

READING**READING PASSAGE 1**

*You should spend about 20 minutes on **Questions 1–13**, which are based on Reading Passage 1 below.*

Why we need to protect polar bears

Polar bears are being increasingly threatened by the effects of climate change, but their disappearance could have far-reaching consequences. They are uniquely adapted to the extreme conditions of the Arctic Circle, where temperatures can reach -40°C . One reason for this is that they have up to 11 centimetres of fat underneath their skin. Humans with comparative levels of adipose tissue would be considered obese and would be likely to suffer from diabetes and heart disease. Yet the polar bear experiences no such consequences.

A 2014 study by Shi Ping Liu and colleagues sheds light on this mystery. They compared the genetic structure of polar bears with that of their closest relatives from a warmer climate, the brown bears. This allowed them to determine the genes that have allowed polar bears to survive in one of the toughest environments on Earth. Liu and his colleagues found the polar bears had a gene known as APOB, which reduces levels of low-density lipoproteins (LDLs) – a form of ‘bad’ cholesterol. In humans, mutations of this gene are associated with increased risk of heart disease. Polar bears may therefore be an important study model to understand heart disease in humans.

The genome of the polar bear may also provide the solution for another condition, one that particularly affects our older generation: osteoporosis. This is a disease where bones show reduced density, usually caused by insufficient exercise, reduced calcium intake or food starvation. Bone tissue is constantly being remodelled, meaning that bone is added or removed, depending on nutrient availability and the stress that the bone is under. Female polar bears, however, undergo extreme conditions during every pregnancy. Once autumn comes around, these females will dig maternity dens in the snow and will remain there throughout the winter, both before and after the birth of their cubs. This process results in about six months of fasting, where the female bears have to keep themselves and their cubs alive, depleting their own calcium and calorie reserves. Despite this, their bones remain strong and dense.

Physiologists Alanda Lennox and Allen Goodship found an explanation for this paradox in 2008. They discovered that pregnant bears were able to increase the density of their bones before they started to build their dens. In addition, six months later, when they finally emerged from the den with their cubs, there was no evidence of significant loss of bone density. Hibernating brown bears do not have this capacity and must therefore resort to major bone reformation in the following spring. If the mechanism of bone remodelling in polar bears can be understood, many bedridden humans, and even astronauts, could potentially benefit.

The medical benefits of the polar bear for humanity certainly have their importance in our conservation efforts, but these should not be the only factors taken into consideration. We tend to want to protect animals we think are intelligent and possess emotions, such as elephants and primates. Bears, on the other hand, seem to be perceived as stupid and in many cases violent. And yet anecdotal evidence from the field challenges those assumptions, suggesting for example that polar bears have good problem-solving abilities. A male bear called GoGo in Tennoji Zoo, Osaka, has even been observed making use of a tool to manipulate his environment. The bear used a tree branch on multiple occasions to dislodge a piece of meat hung out of his reach. Problem-solving ability has also been witnessed in wild polar bears, although not as obviously as with GoGo. A calculated move by a male bear involved running and jumping onto barrels in an attempt to get to a photographer standing on a platform four metres high.

In other studies, such as one by Alison Ames in 2008, polar bears showed deliberate and focussed manipulation. For example, Ames observed bears putting objects in piles and then knocking them over in what appeared to be a game. The study demonstrates that bears are capable of agile and thought-out behaviours. These examples suggest bears have greater creativity and problem-solving abilities than previously thought.

As for emotions, while the evidence is once again anecdotal, many bears have been seen to hit out at ice and snow – seemingly out of frustration – when they have just missed out on a kill. Moreover, polar bears can form unusual relationships with other species, including playing with the dogs used to pull sleds in the Arctic. Remarkably, one hand-raised polar bear called Agee has formed a close relationship with her owner Mark Dumas to the point where they even swim together. This is even more astonishing since polar bears are known to actively hunt humans in the wild.

If climate change were to lead to their extinction, this would mean not only the loss of potential breakthroughs in human medicine, but more importantly, the disappearance of an intelligent, majestic animal.

Test 1

Questions 1–7

Do the following statements agree with the information given in Reading Passage 1?

In boxes 1–7 on your answer sheet, write

TRUE	<i>if the statement agrees with the information</i>
FALSE	<i>if the statement contradicts the information</i>
NOT GIVEN	<i>if there is no information on this</i>

- 1 Polar bears suffer from various health problems due to the build-up of fat under their skin.
- 2 The study done by Liu and his colleagues compared different groups of polar bears.
- 3 Liu and colleagues were the first researchers to compare polar bears and brown bears genetically.
- 4 Polar bears are able to control their levels of 'bad' cholesterol by genetic means.
- 5 Female polar bears are able to survive for about six months without food.
- 6 It was found that the bones of female polar bears were very weak when they came out of their dens in spring.
- 7 The polar bear's mechanism for increasing bone density could also be used by people one day.

Questions 8–13

Complete the table below.

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

Write your answers in boxes 8–13 on your answer sheet.

Reasons why polar bears should be protected

People think of bears as unintelligent and **8**

However, this may not be correct. For example:

- In Tennoji Zoo, a bear has been seen using a branch as a **9**
This allowed him to knock down some **10**
- A wild polar bear worked out a method of reaching a platform where a **11** was located.
- Polar bears have displayed behaviour such as conscious manipulation of objects and activity similar to a **12**

Bears may also display emotions. For example:

- They may make movements suggesting **13** if disappointed when hunting.
- They may form relationships with other species.

READING PASSAGE 2

You should spend about 20 minutes on **Questions 14–26**, which are based on Reading Passage 2 on pages 21 and 22.

Questions 14–20

Reading Passage 2 has seven paragraphs, **A–G**.

Choose the correct heading for each paragraph from the list of headings below.

Write the correct number, **i–ix**, in boxes 14–20 on your answer sheet.

List of Headings

- i** The areas and artefacts within the pyramid itself
- ii** A difficult task for those involved
- iii** A king who saved his people
- iv** A single certainty among other less definite facts
- v** An overview of the external buildings and areas
- vi** A pyramid design that others copied
- vii** An idea for changing the design of burial structures
- viii** An incredible experience despite the few remains
- ix** The answers to some unexpected questions

14 Paragraph **A**

15 Paragraph **B**

16 Paragraph **C**

17 Paragraph **D**

18 Paragraph **E**

19 Paragraph **F**

20 Paragraph **G**

The Step Pyramid of Djoser

- A** The pyramids are the most famous monuments of ancient Egypt and still hold enormous interest for people in the present day. These grand, impressive tributes to the memory of the Egyptian kings have become linked with the country even though other cultures, such as the Chinese and Mayan, also built pyramids. The evolution of the pyramid form has been written and argued about for centuries. However, there is no question that, as far as Egypt is concerned, it began with one monument to one king designed by one brilliant architect: the Step Pyramid of Djoser at Saqqara.
- B** Djoser was the first king of the Third Dynasty of Egypt and the first to build in stone. Prior to Djoser's reign, tombs were rectangular monuments made of dried clay brick, which covered underground passages where the deceased person was buried. For reasons which remain unclear, Djoser's main official, whose name was Imhotep, conceived of building a taller, more impressive tomb for his king by stacking stone slabs on top of one another, progressively making them smaller, to form the shape now known as the Step Pyramid. Djoser is thought to have reigned for 19 years, but some historians and scholars attribute a much longer time for his rule, owing to the number and size of the monuments he built.
- C** The Step Pyramid has been thoroughly examined and investigated over the last century, and it is now known that the building process went through many different stages. Historian Marc Van de Mieroop comments on this, writing 'Much experimentation was involved, which is especially clear in the construction of the pyramid in the center of the complex. It had several plans ... before it became the first Step Pyramid in history, piling six levels on top of one another ... The weight of the enormous mass was a challenge for the builders, who placed the stones at an inward incline in order to prevent the monument breaking up.'
- D** When finally completed, the Step Pyramid rose 62 meters high and was the tallest structure of its time. The complex in which it was built was the size of a city in ancient Egypt and included a temple, courtyards, shrines, and living quarters for the priests. It covered a region of 16 hectares and was surrounded by a wall 10.5 meters high. The wall had 13 false doors cut into it with only one true entrance cut into the south-east corner; the entire wall was then ringed by a trench 750 meters long and 40 meters wide. The false doors and the trench were incorporated into the complex to discourage unwanted visitors. If someone wished to enter, he or she would have needed to know in advance how to find the location of the true opening in the wall. Djoser was so proud of his accomplishment that he broke the tradition of having only his own name on the monument and had Imhotep's name carved on it as well.

- E** The burial chamber of the tomb, where the king's body was laid to rest, was dug beneath the base of the pyramid, surrounded by a vast maze of long tunnels that had rooms off them to discourage robbers. One of the most mysterious discoveries found inside the pyramid was a large number of stone vessels. Over 40,000 of these vessels, of various forms and shapes, were discovered in storerooms off the pyramid's underground passages. They are inscribed with the names of rulers from the First and Second Dynasties of Egypt and made from different kinds of stone. There is no agreement among scholars and archaeologists on why the vessels were placed in the tomb of Djoser or what they were supposed to represent. The archaeologist Jean-Philippe Lauer, who excavated most of the pyramid and complex, believes they were originally stored and then given a 'proper burial' by Djoser in his pyramid to honor his predecessors. There are other historians, however, who claim the vessels were dumped into the shafts as yet another attempt to prevent grave robbers from getting to the king's burial chamber.
- F** Unfortunately, all of the precautions and intricate design of the underground network did not prevent ancient robbers from finding a way in. Djoser's grave goods, and even his body, were stolen at some point in the past and all archaeologists found were a small number of his valuables overlooked by the thieves. There was enough left throughout the pyramid and its complex, however, to astonish and amaze the archaeologists who excavated it.
- G** Egyptologist Miroslav Verner writes, 'Few monuments hold a place in human history as significant as that of the Step Pyramid in Saqqara ... It can be said without exaggeration that this pyramid complex constitutes a milestone in the evolution of monumental stone architecture in Egypt and in the world as a whole.' The Step Pyramid was a revolutionary advance in architecture and became the archetype which all the other great pyramid builders of Egypt would follow.

Questions 21–24

Complete the notes below.

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

Write your answers in boxes 21–24 on your answer sheet.

The Step Pyramid of Djoser

The complex that includes the Step Pyramid and its surroundings is considered to be as big as an Egyptian **21** of the past. The area outside the pyramid included accommodation that was occupied by **22** , along with many other buildings and features.

A wall ran around the outside of the complex and a number of false entrances were built into this. In addition, a long **23** encircled the wall. As a result, any visitors who had not been invited were cleverly prevented from entering the pyramid grounds unless they knew the **24** of the real entrance.

Questions 25–26

Choose **TWO** letters, **A–E**.

Write the correct letters in boxes 25 and 26 on your answer sheet.

Which **TWO** of the following points does the writer make about King Djoser?

- A** Initially he had to be persuaded to build in stone rather than clay.
- B** There is disagreement concerning the length of his reign.
- C** He failed to appreciate Imhotep's part in the design of the Step Pyramid.
- D** A few of his possessions were still in his tomb when archaeologists found it.
- E** He criticised the design and construction of other pyramids in Egypt.

READING PASSAGE 3

You should spend about 20 minutes on **Questions 27–40**, which are based on Reading Passage 3 below.

The future of work

According to a leading business consultancy, 3–14% of the global workforce will need to switch to a different occupation within the next 10–15 years, and all workers will need to adapt as their occupations evolve alongside increasingly capable machines. Automation – or ‘embodied artificial intelligence’ (AI) – is one aspect of the disruptive effects of technology on the labour market. ‘Disembodied AI’, like the algorithms running in our smartphones, is another.

Dr Stella Pachidi from Cambridge Judge Business School believes that some of the most fundamental changes are happening as a result of the ‘algorithmication’ of jobs that are dependent on data rather than on production – the so-called knowledge economy. Algorithms are capable of learning from data to undertake tasks that previously needed human judgement, such as reading legal contracts, analysing medical scans and gathering market intelligence.

‘In many cases, they can outperform humans,’ says Pachidi. ‘Organisations are attracted to using algorithms because they want to make choices based on what they consider is “perfect information”, as well as to reduce costs and enhance productivity.’

‘But these enhancements are not without consequences,’ says Pachidi. ‘If routine cognitive tasks are taken over by AI, how do professions develop their future experts?’ she asks. ‘One way of learning about a job is “legitimate peripheral participation” – a novice stands next to experts and learns by observation. If this isn’t happening, then you need to find new ways to learn.’

Another issue is the extent to which the technology influences or even controls the workforce. For over two years, Pachidi monitored a telecommunications company. ‘The way telecoms salespeople work is through personal and frequent contact with clients, using the benefit of experience to assess a situation and reach a decision. However, the company had started using a[n] ... algorithm that defined when account managers should contact certain customers about which kinds of campaigns and what to offer them.’

The algorithm – usually built by external designers – often becomes the keeper of knowledge, she explains. In cases like this, Pachidi believes, a short-sighted view begins to creep into working practices whereby workers learn through the ‘algorithm’s eyes’ and become dependent on its instructions. Alternative explorations – where experimentation and human instinct lead to progress and new ideas – are effectively discouraged.

Pachidi and colleagues even observed people developing strategies to make the algorithm work to their own advantage. ‘We are seeing cases where workers feed the algorithm with false data to reach their targets,’ she reports.

It's scenarios like these that many researchers are working to avoid. Their objective is to make AI technologies more trustworthy and transparent, so that organisations and individuals understand how AI decisions are made. In the meantime, says Pachidi, 'We need to make sure we fully understand the dilemmas that this new world raises regarding expertise, occupational boundaries and control.'

Economist Professor Hamish Low believes that the future of work will involve major transitions across the whole life course for everyone: 'The traditional trajectory of full-time education followed by full-time work followed by a pensioned retirement is a thing of the past,' says Low. Instead, he envisages a multistage employment life: one where retraining happens across the life course, and where multiple jobs and no job happen by choice at different stages.

On the subject of job losses, Low believes the predictions are founded on a fallacy: 'It assumes that the number of jobs is fixed. If in 30 years, half of 100 jobs are being carried out by robots, that doesn't mean we are left with just 50 jobs for humans. The number of jobs will increase: we would expect there to be 150 jobs.'

Dr Ewan McGaughey, at Cambridge's Centre for Business Research and King's College London, agrees that 'apocalyptic' views about the future of work are misguided. 'It's the laws that restrict the supply of capital to the job market, not the advent of new technologies that causes unemployment.'

His recently published research answers the question of whether automation, AI and robotics will mean a 'jobless future' by looking at the causes of unemployment. 'History is clear that change can mean redundancies. But social policies can tackle this through retraining and redeployment.'

He adds: 'If there is going to be change to jobs as a result of AI and robotics then I'd like to see governments seizing the opportunity to improve policy to enforce good job security. We can "reprogramme" the law to prepare for a fairer future of work and leisure.' McGaughey's findings are a call to arms to leaders of organisations, governments and banks to pre-empt the coming changes with bold new policies that guarantee full employment, fair incomes and a thriving economic democracy.

'The promises of these new technologies are astounding. They deliver humankind the capacity to live in a way that nobody could have once imagined,' he adds. 'Just as the industrial revolution brought people past subsistence agriculture, and the corporate revolution enabled mass production, a third revolution has been pronounced. But it will not only be one of technology. The next revolution will be social.'

Test 1

Questions 27–30

Choose the correct letter, **A**, **B**, **C** or **D**.

Write the correct letter in boxes 27–30 on your answer sheet.

- 27** The first paragraph tells us about
- A** the kinds of jobs that will be most affected by the growth of AI.
 - B** the extent to which AI will alter the nature of the work that people do.
 - C** the proportion of the world's labour force who will have jobs in AI in the future.
 - D** the difference between ways that embodied and disembodied AI will impact on workers.
- 28** According to the second paragraph, what is Stella Pachidi's view of the 'knowledge economy'?
- A** It is having an influence on the number of jobs available.
 - B** It is changing people's attitudes towards their occupations.
 - C** It is the main reason why the production sector is declining.
 - D** It is a key factor driving current developments in the workplace.
- 29** What did Pachidi observe at the telecommunications company?
- A** staff disagreeing with the recommendations of AI
 - B** staff feeling resentful about the intrusion of AI in their work
 - C** staff making sure that AI produces the results that they want
 - D** staff allowing AI to carry out tasks they ought to do themselves
- 30** In his recently published research, Ewan McGaughey
- A** challenges the idea that redundancy is a negative thing.
 - B** shows the profound effect of mass unemployment on society.
 - C** highlights some differences between past and future job losses.
 - D** illustrates how changes in the job market can be successfully handled.

Questions 31–34

Complete the summary using the list of words, **A–G**, below.

Write the correct letter, **A–G**, in boxes 31–34 on your answer sheet.

The ‘algorithmic’ of jobs

Stella Pachidi of Cambridge Judge Business School has been focusing on the ‘algorithmic’ of jobs which rely not on production but on **31**

While monitoring a telecommunications company, Pachidi observed a growing **32** on the recommendations made by AI, as workers begin to learn through the ‘algorithm’s eyes’. Meanwhile, staff are deterred from experimenting and using their own **33**, and are therefore prevented from achieving innovation.

To avoid the kind of situations which Pachidi observed, researchers are trying to make AI’s decision-making process easier to comprehend, and to increase users’ **34** with regard to the technology.

- | | | |
|----------------------|-----------------------|---------------------|
| A pressure | B satisfaction | C intuition |
| D promotion | E reliance | F confidence |
| G information | | |

Test 1

Questions 35–40

Look at the following statements (Questions 35–40) and the list of people below.

Match each statement with the correct person, **A**, **B** or **C**.

Write the correct letter, **A**, **B** or **C**, in boxes 35–40 on your answer sheet.

NB You may use any letter more than once.

- 35 Greater levels of automation will not result in lower employment.
- 36 There are several reasons why AI is appealing to businesses.
- 37 AI's potential to transform people's lives has parallels with major cultural shifts which occurred in previous eras.
- 38 It is important to be aware of the range of problems that AI causes.
- 39 People are going to follow a less conventional career path than in the past.
- 40 Authorities should take measures to ensure that there will be adequately paid work for everyone.

List of people

- A** Stella Pachidi
- B** Hamish Low
- C** Ewan McGaughey

READING

READING PASSAGE 1

You should spend about 20 minutes on **Questions 1–13**, which are based on Reading Passage 1 below.

The White Horse of Uffington



The cutting of huge figures or 'geoglyphs' into the earth of English hillsides has taken place for more than 3,000 years. There are 56 hill figures scattered around England, with the vast majority on the chalk downlands of the country's southern counties. The figures include giants, horses, crosses and regimental badges. Although the majority of these geoglyphs date within the last 300 years or so, there are one or two that are much older.

The most famous of these figures is perhaps also the most mysterious – the Uffington White Horse in Oxfordshire. The White Horse has recently been re-dated and shown to be even older than its previously assigned ancient pre-Roman Iron Age* date. More controversial is the date of the enigmatic Long Man of Wilmington in Sussex. While many historians are convinced the figure is prehistoric, others believe that it was the work of an artistic monk from a nearby priory and was created between the 11th and 15th centuries.

The method of cutting these huge figures was simply to remove the overlying grass to reveal the gleaming white chalk below. However, the grass would soon grow over the geoglyph again unless it was regularly cleaned or scoured by a fairly large team of people. One reason that the vast majority of hill figures have disappeared is that when the traditions associated with the figures faded, people no longer bothered or remembered to clear away the grass to expose the chalk outline. Furthermore, over hundreds of years the outlines would sometimes change due to people not always cutting in exactly the same place, thus creating a different shape to the original geoglyph. The fact that any ancient hill figures survive at all in England today is testament to the strength and continuity of local customs and beliefs which, in one case at least, must stretch back over millennia.

*Iron Age: a period (in Britain 800 BCE – 43 CE) that is characterised by the use of iron tools

The Uffington White Horse is a unique, stylised representation of a horse consisting of a long, sleek back, thin disjointed legs, a streaming tail, and a bird-like beaked head. The elegant creature almost melts into the landscape. The horse is situated 2.5 km from Uffington village on a steep slope close to the Late Bronze Age* (c. 7th century BCE) hillfort of Uffington Castle and below the Ridgeway, a long-distance Neolithic** track.

The Uffington Horse is also surrounded by Bronze Age burial mounds. It is not far from the Bronze Age cemetery of Lambourn Seven Barrows, which consists of more than 30 well-preserved burial mounds. The carving has been placed in such a way as to make it extremely difficult to see from close quarters, and like many geoglyphs is best appreciated from the air. Nevertheless, there are certain areas of the Vale of the White Horse, the valley containing and named after the enigmatic creature, from which an adequate impression may be gained. Indeed on a clear day the carving can be seen from up to 30 km away.

The earliest evidence of a horse at Uffington is from the 1070s CE when 'White Horse Hill' is mentioned in documents from the nearby Abbey of Abingdon, and the first reference to the horse itself is soon after, in 1190 CE. However, the carving is believed to date back much further than that. Due to the similarity of the Uffington White Horse to the stylised depictions of horses on 1st century BCE coins, it had been thought that the creature must also date to that period.

However, in 1995 Optically Stimulated Luminescence (OSL) testing was carried out by the Oxford Archaeological Unit on soil from two of the lower layers of the horse's body, and from another cut near the base. The result was a date for the horse's construction somewhere between 1400 and 600 BCE – in other words, it had a Late Bronze Age or Early Iron Age origin.

The latter end of this date range would tie the carving of the horse in with occupation of the nearby Uffington hillfort, indicating that it may represent a tribal emblem marking the land of the inhabitants of the hillfort. Alternatively, the carving may have been carried out during a Bronze or Iron Age ritual. Some researchers see the horse as representing the Celtic*** horse goddess Epona, who was worshipped as a protector of horses, and for her associations with fertility. However, the cult of Epona was not imported from Gaul (France) until around the first century CE. This date is at least six centuries after the Uffington Horse was probably carved. Nevertheless, the horse had great ritual and economic significance during the Bronze and Iron Ages, as attested by its depictions on jewellery and other metal objects. It is possible that the carving represents a goddess in native mythology, such as Rhiannon, described in later Welsh mythology as a beautiful woman dressed in gold and riding a white horse.

The fact that geoglyphs can disappear easily, along with their associated rituals and meaning, indicates that they were never intended to be anything more than temporary gestures. But this does not lessen their importance. These giant carvings are a fascinating glimpse into the minds of their creators and how they viewed the landscape in which they lived.

*Bronze Age: a period (in Britain c. 2,500 BCE – 800 BCE) that is characterised by the development of bronze tools

**Neolithic: a period (in Britain c. 4,000 BCE – c. 2,500 BCE) that is significant for the spread of agricultural practices, and the use of stone tools

***Celtic: an ancient people who migrated from Europe to Britain before the Romans

Test 2

Questions 1–8

Do the following statements agree with the information given in Reading Passage 1?

In boxes 1–8 on your answer sheet, write

TRUE	<i>if the statement agrees with the information</i>
FALSE	<i>if the statement contradicts the information</i>
NOT GIVEN	<i>if there is no information on this</i>

- 1 Most geoglyphs in England are located in a particular area of the country.
- 2 There are more geoglyphs in the shape of a horse than any other creature.
- 3 A recent dating of the Uffington White Horse indicates that people were mistaken about its age.
- 4 Historians have come to an agreement about the origins of the Long Man of Wilmington.
- 5 Geoglyphs were created by people placing white chalk on the hillside.
- 6 Many geoglyphs in England are no longer visible.
- 7 The shape of some geoglyphs has been altered over time.
- 8 The fame of the Uffington White Horse is due to its size.

Questions 9–13

Complete the notes below.

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

Write your answers in boxes 9–13 on your answer sheet.

The Uffington White Horse

The location of the Uffington White Horse:

- a distance of 2.5 km from Uffington village
- near an ancient road known as the 9
- close to an ancient cemetery that has a number of burial mounds

Dating the Uffington White Horse:

- first reference to White Horse Hill appears in 10 from the 1070s
- horses shown on coins from the period 100 BCE – 1 BCE are similar in appearance
- according to analysis of the surrounding 11 , the Horse is Late Bronze Age / Early Iron Age

Possible reasons for creation of the Uffington White Horse:

- an emblem to indicate land ownership
- formed part of an ancient ritual
- was a representation of goddess Epona – associated with protection of horses and 12
- was a representation of a Welsh goddess called 13

READING PASSAGE 2

You should spend about 20 minutes on **Questions 14–26**, which are based on Reading Passage 2 below.

I contain multitudes

Wendy Moore reviews Ed Yong's book about microbes

Microbes, most of them bacteria, have populated this planet since long before animal life developed and they will outlive us. Invisible to the naked eye, they are ubiquitous. They inhabit the soil, air, rocks and water and are present within every form of life, from seaweed and coral to dogs and humans. And, as Yong explains in his utterly absorbing and hugely important book, we mess with them at our peril.

Every species has its own colony of microbes, called a 'microbiome', and these microbes vary not only between species but also between individuals and within different parts of each individual. What is amazing is that while the number of human cells in the average person is about 30 trillion, the number of microbial ones is higher – about 39 trillion. At best, Yong informs us, we are only 50 per cent human. Indeed, some scientists even suggest we should think of each species and its microbes as a single unit, dubbed a 'holobiont'.

In each human there are microbes that live only in the stomach, the mouth or the armpit and by and large they do so peacefully. So 'bad' microbes are just microbes out of context. Microbes that sit contentedly in the human gut (where there are more microbes than there are stars in the galaxy) can become deadly if they find their way into the bloodstream. These communities are constantly changing too. The right hand shares just one sixth of its microbes with the left hand. And, of course, we are surrounded by microbes. Every time we eat, we swallow a million microbes in each gram of food; we are continually swapping microbes with other humans, pets and the world at large.

It's a fascinating topic and Yong, a young British science journalist, is an extraordinarily adept guide. Writing with lightness and panache, he has a knack of explaining complex science in terms that are both easy to understand and totally enthralling. Yong is on a mission. Leading us gently by the hand, he takes us into the world of microbes – a bizarre, alien planet – in a bid to persuade us to love them as much as he does. By the end, we do.

For most of human history we had no idea that microbes existed. The first man to see these extraordinarily potent creatures was a Dutch lens-maker called Antony van Leeuwenhoek in the 1670s. Using microscopes of his own design that could magnify up to 270 times, he examined a drop of water from a nearby lake and found it teeming with tiny creatures he called 'animalcules'. It wasn't until nearly two hundred years later that the research of French biologist Louis Pasteur indicated that some microbes caused disease. It was Pasteur's 'germ theory' that gave bacteria the poor image that endures today.

Yong's book is in many ways a plea for microbial tolerance, pointing out that while fewer than one hundred species of bacteria bring disease, many thousands more play a vital role in maintaining our health. The book also acknowledges that our attitude towards bacteria is not a simple one. We tend to see the dangers posed by bacteria, yet at the same time we are sold yoghurts and drinks that supposedly nurture 'friendly' bacteria. In reality, says Yong, bacteria should not be viewed as either friends or foes, villains or heroes. Instead we should realise we have a symbiotic relationship, that can be mutually beneficial or mutually destructive.

What then do these millions of organisms do? The answer is pretty much everything. New research is now unravelling the ways in which bacteria aid digestion, regulate our immune systems, eliminate toxins, produce vitamins, affect our behaviour and even combat obesity. 'They actually help us become who we are,' says Yong. But we are facing a growing problem. Our obsession with hygiene, our overuse of antibiotics and our unhealthy, low-fibre diets are disrupting the bacterial balance and may be responsible for soaring rates of allergies and immune problems, such as inflammatory bowel disease (IBD).

The most recent research actually turns accepted norms upside down. For example, there are studies indicating that the excessive use of household detergents and antibacterial products actually destroys the microbes that normally keep the more dangerous germs at bay. Other studies show that keeping a dog as a pet gives children early exposure to a diverse range of bacteria, which may help protect them against allergies later.

The readers of Yong's book must be prepared for a decidedly unglamorous world. Among the less appealing case studies is one about a fungus that is wiping out entire populations of frogs and that can be halted by a rare microbial bacterium. Another is about squid that carry luminescent bacteria that protect them against predators. However, if you can overcome your distaste for some of the investigations, the reasons for Yong's enthusiasm become clear. The microbial world is a place of wonder. Already, in an attempt to stop mosquitoes spreading dengue fever – a disease that infects 400 million people a year – mosquitoes are being loaded with a bacterium to block the disease. In the future, our ability to manipulate microbes means we could construct buildings with useful microbes built into their walls to fight off infections. Just imagine a neonatal hospital ward coated in a specially mixed cocktail of microbes so that babies get the best start in life.

Test 2

Questions 14–16

Choose the correct letter, **A**, **B**, **C** or **D**.

Write the correct letter in boxes 14–16 on your answer sheet.

- 14** What point does the writer make about microbes in the first paragraph?
- A** They adapt quickly to their environment.
 - B** The risk they pose has been exaggerated.
 - C** They are more plentiful in animal life than plant life.
 - D** They will continue to exist for longer than the human race.
- 15** In the second paragraph, the writer is impressed by the fact that
- A** each species tends to have vastly different microbes.
 - B** some parts of the body contain relatively few microbes.
 - C** the average individual has more microbial cells than human ones.
 - D** scientists have limited understanding of how microbial cells behave.
- 16** What is the writer doing in the fifth paragraph?
- A** explaining how a discovery was made
 - B** comparing scientists' theories about microbes
 - C** describing confusion among scientists
 - D** giving details of how microbes cause disease

Questions 17–20

Complete the summary using the list of words, **A–H**, below.

Write the correct letter, **A–H**, in boxes 17–20 on your answer sheet.

We should be more tolerant of microbes

Yong's book argues that we should be more tolerant of microbes. Many have a beneficial effect, and only a relatively small number lead to **17** And although it is misleading to think of microbes as 'friendly', we should also stop thinking of them as the enemy. In fact, we should accept that our relationship with microbes is one based on **18**

New research shows that microbes have numerous benefits for humans. Amongst other things, they aid digestion, remove poisons, produce vitamins and may even help reduce obesity. However, there is a growing problem. Our poor **19**, our overuse of antibiotics, and our excessive focus on **20** are upsetting the bacterial balance and may be contributing to the huge increase in allergies and immune system problems.

- | | | |
|-----------------------|----------------------|----------------------|
| A solution | B partnership | C destruction |
| D exaggeration | E cleanliness | F regulations |
| G illness | H nutrition | |

Test 2

Questions 21–26

Do the following statements agree with the claims of the writer in Reading Passage 2?

In boxes 21–26 on your answer sheet, write

YES *if the statement agrees with the claims of the writer*
NO *if the statement contradicts the claims of the writer*
NOT GIVEN *if it is impossible to say what the writer thinks about this*

- 21 It is possible that using antibacterial products in the home fails to have the desired effect.
- 22 It is a good idea to ensure that children come into contact with as few bacteria as possible.
- 23 Yong's book contains more case studies than are necessary.
- 24 The case study about bacteria that prevent squid from being attacked may have limited appeal.
- 25 Efforts to control dengue fever have been surprisingly successful.
- 26 Microbes that reduce the risk of infection have already been put inside the walls of some hospital wards.

READING PASSAGE 3

You should spend about 20 minutes on **Questions 27–40**, which are based on Reading Passage 3 below.

How to make wise decisions

Across cultures, wisdom has been considered one of the most revered human qualities. Although the truly wise may seem few and far between, empirical research examining wisdom suggests that it isn't an exceptional trait possessed by a small handful of bearded philosophers after all – in fact, the latest studies suggest that most of us have the ability to make wise decisions, given the right context.

'It appears that experiential, situational, and cultural factors are even more powerful in shaping wisdom than previously imagined,' says Associate Professor Igor Grossmann of the University of Waterloo in Ontario, Canada. 'Recent empirical findings from cognitive, developmental, social, and personality psychology cumulatively suggest that people's ability to reason wisely varies dramatically across experiential and situational contexts. Understanding the role of such contextual factors offers unique insights into understanding wisdom in daily life, as well as how it can be enhanced and taught.'

It seems that it's not so much that some people simply possess wisdom and others lack it, but that our ability to reason wisely depends on a variety of external factors. 'It is impossible to characterize thought processes attributed to wisdom without considering the role of contextual factors,' explains Grossmann. 'In other words, wisdom is not solely an "inner quality" but rather unfolds as a function of situations people happen to be in. Some situations are more likely to promote wisdom than others.'

Coming up with a definition of wisdom is challenging, but Grossmann and his colleagues have identified four key characteristics as part of a framework of wise reasoning. One is intellectual humility or recognition of the limits of our own knowledge, and another is appreciation of perspectives wider than the issue at hand. Sensitivity to the possibility of change in social relations is also key, along with compromise or integration of different attitudes and beliefs.

Grossmann and his colleagues have also found that one of the most reliable ways to support wisdom in our own day-to-day decisions is to look at scenarios from a third-party perspective, as though giving advice to a friend. Research suggests that when adopting a first-person viewpoint we focus on 'the focal features of the environment' and when we adopt a third-person, 'observer' viewpoint we reason more broadly and focus more on interpersonal and moral ideals such as justice and impartiality. Looking at problems from this more expansive viewpoint appears to foster cognitive processes related to wise decisions.

Test 2

What are we to do, then, when confronted with situations like a disagreement with a spouse or negotiating a contract at work, that require us to take a personal stake? Grossmann argues that even when we aren't able to change the situation, we can still evaluate these experiences from different perspectives.

For example, in one experiment that took place during the peak of a recent economic recession, graduating college seniors were asked to reflect on their job prospects. The students were instructed to imagine their career either 'as if you were a distant observer' or 'before your own eyes as if you were right there'. Participants in the group assigned to the 'distant observer' role displayed more wisdom-related reasoning (intellectual humility and recognition of change) than did participants in the control group.

In another study, couples in long-term romantic relationships were instructed to visualize an unresolved relationship conflict either through the eyes of an outsider or from their own perspective. Participants then discussed the incident with their partner for 10 minutes, after which they wrote down their thoughts about it. Couples in the 'other's eyes' condition were significantly more likely to rely on wise reasoning – recognizing others' perspectives and searching for a compromise – compared to the couples in the egocentric condition.

'Ego-decentering promotes greater focus on others and enables a bigger picture, conceptual view of the experience, affording recognition of intellectual humility and change,' says Grossmann.

We might associate wisdom with intelligence or particular personality traits, but research shows only a small positive relationship between wise thinking and crystallized intelligence and the personality traits of openness and agreeableness. 'It is remarkable how much people can vary in their wisdom from one situation to the next, and how much stronger such contextual effects are for understanding the relationship between wise judgment and its social and affective outcomes as compared to the generalized "traits",' Grossmann explains. 'That is, knowing how wisely a person behaves in a given situation is more informative for understanding their emotions or likelihood to forgive [or] retaliate as compared to knowing whether the person may be wise "in general".'

Questions 27–30

Choose the correct letter, **A**, **B**, **C** or **D**.

Write the correct letter in boxes 27–30 on your answer sheet.

- 27** What point does the writer make in the first paragraph?
- A** Wisdom appears to be unique to the human race.
 - B** A basic assumption about wisdom may be wrong.
 - C** Concepts of wisdom may depend on the society we belong to.
 - D** There is still much to be discovered about the nature of wisdom.
- 28** What does Igor Grossmann suggest about the ability to make wise decisions?
- A** It can vary greatly from one person to another.
 - B** Earlier research into it was based on unreliable data.
 - C** The importance of certain influences on it was underestimated.
 - D** Various branches of psychology define it according to their own criteria.
- 29** According to the third paragraph, Grossmann claims that the level of wisdom an individual shows
- A** can be greater than they think it is.
 - B** will be different in different circumstances.
 - C** may be determined by particular aspects of their personality.
 - D** should develop over time as a result of their life experiences.
- 30** What is described in the fifth paragraph?
- A** a difficulty encountered when attempting to reason wisely
 - B** an example of the type of person who is likely to reason wisely
 - C** a controversial view about the benefits of reasoning wisely
 - D** a recommended strategy that can help people to reason wisely

Test 2

Questions 31–35

Complete the summary using the list of words, **A–J**, below.

Write the correct letter, **A–J**, in boxes 31–35 on your answer sheet.

The characteristics of wise reasoning

Igor Grossmann and colleagues have established four characteristics which enable us to make wise decisions. It is important to have a certain degree of **31** regarding the extent of our knowledge, and to take into account **32** which may not be the same as our own. We should also be able to take a broad **33** of any situation. Another key characteristic is being aware of the likelihood of alterations in the way that people relate to each other.

Grossmann also believes that it is better to regard scenarios with **34** By avoiding the first-person perspective, we focus more on **35** and on other moral ideals, which in turn leads to wiser decision-making.

- | | | |
|-------------------|----------------------|----------------------|
| A opinions | B confidence | C view |
| D modesty | E problems | F objectivity |
| G fairness | H experiences | I range |
| J reasons | | |

Questions 36–40

Do the following statements agree with the information given in Reading Passage 3?

In boxes 36–40 on your answer sheet, write

TRUE if the statement agrees with the information
FALSE if the statement contradicts the information
NOT GIVEN if there is no information on this

- 36 Students participating in the job prospects experiment could choose one of two perspectives to take.
- 37 Participants in the couples experiment were aware that they were taking part in a study about wise reasoning.
- 38 In the couples experiments, the length of the couples' relationships had an impact on the results.
- 39 In both experiments, the participants who looked at the situation from a more detached viewpoint tended to make wiser decisions.
- 40 Grossmann believes that a person's wisdom is determined by their intelligence to only a very limited extent.

READING

READING PASSAGE 1

You should spend about 20 minutes on **Questions 1–13**, which are based on Reading Passage 1 below.

Roman shipbuilding and navigation

Shipbuilding today is based on science and ships are built using computers and sophisticated tools. Shipbuilding in ancient Rome, however, was more of an art relying on estimation, inherited techniques and personal experience. The Romans were not traditionally sailors but mostly land-based people, who learned to build ships from the people that they conquered, namely the Greeks and the Egyptians.

There are a few surviving written documents that give descriptions and representations of ancient Roman ships, including the sails and rigging. Excavated vessels also provide some clues about ancient shipbuilding techniques. Studies of these have taught us that ancient Roman shipbuilders built the outer hull first, then proceeded with the frame and the rest of the ship. Planks used to build the outer hull were initially sewn together. Starting from the 6th century BCE, they were fixed using a method called mortise and tenon, whereby one plank locked into another without the need for stitching. Then in the first centuries of the current era, Mediterranean shipbuilders shifted to another shipbuilding method, still in use today, which consisted of building the frame first and then proceeding with the hull and the other components of the ship. This method was more systematic and dramatically shortened ship construction times. The ancient Romans built large merchant ships and warships whose size and technology were unequalled until the 16th century CE.

Warships were built to be lightweight and very speedy. They had to be able to sail near the coast, which is why they had no ballast or excess load and were built with a long, narrow hull. They did not sink when damaged and often would lie crippled on the sea's surface following naval battles. They had a bronze battering ram, which was used to pierce the timber hulls or break the oars of enemy vessels. Warships used both wind (sails) and human power (oarsmen) and were therefore very fast. Eventually, Rome's navy became the largest and most powerful in the Mediterranean, and the Romans had control over what they therefore called *Mare Nostrum* meaning 'our sea'.

There were many kinds of warship. The 'trireme' was the dominant warship from the 7th to 4th century BCE. It had rowers in the top, middle and lower levels, and approximately 50 rowers in each bank. The rowers at the bottom had the most uncomfortable position as they were under the other rowers and were exposed to the water entering through the oar-holes. It is worth noting that contrary to popular perception, rowers were not slaves but mostly Roman citizens enrolled in the military. The trireme was superseded by larger ships with even more rowers.

Test 3

Merchant ships were built to transport lots of cargo over long distances and at a reasonable cost. They had a wider hull, double planking and a solid interior for added stability. Unlike warships, their V-shaped hull was deep underwater, meaning that they could not sail too close to the coast. They usually had two huge side rudders located off the stern and controlled by a small tiller bar connected to a system of cables. They had from one to three masts with large square sails and a small triangular sail at the bow. Just like warships, merchant ships used oarsmen, but coordinating the hundreds of rowers in both types of ship was not an easy task. In order to assist them, music would be played on an instrument, and oars would then keep time with this.

The cargo on merchant ships included raw materials (e.g. iron bars, copper, marble and granite), and agricultural products (e.g. grain from Egypt's Nile valley). During the Empire, Rome was a huge city by ancient standards of about one million inhabitants. Goods from all over the world would come to the city through the port of Pozzuoli situated west of the bay of Naples in Italy and through the gigantic port of Ostia situated at the mouth of the Tiber River. Large merchant ships would approach the destination port and, just like today, be intercepted by a number of towboats that would drag them to the quay.

The time of travel along the many sailing routes could vary widely. Navigation in ancient Rome did not rely on sophisticated instruments such as compasses but on experience, local knowledge and observation of natural phenomena. In conditions of good visibility, seamen in the Mediterranean often had the mainland or islands in sight, which greatly facilitated navigation. They sailed by noting their position relative to a succession of recognisable landmarks. When weather conditions were not good or where land was no longer visible, Roman mariners estimated directions from the pole star or, with less accuracy, from the Sun at noon. They also estimated directions relative to the wind and swell. Overall, shipping in ancient Roman times resembled shipping today with large vessels regularly crossing the seas and bringing supplies from their Empire.

Questions 1–5

Do the following statements agree with the information given in Reading Passage 1?

In boxes 1–5 on your answer sheet, write

TRUE *if the statement agrees with the information*
FALSE *if the statement contradicts the information*
NOT GIVEN *if there is no information on this*

- 1 The Romans' shipbuilding skills were passed on to the Greeks and the Egyptians.
- 2 Skilled craftsmen were needed for the mortise and tenon method of fixing planks.
- 3 The later practice used by Mediterranean shipbuilders involved building the hull before the frame.
- 4 The Romans called the Mediterranean Sea *Mare Nostrum* because they dominated its use.
- 5 Most rowers on ships were people from the Roman army.

Questions 6–13

Complete the summary below.

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

Write your answers in boxes 6–13 on your answer sheet.

Warships and merchant ships

Warships were designed so that they were **6** and moved quickly. They often remained afloat after battles and were able to sail close to land as they lacked any additional weight. A battering ram made of **7** was included in the design for attacking and damaging the timber and oars of enemy ships. Warships, such as the 'trireme', had rowers on three different **8**

Unlike warships, merchant ships had a broad **9** that lay far below the surface of the sea. Merchant ships were steered through the water with the help of large rudders and a tiller bar. They had both square and **10** sails. On merchant ships and warships, **11** was used to ensure rowers moved their oars in and out of the water at the same time.

Quantities of agricultural goods such as **12** were transported by merchant ships to two main ports in Italy. The ships were pulled to the shore by **13** When the weather was clear and they could see islands or land, sailors used landmarks that they knew to help them navigate their route.

READING PASSAGE 2

You should spend about 20 minutes on **Questions 14–26**, which are based on Reading Passage 2 below.

Climate change reveals ancient artefacts in Norway's glaciers

- A** Well above the treeline in Norway's highest mountains, ancient fields of ice are shrinking as Earth's climate warms. As the ice has vanished, it has been giving up the treasures it has preserved in cold storage for the last 6,000 years – items such as ancient arrows and skis from Viking Age* traders. And those artefacts have provided archaeologists with some surprising insights into how ancient Norwegians made their livings.
- B** Organic materials like textiles and hides are relatively rare finds at archaeological sites. This is because unless they're protected from the microorganisms that cause decay, they tend not to last long. Extreme cold is one reliable way to keep artefacts relatively fresh for a few thousand years, but once thawed out, these materials experience degradation relatively swiftly.

With climate change shrinking ice cover around the world, glacial archaeologists need to race the clock to find newly revealed artefacts, preserve them, and study them. If something fragile dries and is windblown it might very soon be lost to science, or an arrow might be exposed and then covered again by the next snow and remain well-preserved. The unpredictability means that glacial archaeologists have to be systematic in their approach to fieldwork.

- C** Over a nine-year period, a team of archaeologists, which included Lars Pilø of Oppland County Council, Norway, and James Barrett of the McDonald Institute for Archaeological Research, surveyed patches of ice in Oppland, an area of south-central Norway that is home to some of the country's highest mountains. Reindeer once congregated on these icy patches in the later summer months to escape biting insects, and from the late Stone Age**, hunters followed. In addition, trade routes threaded through the mountain passes of Oppland, linking settlements in Norway to the rest of Europe.

The slow but steady movement of glaciers tends to destroy anything at their bases, so the team focused on stationary patches of ice, mostly above 1,400 metres. That ice is found amid fields of frost-weathered boulders, fallen rocks, and exposed bedrock that for nine months of the year is buried beneath snow.

'Fieldwork is hard work – hiking with all our equipment, often camping on permafrost – but very rewarding. You're rescuing the archaeology, bringing the melting ice to wider attention, discovering a unique environmental history and really connecting with the natural environment,' says Barrett.

*Viking Age: a period of European history from around 700 CE to around 1050 CE when Scandinavian Vikings migrated throughout Europe by means of trade and warfare

** The Stone Age: a period in early history that began about 3.4 million years ago

Test 3

- D** At the edges of the contracting ice patches, archaeologists found more than 2,000 artefacts, which formed a material record that ran from 4,000 BCE to the beginnings of the Renaissance in the 14th century. Many of the artefacts are associated with hunting. Hunters would have easily misplaced arrows and they often discarded broken bows rather than take them all the way home. Other items could have been used by hunters traversing the high mountain passes of Oppland: all-purpose items like tools, skis, and horse tack.
- E** Barrett's team radiocarbon-dated 153 of the artefacts and compared those dates to the timing of major environmental changes in the region – such as periods of cooling or warming – and major social and economic shifts – such as the growth of farming settlements and the spread of international trade networks leading up to the Viking Age. They found that some periods had produced lots of artefacts, which indicates that people had been pretty active in the mountains during those times. But there were few or no signs of activity during other periods.
- F** What was surprising, according to Barrett, was the timing of these periods. Oppland's mountains present daunting terrain and in periods of extreme cold, glaciers could block the higher mountain passes and make travel in the upper reaches of the mountains extremely difficult. Archaeologists assumed people would stick to lower elevations during a time like the Late Antique Little Ice Age, a short period of deeper-than-usual cold from about 536–600 CE. But it turned out that hunters kept regularly venturing into the mountains even when the climate turned cold, based on the amount of stuff they had apparently dropped there.

'Remarkably, though, the finds from the ice may have continued through this period, perhaps suggesting that the importance of mountain hunting increased to supplement failing agricultural harvests in times of low temperatures,' says Barrett. A colder turn in the Scandinavian climate would likely have meant widespread crop failures, so more people would have depended on hunting to make up for those losses.

- G** Many of the artefacts Barrett's team recovered date from the beginning of the Viking Age, the 700s through to the 900s CE. Trade networks connecting Scandinavia with Europe and the Middle East were expanding around this time. Although we usually think of ships when we think of Scandinavian expansion, these recent discoveries show that plenty of goods travelled on overland routes, like the mountain passes of Oppland. And growing Norwegian towns, along with export markets, would have created a booming demand for hides to fight off the cold, as well as antlers to make useful things like combs. Business must have been good for hunters.
- H** Norway's mountains are probably still hiding a lot of history – and prehistory – in remote ice patches. When Barrett's team looked at the dates for their sample of 153 artefacts, they noticed a gap with almost no artefacts from about 3,800 to 2,200 BCE. In fact, archaeological finds from that period are rare all over Norway. The researchers say that could be because many of those artefacts have already disintegrated or are still frozen in the ice. That means archaeologists could be extracting some of those artefacts from retreating ice in years to come.

Questions 14–19

Reading Passage 2 has eight sections, **A–H**.

Which section contains the following information?

*Write the correct letter, **A–H**, in boxes 14–19 on your answer sheet.*

- 14** an explanation for weapons being left behind in the mountains
- 15** a reference to the physical difficulties involved in an archaeological expedition
- 16** an explanation of why less food may have been available
- 17** a reference to the possibility of future archaeological discoveries
- 18** examples of items that would have been traded
- 19** a reference to the pressure archaeologists are under to work quickly

Questions 20–22

Complete the summary below.

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

Write your answers in boxes 20–22 on your answer sheet.

Interesting finds at an archaeological site

Organic materials such as animal skins and textiles are not discovered very often at archaeological sites. They have little protection against **20** , which means that they decay relatively quickly. But this is not always the case. If temperatures are low enough, fragile artefacts can be preserved for thousands of years.

A team of archaeologists have been working in the mountains in Oppland in Norway to recover artefacts revealed by shrinking ice cover. In the past, there were trade routes through these mountains and **21** gathered there in the summer months to avoid being attacked by **22** on lower ground. The people who used these mountains left things behind and it is those objects that are of interest to archaeologists.

Test 3

Questions 23 and 24

Choose **TWO** letters, **A–E**.

Write the correct letters in boxes 23 and 24 on your answer sheet.

Which **TWO** of the following statements does the writer make about the discoveries of Barrett's team?

- A** Artefacts found in the higher mountain passes were limited to skiing equipment.
- B** Hunters went into the mountains even during periods of extreme cold.
- C** The number of artefacts from certain time periods was relatively low.
- D** Radiocarbon dating of artefacts produced some unreliable results.
- E** More artefacts were found in Oppland than at any other mountain site.

Questions 25 and 26

Choose **TWO** letters, **A–E**.

Write the correct letters in boxes 25 and 26 on your answer sheet.

Which **TWO** of the following statements does the writer make about the Viking Age?

- A** Hunters at this time benefited from an increased demand for goods.
- B** The beginning of the period saw the greatest growth in the wealth of Vikings.
- C** Vikings did not rely on ships alone to transport goods.
- D** Norwegian towns at this time attracted traders from around the world.
- E** Vikings were primarily interested in their trading links with the Middle East.

READING PASSAGE 3

You should spend about 20 minutes on **Questions 27–40**, which are based on Reading Passage 3 below.

Plant ‘thermometer’ triggers springtime growth by measuring night-time heat

A photoreceptor molecule in plant cells has been found to have a second job as a thermometer after dark – allowing plants to read seasonal temperature changes. Scientists say the discovery could help breed crops that are more resilient to the temperatures expected to result from climate change

- A** An international team of scientists led by the University of Cambridge has discovered that the ‘thermometer’ molecule in plants enables them to develop according to seasonal temperature changes. Researchers have revealed that molecules called phytochromes – used by plants to detect light during the day – actually change their function in darkness to become cellular temperature gauges that measure the heat of the night.
- The new findings, published in the journal *Science*, show that phytochromes control genetic switches in response to temperature as well as light to dictate plant development.
- B** At night, these molecules change states, and the pace at which they change is ‘directly proportional to temperature’, say scientists, who compare phytochromes to mercury in a thermometer. The warmer it is, the faster the molecular change – stimulating plant growth.
- C** Farmers and gardeners have known for hundreds of years how responsive plants are to temperature: warm winters cause many trees and flowers to bud early, something humans have long used to predict weather and harvest times for the coming year. The latest research pinpoints for the first time a molecular mechanism in plants that reacts to temperature – often triggering the buds of spring we long to see at the end of winter.
- D** With weather and temperatures set to become ever more unpredictable due to climate change, researchers say the discovery that this light-sensing molecule also functions as the internal thermometer in plant cells could help us breed tougher crops. ‘It is estimated that agricultural yields will need to double by 2050, but climate change is a major threat to achieving this. Key crops such as wheat and rice are sensitive to high temperatures. Thermal stress reduces crop yields by around 10% for every one degree increase in temperature,’ says lead researcher Dr Philip Wigge from Cambridge’s Sainsbury Laboratory. ‘Discovering the molecules that allow plants to sense temperature has the potential to accelerate the breeding of crops resilient to thermal stress and climate change.’

- E** In their active state, phytochrome molecules bind themselves to DNA to restrict plant growth. During the day, sunlight activates the molecules, slowing down growth. If a plant finds itself in shade, phytochromes are quickly inactivated – enabling it to grow faster to find sunlight again. This is how plants compete to escape each other's shade. 'Light-driven changes to phytochrome activity occur very fast, in less than a second,' says Wigge.

At night, however, it's a different story. Instead of a rapid deactivation following sundown, the molecules gradually change from their active to inactive state. This is called 'dark reversion'. 'Just as mercury rises in a thermometer, the rate at which phytochromes revert to their inactive state during the night is a direct measure of temperature,' says Wigge.

- F** 'The lower the temperature, the slower the rate at which phytochromes revert to inactivity, so the molecules spend more time in their active, growth-suppressing state. This is why plants are slower to grow in winter. Warm temperatures accelerate dark reversion, so that phytochromes rapidly reach an inactive state and detach themselves from the plant's DNA – allowing genes to be expressed and plant growth to resume.' Wigge believes phytochrome thermo-sensing evolved at a later stage, and co-opted the biological network already used for light-based growth during the downtime of night.

- G** Some plants mainly use day length as an indicator of the season. Other species, such as daffodils, have considerable temperature sensitivity, and can flower months in advance during a warm winter. In fact, the discovery of the dual role of phytochromes provides the science behind a well-known rhyme long used to predict the coming season: oak before ash we'll have a splash, ash before oak we're in for a soak.

Wigge explains: 'Oak trees rely much more on temperature, likely using phytochromes as thermometers to dictate development, whereas ash trees rely on measuring day length to determine their seasonal timing. A warmer spring, and consequently a higher likeliness of a hot summer, will result in oak leafing before ash. A cold spring will see the opposite. As the British know only too well, a colder summer is likely to be a rain-soaked one.'

- H** The new findings are the culmination of twelve years of research involving scientists from Germany, Argentina and the US, as well as the Cambridge team. The work was done in a model system, using a mustard plant called *Arabidopsis*, but Wigge says the phytochrome genes necessary for temperature sensing are found in crop plants as well. 'Recent advances in plant genetics now mean that scientists are able to rapidly identify the genes controlling these processes in crop plants, and even alter their activity using precise molecular "scalpels",' adds Wigge. 'Cambridge is uniquely well-positioned to do this kind of research as we have outstanding collaborators nearby who work on more applied aspects of plant biology, and can help us transfer this new knowledge into the field.'

Questions 27–32

Do the following statements agree with the information given in Reading Passage 3?

In boxes 27–32 on your answer sheet, write

TRUE *if the statement agrees with the information*
FALSE *if the statement contradicts the information*
NOT GIVEN *if there is no information on this*

- 27 The Cambridge scientists' discovery of the 'thermometer molecule' caused surprise among other scientists.
- 28 The target for agricultural production by 2050 could be missed.
- 29 Wheat and rice suffer from a rise in temperatures.
- 30 It may be possible to develop crops that require less water.
- 31 Plants grow faster in sunlight than in shade.
- 32 Phytochromes change their state at the same speed day and night.

Questions 33–37

Reading Passage 3 has eight sections, **A–H**.

Which section contains the following information?

*Write the correct letter, **A–H**, in boxes 33–37 on your answer sheet.*

- 33 mention of specialists who can make use of the research findings
- 34 a reference to a potential benefit of the research findings
- 35 scientific support for a traditional saying
- 36 a reference to people traditionally making plans based on plant behaviour
- 37 a reference to where the research has been reported

Test 3

Questions 38–40

Complete the sentences below.

Choose **NO MORE THAN TWO WORDS** from the passage for each answer.

Write your answers in boxes 38–40 on your answer sheet.

- 38 Daffodils are likely to flower early in response to weather.
- 39 If ash trees come into leaf before oak trees, the weather in
will probably be wet.
- 40 The research was carried out using a particular species of

TEST 1

READING



Answer key with extra explanations
in Resource Bank

**Reading Passage 1,
Questions 1–13**

- 1 FALSE
- 2 FALSE
- 3 NOT GIVEN
- 4 TRUE
- 5 TRUE
- 6 FALSE
- 7 TRUE
- 8 violent
- 9 tool
- 10 meat
- 11 photographer
- 12 game
- 13 frustration

**Reading Passage 2,
Questions 14–26**

- 14 iv
- 15 vii
- 16 ii
- 17 v
- 18 i
- 19 viii
- 20 vi
- 21 city

- 22 priests
- 23 trench
- 24 location
- 25&26 IN EITHER ORDER
- B
- D

**Reading Passage 3,
Questions 27–40**

- 27 B
- 28 D
- 29 C
- 30 D
- 31 G
- 32 E
- 33 C
- 34 F
- 35 B
- 36 A
- 37 C
- 38 A
- 39 B
- 40 C

If you score ...

1–17	18–25	26–40
you are unlikely to get an acceptable score under examination conditions and we recommend that you spend a lot of time improving your English before you take IELTS.	you may get an acceptable score under examination conditions but we recommend that you think about having more practice or lessons before you take IELTS.	you are likely to get an acceptable score under examination conditions but remember that different institutions will find different scores acceptable.

TEST 2

READING



Answer key with extra explanations
in Resource Bank

**Reading Passage 1,
Questions 1–13**

- 1 TRUE
- 2 NOT GIVEN
- 3 TRUE
- 4 FALSE
- 5 FALSE
- 6 TRUE
- 7 TRUE
- 8 NOT GIVEN
- 9 Ridgeway
- 10 documents
- 11 soil
- 12 fertility
- 13 Rhiannon

**Reading Passage 2,
Questions 14–26**

- 14 D
- 15 C
- 16 A
- 17 G
- 18 B
- 19 H
- 20 E

- 21 YES
- 22 NO
- 23 NOT GIVEN
- 24 YES
- 25 NOT GIVEN
- 26 NO

**Reading Passage 3,
Questions 27–40**

- 27 B
- 28 C
- 29 B
- 30 D
- 31 D
- 32 A
- 33 C
- 34 F
- 35 G
- 36 FALSE
- 37 NOT GIVEN
- 38 NOT GIVEN
- 39 TRUE
- 40 TRUE

If you score ...

1–17	18–25	26–40
you are unlikely to get an acceptable score under examination conditions and we recommend that you spend a lot of time improving your English before you take IELTS.	you may get an acceptable score under examination conditions but we recommend that you think about having more practice or lessons before you take IELTS.	you are likely to get an acceptable score under examination conditions but remember that different institutions will find different scores acceptable.

TEST 3

READING



Answer key with extra explanations
in Resource Bank

**Reading Passage 1,
Questions 1–13**

- 1 FALSE
- 2 NOT GIVEN
- 3 FALSE
- 4 TRUE
- 5 TRUE
- 6 lightweight
- 7 bronze
- 8 levels
- 9 hull
- 10 triangular
- 11 music
- 12 grain
- 13 towboats

**Reading Passage 2,
Questions 14–26**

- 14 D
- 15 C
- 16 F
- 17 H
- 18 G
- 19 B
- 20 microorganisms / micro-organisms
- 21 reindeer

- 22 insects
- 23&24 IN EITHER ORDER
- B
- C
- 25&26 IN EITHER ORDER
- A
- C

**Reading Passage 3,
Questions 27–40**

- 27 NOT GIVEN
- 28 TRUE
- 29 TRUE
- 30 NOT GIVEN
- 31 FALSE
- 32 FALSE
- 33 H
- 34 D
- 35 G
- 36 C
- 37 A
- 38 warm (winter)
- 39 summer
- 40 mustard plant(s) / mustard

If you score ...

1–17	18–26	27–40
you are unlikely to get an acceptable score under examination conditions and we recommend that you spend a lot of time improving your English before you take IELTS.	you may get an acceptable score under examination conditions but we recommend that you think about having more practice or lessons before you take IELTS.	you are likely to get an acceptable score under examination conditions but remember that different institutions will find different scores acceptable.