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Moving slime: exploring chemotaxis with slime mould

What are slime moulds?

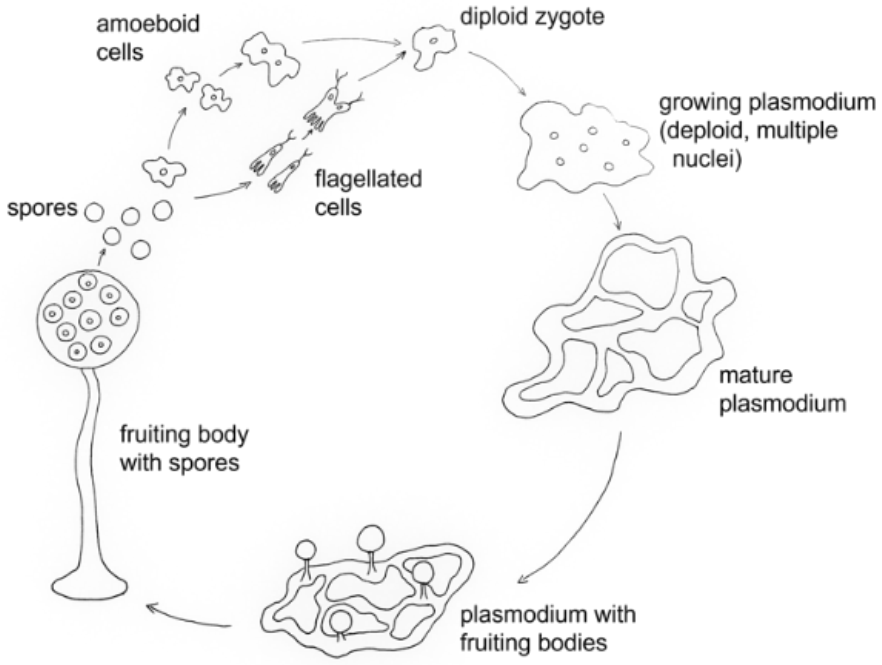
In nature, slime moulds (*Myxomycetes*) can appear as brightly coloured, slimy networks, which are often found in the woods on tree trunks or fallen leaves. They are living and moving organisms that are neither animals nor plants nor fungi, even though they were once classified as fungi. Genetic analysis has revealed that they are more closely related to amoeba, which is why we can refer to them as protists.

A slime mould in nature
Image: Ann Evankow/ iNaturalist.org

There are two kinds of slime moulds. Plasmodial slime moulds are a single individual consisting of one large cell with many nuclei. Cellular slime moulds are single cells with only one nucleus, which can cluster to act as one big organism. The most common slime mould used for scientific research and for teaching and is the plasmodial slime mould *Physarum polycephalum* ('the many-headed'). It consists of one single eukaryotic cell. By definition, it is a microorganism, but this single cell can be several square centimetres to square meters in size. The largest slime mould kept in a laboratory reached a size of 3 m^2.

Life cycle and reproduction

A slime mould has different states during its lifetime. In the state where it is visible with the naked eye, it is called a plasmodium. It prefers dark and moist places and moves around to search for food. It keeps growing and, if the conditions are good, it doubles its size every day. While it is growing, the nucleus divides, but the whole cell does not. A slime mould is one big growing cell with many nuclei that contain its genetic information (DNA). Its multiple nuclei allow the slime mould to stay alive when it is cut into pieces. Every piece contains all the genetic information it needs to live on. If two pieces with the same genetic information meet, they will fuse again.



Life cycle of *Physarum polycephalum*
Image courtesy of Amber Buchta

If the environment is too dry, the slime mould becomes a sclerotium. It reduces its size due to dehydration and does not move anymore – but it is not dead! Once the conditions are good again, it turns back into a plasmodium.

To reproduce, it develops fruiting bodies, which are formed when the slime mould is exposed to light. With these fruiting bodies, the slime mould resembles mushrooms, even though it is not a mushroom. The fruiting bodies develop haploid spores that are carried away by the wind. Older slime moulds move to the light deliberately, so that they can spread their spores. The spores develop into amoeboid or flagellated cells. When two cells of the same kind, e.g., two amoeboid cells or two flagellated cells meet, they will merge to form a new diploid plasmodium.

haploid = only one set of chromosomes

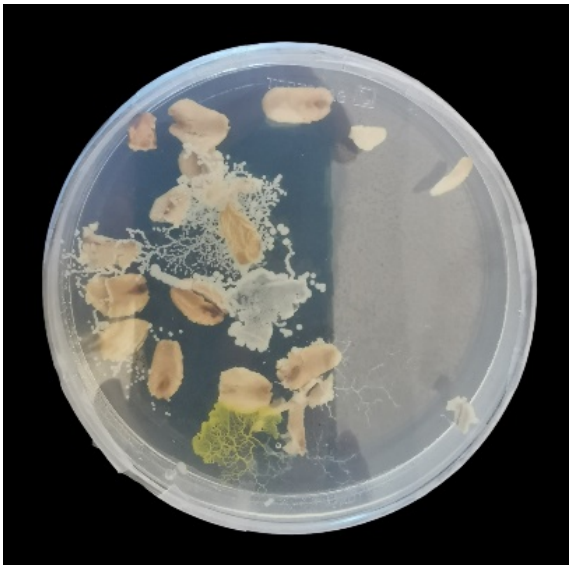
diploid = two homologous sets of chromosomes (each chromosome is present twice)

Chemotaxis and the search for food

A slime mould does not have sensing organs like animals, but it still can find the right way to its food. The reason for this is that it has special structures in its cell membrane. They are called chemoreceptors, which means that they can sense chemicals in the slime mould's environment. These receptors allow the slime mould to determine whether a substance is good and it should move towards it (these substances are called attractants), or if it is toxic and it should move in another direction (repellents).

While searching for food, the slime mould spreads out in different directions. As soon as it has found a suitable food source, it will strengthen the shortest and most efficient connection to the food and will draw back from other areas it explored. Slime moulds feed by phagocytosis, which means that they take in particles of their food.

External memory



Slime mould (yellow) and the trace it left behind while exploring the plate (white)

Image courtesy of the authors

A slime mould does not have a brain, but it still needs to remember which places it has already explored. To do this, it leaves a trace of colourless slime behind. Whenever it crosses this trace again, it knows that it has already been there and it does not need to look for food again.