

HUMAT SIMULATION TEST 2
6 Reading passages
36 questions
72 minutes

TASK 1

Read the article below and choose the answer (A, B, C or D) for each question which fits best according to the text.

New insights into the brains of birds

Recent research suggests that the brains of birds, once generally assumed to be hard-wired to respond instinctively to given stimuli, are actually capable of flexible and even imaginative thinking. For example, zoologist Alex Kacelnik's study of New Caledonian crows included an experiment in which a bird could see a morsel of food through a narrow opening in a container, but it was out of reach. Beside the bird were cylinders, some with hollow ends and some solid. Within minutes, the bird worked out how to fit three pieces together to create a pole long enough to retrieve the treat. This feat represents the first recorded instance of any non-human animal putting together a three-part compound tool, implying the ability to anticipate the properties of an unfamiliar object. It's the latest in an astonishing **roll call** of avian accomplishments, including another crow bending a straight wire into a hook to lift food from a box, and experiments showing that, far from simply mimicking the human voice, parrots acquire some understanding of what words mean.

As artificial intelligence becomes increasingly significant as a research theme, scientists are looking for clues from non-human animals about new ways to develop it. Kacelnik, for example, has begun to model some of his insights from crows in computers and robots. 'The mental abilities of crows and parrots are as sophisticated and diverse as those of apes,' says Onur Güntürkün, a neuroscientist specialising in animal cognition. These bird groups match the most intelligent non-human mammals in standard measures of cognition, including memory, numerical ability, self-recognition, distinguishing simple words, planning ahead and keeping hidden objects in mind. Even pigeons, a less mentally agile species, can perform at primate level in several tests, including learning hundreds of abstract symbols.

According to Dora Biro, who studies the behaviour of both chimpanzees and birds, there's no straight answer to the question: which is more intelligent? 'Many very social bird species show high levels of intelligence, including an ability to manipulate others and avoid being manipulated themselves.' For example, ravens and jays, which hide food, change their behaviour according to whether they're aware of others nearby who might steal their cache. Meanwhile, Irene Pepperberg, a psychologist working with African grey parrots studied one bird intensively for thirty years. This bird could count, do simple calculations and demonstrably learnt the meaning of scores of English words, as well as sorting previously unseen objects according to colour, texture and shape.

Neuroscientists have long been reluctant to consider the cognitive prowess of birds, whose brains typically weigh less than 20g (ape brains reach 500g,) and have no cortex, the brain region regarded as the neural basis of cognition in mammals. But evidence of sophisticated and diverse mental abilities points to bird brains being anatomically very different to those of mammals, from which their evolutionary line separated three-hundred million years ago. Researchers like Güntürkün are now elaborating this. As he says: 'It's an example of parallel evolution converging on similar mechanisms for cognition and complex behaviour, though the overall organisation of the brain looks vastly different.' As for brain size, Güntürkün points out that bird brains pack in neurons at six times the density of their mammalian counterparts. 'Because they're closer together, switching and signal processing within the brain may be faster.' Such neural efficiency may account for some uncanny avian abilities, such as communicating almost instantly as they flock together, maintaining their flying formation and, in the case of migrating species, ending up in the right place.

When it comes to analysing the emotional lives of non-human animals – the extent to which they experience feelings such as grief, joy and sadness – science still has a way to go. What humans display through facial muscles, birds can show through head orientation and feather movements, says Thomas Bugnyar, a biologist at the University of Vienna. He's trying to probe avian feelings through both biochemical and electronic means. One approach is to test birds' blood and saliva for changing levels of hormones associated with stress and emotion, including mesotocin, the avian equivalent of oxytocin, the hormone promoting social bonding in mammals. Another is to scan birds' brains for neural activity, though putting them in a brain scanner isn't the easiest of tasks.

1. What was most significant about Kacelnik's experiment with a New Caledonian crow?

- A. the speed with which the bird was able to solve a problem
- B. the unexpected solution that the bird found to a problem
- C. the thought processes that allowed the bird to solve a problem
- D. the bird's choice of materials in seeking to solve a problem

2. What is suggested by the use of the term 'roll call' in the first paragraph?

- A. a growing body of evidence
- B. a fast developing scenario
- C. a surprising turn of events
- D. a series of unrelated findings

3. In mentioning pigeons in the second paragraph, the writer is

- A. accepting that the mental abilities of crows and parrots may be exceptional.
- B. questioning the validity of comparing the mental abilities of birds and mammals.
- C. acknowledging that each bird species is likely to have differing mental abilities.
- D. suggesting that a wide range of bird species may display certain mental abilities

4. Which researcher's work may provide a possible answer to the question considered by Biro?

- A. Alex Kacelnik
- B. Irene Pepperberg
- C. Thomas Bugnyar
- D. Onur Güntürkün

5. Which of the researchers is investigating the wider implications of their findings for science in general?

- A. Dora Biro
- B. Alex Kacelnik
- C. Onur Güntürkün
- D. Thomas Bugnyar

6. Whose area of research does the writer regard as being in its infancy?

- A. Alex Kacelnik
- B. Thomas Bugnyar
- C. Dora Biro
- D. Onur Güntürkün

TASK 2

Studies of asthma

Asthma is one of the commonest non-communicable diseases and for many has a substantial impact on quality of life. Globally, it ranks 16th amongst leading causes of years lived with disability and 28th amongst leading causes of burden of disease, as measured by disability-adjusted life years. Around 300 million people have asthma worldwide, and it's likely that a further 100 million may be affected by 2025. There's a large geographical variation in both the disease and the patient's prospects of recovery. While the disease itself is more often seen in high-income countries, most asthma-related mortality occurs in low- and middle-income countries. Despite advances in treatment in the last few decades, there are still gains to be made in terms of enhancing patient education, employing new diagnostic approaches, and implementing personalised case management.

Patterns in the incidence of asthma differ between children and adults. It's well known that asthma often begins in childhood but can occur at any time throughout life, with some people developing asthma as adults. While incidence is higher in children, asthma-related healthcare use and mortality are both higher in adults. Interestingly, incidence differs by gender across the lifespan. Pre-pubertal boys have a higher incidence and hospitalisation rate than girls of the same age, but this trend reverses during adolescence. Females then continue to have a higher burden than males well into the fifth decade of life. However, this gap narrows around the fifth decade. Some even suggest that it may reverse again, following a sharp increase in incidence in males around the fourth decade of life. **Such shifts** in the burden of asthma around major reproductive events suggest that hormones may play a role.

Current evidence suggests that asthma is a complex multifactorial disorder, increasingly attributed to interactions between genetic susceptibility, host factors such as obesity, nutrition and allergies, and environmental factors such as air pollution, pollens, mould and other aeroallergens. Although the underlying mechanisms of asthma are yet to be fully understood, it is now recognised that rather than a single disease, asthma may be a group of heterogeneous phenotypes with different causes, which progress in different ways. While phenotyping individuals with asthma has been used to help guide clinical management, defining what asthma actually is has been a major challenge encountered in research, especially in epidemiological research, where in-depth data collection needs to be balanced against a large number of study participants.

Another major impact of asthma is associated additional morbidities, including a predisposition to infections such as bacterial pneumonia and herpes zoster. The links between childhood asthma and allergies such as eczema are well-established, whilst adult asthma is commonly associated with diabetes, osteoporosis, cardiovascular diseases, and mental-health issues like depression. Around 60% of patients with asthma have at least one other condition and 16% have four. Although this prevalence is too great to be the chance development of chronic conditions as part of the ageing process, it isn't so great as to imply causality. The cause of asthma co-morbidities may be linked to asthma itself, other morbidities, shared mechanisms, shared environmental, and/or shared genetic risk factors. But whatever the causes, it's evident that asthma comorbidities are associated with worse outcomes for both patients and healthcare systems, and that managing asthma comorbidities can bring significant improvement in its prognosis. Revising guidelines on

handling comorbidities may lead to more patient-centred asthma management, which may in turn lead to better outcomes.

In terms of environmental risk factors for asthma, the evidence is stronger for childhood asthma, although this is partly related to the greater attention that childhood asthma has received from the research community. The global epidemic of asthma is continuing, especially in low- to middle-income countries, although it has subsided in some high-income countries. Epidemiological research has helped to uncover some important environmental factors that trigger the disease, but the role of these as an underlying cause of asthma remains for the most part unknown.

Research into interactions between potential factors underlying the disease may gradually help to tease out the causes, however. There is therefore an urgent need to further investigate the complex mechanisms driving the relationship between environmental and genetic determinants in order to identify high-risk groups and key modifiable exposures. Given the long-term impact of both childhood and adult asthma, we would argue that to reduce the health burden of asthma, the emphasis going forward should be firmly on improving not only short-term symptoms, but also the long-term respiratory and other health outcomes.

7 In the first paragraph, the writer is claiming that recent improvements in the treatment of asthma haven't

- A. benefitted all parts of the world equally.
- B. stemmed the growth in case numbers.
- C. reduced death rates amongst patients.
- D. gone far enough in certain respects

8 The phrase 'such shifts' in the second paragraph is referring to changes in

- A. the ratio of male to female asthma patients at different ages.
- B. the age at which one gender becomes more susceptible to asthma.
- C. the risk of contracting asthma in older people of either gender.
- D. the effects of asthma on teenagers as the illness progresses.

9 In the third paragraph, the writer highlights the difficulty in

- A. establishing how many factors may combine in triggering asthma.
- B. using genetic profiling to identify some ways of preventing asthma.
- C. deciding what range of conditions may be viewed as forms of asthma
- D. evaluating the effectiveness of different remedies for asthma.

10 What point does the writer make about comorbidities?

- A. These are probably more related to age than to asthma.
- B. Treating these can help with the treatment of asthma
- C. It is difficult to know if these exacerbate asthma or not.
- D. Some of these share some key symptoms with asthma.

11 What does the writer suggest about research into possible environmental triggers for asthma?

- A. It has failed in its main objective.
- B. It has been uneven in its focus.
- C. It has been wholly inconclusive.
- D. It has had few positive outcomes.

12 In the final paragraph, the writer is proposing that researchers

- A. seek to establish who is most susceptible to asthma.
- B. pay less attention to treatment options for asthma.
- C. rethink their approach to the ongoing study of asthma.
- D. focus on pinpointing the principal causes of asthma.

TASK 3

The case for mining on the Moon

To date, all human economic activity has, perhaps understandably, depended solely on the resources here on Earth. It is conceivable, though, that future advances in space exploration could change this by opening up the potentially unlimited resources in space, including energy. As the Earth's nearest neighbour, the Moon would seem a practical place to start, and already a number of private enterprises have been set up to explore the possibilities. It is important to stress that even now, decades after the Apollo landings on the Moon, there is still no complete picture of its economic potential, and obtaining one calls for a programme of thorough lunar exploration and analysis to be undertaken.

Nevertheless, enough is known to make a first-order assessment of lunar resource potential. And, in doing so, it is useful to set out possible future applications of lunar resources. Firstly, there is the option of using lunar materials to facilitate continued exploration and future economic development of the Moon itself. The concept is usually referred to as In Situ Resource Utilisation, or ISRU. Secondly, use could be made of lunar resources to facilitate scientific and economic activity in the vicinity of both the Earth and the Moon (so-called cislunar space), as well as future exploration deeper into the solar system. And finally, lunar resources could be imported to the Earth where they would contribute directly to the economy.

Recent work has shown that the Moon does possess materials suitable for ISRU. Most important in this respect is evidence for deposits of water ice and other volatiles trapped in permanently-shadowed, very cold (less than minus 173°C) craters at the lunar poles. In addition to supporting human life, water is also a ready source of oxygen (required for rocket fuel oxidiser) and hydrogen (a valuable rocket fuel). It has been known since the very first sample was brought back from the Moon that in addition to ice deposits, lunar soil contains volatiles – substances (e.g. hydrogen, helium, carbon, nitrogen) derived ultimately from the solar wind, and that these may also be exploitable for ISRU activities.

Although ISRU will undoubtedly benefit future scientific exploration, it is true that such activities will only make wider economic sense if lunar exploration provides net economic benefits. It is here that cis-lunar space activity comes into play. Businesses, governments and indeed society are highly dependent on satellites for communications, navigation, weather forecasting, etc., and this reliance is set to increase. However, satellites have high launch costs, and failed satellites cannot currently be repaired in orbit. The availability of resources obtained from the Moon would help mitigate these obstacles to further economic development in Earth's orbit. What's more, it would take twenty times less energy to launch a satellite from the surface of the Moon into Earth's orbit than to launch it from Earth.

While this all seems encouraging for companies considering mining on the Moon, opportunities for importing lunar resources to Earth are limited. The Earth possesses the same basic mix of chemical elements as the Moon, and has a well-developed mining infrastructure. However, helium-3 (from lunar soils) is cited as an exception because it is perceived by some to be a potential fuel for nuclear fusion. Others point out the concentration of helium-3 in lunar soils is so low that excavating vast areas of the lunar surface would have cost implications. However, platinum-group elements and rare-earth elements might be imported because the environmental costs of mining on Earth may make lunar sources more attractive.

Taking all the evidence into account, it remains difficult to identify any single lunar resource that will be sufficiently valuable to drive a mining industry on its own. However, the Moon does possess abundant raw materials that may be of economic interest. It is necessary to think of a hierarchy of future applications. This begins with the use of lunar materials to facilitate human activities on the Moon itself. In this way, gradually increasing access to lunar resources may bring about a self-sustaining space-based economy from which the global economy will eventually benefit.

13 When introducing the idea of the economic exploitation of space, the writer suggests that

- A. it is surprising that the Moon continues to be largely ignored.
- B. a series of targeted missions to the Moon should be planned.
- C. regulation of companies operating on the moon is required.
- D. the Moon may well possess more materials than we need.

14 What is the writer doing when discussing the potential of lunar resources?

- A. stressing the most urgent use for them
- B. predicting how they will be used initially
- C. insisting that other resources are used first
- D. identifying different ways of using them

15 Which question is answered by the information in the third paragraph?

- A. How was water formed on the Moon initially?
- B. How much water could there be on the Moon?
- C. How did hydrogen come to be on the Moon?
- D. How easy is it to utilise the Moon's hydrogen?

16 What does the writer argue about satellites in space?

- A. A more efficient way of getting them there can be used.
- B. They can be stored on the Moon after decommissioning.
- C. It makes complete financial sense to produce larger ones.
- D. It is unlikely they could be serviced at bases on the Moon.

17 The writer identifies a difference of opinion about whether mining on the Moon

- A. is financially viable in the case of one particular material.
- B. is based on reliable estimates of the amount of material.
- C. has been subject to sufficient analysis of the risks involved.
- D. should have priority over solving some problems on Earth.

18 When making the case for mining on the Moon, the writer suggests that

- A. it is unlikely to bring financial returns.
- B. it has to be a long-term undertaking
- C. it needs to be very carefully regulated.
- D. it will always need external investment.

TASK 4

The future of food: urban rooftop farms

In recent years, urban rooftop farming (URF) has been experiencing increasing popularity, although it is true to say that most URF initiatives have been motivated by social and educational factors, rather than the aim of creating large-scale food production systems. There is a reasonable amount of literature available on urban farming, but this doesn't generally consider business-oriented operations. This study of URF sets out to assess such operations, beginning with the world's largest urban rooftop farm on the top of an exhibition hall in Paris. Here, produce such as strawberries, salad and herbs is grown in soil-free plastic columns.

According to project leader Pascal Hardy, the rooftop farm is a clean, productive and sustainable model of agriculture that can eventually make a real contribution to the social, economic and environmental resilience of big cities. Hardy, an engineer and sustainable development consultant, began experimenting with vertical farming and aeroponic growing towers – as the columns are known – five years ago. His urban farm is the size of two football pitches, with roughly 30% of available space already planted up. When the remainder is in production, 1,000kg of 35 different varieties will be harvested daily. 'We're never going to feed the whole city this way,' cautions Hardy. 'In the urban environment you're working with significant practical constraints, but if enough unused rooftops, walls, small patches of land – can be developed like this, there's no reason why we shouldn't eventually attain 5–10% of all produce consumed in the city.'

Hardy's farm is a real-life showcase for the work of his flourishing urban agriculture consultancy, which is currently taking enquiries from around the world to design, build and equip a new breed of soil-free inner-city farm. Quite apart from finally assuring that most of the price consumers pay for fresh food goes to producers rather than wholesalers and transport companies, an admirable achievement in itself, the advantages of Hardy's method over intensive farming methods are many: conventional crops are treated with multiple pesticides, and the industry is a huge generator of greenhouse gases, with crop varieties often selected for their capacity to withstand the refrigerated journey from field to plate, rather than for taste.

Hardy's method relies solely on a small quantity of water, enriched with organic nutrients, minerals and bacteria, pumped around a circuit of pipes, towers and trays. 'It's produced up here, and sold locally, just down there. It barely travels,' Hardy says. 'You can pick crops when they're at their absolute best, and not

before. No pesticides or fungicides are needed, no soil is exhausted, and the water that gently showers the plants' roots every twelve minutes is recycled, so the method uses 90% less water than classic intensive farming for the same yield. This automated process can be monitored and controlled, on site or remotely, with a tablet.'

Urban farming isn't, of course, a new phenomenon. In Paris, local groups have already been invited to come up with horticulture projects, with the aim of covering at least 100 hectares of rooftops, walls and facades with greenery, including fruit and vegetables. Ingenious projects are underway elsewhere. Strawberries are being grown in disused shipping containers and mushrooms in underground car parks. Not all techniques, however, are environmentally friendly: ultra-intensive, ten-storey indoor farms in the USA employ banks of LED lighting and are major consumers of energy. This is in stark contrast to urban aeroponic farming, where the equipment is highly portable and can be installed on virtually any flat surface. It also happens to consume a tiny fraction of the electricity used by some techniques. Produce grown aeroponically typically sells at prices that, while generally higher than those of intensive agriculture, are lower than soil-based organic growers.

Much of the produce grown on urban farms is suited to the summer months, and farmers are restricted by what can be planted. At present, cultivating fruit trees and long-rooted vegetables isn't feasible. In addition, beans take up a disproportionate amount of space for the financial return on them. Nevertheless, given time and the engagement of urban residents, inner-city agricultural projects have the potential to prompt people to think differently both about cities, by breaking down their traditional geography of different zones for working, living and playing, and about agriculture, by bringing food production closer to people's lives.

19 The writer feels that previous research into urban rooftop farming has

- A. ignored the role of food insecurity as a key problem.
- B. been largely focussed on non-commercial initiatives
- C. been lacking in detail about the cultivation methods.
- D. tended to measure success purely in financial terms.

20 What do we learn about the attitude of Pascal Hardy towards his project?

- A. He is indifferent to criticisms of it.
- B. He is ambitious about scaling it up.
- C. He is realistic about its future scope.
- D. He is wary of using certain spaces.

21 The writer suggests that his main criticism of intensive farming methods is

- A. the lack of clear regulation regarding their emissions.
- B. the great reluctance to modify the existing approach.
- C. the very limited number of crop types that are grown.
- D. the unfair distribution of income in the supply chain.

22 What claim does Pascal Hardy make about the food he grows and sells?

- A. He knows his customers personally.
- B. He is constantly there to inspect it.
- C. He guarantees consumers high quality
- D. He avoids the use of most fertilisers.

23 In the fifth paragraph, the writer praises this type of urban farming for its

- A. great versatility.
- B. low labour costs.
- C. rapid expansion.
- D. high profitability.

24 The writer's conclusion about urban farming is that

- A. it is unlikely that solutions for growing all crops can be found.
- B. persuading the public to get involved in projects is a challenge.
- C. it has implications beyond providing food for local residents.
- D. climate change is the greatest threat to its long-term success.

TASK 5

Climate miserabilism

At one time, the image of a lone polar bear standing on a fast-diminishing ice floe was a familiar metaphor for the threat posed by climate change. As carbon emissions belched into the atmosphere, rising temperatures were destroying the bears' environmental niche and threatening them with starvation. The animal even found its way onto the 'threatened' list, despite any hard evidence that numbers were actually collapsing. Indeed, estimates by specialists suggested the opposite. It's a **fallacy** explored by Bjorn Lomborg in his book, *False Alarm*. The main threat to polar bears, he claims came in the form of wild hunters. With the curbing of their activities, bear numbers have witnessed a marked increase. Seeking to protect them by reducing carbon dioxide emissions was perhaps more than slightly misguided – all that was needed was to stop shooting them.

Lomborg's is one of two books that set out to challenge what one might call 'climate miserabilism'. The other is *Apocalypse Never* by Michael Shellenberger. Each explores the way in which climate policy is increasingly shaped by emotive, alarmist and at times misleading messages. Such messages aren't just depressing the public, they argue, they're radicalising political opinion and leading developed nations to make rash choices about remedial action. This, they argue, makes our predicament not better but worse. Lomborg challenges a

number of frequently heard claims, for example that the incidence of wildfires is massively increasing. He points to satellite data showing that the amount of land burnt has fallen by a quarter in the past two decades. As for extreme weather and the rising cost of flood damage, he notes that as a percentage of US GDP, flood losses today are a tenth of what they were in 1903.

Some may see such challenges as an attempt to play down the reality of climate change. A controversial figure in the eyes of many environmentalists, Lomborg has been accused of 'lukewarmism'. But it's precisely because the problem is so serious, he argues, that it needs approaching cool-headedly. The alternative, in Lomborg's view, is letting ourselves be panicked, at great cost, into trying to fix the climate without having the necessary technology to hand, something he regards as a fool's errand. His main argument is that we should pay more attention to adaptation, while focusing on research to find zero-carbon energy sources that work at acceptable cost. Many of his points hit home. Renewable energy isn't likely to be the world's saviour. It's actually been falling as a share of global energy – from 25% in 1900 to just 11% today – and most of that is accounted for by traditional fuels like wood and dung.

Some of Lomborg's suggestions will raise hackles. Take his ideas about adaptation. Rich countries might have the wherewithal to build sea defences to keep out rising sea levels, but highly vulnerable poorer ones do not. Much in the end hangs on whether you share his faith in how much headroom the world has available. Citing research by the economist Nordhaus, he suggests that a temperature rise of 4°C is possible without jeopardising more than 2.9% of global GDP. If he's right, then the world can endure quite a lot of adaptation. But what if rising CO2 levels lead to tipping points, with galloping rises in temperature? Lomborg isn't sure, holding out the possibility of geo-engineering as a form of emergency brake. Some will take this as an admission that the underlying thesis may be reckless.

Shellenberger meanwhile takes fewer risks with global temperatures. He's more concerned with the anti-development streak evident amongst environmentalists, provocatively making the case for such green bugbears as fast fashion and industrial farming. What's more, he insists that in nuclear power the world already has a technology to rival fossil fuels, but that its share of energy output is rapidly and perversely declining. He roots **this** in the concerns of wealthy environmentalists who sought to oppose nuclear expansion in the 1950s on the basis that something so cheap and ubiquitous would lead to excessive and unsightly development.

Although many will take issue with some of the detailed arguments, these books provide a corrective to many of the green assumptions that dominate the media. And if they make the world a little more circumspect when presented with the next polar bear story, that's no bad thing.

25 The 'fallacy' referred to in the first paragraph is a mistaken belief about

- A. the conservation status assigned to polar bears.
- B. trends in the size of the polar-bear population.
- C. the cause of a decline in the polar bear population.
- D. the reasons behind changes in polar-bear habitats.

26 Lomborg and Shellenberger both feel that climate policies in developed countries

- A. may be counter-productive in terms of their wider aims.
- B. tend to be based on demonstrably inaccurate data.
- C. are inclined to focus too much on short-term measures.
- D. are driven by the need to respond to natural disasters.

27 In the third paragraph, the writer suggests that Lomborg's views on tackling climate change

- A. reveal an underlying belief that the problem is exaggerated.
- B. reflect his frustration with assumptions made by his critics.
- C. include observations that are worthy of further consideration.
- D. place too much emphasis on certain alternative technologies.

28 What is the writer doing in the fourth paragraph?

- A. explaining why some of Lomborg's ideas are seen as questionable
- B. presenting a counter argument to some of Lomborg's key ideas
- C. providing further evidence to back up some of Lomborg's ideas
- D. revealing a key inconsistency underlying some of Lomborg's ideas

29 The writer suggests that, in his book, Stellenberger attempts to

- A. avoid discussion of issues of importance.
- B. give a balanced view of conflicting ideas.
- C. reveal contradictions in certain arguments.
- D. account for and reverse one recent trend.

30 The word 'this' in the fifth paragraph refers to

- A. the speed with which something is happening.
- B. the particular direction of a noticeable trend.
- C. the strength of an argument being put forward.
- D. the reasons why something wasn't adopted.

TASK 6

Polar bears

As the most carnivorous and only marine-living ursid, the polar bear (*Ursus maritimus*) is lone among bears in its reliance on marine mammal prey. Evolution of this Arctic apex predator included behavioral and

physiological adaptations that distinguish polar bears from terrestrial bears, which has made them dependent on the sea ice and may increase their vulnerability to climate change. As a consequence of living in this ever-changing marine habitat, polar bears occupy expansive home ranges that are considerably greater than those occupied by other ursids or predicted for similarly sized terrestrial carnivorous mammals. They also exhibit remarkable abilities to swim for extended distances.

However, long-distance movements, whether walking or swimming, necessitate substantial energetic resources to satisfy locomotor demands. Historically, sufficient resources were afforded through the availability of fatty, energy-dense seal prey, which could be hunted efficiently from the sea ice. Presently, the sea ice minimum extent across the Arctic is shrinking at a rate of 14% per decade, spring break-up is occurring earlier, and fall freeze-up is occurring later. This decline is likely reducing access to, and abundance of, seal prey.

Some previous studies of polar bears have reported that their energy costs from walking are greater than thought for other similarly sized mammals. Some of the models of polar bear metabolic rates wrongly predicted these would be relatively low, because of the animal's sit-and-wait style of catching prey and its assumed ability to reduce metabolism while fasting.

What's more, no previous study provided quantitative estimates of metabolic rates of active polar bears on the sea ice where they spend most or all of the year.

Our study measured the field metabolic rates (FMRs) of nine female polar bears during April 2014–2016 in the Beaufort Sea over 8 to 11 days during April over the course of three years. We captured the animals in order to fit video camera collars and sensors to determine activity and behavior in order to assess their field metabolic rates (or FMRs), that is the rate during periods of activity. Using our measures of daily FMR, we estimated that a solitary female bear on the spring sea ice would on average need to eat one adult or three subadult seals, or 19 seal pups, every 10–12 days to remain in energy balance. Polar bears put on the majority of their body fat in late spring and early summer and can reach a relative fatness of 1kg of fat per kg of lean body mass. To attain this body condition, bears would either need to reduce their energy demands or increase their rate of food consumption.

We found that more than half of the bears in this study lost body mass. Four of the bears lost $\geq 10\%$ of their body mass. Despite their use of efficient sit-and-wait hunting tactics, polar bears in the spring exhibited activity patterns ranging from 22% to 40%. Bears spent 28% of the time walking and only 0.3% of the time swimming. By simultaneously measuring field metabolic rates, daily activity patterns, body condition, and foraging success of polar bears moving on the spring sea ice, we found that high metabolic rates (1.6 times greater than previously assumed) coupled with inadequate intake of fat-rich marine mammal prey resulted in an energy deficit for more than half of the bears examined.

Although the polar bear appears to be well adapted to the extreme conditions of their Arctic habitat, our research showed that their activity and movement on the sea ice strongly influenced their metabolic demands. Consequently, likely increases in mobility resulting from ongoing and forecasted declines in and fragmentation of sea ice are likely to increase energy demands and may be an important factor in explaining observed declines in body condition and survival. Polar bears in the spring exhibit greater energetic demands than those of previous predictions both for maintenance functions and locomotion. These demands necessitate access to high-energy-content prey. Yet as their hunting grounds on the sea ice become increasingly short-lived year by year, polar bears are likely to experience increasingly stressful conditions and higher mortality rates.

- 31 What do we learn about polar bears in the first paragraph?**
- A. Compared to all species of bear, an individual polar bear has the largest territory.
 - B. They are able to swim further than any other kind of meat-eating land mammal.
 - C. Of all arctic mammals, they are able to cope best with the local conditions.
 - D. They have undergone more evolutionary changes than any other bear species.
- 32 What does the phrase 'this decline' refer to in the second paragraph?**
- A. the break-up of ice in spring
 - B. the area covered by frozen sea
 - C. the availability of food resources
 - D. the distances polar bears travel
- 33 In the third paragraph, the writer makes the point that earlier research into polar bears**
- A. gave too much attention to their metabolic rates during periods of activity.
 - B. made an incorrect assumption about their metabolic rate when hunting
 - C. was unhelpful in comparing their metabolic rates with that of other animals.
 - D. produced confusing data on their metabolic rates at different times of year.
- 34 What do we learn about the researchers' approach from the fourth paragraph?**
- A. They didn't focus on one family group.
 - B. They didn't observe a range of bear activity.
 - C. They came into close proximity with the bears
 - D. They extended their original study period.
- 35 One key finding was that the particular group of bears they studied**
- A. had dramatic fluctuations in their annual metabolic rates.
 - B. proved to be less efficient swimmers than expected.
 - C. displayed hunting techniques that were considered atypical.
 - D. used more energy than their food intake would suggest
- 36 What point is made about polar bears in the final paragraph?**
- A. They will mostly be unable to cope with the changing environment.
 - B. They will soon be competing with each other for food.
 - C. Their current sources of prey are likely to continue to diminish.
 - D. They will probably find a way to adjust to present conditions.