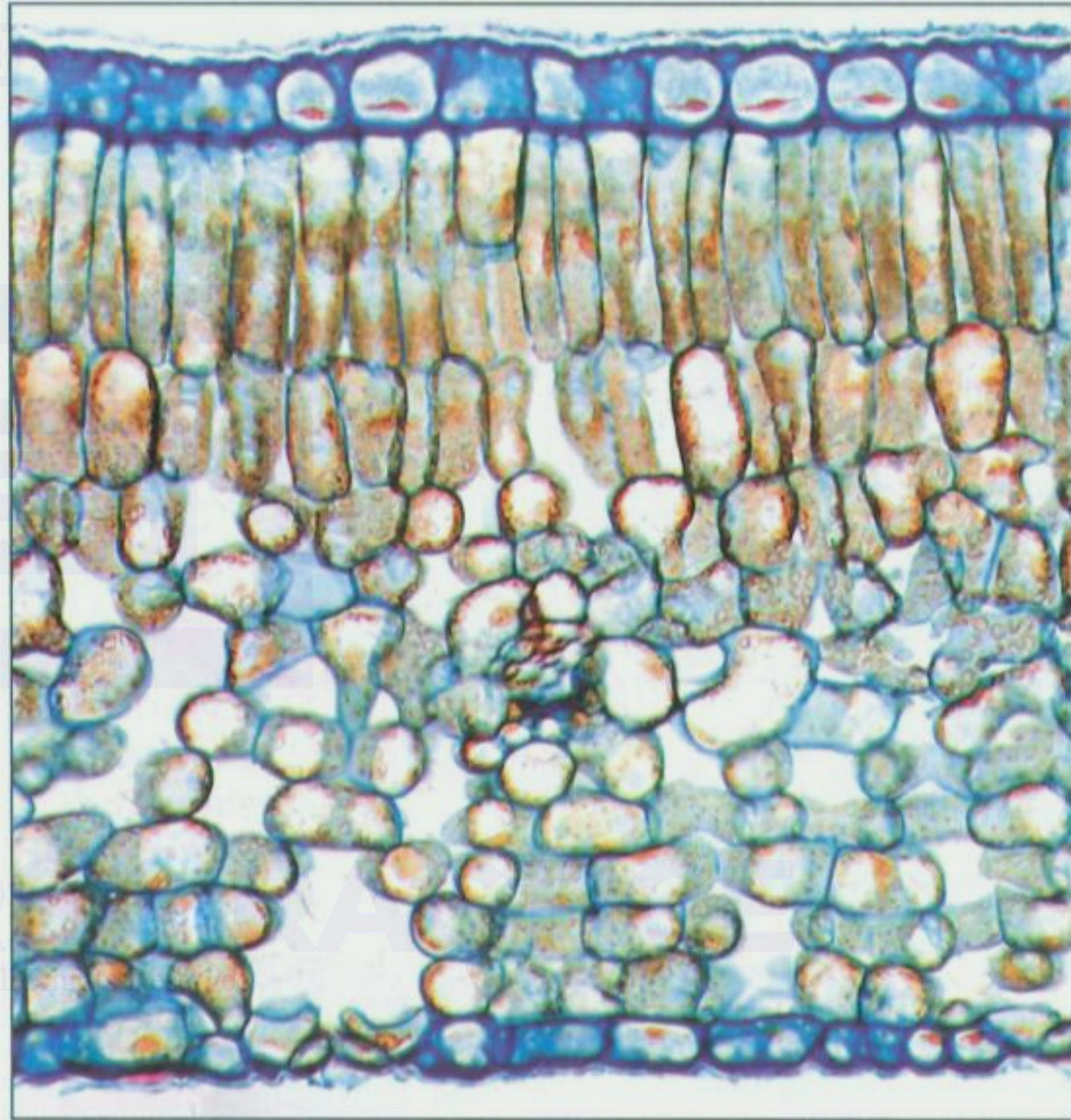


Figure 6.5 This photograph was taken using a light microscope. It shows a transverse section of a leaf from a tea plant. Can you identify all the tissues labelled in Figure 6.3? ($\times 400$).

- ♠ what is another name of a leaf stalk?
- ♠ which kind of cell makes the cuticle on a leaf?
- ♠ what is the function of the cuticle?
- ♠ what are stomata?
- ♠ what are guard cell?
- ♠ list three kinds of cell in a leaf which contain chloroplasts, and one kind of which does not?

Organic substance 有机物
Inorganic substance 无机物

molecular formula 分子式
balanced equation 平衡方程
chemical energy 化学能

epidermis 表皮
cuticle 角质层
waxy substance 蜡质

stomata(stoma) 气孔
guard cell 保卫细胞
sausage-shaped 香肠状的

petiole (leaf stalk) 叶柄
lamina 叶片
midrib 中脉
vein 叶脉
margin 边缘
transverse section 横切面
cross-section 横切面
Vascular bundles 维管束

mesophyll 叶肉
palisade layer 栅栏层
spongy layer 海绵层

vascular bundle 维管束
xylem 木质部
phloem 韧皮部
xylem vessel 木质部导管
phloem tube 韧皮部管道

Organic substance
Inorganic substance

molecular formula
balanced equation
chemical energy

epidermis
cuticle
waxy substance

stomata(stoma)
guard cell
sausage-shaped

petiole (leaf stalk)
lamina
midrib
vein
margin
transverse section
cross-section
Vascular bundles

mesophyll
palisade layer
spongy layer

vascular bundle
xylem
phloem
xylem vessel
phloem tube

- ♠ what is another name of a leaf stalk?
- ♠ which kind of cell makes the cuticle on a leaf?
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- ♠ what are stomata?
- ♠ what are guard cell?
- ♠ list three kinds of cell in a leaf which contain chloroplasts, and one kind of which does not?

Which factors are essential for plants?

Carbon dioxide

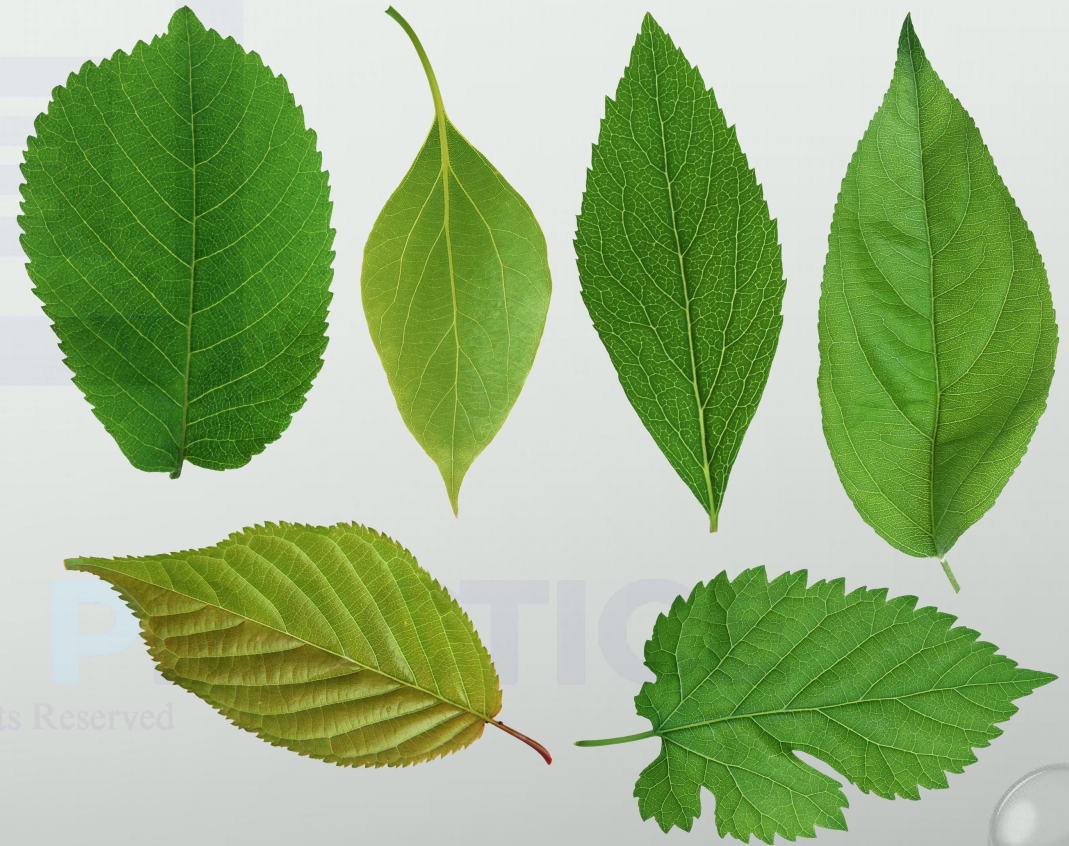
light

water

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Carbon dioxide

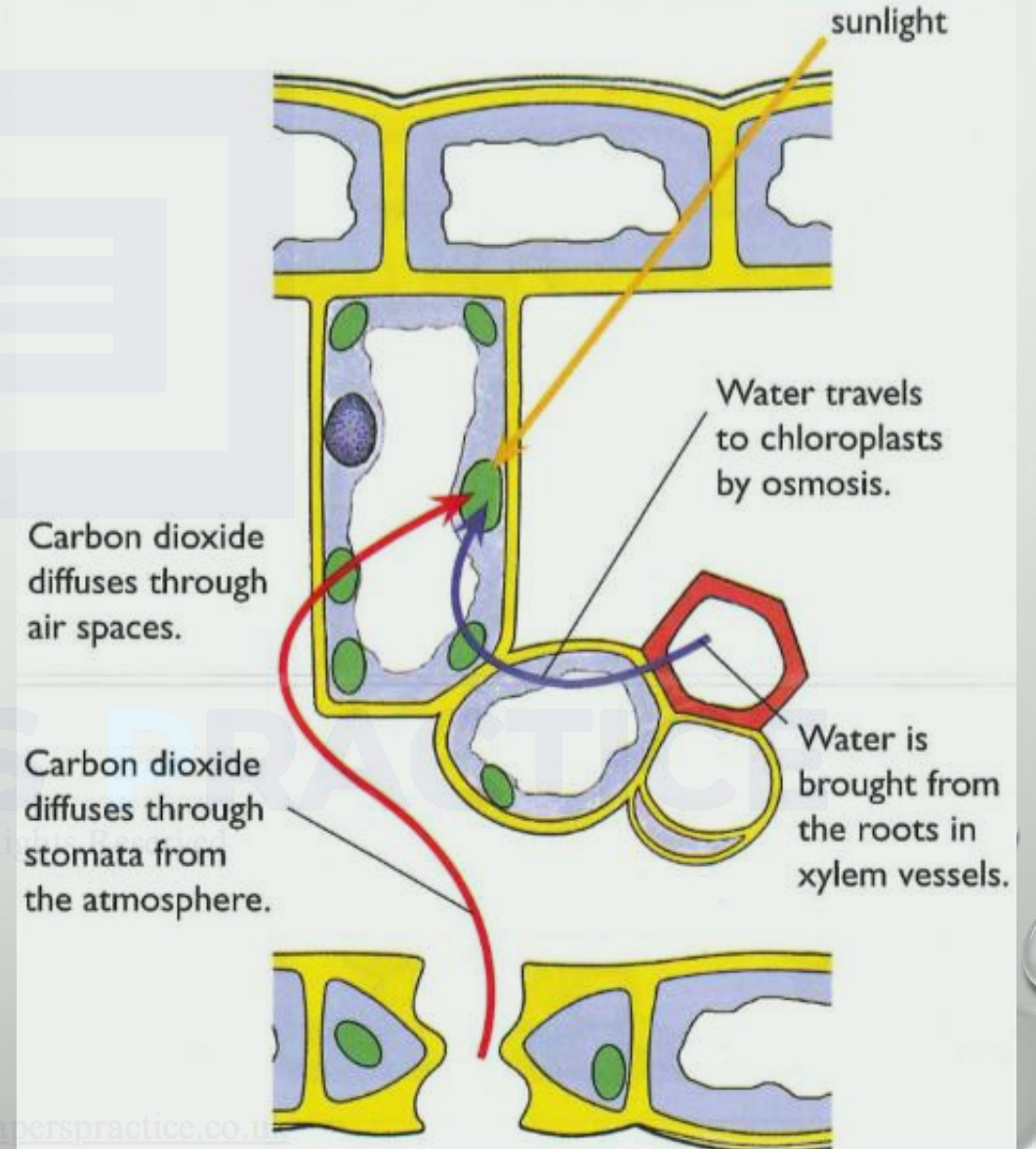
- ✦ large surface area
- ✦ stomata (diffuse carbon dioxide)
- ✦ behind stomata is an air space which connects up with other air spaces between the spongy mesophyll)



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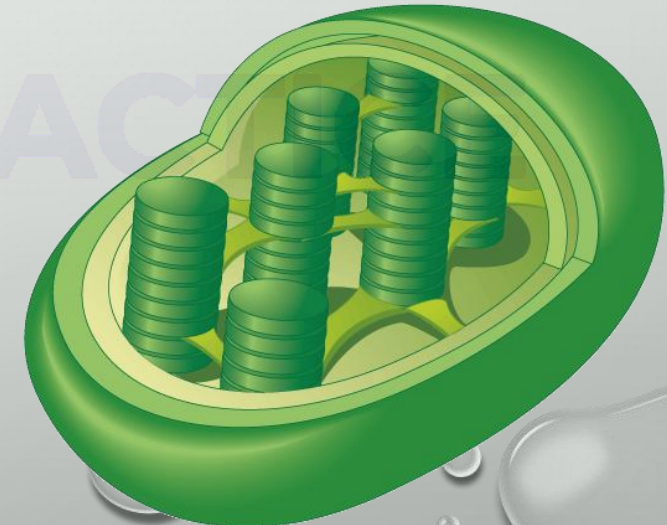
Water

- root hairs
- xylem vessels
- cuticle



sunlight

- ✦ **broad, flat surface** (plants that live in shady places often have particularly big leaves)
- ✦ leaves are **arranged** so that **do not cut off light** from one another more than necessary.
- ✦ **thinness** of the leaf
- ✦ **epidermal cells** are **transparent**
- ✦ the **chloroplasts** can **lie broadside** (but in strong sunlight, they often **arrange themselves end on**)
- ✦ the **chlorophyll** is arranged **on flat membranes**.



Adaptation	Function
supported by stem and petiole	
large surface area	
thin	
stomata in lower epidermis	
air spaces in spongy mesophyll	
no chloroplasts in epidermal cells	
chloroplasts containing chlorophyll present in the mesophyll layer	
palisade cells arranged end on	

Adaptation	Function
chloroplasts inside palisade cells often arranged broadside on	
chlorophyll arranged on flat membranes inside the chloroplasts	
xylem vessels within short distance of every mesophyll cell	
phloem tubes within short distance of every mesophyll cell	

What are the raw materials needed for photosynthesis?

how does carbon dioxide get into a leaf?

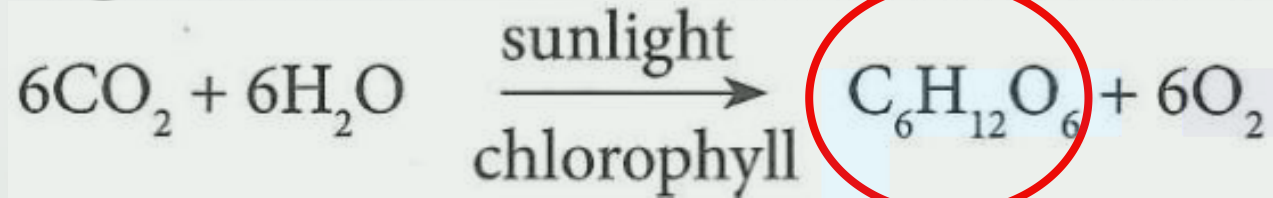
how does a leaf obtain its water?

give two reasons why the large surface area of leaves is advantageous to the plant?

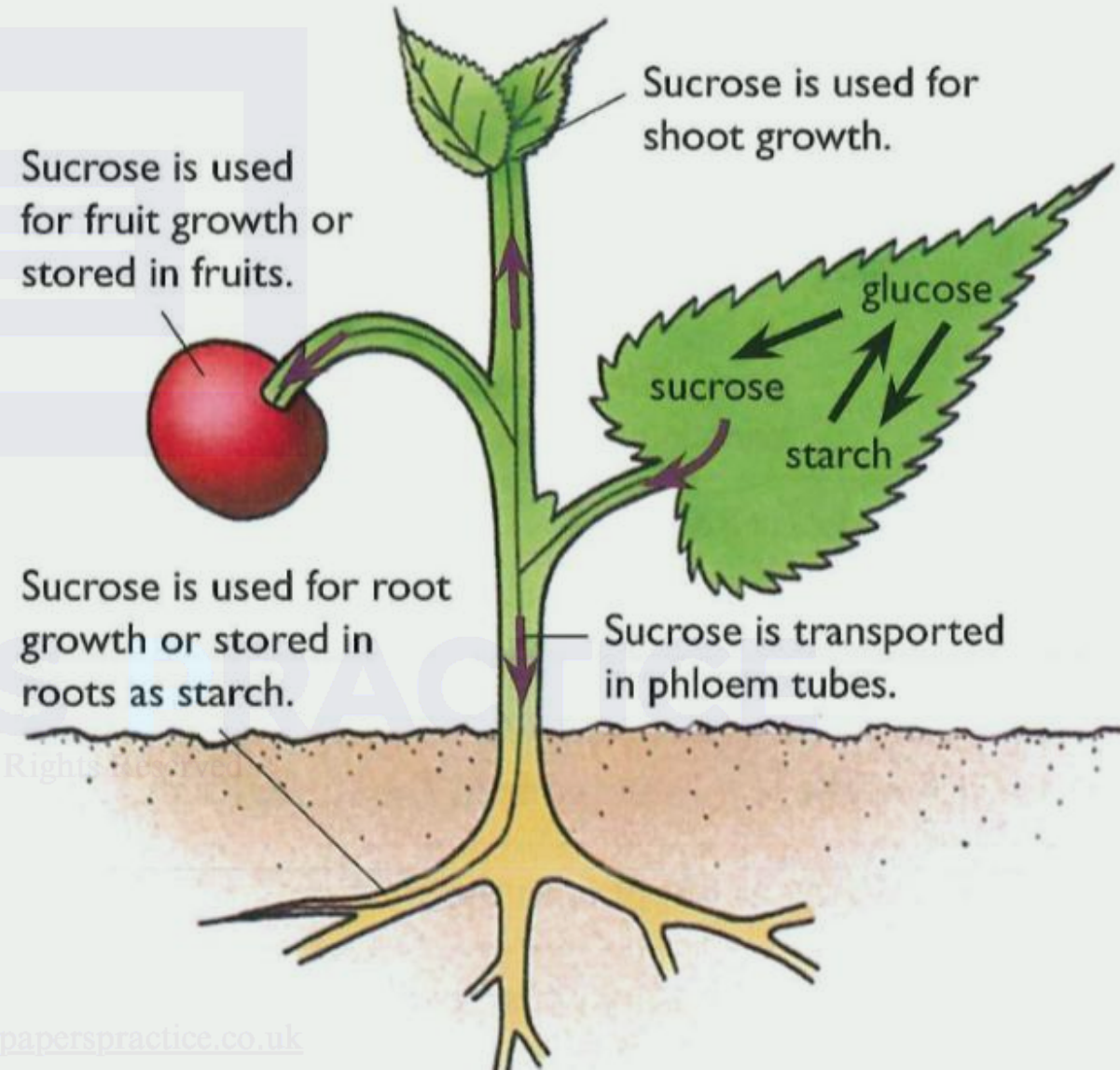
leaves are thin. What purpose does this serve?

Plant nutrition

Leaf adaptation



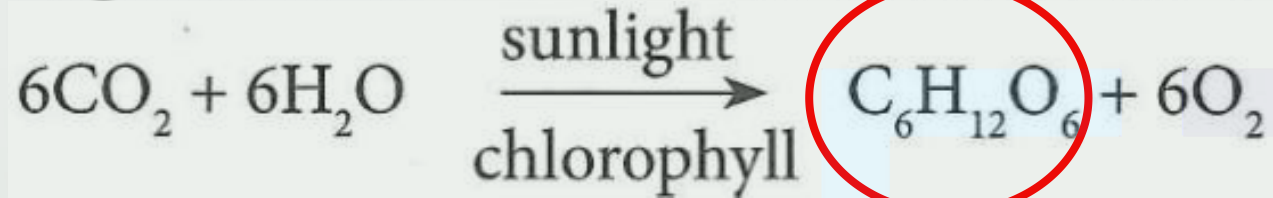
Used for energy
respiration



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Plant nutrition

Leaf adaptation



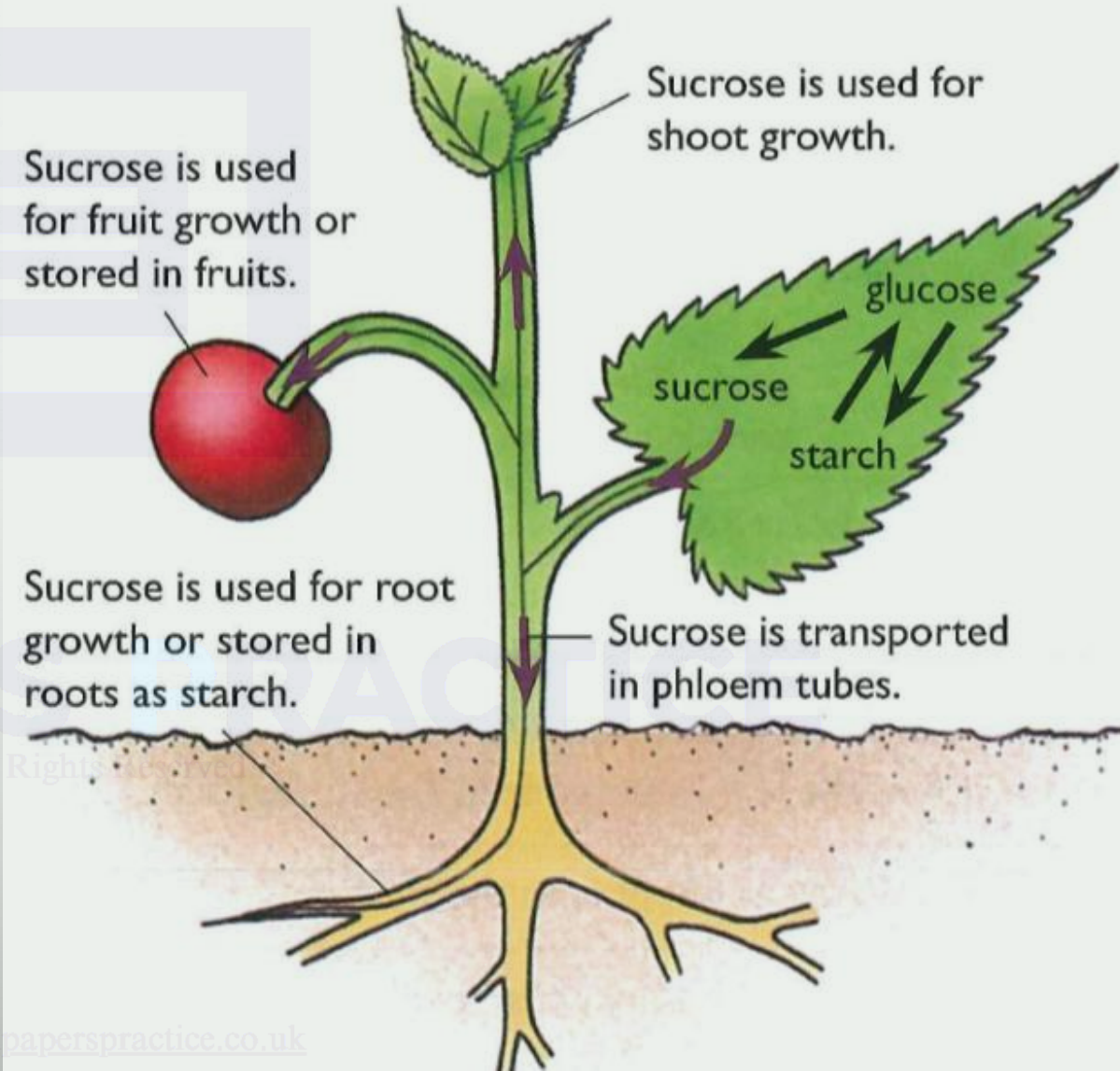
Stored as starch

Why glucose is stored in the leaf?

active

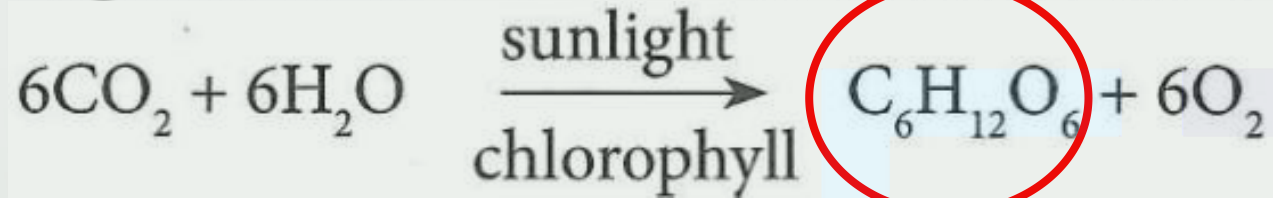
soluble

when dissolved, it would increase the concentration of the solution in the cell → cause damage



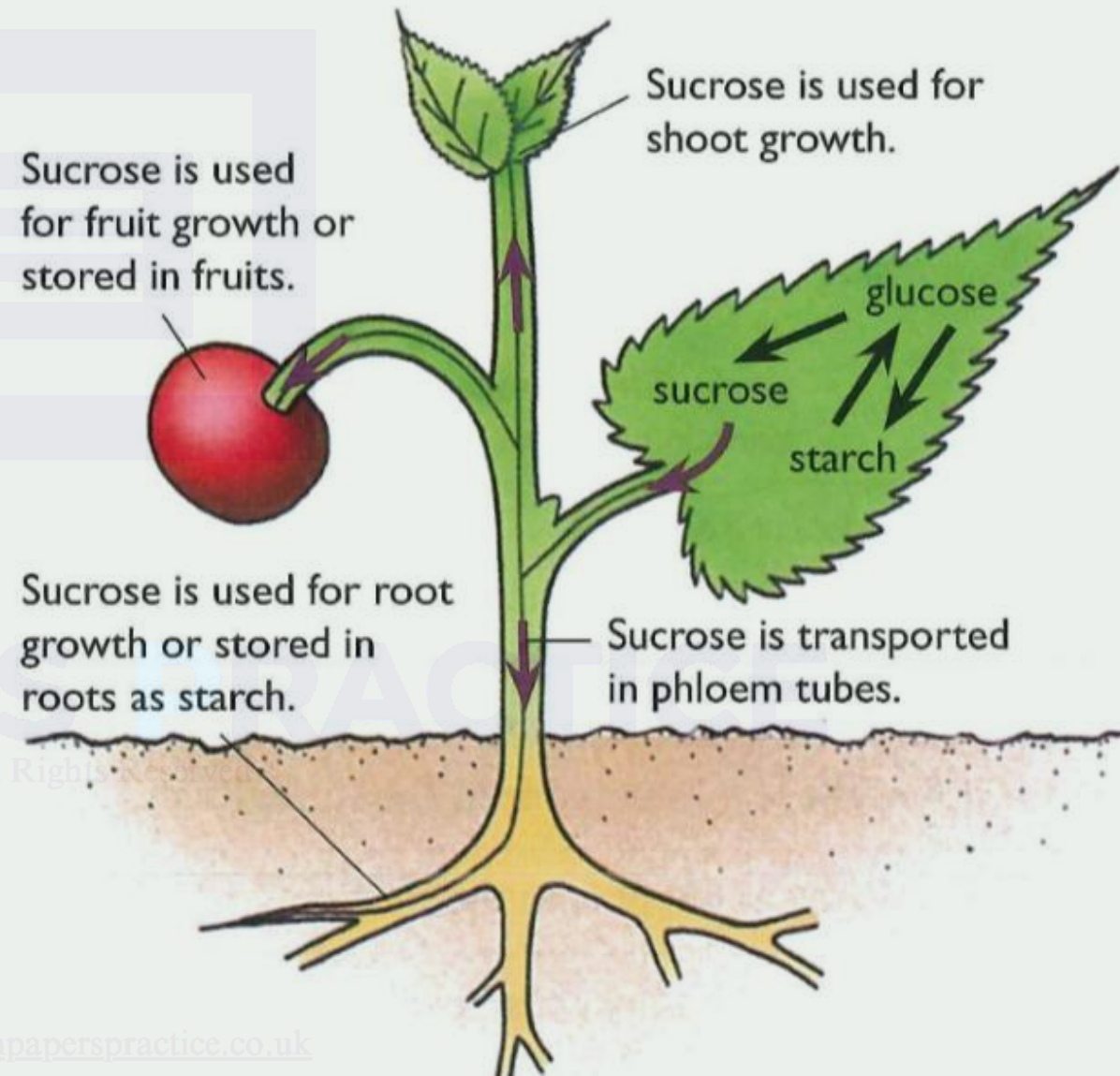
Plant nutrition

Leaf adaptation



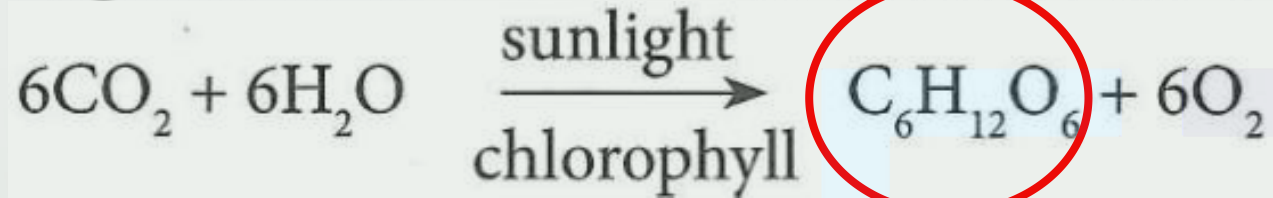
Used to make proteins and other organic substances

Element	nitrogen	magnesium
Mineral salt	nitrates or ammonium ions	magnesium ions
Why needed	to make proteins	to make chlorophyll
Deficiency	weak growth, yellow leaves	yellowing between the veins of leaves

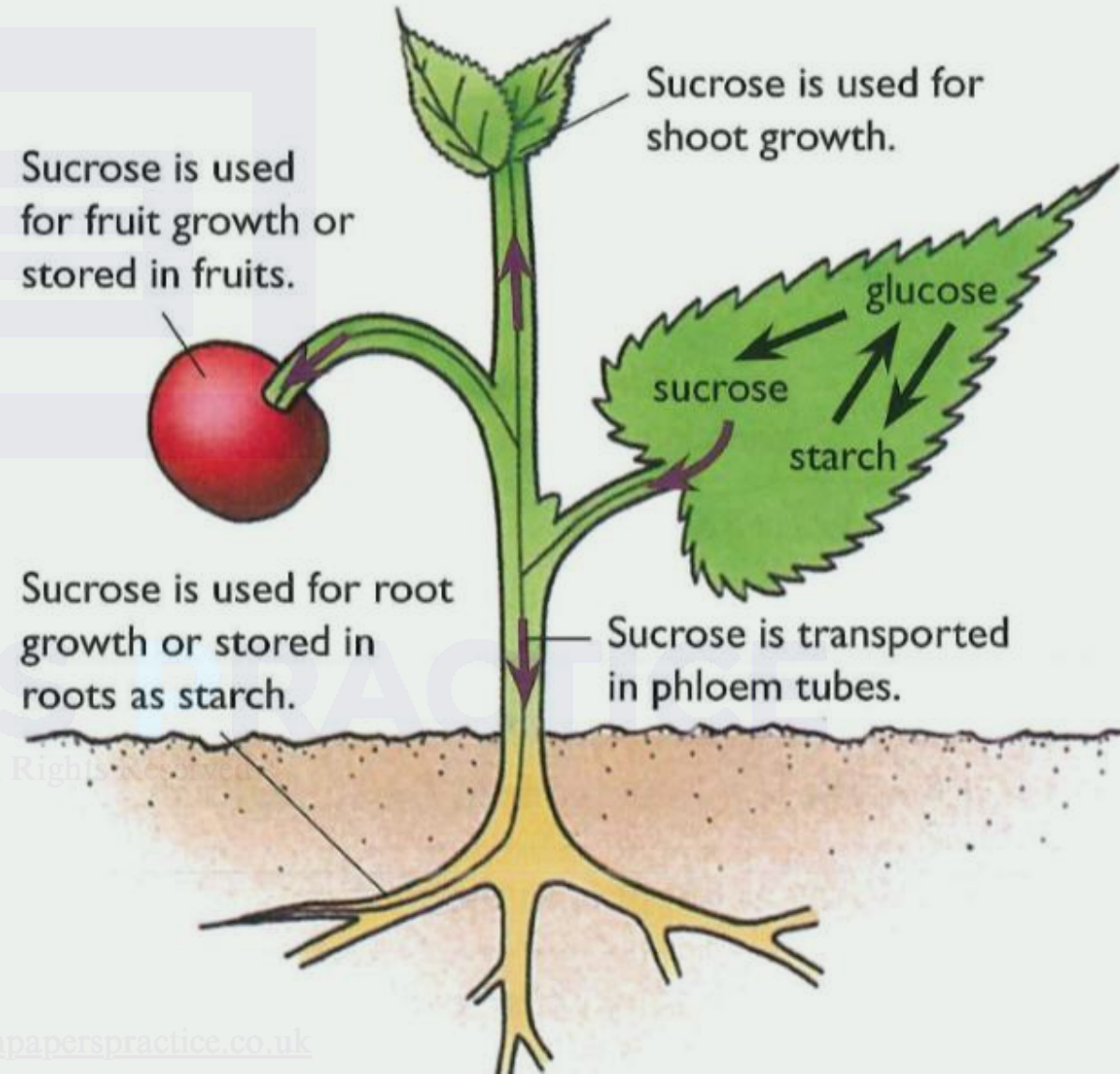


Plant nutrition

Leaf adaptation

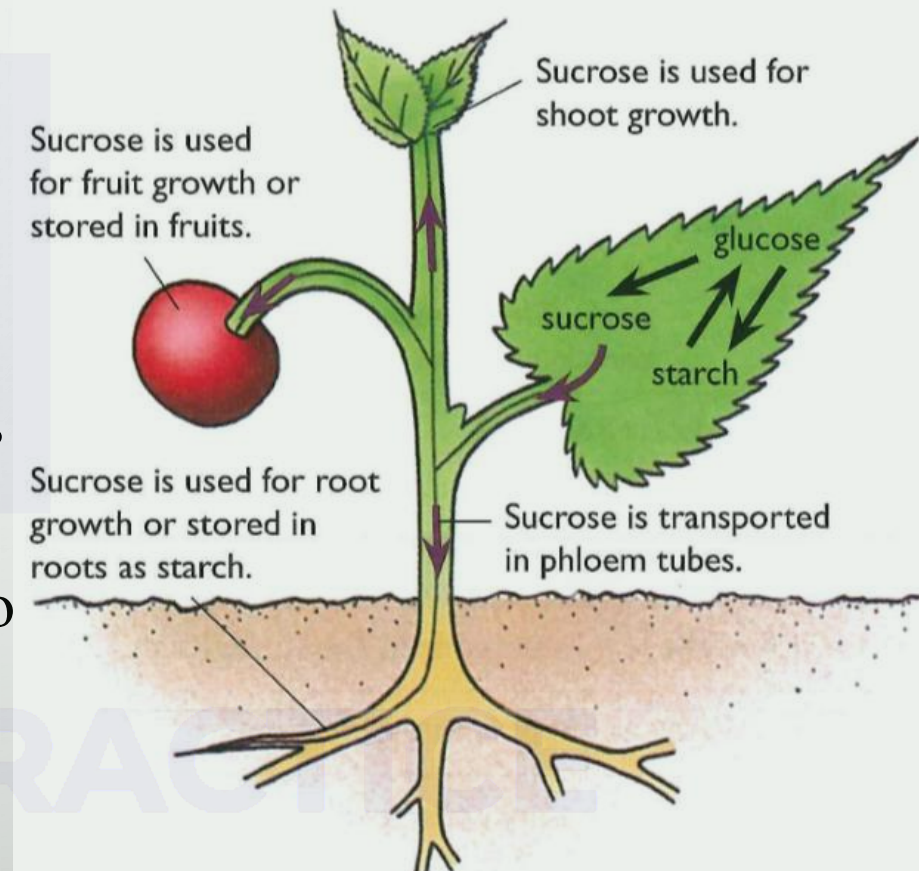


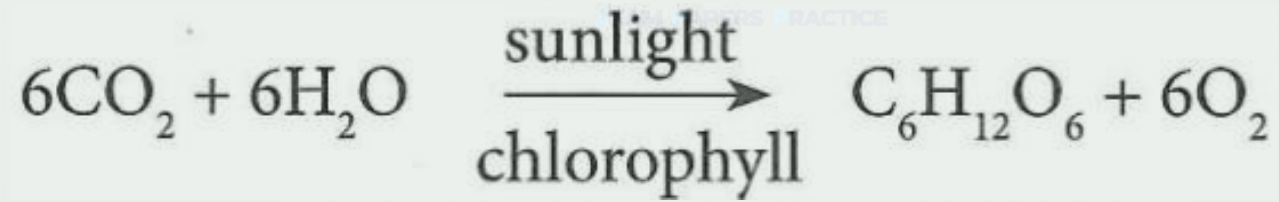
Changed to sucrose for transport



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- ♠ why is glucose not very good for storage in a leaf?
- ♠ what substances does a plant need to be able to convert glucose into proteins?
- ♠ explain why a plant that does not get enough nitrate has weak growth?
- ♠ how do parts of the plant such as the roots, which cannot photosynthesis, obtain food?





How to test whether light is needed for photosynthesis?

How to test whether chlorophyll is needed for photosynthesis?

How to know whether photosynthesis happen?

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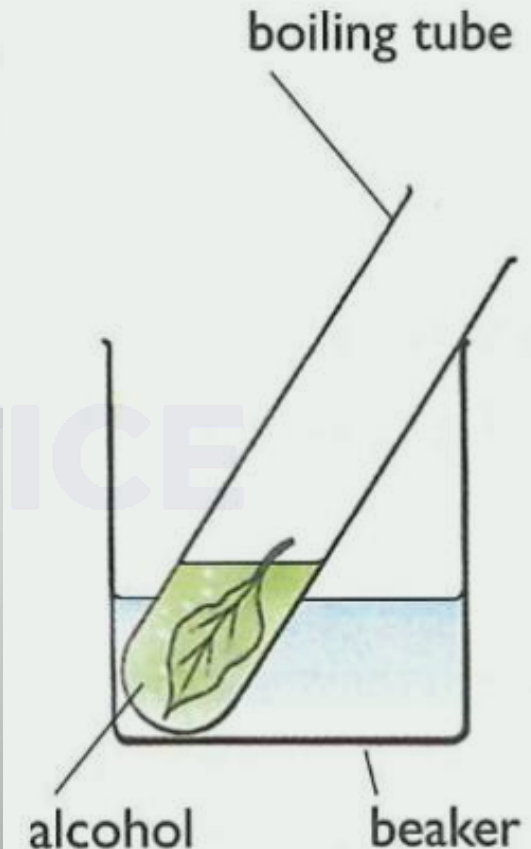
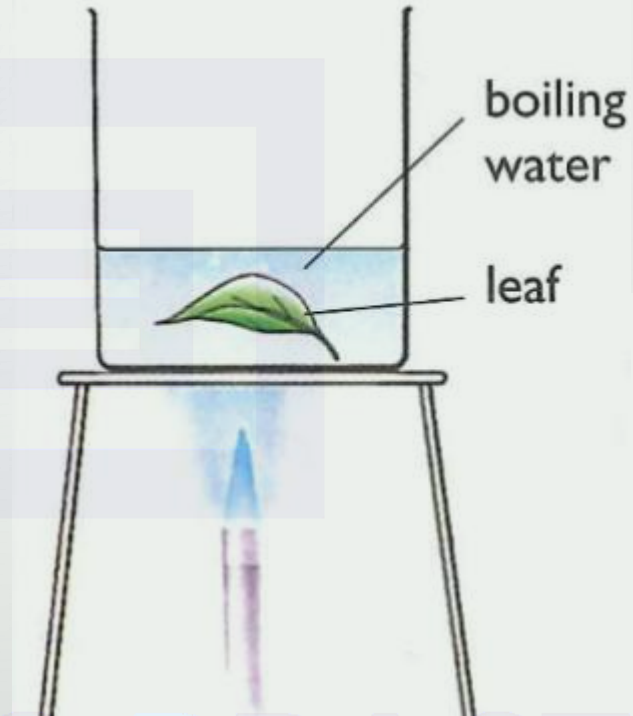
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Plant nutrition

Test photosynthesis

Testing leaves for starch

- ✦ take a leaf from a healthy plant, and drop it into boiling water in a water bath.
(break down cell membrane)
- ✦ remove the leaf, and drop it into a tube of alcohol. (remove chlorophyll)
- ✦ remove leaf from the alcohol, and dip it into hot water again (to soften leaf)
- ✦ spread out the leaf on a white tile, and cover it with iodine solution.



Plant nutrition

Test photosynthesis

To see if light is needed for photosynthesis

- ✦ take a healthy plant, growing in a pot. Leave it in a cupboard for few days, to **destarch** it.
- ✦ test one of its leaves for starch, to check that it does not contain any.
- ✦ using a folded piece of **black paper or aluminium foil**. Fasten the paper or foil over both sides of a leaf on plant. (**shade light**)
- ✦ leave the plant near a warm, sunny window for a few days.
- ✦ remove the cover from your leaf, and **test the leaf for starch**.



destarch 脱浆, 去淀粉 **aluminium foil** 铝箔

To see if chlorophyll is needed for photosynthesis

✻ destarch a plant with **variegated** (green and white) leaves. Then leave plant in a warm, sunny spot for few days.

✻ test one of the leaves for starch



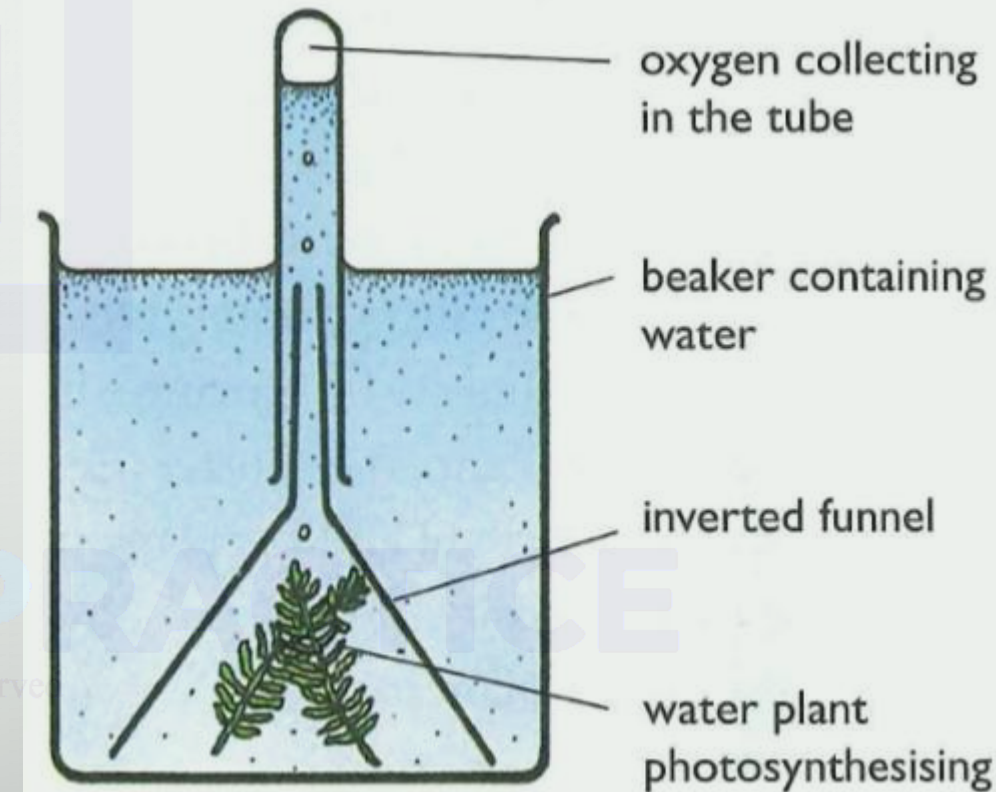
variegated 杂色的

Plant nutrition

Test photosynthesis

To see the rate of photosynthesis (oxygen)

- ♣ set up the apparatus shown in the diagram. Make sure that the **test tube is completely full of water**.
- ♣ leave the apparatus near a warm, sunny window for a few days.
- ♣ carefully **remove** the test tube from the top of the **funnel**, allowing the **water to run out**, but not allowing the **gas to escape**.
- ♣ light a **wooden splint**, and then blow it out so that it is just glowing. Carefully put it into the gas in the test tube. If it **bursts into flame**, then the gas is **oxygen**.



funnel 漏斗
wooden splint 木条

How to investigating the effect of light intensity on photosynthesis

@ hypothesis

should be one sentence, it should describe the relationship that you think exists between light intensity and the rate of photosynthesis

@ design experiment

what apparatus and other materials will you need?

what will you vary in experiment? How will you vary it?

what will you keep the same? How will you do this?

what will you measure in your experiment? When will you measure it?

Will you do repeat measurement and calculate a mean?

how will you record you results?

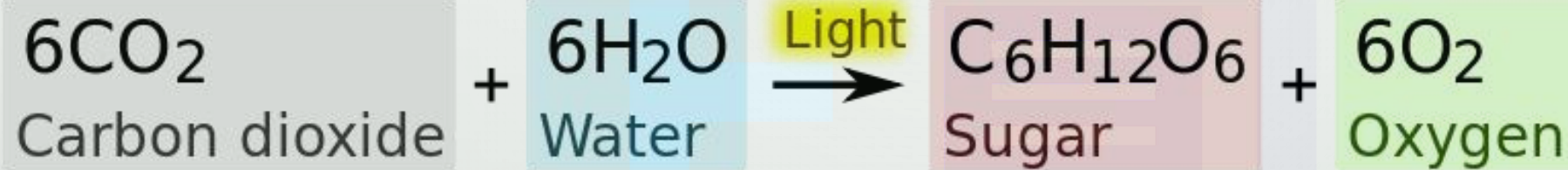
how will you display you results?

what will your results be if your hypothesis is correct?

variegated 杂色的

Plant nutrition

Limiting factors



Limiting factors

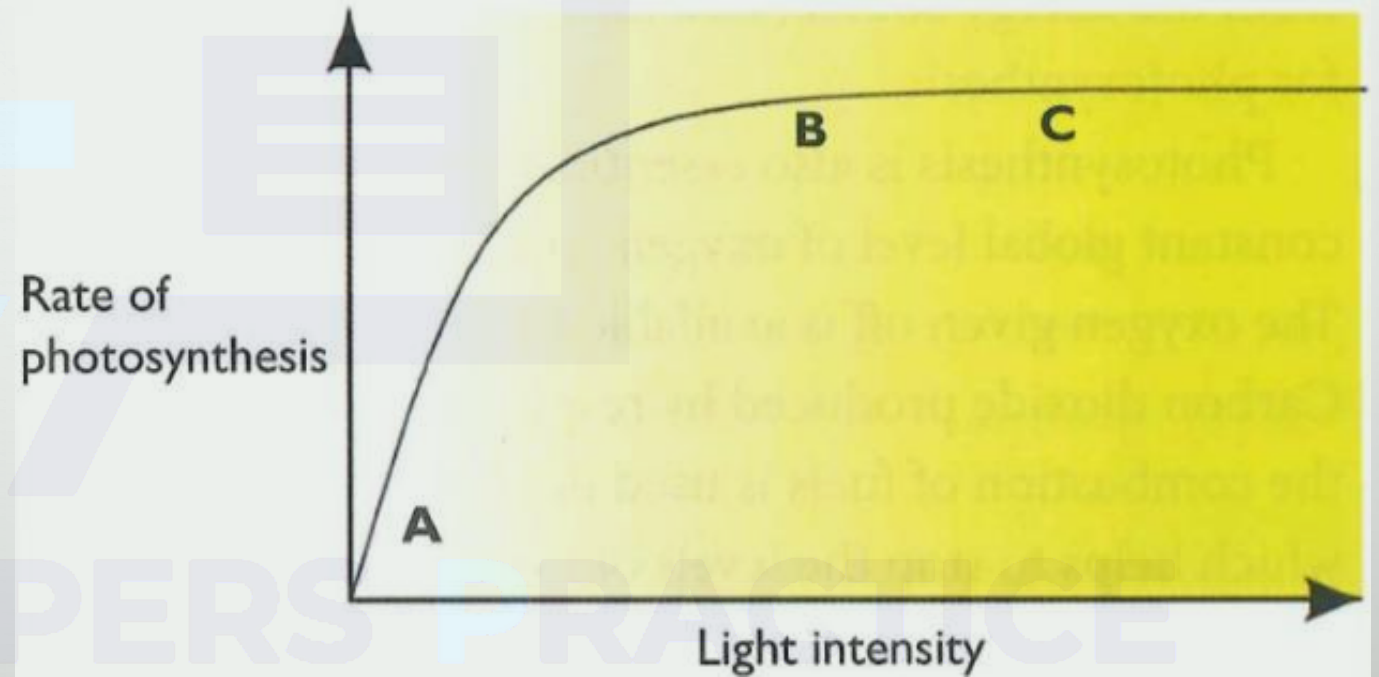
Something present in the environment in such **short supply** that it **restricts** life process.

sunlight
carbon dioxide
temperature
stomata

limiting factor 限制性因素

Sunlight (light density)

- ♣ between A and B
Light **is** a limiting factor
- ♣ between B and C
Light **is not** a limiting factor



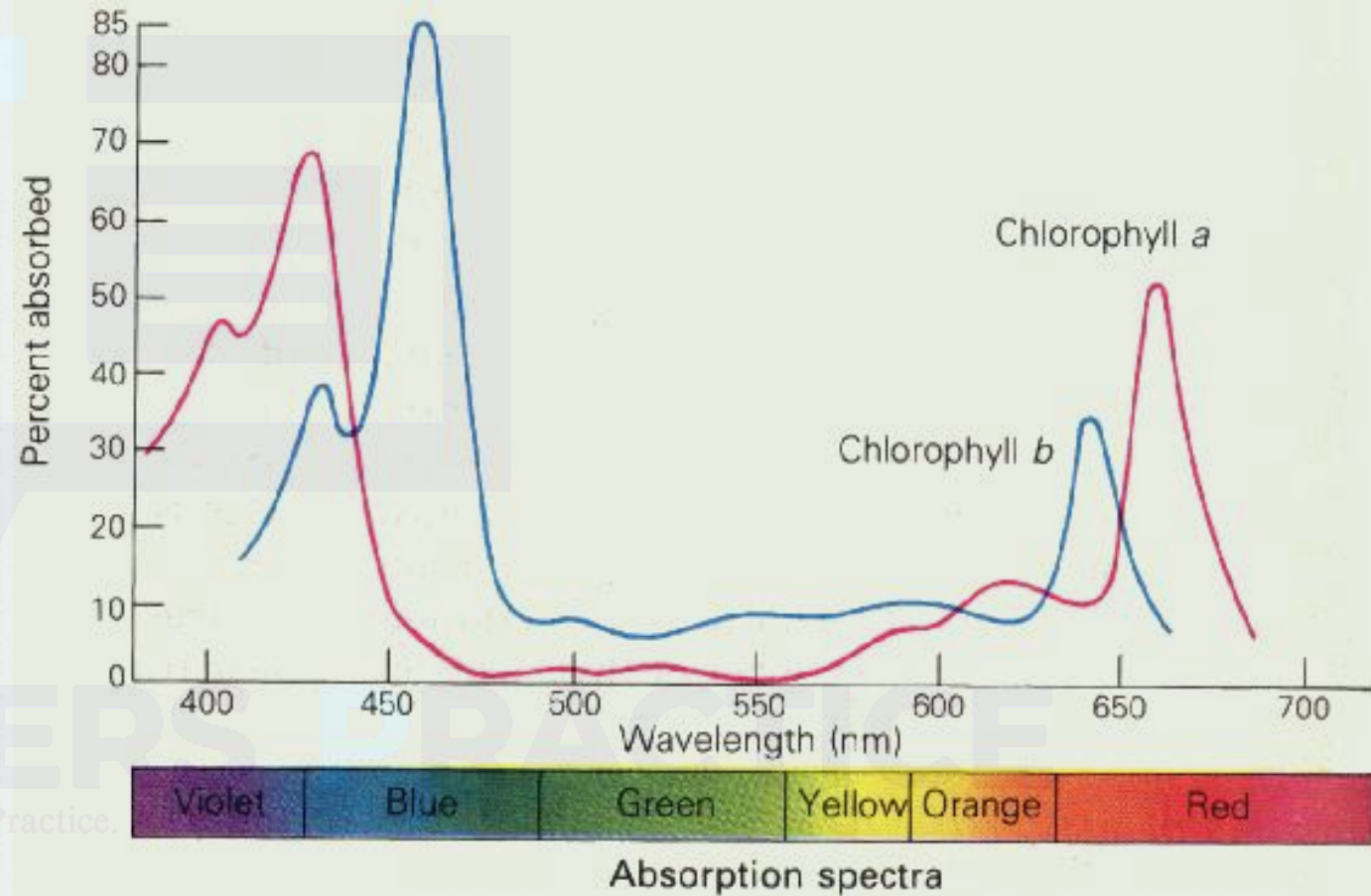
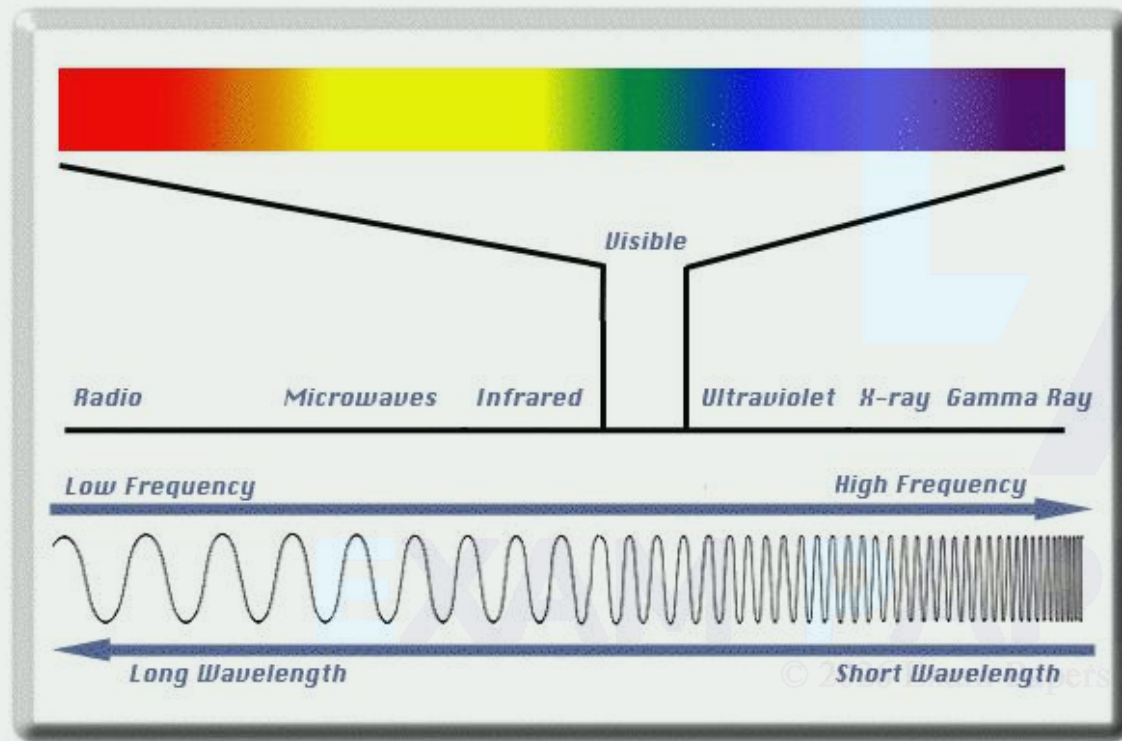
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limiting factor 限制性因素

Plant nutrition

Limiting factors

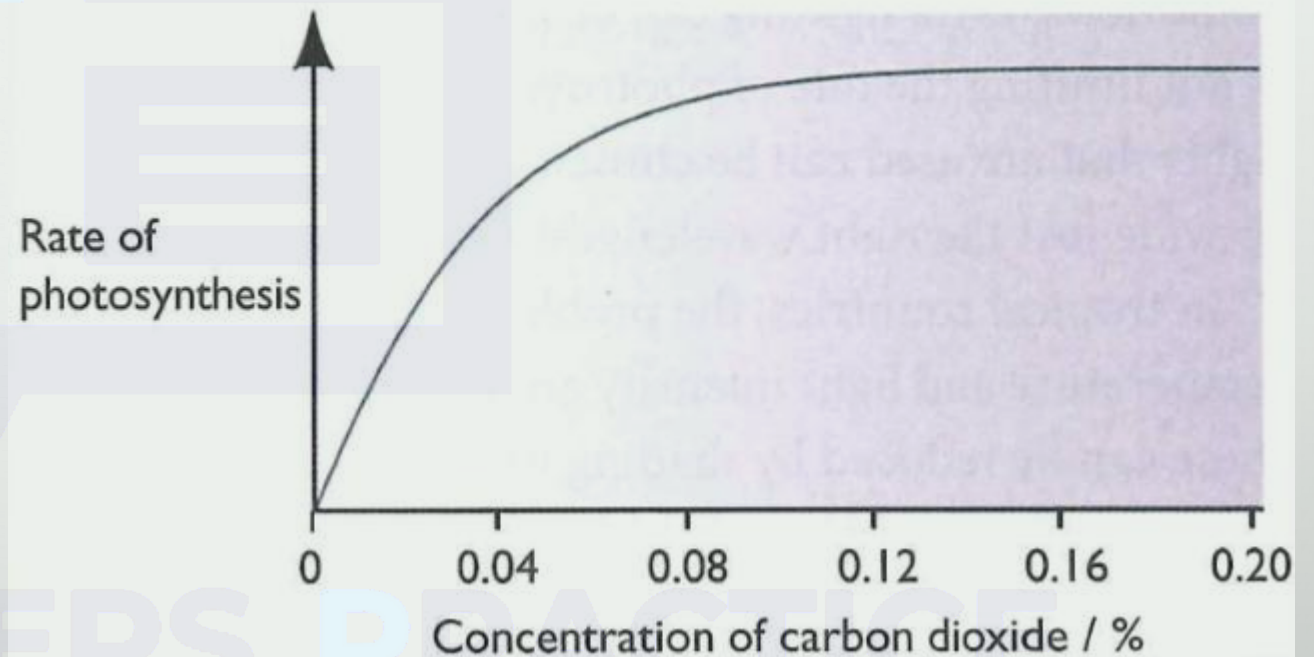
Sunlight (light quality)



Light quality 光质

Carbon dioxide

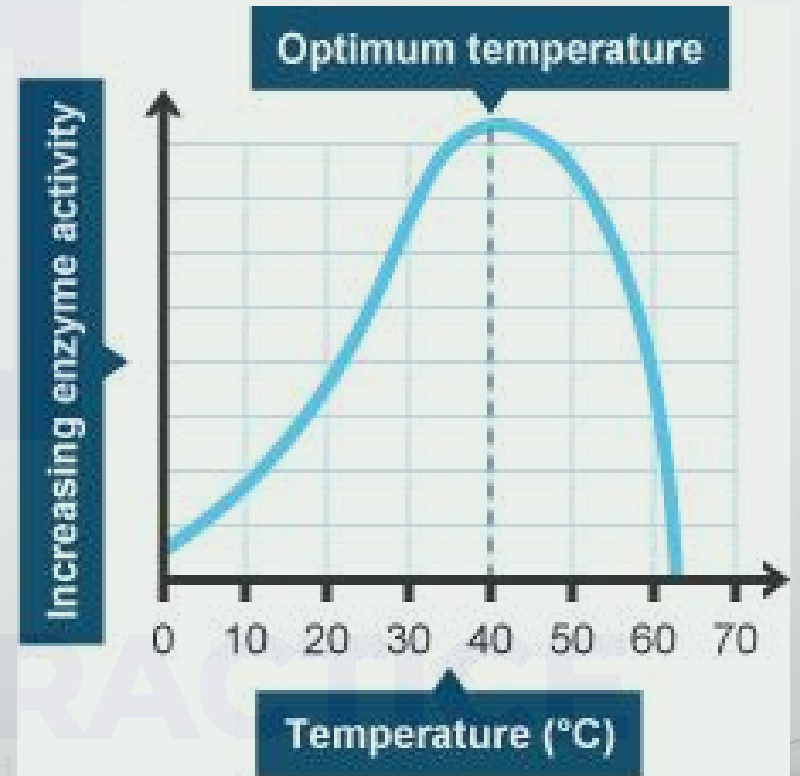
- ♣ between A and B
Light **is** a limiting factor
- ♣ between B and C
Light **is not** a limiting factor



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Temperature

A plant can photosynthesis faster on a warm day than on a cold one.



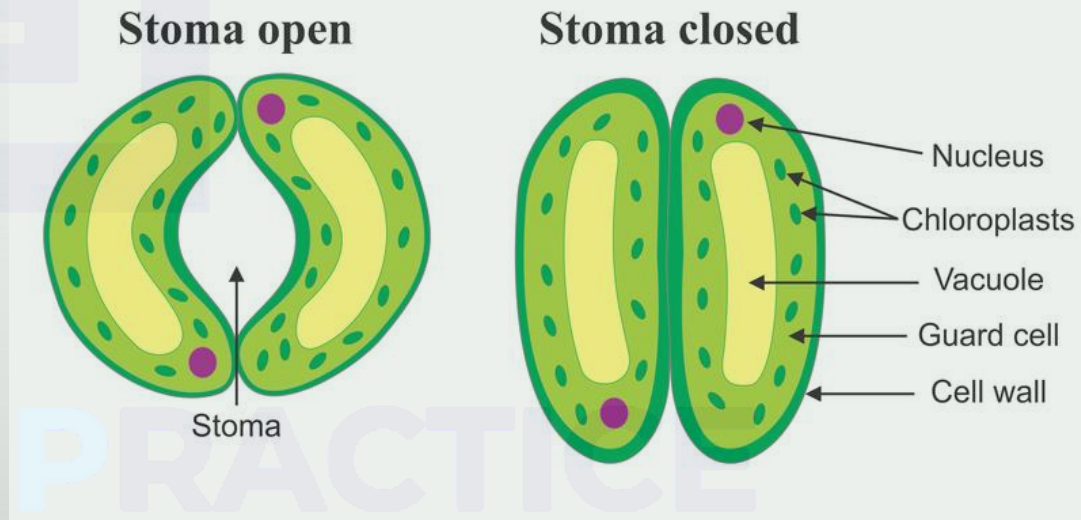
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stomata

stomata often close if the weather is very hot and sunny, to prevent too much water being lost.

→ can not obtain enough carbon dioxide

→ photosynthesis may slow down



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Plant nutrition

Limiting factors

Growing crops in glasshouses

- ♣ the temperature can be kept at the optimum level
- ♣ in cloudy or dark conditions, **extra lighting** can be provided.
- ♣ provide that the right **wavelengths**
- ♣ if **temperature and light intensity** are too high. These can be reduced by **shading** the plants.
- ♣ if carbon dioxide concentration is too low. Provide extra carbon dioxide.

greenhouse/ glasshouse



Photosynthesis

Bring the energy of the sun into ecosystem (the flow of energy in ecosystems is one-way)

Is essential for maintaining a constant global level of oxygen and carbon dioxide.

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