Opinion

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The Emperor's New Genes

Peter Mansfield

Independent Doctor and Health Scientist, Newark-on-Trent, UK

Corresponding author: Peter Mansfield, Independent Doctor and Health Scientist, Newark-on-Trent, UK, Tel: +447957861775; E-mail: mansfield.pj@gmail.com

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Abstract

Manifold advances in genetics in the past 60 years have brought us no nearer to understanding what makes us *homo sapiens*. We have been blind to the causation of organic form, until recently trusting genes to account eventually for everything. Now that we are at last thinking epigenetically, we should check what physics can tell us.

Opinion

Introduction

When in 1963 I began my medical training in Cambridge, Crick and Watson's discovery there of the structure of DNA [1] was still recent history. The pace and intensity of developments in biochemistry was such that textbooks were out of date before they were published. Lecturers struggled to keep their output contemporary with the state of research. Biochemical doctrine changed significantly year by year.

Since then genetic research and engineering have burgeoned, several genome mapping projects have been completed [2], and genetic manipulation of human embryos is permitted in the UK [3].

Yet we are no nearer to defining the human being, or explaining why we differ so much from other organisms, and they from each other. Whatever the Emperor's genes may be, we are blind to what forms his body – let alone the robes that adorn it.

Are we mistaken in our thinking, and if so how? To trace an answer we must briefly review what we know for sure.

The modern era in biology began with the seminal work of Charles Darwin [4], which is now almost universally acclaimed. Darwin's work predated modern biochemistry by 50 years, and genetics by a whole century. So he worked entirely from observations of organisms in their environments.

He noted the variation of forms in nature, the relationship between those forms and their environments, and their responsiveness to environmental change. His chief contribution was to propose that survival was competitive as between species and varieties within species, and that the forms best fitted to cope with the conditions prevailing would survive and supersede their less well-adapted competitors.

He did not propose a biological mechanism for this adaptability, but others have done since. Once genes had been identified and characterised, they acquired the mantle Darwin had ascribed to the whole organism. Evolution came to be attributed entirely to variation of genes within the organism, by a process of inter-breeding and mutation [5]. Prominent among advocates of this position is Richard Dawkins, who has based his critique of religion upon it [6].

This conclusion is a jump too far, however. Fundamentalist religion is not the only possible alternative to reductionist genetic materialism. Whilst genetic mutation is clearly a factor in evolution, it does not rule out other mechanisms working in parallel. In fact, mutation is far too slow and wasteful to bear the brunt of the process.

Not All in the Genes

Genes cannot, in any case, logically account entirely for the form of a complex organism, let alone its functioning as a whole in its world.

Genes are in principal identical in every cell of any organism that began as a fertile egg or seed of some sort, since multiplication of cells during maturation produces identical sets of genes in every daughter-cell. Yet every cell in the organism's body differs slightly from all its neighbours, at every stage in its life. At the boundary of a specialized organ within the whole body, the form and function of neighbouring cells changes radically and abruptly.

As if that were not enough, the entire body comprising all these cells manages somehow to function as a whole, and to respond gracefully and instantaneously to stimuli from the world around it. Whole communities of organisms can show the same spontaneity and grace, as when starlings fly in a close-packed mass formation that swirls and weaves on the evening air without collision.

It is clear, on reflection, that the mass of cells comprising a whole creature have managed somehow to retain the integrity that existed as a potential within the fertile egg that gave it rise. All that has happened during maturation, is the full physical and functional expression of that potential – locomotion, manipulation, nourishment, respiration, reproduction, perception - to name but a few of its aspects, none of them expressible in full by one cell alone.

Genes on their own cannot account for this. And there is no higher biochemical mechanism available. Scientists, from chemist Justus von Leibig to embryologist Hans Driesch, have puzzled over this since the 19th century [7]. Epigenetics is the general word for the formative influence we need, but where can that be found [8]?

Input from Physics

Biology and physics make very different demands on their practitioners, so that there is very little cross-fertilization of the two. In particular, this means that the potential in biology of the field phenomena identified within physics has yet to be realized.

Some physicists have contributed [9,10], but are viewed with scepticism by the physics establishment and have seldom been taken up. One notable modern biologist has not only proposed a field phenomenon within biology but designed and executed elegant experiments to substantiate its reality. So hostile was the establishment response to Rupert Sheldrake's ideas, however, that his first book [11] was described by Sir John Maddox in the prestigious journal *Nature* as ". . . the best candidate for burning there has been for many years" [12].

Sheldrake proposes that the forms of organisms are accounted for by Morphogenetic Fields, aka Fields of Formative Causation. Every member of any particular species is tuned in to the field appropriate to that species. Every mother invests her offspring with it both before and throughout gestation. From that field each cell takes the information that overlies its location in the organism at a particular time, and its genetic toolkit responds to make the physical adaptations called for in that location.

But that is not all. A morphogenetic field can evolve. It informs individuals, but they also feed back to it. Sheldrake terms this two-way process Morphic Resonance, and claims it enables newly learned tricks and habits to be shared – not just with neighbours in the same local community but universally. Sheldrake reviews [13] an impressive mass of evidence from successful experiments designed to test morphic resonance.

Maddox scornfully dubbed this "pseudo-science" without considering possibly physical media for the proposed phenomena. Physicists make little direct comment on this, but are familiar from their studies of quantum mechanics with the phenomenon of scalar fields. These encode information, rather than force, and do so non-locally. Information coded into a particular point within a scalar field is actually scattered everywhere. Damaging regions of the field does not destroy that information, only degrades the detail or resolution of it.

Holograms are examples of scalar fields, and provide a vivid illustration of the potential importance of scalar fields in morphogenesis. If the cells of an organism have a way of reading and acting upon the information provided at each location in a holographically projected design, then we can begin to understand how cells widely distributed across the organism may know to adopt their unique structures and functions.

Pseudo-science this is not. That would describe a refusal fairly to consider the possibility. Elsewhere Maddox himself pondered whether biology is becoming a branch of physics, but did not discuss how, and simply decided "not yet" [14].

If we suppose, for the sake of argument, that something along these lines can indeed account for form in nature, then why does it? We have means and opportunity, but we lack motive.

Health

Now we are faced with a phenomenon foreign to biologists, but potentially more familiar to theoretical physicists.

Newton defined how masses are attracted to each other. But something analogous applies to organisms. Between humans we speak of liking or love. In other animal species we are familiar with courtship and mating. The difference from Newtonian gravity is the lack of relation to the distance between the attractive bodies. In humans, at least, the appeal is non-local.

I submit that these are just familiar examples of a much more general attractive force in nature. I now propose to borrow the approach of theoretical physics, and generalise about the relationship of whole living beings with each other, on every scale from the sub-microscopic to the unimaginably large.

The attraction between two suited wholes creates something greater than either – in the animal case, for example, a mated pair with the potential to reproduce.

A mated human pair is commonly termed "an item". These two wholes certainly behave together as one greater whole, fashioned out of the action and relationship of the two original individuals.

We see, in fact, that any one whole relating to another make a third whole, with similar general characteristics as the originals, but without destroying them. One plus another makes three.

This is the fundamental arithmetic of all living (as opposed to mere existence), what we may identify with the quality of life.

Qualities have not been scientifically respectable for several centuries, but physics is accidentally rediscovering them. Scalar Fields of Formative Causation are plausible – perhaps inescapable – vehicles of the qualities of life.

Mansfield [15] defines health as the process whereby parts relate, and their urge to create or sustain larger wholes – e.g. their original mother-egg. Without health, a large multi-cellular organism would be literally inconceivable.

With it, however, we can at last imagine a process running through all of creation, from its smallest components to its ultimate whole: two wholes creating a third, at every level in the complex, magnificent web we call Nature (Figure 1).

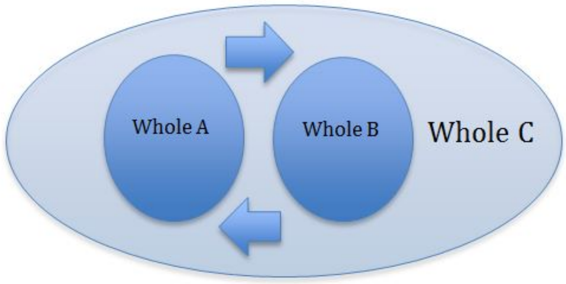

Figure 1: Diagram One: The Proposed Hierarchy of Wholes

In creating a greater whole, each participant feels the love, well-being or ease inseparable from wholesome action. This is private to the participant wholes, but highly motivating to them both.

As their creative relationship continues over time an additional feature emerges, the orderliness appropriate to the larger whole. This is visible to observers outside the relationship, and is where beauty can be found. Ease and order are little-used terms, but their absence – disease and disorder – are all too familiar.

This is not a way of thinking that is customary today, but it has exercised a few good minds throughout the past century. The authors of The Peckham Experiment [16] reflected on their experience and set about inventing an appropriate terminology for discussing it [17]. One theologian went some way towards relating the wholeness process to Trinitarian theology [18]. These may be essays in philosophy rather than science, but there is enormous scope for further exploration of both.

Conclusion

Genetic mutation and interbreeding doubtless contribute importantly to evolution, but cannot bear the brunt of it, since there is no plausible means by which they unaided can fashion cells into the complex organisms with which Darwin - and other naturalists of the 18th and 19th centuries - made us familiar.

This truth has forced the emergence of epigenetics as a topic, still in its infancy. The possible contribution of field phenomena known from physics has been undervalued, chiefly because of large differences in the mindsets of physicists and biologists.

The causation of form in biology is likely to depend on holographic field-based phenomena, which could well encompass the morphogenetic fields proposed by Sheldrake. Were our best minds to take seriously this possibility, a step change would quickly follow in our grasp of biology, medicine and health.

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