

### Astronaut ice cream, anyone?

Freeze-drying is like suspended animation for food: you can store a freeze-dried meal for years, and then, when you're finally ready to eat it, you can completely revitalise it with a little hot water. Even after several years, the original foodstuff will be virtually unchanged. The technique basically involves completely removing the water from some material, such as food while leaving the rest of the material virtually intact. The main reason for doing this is either to preserve the food or to reduce its weight. Removing the water from food keeps it from spoiling, because the microorganisms such as bacteria that cause spoiling cannot survive without it. Similarly, the enzymes which occur naturally in food cannot cause ripening without water, so removing water from food will also stop the ripening process.

Freeze-drying significantly reduces the total weight of the food because most food is largely made up of water; for example, many fruits are more than 80 00% water. Removing this makes the food much lighter and therefore makes transportation less difficult. The military and camping-supply companies freeze-dry foods to make them easier for an individual to carry and NASA has also freeze-dried foods for the cramped quarters on board spacecraft.

The process is also used to preserve other sorts of material, such as pharmaceuticals. Chemists can greatly extend pharmaceutical shelf life by freeze-drying the material and storing it in a container free of oxygen and water. Similarly, research scientists may use freeze-drying to preserve biological samples for long periods of time. Even valuable manuscripts that had been water damaged have been saved by using this process.

Freeze-drying is different from simple drying because it is able to remove almost all the water from materials, whereas simple drying techniques can only remove 90-95%. This means that the damage caused by bacteria and enzymes can virtually be stopped rather than just slowed down. In addition, the composition and structure of the material is not significantly changed, so materials can be revitalised without compromising the quality of the original.

This is possible because in freeze-drying, solid water – ice – is converted directly into water vapour, missing out the liquid phase entirely. This is called 'sublimation', the shift from a solid directly into a gas. Just like evaporation, sublimation occurs when a molecule gains enough energy to break free from the molecules around it. Water will sublime from a solid (ice) to a gas (vapour) when the molecules have enough energy to break free but the conditions aren't right for a liquid to form. These conditions are determined by heat and atmospheric pressure. When the temperature is above freezing point, so that ice can thaw, but the atmospheric pressure is too low for a liquid to form (below 0.06 atmospheres (ATM)) then it becomes a gas.

This is the principle on which a freeze-drying machine is based. The material to be preserved is placed in a freeze-drying chamber which is connected to a freezing coil and refrigerator compressor. When the chamber is sealed the compressor lowers the temperature inside it. The material is frozen solid, which separates the water from everything around it on a molecular level, even though the water is still present. Next, a vacuum pump forces air out of the chamber, lowering the atmospheric pressure below to 0.06 ATM. The heating units apply a small amount of heat to the shelves in the chamber, causing the ice to change phase. Since the pressure in the chamber is so low, the ice turns directly into water vapour, which leaves the freeze-drying chamber, and flows past the freezing coil. The water vapour condenses onto the freezing coil in the form of solid ice, in the same way that water condenses as frost on a cold day.

The process continues for many hours (even days) while the material gradually dries out. This time is necessary to avoid overheating, which might affect the structure of the material. Once it has dried sufficiently, it is sealed in a moisture-free package. As long as the package is secure, the material can sit on a shelf for years and years without degrading, until it is restored to its original form with a little hot water. If everything works correctly, the material will go through the entire process almost completely unscathed.

In fact, freeze-drying, as a general concept, is not new but has been around for centuries. The ancient Incas of Peru used mountain peaks along the Andes as natural food preservers. The extremely cold temperatures and low pressure at those high altitudes prevented food from spoiling in the same basic way as a modern freeze-drying machine and a freezer.

**Questions 1-5**

Complete the notes below. Choose **NO MORE THAN THREE WORDS** from the passage for each answer.

Uses of freeze-drying:

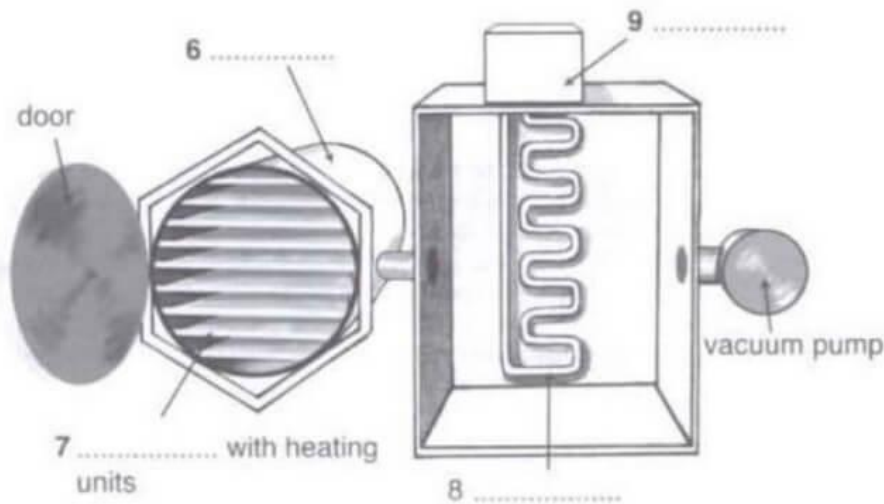
- food preservation
- easy (1)..... of food items
- long-term storage of (2).....and biological samples
- preservation of precious (3).....

**Freeze-drying**

- is based on process of (4)..... is more efficient than (5).....

**Questions 6-9**

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



**Questions 10-13**

Complete the summary below. Choose **NO MORE THAN THREE WORDS AND/OR A NUMBER** from the passage for each answer.

Freeze-drying prevents food from going bad by stopping the activity of microorganisms or (10).....Its advantages are that the food tastes and feels the same as the original because both the (11).....and structure are preserved. The process is carried out slowly in order to ensure that (12).....does not take place. The people of one ancient mountain civilisation were able to use this method of food preservation because the conditions needed were present at (13).....

**THE WILD SIDE OF TOWN**

The past half century has seen an interesting reversal in the fortunes of much of Britain’s wildlife. Whilst the rural countryside has become poorer and poorer, wildlife habitat in towns has burgeoned. Now, if you want to hear a deafening dawn chorus of birds or familiarise yourself with foxes, you can head for the urban forest. Whilst species that depend on wide open spaces such as the hare, the eagle and the red deer may still be restricted to remote rural landscapes, many of our wild plants and animals find the urban ecosystem ideal. This really should be no surprise,

since it is the fragmentation and agrochemical pollution in the farming lowlands that has led to the catastrophic decline of so many species.

By contrast, most urban open spaces have escaped the worst of the pesticide revolution, and they are an intimate mosaic of interconnected habitats. Over the years, the cutting down of hedgerows on farmland has contributed to habitat isolation and species loss. In towns, the tangle of canals, railway embankments, road verges and boundary hedges lace the landscape together, providing first-class ecological corridors for species such as hedgehogs, kingfishers and dragonflies.

Urban parks and formal recreation grounds are valuable for some species, and many of them are increasingly managed with wildlife in mind. But in many places their significance is eclipsed by the huge legacy of post-industrial land demolished factories, waste tips, quarries, redundant railway yards and other so-called 'brownfield' sites. In Merseyside, South Yorkshire and the West Midlands, much of this has been spectacularly colonised with birch and willow woodland, herb-rich grassland and shallow wetlands. As a consequence, there are song birds and predators in abundance over these once-industrial landscapes.

There are fifteen million domestic gardens in the UK. and whilst some are still managed as lifeless chemical war zones, most benefit the local wildlife, either through benign neglect or positive encouragement. Those that do best tend to be woodland species, and the garden lawns and flower borders, climber-covered fences, shrubberies and fruit trees are a plausible alternative. Indeed, in some respects gardens are rather better than the real thing, especially with exotic flowers extending the nectar season. Birdfeeders can also supplement the natural seed supply, and only the millions of domestic cats may spoil the scene.

As Britain's gardeners have embraced the idea of 'gardening with nature', wildlife's response has been spectacular. Between 1990 and the year 2000. the number of different bird species seen at artificial feeders in gardens increased from 17 to an amazing 81. The BUGS project (Biodiversity in Urban Gardens in Sheffield) calculates that there are 25.000 garden ponds and 100.000 nest boxes in that one city alone.

We are at last acknowledging that the wildlife habitat in towns provides a valuable life support system. The canopy of the urban forest is filtering air pollution, and intercepting rainstorms, allowing the water to drip more gradually to the ground. Sustainable urban drainage relies on ponds and wetlands to contain storm water runoff, thus reducing the risk of flooding, whilst reed beds and other wetland wildlife communities also help to clean up the water. We now have scientific proof that contact with wildlife close to home can help to reduce stress and anger. Hospital patients with a view of natural green space make a more rapid recovery and suffer less pain.

Traditionally, nature conservation in the UK has been seen as marginal and largely rural. Now we are beginning to place it at the heart of urban environmental and economic policy. There are now dozens of schemes to create new habitats and restore old ones in and around our big cities. Biodiversity is big in parts of London. thanks to schemes such as the London Wetland Centre in the south west of the city. This is a unique scheme masterminded by the Wildfowl and Wetlands Trust to create a wildlife reserve out of a redundant Victorian reservoir. Within five years of its creation the Centre has been hailed as one of the top sites for nature in England and made a Site of Special Scientific Interest. It consists of a 105-acre wetland site, which is made up of different wetland habitats of shallow, open water and grazing marsh. The site attracts more than 104 species of bird, including nationally important rarities like the bittern. We need to remember that if we work with wildlife, then wildlife will work for us and this is the very essence of sustainable development.

#### **Questions 14-19**

Do the following statements agree with the information given in Reading Passage 2? In boxes 14-19 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

14. There is now more wildlife in UK cities than in the countryside.
15. Rural wildlife has been reduced by the use of pesticides on farms.
16. In the past, hedges on farms used to link up different habitats.
17. New urban environments are planned to provide ecological corridors for wildlife.
18. Public parks and gardens are being expanded to encourage wildlife.
19. Old industrial wastelands have damaged wildlife habitats in urban areas.

### Questions 20-23

Answer the questions below, using NO MORE THAN THREE WORDS AND/OR A NUMBER from the passage for each answer.

20. Which type of wildlife benefits most from urban gardens?
21. What type of garden plants can benefit birds and insects?
22. What represents a threat to wildlife in urban gardens?
23. At the last count, how many species of bird were spotted in urban gardens?

### Question 24-26

Choose THREE letters A-G.

**In which THREE ways can wildlife habitats benefit people living in urban areas?**

- A they can make the cities greener
- B they can improve the climate
- C they can promote human well being
- D they can extend the flowering season
- E they can absorb excess water
- F they can attract wildlife
- G they can help clean the urban atmosphere

### Question 27

Choose the correct answer, A, B, C or D.

**27. The writer believes that sustainable development is dependent on**

- A urban economic policy.
- B large restoration schemes.
- C active nature conservation.
- D government projects.

### Running on empty

A For almost a century, scientists have presumed, not unreasonably, that fatigue – or exhaustion in athletes originates in the muscles. Precise explanations have varied but all have been based on the 'limitations theory'. In other words, muscles tire because they hit a physical limit: they either run out of fuel or oxygen or they drown in toxic by-products.

B In the past few years, however, Timothy Noakes and Alan St Clair Gibson from the University of Cape Town, South Africa, have examined this standard theory. The deeper they dig, the more convinced they have become that physical fatigue simply isn't the same as a car running out of petrol. Fatigue, they argue, is caused not by distress signals springing from overtaxed muscles, but is an emotional response which begins in the brain. The essence of their new theory is that the brain, using a mix of physiological, subconscious and conscious cues, paces the muscles to keep them well back from the brink of exhaustion. When the brain decides its time to quit, it creates the

distressing sensations we interpret as unbearable muscle fatigue. This 'central governor\*' theory remains controversial, but it does explain many puzzling aspects of athletic performance.

C A recent discovery that Noakes calls the 'lactic acid paradox' made him start researching this area seriously. Lactic acid is a by-product of exercise, and its accumulation is often cited as a cause of fatigue. But when research subjects exercise in conditions simulating high altitude, they become fatigued even though lactic acid levels remain low. Nor has the oxygen content of their blood fallen too low for them to keep going. Obviously, Noakes deduced, something else was making them tire before they hit either of these physiological limits.

D Probing further, Noakes conducted an experiment with seven cyclists who had sensors taped to their legs to measure the nerve impulses travelling through their muscles. It has long been known that during exercise, the body never uses 100% of the available muscle fibres in a single contraction. The amount used varies, but in endurance tasks such as this cycling test the body calls on about 30%.

E Noakes reasoned that if the limitations theory was correct and fatigue was due to muscle fibres hitting some limit, the number of fibres used for each pedal stroke should increase as the fibres tired and the cyclist's body attempted to compensate by recruiting an ever-larger proportion of the total. But his team found exactly the opposite. As fatigue set in, the electrical activity in the cyclists' legs declined – even during sprinting, when they were striving to cycle as fast as they could.

F To Noakes, this was strong evidence that the old theory was wrong. 'The cyclists may have felt completely exhausted,' he says, 'but their bodies actually had considerable reserves that they could theoretically tap by using a greater proportion of the resting fibres.' This, he believes, is proof that the brain is regulating the pace of the workout to hold the cyclists well back from the point of catastrophic exhaustion.

G More evidence comes from the fact that fatigued muscles don't actually run out of anything critical. Levels of glycogen, which is the muscles' primary fuel, and ATP, the chemical they use for temporary energy storage, decline with exercise but never bottom out. Even at the end of a marathon, ATP levels are 80-90% of the resting norm, and glycogen levels never get to zero.

H Further support for the central regulator comes from the fact that top athletes usually manage to go their fastest at the end of a race, even though, theoretically, that's when their muscles should be closest to exhaustion. But Noakes believes the end spurt makes no sense if fatigue is caused by muscles poisoning themselves with lactic acid as this would cause racers to slow down rather than enable them to sprint for the finish line. In the new theory, the explanation is obvious. Knowing the end is near, the brain slightly relaxes its vigil, allowing the athlete to tap some of the body's carefully hoarded reserves.

I But the central governor theory does not mean that what's happening in the muscles is irrelevant. The governor constantly monitors physiological signals from the muscles, along with other information, to set the level of fatigue. A large number of signals are probably involved but, unlike the limitations theory, the central governor theory suggests that these physiological factors are not the direct determinants of fatigue, but simply information to take into account.

J Conscious factors can also intervene. Noakes believes that the central regulator evaluates the planned workout, and sets a pacing strategy accordingly. Experienced runners know that if they set out on a 10-kilometre run, the first kilometre feels easier than the first kilometre of a 5-kilometre run, even though there should be no difference. That, Noakes says, is because the central governor knows you have farther to go in the longer run and has programmed itself to dole out fatigue symptoms accordingly.

K St Clair Gibson believes there is a good reason why our bodies are designed to keep something back. That way, there's always something left in the tank for an emergency. In ancient times, and still today, life would be too

dangerous if our bodies allowed us to become so tired that we couldn't move quickly when faced with an unexpected need.

**Questions 28-33**

Reading Passage 3 has eleven paragraphs A-K. Choose the correct heading for Paragraphs A-F from the list of headings below.

**List of headings**

- i Avoiding tiredness in athletes
- ii Puzzling evidence raises a question
- iii Traditional explanations
- iv Interpreting the findings
- v Developing muscle fibres
- vi A new hypothesis
- vii Description of a new test
- viii Surprising results in an endurance test

**28. Paragraph A**

- 29. Paragraph B
- 30. Paragraph C
- 31. Paragraph D
- 32. Paragraph E
- 33. Paragraph F

**Questions 34-40**

**Classify the following ideas as relating to**

- A** the Limitations Theory
- B** the Central Governor Theory
- C** both the Limitations Theory and the Central Governor Theory

- 34. Lactic acid is produced in muscles during exercise.
- 35. Athletes can keep going until they use up all their available resources.
- 36. Mental processes control the symptoms of tiredness.
- 37. The physiological signals from an athlete's muscles are linked to fatigue.
- 38. The brain plans and regulates muscle performance in advance of a run.
- 39. Athletes' performance during a race may be affected by lactic acid build-up.
- 40. Humans are genetically programmed to keep some energy reserves.

**Task1 - The chart below gives information about the ratio of income to spending (in dollars) by Americans by age range in 2013. Summarise the information by selecting and reporting the main features and make comparisons where relevant.**

