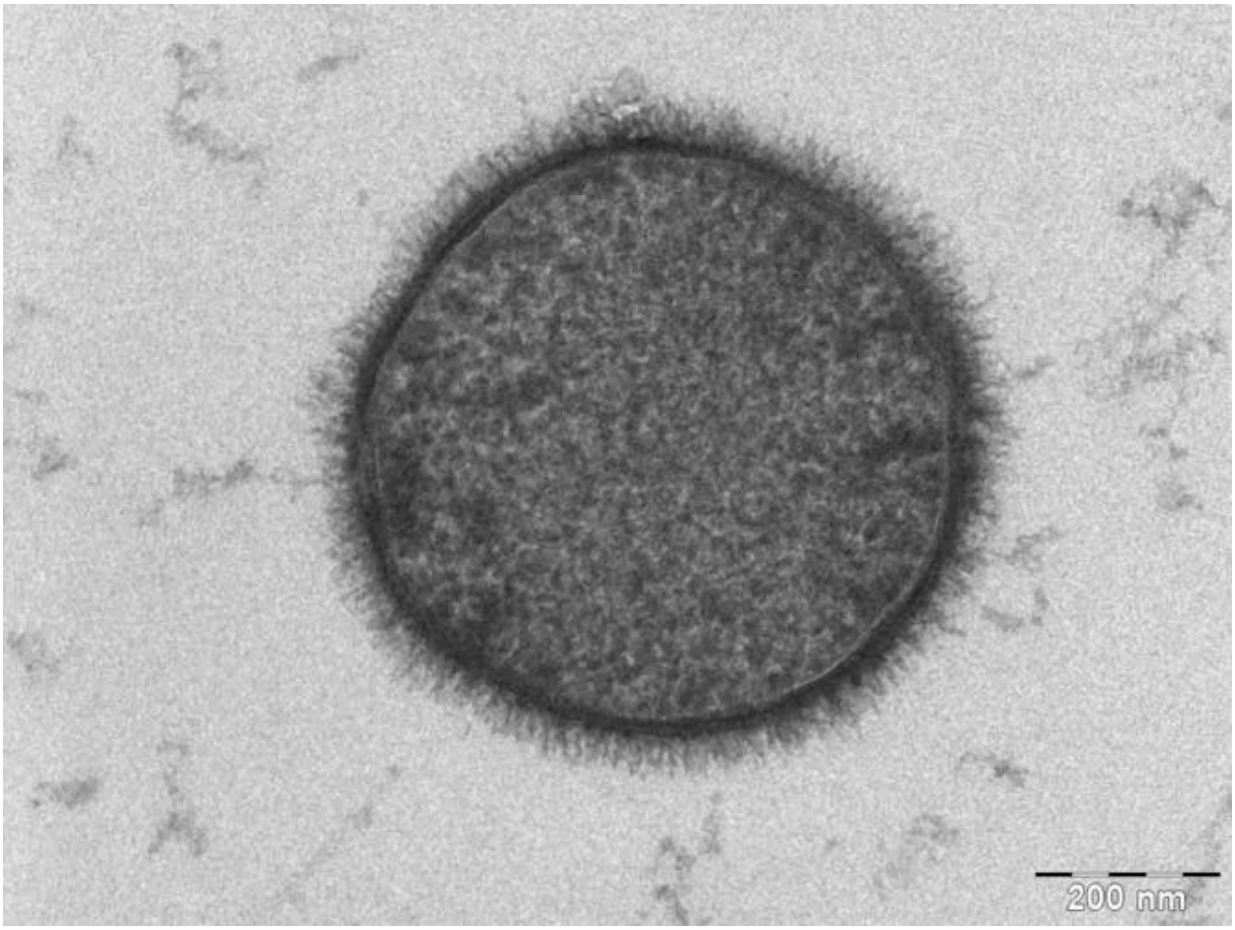
Why bacteria could be the answer to a future without oil

July 30 2015, by Jeff Errington



Fossil free. Credit: Allonweiner

Chemicals are all around us. They are crucial in all manner of industries,

from agriculture to food to cosmetics. Most people give little thought to how these chemicals are made – and certainly very few would consider the chemical industry as a contributor to our society's dependence on oil. But it is.

Historically petroleum has been used to develop the chemicals needed for products such as pesticides, food supplements and make-up. Although many of the building blocks required to make these chemicals occur naturally, trying to take those natural materials and use them in large-scale industrial processes has proved difficult and costly. So petroleum is used instead.

Until recently, oil was seen as a cheap commodity which was available in abundance, so petroleum was perfect for use in the chemical industry. However, the world has changed. We now recognise the need to reduce our reliance on oil in order to protect the environment and maintain our national security. There are also health concerns over the use of petroleum in products we eat and apply to our bodies.

This is why new advanced methods for industrial biotechnology are so important; they are enabling the use of engineered bacterial cells, rather than petroleum, in developing chemicals to be used in these products. Importantly, the bacteria can be grown on a range of cheap and renewable resources, even various kinds of farmland waste.

However, in order to use bacteria effectively – and in a manner which can be scaled up by industry – we need to know a lot more about bacterial cell biology. Only by investigating the machinery and processes at the heart of cells can we learn how to use them to develop organic chemicals in a manner that was previously unfeasible for industry.

Friendly bacteria

At Newcastle University's Centre for Bacterial Cell Biology we've spent years studying *Bacillus subtilis*, a bacterium that lives peacefully in soil or even in the human gut. This organism and its relatives are very good at making and secreting enzymes which are catalysts for all sorts of useful processes. It means *Bacilli* are already used widely by industry, for example in producing the enzymes that are used in biological washing powders such as proteases (which break down blood, egg and other protein stains) or amylases (which dissolve starch).

However, the range of enzymes they can secrete efficiently is much more limited than we would like. Studies on fundamental structures and processes of the bacterium are now beginning to give us the ability to engineer the cells to secrete a wider range of proteins from a diverse range of sources.

This means that before long *Bacillus* will be used to make all kinds of enzymes, including those needed in the chemical industry to replace processes presently dependent on petroleum.

This is a huge opportunity. The European industrial biotechnology industry has an estimated annual turnover of more than €60 billion, and the global industrial enzyme market is predicted to be worth US$7.1 billion by 2018. Detergent enzymes alone make up a billion dollar business.

However, continued reliance on oil-based solutions will hamper growth and could have significant societal and environmental consequences. Replacing petroleum with bacteria will have a real impact on people's lives.

Algae vs sunburn

Suncream is a good example. One of the projects we are working on at

Newcastle is to develop organic UV-absorber compounds from renewable materials to be used in sunscreens.

Damage from exposure to UV radiation is a major worry, and there is increasing demand for cosmetics that block UV rays. The industry relies on oil-based technology and inorganic metal oxide particles to create materials that block UV rays for use in sunscreen.

However, we know that photosynthetic bacteria called cyanobacteria that grow in the sea make their own organic sunscreen molecules. By taking the relevant genes from cyanobacteria and transplanting them into a bacterium that is already widely used in chemical production, we hope to be able to change this. If we are successful, the process could easily be scaled up so the cosmetics industry will be able to develop cheap organic sunscreen.

This is just one example of the way in which bacteria could support a future without oil. Work is already in progress to explore the potential of using waste to grow bacteria or other micro-organisms that could make chemicals such as ethanol for use as "biofuel" for cars and aeroplanes, further reducing the use of oil.

There is a lot of work still to be done to make this vision a reality, but by continuing to investigate how bacterial cells work and how they could be used in chemical production we can see a future in which waste becomes energy and we can live without oil.

Source: Newcastle University