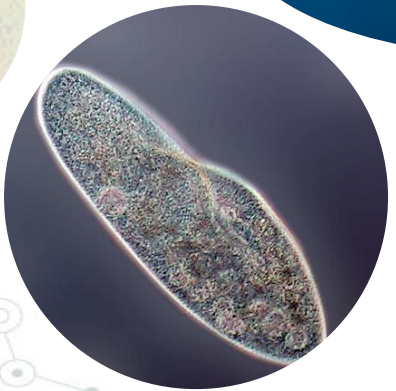
1.1.U2
Unicellular organisms carry out all functions of life.

Outline the functional characteristics of life.

- **What do all forms of life have in common?** All living organisms, from the smallest bacterium to the largest whale, share certain characteristics of life.



Outline the functional characteristics of life.

- The **functional characteristics** of life are the structural, biochemical, physiological, or behavioural traits shared by **all living things**.
  - Even unicellular organisms!
  - Life is an emergent property!

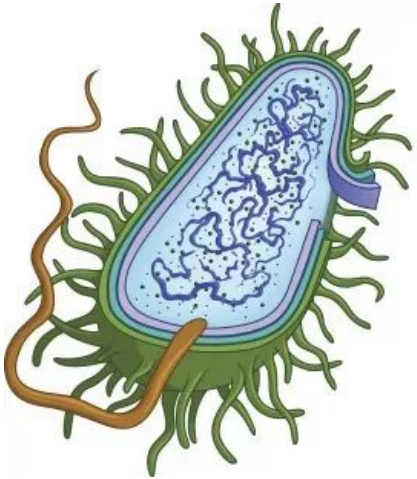
- There is general consensus* around the functional characteristics of life.

** General consensus does not mean 100% agreement! Believe it or not, there is still active debate between biologists about how to define "life."*

Outline the functional characteristics of life.

- All life has a **cellular structure** (according to the cell theory, all living things are composed of cells).

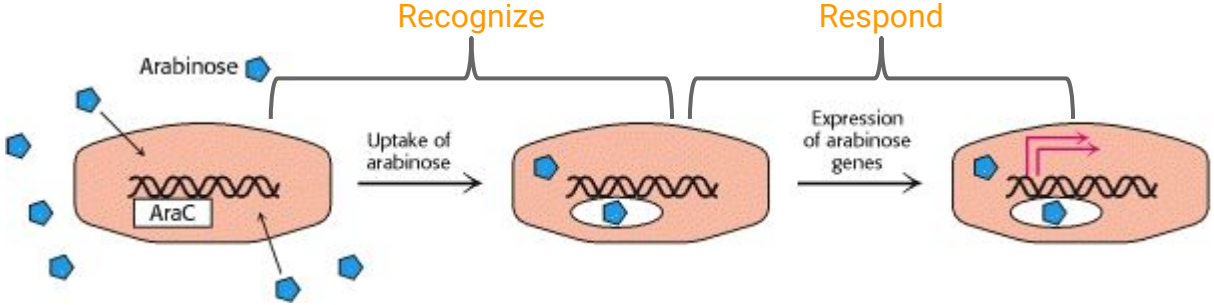
Prokaryotic celled organisms have a simple cell structure without internal membrane bound compartments



Eukaryotic celled organisms have a more complex cell structure with internal membrane bound compartments

Outline the functional characteristics of life.

- All life can **recognize and respond to changes in environmental conditions**.
  - Even single celled organisms can recognize what is going on around them, and respond to changes in the environment. Read more here!



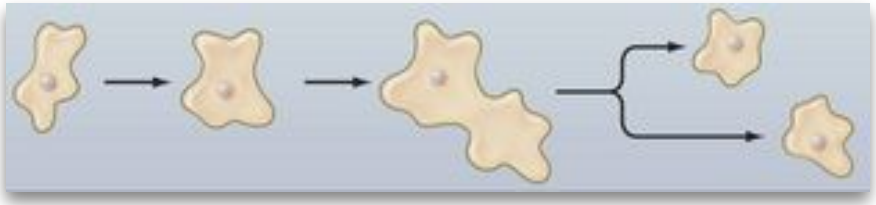
In E. coli cells, the uptake of arabinose sugar from the environment triggers the production of enzymes necessary for its utilization as a nutrient source.

  - How do cells recognize their environment? Often the first step is stimulation of a protein embedded in the cell membrane.

- *Chemoreceptors: stimulated by changes in the chemical concentration of substances.*
- *Thermoreceptors. stimulated by changes in temperature*
- *Mechanoreceptors. stimulated by changes in pressure or movement*
- *Photoreceptors. stimulated by light energy*

Outline the functional characteristics of life.

- All living things can **grow and/or develop the lifespan.**
  - Growth is the increase in size and mass of an organism.
  - Development is the transformation of the organism through its lifespan.



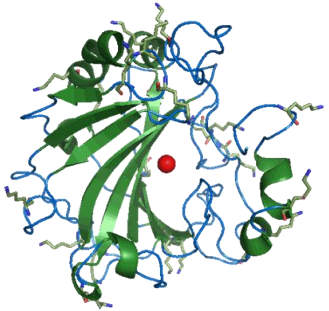
Even single celled organisms, like this amoeba, will grow. If the parent cell does not grow, then each subsequent generation will just be smaller than the previous generation

Metamorphosis (in an insect or amphibian), is the process of transformation from an immature form to an adult form in two or more distinct stages. It is a really extreme form of development!

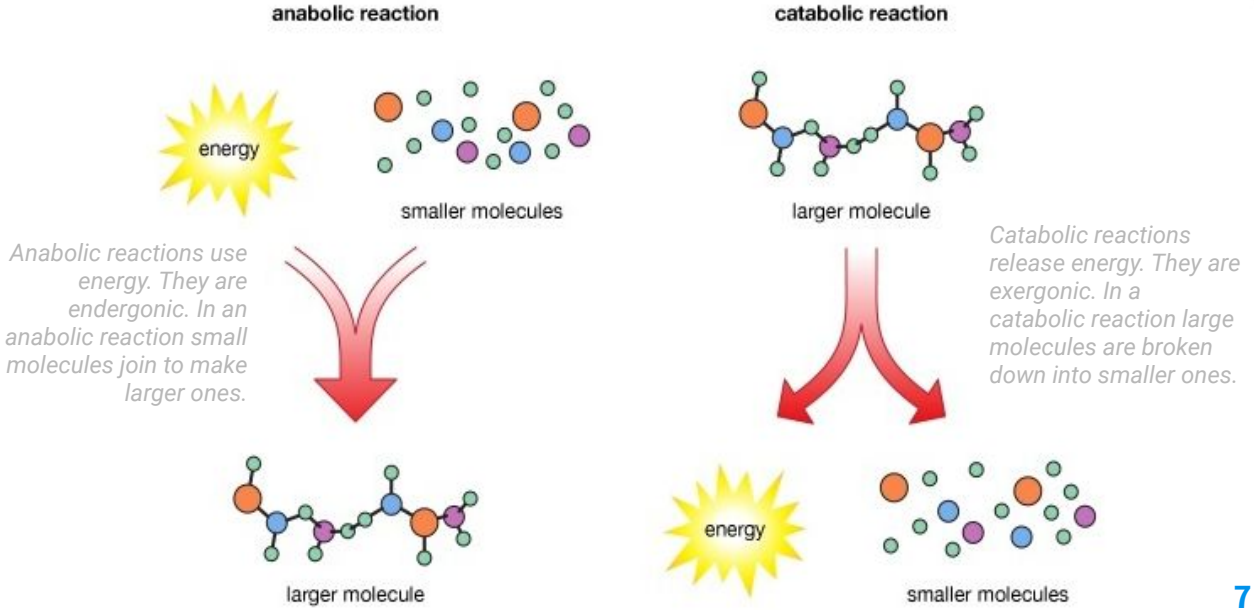
In many multicellular organisms, cell growth is influenced by hormones.

Outline the functional characteristics of life.

- All life has **metabolism**.
  - Countless chemical reactions take place in cells and are responsible for all the actions of organisms.
  - Metabolism is the sum of all the chemical reactions in a cell.
  - Viruses lack metabolism, a reason they are not considered to be living



Enzymes are a type of protein that catalyze metabolic reactions



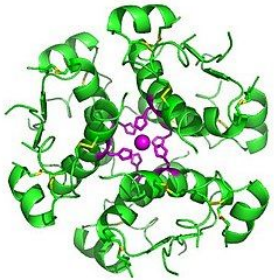
Anabolic reactions use energy. They are endergonic. In an anabolic reaction small molecules join to make larger ones.

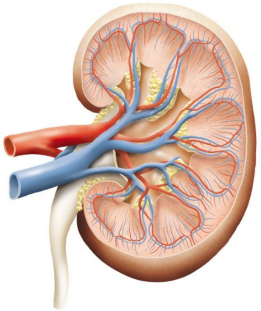
Catabolic reactions release energy. They are exergonic. In a catabolic reaction large molecules are broken down into smaller ones.

Outline the functional characteristics of life.

- All life has a maintenance of **homeostasis.**
  - Living organisms keep their internal environments within a certain range (they maintain a stable internal condition), despite changes in their external environment.
  - Even single celled organisms maintain homeostasis, for example by keeping concentrations of water and minerals within certain levels.

Many hormones function in order to maintain homeostasis For example, insulin and glucagon regulate blood glucose levels in humans





Anatomical structures, like the human kidney, have functions that help the organism maintain homeostasis
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Paramecium are single celled organisms whose cytoplasm contains a greater concentration of solutes than their surroundings, so they absorb water by osmosis. To maintain homeostasis, the excess water is collected into a pair of "contractile vacuoles" which alternately swell and expel water through an opening in the cell membrane. More about the functions of life in the paramecium in

Many adaptations, like the large ears of the jackrabbit have evolved to help organisms maintain homeostasis

Outline the functional characteristics of life.

- All life has the **capability for reproduction;** ***life will create more life.***

Sexual reproduction involves two parents and the fusion of haploid sex cells from each parent.

- Meiosis allows for a sexual life cycle with fusion of gametes.
- Sexual reproduction produces offspring that are genetically unique and increases genetic variation within a species.

Asexual reproduction involves only one parent.

- Asexual reproduction produces offspring that are all genetically identical to the parent.
- Binary fission and mitosis are mechanism of asexual reproduction.

Test yourself here to see if you can identify the method of reproduction in different organisms!

Outline the functional characteristics of life.

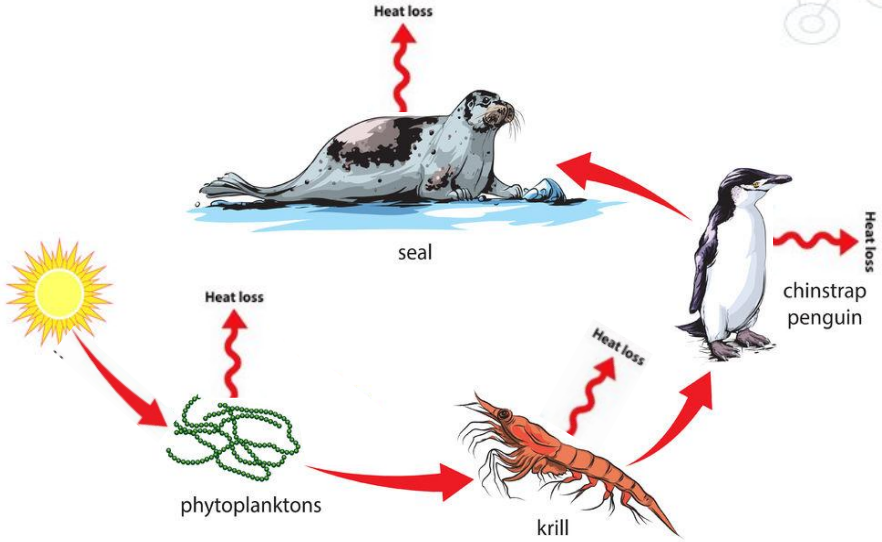
- All life **exchanges energy and matter with the environment.**

  All organisms use a source of **energy** for their metabolic activities.

  - Photoautotrophs capture energy from the sun and convert it into chemical energy in food\
  - Heterotrophs use chemical energy in matter they take in as food
  - Metabolism releases heat energy back to the environment

  All organisms excrete metabolic waste **matter**

  - In humans, excretion occurs via lungs, kidneys and skin
  - In many plants, excretion occurs via leaves, roots and stem
  - In unicellular organisms, excretion occurs through the cell membrane, which is one reason cells must have a large surface area to volume ratio.

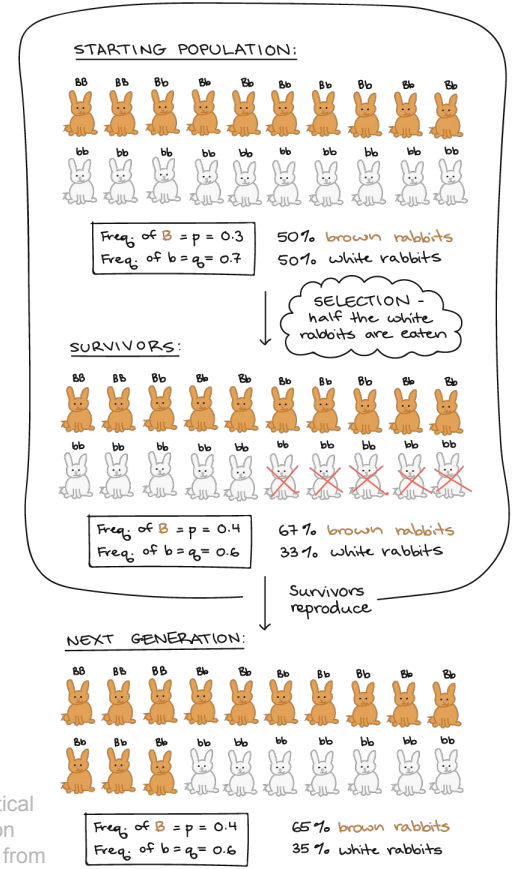


Outline the functional characteristics of life.

- At the population level, life **adapts and changes over time.**

  This characteristic is a little tricky, because **a** life (one single organism) does not adapt. Adaptation is a result of evolution by natural selection, which occurs at the level of the population.

  When a population is evolving, the ratio of different genetic types in the population is changing -- each individual organism's genes do not change.



Hypothetical population scenario from Khan Academy

The brown rabbit is more adapted to its current habitat. The white rabbit as an individual can not adapt in its lifetime. Read more to find out how some animal populations are adapting (or not) to rapid climate change.