

# Isolate & inactivate

Limited language skills may prove the Waterloo for bacteria, says s ananthanarayanan

**DURING** the Indo-Pakistani conflict of 1971, radio communications were compromised and both sides could hear everything the other was saying. The Indians still stayed ahead because their radio operators spoke Malayalam, which true of the Pakistanis could not understand. But the same was not true of the Pakistani messages, because they had no fallback of an unfamiliar language. Helen Blackwell and colleagues at the University of Wisconsin-Madison have discovered that most bacteria use the same few chemical signals to communicate before they turn toxic. Finding ways to jam this medium could, hence, be a way to stop many varieties of bacteria from getting their act together!

Bacteria are single-celled creatures that differ from most other living cells in that they have no cell nucleus where the DNA, or genetic record, is stored. This category of living things hence remains single-celled and has not formed major life forms, like plants and animals, and their activity was thought to be little other than feeding and reproduction. Organisation, or structure, in the form of tissue or growth or groups of bacteria was considered non-existent. But this view has been changing and it is now known that development processes similar to those of multicellular life are a vital part of the biology of bacteria. A number of genetic and biochemical studies in the 1960s and '70s has yielded strong evidence for an "organised social behaviour" which uses sophisticated communication systems to coordinate the activities of individual single-cell organisms within a population.

**Quorum sensing**

Quorum sensing happens when the members of a group communicate with each other and sense that some minimum number of them is ready, before they act in some way. One example is of social insects, like ants and honeybees, which use this method to select a place to nest. The concept has application in computer systems, particularly in robotics, where the individuals decide, based on a way to sense numbers, rather than an external agency like an operating system that is keeping a count. But the best instance is the way bacteria regulate certain behaviour based on their own numbers. The classic example is of the bacterium *Vibrio fischeri*, which lives in a symbiotic relationship with the squid-like *Hawaitan bobtail squid*, or the *Flashlight squid*. The adaptation of the Hawaiian squid is a marvel of evolved survival strategy. While foraging at night in the shallow Pacific Ocean (and some parts of the Indian Ocean), it presents a silhouette or shadow against the moonlight or starlight to predators below, and becomes a sitting duck target. The squid has evolved to carry a light-emitting apparatus that senses the light coming from above and beams it downwards, with just the right intensity and colour for the squid to become invisible.

But what is the nature of the light emitting arrangement? This is a colony of light emitting bacteria called *Vibrio fischeri* which live off the sugar and amino acid nutrients from the squid and repay by getting luminescent, as and when required, for the host to hide its shadow. And this is where quorum sensing comes in. The *Vibrio fischeri* is not luminescent when by itself in the open sea. It is only when it is present in good numbers, like in the "phosphore" organ of the squid, that it begins to emit light. Which is just as well, because if it were luminescent in the ordinary course it would lose energy, at low intensity, to no purpose. But switching on when in numbers and able to generate a strong glow helps its host, the Hawaiian squid, which provides safety and nutrients in return.

**The medium**

The way bacteria respond to numbers of themselves is with the help of "auto-inducers", chemical signal molecules that the bacteria constantly produce. The molecules are called "auto-inducers" because they are produced by the organism itself and the organism has "receptors" that can detect them in the environment. Now, when there are greater numbers of the organism present, there are more of these molecules and a threshold can be set for a particular behaviour to commence. The behaviour, typically, is the expression of a gene and the creation of agents, like *luciferase*, which cause emission of light in the case of *Vibrio fischeri*. The inducer, in fact, activates genes that cause more inducers to be secreted and crossing the threshold causes a *cascade*, or sudden activation, like the effect of a switch!

Since 2001, important steps have been taken in identifying the agents used in quorum sensing in bacteria. The studies have yielded the basic structures and categories of the chemicals involved, the important group being compounds called *lactones*. It is considered that the quorum sensing agents may have developed very early in the course of evolution and would hence be similar in all strains of bacteria.

This is borne out fairly well in the main groups of bacteria, although there are unexplained areas of certain cases being very different, although similar in function.

Interestingly, Helen Blackwell and colleagues, in the work they report in the journal *ChemBioChem*, have found that a large number of bacteria species all respond to the same quorum sensing signals. Synthetic lactones developed in the lab also showed the same efficiency as native lactones that the bacteria used. The importance of this result is that a single or a small number of drugs could be developed to break the communication between individuals in different strains of bacteria so that they never sense their numbers.

**Application**

The crisis in diseases arising from bacteria is that many have developed resistance to a wide band of antibiotics. Resistance arises from mutations of bacteria that survive an antibiotic dose and then multiply, as a resistant strain, unimpeded by competing bacteria. With uncontrolled use of antibiotics, the number of strains showing resistance has grown to alarming levels.

Bacterial action also depends on specific genes that lead to disease-causing action getting activated when sufficient numbers of bacteria are present. A method of attacking the communication medium, for sensing the quorum, could then effectively shut off the toxic action of bacteria. As it is the means of communication that is being addressed, and not the bacteria themselves, there is no question of "survival" of resistant individuals and, hence, of development of resistance.

"Bacteria are always looking out for themselves and they are looking for food and a safe place to live. If they try to do this as individual cells, the host will fight them off. But as a group, bacteria can potentially overwhelm their host. If we can figure out how to stop them from 'counting themselves' via quorum sensing, we could block such group behaviour; and that is what we are after," says Blackwell.

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EVERY schoolchild knows that the "small step for man" and the "giant leap for mankind" were words uttered by Neil Armstrong during the 1969 Apollo 11 moon landing. But now the famously reclusive astronaut has made a rare foray into the public arena to give an answer to a puzzling question: having gone all that way at such vast expense, why were the steps and leaps so few?

The subject arose when science blogger Robert Krulwich mused on his National Public Radio page about why Armstrong and crewmate Buzz Aldrin had covered an area barely larger than a football pitch. "The trip was a 'leap' to be sure, a fantastic accomplishment," he wrote. "But the first moon explorers explored an astonishingly small area."

There it might have rested. But much to Krulwich's surprise, he got an answer – and from the commander himself. In an emailed response, Armstrong, who at 80 is still campaigning to have the National Aeronautics and Space Administration resume its exploration of the lunar surface, said there were multiple reasons for the small footprint of that first landing, not least among them nervousness about how well their water-cooled suits would work. "We were operating in a near perfect

## How come you didn't see all of the moon? The famously reclusive Neil Armstrong breaks silence to answer the burning question, writes david usborne

vacuum with the temperature well above 200° Fahrenheit with the local gravity only one-sixth that of earth," he explained. "That combination cannot be duplicated here on earth. We did not have any data to tell us how long the small water tank in our backpacks would suffice."

The reply from a man who famously refuses to give autographs and long refused to speak about the moon landings even as his colleagues enthusiastically spoke of their adventures, was surprising enough in itself. Perhaps more surprising still was the detail that an apparently enthused Armstrong went into about the difficulties of exploration. First there was the question of television coverage – for us back on earth and for mission control



A photograph of Neil Armstrong on the moon.

Placing a fixed video camera on the moon's surface was one of Armstrong's first tasks and NASA was very clear that thereafter everything he and Aldrin did had to be within its range of view, which wasn't large. They wanted to be able to

see, for instance, how well they were walking in those clunky outfits.

Here we learn, however, that even Armstrong himself was unable entirely to play by the rules. "I candidly admit that I knowingly and deliberately left the planned working area out of TV coverage to examine and photograph the interior or crater walls for possible bedrock exposure or other useful information," he acknowledged. "I felt the potential gain was worth the risk."

Armstrong repeated his disappointment that NASA had not been back and his frustration with those who argued there was little point, since that space frontier had already been reached. "I find that mystifying," he said. "It would be as if 16th century mon-

archs proclaimed that 'we need not go to the New World, we have already been there'... Americans have visited and examined six locations on Luna, varying in size from a suburban lot to a small township. That leaves more than 14 million square miles yet to explore."

**Moon moments**

■ During the Apollo 11 mission, Buzz Aldrin briefly held up NASA's schedule when he became the first man to urinate while standing on the moon. While millions watched at home on live television, he made use of a tube fitted inside his space suit to relieve himself.

■ In 1971, the first American in space, Alan Shepard, also became the first man to hit a golfball on the moon. After successfully smuggling a club head and balls on to the Apollo 14 inside his spacesuit, he took the opportunity at the end of the moonwalk to hit two balls. He later joked that they went "miles and miles and miles."

■ In 1972, astronaut Harrison Schmitt of the Apollo 17 mission added a musical soundtrack to planned proceedings. While skipping along the surface of the moon, he sang, "I was strolling on the moon one day in the merry, merry month of... December..."

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Painting by Brijin V. Sivadana, 14 years Kendriya Vidyalaya No.1, Narsul Base, Kochi

Taken from Art Collection of the I.T. Department

### Today is the last date for payment of Advance Tax

(3<sup>rd</sup> Instalment for Companies, 2<sup>nd</sup> Instalment for Others)

#### Who has to pay Advance Tax?

- ▶ Any assessee, whose tax liability, as reduced by tax deducted/collected at source is Rs. 10,000/- or more.
- ▶ Salaried employees also have to deposit Advance Tax if their tax liability on the total income (including income other than salary) as reduced by TDS is Rs. 10,000/- or more.

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##### e-Payment

e-Payment (online tax payment) is mandatory for:

- ▶ All corporates;
- ▶ All persons whose accounts are required to be audited u/s 44AB.

Many Banks (authorized by RBI for receiving Govt. Challans) presently provide online tax payment facility. For details, please log in to [tin-nsdl.com](http://tin-nsdl.com)

##### Payment at Authorised Bank Branches

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- ▶ Use Challan ITNS 280 which is a single copy Challan.
- ▶ Fill all columns of the Challan properly.
- ▶ Fill correct PAN to ensure proper credit of tax paid.
- ▶ Fill Assessment Year as 2011-12.
- ▶ Tick 0020, for a Corporate taxpayer; Tick-0021, for other than Companies.

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