die of starvation unless a compromise could be found, but by now it was tightly bound to the methanogen and couldn't just leave. One possibility would have been for it to physically move inside the methanogen. The methanogen could then use its own surface to absorb all the food needed, and the two could continue their cosy arrangement. So the α-proteobacterium moved in.

Before we continue with our just-so story, let's just note that there are several examples of bacteria living inside other bacteria; it's not necessary to be phagocytosed. The best-known example is *Bdellovibrio*, a fearsome bacterial predator that moves quickly, at about 100 cell-lengths per second, until it collides with a host bacterium. Just before colliding it spins rapidly and penetrates the cell wall. Once inside, it breaks down the host's cellular constituents and multiplies, completing its life cycle within 1–3 hours. How many non-predatory bacteria gain access to other bacteria or archaea is a moot question, but the basic postulate of hydrogen hypothesis, that phagocytosis is not necessary to breech another cell, does not sound unreasonable. Indeed, a discovery in 2001 makes it seem more reasonable: mealybugs, the small, white, cotton ball-like insects found living on many house plants, contain β-proteobacteria living within some of their cells as endosymbionts (collaborative bacteria living inside other cells). Incredibly, these endosymbiotic bacteria contain even smaller γ-proteobacteria living inside them. Thus one bacterium lives in another, which in turn lives inside an insect cell, showing that bacteria can indeed live peacefully inside one another. The discovery smacks of the old verse: 'big fleas have little fleas upon their backs to bite 'em; and little fleas have smaller fleas, and so ad infinitum.'

Let's resume our story. The α-proteobacterium has now found itself inside a methanogen; so far so good. But there was a new problem. The methanogen wasn't practiced at absorbing its food—it normally made its own from hydrogen and carbon dioxide, and so it couldn't feed its benefactor after all. Luckily, the α-proteobacterium came to the rescue. It had all the genes necessary for absorbing food, so it could hand them over to the methanogen and all would

4 Hydrogen hypothesis. Simplified schematic showing the relationship between a versatile bacterium and a methanogen. (a) The bacterium is capable of different forms of aerobic and anaerobic respiration, as well as fermentation to generate hydrogen; under anaerobic conditions the methanogen makes use of the hydrogen and carbon dioxide given off by the bacterium. (b) The symbiosis becomes closer as the methanogen is now dependent on hydrogen produced by the bacterium, which is gradually engulfed. (c) The bacterium is now completely engulfed. Gene transfer from the bacterium to the host enables the host to import and ferment organics in the same way as the bacterium, freeing it from its commitment to methanogenesis. The dashed line indicates that the cell is chimeric.