Prototype paper test can detect Ebola strains

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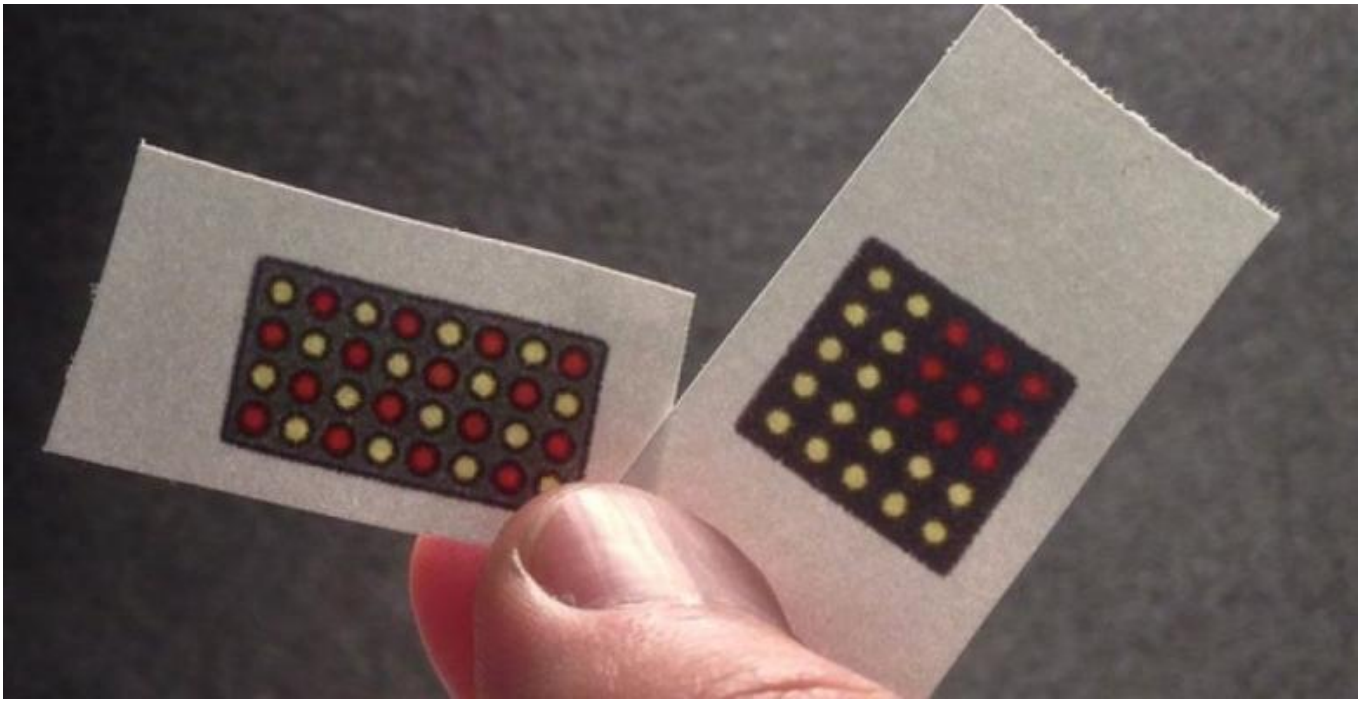


Researchers have proved the technique works by developing a prototype Ebola test in just 12 hours, and using just $20 of materials.

The smart diagnostics use a soup of biological ingredients including the genetic material RNA.

The researchers say this can be freeze-dried and preserved on ordinary paper.

Team leader Jim Collins, who has joint appointments at Boston and Harvard Universities, says the biological powder can be reactivated by simply adding water, like living powdered soup.

"We were surprised at how well these materials worked after being freeze dried," he told the BBC.

"Once they're rehydrated, these biological circuits function in these small paper disks as if they were inside a living cell."

Genetic hacking

Jim Collins is a leading pioneer in the field of synthetic biology, whose 2000 paper showing genetic circuits could be created in the same way as electronic circuits can be programmed, helped launch the discipline.

Since then, synthetic biology has become a powerful tool in fundamental biology, with

researchers hacking the genetic programmes of microbes to study their life processes, or give them the power to compute using logic like a digital processor.

Collins' group has previously reprogrammed bacteria to become cellular spies, recording events as they pass through an animal's bowels.

But the discipline has required specialist skills, so that few laboratories can take advantage of the techniques. The researchers' avowed intention in the new work, described in the journal Cell, is to make synthetic biology widely available.

They've definitely succeeded, says Professor Lingchong You, an expert in cellular reprogramming at Duke University.

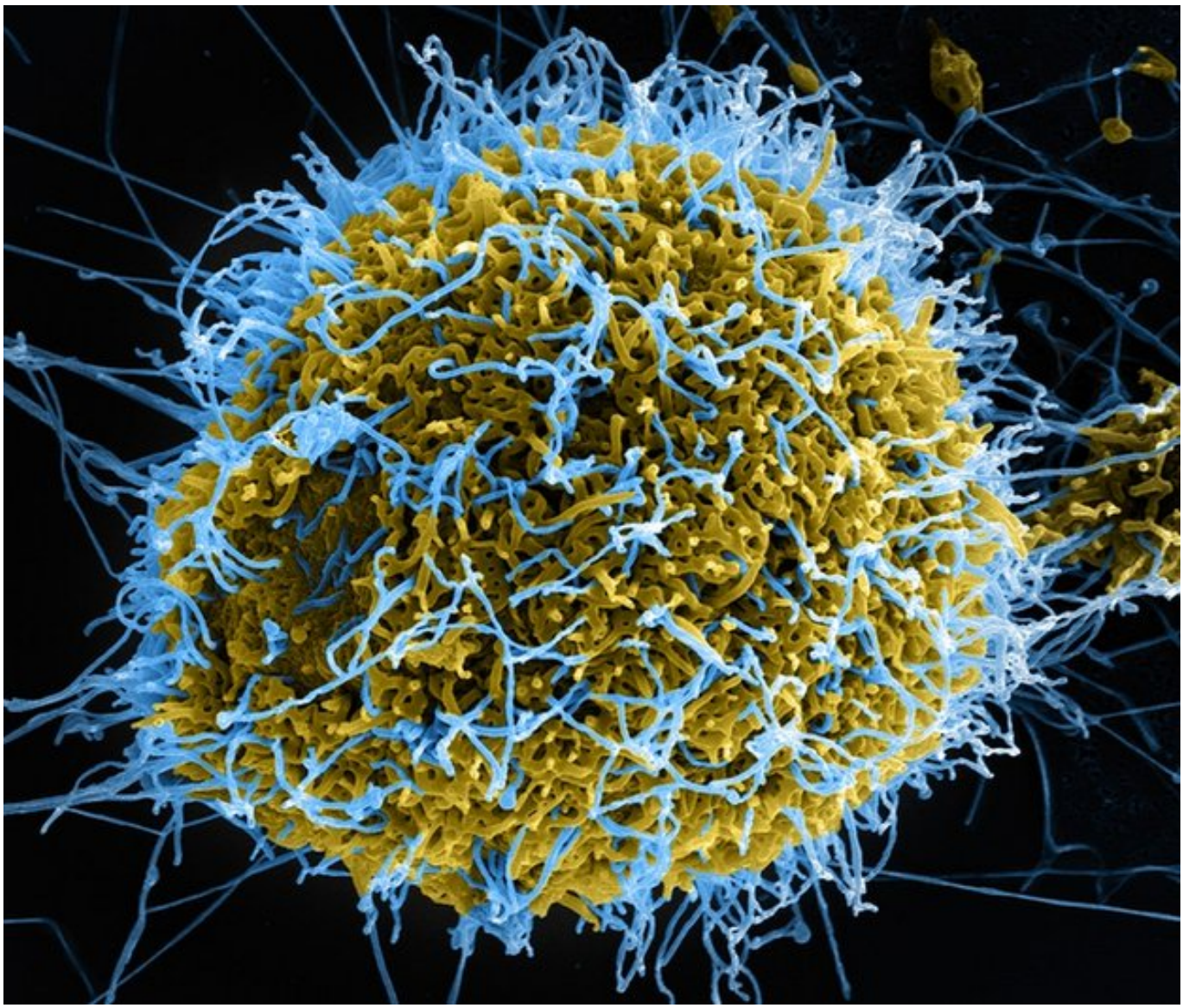
"This paper-based approach is incredibly attractive. It feels like you could use it in your garage! It'll give scientists a synthetic-biology playground for a very low cost."

'Biochemical soup'

The materials in the powdered biochemical soup include simple enzymes that bacteria need, molecules to power the chemical reactions, amino acids which are the bricks of cell biology, and importantly ribosomes, giant molecular machines that read genetic material and use it to assemble the bricks into functioning proteins.

In liquid form, these cell extracts are routinely used in biology labs. Linchong You gives credit to Collins for having the imagination to freeze dry them with synthetic genes.

"With hindsight, it's obvious it should work. But most of us don't think in this direction - there was a real leap of faith. But the fact you can leave these freeze-dried systems for a year, and they'll still work - that's quite remarkable."



The prototype test was able to distinguish between different strains of Ebola virus - seen here in blue, budding from a cell

Alongside the paper-based biochemistry, Jim Collins' team - in collaboration with Peng Yin, also at Harvard University's Wyss Institute - has also introduced a new way of programming RNA, the molecular cousin of DNA which ribosome machines read. Their method makes the gene-circuits far more flexible than previous approaches.

The new type of RNA can be programmed to react and respond to any particular biochemical input, and then switch on the rest of the genetic machinery.

"This gives us a programmable sensor that can be readily and rapidly designed," Collins explains.

The Ebola test they experimented with is a proof of principle showing how flexible the programming step is.

"In a period of just 12 hours, two of my team managed to develop 24 sensors that would detect different regions of the Ebola genome, and discriminate between the Sudan and the Zaire strains."

In contrast, conventional antibody tests take months and cost thousands of pounds to devise, the researchers argue.

Quick response

The genetic test kit gives a simple colour output, turning the paper from yellow to purple, with the change visible within half an hour. By changing the input trigger, variants of the test could be used to reveal antibiotic resistance genes in bacterial infections or biomarkers of other disease conditions.

Their Ebola test is not suitable for use in the epidemic areas at the moment, Collins emphasises, but it would be simple to devise one that is.

The arrays of programmed paper dots would be easy to mass produce. Lingchong You envisions an "entire fabrication process carried out by computer-aided circuit design, robotics-mediated assembly of circuits, and printing onto paper."

And price is not the only consideration. Collins points out the freeze-dried circuits are stable at room temperature. In large parts of the world where electricity is unreliable, or there are no refrigerators, this would be a particular advantage.

"We are very excited about this," he added. "In terms of significance, I rank this alongside all the other breakthroughs I've been involved in."