A challenge to the genetic interpretation of biology

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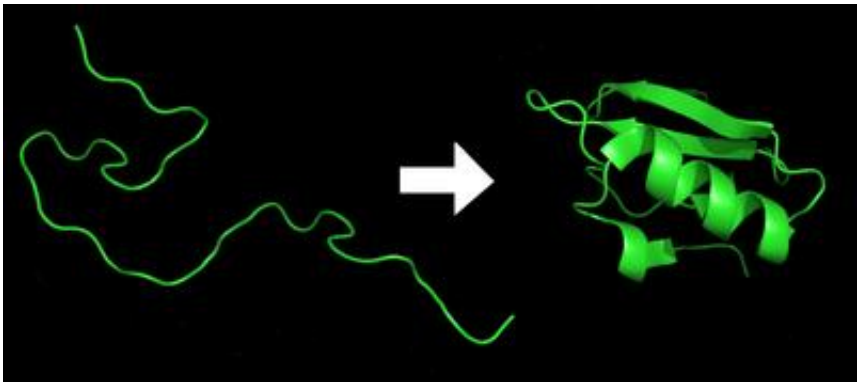

The inactive linear peptide molecule with a sequence of amino acids derived from the gene coding sequence folds to a protein. Credit: http://en.wikibooks.org/wiki/Proteomics/Proteomics_and_Drug_Discovery/Protein_Aggregation

A proposal for reformulating the foundations of biology, based on the 2nd law of thermodynamics and which is in sharp contrast to the prevailing genetic view, is published today in the *Journal of the Royal Society Interface* under the title "Genes without prominence: a reappraisal of the foundations of biology".

The authors, Arto Annila, Professor of physics at Helsinki University and Keith Baverstock, Docent and former professor at the University of Eastern Finland, assert that the prominent emphasis currently given to the gene in biology is based on a flawed interpretation of experimental genetics and should be replaced by more fundamental considerations of

how the cell utilises energy. There are far-reaching implications, both in research and for the current strategy in many countries to develop personalised medicine based on genome-wide sequencing.

Is it in your genes?

By "it" we mean intelligence, sexual orientation, increased risk of cancer, stroke or heart attack, criminal behaviour, political preference and religious beliefs, etcetera. Genes have been implicated in influencing, wholly or partly, all these aspects of our lives by researchers. Genes cannot *cause* any of these features, although geneticists have found *associations* between specific genes and all of these features, many of which are entirely spurious and a few are fortuitous.

How can we be so sure?

When a gene, a string of bases on the DNA molecule, is deployed, it is first transcribed and then translated into a peptide – a string of amino acids. To give rise to biological properties it needs to "fold" into a protein.

This process consumes energy and is therefore governed by the 2nd law, but also by the environment in which the folding takes place. These two factors mean that there is no *causal* relationship between the original gene coding sequence and the biological activity of the protein.

Is there any empirical evidence to support this?

Yes, a Nordic study of twins conducted in 2000 showed there was no evidence that cancer was a "genetic" disease – that is – that genes play no role in the causation of cancer. A wider international study involving

50,000 identical twin pairs published in 2012, showed that this conclusion applied to other common disease as well. Since the sequencing of the human genome was completed in 2001 it has not proved possible to relate abnormal gene sequences to common diseases giving rise to the problem of the "missing heritability".

What is the essence of the reformulation?

At the most fundamental level organisms are energy-consuming systems and the appropriate foundation in physics is that of complex dissipative systems. As energy flows in and out and within, the complex molecular system called the cell, fundamental physical considerations, dictated by the 2nd law of thermodynamics, demand that these flows, called *actions*, are maximally efficient (follow the path of least resistance) in space and time. Energy exchanges can give rise to new emergent properties that modify the actions and give rise to more new emergent properties and so on. The result is evolution from simpler to more complex and diverse organisms in both form and function, without the need to invoke genes. This model is supported by earlier computer simulations to create a virtual ecosystem by Mauno Rönkkö of the University of Eastern Finland.

What implications does this have in practice?

There are many, but two are urgent.

1. to assume that genes are unavoidable influences on our health and behaviour will distract attention from the *real causes* of disease, many of which arise from our environment;
2. the current strategy towards basing healthcare on genome-wide sequencing, so called "personalised healthcare", will prove costly

and ineffective.

What is personalised health care?

This is the idea that it will be possible to predict at birth, by determining the total DNA sequence (genome-wide sequence), health outcomes in the future and take preventive measures. Most European countries have research programmes in this and in the UK a pilot study with 100,000 participants is underway.

More information: "Genes without prominence: a reappraisal of the foundations of biology." Arto Annila and Keith Baverstock. *Journal of the Royal Society Interface*.

Provided by University of Eastern Finland