

### READING PASSAGE 3

You should spend about 20 minutes on **Questions 29-40**, which are based on Reading Passage 3 below.

## Penguins' anti-ice trick revealed

Scientists studying penguins' feathers have revealed how the birds stay ice free when hopping in and out of below zero waters in the Antarctic. A combination of nano-sized pores and an extra water repelling preening oil the birds secrete is thought to give Antarctic penguins' feathers superhydrophobic properties. Researchers in the US made the discovery using Scanning Electron Microscopy (SEM) to study penguin feathers in extreme detail. Antarctic penguins live in one of Earth's most extreme environments, facing temperatures that drop to -40C, winds with speeds of 40 metres per second and water that stays around -2.2C. But even in these sub-zero conditions, the birds manage to prevent ice from coating their feathers.

"They are an amazing species, living in extreme conditions, and great swimmers. Basically they are living engineering marvels," says research team member Dr Pirouz Kavehpour, professor of Mechanical and Aerospace Engineering at the University of California, Los Angeles (UCLA). Birds' feathers are known to have hydrophobic, or non-wetting, properties. But scientists from UCLA, University of Massachusetts Amherst and SeaWorld, wanted to know what makes Antarctic penguins' feathers extra ice repelling.

"What we learn here is how penguins combine oil and nano-structures on the feathers to produce this effect to perfection," explains Kavehpour. By analysing feathers from different penguin species, the researchers discovered Antarctic species the gentoo penguin (*Pygoscelis papua*) was more superhydrophobic compared with a species found in warmer climes – the Magellanic penguin (*Spheniscus magellanicus*) – whose breeding sites include Argentinian desert.

Gentoo penguins' feathers contained tiny pores which trapped air, making the surface hydrophobic. And they were smothered with a special preening oil, produced by a gland near the base of the tail, with which the birds cover themselves. Together, these properties mean that in the wild, droplets of water on Antarctic penguins' superhydrophobic feathers bead up on the surface like spheres – formations that, according to the team, could provide geometry that delays ice formation, since heat cannot easily flow out of the water if the droplet only has minimal contact with the surface of the feather.

“The shape of the droplet on the surface dictates the delay in freezing,” explains Kavehpour. The water droplets roll off the penguin's feathers before they have time to freeze, the researchers propose. Penguins living in the Antarctic are highly evolved to cope with harsh conditions: their short outer feathers overlap to make a thick protective layer over fluffier feathers which keep them warm. Under their skin, a thick layer of fat keeps them insulated. The flightless birds spend a lot of time in the sea and are extremely agile and graceful swimmers, appearing much more awkward on land.

Kavehpour was inspired to study Antarctic penguins' feathers after watching the birds in a nature documentary: “I saw these birds moving in and out of water, splashing everywhere. Yet there is no single drop of frozen ice sticking to them,” he tells BBC Earth. His team now hopes its work could aid design of better man-made surfaces which minimise frost formation.

“I would love to see biomimicking of these surfaces for important applications, for example, de-icing of aircrafts,” says Kavehpour. Currently, airlines spend a lot of time and money using chemical de-icers on aeroplanes, as ice can alter the vehicles' aerodynamic properties and can even cause them to crash.

### Questions 29-33

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

Write the correct letter in boxes **29-33** on your answer sheet.

**29.** Penguins stay ice free due to:

- A.  A combination of nano-sized pores
- B.  An extra water repelling preening oil
- C.  A combination of nano-sized pores and an extra water repelling preening oil
- D.  A combination of various factors

**30.** Antarctic penguins experience extreme weather conditions, including:

- A.  Low temperature, that can drop to -40
- B.  Severe wind, up to 40 metres per second
- C.  Below zero water temperature
- D.  All of the above

31. In line 5 words *engineering marvels* mean:

- A.  That penguins are very intelligent
- B.  That penguins are good swimmers
- C.  That penguins are well prepared to living in severe conditions
- D.  Both B and C

32. Penguin feather has everything, **EXCEPT**:

- A.  Hydrophobic properties
- B.  Extra ice repelling
- C.  Soft structures
- D.  Oil structures

33. The gentoo penguin:

- A.  Is less superhydrophobic compared to the Magellanic penguin
- B.  Has feathers that contain tiny pores
- C.  Can't swim
- D.  Lives in Argentinian desert

### Questions 34-40

Complete the sentences below.

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

Write your answers in boxes **34-40** on your answer sheet.

34. Formations like  could provide geometry that delays ice formation.

35. The delay in freezing is dictated by the  of the droplet.

36. Penguins in Antarctic are highly evolved to be able to cope with  conditions.

37. Penguins are insulated by a  layer of fat.

38. On the land, penguins appear much more  than in the sea.

39. The inspiration came to Kavehpour after watching a  about penguins.

40. Kavehpour would like to see  surfaces which minimise frost formation.

Answers on next page

## **ANSWERS**

Each question correctly answered scores 1 mark. **Correct** spelling is needed in all answers.

### **Section 3**

- 29. C
- 30. D
- 31. D
- 32. C
- 33. B
- 34. Spheres
- 35. Shape
- 36. Harsh
- 37. Thick
- 38. Awkward
- 39. Documentary
- 40. Biomimicking