1.1 Communication

The characteristics of life and the need for communication in multicellular organisms

The characteristics of life

Scientists have long debated what the criteria for life are, and there is still no definite answer. Take, for example, viruses – which to this day scientists have still not agreed on whether or not they are to be considered life forms. Some examples of characteristics of life include:

- homeostasis
- organisation
- metabolism
- growth
- adaptation
- response to stimuli
- reproduction

The process known as **homeostasis** is vital to life because it is essential that the right internal conditions are maintained within an organism, so that they are sufficient for enzymes to work efficiently, as enzymes are vital to maintaining life as they are involved in all major metabolic life reactions.

Communication

Animals are an example of a multicellular organism. There is a division of labour between different tissues and organs (and cells) which keeps the organism functioning. Stimulus and response is required, to allow the different tissues to communicate with each other.

Multicellular organisms require **communication** as they are differentiated and have this division of labour, in order to coordinate the functions of the different systems. It provides a link between the *receptor*, detecting a **stimulus**, and the *effector* being triggered to carry out an appropriate **response**.

Stimulus and response

The body must respond to *external stimuli* (such as changes in temperature, light, sound, taste, etc) as well as *internal stimuli* (such as changes in body temperature, blood sugar levels and presence of pathogens). The communication which takes place between the detection of a stimulus and the implementation of the response relies on two systems: the **nervous system** and the **endocrine system** (hormonal system).

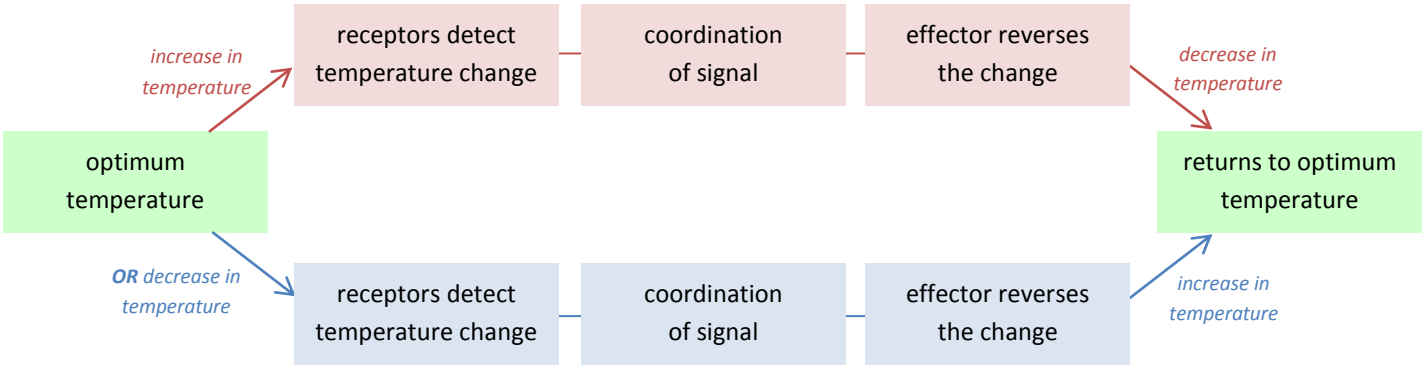
Nervous communication uses signals carried by nerves throughout the central nervous system (CNS), in the form of an electrical impulse. The endocrine system uses hormones, which travel around in the bloodstream and trigger a response when they bind with *target cells* or *target tissues*.

Homeostasis

The term homeostasis describes the process of maintaining a constant internals environment despite external changes which may be taking place.

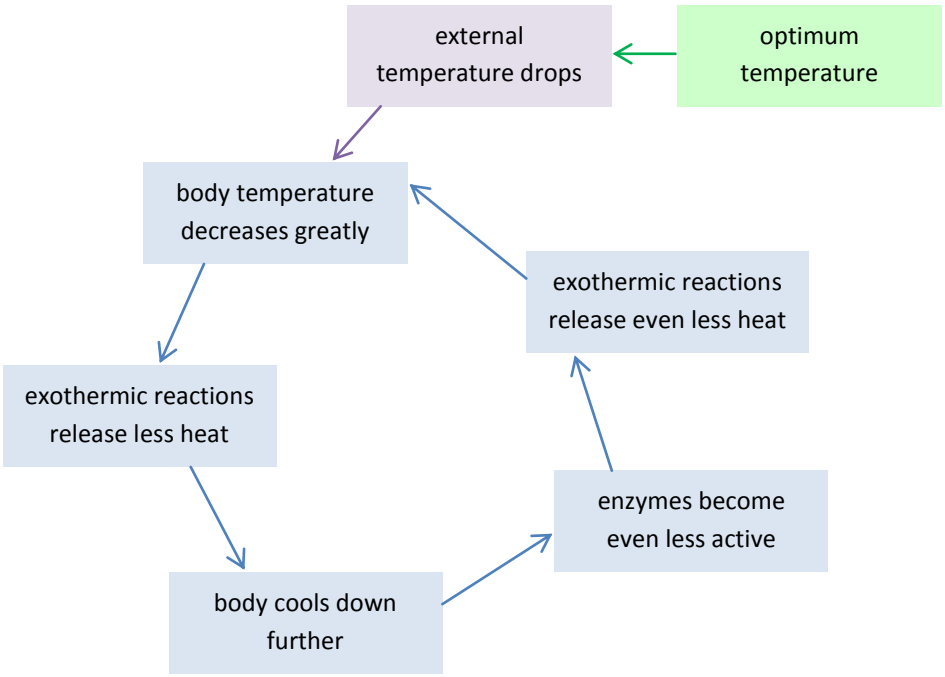
Negative feedback

One mechanism, called **negative feedback**, operates by detecting the external change (stimulus), communicating with other cells, and *reversing* the change (response). The diagram outlines negative feedback response for a change in temperature:



Positive feedback

The other type of feedback, which is much less common than negative feedback, is called **positive feedback**. This type of feedback usually doesn't lead to homeostasis, as the effector actually increases the change detected by the receptor, and so it can be seen as a 'vicious cycle' approach. With positive feedback, the change is amplified, which is usually harmful to the organism. One example of this is, again, using temperature. However, this time, we must assume that the body is getting too cold due to a severely low temperature. Normally, if the external temperature decreases slightly, our bodies can react to the change, but when our bodies get too cold:



When the internal body temperature falls below a certain level, enzyme action decreases. This means that the reactions which release heat occur more slowly and less often, so less heat is released. The effect is that the body temperature falls even lower, and so this causes even less enzymes to function properly, so even fewer exothermic reactions release heat, so body temperature falls again, and so on.

Another example might be childbirth: when contractions begin in labour, the cervix widens, which is detected by receptors, which trigger the release of oxytocin which causes further contractions, so the cervix widens further, which stimulates the release of yet more oxytocin, and so the cycle continues. This is an example of where positive feedback is actually beneficial. When the cervix has widened enough, the baby can be born. Of course, this cycle will eventually end at some point, but this cannot always be said for every type of positive feedback, which is why (for example, with the temperature) it can be very dangerous.