Biology revision notes.

Photosynthesis.

Brief notes- OUTLINE.

Photosynthesis = The process that makes food (glucose) in plants.

- It takes place in the green leaves of plants.
- Sun light is very essential and is taken in by the green pigment in plants: Chlorophyll.
- Chlorophyll is in the chloroplasts. Chlorophyll changes the light energy from the sun to chemical energy.
- The raw materials = ***carbon dioxide*** and ***water.***
- The products = ***glucose*** (***which is later turned into other substances like starch)*** and ***oxygen.***

- The word equation =

carbon dioxide + water $\xrightarrow{\text{sun light energy absorbed by chlorophyll}}$ glucose + oxygen

or the chemical equation:

$$6CO_2 + 6H_2O \xrightarrow{\text{sun light energy absorbed by chlorophyll}} C_6H_{12}O_6 + 6O_2$$

Experiments for photosynthesis:

- Iodine shows if starch is present.
- The factor/thing we want to investigate is taken away from the plant.
- We use a control as a comparison. This is a plant that is given normal conditions INCLUDING the factor we are investigating.

Detailed notes:

Plants make their own organic food such as starch, but *how do they do it?????*

Experiments:

What does a plant need for photosynthesis??

Experiments to show factors needed for photosynthesis:

(1) Remove all starch from leaves of plant (de -starch). (Put it in the dark for a few days)

(2) Give the plant everything it needs apart from the factor we're investigating.

(3) Do starch test on the leaves to see if it has been making starch.

- ⇒ **If plant did not produce any starch it means there was no photosynthesis meaning that the factor we were investigating *is needed* for production of starch/photosynthesis to take place.**
- ⇒ ***No starch = factor is needed for photosynthesis.***

The individual experiments:

To see if photosynthesis has taken place you use the starch test:

The starch test:

(1) Boil leaf in water to kill it.
(2) Boil leaf in ethanol to remove chlorophyll.
(3) Wash leaf in water to soften the leaf.
(4) Cover with iodine solution to stain starch.

(1) Do plants need carbon dioxide to make starch??

We remove carbon dioxide from the air surrounding a plant using soda lime while another (the control) has carbon dioxide. We then test the leaves of both the plants with iodine to see if any starch was made.

(2) Do plants need chlorophyll to make starch??

It's impossible to remove chlorophyll from a leaf without kill ing it!!!!
So we have to use a plant that has **variegated** leaves.

⇒ These are plants which have parts that are green (contain chlorophyll) and parts that aren't (***don't*** contain chlorophyll).

Examples of plants with variegated leaves: Hibiscus and certain types of ivy.

So we carry out a starch test on a variegated leaf.

(3) Do plants need light for making starch??

1 plant in the dark, control in the light for a few days.
Do starch test.
OR
Cover part of a leaf with black paper and leave rest of plant i n light.
Do starch test on covered leaf.

(4) Do plants need water to make starch??

No simple experiment. Taking away water kills plant.

What does photosynthesis produce??

(Apart from* starch *what else* is produced in the process *of* photosynthesis??*)

Is oxygen produced during photosynthesis??

Joseph Priestly's experiment (in 1771).

Joseph Priestly did an experiment to answer the question above.

The experiment:

(1) A lit candle is placed in a sealed chamber. The candle goes out quickly.
(2) **A sprig of mint in a jar of water is put into the chamber without any air being let in.**
(3) **It is left in the light.**
(4) **After about 10 days the candle burns again.**

Conclusions from experiment:
This experiment shows that oxygen is produced from photosynthesis.
The candle, when put into the sealed chamber, quickly used up the oxygen. When the mint was added it obviously produced oxygen so that the candle could burn again.

⇒ ***Plants give off oxygen!***

Another experiment to find out if plants give off oxygen:
Use Elodea or Hydrilla (plants that produce bubbles when put in the light).The bubbles that the plant gives off can be collected and tested for oxygen.

So, what happens during photosynthesis??

The experiments above all show that plants need:

- Carbon dioxide
- Water
- Light
- Chlorophyll

} **raw materials**

for photosynthesis and produce:

- Starch (originally glucose)
- Oxygen.

} **products**

The rate of photosynthesis.

What controls the rate of photosynthesis??

⇒ ***Four factors*** affect the rate of photosynthesis:

- ***Light***
- ***Carbon dioxide***
- ***Temperature***
- ***Water.***

When one of these limits the rate of photosynthesis the factor is called the "Limiting factor".

At any one time one of the four factors must be stopping the photosynthesis going faster. On warm, bright days carbon dioxide is the limiting factor and on cool, dull days temperature or light may be limiting factors.

Light:

We can find the affect of light intesnsity on the rate a plant photosynthesises by using a plant that produces bubbles in light (e.g.: elodea).
When the light is brighter more bubbles are produced meaning the photosynthesis is faster.

Rate of photosynthesis = ***Volume of gas or no. of bubbles /time***

⇒ **In general: the *brighter the light, the faster the rate of photosynthesis.***

***BUT:* If a plant has too bright a light on it then photosynthesis can slow down. (Bright light contains a lot of UV light which can damage a plant.)**

Carbon dioxide:

⇒ **The higher the concentration carbon dioxide, the faster the rate of photosynthesis.**

There is **0.04 %** CO_2 in the atmosphere which doesn't vary much, but it can.

Temperature:

⇒ **In general: the higher the temperature, the faster the rate of photosynthesis.**

***BUT:* If the temperature goes above about 40 º C then the enzymes related to the chemical reactions of photosynthesis are denatured which slows down the photosynthesis rate.**

Water:

A plant lacking water will photosynthesise at a slower rate.
Mainly because its stomata are closed.

Measuring the rate of photosynthesis:

Use a plant that produces bubbles (e.g. elodea). Put it in water in a test tube.

Rate of photosynthesis = **volume of gas / time** or **no. bubbles / time**

The leaf.

The internal structure of the leaf.

- ***Waxy cuticle*** **on top of leaf so it's water-proof (prevent water loss).**
- **Lined above and below by the *epidermis.* *(Upper and lower)***
- **In between = lots of cells which make up the *mesophyll.***
- **Mesophyll is divided into the *palisade mesophyll* (above) and the *spongy mesophyll* (below).**
- **The palisade mesophyll is tightly packed together whereas the spongy mesophyll contains large air spaces.**
- **In middle of leaf = vascular bundle-contains two main types of vessel: *xylem vessels* (top) and *phloem vessels* (below)**
  - ⇒ **The xylem vessels transport water**
    The phloem vessels transport glucose.
- **There are stomata under the surface of the leaf. They open during the day to let in carbon dioxide and let out oxygen and close during the night to stop water loss.**

SEE A DIAGRAM!

Questions about the structure of the leaf.

Why do the mesophyll cells contain chloroplasts??
Photosynthesis takes place in the mesophyll cells.
Both the spongy mesophyll and the palisade cells contain chloroplasts for photosynthesis. But there are more chloroplasts in the palisade cell so photosynthesis mainly takes place here.

Why do leaves have a large surface area?

- ⇒ **Large area to absorb max amount of carbon dioxide from air.**
- ⇒ **Large area to absorb max amount of light energy from sun.**

Why do leaves have pores/stomata?

- ⇒ **To allow gases to pass in and out of leaf.**

Why are leaves thin?

- ⇒ **Small distance for CO2 to diffuse through after entering leaf.**

Why do leaves have veins?

- ⇒ **Skeleton. Hold leaf out flat.**

Why is the upper epidermis covered by a waxy cuticle?
Saves water from evaporating.

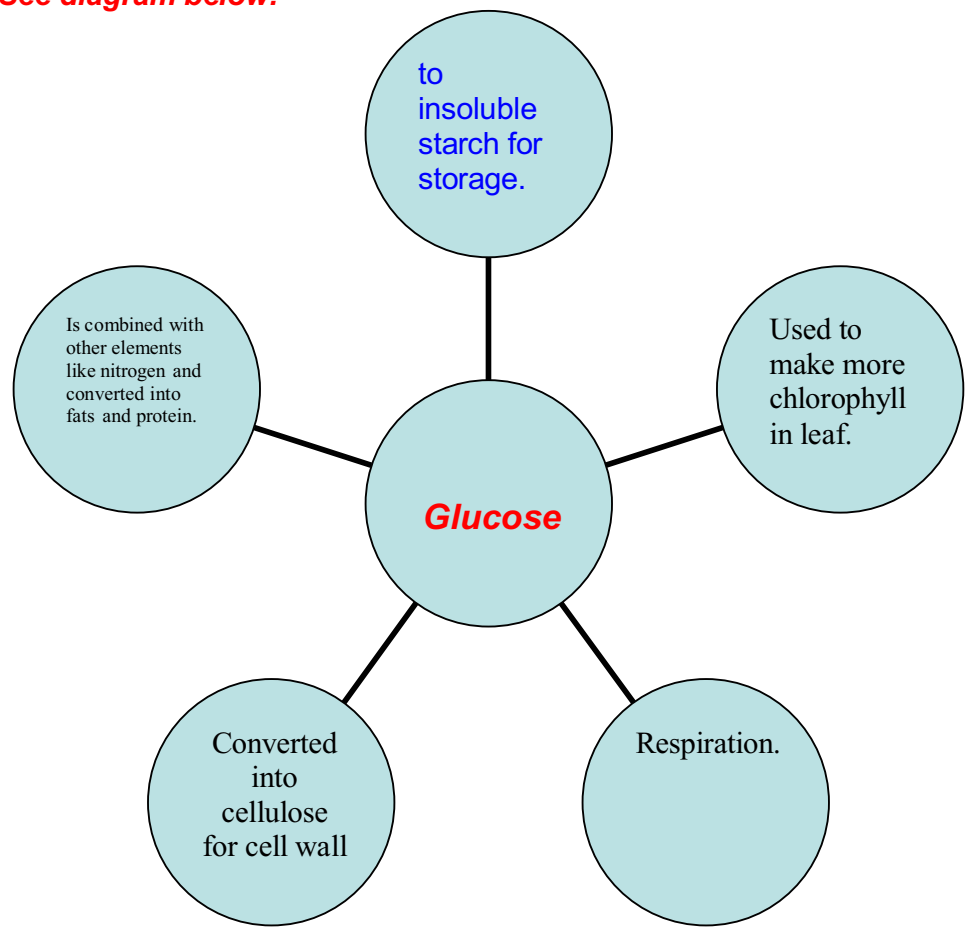
Q. Why are there air spaces between the spongy mesophyll cells?
A. So CO2 can diffuse readily through stomata into these spaces.

What next????

Q. What happens to the glucose the leaf makes?
A.
It is either stored as starch or converted to another type of sugar: sucrose.

- ***Some is converted into starch and stored.***
- ***Some is broken down straight away in to sucrose to provide energy for leaf to produce more chlorophyll.***
- ***Some is converted to cellulose which is needed to support the plant .***
- ***The rest is converted to sucrose and sent to other parts of the plant through the phloem vessels for energy or to be stored there.***

See diagram below!



Other notes:

- ***Concentration of gases in the air:***

20% Oxygen
79% Nitrogen

0.04% Carbon dioxide.

- Chemicals in plants:
    - **Cellulose** (insoluble)
    - **Starch** (insoluble)
    - **Glucose** (monomer) – soluble.
    - **Sucrose** (sugar) – made up of glucose and fructose molecules.
    - ~~**Glycogen –**~~ ***NOT IN PLANTS*** only in mammals and yeast.

Wise up:

- Photosynthesis is a chemical reaction occurring in the leaves of green plants.
- Using the energy from sunlight and converting it into chemical energy, chlorophyll changes carbon dioxide and water into glucose and oxygen.
- Oxygen is a 'waste' product of photosynthesis.
- Glucose can be converted to sucrose and carried to other parts of the plant in ***phloem vessels.*** Glucose can also be converted into starch and stored (the starch can be later turned back into glucose and used in respiration).

Respiration.

- Respiration is the process in all living cells which releases energy from glucose to do work.

- There are ***two types*** of respiration:
  - ⇒ Aerobic respiration
  - ⇒ Anaerobic respiration

Aerobic respiration.

Aerobic respiration needs plenty of oxygen and releases all the energy in the glucose.

Word equation:

Glucose + oxygen ⟶ Carbon dio xide + water (+ energy)

Chemical equation:

$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$

Anaerobic respiration.

Anaerobic respiration can happen without oxygen, but very little energy is released.

In humans it often happens during vigorous exercise wh en muscles can't get enough oxygen (are demanding more oxygen than can be provided).

Word equation:

Glucose ⟶ Lactic acid (+ a little energy)

Chemical equation:

$C_6H_{12}O_6 \longrightarrow$

Lactic acid is a mild poison and causes cramps and stitches during exercise. After exercise we pant because we need to take in oxygen to break down the lactic acid produced during respiration.

In yeast anaerobic respiration is called ***fermentation.***

The end products are a little energy, alcohol /ethanol and carbon dioxide.

Word equation:

Glucose ⟶ alcohol + carbon dioxide (+ energy)

$C_6H_{12}O_6 \longrightarrow C_2H_5OH + CO_2$

The differences between photosynthesis and respiration:

Photosynthesis only occurs in the day (when there's light).
Respiration happens all the time!!!!!

They are the opposite way round to eachother!!!!

P: Happens only in daylight
R: Happens all the time!
P: Uses CO2 and water
R: Uses O2 and glucose
P: Only happens in plants
R: Happens in all living things

Everything I know about photosynthesis.

Photosynthesis is the process by which plants make their own food from Carbon dioxide from the air and water from the soil.

The equation for this process is:
Carbon dioxide + water → Glucose + oxygen

Chemical equation =
$CO_2 + H_2O \rightarrow C_6H_{12}O_6 + O_2$

Chlorophyll is vital for photosynthesis to take place. It is a green pigment found in chloroplasts. Chlorophyll absorbs light from the sun which changes to chemical energy which drives the reaction of photosynthesis.

Photosynthesis takes place in the mesophyll cells, mainly in the palisade cells as there are more chloroplasts here.

For photosynthesis to take place there must be:
Water
Carbon dioxide
Chlorophyll
Light

The products are:
Oxygen (waste product)
Glucose.

The glucose a plant produces is:
-Some is converted to sucrose and transported through phloem vessels to other parts of the plant to be used as energy.
Some is converted starch and stored.
-Some is converted in to cellulose and used to support the plant.

The structure of the leaf.

The upper epidermis is covered with a waxy cuticle which stops the water from evaporating.

The leaf is covered by the epidermis at the top and the bottom.

Leaves have a large surface area to expose a large area to th e sun light to absorb a lot of light and to the air to absorb a lot of CO2.
There are stomata so that gases can pass in and out of the leaf.

The mesophyll cell is made up of the palisade mesophyll cell (at the top) and the spongy mesophyll cell (at the bo ttom).

There is a small vein in the middle of the leaf which is made up of two cells the xylem (top) and the phloem (bottom).

Why are leaves so thin?
Leaves are so thin to provide the smallest distance for the CO2 to diffuse through after entering the st omata.

Leaves have veins as a sort of skeleton. The veins hold the leaf out flat.

Experiments.

What is needed for photosynthesis????
Always take these steps for these experiments:
(1) De-starch plant (leave it in darkness for a few days)
(2)

An experiment to find out if light is needed for photosynthesis.

A plant is put in darkness for a few days.
Then the leaf is tested for starch using the starch test.
If starch is not present it means that light is needed for photosynthesis to take place.

An experiment to find out if chlorophyll is needed for photosynthesis.

Impossible to get rid of chlorophyll without killing plant.
Luckily there are plants with variegated leaves. (leaves partly green, partly not) For example: Certain types of ivy.

Leaf is tested for starch.

An experiment to show if CO2 is needed for photosynthesis.

One plant is put in a sealed place with sodium hydroxide solution (to absorb all of CO_2)

Everything I know.
Photosynthesis: The process in which plants make their own food u sing carbon dioxide and water.
Respiration: The process in which living things produce energy from glucose and oxygen.