Discovery: malaria parasite has ancient chloroplast

by Professor Geoff McFadden

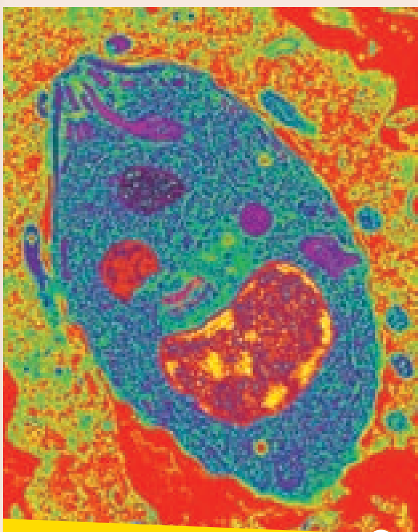


Figure 17.19
Colour-enhanced electron micrograph of the malaria parasite, which is a single-celled organism that infects red blood cells. The relic chloroplast in the parasite is shown as the red structure on the left side.

Botanists do not generally work on human diseases but Professor Geoff McFadden, a Research Professor in Botany at the University of Melbourne, is doing just that. Professor McFadden discovered that the malaria parasite (see Chapter 9), which is responsible for millions of deaths every year, is in fact a strange kind of plant-like organism.

The malaria parasite is a microscopic eukaryote related to photosynthetic protists. McFadden and his team have identified that the parasite has a **relic chloroplast**—a chloroplast that has survived from an earlier period (Figure 17.19). It has the same origin as the chloroplasts of plants and algae. In plants and algae, the evolutionary origin of the chloroplast was by the process of **endosymbiosis**, where a photosynthetic cyanobacterium was swallowed by a eukaryote cell and retained as a permanent structure (the chloroplast) within the eukaryotic cell. This essentially means that algae and plant cells have a bacterium living inside them and this tiny guest synthesises sugars for the host cell by photosynthesis. The chloroplast of the malaria parasite has the same basic origin, except that it does not photosynthesise. The relic chloroplast contains a collection of bacterial genes that perform other important services for the parasite cell, such as fatty acid metabolism.

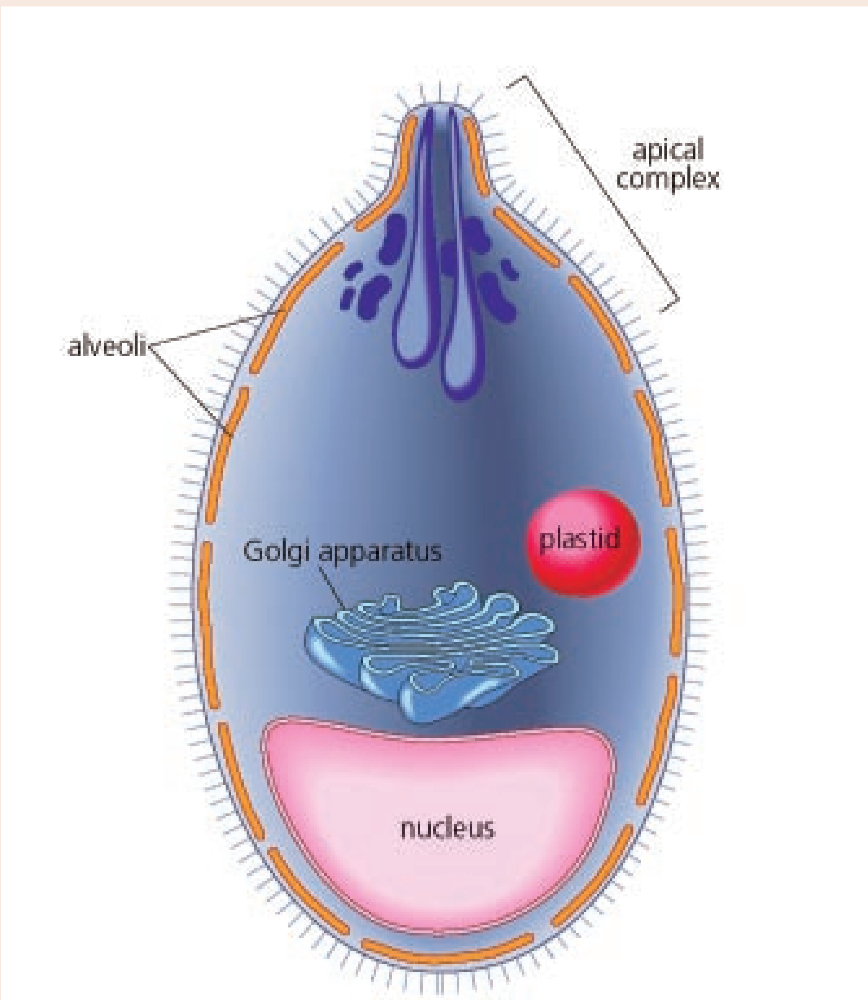
It has been concluded that malaria was once a photosynthetic organism that somehow converted to parasitism and found its way into the human bloodstream. The relic chloroplast is the tell-tale clue to this bizarre change in lifestyle, but it promises to be more than just an evolutionary curiosity. Professor McFadden hopes that the relic chloroplast might hold a key to winning the battle against malaria, which is one of the world's worst health problems.

Drug-targeting the relic chloroplast

Some potent antimalarial drugs have been developed but the parasite has now become resistant to our best drugs, many of which are virtually useless in many parts of the world. The ideal solution would be to develop a malaria vaccine and eliminate the disease, as was successfully done for smallpox, but vaccine development has proven unexpectedly difficult and no good vaccine is yet on the horizon. It is therefore vital that we secure new drug options, which is why the recent identification of a relic chloroplast in malaria and its evolutionary history is so important.

Antibacterial compounds (*antibacterials*) developed to fight bacterial infections usually inhibit chloroplasts of plants. Numerous herbicides are based on the fact that they affect bacterial-like processes in chloroplasts but typically have no effect on the host plant cell. When Professor McFadden identified a chloroplast in malaria he predicted that many antibacterials and herbicides might potentially be antimalarials. Subsequent trials in McFadden's lab and in other malaria labs have confirmed this prediction. As a result, a large number of new types of drugs have suddenly become possible and are being assessed. One such antibacterial, doxycycline, was already in wide use against malaria and McFadden's discovery now explains why it works. McFadden uses doxycycline to protect himself when visiting malaria prone countries like Africa, China and India during his work. "You've got to have the courage of your convictions", says McFadden.

The discovery that the malaria parasite has a chloroplast is a classic example of basic, evolutionary science and curiosity-driven research turning up highly significant findings that could not have been anticipated. No one predicted that malaria parasites would have a chloroplast, and a whole therapeutic strategy would have gone unnoticed except for some good old-fashioned sleuthing by scientists with an interest in piecing together the evolution of organisms.



Professor Geoff McFadden

Professor Geoff McFadden, a Research Professor in Botany at the University of Melbourne, studies the malaria parasite and discovered that it is related to photosynthetic protists—unicellular algae.

Figure 17.20
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