

Brief for Project Manager

As **Project Manager**, it is your job to make sure the team achieves the project brief. The project brief has two parts. The first concerns the basic science behind understanding plants. The second part is more sensitive, and should remain confidential until you have satisfied the first brief.

Project brief 1

Draw up a poster to explain *how a plant manages to obtain the energy and materials needed to live*. **Your poster should make it clear how individual cells throughout the plant get their supply of carbon, nitrogen and energy.**

A very good poster will suggest

- why roots often spread out into the soil
- why leaves are green
- why leaves have spongy tissue
- why leaves have pores
- why the stomata are usually only on the underside of the leaves
- why leaves are often supported on stems, and spread out in different directions
- why some plants have underground stores of starch

Your team includes a *biologist*, a *chemist* and a *physicist*. Each of these specialists has information to help your team complete the project.

Project brief 2

*When you have completed your poster, open the envelope marked '**confidential – restricted to Conceptual Synthesis Team**'.*

SynBot Conceptual Synthesis Project Team

Brief for Project Specialist - Biologist

- all living things use energy for their life processes
- most living things are made up of large numbers of cells
- each cell in a living organism has a complex metabolism – with lots of chemical reactions
- in multi-cellular organisms, each cell needs energy to support its own internal processes
- all living cells need to be supplied with a means of releasing energy and with materials for maintaining their structures
- cellular processes occur all the time, so cells need to keep respiring or they die
- most cells use sugar and oxygen as the basis for respiration – the process which acts as a source of energy
- cellular structures comprise of materials such as proteins
- plant cells need to make cellulose to build their walls
- plants often have structures which contain starch, a material which can be used as a source of glucose
- plants have vascular (vein-like) structures called xylem and phloem
- xylem act as tubes through which water and dissolved salts can be transported
- phloem act as tubes through which sugar solutions can be transported
- a plant has roots which are able to absorb water and dissolved salts from soil
- many, but not all, plant cells contain organelles called chloroplasts
- chloroplasts contain a substance called chlorophyll
- chlorophyll is a green pigment
- chlorophyll enables energy from the sun to be absorbed, to be used in photosynthesis
- photosynthesis can only occur during daylight hours
- cells in plant leaves usually have large numbers of chloroplasts
- the process of water passing from soil to plant to the atmosphere is called transpiration
- the arrangement of cells in a leaf often provides gaps between cells, like a 'spongy' structure
- the undersides of leaves often have pores called stomata (one stoma, several stomata)

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Brief for Project Specialist - Chemist

- chemical reactions occur when one or more substance(s) is/are changed into one or more new substance(s)
- chemical reactions can be represented by chemical equations
- the equation for photosynthesis is $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$
- the equation for respiration is $\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$
- glucose, $\text{C}_6\text{H}_{12}\text{O}_6$, is a carbohydrate, a sugar
- energy is absorbed when bonds break during chemical reactions
- energy is released when bonds are formed during chemical reactions
- photosynthesis is an endothermic chemical reaction – it requires an energy input
- photosynthesis can only occur when carbon dioxide and water are present
- photosynthesis can only occur in the presence of light
- respiration is an exothermic chemical reaction – it releases energy
- respiration can only occur when glucose and oxygen are available
- glucose is soluble in water
- glucose can be converted into a polymer called starch
- starch is an insoluble material
- starch is a compound of carbon, hydrogen and oxygen
- starch can be broken down to give glucose
- glucose can be converted into a polymer called cellulose
- cellulose is an insoluble material
- cellulose is a compound of carbon, hydrogen and oxygen
- soil contains ions such as magnesium ions, and nitrate ions.
- salts contain ions, usually a metal ion (sodium, potassium, magnesium etc.) and a non-metal ion (chloride, or nitrate, etc.)
- many salts, such as nitrates, dissolve in water
- proteins are compounds carbon, nitrogen, hydrogen and oxygen
- nitrates are compounds of nitrogen and oxygen with a metal
- biological catalysts, called enzymes, speed up the rate of metabolic reactions
- plant cells release hormones which influence aspects of plant growth
- chlorophyll is a complex molecule containing a magnesium ion wrapped in a inside a large protein ring

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Brief for Project Specialist - Physicist

- energy is never created nor destroyed but is always conserved
- energy may seem to change its form, the total amount is constant
- all hot objects emit 'thermal' radiation
- at familiar temperatures, thermal radiation is usually infra-red
- the amount of radiation an object emits is greater at higher temperatures
- nuclear reactions in the sun release vast quantities of energy
- the centre of the sun is at an extremely high temperature
- the sun emits energy in the form of electromagnetic radiation
- solar radiation includes infra-red, visible and ultra-violet radiation
- electromagnetic radiation allows energy to be transferred from place to place
- electromagnetic radiation can pass through the vacuum of space
- the earth's atmosphere is transparent to a large range of frequencies in solar radiation
- materials are coloured because they absorb some frequencies of visible radiation and reflect others
- energy is transferred to a material that absorbs radiation
- gases such as oxygen, carbon dioxide and water vapour will diffuse (spread)
- diffusion occurs in gas mixtures and solutions, from a high concentration to a lower concentration
- concentration is higher nearer a source, and lower where a material is removed from the mixture
- water will rise up thin tubes by a process called 'capillary action'
- gases in the atmosphere do absorb some radiation
- carbon dioxide is a 'greenhouse gas' – a gas that is quite effective at absorbing radiation of some frequencies
- the temperature of an object increases if it absorbs radiation faster than it emits radiation
- a larger surface area can allow more radiation to be absorbed
- when water evaporates it becomes water vapour
- evaporation is a process which requires energy
- the atmosphere contains about 21% oxygen *on average*
- the atmosphere contains a varying amount of water vapour
- the atmosphere only contains 0.03% carbon dioxide *on average*