Chemists devise means to use bacteria to encode secret messages

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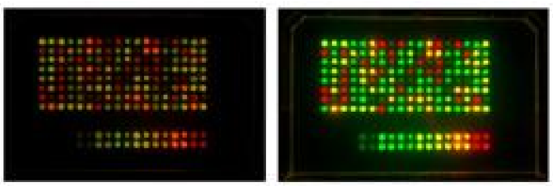

Fluorescence images of BL21(DE3)pLysE fluorescent strains after growth and induced FP expression by IPTG. Image (c) PNAS, see doi:10.1073/pnas.1109554108

(PhysOrg.com) -- In the endless search to develop newer and cooler ways to send messages between people without other's intercepting them, chemists from Tufts University working together have figured out a way to use a strain of bacteria to encode a message on a paper-like material that can then later be de-coded by the receiver. Manuel Palacios and David Walta, along with their team describe in their paper published in the *Proceedings of the National Academy of Sciences*, how they did it.

Called Steganography by Printed Arrays of Microbes (SPAM), the process is pretty simple. The team first developed seven different strains of the *E. coli* bacteria that grow in different colors (when bathed in ultraviolet light). They then devised a simple coding scheme based on pairings of the colors to represent letters of the alphabet (and some symbols). Next, they applied the bacteria to a plate of agar (a gelatinous substance that serves as food for the bacteria) where they grew into their respective color types. Next, a sheet of a nitrocellulose type material (that looks pretty much like paper) was pressed over the plate of agar, imprinting it with the bacteria. The result was then dried, causing the coloring attribute to disappear, making it ready for possible placement into an envelope for posting. After some time passed, the paper-like material was pressed onto an agar plate and the bacteria grew once again into their coloring, revealing the coded message.

The process is so simple in fact, that it's a wonder that no one thought to do it until now. Other means for encoding messages, such as stamping them into DNA, are in comparison much more complicated and expensive. The downside to this method of course, is that if someone wishes to intercept the message, it wouldn't be all that hard to decode the message if they knew that it was bacteria encoded. To get around this problem, the team added fluorescence to antibiotic resistant genes so that the message would only become visible when ampicillin, for example, was introduced. Thus, the would-be snooper would not only need to know which method of coding was used, e.g. bacterial, they'd also have to know which antibiotic to use to reveal the right message. Message makers could even encode a false message for those using the wrong antibiotic.

The authors also note that other factors could be engineered into their process as well, such as setting the bacteria to grow at certain times, or to die at others so the message won't last long. Also, other types of nutrients that are maybe a little harder to find could be used re-grow the bacteria.

Also, while such technology has obvious applications in espionage, other uses might be to watermark certain organic material or organisms to prevent counterfeiting.

More information: InfoBiology by printed arrays of microorganism

colonies for timed and on-demand release of messages, *PNAS*, Published online before print September 26, 2011, doi:10.1073/pnas.1109554108

Abstract
This paper presents a proof-of-principle method, called InfoBiology, to write and encode data using arrays of genetically engineered strains of Escherichia coli with fluorescent proteins (FPs) as phenotypic markers. In InfoBiology, we encode, send, and release information using living organisms as carriers of data. Genetically engineered systems offer exquisite control of both genotype and phenotype. Living systems also offer the possibility for timed release of information as phenotypic features can take hours or days to develop. We use growth media and chemically induced gene expression as cipher keys or "biociphers" to develop encoded messages. The messages, called Steganography by Printed Arrays of Microbes (SPAM), consist of a matrix of spots generated by seven strains of E. coli, with each strain expressing a different FP. The coding scheme for these arrays relies on strings of paired, septenary digits, where each pair represents an alphanumeric character. In addition, the photophysical properties of the FPs offer another method for ciphering messages. Unique combinations of excited and emitted wavelengths generate distinct fluorescent patterns from the Steganography by Printed Arrays of Microbes (SPAM). This paper shows a new form of steganography based on information from engineered living systems. The combination of bio- and "photociphers" along with controlled timed-release exemplify the capabilities of InfoBiology, which could enable biometrics, communication through compromised channels, easy-to-read barcoding of biological products, or provide a deterrent to counterfeiting.