Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Plants

BBC: Life Series - Video Worksheet

1. Plants have a family tree stretching back nearly half a billion \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
2. Bristlecone pines are the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ living things on Earth.
3. Like animals, plants are constantly competing for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
4. Like animals, plants need food and water but what sets them apart is their struggle for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

VINES

5. But they still have a problem. The light is \_\_\_\_\_\_\_\_\_\_\_ metres above them.

6. But they won't get very high unless they can hold on tight. Like fingertips searching for a hold, this ivy's adhesive pads \_\_\_\_\_\_\_\_\_\_\_\_\_ the bark.

7. In a matter of just \_\_\_\_\_\_\_\_\_\_\_\_, these climbers make it to the canopy. Now with light in plentiful supply, these plants are able to flower.

AIR PLANTS

8. These are air-plants. They grow on the upper \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of tall trees and spend their whole lives basking in the light. But growing 50 metres above the ground does have its drawbacks.

9. For an air-plant, with their roots planted in the tree tops, this isn't an option. But they have a solution. First, the bare roots have an extraordinary ability to soak up \_\_\_\_\_\_\_\_\_\_\_\_\_ like blotting paper.

10. Their roots trap falling leaves which eventually rot and provide the plants with their own personal supply of compost. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ different plants - orchids, bromeliads and ferns have taken up this remarkable lifestyle.

SUN DEWS

11. The soil in this waterlogged bog is very poor quality, lacking in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. But these strange plants have an ingenious strategy.

12. They're sweet-smelling and attractive to many insects. But they're also extremely \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Mosquitoes emerge in huge numbers from the boggy water and the sundews are ready.

13. Digestive enzymes break down the body into a nitrogen-rich meal which is absorbed by the plant. Without \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ tissues, this plant would not survive.

VENUS FLY TRAP

14. The Venus fly trap. Like the sundew, it makes itself very attractive, oozing nectar across the brim of each leaf. But any visiting insect had better watch out for these \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ tiny hairs.

15. A second strike in less than \_\_\_\_\_\_\_\_\_\_\_\_\_\_ seconds and the fly is doomed. An electrical impulse is triggered and the leaf snaps shut in just a fraction of a second. The tips lock together like prison bars.

16. If the fly is very big, or very small, it may just manage to escape. But most are trapped. And die. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ days later, the trap re-opens. All that remains is a husk.

17. When pollination is over, it's back to business as usual. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_% of plant species on Earth have flowers. Flowers have just one role - to enable the plant to produce offspring.

SUNFLOWERS

18. And, like most flowers, sunflowers establish a close relationship with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in order to ensure their reproduction.

19. As these bees busily feed on nectar, they unwittingly brush against the stamens, collecting \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and then carry it from flower to flower. The sunflower is fertilized.

RICHEA HONEY BUSHES

20. To reproduce, the Richea honey bush must \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. But the delicate parts of the flowers risk being damaged by the cold. The plant appears to have an ingenious solution.

21. This attracts a bird - the Black Currawong. It has the strength to rip open the flowers' outer casing and gets its reward of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

22. For some plants, the relationship with their pollinators is not collaborative, it's \_\_\_\_\_\_\_\_\_\_\_\_\_.

SANDHILL MILKWEEDS

23. The Sandhill milkweed blooms every spring in the sandy meadows of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. It times its flowering perfectly to match the arrival of Monarch butterflies migrating here from Mexico.

24. But the milkweed has a defense mechanism. As the caterpillar \_\_\_\_\_\_\_\_\_\_\_ into a vein, a kind of latex swells out engulfing it.

25. As it moves across the flower heads, its feet slide between grooves in the petals where the flower's pollen sacs are waiting. As it flies off, the Monarch's feet hook out the \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and carry it to the next flower and pollination is achieved.

HELICONIAS

26. Here in Dominica there's a plant that is so manipulative that it has enslaved its pollinator. The bright red structures of the Heliconia are actually modified \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. These are its flowers.

27. But, cleverly, the Heliconia rations the amount of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ it produces to force the hummingbird into returning to the flower time and time again.

28. The hummingbird is like an addict. Not only does it never stray, but it will aggressively defend the flowers from thieves. The plant is the master in this relationship.

SAGUARO CACTUS

33. In the desert of Arizona lives a master - the Saguaro cactus. In the cool of the night, the cacti open their radiant flowers. They're soon visited by nectar-feeding \_\_\_\_\_\_\_\_\_\_\_ and as the bats move from cactus to cactus, they pollinate them.

34. Each flower only lasts a night, but over three weeks, each cactus will produce more than \_\_\_\_\_\_\_\_\_\_ flowers.

35. White winged doves are among the first to reach the ripening fruit. The seeds survive in the birds' stomachs and will be carried many \_\_\_\_\_\_\_\_\_\_\_\_\_\_ before being deposited in their droppings.

DRAGON BLOOD TREES

36. The Dragon's Blood tree. The key to their success lies in their bizarre shape. They live on the mountain tops where there's little \_\_\_\_\_\_\_\_\_\_\_\_, but there are critical compensations.

37. It shades the ground so effectively it allows time for the water to seep into the sand. And it also shades the network of roots that lie just under the surface.

RED MANGROVE

38. But the pores become useful in a quite different way when they're submerged again. They allow water into the plant, but filter out \_\_\_\_\_\_\_\_\_\_\_\_\_% of the salt as it passes through.

39. Any salt that gets in is pumped into a few sacrificial leaves that turn \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and are discarded.

CONIFEROUS TREES

42. Pine trees can survive much colder conditions. They have \_\_\_\_\_\_\_\_\_\_\_\_\_\_ in the leaves themselves, that means they can keep them all winter.

43. The needle-like leaves also have a thick waxy coating that limits any\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ loss through pores. The winters here are long and hard.

44. Almost continuous freezing temperatures and savage winds make life so tough that these bristle cones only manage to grow for \_\_\_\_\_\_\_\_\_\_ weeks of the year. Everything is about conserving energy.

**Transcript:**

Plants have a family tree stretching back nearly half a billion years. They have developed an extraordinary range of strategies to survive. This tree is a bristlecone pine. It's taken thousands of years to reach this size. It has seen empires rise and fall, kings, queens and presidents come and go and may have seen the sun rise more than 1.5 million times. Bristlecone pines are the oldest living things on Earth. Bamboo is the fastest growing plant. It will be full-grown - 30 metres tall - in just 90 days. Like animals, plants are constantly competing for food. Striving to produce offspring and battling against predators. They will deceive and, in some cases, they will even hunt. We often don't notice such dramatic behaviour because, to our eyes, it happens so slowly. But if time is compressed and you shift perspective to the plants' point of view, their world comes spectacularly to life. The events in this woodland can build to a view of half a year in less than a minute. Like animals, plants need food and water. But what sets them apart is their struggle for light. Plants must have light in order to grow and will do anything to get as much as they need. The forest might appear to be the perfect place for plants to thrive.

Yet down here on the forest floor is one of the hardest places imaginable for a young plant to begin its life. The canopy above is so thick that only a little sunlight can filter through. For this sapling, too little light means death. But plants on the forest floor need not be passive. If the light won't come to them, they can go to the light. But they still have a problem. The light is 50 metres above them. So, they must climb. It's much easier to use another plant as scaffolding. But they won't get very high unless they can hold on tight. Like fingertips searching for a hold, this ivy's adhesive pads grip the bark. Instead of sticking to the trees, some climbers use sharp claws. The cat's claw creeper hooks its tendrils into the tiniest crevices and hauls itself to the top. With every metre it climbs, the light gets a little stronger, fueling more growth. This tendril of a passion flower seems to flail aimlessly in mid-air, but in fact it's searching for an anchor point. Its tendril coils on itself, pulling the plant towards its support. In a matter of just days, these climbers make it to the canopy. Now with light in plentiful supply, these plants are able to flower. Other plants have a different strategy to find the light they need in the crowded forest. These are air-plants. They grow on the upper branches of tall trees and spend their whole lives basking in the light. But growing 50 metres above the ground does have its drawbacks. Most plants get water and nutrients through their roots in the ground. For an air-plant, with their roots planted in the tree tops, this isn't an option. But they have a solution. First, the bare roots have an extraordinary ability to soak up water like blotting paper. The slightest rain or mist, and they absorb every drop. They also have a way of gathering nutrients. Their roots trap falling leaves which eventually rot and provide the plants with their own personal supply of compost. 20,000 different plants - orchids, bromeliads and ferns have taken up this remarkable lifestyle. For a plant to thrive, it must not only get enough nutrients, but also the right balance of nutrients. The soil in this waterlogged bog is very poor quality, lacking in nitrogen. But these strange plants have an ingenious strategy. Their leaves are covered in tentacles, tipped with droplets of what appears to be morning dew. These droplets give the plant its name - the sundew. They're sweet-smelling and attractive to many insects. But they're also extremely sticky. Mosquitoes emerge in huge numbers from the boggy water and the sundews are ready. The sundew's tentacles are living fly-paper. Struggling only makes matters worse. With each contact, the plant tightens its grip. As more and more tentacles envelop the prey, the droplets spread across its body. Eventually, the insect is smothered and drowns in sticky fluid. Digestive enzymes break down the body into a nitrogen-rich meal which is absorbed by the plant. Without animal tissues, this plant would not survive. But there's another carnivorous plant that's an even more sophisticated predator. The Venus fly trap. Like the sundew, it makes itself very attractive, oozing nectar across the brim of each leaf. But any visiting insect had better watch out for these six tiny hairs. This fly has to tread carefully. If it strikes one hair, it can carry on feeding. But a timer has been set. A second strike in less than 20 seconds and the fly is doomed. An electrical impulse is triggered and the leaf snaps shut in just a fraction of a second. The tips lock together like prison bars. If the fly is very big, or very small, it may just manage to escape. But most are trapped. And die. Ten days later, the trap re-opens. All that remains is a husk. The plant has finished its meal and resets itself for its next victim. But there is one time of year when the Venus fly trap needs some of the visiting insects to live. It needs their help to be pollinated. It sends up flowers on tall stems, well away from the danger of the traps below. Here, insects can feed safely on nectar. In return, they provide a vital service, carrying pollen from flower to flower. But the truce is only temporary. When pollination is over, it's back to business as usual. 80% of plant species on Earth have flowers. Flowers have just one role - to enable the plant to produce offspring. Colour, perfume, nectar and shape all act to make a flower irresistible. Sunflowers grow to face the rising sun. The warmth of the rays speeds the production of nectar and this lures pollinators. One after another, hundreds of individual florets produce pollen-covered stamens. And, like most flowers, sunflowers establish a close relationship with animals in order to ensure their reproduction. As these bees busily feed on nectar, they unwittingly brush against the stamens, collecting pollen, and then carry it from flower to flower. The sunflower is fertilized. In the sun-drenched fields of southern France, the flowering season is a long one, but not all plants have this luxury. Cradle Mountain in Tasmania is blasted by bitter Antarctic winds. To reproduce, the Richea honey bush must flower. But the delicate parts of the flowers risk being damaged by the cold. The plant appears to have an ingenious solution. The flower petals fuse together, forming an insulated, protective case around its stamens. However, this creates another problem, the flower case is so well sealed that, unfortunately, it also keeps out pollinating insects. During brief, sunny spells, the flowers warm up and suddenly start producing nectar. This attracts a bird - the Black Currawong. It has the strength to rip open the flowers' outer casing and gets its reward of nectar. At the same time, it exposes the delicate stamens to waiting insects. With luck, there's enough time for pollination before the biting wind kills the flowers. For some plants, the relationship with their pollinators is not collaborative, it's war. Butterflies, and in such numbers, would seem to be perfect pollinators for any flower. The Sandhill milkweed blooms every spring in the sandy meadows of Florida. It times its flowering perfectly to match the arrival of Monarch butterflies migrating here from Mexico. The Monarchs search out milkweed plants, but they have something other than pollination on their minds. Rather than collect pollen, this female lays her eggs on the milkweed leaf. This is the only plant the caterpillars can eat. But the milkweed has a defense mechanism. As the caterpillar bites into a vein, a kind of latex swells out engulfing it.

If the caterpillar isn't quick, it will drown... or find its jaws glued together. The plants' defense is so effective that only one third of the Monarch caterpillars make it through the first day. But the caterpillars that survive, grow in size and strength. And they go for the jugular. By carefully chewing through the main vein, the caterpillar drains the leaf of latex and cuts off its supply.

The milkweed's leaf is now defenseless and the caterpillar eats in safety before preparing to pupate into a butterfly. But after about ten days, it becomes clear why the plant has endured this onslaught. A newly-hatched Monarch simply can't resist the nectar-filled cups of the milkweed flowers. As it moves across the flower heads, its feet slide between grooves in the petals where the flower's pollen sacs are waiting. As it flies off, the Monarch's feet hook out the pollen and carry it to the next flower and pollination is achieved. Although the milkweed has paid a heavy price, in the end it used the Monarch to get its way. Here in Dominica there's a plant that is so manipulative that it has enslaved its pollinator. The bright red structures of the Heliconia are actually modified leaves. These are its flowers. They may be small, but they play a very important role keeping nectar well guarded at the very bottom of their long stems. The purple-throated Carib hummingbird, with its long curved beak, is the only bird capable of reaching this energy-rich food. But, cleverly, the Heliconia rations the amount of nectar it produces to force the hummingbird into returning to the flower time and time again. Every time it makes a visit, it picks up more pollen on its beak and feathers. The hummingbird is like an addict. Not only does it never stray, but it will aggressively defend the flowers from thieves. The plant is the master in this relationship. To ensure it gets pollinated, Heliconia has made the hummingbird its prisoner. A plant's problems don't end once it's been pollinated. Plants need to spread their seeds as far away as possible, otherwise the adults will be in direct competition with their offspring. Here in South Africa, one flower achieves this by performing a remarkable trick. The plant waits dormant underground for more than a year. The first heavy rains for many months are the trigger the plant has been waiting for. Brunsvigia burst into flower. Their timing is perfect. These conditions are ideal for insects too. The flowers enjoy a few days of frenzied pollination. But it's not long before the searing heat returns. The flowers start to wilt, shrivel and die. Brunsvigia now needs to disperse its seeds widely, yet the flowers still have their seeds trapped inside. But the flower isn't finished yet. There are strong winds that blow across this landscape. They snap the dry, dead stalks, sending each and every plant cart-wheeling across the ground, casting seeds as it goes. With the heat threatening to dry them out, the seeds' germination has to be immediate. Deep in the forests of Borneo, some plants also use the wind to disperse their seeds, but in a completely different way - by giving their seeds wings. Some are helicopters that twist and turn their way down to the ground. But there is one that has a design that enables it to travel greater distances than all the others. This is Alsomitra. Its football-sized pod is packed full of hundreds of extraordinary seeds. Each is an almost aerodynamically perfect glider that can be supported by even the slightest breeze. Its paper-thin upswept wings allow it to travel hundreds of metres through the forest. Once the seed hits the ground, the wings rot away and the seed starts to germinate. A new Alsomitra vine starts to grow up towards the canopy and into the light - well away from its parent. There are other ways to disperse seeds and plants have evolved different tactics depending on where they live. In the desert of Arizona lives a master - the Saguaro cactus. In the cool of the night, the cacti open their radiant flowers. They're soon visited by nectar-feeding bats and as the bats move from cactus to cactus, they pollinate them. Each flower only lasts a night, but over three weeks, each cactus will produce more than 200 flowers. Every pollinated flower immediately begins to form a fruit at its base, packed with thousands of seeds. The mature Saguaro cacti are superbly adapted to survive out in the intense heat of the Sonoran Desert. But their seeds are delicate, and must find shade or they will scorch to death before they germinate. The seeds are covered with succulent sweet flesh - a meal that all sorts of desert creatures find irresistible.

White winged doves are among the first to reach the ripening fruit. The seeds survive in the birds' stomachs and will be carried many miles before being deposited in their droppings. Their own little packet of fertilizer. But the cactus doesn't just rely on birds. Fallen fruit provides a bonanza for creatures on the ground. Foraging ants quickly gather seeds and flesh.

That's if a tortoise doesn't get there first. The greater range of animals the cactus can get to eat its fruit, the more likely the seeds within will be carried to the perfect place to germinate. The ants carry the seeds underground into their nests, often excavated among the roots of trees.

The tortoise too will head for shade. It spends much of its day cooling off under trees where it's sure to leave undigested seeds in its dung. Now the seeds wait for the rains to come.

THUNDER Of the 40 million or so seeds a cactus produces in its lifetime, the chances are that only one will develop into a plant that outlives its parent. If it was lucky enough to find shade, a seed will still take ten years to become a five centimetre tall cactus. To reach the size of its parents, possibly ten metres, will take at least 100 years. Plants can survive in the most unlikely and inhospitable places on Earth. Here on Socotra, a remote island in the Arabian Sea, the dry season is brutal. But this strange tree has a strategy to survive it. The Dragon's Blood tree. The key to their success lies in their bizarre shape. They live on the mountain tops where there's little soil, but there are critical compensations. Occasional morning mists sweep across the high ground. The mist condenses on the skyward-pointing waxy leaves. The droplets run down to the centre of the trunk and down to its roots. Water is so precious that the tree cannot afford to waste any. Drops that do escape and fall to the ground are not totally lost. The tree's huge, densely packed crown acts as a parasol. It shades the ground so effectively it allows time for the water to seep into the sand. And it also shades the network of roots that lie just under the surface. Another plant shares this parched desert, but survives in a very different way. The Desert Rose. In really harsh conditions, it jettisons its leaves to minimise water loss. Strangely, it chooses this time to flower. Its bulbous trunk is like a barrel that stores water all year round. It's so hardy it can grow out of bare rock. It might seem that conditions can't get much tougher for a plant than here. But, for some, the conditions are even harsher. Six hours ago, here on the coast of Australia, this tree was high and dry on a sandy beach. For almost all plants, saltwater is lethal, so submersion of this tree's roots by the tide twice a day should kill it.Yet this Red Mangrove is flourishing. The retreating tide reveals the key to surviving the sea's assault. The mangrove's roots are covered in warty growths. The growths surround pores that take in oxygen from the air when the roots are above water. But the pores become useful in a quite different way when they're submerged again. They allow water into the plant, but filter out 99% of the salt as it passes through. Any salt that gets in is pumped into a few sacrificial leaves that turn yellow and are discarded. Plants can not only cope with being poisoned, parched and scorched, but they can also survive being frozen. In the world's northern forests, the changing of the seasons creates its own challenges. As summer moves to autumn, plants prepare themselves for the toughest time of their year. Broad-leaved trees unveil what seems to us a colourful spectacle. But for these plants it is the beginning of a series of urgent and drastic survival strategies to cope with the coming cold. They begin by pulling all the water and nutrients within their leaves back into the trunk. The last rays of useful sunlight are channelled into making a sugary anti-freeze that will protect the body of the tree.

The green pigment - chlorophyll - disappears, leaving purples, reds, oranges and yellows. Finally, the leaves die and the trees discard them. As temperatures drop below freezing, the plants of broad-leaved forests settle down to hibernate until spring. Pine trees can survive much colder conditions. They have anti-freeze in the leaves themselves, that means they can keep them all winter. The needle-like leaves also have a thick waxy coating that limits any water loss through pores. The winters here are long and hard. The trees have to survive temperatures of down to -40C for five months. But one pine tree is capable of surviving even harsher conditions. These pines live at the limit of life - above 3,000 metres in the mountains of western America. Almost continuous freezing temperatures and savage winds make life so tough that these bristle cones only manage to grow for six weeks of the year. Everything is about conserving energy. They hardly ever shed their needles, which can last more than 30 years. After centuries of being blasted by storms, a full-grown tree still survives with only a strip of bark a few inches wide. These trees live life at such a slow pace that they can reach great age. Some are over 5,000 years old. It's been said of the bristlecones, that to live here is to take a very long time to die. As the northern spring approaches, the warming temperatures and increased day length release the land from winter. Plants that have lain dormant begin to grow again. These have over-wintered, buried in the mud at the bottom of this frozen lake. The retreating ice allows the water to warm and this white water lily to flourish for another season. And, as all the trees come out of their winter rest, the vivid green of new leaves returns to the land. From the frozen north to the southern deserts, the spring bloom symbolises the success of plants in surviving against the odds. But the most successful type of flowering plant is one that makes up 20% of all plant life on the planet. Grass. There are 10,000 different species. Today, they form the diet of many thousands of different animals. And a few grasses, particularly rich in nutrients, have developed a relationship with one animal and together, the two have changed the world. 10,000 years ago, we humans started to cultivate rice in order to harvest its food-rich seeds. Now, half of the world's population depends on it. But there is one other grass that has spread even further across the planet due to its relationship with humans...

wheat. It underpinned the development of western civilization. Today, it covers more of the land than any other kind of plant. Plants have been residents on land longer than animals and have had nearly half a billion years to evolve. During that time, they've diversified into countless forms and have colonized every habitat. As well as collaborating with animals, plants are sometimes their masters, exploiting them to their own advantage. Plants capture energy from the sun and all life on land, directly or indirectly, depends on them. So, ultimately, plants fuel the diversity of life on Earth.



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