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Emerging Technology From the arXiv
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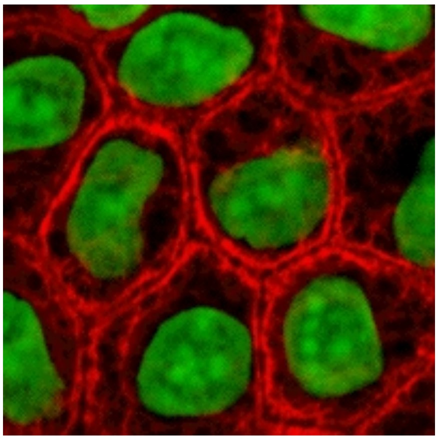
The Emerging Field of Biophotonic Communication

The growing evidence that cells communicate with photons is generating an exciting new field of research.



Last year, researchers at the Rush University Medical Center in Chicago showed that human cells in culture could synchronize their internal chemical processes even though they were mechanically, chemically, and electrically isolated from one another. The cells, it seemed, were communicating through the exchange of photons.

Various other groups have shown similar effects. Many cells seems to produce optical and UV photons at about 10 photons per square cm/s, a rate that cannot be explained by ordinary thermodynamic emissions. Other evidence indicates that this form of optical communication can increase the rate of mitosis in cells by up to 50 percent.

So how do they do it? Today Sergei Mayburov at the Lebedev Institute of Physics in Moscow puts forward the idea that optical communication is a natural process in many cells that can be explained by the way we already know many cells to function.

He points out that biologists have long known that photons play a central role in the biochemistry of many plant and bacterial cells. The basic idea, laid out in the 1960s, is that optical or UV photons enter a cell and stimulate the creation of excitons, electron-hole pairs, on certain long chain molecules. The exciton travels along the molecule, influencing the way it reacts with other species within the cell. This is the basic theory behind photosynthesis.

Mayburov's idea is that this process is, first, reversible, second, not limited to photosynthetic cells and third, possible to modulate for communication.

Let's unpack those ideas. Take the first: if photons can create excitons in cells, it seems reasonable to assume that the process can occur in reverse (exactly this happens in semiconductors to create light).

The second idea is also plausible. If excitons form in photosynthetic molecules, why not in other types of biological molecules, too. The problem with Mayburov's hypothesis is that it's not immediately obvious which other biological molecules may be capable of this and neither does he make any suggestions.

Finally, is it possible for cells to modulate the way they generate photons to transmit information and for others to receive it? It's certainly conceivable that photon production could be switched on and off by a change in some internal state of a cell. Certainly, if we're to explain the experimental evidence, something like that must be going on. But Mayburov leaves us wondering how this might happen on the molecular scale.

This is a rapidly emerging field which overturns some well entrenched thinking in biology so it's hardly surprising that it generates more questions than answers. For example, how do cells discriminate between biophotons and background light? And what to make of other evidence that the photons can sometimes be coherent?

These are exciting problems. But Mayburov's broad claim that the phenomena is closely related to photosynthesis is an important step that should bring this emerging field to the attention of a much wider audience.

Ref: arxiv.org/abs/0909.2676: Coherent and Noncoherent Photonic Communications in Biological Systems

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