



# Energy and Growth

BIOLOGY • PLANTS • ENERGY AND GROWTH

## Section 1: Photosynthesis

### • How do plants acquire their nutrition?

Plants are autotrophs, which means they are able to manufacture their food from simple inorganic molecules. They use a chemical process called photosynthesis to manufacture glucose from carbon dioxide and water, obtaining carbon dioxide from the air around them and the water from the soil. This process requires energy from sunlight, which they absorb with the chlorophyll in their leaves. The whole process takes place inside organelles called chloroplasts, and oxygen is produced as a waste gas. The word equation for photosynthesis is:

Carbon dioxide + Water → Glucose + Oxygen

### • Suggested Film

- Photosynthesis

### Extension Question

#### Q1. How are leaves adapted to carry out photosynthesis?

Leaves have large surface areas and their cells are packed with chloroplasts, containing chlorophyll, which is ideal for absorbing sunlight. They are thin, have pores called stomata and air spaces inside - ideal for the rapid diffusion of gases. They also contain a system of veins to bring water and minerals to the leaf and carry away the food that they manufacture to the rest of the plant.

### • What else do plants need to grow?

The process of photosynthesis leads to the formation of glucose, but plants need and are able to create a lot of other biological molecules, which they need to grow and survive. Plants can convert glucose into a wide range of carbohydrates, like starch and cellulose, as well as all the fats, proteins and nucleic acids they need. In order to create some of these molecules plants need a wide range of minerals from the soil, such as nitrates, sulphates and phosphates. These are absorbed by the roots and transported to the leaves where they are used.

### • Suggested Film

- What Plants Need to Grow



Farmers add fertilisers to ensure crops are getting the necessary minerals

### Extension Question

#### Q2. What are fertilisers?

Fertilisers are substances which can be added to soil to enrich its nutrient content. They can be artificially produced or natural organic materials, such as composts and manures. They are regularly used by farmers to increase the growth rate of their crops.

### • What do plants do with the food they make?



The painkiller codeine is extracted from the opium poppy

Plants are able to manufacture all the substances they need to grow, survive and reproduce. These include sugars, starches, cellulose, fats, proteins and nucleic acids. The plant uses these to construct the cells and tissues it needs, and to carry out the essential biological processes of life such as respiration.

Man can take advantage of the wide range of materials that plants produce by growing crops not only for food but for lots of different purposes including materials, fuels and drugs.

#### • Suggested Films

- FactPack: Non-Edible Crops
- Plants and Medicine
- Plants and Medicine: Aspirin

#### Extension Question

##### Q3. Why is photosynthesis so essential to life on Earth?

Plants are producers of food and so they are at the base of almost every food chain on Earth. Without them other organisms would not be able to feed and survive. They are also essential to help maintain a balance of gases in the atmosphere, as they remove carbon dioxide from the air and excrete oxygen.

## Section 2: Plant Transport

### • Why do plants need a transport system?

Plants are multicellular organisms with organs that have specialised functions, such as the leaves, roots, stem and flowers. Different substances need to be transported between these different parts. For example, water and minerals from the soil need to be transported from the roots to the leaves, and substances manufactured in the leaves need to be transported to the roots and flowers. To achieve this, plants have developed a transport system which can move materials far quicker than would happen by diffusion alone.

#### Extension Question

##### Q4. Do plants have a circulatory system like humans?

No, the transport system in plants is very different. Essentially they have two systems: one for transporting water and minerals up from the soil to the leaves, and the other for transporting food substances all over the plant. The two systems are separate from each other and the materials in them are not circulated, but instead simply moved from the source to the site required.

### • How do plants transport water and minerals up from the soil?

The transport system in plants essentially consists of two systems. One transports water and minerals from the soil to the leaves, and it consists of long hollow tubes called xylem vessels. These tubes consist of dead cells and simply provide a route by which water can be easily pulled up the plant. When water evaporates from the leaf it is replaced by water in the xylem vessels in the leaf. This in turn pulls more water up from further down the stem. Ultimately the soil provides water to the plant at the roots, which absorb it through the process of osmosis.

#### • Suggested Film

- Plant Transport

- Root Hairs



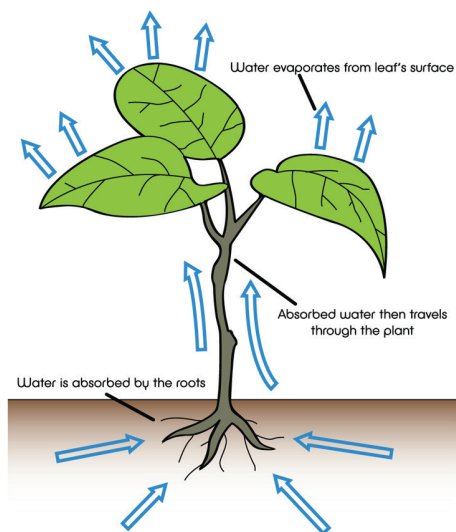
An effective plant transport system helps these tall plants get all the food and water they need

### DIAGRAM 01:



#### Transpiration

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#### Extension Question

Q5. What is osmosis?

Osmosis is simply the diffusion of water across a semi permeable membrane, such as the membranes found in plant and animal cells. Because water is continually being pulled up the stem from the roots, water tends to diffuse into the roots to replace that which has been lost.

### • How do plants transport food substances?

Plants transport manufactured food substances from the leaves to other plant parts through a system of tubes called phloem. There is not a circulatory system, like in humans, but simply a system of tubes taking the materials from the source of production to the site of use. The phloem tubes are packaged together with the xylem vessels in vascular bundles, more commonly called veins. Despite this the two transport systems basically operate in isolation from one another.

Because the phloem vessels are full of food substances, such as sugars and amino acids, many organisms have adapted life strategies to feed on them. For example, many insects have needle-like mouthparts, which can puncture phloem vessels and feed on the contents. Even some plants are able to parasitise other plants by tapping into their transport systems and stealing food, water and minerals!

#### • Suggested Film

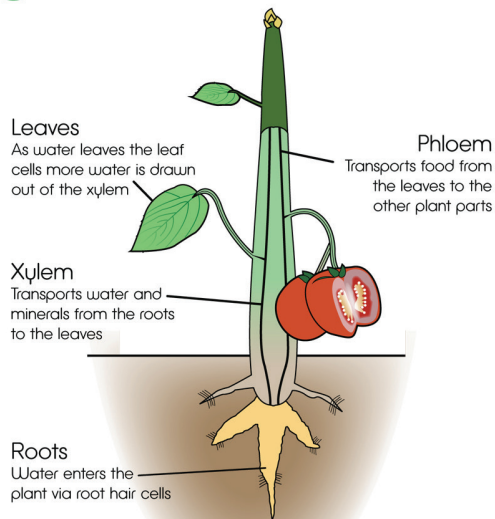
- Parasitic Plants

## DIAGRAM 02:

Twig

### Plant Transport System

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Mistletoe grows on the branches of host trees and steals water and sugary sap

### Extension Question

Q6. What is a parasite?

A parasite is an organism which lives on, or in, another host organism and derives nutrition from that relationship. As a result the host is harmed in some way. For example, many animals have worms that live in their guts and insects which feed on their blood. Similarly, plants can be parasitised by insects, fungi and even some other plants!

## Section 3: Tropisms and Hormones

### • How do plants respond to their environment?

Like all living things, plants have to be able to sense and respond to changes in their environment. It is not always obvious to see, but plants can respond to a whole range of stimuli including light, gravity, touch, temperature and even day length! Some plants have rapid response mechanisms, such as the Venus flytrap, but more usually plant responses are slow and often include growth movements over a period of several days or longer. Being able to sense and respond to the environment is critical to survival and has been a powerful selection pressure in plant evolution. It allows plants to know which way to grow in order to get light and water, when to flower to achieve successful pollination, and when to shed leaves ahead of winter.

### • Suggested Film

- Carnivorous Plants



The Venus flytrap uses a spring-loaded trap to catch insects

### Extension Question

#### Q7. How does a Venus flytrap work?

The leaves of a Venus flytrap are adapted in a number of ways. Firstly, they secrete sweet nectar to attract insects. Trigger hairs in the trap detect the presence of a fly and cause a rapid change in the water pressure inside cells near the hinge of the trap, causing it to close. The fly can then be slowly digested to provide essential nutrients to the plant. The plant can do all this without a nervous system or muscles!

### • What are tropisms?

Tropisms are growth movements by a plant in response to a stimulus. For example, plant stems can grow towards light (positive phototropism) and away from gravity (negative geotropism). Roots can grow towards gravity (positive geotropism) and towards water (positive hydrotropism). These growth movements are controlled by the plant hormone system involving a hormone called auxin. Auxin affects the rate of growth in plants and its uneven distribution can therefore cause uneven growth of plant organs. For example, if there is more auxin on one side of a root or stem then it will tend to grow quicker on one side than the other, causing it to bend towards or away from a stimulus.

### • Suggested Film

- Tropisms and Hormones



Plant shoots grow towards the light. This is positive phototropism

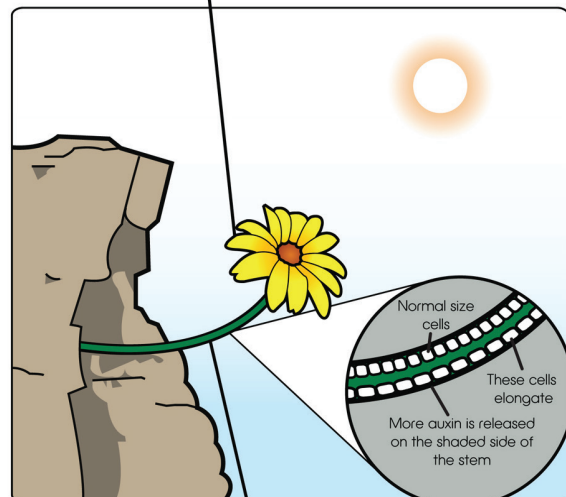
## DIAGRAM 03:

Twig

### Tropisms

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Phototropism - Responses to light  
Phototropism causes the plant to grow towards the sunlight



Geotropism - Responses to gravity  
Allows the plant to grow upwards even if its stem originally faced a different direction

### Extension Question

#### Q8. What are the advantages of phototropism and geotropism?

These growth responses cause the plant to grow its stem and leaves up and towards the light for photosynthesis, and its roots down into the soil to absorb water and minerals.

### • What else do plant hormones control?

Plants don't have nervous systems, but instead rely on a range of hormones to control processes such as growth, flowering, fruit development and leaf shedding. As well as auxins there are hormones called cytokines, gibberellins and abscisic acid.

### • Suggested Film

- Tropisms and Hormones





## • Quizzes

## Photosynthesis

## Basic

• What is the name of the gas that plants need for photosynthesis?

- A – oxygen
- B – nitrogen
- C – hydrogen
- D – carbon dioxide

• What is the name of the green pigment that absorbs sunlight?

- A – chloroplast
- B – chlorella
- C – chlorophyll
- D – chlorine

• Which of the following is produced by photosynthesis?

- A – carbon dioxide
- B – water
- C – glucose
- D – energy

## Advanced

• How does carbon dioxide enter the leaf?

- A – through the xylem
- B – through stomata
- C – through the veins
- D – through the phloem

• In what organelles does photosynthesis take place?

- A – chloroplast
- B – leaves
- C – palisade cells
- D – mitochondria

• Which of the following is produced by photosynthesis?

- A – carbon dioxide
- B – water
- C – oxygen
- D – energy

• In what form does the plant store the glucose it makes in photosynthesis?

- A – starch
- B – carbon dioxide
- C – chlorophyll
- D – cellulose

## Plant Transport

### Basic

#### • What does xylem transport?

- A – water up and down the plant
- B – water and minerals up the plant
- C – sugars up and down the plant
- D – sugars up the plant

#### • What does phloem transport?

- A – water up and down the plant
- B – water and minerals up the plant
- C – sugars up and down the plant
- D – sugars up the plant

#### • Which tissue consists of dead hollow tubes?

- A – root
- B – stomata
- C – xylem
- D – phloem

#### • Which term is used to describe the evaporation of water from leaves?

- A – active transport
- B – transpiration
- C – osmosis
- D – capillarity

### Advanced

#### • Which tissue consists of dead hollow tubes?

- A – root
- B – stomata
- C – xylem
- D – phloem

#### • What does phloem transport?

- A – water up and down the plant
- B – water and minerals up the plant
- C – sugars up and down the plant
- D – sugars up the plant

#### • How does water enter root cells?

- A – active transport
- B – transpiration
- C – osmosis
- D – capillarity

#### • What process generates the force to pull water up a plant?

- A – active transport
- B – transpiration
- C – osmosis
- D – capillarity

## Tropisms and Hormones

### Basic

• What do we call plant growth responses to light?

- A – photosynthesis
- B – geotropisms
- C – hydrotropisms
- D – phototropisms

• Which part of the plant shows positive geotropism?

- A – stem
- B – leaf
- C – flower
- D – root

• Which hormone controls plant tropisms?

- A – chlorophyll
- B – xylem
- C – auxin
- D – osmosis

### Advanced

• Which describes a tropism towards light?

- A – positive geotropism
- B – positive phototropism
- C – negative phototropism
- D – photosynthesis

• Which part of the plant shows positive geotropism?

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• Which hormone controls plant tropisms?

- A – chlorophyll
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- C – auxin
- D – osmosis

• Where is auxin produced in the plant?

- A – flowers
- B – phloem
- C – growing tips of stems and roots
- D – root hairs





## • Answers

## Photosynthesis

## Basic

• What is the name of the gas that plants need for photosynthesis?

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• What is the name of the green pigment that absorbs sunlight?

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## Advanced

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D – mitochondria

• Which of the following is produced by photosynthesis?

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• In what form does the plant store the glucose it makes in photosynthesis?

B – carbon dioxide

C – chlorophyll

D – cellulose

## Plant Transport

### Basic

- What does xylem transport?

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