1.2 Maintaining a regular body temperature

Endotherm and ectotherm behaviours for maintaining a constant internal temperature

The need to maintain body temperature

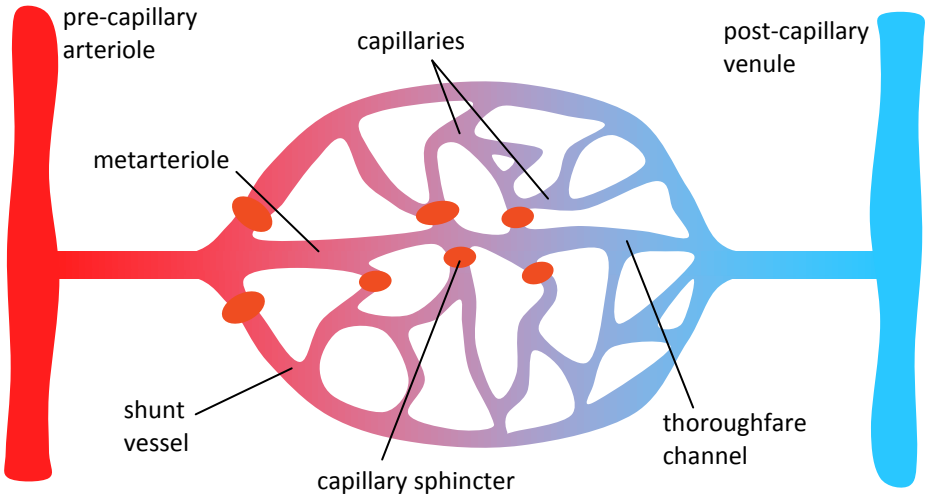
As you saw in 1.1 Communication, any change in temperature has an effect on an organism. A temperature which rises too high or falls too low to fit within the acceptable range will cause enzyme action to decrease, and may cause them to denature. With non-functioning proteins and enzymes, the level of activity that organism can achieve is reduced.

Endotherms

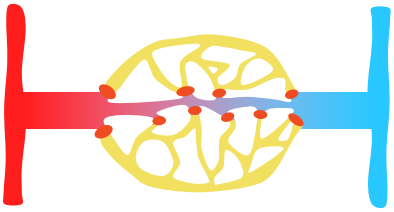
An **endotherm** is an organism which can use physiological mechanisms to regulate internal body temperature independently of the environment. Endotherms used to be classed as 'warm-blooded' animals, but this is not correct to say. Many chemical reactions within endothermic organisms are **exergonic** – release heat. Endotherms have a variety of both physiological and behavioural mechanisms of regulating their body temperature.

Vasodilation, vasoconstriction and radiation

The arterioles leading to capillaries in the skin have an important role in temperature regulation. When an endotherm has a raise in body temperature, the areas of smooth muscle, called **capillary sphincters**, dilate, allowing more blood to flow near to the surface of the skin so that more heat can be radiated from the skin. This is called **vasodilation** (below, left).



Alternatively, when the organism's core body temperature falls too low, the capillary sphincters can contract, to restrict blood flow into the capillaries – this is called **vasoconstriction** reducing the amount of heat radiated from the skin (diagram below).



Sweat glands and hairs in the skin

When the body temperature gets too high, an endotherm will secrete more sweat onto the skin. The water in the sweat evaporates, using the heat from the blood to supply the latent heat of the vaporisation. Hairs on the skin also lay down flat in such conditions, so hardly insulate the skin, so more heat is lost via convection and radiation.

However, when the body temperature gets too low, the opposite happens. Sweating is kept to a minimum so that less heat is lost through evaporation of the water. Also, hairs will raise up to trap a layer of insulating hair on the skin surface, which will reduce the amount of heat lost from the skin.

Spontaneous muscular contractions

When too hot, skeletal muscles make no spontaneous contractions – but when too cold, there are such contractions within the muscles (commonly called shivering). These contractions generate more heat are more respiration occurs.

Behavioural mechanisms

Some of the behavioural mechanisms endotherms have to control body temperature are:

- moving into the shade when too hot, and into the sunlight when too cold
- orientating body to increase or decrease the surface area exposed to the sunlight depending on the temperature
- remaining inactive when too hot, and moving about when too cold in order to generate heat from the muscles (unless it is extreme cold, where it is safer to stay still and roll into a ball to reduce surface area)

Ectotherms

The body temperature of an **ectotherm** will fluctuate with changes in external temperature. Ectotherms used to be known as 'cold-blooded' animals, but again, this is not correct – many ectotherms can maintain their body temperature at around 37^{o}C, which is too high to be considered cold.

Ectotherms do not use internal energy sources to maintain their temperature when cold, although once they are active the muscle contractions do generate some heat from the increased respiration. When hot, an ectotherm will use cunning behavioural and physiological mechanisms to decrease heat absorption from the sun and increase heat loss to the surroundings; and vice versa will try to increase heat absorption and decrease heat loss when cold.

To warm up, an ectotherm will normally bask in the sun, or lie on a warm surface, and when too hot will find some shade to rest in, or alternatively hide in a burrow. These behavioural mechanisms help to control heat absorption from the sun, but some ectotherms use physiological mechanisms too to control heat loss to the environment. For example, locusts have been seen to increase abdominal breathing when hot too increase evaporation of water and aid cooling.

Advantages and disadvantages of endothermy and ectothermy

Being an endotherm and being an ectotherm have their own pros and cons. Endotherms have multiple behavioural and physiological mechanisms to control body temperature. But it is not correct to say that ectotherms do not regulate their body temperature, they do, using their own cunning mechanisms.

Advantages and disadvantages of endothermy are:

- ✓ generally speaking, endotherms have the ability to maintain a constant internal body temperature regardless of external conditions (although extreme changes may not be able to be regulated)
- ✓ activity is possible when the external temperature is quite cool, such as at night, early in the morning or during winter
- ✓ the ability to inhabit colder parts of the planet due to their ability to maintain that internal temperature
- × a sufficient proportion of energy intake is used in the regulation of an internal body temperature in the cold
- × more food is required for this contributing factor to homeostasis (for example, a shrew has to eat its own body mass in food each day to prevent itself from starving)
- × less energy obtained from food is used for growth (or at least more food is needed for growth)

And the advantages and disadvantages of ectothermy are:

- ✓ less energy intake is required from food for maintaining temperature, so less food overall is needed, as expense of energy on metabolism is far lower
- ✓ ectotherms do not need to eat as often and can survive greater periods of starvation than endotherms
- ✓ greater proportions of the energy from food can be used for growth
- × are only able to survive in certain climates, and cannot survive in very cold climates
- × the need to hibernate (remain inactive) during the winter as organisms cannot be active at that time
- × vulnerability to predation when basking in the sun
- × the need to rely on ambush predation, rather than sprint predation, as they cannot chase prey as quickly and for as great distances as endotherms can