

Key Stage 5 Worksheet

Earth LIVE Lessons: Rainforest In Your Home (The Eden Project)

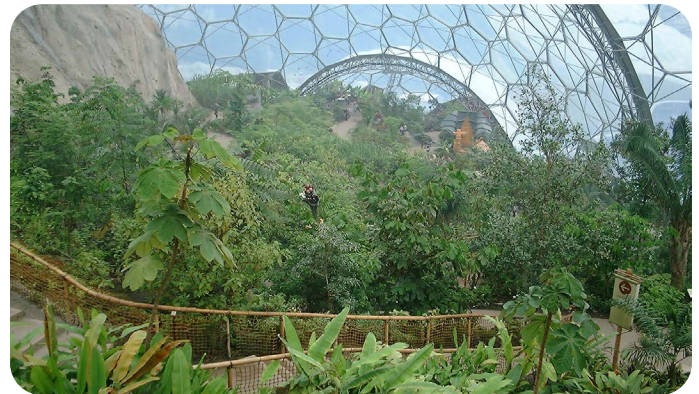


What is it about?

This video is presented by Dan Ryan from **The Eden Project**, an educational charity with a visitor centre in Cornwall comprising two large biomes, one of which contains the **largest indoor rainforest** in the world. This biome is 200m wide and 50m tall, allowing The Eden Project to grow rainforest trees to their full height indoors. In the video Dan talks about the definition of rainforests, their high levels of biodiversity, valuable plants we have obtained from the rainforests, and the adaptations of certain rainforest plant species.

Watch the video here:
youtu.be/nWEoWW1QayQ

**Open the file in your
web browser to click on
the links.**



What is a rainforest?

Rainforests are a type of ecosystem, defined as forests that experience extremely high levels of rainfall. The rainforests we tend to think of are found in tropical areas, including in central and western Africa (e.g. Cameroon, Ghana and Congo), southeast Asia (e.g. Malaysia, Indonesia, Thailand, Sri Lanka and southern India), and central South America, i.e. the **Amazon rainforest** in Brazil.

There are, however, also sub-tropical rainforests, such as the **Atlantic Forest** found in southern Brazil, Argentina and Paraguay. There are even rainforests in temperate regions, including the western seaboard of the United States of America and in the **United Kingdom**, particularly West Wales, Devon, Cornwall, Scotland and some parts of Ireland.

Rainforests generate their own rain - it is the finely-balanced ecosystem itself that determines their climate. This means that when rainforests are cleared, these areas can dry up and the land can become degraded, a process known as **desertification**. Desertification also happens in dryland areas where land has been mismanaged, for example through intensive agriculture, so that the soil becomes eroded and degraded and no longer fertile. This results in **diminishing areas suitable for growing crops**, which is exacerbated by climate change.

Why are rainforests so important?

Rainforests provide vital **ecosystem services** that support human life, including capturing and storing carbon and supplying food and medicinal plants.

Rainforests are **carbon sinks**, they contain dense vegetation which absorbs large amounts of carbon dioxide from the atmosphere and releases oxygen through **photosynthesis**. This process of carbon capture helps to reduce climate change, with the Amazon rainforest alone absorbing around 5% of the world's carbon dioxide emissions every year. Many rainforests are also **peatlands**, which trap huge amounts of carbon not just in the living vegetation but in the slowly decomposing plant material in the soil.

However, rainforests now absorb a third less carbon than they did in the 1990s due to deforestation and rising temperatures, and scientists predict they could even become **carbon sources, rather than sinks, by the 2060s**. This means that rainforests would put more carbon dioxide into the atmosphere than they would absorb.

Why are rainforests so important? continued...

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Rainforests also play a role in the world's **water cycle**. Water is taken up through the roots of the plants, which then travels up through the plant's xylem and then evaporates from the leaves, a process called **transpiration**. Transpiration of water from the dense vegetation adds water to the atmosphere, creating clouds and affecting the climate. This transpiration contributes not only to the rain and humidity in the rainforest, but this moisture can also travel around the world and **affect the climate in other regions**.

Rainforests are the source of many useful products, some examples of which are given below, including **foods** like bananas, chocolate, coffee and cinnamon. Around **25% of medicines** also have their origins in the rainforest, including quinine, one of the **first drugs used to treat malaria**, which is derived from the bark of the cinchona tree. ACE inhibitors, which are used by millions of people globally to treat hypertension (high blood pressure), were discovered by studying the venom of an Amazonian species of viper.



Sunrise in the rainforest. Amazon forest.

Rainforest biodiversity

Rainforests also support exceptionally high levels of **biodiversity** - around half of all life on Earth can be found in rainforests. There are believed to be around 300,000 species of plants globally (although the exact number depends on how different species are classified), and around 150-200,000 of these species are found in rainforests. Rainforests cover only around 2% of the Earth's surface but also contain around 50% of all animal species, therefore their conservation is essential.

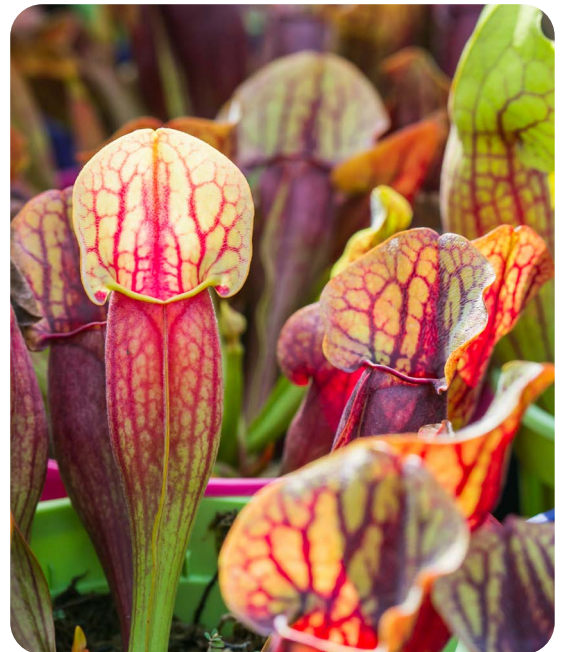
In this video, Dan argues that many people experience “plant blindness”, focusing on the importance of conserving animals, particularly charismatic animals like tigers and polar bears, and not realising how important plant conservation is in order to maintain healthy, functioning ecosystems.

Special rainforest plant species

Rainforests are home to the highland tropical **pitcher plant** (*Nepenthes*), a carnivorous plant that feeds on animals. These plants are brightly coloured and possess nectar-secreting glands in order to attract insects. Insects are then trapped and digested with the help of bacteria that live inside the “cups” of the pitcher plant, providing the plant with nitrogen, one of the nutrients that is **essential for healthy plant growth** (this is why farmers add it to their fields in fertilisers). This enables pitcher plants to grow in nitrogen-poor soils where other plants cannot survive.

The **Titan arum** (*Amorphophallus titanum*) is a threatened species that grows over 2m tall and produces fluorescent flowers. It is known as the “corpse flower”, and the “**smelliest flower in the world**”, as its flowers emit a strong scent of rotting flesh. This strategy enables the plant to attract insects that feed and breed on dead, decaying animals, which then help with pollination. This strategy is also adopted by the **hawthorn tree** in the UK.

The **sensitive plant** (*Mimosa pudica*) is a plant **folds up its leaves** when touched, an adaptation to protect it from consumption by herbivores by concealing the leaves and exposing its sharp spurs. The plant contains mechanoreceptors in the leaves which respond to mechanical stimuli (i.e. touch), which then induces an electrical signal, like a nerve impulse in animals, which travels along the centre of the leaf and causes some of the **plant's cells** to expel water from the vacuoles. This causes them to contract, resulting in the whole leaf folding up.



An example of a pitcher plant. Insects are attracted to the plant then fall into the large funnels, where they are then digested.

Food from the rainforest

In the video, Dan shows common foods and drinks that come from the rainforest, including coffee and Coca Cola, which was originally made from two rainforest plants that give it its name - the leaf of the coca plant and the kola nut.

Bananas originate from rainforests in southeast Asia (e.g. Malaysia and The Philippines). **Wild bananas** are very small and full of seeds, whereas cultivated bananas are large and fleshy and have no seeds. This is a result of an event that occurred during their cultivation, believed to have happened around 8000 years ago.



Wild bananas don't contain much flesh and are full of seeds.

Most species, including the ancestors of modern bananas are **diploid**, i.e. they possess two sets of chromosomes, one from each parent. However, **an event occurred in the history of cultivated bananas** whereby one parent passed on one copy of its chromosomes by producing a haploid gamete through normal **meiosis**, but the other parent passed on both copies, resulting in offspring with three copies of its chromosomes, known as a triploid.

With three copies of each chromosome, it is impossible for chromosomes to form pairs and line up during metaphase of meiosis, so seeds cannot be produced (unlike in other fruits). Farmers propagate bananas vegetatively instead, as bananas produce rhizomes to allow them to reproduce asexually.

Threats to rainforests

Rainforests have been **extensively cleared**, and continue to be cut down to make way for urbanisation, cattle ranching, mining, and cultivation of oil palm and soya, and to use the wood from the forest as timber for construction. More than 20% of the Amazon rainforest has already been destroyed.

Oil palm trees are planted to produce **palm oil**, which is used in a wide range of processed food products such as bread, cereal, chocolate, ready meals, instant noodles, crisps and margarine. It is also used in cleaning products and toiletries like shampoo and soap. If this palm oil isn't **sustainably produced**, its production is often linked to further destruction of rainforest.

Threats to rainforests continued...

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Consumers are now becoming more aware of the impact of oil palm cultivation and are therefore checking the labels of the products they buy in order to avoid it. The EU made labelling of palm oil a **legal requirement in 2015**, as previously manufacturers had been able to list it as “vegetable oil” in an ingredients list, making it easier for consumers to know what they were buying. However, alternatives to palm oil, such as coconut oil, have **their own environmental impacts** that consumers need to consider.

Oil palm is also used for the production of biofuels, which are being invested in as a renewable form of energy in order to reduce reliance on fossil fuels. Biofuels emit carbon dioxide when combusted, however, it is impossible for them to release more carbon dioxide than was captured during the growth of the plant, therefore they are considered at worst to be carbon neutral. However, financial incentives, for example those provided by the EU, for **biofuel production led to deforestation** of rainforests in order to grow oil palm, which had a negative impact on climate change mitigation rather than a positive one. The production of biofuels needs to be properly managed to ensure that no further land is being cleared.

African rainforests are being deforested at a rate of 0.3% every year. It is believed that destruction of rainforests in Africa might have caused the **Ebola epidemic** in 2014, as the species of bats which naturally carries the disease came into close proximity with humans after losing its rainforest habitat.



Oil palm plantation. Aerial photo of environmental damage in Southeast Asia.



Rainforest recovery – pioneer plants

An important plant that helps to facilitate the recovery of rainforest in South America is the *Cecropia* tree. This species is a **pioneer plant**, and therefore grows on the bare ground that is left after rainforests are cleared, or if a gap forms in the rainforest, for example if a tree falls down. After the extensive **burning of the Amazon rainforest in 2019**, this tree was the first to colonise the areas affected by the fire.

Cecropia's success can be explained by a **symbiotic relationship between the tree and a species of fire ant called *Azteca***. This symbiosis is believed to have evolved around 8 million years ago. The ants are provided with a safe place to build their colonies, in the hollow nodes between the leaves and stems of the tree. *Cecropia* also provides food for the ants, and has actually evolved a specialised structure called a trichilium that produces food bodies of the perfect size and shape to be eaten by the ants. The plant provides both carbohydrate, in the form of glycogen, and fat for the ants.

Cecropia benefits from this symbiotic relationship as the ants prevent the tree from being eaten by herbivores. If a herbivore approaches the tree, the ants swarm and bite, scaring it off, which helps the tree to survive and grow. Sloths are the only animals known to be immune to the bites of the fire ants, potentially because of their thick skin, or possibly even because they too have a role to play in this relationship, with the sloth spreading the seeds of *Cecropia*.

Find out more

- Discover where the rainforests are in the UK **here**, and why they need protection **here**.
- Find out more about the threats to Africa's rainforests, and why their conservation is so important **here**.
- Explore the theories to explain why biodiversity is so high in tropical rainforests, and how biodiversity is spread throughout the world **here**.
- Find out more about how the Amazon rainforest's biodiversity helps to support human life **here**.
- Find out more about how palm oil production is linked to rainforest deforestation **here**.
- Bananas aren't the only species of plants to have more than one pair of chromosomes. Discover more about the phenomenon of polyploidy in plants **here**.
- Discover some other amazing rainforest plant adaptations **here**.

Questions

Interactive: Click on box to start typing



Name three ecosystem services provided by rainforests.

Describe the symbiotic relationship between *Cecropia* trees and Azteca fire ants.

How do rainforests increase the amount of water vapour in the atmosphere?

Describe at least one adaptation for each of the following plants:

- Pitcher plant
- Sensitive plant
- Titan arum

Why don't cultivated bananas contain seeds?

What is palm oil used for, and how does palm oil production threaten rainforests?

Try an exercise!

Create a model of the process of meiosis, for example by cutting out chromosome shapes from a piece of paper or by using pipe cleaners. Use your model to revise the processes that occur during meiosis. Then add another set of chromosomes to create a triploid cell, and use your model to demonstrate why meiosis doesn't work in triploid cells, like those of cultivated bananas.



Swansea University
Science for
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(S4) Funded by the European Social Fund and the Welsh Government.

For teachers and home schoolers

Links to Science in the National curriculum for Wales (KS5)

<https://www.wjec.co.uk/media/gcgjtvqj/wjec-gce-biology-spec-from-2015.pdf>

AS Biology: Basic Biochemistry and Cell Organisation – Cell structure and organisation [(a) the structure and function of the following: mitochondria; endoplasmic reticulum (rough and smooth); ribosomes; Golgi body; lysosomes; centrioles; chloroplasts; vacuoles; nucleus; chromatin; nuclear envelope; nucleolus; plasmodesmata] – the structure of the plant cell including the role of the vacuoles in storing water, and how this property is exploited by the sensitive plant.

AS Biology: Basic Biochemistry and Cell Organisation – Cell membranes and transport [(a) the principal components of the plasma membrane and understand the fluidmosaic model] – the effect of osmotic imbalance in the sensitive plant, and the function of protein channels, including voltage-gated channels, in the plasma membrane.

AS Biology: Basic Biochemistry and Cell Organisation – Genetic information is copied and passed on to daughter cells [(d) the main stages of meiosis (names of subdivisions of prophase 1 not required) and cytokinesis] – the effect of triploidy in disrupting the alignment of homologous chromosomes during metaphase I.

AS Biology: Biodiversity and Physiology of Body Systems – All organisms are related through their evolutionary history [(n) the different types of adaptations of organisms to their environment including anatomical, physiological and behavioural adaptations] – the adaptations of four different species of rainforest plants to enable their survival.

AS Biology: Biodiversity and Physiology of Body Systems – Adaptations for transport [(n) the movement of water from root to leaf including the transpiration stream and cohesion-tension theory] – transpiration of water in the rainforest and the impact of this on local and global climate.

A2 Biology: Energy, Homeostasis and the Environment – Population size and ecosystems [(e) the concept of ecosystems, including that ecosystems range in size from very large to very small; (j) the terms primary and secondary succession, pioneers, sere and climax community] – the rainforest as a type of ecosystem containing a highly biodiverse community of organisms, and the role of Cecropia as a pioneer plant species colonising bare ground.

A2 Biology: Energy, Homeostasis and the Environment – Population size and ecosystems [(m) the effects of human activities on the carbon cycle including climate change affects the distribution of species and is a possible cause of extinction] – the role of rainforests as carbon sinks and the effect of temperature increases on the ability of rainforests to sequester carbon.

A2 Biology: Energy, Homeostasis and the Environment – Human impact on the environment [(c) the issues in agricultural exploitation - conflicts between production and conservation and possible means to resolve such conflicts as illustrated by deforestation and overfishing (d) the increased human pressures on the environment including the need to achieve sustainability by changes in human attitudes and making informed choices] – deforestation of rainforests, in particular for agriculture, and consumer choice relating to products containing palm oil.

A2 Biology: Energy, Homeostasis and the Environment – The nervous system [(a) the components of a nervous response; from the detection of internal and external stimuli by receptors to the response by the effector; (g) the nature and transmission of the nerve impulse] – the detection of touch by mechanoreceptors in the sensitive plant, the influx and efflux of ions during the action potential and the response of the cells.

A2 Biology: Options – Immunology and disease [(a) the meaning of the following terms: pathogenic, infectious, carrier, disease reservoir, endemic, epidemic, pandemic, vaccine, antibiotic, antigen, antibody, resistance, vector, toxin, antigenic types] – the role of deforestation in bringing humans into contact with novel pathogens such as Ebola, which may lead to epidemics and pandemics.

<https://www.wjec.co.uk/media/wijlspii/wjec-gce-geography-spec-from-2016-e.pdf>

A2 Geography: 3.1.7 Carbon stores in different biomes [Size of carbon stores in the tropical rainforest and temperate grassland and factors influencing the size of these stores including temperature, precipitation and light; Changes in the size of carbon stores due to human activity including land-use change (deforestation, afforestation and agricultural activity)] – the carbon capture extent of the rainforests and the amount this has reduced and is predicted to reduce going into the future.

A2 Geography: 3.1.9 Links between the water and carbon cycles [Links between the water and carbon cycles at the local scale] – the impact of transpiration from rainforest vegetation on the water cycle and in determining local climate and affecting global climate.

A2 Geography: 4.2.3 Biodiversity under threat [Threats to biodiversity from direct action and indirect action operating at a range of scales from local to global, Ecosystems at greatest risk including tropical rainforests, coral reefs and wetlands] – the threats to rainforests as a result of human activity, including the impact of rainforest clearance for oil palm cultivation.