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SCIENCE AND TECHNOLOGY

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ISSUE 250 / JANUARY 2013 / £3.99

BREAKTHROUGHS OF

2013

Top experts predict the discoveries that will shape the future



MAGGIE ADERIN-POCOCK
on space technology



JESSICA GREEN
on invisible ecosystems



JIM AL-KHALILI
on quantum biology



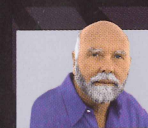
MARK MIODOWNIK
on self-healing buildings



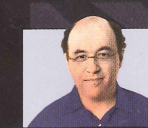
SHEILA NIRENBERG
on rewiring the brain



ANDREA SELLA
on new energy sources



CRAIG VENTER
on 3D biological printers



STEPHEN WOLFRAM
on artificial intelligence



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BREAKTHROUGHS OF

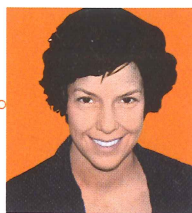
2013

From printing DNA to earthquake-cloaked buildings, science's biggest names predict the most influential discoveries of the coming 12 months

THE NEW YEAR means it's time to get excited about the scientific breakthroughs and technological surprises that will adorn the pages of *Focus* in the coming months. But what can we expect? We've asked the world's top scientists, including Jim Al-Khalili, Maggie Aderin-Pocock, Craig Venter and Stephen Wolfram, to give us their expert predictions. And if we've whetted your appetite, don't miss the new TV season *The Genius Of Invention*, which starts on BBC Two on 12 January.



BUILDINGS WITH MICROBIAL ECOSYSTEMS



JESSICA GREEN

TED fellow and Principal Investigator at the Green Lab, University of Oregon

THE MOST PROMISING innovation in the near future is 'bio-informed design'. Our homes, cars and phones all have these invisible ecosystems comprised of tiny life forms - bacteria, viruses and fungi - living on them. We spend 90 per cent of our lives indoors, so we should be asking how these unseen worlds are impacting on our health. We're able to do this now, thanks to advances in DNA sequencing. In particular, there's the Human Microbiome Project, which is identifying the microbial communities that live on and in the body. Our personal ecosystems really define our health, so the question is, 'can we influence the microbial ecosystems that we come into contact with for the better?'

Funding has been put forward by the Alfred P Sloan Foundation to discover exactly this - how certain architectural designs impact on microbial communities.

An obvious application will be in designing environments with a low chance of infection, like a hospital. We recently published a study that shows that natural ventilation alters the microscopic ecosystem indoors. So if you operate a hospital as normal - windows closed with air conditioning - you end up with a monoculture of microbes inside - a low variety of types. This monoculture will contain more microbes closely related to pathogens than if the building had been naturally aerated. We know that the more variety there is in an ecosystem, the less disease there is, and opening windows to let in outdoor air cultivates a rich variety of microorganisms inside. We still don't know that this will definitely reduce infection, and we're not there yet, but we will see this innovation in 2013.



Seen here as coloured patches on the sofas and walls, can we harness the plethora of microbes with which we coexist?

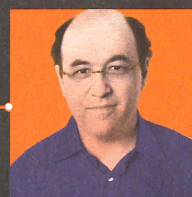
PHOTO: MAGICTORCH, GETTY

✦ SAMPLING THE BUGS THAT LIVE IN THE SKY

"There's a small cohort of aerobiologists who are now looking at charting microbial life in the atmosphere on a global scale, just like Craig Venter did with the oceans. We're talking about using rockets and high-altitude balloons. We're in talks with Red Bull to see if we can use their balloon system to sample life at 30.5km (100,000ft).

It's always been assumed that all of the processes going on in the atmosphere are just based on chemistry and physics. But there are some groups that think that if microbes are metabolically active in the atmosphere they could fundamentally change our understanding of atmospheric chemistry, global climate change and pollution."

NATURAL LANGUAGE PROGRAMMING



STEPHEN WOLFRAM

Creator of Wolfram Alpha and CEO of Wolfram Research



PEOPLE HAVE HAD the point of view up to now that there are programmers and then there are the rest of us. If you

want to get a computer to do something new that's not trivial, you need a programmer in the loop. But that's on the cusp of changing.

Software has been developing up to the point where, if put together in the right way, we will be able to introduce what's called natural language programming. It's one of these things that's been a gradual process for a great many years and I think we're finally at the point where we're at a qualitative change that's about to happen.

The idea is that rather than talk to your computer in computer language you can at least start in a language that you, as a human, know. It's something that you can see starting in Apple's voice-controlled Siri in a minor way. But what we're talking about is telling your phone, for example, that you want to take a picture with the second face on the left in focus. Or that you want all pictures taken before sunset in Bermuda put into one folder. We're at a point where the technology is powerful enough.

For example, part of this problem that's been solved is where the data sits. Until now, when you wrote a program, it would connect to a database that has the data you're trying to manipulate. But we can change that, so that the programming already has the data embedded in it, so there's no reason to