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Biology takes a quantum leap

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Quantum physics may give an insight into biological processes such as photosynthesis and mutation

Clive Cookson OCTOBER 19, 2012

The weird world of quantum physics may seem a long way from biology. How can counterintuitive concepts, such as the "entanglement" of subatomic particles and their "tunnelling" through insuperable energy barriers, apply to everyday life?

Until recently most biologists and physicists would have said that they can't – and many still say so. Quantum physicists, such as last week's Nobel laureates Serge Haroche and David Wineland, require rigorous experimental conditions to shield their particles from outside disturbances that kill quantum effects. So the wet, warm and messy world of living cells would seem an inhospitable place for quantum phenomena.

Evidence is beginning to emerge, however, that quantum effects do play a role in biological processes, including photosynthesis, bird navigation, the mammalian sense of smell and genetic mutation. There are also some untested claims that quantum mechanics could even solve the mystery of consciousness.

Much research will be required to give us an idea of how important quantum effects are in the living world. And already scientists have founded a new interdisciplinary field, quantum biology, as a focus for the work. Last month, about 50 adherents attended a conference at the University of Surrey.

In the blood

A genetic study has identified 21 gene variants associated with blood fat levels, including levels of "good" HDL and "bad" LDL cholesterol – risk factors for heart disease.

The basic idea is far from new. In 1944, Erwin Schrödinger, co-founder of quantum mechanics, proposed, in his book *What is Life?*, that quantum effects were important in genetics; but he provided no way of testing the theory. "By and large, it was ignored by 20th-century biologists," says Johnjoe McFadden, professor of molecular genetics at Surrey. "But in the second decade of the 21st century, ignoring Schrödinger's bold proposal is no longer an option."

Quantum biologists do generally ignore unverifiable speculation that human consciousness is a quantum phenomenon, McFadden says, and focus on effects that might be susceptible to experimental investigation and explanation.

The ways birds navigate, using Earth's magnetic field, is a leading contender. What happens is that a photon hits a specialised photoreceptor in the avian eye, creating two electrons that are entangled in a quantum sense. The behaviour of the spinning electrons as they move apart depends on the orientation of the magnetic field, giving the birds a quantum compass.

Equally complex mechanisms are suggested for other proposed quantum processes. These include genetic mutation, the way nasal receptors recognise smell, and the speed of photosynthesis and other biochemical reactions. Experimentation should soon resolve the issue of whether quantum biology is real and, if so, how widespread its effects are.

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An absorbing way of cleaning up oil spills

Disastrous spills at sea haunt oil companies for years, writes **Denise Roland**. The impact on the local economy and environment does not recede swiftly – and the clean-up costs take their toll on the balance sheet.

But these devastating effects may soon become a thing of the past. Scientists at Pennsylvania State University have developed a "super-absorbent" material that can soak up 45 times its weight in oil, creating a gel that can easily be removed from water.

"Had this material been applied to the top of the leaking well head in the Gulf of Mexico during the 2010 spill, it could have effectively transformed the gushing brown oil into a floating gel for easy collection and minimised the pollution consequences," said authors Xuepei Yuan and Mike Chung, describing their findings in the journal Energy & Fuels.

The technology has existed for some time but has never been applied to oil slicks. “We have been working with these kinds of polymers for 20 years, but after the Gulf of Mexico oil spill we wondered whether our material could provide a solution,” says Yuan.

Although mopping up oil is nothing new, the existing methods can lead to further environmental problems. Various substances have been used to soak up slicks, ranging from straw and silkworm cocoons to synthetic fibre pads. But these materials take up oil slowly, do not retain it well and can render it unrecoverable by absorbing water at the same time.

The new polymer, which is cheap and easy to make, forms much stronger bonds with oil than existing materials. And since the resulting gel is similar enough to crude oil to be refined and sold, it avoids issues of waste and disposal.

The researchers believe they may have discovered a complete solution for tackling oil spills. “This cost-effective new technology should dramatically reduce the environmental impacts from oil spills and help recover one of our most precious natural resources,” they say.

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Gouldian finches’ behaviour can be predicted by their plumage

Birds show character through their colour

Red-heads are aggressive and dominant, while black-heads are quieter and submissive but at the same time inquisitive and willing to take risks. The heads in question belong to Gouldian finches, a sociable Australian species whose feathers grow in a variety of colours.

Researchers at Liverpool John Moores University found that a finch’s behaviour could be predicted from its head plumage, which is usually black or red (and very rarely yellow). The study, published in the journal Animal Behaviour, measured three aspects of avian personality: aggression, boldness and risk-taking.

The scientists investigated boldness from the birds’ willingness to investigate unfamiliar objects such as strings dangling from a perch. Black-headed birds were more likely to approach and touch them than the red-heads.

To test for risk-taking behaviour, they presented scary images of a predatory hawk close to the birds’ feeders. Again, birds with black heads returned to feed sooner than the red-heads. For aggression, the researchers put a feeder out for two hungry birds, with room for just one bird to

eat. They found that red-heads were quicker than black-heads to display threatening behaviour and fight off another bird.

Leah Williams of Liverpool John Moores commented: “We think that head colour is used as a signal of personality to other birds in the flock, so they know who to associate with.”

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A good harvest: farming in sub-Saharan Africa could become more productive

A way to ensure that Africa’s bread rises

African lifestyles are changing fast and so too are gastronomic habits, as people leave rural settlements for the cities, writes **Denise Roland**. High demand for wheat, the basis of many convenience foods, is causing a crisis in the region, which only grows 44 per cent of what it consumes and faces rising costs of importing the crop.

But wheat farming in sub-Saharan Africa could be at least four times more productive, with potential for 10-fold increases in some areas, according to research by scientists at the International Maize and Wheat Improvement Centre in Mexico. This would greatly reduce or even eliminate dependence on expensive foreign imports.

Researchers used climate and soil data to simulate crop growth using computer modelling. They found that eight sub-Saharan nations could significantly improve their wheat output without needing irrigation, by exploiting genetically modified grain varieties and using advanced management methods.

Turning the theory into reality will require strong support from governments and NGOs, says lead researcher Bekele Shiferaw: “Our work suggests that fulfilling the promise of this study will require a shift in how the crop is viewed in sub-Saharan Africa and will only occur with significant support from governments and development agencies.”

But the huge economic benefits from applying these techniques may be difficult for governments to ignore as the continent’s urban population looks set to quadruple by 2050 and, with it, Africa’s appetite for wheat.

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