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Bacteria producing electricity?

EVERYBODY knows that the bacterial world, is, for lack of a better word, 'energetic.' Vesicles shuttle in the cytoplasm powered by motors known as kinesins. Chromatins are reeled apart by thin thread like structures during cell division. Active efflux pumps continually exude unwanted ions out of the bacteria. All of these mechanisms are powered by energy which bacteria obtain by digesting food.

But did you also know that, today, researchers can tap into this biochemical energy, and use it to power electrical appliances.

Certain bacteria can aggregate and stick to each other to form biofilms. Such biofilms can form on a variety of surfaces – living or non-living – such as on the surface of teeth, on rocks and pebbles, on the interior lining of the large intestine, etc. Although bacterial biofilms are often pathogenic, some biofilms are also 'grown' and 'harvested' by researchers because they have several uses.

They can be used to break down organic adulterants in water, and hence purify it. They can be used to clear oil spills in sea. They can be used as a vehicle to deliver beneficial proteins and enzymes into the digestive tracts of individuals. But one other particular potential application of bacterial biofilms has long intrigued the research community: the electricity producing microbial fuel cell, MFC in short.

The MFC is similar in construction to its forefather the Galvanic cell. Two chambers. Each chamber having a certain electrolyte. An anode. A cathode. And of course a salt bridge. But unlike the Galvanic cell, which has a metal for the anode, a microbial fuel cell has a bacterial biofilm that is submerged in a carbon rich broth – the food for the bacteria. Therefore, when the cathode and the anode are connected by a wire, the bacteria oxidize the food at anode, thus releasing electrons which flow through the wire – as electricity – towards the cathode.

The MFC has several advantages over traditional fuel cells: (a) unlike the metals in fuel cells, the bacteria are a renewable and a green energy source; (b) MFCs can be operated at variable temperatures; and (c) in MFCs no toxic gases are released. Given such advantages, therefore, it should come as no surprise that in recent years the electricity producing capability of different bacteria is being evaluated by researchers world over. A Research Article, **page 925**, adds to this list of microbial bioreactors by evaluating the electricity producing efficiency of four bacteria: *Paenibacillus lautus*; *Pseudomonas mendocina*; *Stenotrophomonas acidaminiphila*; and *Pseudomonas pseudoalcaligenes*.

Breaking symmetry for symmetry

If we can understand the symmetry breaking mechanisms found in organisms, we can, perhaps, evolve new organisms of our own, or at least, reengineer those that are extinct.

TAKE a good look around and observe life around you. You would realize that symmetry in life has three forms: spherical, bilateral, and radial. Freshwater green alga, *Volvox* is spherically symmetrical – any line running through its centre would divide it into two congruent halves. Humans are bilaterally symmetrical – only one particular plane running from our heads to toes, when we stand erect, will divide our bodies into mirror image halves of one another. And, when a number of different planes can divide an organism's body into identical pieces, the organism – such as the starfish – is known to exhibit radial symmetry.

Life forms are therefore symmetric. And all organisms – with the exception of sponges – most assuredly exhibit any one of the symmetric forms. But, often, as evidenced by the evolutionary history of these symmetric organisms, an earlier symmetry needed to be broken to realize a new symmetry. In other words, life is known to evolve through symmetry breaking transitions.

Think of a piece of clay that is flattened into a perfect disc on the floor. It is bilaterally symmetric. But to mould this disc into a sphere – another symmetric shape – one needs to break the previous symmetry. Life evolves in a similar way: breaking, maintaining, and breaking the symmetry again. A General Article, **page 819**, analyses such symmetry breaking transitions in nature.

Analysing rise in sea levels

Rise in sea levels = Global warming?

IF one had dipped one's feet into the ocean in the early 1900s, and stood there for a full hundred years, till today, 2015, the sea level would have risen by a few millimetres. But these few millimetres are unnoticeable to the eye, and even if one would have measured the sea level by dipping a ruler into the sea, one would get varying results because – influenced by winds, and waves – the sea level would change on an hourly basis. So, how do scientists measure these invisible millimetres, and that too with such great accuracy?

Traditionally, a technology known as the tide gauge has been used to measure the changes in global sea levels. A tide gauge is basically a long pipe, that has an orifice at the bottom. Mounted on a pier along the coast, the pipe is dipped deep enough to ensure that the orifice is well below the water line. Hence, although the water level *outside* the pipe changes continually throughout the day, the water level *inside* the pipe, owing to the orifice, remains constant, and thus is an accurate measure of the sea level. But these tide gauges are only found at certain coastal points, and the data so gleaned is limited. Therefore, to get a bird's eye view of the global sea levels along the entire coastline of the world, scientists have now begun to use a far more sophisticated technology: the satellite altimeter.

The satellite altimeter, as the name suggests, is a device that beams microwaves from outer-space towards the surface of the seas and clocks the amount of time the beam takes to return to its radiometer. By evaluating the strength and the shape of this returning microwave, the altimeter can deduce with great accuracy – to about an inch – any change in the sea levels. Indeed, by analysing the altimeter and tide gauge data, scientists estimate that the global sea level is rising at an alarming rate of 3 mm/year.

Global warming!

Are the first words to ping in one's mind whenever such an insidious rise in sea levels is reported. A Research communication, **page 966**, however, cautions against jumping the gun, and reports that several other culprits – such as climatic variations, change in oceanic heat content – could also contribute to a rise in sea levels...

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