You should spend about 20 minutes on **Questions 1-12**, which are based on Reading Passage 1 below.

Scientists Are Mapping the World's Largest Volcano

(A) After 36 days of battling sharks that kept biting their equipment, scientists have returned from the rem Pacific Ocean with a new way of looking at the world's largest - and possibly most mysterious - volcano,

Massif.

(A) The team has begun making 3-D maps that offer the clearest look yet at the underwater mountain, whi covers an area the size of New Mexico. In the coming months, the maps will be refined and the data analy with the ultimate goal of figuring out how the mountain was formed.

(B) It's possible that the western edge of Tamu Massif is actually a separate mountain that formed at a diff time, says William Sager, a geologist at the University of Houston who led the expedition. That would exp some differences between the western part of the mountain and the main body.

(C) The team also found that the massif (as such a massive mountain is known) is highly pockmarked wit

craters and cliffs. Magnetic analysis provides some insight into the mountain's genesis, suggesting that pa formed through steady releases of lava along the intersection of three mid-ocean ridges, while part of it is to explain. A working theory is that a large plume of hot mantle rock may have contributed additional heat material, a fairly novel idea.

1. Tamu Massif lies about 1,000 miles (1,600 kilometers) east of Japan. It is a rounded dome, or shield volcano, measuring 280 by 400 miles (450 by 650 kilometers). Its top lies more than a mile (about 2,000 meters) below the ocean surface and is 50 times larger than the biggest active volcano on Earth, Hawaii's Mauna Loa. Sager published a paper in 2013 that said the main rise of Tamu Massif is most likely a single volcano, instead of a complex of multiple volcanoes that smashed together. But he couldn't explain how something so big formed.

2. The team used sonar and magnetometers (which measure magnetic fields) to map more than a million square kilometers of the ocean floor in great detail. Sager and students teamed up with Masao Nakanishi o Japan's Chiba University, with Sager receiving funding support from the National Geographic Society and Schmidt Ocean Institute.

3.
pretty chomped
by more sharks. The magnetic field research suggests the mountain formed relatively quickly, sometime a 145 million years ago. Part of the volcano sports magnetic "stripes," or bands with different magnetic properties, suggesting that lava flowed out evenly from the mid-ocean ridges over time and changed in po each time Earth's magnetic field reversed direction. The central part of the peak is more jumbled, so it ma formed more quickly or through a different process.

Since sharks are attracted to magnetic fields, the toothy fish "were all over our magnetometer, and it g up," says Sager. When the team replaced the device with a spare, that unit was nearly ripp

(H) Sager isn't sure what caused the magnetic anomalies yet, but suspects more complex forces were at w than simply eruptions from the ridges. It's possible a deep plume of hot rock from the mantle also contribu the volcano's formation, he says. Sager hopes the analysis will also help explain about a dozen other simil features on the ocean floor, as well as add to the overall understanding of plate tectonics.

Questions 1-8

Reading Passage 1 has eight paragraphs, **A-H.**

What paragraph has the following information? Write the correct letter, **A-H**, in boxes 1-8 on your answer sheet.

15. Possible explanation of the differences between parts of the mountain

16. Size data

17. A new way of looking

18. Problem with sharks

19. Uncertainty of the anomalies

20. Equipment which measures magnetic fields

21. The start of making maps

22. A working

theory Questions 9-

12

Complete the sentences using NO MORE THAN TWO WORDS from the passage.

Write your answers in boxes 9 12 on your answer sheet.

9. A large plume of ….. rock may have contributed additional heat and material.

10.Tamu Massif is a ….

,

or

shield volcano.

11. Replacing the device with a …. didn't help, as that unit was nearly ripped off by more sharks.

12. Sager believes that the magnetic anomalies were caused by something more than …. from the ridges

READING PASSAGE 2

You should spend about 20 minutes on **Questions 13-28**, which are based on Reading Passage 2 below.

We know the city where HIV first emerged

It is easy to see why AIDS seemed so mysterious and frightening when US medics first encountered it 35 ago. The condition robbed young, healthy people of their strong immune system, leaving them weak and vulnerable. And it seemed to come out of nowhere.

Today we know much more how and why HIV the virus that leads to AIDS has become a global pand Unsurprisingly, sex workers unwittingly played a part. But no less important were the roles of trade, the collapse of colonialism, and 20th Century sociopolitical reform.

HIV did not really appear out of nowhere, of course. It probably began as a virus affecting monkeys and a west central Africa.

From there it jumped species into humans on several occasions, perhaps because people ate infected bush Some people carry a version of HIV closely related to that seen in sooty mangabey monkeys, for instance. HIV that came from monkeys has not become a global problem.

We are more closely related to apes, like gorillas and chimpanzees, than we are to monkeys. But even whe HIV has passed into human populations from these apes, it has not necessarily turned into a widespread he issue.

HIV originating from apes typically belongs to a type of virus called HIV-1. One is called HIV-1 group O human cases are largely confined to west Africa.

In fact, only one form of HIV has spread far and wide after jumping to humans. This version, which proba originated from chimpanzees, is called HIV-1 group M (for "major"). More than 90% of HIV infections b in group M. Which raises an obvious question: what's so special about HIV-1 group M?

A study published in 2014 suggests a surprising answer: there might be nothing particularly special about M.

It is not especially infectious, as you might expect. Instead, it seems that this form of HIV simply took advantage of events. "Ecological rather than evolutionary factors drove its rapid spread," says Nuno Faria University of Oxford in the UK.

Faria and his colleagues built a family tree of HIV, by looking at a diverse array of HIV genomes collecte from about 800 infected people from central Africa.

Genomes pick up new mutations at a fairly steady rate, so by comparing two genome sequences and count the differences they could work out when the two last shared a common ancestor. This technique is widely for example to establish that our common ancestor with chimpanzees lived at least 7 million years ago.

"RNA viruses such as HIV evolve approximately 1 million times faster than human DNA," says Faria. Th means the HIV "molecular clock" ticks very fast indeed.

It ticks so fast, Faria and his colleagues found that the HIV genomes all shared a common ancestor that ex no more than 100 years ago. The HIV-1 group M pandemic probably first began in the 1920s.

Then the team went further. Because they knew where each of the HIV samples had been collected, they c place the origin of the pandemic in a specific city: Kinshasa, now the capital of the Democratic Republic o Congo.

At this point, the researchers changed tack. They turned to historical records to work out why HIV infectio an African city in the 1920s could ultimately spark a pandemic.

A likely sequence of events quickly became obvious. In the 1920s, DR Congo was a Belgian colony and Kinshasa then known as Leopoldville had just been made the capital. The city became a very attractive destination for young working men seeking their fortunes, and for sex workers only too willing to help the spend their earnings. The virus spread quickly through the population.

It did not remain confined to the city. The researchers discovered that the capital of the Belgian Congo wa the 1920s, one of the best connected cities in Africa. Taking full advantage of an extensive rail network us hundreds of thousands of people each year, the virus spread to cities 900 miles (1500km) away in just 20 y

Everything was in place for an explosion in infection rates in the 1960s.The beginning of that decade brou another change.

Belgian Congo gained its independence, and became an attractive source of employment to French speake elsewhere in the world, including Haiti. When these young Haitians returned home a few years later they t particular form of HIV-1 group M, called "subtype B", to the western side of the Atlantic.

It arrived in the US in the 1970s, just as sexual liberation and homophobic attitudes were leading to concentrations of gay men in cosmopolitan cities like New York and San Francisco. Once more, HIV took advantage of the sociopolitical situation to spread quickly through the US and Europe.

"There is no reason to believe that other subtypes would not have spread as quickly as subtype B, given si ecological circumstances," says Faria.

The story of the spread of HIV is not over yet.

For instance, in 2015 there was an outbreak in the US state of Indiana, associated with drug injecting.

The US Centers for Disease Control and Prevention has been analyzing the HIV genome sequences and da about location and time of infection, says Yonatan Grad at the Harvard School of Public Health in Boston, Massachusetts. "These data help to understand the extent of the outbreak, and will further help to understa when public health interventions have worked."

This approach can work for other pathogens. In 2014, Grad and his colleague Marc Lipsitch published an investigation into the spread of drug-resistant gonorrhoea across the US.

"Because we had representative sequences from individuals in different cities at different times and with different sexual orientations, we could show the spread was from the west of the country to the east," says Lipsitch.

What's more, they could confirm that the drug-resistant form of gonorrhoea appeared to have circulated predominantly in men who have sex with men. That could prompt increased screening in these at-risk populations, in an effort to reduce further spread.

In other words, there is real power to studying pathogens like HIV and gonorrhoea through the prism of h society.

Questions 13-20

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

In boxes 13-20 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

(D) AIDS were first encountered 35 years ago.

(E) The most important role in developing AIDS as a pandemia was played by sex workers.

(F) It is believed that HIV appeared out of nowhere.

(G) Humans are not closely related to monkey.

(H) HIV-1 group O originated in 1920s.

(I) HIV-1 group M has something special.

(J) Human DNA evolves approximately 1 million times slower than HIV.

(K) Scientists believe that HIV already existed in 1920s.

Questions 21-28

Complete the sentences below.

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

Write your answers in boxes 21-28 on your answer sheet.

21. Scientists can place the origin of …. in a specific city.

ng to spend their money.

22. Kinshasa was a very …. for young working men and many others willi

23. In just 20 years virus managed to …. to cities 900 miles away.

24. Belgian Congo became an attractive source of employment to French speakers when it gained …..

25. HIV has spread quickly through the US and Europe

because of the ….

26. It is said that outbreak in Indiana was associated with ….

27. The same approach as for HIV can work for …

resistant appeared to have ….

28. The form of gonorrhoea that is drug- in men who have sex with me

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 c
below zero waters in the Antarctic. A combination of nano-sized pores and an extra water repelling preeni
the birds secrete is thought to give
US made the discovery using Scanning Electron Microscopy (SEM) to study penguin feathers in extreme
acing temperatures that drop to -40
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.

Antarctic penguins' feathers superhydrophobic properties. Researchers

Antarctic penguins live in one of Earth's most extreme environments, f

xtreme conditions, and great swimmers. Basically they are living

known t
hydrophobic, or non-wetting, properties. But scientists from UCLA, University of Massachusetts Amherst

"They are an amazing species, living in e
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

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 effec
perfection," explains Kavehpour. By analysing feathers from different penguin species, the researchers
discovered Antarctic species the gentoo penguin *(Pygoscelis papua)* was more superhydrophobic compare
with a species found in warmer climes the Magellanic penguin *(Spheniscus magellanicus)* whose bree sites
include Argentinian desert.

Gentoo penguins' feathers contained tiny pores which trapped air, making the surface hydrophobic. And tl
were smothered with a special preening oil, produced by a gland near the base of the tail, with which the b

cover themselves. Together, these properties mean that in the wild, droplets of water on Antarctic penguin
superhydrophobic feathers bead up on the surface like spheres formations that, according to the team, co
provide geometry that delays ice formation, since heat cannot easily flow out of the water if the droplet on
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 dr
roll off the penguin's feathers before they have time to freeze, the researchers propose. Penguins living in t
Antarctic are highly evolved to cope with harsh conditions: their short outer feathers overlap to make a thi
protective layer over fluffier feathers which keep them warm. Under their skin, a thick layer of fat keeps th
insulated. The flightless birds spend a lot of time in the sea and are extremely agile and graceful swimmer
appearing much more awkward on land.

Kavehpour was inspired to study Antarctic penguins' feathers after watching the birds in a nature documer
"I saw these birds moving in and out of water, splashing everywhere. Yet the
sticking to them," he tells BBC Earth. His team now hopes its work could aid design of better man
surfaces which minimise frost formation.

re is no single drop of frozen
-made

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

s, for example, de-icing of
-icers on

Questions 29-33

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

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

31. Penguins stay ice free due to:

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

32. Antarctic penguins experience extreme weather conditions, including:

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

33. In line 5 words engineering marvels mean:

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

34. Penguis feather has everything, EXCEPT:

- Hydrophobic properties
- Extra ice repelling
- Soft structures
- Oil structures

(F) 33. The gentoo penguin:
(G) Is less superhydrophobic compared to the Magellanic penguin
(H) Has feathers that contain tiny pores
(I) Can't swim
(J) 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.

…
26. Formations like ..... could provide geometry that delays ice formation.

…
27. The delay in freezing is dictated by the ..... of the droplet.

….

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

34. Penguins are insulated by a ..... layer of fat.

….

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

….

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

…

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