

READING PASSAGE 2

Answer **Questions 17–32**, which are based on Reading Passage 2 on pages 6 and 7.

How plants fight back

A Recent research has shown that plants are more aware of their environment and more active in their responses than was ever previously imagined. Simon Gilroy, a professor of botany at the University of Wisconsin-Madison in the USA, has spent much of his career trying to understand how plants work. Now, Gilroy and one of his post-doctoral researchers, Masatsugu Toyota, have produced a series of videos that shows how plants responded when they subjected them to wounds, including scissor cuts and caterpillar bites.

B Gilroy and Toyota discovered that when one part of a plant is attacked or damaged, a wave of calcium spreads throughout the rest of the plant. The calcium alerts the plant to danger and the need to deploy defence tactics. The team were able to see this by utilising a naturally occurring fluorescent-green protein which binds to the calcium, making its path visible.

While scientists already knew that plants reacted to danger via an electrical charge that moves across their tissue, they didn't know exactly how it happened. Gilroy and Toyota suspected it had something to do with glutamate – an abundant neurotransmitter in animals – triggers this wave of calcium.

C The find was fortuitous given that Gilroy hadn't intended to study wounding at all. His real passion is understanding how plants sense gravity and seem to know which way is up – something that's proving extremely hard to work out. It was during the early stages of an experiment into gravity that Toyota came across the wounding response.

'We work very intensely on the calcium signal, because it's a ubiquitous signal. Biology uses it absolutely everywhere,' explains Gilroy. 'It makes your heart beat, it makes your muscles contract. Plants use it for a lot of their signalling machinery. We had some hints that the gravity-sensing system is based around the calcium signal, and so we were developing the technology to image calcium cells in real-time.' It was during this process that Gilroy and Toyota realised they'd captured something never usually visible to humans.

D The team found that the calcium travels at one millimetre per second, fast enough to spread to other leaves in just a couple of minutes. From the data collected up to now, it appears that how far the calcium travels depends on the extent of the wound, or, as Gilroy puts it, 'The more you hurt it, the louder it screams.'

That 'scream' can result in a range of responses. 'Plants are masters of chemistry,' says Gilroy. 'We deal with the world by running away from it, plants deal with the world by growing in response to it, or by making a tonne of stuff.' That 'tonne of stuff' could be chemicals that poison a hungry insect, or that make the plant unattractive, tough or unpalatable. Some plants even make proteins that block the ability of a caterpillar's gut to digest the plant material. This is dinner that fights back.

E The next step for Gilroy and his team is to delve deeper into the signalling response on a cellular level, dissecting the genes and proteins responsible. In contrast to our understanding of human nerve cells, Gilroy admits that the equivalent responses in plants are still barely understood. He is also going to widen the scope of the study and look at other signals that plants send out – signals regarding temperature and changes in light and touch.

Gilroy explains that there may be a wider use for the research, albeit a long way in the future. Once scientists have managed to identify the specific genes that make the signalling process work and can understand what happens when you switch those genes on and off, it's not hard to think about the potential. 'You can imagine that we should be able to take a crop plant and switch on its defences on-call,' says Gilroy. 'We're nowhere near that point yet, but once we get there – say you're in a field and you predict there's going to be an outbreak of some pest, you could go in and pre-defend all of the plants in the field, but you do it on-call so the plants aren't wasting their resources defending themselves the whole time.'

F For now, though, Gilroy is happy to simply increase understanding of plants. He is energetic in his insistence that they are not the inactive and unreceptive organisms that people generally believe them to be. For that reason, he's as enthusiastic about the way the videos bring the response process to life as he is about the future potential of the research. 'When you look at a plant, just because it doesn't do what we do, and it doesn't move, that doesn't mean it isn't doing anything. They're hugely dynamic organisms,' he says.

Questions 17–23

Reading Passage 2 has six sections, **A–F**.

Which section contains the following information?

Write the correct letter, **A–F**, in boxes 17–23 on your answer sheet.

NB You may use any letter more than once.

17 reference to the different ways in which plants protect themselves from being eaten

18 an explanation of how scientists were able to observe plants sending warning signals

19 mention of a commonly held view about plant life

20 examples of the means used by scientists to provoke plants' signalling response

21 reference to the idea that we could one day manipulate plants' signalling abilities

22 the purpose of the research which led to Gilroy and Toyota's discovery

23 a comparison regarding levels of scientific knowledge about responses in plants and humans

Questions 24–28

Complete the summary below.

Choose **ONE WORD ONLY** from the passage for each answer.

Write your answers in boxes 24–28 on your answer sheet.

Gilroy and Toyota's research

As part of their research at the University of Wisconsin-Madison, Simon Gilroy and Masatsugu Toyota made several **24** revealing plants' reactions to cuts, bites and other **25**

These indicated how the spread of calcium warns plants about the presence of

26

The use of a brightly coloured **27** enabled the researchers to see the movement of calcium through the plant. The research also showed how

28 activates the release of calcium in the plant.

Questions 29 and 30

Choose **TWO** letters, **A–E**.

Write the correct letters in boxes 29 and 30 on your answer sheet.

Which **TWO** aspects of the calcium signal in plants does the writer mention?

- A** the volume of calcium released following an attack
- B** the rate at which calcium flows through plants
- C** the different parts of the plant where calcium is produced
- D** the species of plants which produce calcium as a warning signal
- E** the link between the severity of an attack and the distance calcium moves

Questions 31 and 32

Choose **TWO** letters, **A–E**.

Write the correct letters in boxes 31 and 32 on your answer sheet.

Gilroy's team have made certain plans for the future.

Which **TWO** plans are mentioned by the writer?

- A** research plants' reactions to heat and cold
- B** use their findings to help grow a greater variety of crops
- C** investigate warning signals in organisms other than plants
- D** analyse further the chemical processes involved in signalling responses
- E** conduct studies to compare human cell and plant cell behaviour