inkBiology

ANSWER BOOK

# Thermoregulation in endotherms and ectotherms

Hormonal communication, plant responses and homeostasis · Unit B15

AQA 3.6.4.1 · OCR A 5.1.1 · Edexcel A 5.16, 7.12 · Edexcel B 5.1 i, 9.1 ii, 9.9 vi, 9.9 vii
CAIE not examined as a topic

15 questions · 50 marks

NAVY EDITION

Every question in this book has a code beside its number.
Type inklearning.co.uk/q/ followed by the code to open that question online.



inklearning.co.uk/biology/ · youtube.com/@InkPhysics

## SECTION A · Short, 1 to 2 marks

**A1** TCH-Q15

**B1** core temperature is the temperature of the blood and the deep organs, whereas skin temperature is the temperature of the body surface and extremities. **B1** it is core temperature that is regulated within narrow limits; skin temperature is allowed to vary considerably, since reducing blood flow to the surface is itself one of the mechanisms that conserves core heat. [2]

## SECTION B · Standard, 3 to 5 marks

**B1** TCH-Q8

**B1** in support: as air temperature rises, an ectotherm needs to spend less time and behaviour maintaining a workable body temperature and may reach an active temperature for more of the day. **B1** in support: an ectotherm already converts a much larger share of the food it eats into new tissue than an endotherm does, so a longer active season without the fixed cost of internally generated heat could increase its growth and reproduction. **B1** against: an ectotherm's body temperature depends directly on its surroundings, so if air temperature rises above the optimum for its enzymes it has far less physiological ability to cool itself than an endotherm's hypothalamus and effectors provide. **B1** against: an endotherm holds its core temperature near the optimum for its enzymes largely independently of the surroundings, so it is buffered against a change in air temperature in a way an ectotherm is not, at the continuing cost of needing more food. **B1** judgement: the claim is too simple; whether warming helps or harms a species depends on how far conditions move from that species' own optimum and on whether food supply changes as well, not on being an ectotherm or an endotherm as such. [5]

**B2** TCH-Q1

**B1** the arterioles supplying the capillary networks near the surface dilate, which is vasodilation. **B1** the shunt vessels beneath them constrict, so more blood is diverted through the surface capillaries and more heat is lost by radiation and convection. **B1** the sweat glands secrete sweat onto the surface of the skin, and its evaporation takes latent heat from the skin. **A1** the hair erector muscles relax so the hairs lie flat, trapping a thinner layer of still air and so reducing the insulation. [4]

**B3** TCH-Q2

**B1** in the cool of the morning it basks in the sun, absorbing heat by radiation, and presses its underside against rock the sun has warmed so that heat is also gained by conduction. **B1** it flattens its body and turns its flank towards the sun, presenting the largest possible surface area to the radiation, and may darken in colour so that more is absorbed. **B1** as the day becomes hot it moves into the shade of a rock or into a burrow, turns to face the sun so that less of it is exposed, and raises its body clear of the hot ground. **A1** it may also gape to evaporate water from the mouth, and shift its activity to the cooler hours of the morning and evening. [4]

**B4** TCH-Q3

**B1** an endotherm holds its core temperature near the optimum for its enzymes whatever the surroundings are doing, so it can be fully active at night, in winter and in cold habitats that an ectotherm cannot occupy. **B1** that independence widens the range of habitats available to it and means it is not immobilised at dawn, so it can hunt or escape at any hour. **B1** against that, much of the energy it assimilates is spent on producing heat, so it needs perhaps ten times as much food as an ectotherm of the same mass and must find it regularly. **A1** an ectotherm converts a far greater share of its food into new tissue and can survive long periods without eating, so where food is scarce and the climate is warm the ectotherm's strategy is the better one. [4]

**B5** TCH-Q9

**B1** the arterioles supplying the surface capillary networks constrict, vasoconstriction, while the shunt vessels beneath them dilate, so less blood reaches the surface and less heat is lost by radiation and convection. **B1** the hair erector muscles contract, pulling each hair upright and trapping a thicker layer of still air next to the skin, which insulates, although this effect is small in a human. **B1** sweat glands secrete little or no sweat, so little heat is lost by evaporation. **A1** skeletal muscle begins to shiver, contracting rapidly without doing useful work, so nearly all of the extra energy released by the increased respiration appears as heat, raising the rate of heat production. [4]

**B6** TCH-Q4

**B1** below the optimum, molecules have less kinetic energy, so there are fewer successful collisions between substrate and active site and the rate of every enzyme-controlled reaction falls. **B1** above the optimum, increased vibration breaks the hydrogen bonds and ionic bonds holding the tertiary structure, so enzymes denature and the active site is no longer complementary to the substrate. **A1** denaturation is not reversed by cooling, so a core temperature much above 37 °C is far more dangerous than one the same distance below it. [3]

**B7** TCH-Q5

**B1** peripheral thermoreceptors are nerve endings in the skin and detect the temperature of the surface and so of the surroundings, whereas central thermoreceptors lie in the hypothalamus and detect the temperature of the blood. **B1** the blood temperature the central receptors detect is the core temperature, which is the variable actually being regulated, whereas the skin temperature is not. **A1** the peripheral receptors respond to a change and so allow correction to begin before the core has altered at all, which the central receptors cannot do. [3]

**B8** TCH-Q6

**B1** capillaries are vessels one cell thick held in position by the tissue around them, and there is no mechanism that could move them through the dermis. **B1** what changes is the diameter of the arterioles supplying the surface capillary networks, which dilate when the body is warm and constrict when it is cold. **A1** the shunt vessels running beneath the surface network do the opposite, so the volume of blood flowing near the surface changes while the vessels themselves stay where they are. [3]

**B9** TCH-Q7

**B1** at an air temperature close to body temperature there is little gradient for heat loss by radiation and convection, so evaporation of sweat is doing nearly all of the cooling. **B1** in humid air the water vapour concentration outside is already high, so sweat evaporates only slowly and instead runs off the skin, taking little latent heat with it. **A1** heat production from respiration continues while heat loss has effectively stopped, so the core temperature rises, and the sweat lost still costs the person water and ions. [3]

**B10** TCH-Q10

**B1** adrenaline and thyroxine raise the metabolic rate of the liver and other tissues, so more heat is released as a by-product of increased respiration. **B1** in an infant, brown adipose tissue respires in a way that releases the energy directly as heat rather than using it to make ATP. **A1** because this route relies on thyroxine, released over days and weeks rather than a nerve impulse, its effect builds up slowly and accounts for acclimatisation after prolonged cold exposure, rather than an instant response to a single cold moment. [3]

**B11** TCH-Q11

**M1** percentage = ectotherm's intake ÷ endotherm's intake × 100 = 190 ÷ 2100 × 100. **A1** 9.0 per cent. **A1** the endotherm eats 2100 ÷ 190 = about 11 times as much food as the ectotherm over the same week, consistent with the roughly tenfold difference typical of the two strategies. [3]

**B12** TCH-Q12

**B1** erecting hairs traps a layer of still air next to the skin, and still air is a poor conductor of heat, so trapping more of it increases insulation. **B1** a furred mammal has hair dense enough that erecting it traps a substantial, continuous layer of still air over the whole body surface. **A1** human body hair is too sparse to trap a significant layer of air even when the hair erector muscles contract fully, which is why the response, although still present, achieves very little extra insulation in a person compared with a well-furred animal. [3]

**B13** TCH-Q13

**B1** maintaining a normal core temperature is energetically expensive, since much of the energy an endotherm assimilates is spent simply producing heat. **B1** in winter, food such as insects and other invertebrates is scarce, so a small mammal may not be able to eat enough to sustain its normal high metabolic rate. **A1** by lowering its body temperature and metabolic rate it greatly reduces its energy expenditure during the period when food cannot be found, surviving on stored fat until conditions improve, at the cost of being unable to respond quickly to danger while torpid. [3]

**B14** TCH-Q14

**B1** the nervous component, impulses from the hypothalamus along the autonomic nervous system to effectors such as the arterioles and skeletal muscle, acts within seconds of a temperature change. **B1** the hormonal component, thyroxine with adrenaline raising the metabolic rate of tissues such as the liver, is released more slowly and its effect builds up over days to weeks of continued cold exposure. **A1** the nervous route therefore handles an immediate cold snap, such as stepping outside, while the hormonal route underlies acclimatisation to a cold season, and the two operate on different timescales rather than one replacing the other. [3]

## THIS BOOK ONLINE

Scan the code, or type the address, to open the questions in this book online:

inklearning.co.uk/biology/practise/questions/thermoregulation-in-endotherms-and-ectotherms/