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## **Theme: Nutrition in plants and animals**

### **S2 New Curriculum Biology-Chapter 4 – Nutrition in plants**

## **Autotrophic Nutrition**

This is the synthesis of organic compounds from inorganic sources.

There are two types autotrophic nutrition.

- (a) Chemosynthesis: is the synthesis of organic compounds from carbon dioxide and water using energy from oxidation of inorganic materials such as hydrogen sulphide, ammonia and iron II.
- (b) Photosynthesis is the synthesis of organic compounds from carbon dioxide and water using energy from light.

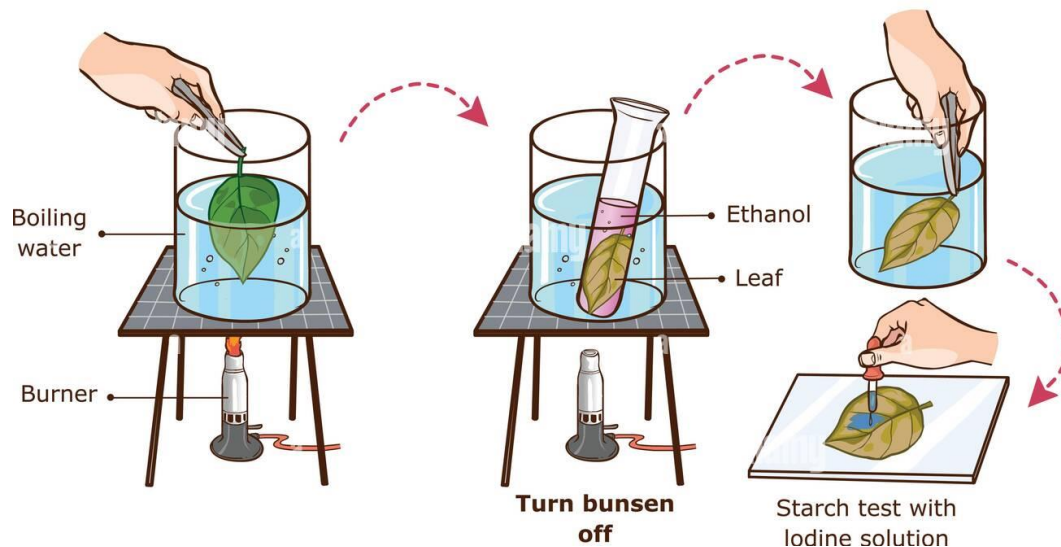
### **Importance of Autotrophic nutrition**

1. Sugars resulting from autotrophic nutrition constitute structures of plants and animals
2. Sugars obtained from autotrophic nutrition are source of energy
3. Hyman depend on photosynthesis for energy containing fuel, which have developed over millions of years
4. Photosynthesis maintains a constant concentration of carbon dioxide and oxygen in atmosphere. Oxygen is added to atmosphere as a result of photosynthesis while carbon dioxide is removed.

### **Testing for starch in leaves**

- (i) Dip a leaf in boiling water for a few minutes to kill the cells.
- (ii) Then boil it in alcohol to remove chlorophyll until it is decolorized.
- (iii) Dip the decolorized leaf in warm water to soften it.
- (iv) Lay the soft leaf on a white tile and add drops of iodine solution

## Testing a leaf for starch



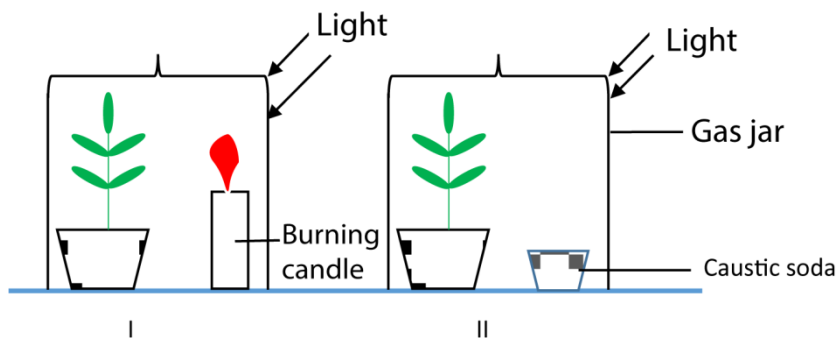
### Observation

When the leaf turns blue/black it indicates presence of starch. When it remains brown, it indicates absence of starch.

### Conditions necessary for photosynthesis

- (a) **Carbon dioxide:** is obtained from the atmosphere and water in case of aquatic plants. It is the source of carbon in carbohydrates.

### Experiment to show that carbon dioxide is necessary for photosynthesis



The experiment is set up as shown above

- Two younger seedling growing in pots are kept in the dark for 3 days (to remove starch) and a leaf from each plant is tested to confirm absence of starch.
  - In experiment I the burning candle supplies carbon dioxide while in experiment II carbon dioxide is absorbed by caustic soda.
  - After 3 hours, a leaf is taken from each plant and tested for the presence of starch. Starch is found in the leaf of experiment I which had carbon dioxide. This shows that carbon dioxide is necessary for photosynthesis.
- (b) Water provides hydrogen that reduce carbon dioxide to form carbohydrates
- (c) Light usually from the sun is the source of energy for photosynthesising tissues.

(d) Chlorophyll: this is a green pigment which helps to trap light energy for photosynthesis.

#### **Experiment to show that chlorophyll is necessary for photosynthesis**

When a variegated leaf is picked from a plant on a sunny day and tested for starch. Starch is found only in parts that originally contained chlorophyll.

(e) **A suitable temperature:** photosynthesis proceed by a series of chemical reactions controlled by enzymes which are sensitive to temperature. By comparing the rates of photosynthesis, at different temperatures, optimum temperatures for various plants are obtained.

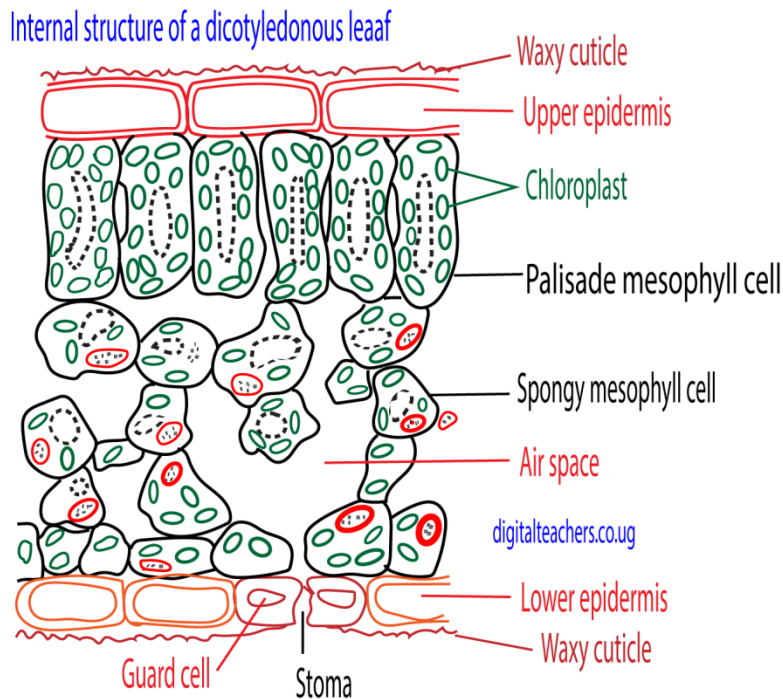
### **The leaf**

In higher plant the major photo synthetic organ is the leaf.



#### **Functions of the leaves**

1. Carry out photosynthesis with subsequent production of organic materials
2. Carry out gaseous exchange through the stomata
3. Transpiration takes place mainly through the leaves resulting in the cooling of plant and absorption of mineral salts and water
4. Some leaves such as those of peas are modified by tendrils for support.
5. Some leaves such as those of bryophyllum are modified for storage
6. Some leaves such as those of bryophyllum are modified for vegetative reproduction
7. Some leaves possess itching hairs, thorns, spikes and poisonous substances for protection of plant.
8. Some leaves e.g. Venus fly trap are modified for capturing and extracting nitrogen from animals
9. Some produce substances that kill parasites.



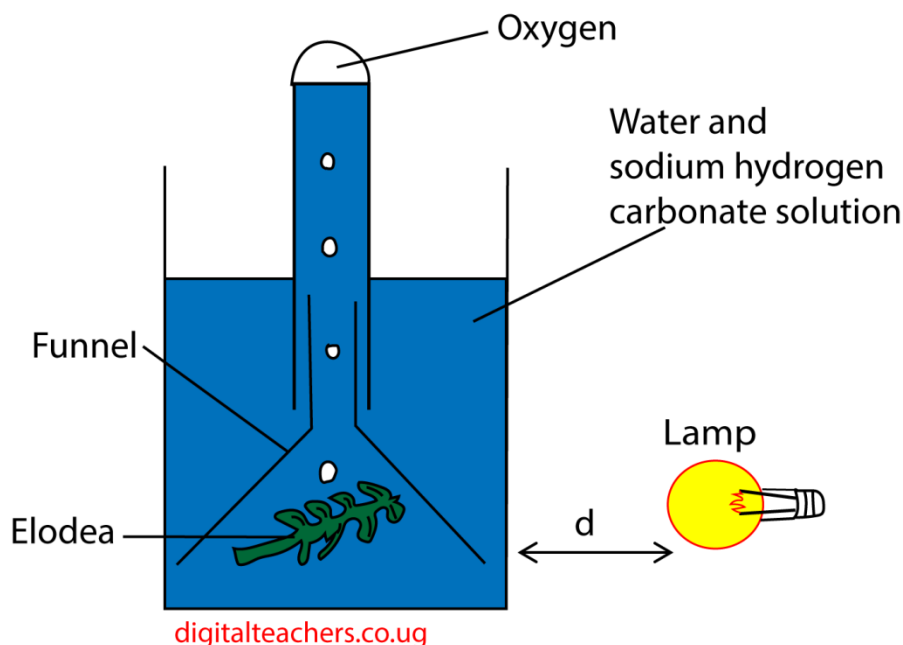
### Functions of tissues in dicotyledonous leaves

Tissue	Structure	Function
1. Upper and lower epidermis	One cell thick External walls covered with cutin (waxy substance) Contain stomata (pores surrounded by guard cells)	<ul style="list-style-type: none"> <li>- Protective</li> <li>- Cutin is water proof and reduce water loss from the leaves</li> <li>- Allow gaseous exchange</li> </ul>
2. Palisade mesophyll	Column-shaped cells with numerous chlorophyll in thin layer of cytoplasm	<ul style="list-style-type: none"> <li>- Main photosynthetic tissue. Chloroplast may move towards light</li> </ul>
3. Spongy mesophyll	Irregular shaped cells fitting loosely to leave large air space	<ul style="list-style-type: none"> <li>- Photosynthetic, but fewer chloroplast than palisade cells. Gaseous exchange can occur through the large air space via stomata.</li> </ul>
4. Vascular tissue	Extensive finely branching network through leaf	<ul style="list-style-type: none"> <li>- Conduct water and mineral salts to the leaf in xylem</li> <li>- Remove photosynthetic products through phloem</li> <li>- Provide a supporting skeleton to the lamina, aided by turgidity</li> </ul>

## Adaptation of leaves to photosynthesis

1. The leaf is only a few cells thick for easy penetration of light and gases.
2. Wax cuticle prevent excessive water loss
3. The palisade cells that contain numerous chloroplasts are well positioned to receive light.
4. Presence of xylem that supply the leaf with water for photosynthesis
5. The spongy mesophyll has many air space. Gases can readily diffuse to all photosynthetic cells
6. They are broad and flat to offer a large surface area exposed to light and air
7. Stomata control passage of gases
8. The arrangement of leaves to the plant is such way that each leaf receives light.

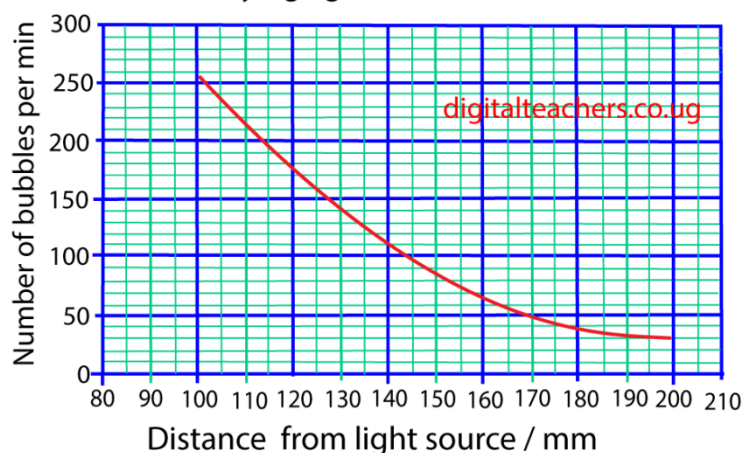
## Measuring the rate of photosynthesis



## Method

- a. The apparatus is filled with carbonated water to enrich it with carbon dioxide.
- b. The setup is allowed to adjust to light intensity for 2-3 minutes. The rate of bubbling should be adequate such as 10 bubbles per minute.
- c. Light intensity is varied by increasing the distance,  $d$ , between the light source and the apparatus such as 10, 15, 20, 40 and 45cm. the bigger the distance,  $d$ , the lower the light intensity.
- d. The rate of formation of bubbles per minute at different distances,  $d$ , is an empirical measure of photosynthesis at a given light intensity.
- e. Temperature change is buffered by using a beaker of bigger capacity.

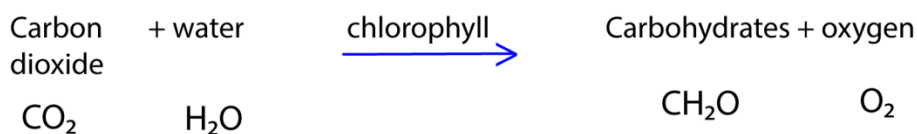
Rate of photosynthesis in *E. Canadensis* with varying light intensities



### Chemistry of photosynthesis

In the process of photosynthesis obtain energy from sunlight is trapped by chlorophyll and used for the manufacture of carbohydrates from carbon dioxide and water.

The process is summarised by the following equation



### Questions

- The following data was obtained from an experiment on the effect of light intensity on the rate of photosynthesis.

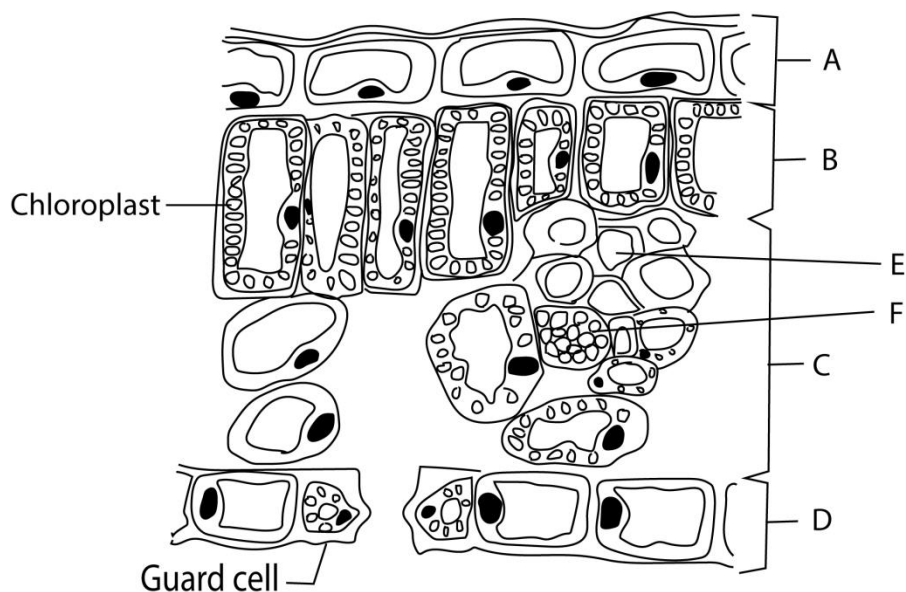
Distance of the test tube from light source	10	20	40	60	80	100
Number of bubbles per minute	15	10	6	4	2	1

- Plot a graph of number of bubbles per minute against distance of the test tube from light source.
  - From your graph, describe the relationship between light intensity and rate of photosynthesis.
- A shoot of water plant was placed in a test tube containing carbonated water. A bench lamp with a shining bulb was placed 25cm away. The set up was connected to syringe. The concentration of oxygen was recorded every after 5minutes. The experiment was repeated but with the lamp placed 5cm away from boiling tube.

The results are given in the table below

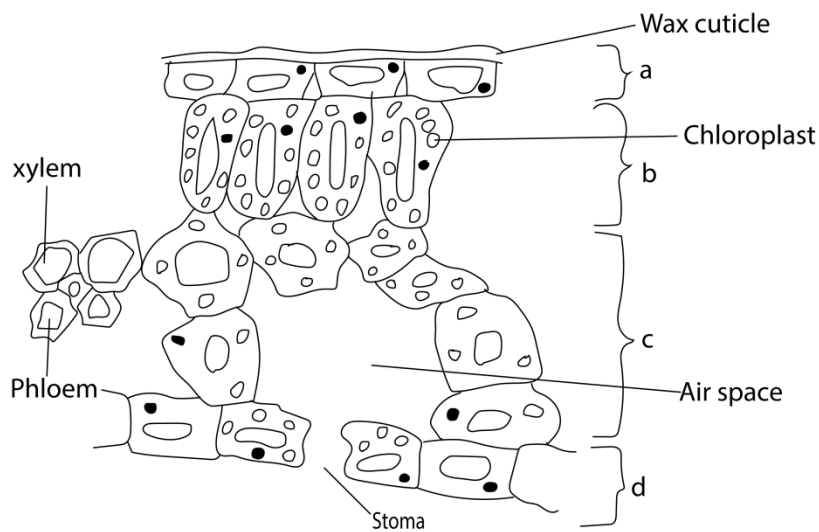
Distance of the lamp/cm	Oxygen concentration after 5 minutes	Oxygen concentration after 10 minutes
25	60	65
5	64	84

- Draw the experiment setup as described above
  - Based on the results of this experiment, explain the effect of light intensity on oxygen production.
  - What process is being investigated when oxygen concentration is measured in the experiment?
    - Why is the measurement of oxygen concentration considered as inaccurate measurement of the rate of the process state in (i)?
  - State the environmental condition that would need to be kept constant.
3. How are plant leaves adapted for photosynthesis.
4. The figure below is a transverse section of a leaf.

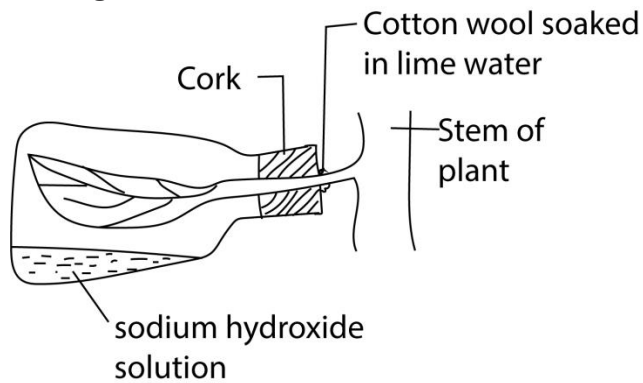


- Name the parts labeled A, B, C and D. (02marks)
- How are cells in layers A, B, and C adapted to perform their function? (3 ½ marks)
- Name the material transported by structures E and F (1 ½ mark)
- From the diagram, state three adaptations of a leaf for uptake of carbon dioxide for photosynthesis. (0marks)

5. The diagram below shows an internal structure of a leaf.



- (a) Label the layer a, b,c, and d on the diagram (02marks)
  - (b) Give three differences between layers b and c, (03marks)
  - (c) Using evidences from the diagram, describe how the structure of a leaf is suited for photosynthesis. (04marks)
  - (d) What is the importance of wax on layer (a)? (01marks)
6. The figure below is an experiment set up to investigate the condition for photosynthesis. The plant is in light but had previously been kept in the dark overnight.



- (a) Which condition is being investigated?(01mark)
- (b) why
  - (i) It was necessary to keep the plant in the dark overnight? (1mark)
  - (ii) Is left attached to the plant? (01mark)
- (c) What is the purpose of sodium hydroxide in the flask? (01mark)
- (d) How would you test for starch after some time? (04marks)

## Answers

### 3. (c)(i) Photosynthesis

(c)(ii) because some produced during photosynthesis may be used for respiration

### (d) Temperature

4. (a) A- upper epidermis

B- palisade layer

C- spongy mesophyll

D- lower epidermis

(b) A – is water tight to prevent drying of photosynthesizing tissues.

- transparent to allow passage of light

- thin to allow penetration of light

B - contains high concentration of light to trap sunlight

- well placed to receive light

- well packed to maximize space and expose each cell to receive light

C - cell loosely packed to allow easy flow of gases

- contain chlorophyll to trap light for photosynthesis

(c) E - water

F - manufactured food

(d) - contain xylem to supply water for photosynthesis

- phloem transport manufactured food

- stoma allows gaseous exchange

- chloroplasts trap light energy for photosynthesis

- spongy mesophyll has many air spaces for gaseous exchange

- the leaf is a few cell thick to allow penetration of gases and light

5. (a) a- upper epidermis

b- palisade layer

c- spongy mesophyll

d- lower epidermis

(b) Differences between layer b and c

Layer b	Layer c
High number of chloroplast	Low number of chloroplast
Small air space	Big air space
Cell elongated	Cells irregularly shaped

- (c)
- contain xylem to supply water for photosynthesis
  - phloem transport manufactured food
  - stoma allows gaseous exchange
  - chloroplasts trap light energy for photosynthesis
  - spongy mesophyll has many air spaces for gaseous exchange
  - the leaf is a few cell thick to allow penetration of gases and light

(d) reduce water loss

6 (a) carbon dioxide

(b)(i) to remove starch from the leaves

(ii) to enable the leaf to obtain water

(c) To absorb carbon dioxide

(d) Testing for starch in the leaves

- A leaf is boiled in water to kill protoplasm and burst starch granule present
- Then, it is boiled in alcohol to remove chlorophyll
- Then, it is dipped in hot water to soften it
- Iodine is applied on a white tile
- The leaf is washed with water
- Parts that contain starch remain blue

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Thanks

**Dr. Bbosa Science**