"Genes are followers not leaders". Was: Birds of feather...

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(The title of this post is based on West−Eberhard's view on the relative role of genes in heredity and evolution as expressed in her Developmental Plasticity and Evolution (2003), an excellent book that, in Prof. Nijhout's opinion "may prove to be the most important and insightful book about evolution since "The Origin of Species").

I thank P. Fellini for inviting me to present here in sbe my views on what he chose to call "alluring (necessarily/realistically tenuous) proposition".
Peter, I thought a little about it and concluded that I could make my view clear in the process: by first challenging the status of the prevailing gene theory as a theory of heredity in metazoans and then presenting ESSENTIALS (constrained by space limitations and other issues in sbe) of my alternative view. In the course of discussions readers could create their opinion on the relative merits of each theory and the degree to which each of them reflects the real state of things in the living world.

The role of genes in heredity is becoming probably the most controversial issue in modern biology. The majority of leading biologists still believe that genes determine the heredity of all the living organisms and their evolution is essentially the evolution of their genes (now the words genetics and genetical have become synonymous to heredity and hereditary!). On the other pole there is a growing minority of distinguished biologists that do not endorse that view, or even reject it, insisting that genes do not do more than what is experimentally known they do: provide information for protein biosynthesis.

Personally, I don't believe we have seen the facts or heard reasons why genes must be considered to be determinants of heredity and the "raw material of evolution". We are told that evolution of a gene (not just any change), takes evolutionarily considerable periods of time, that evolution of a structure may need evolution of a varying number of genes, and evolution of a new organ requires evolution of an even greater number of genes and longer periods of time. Accordingly, it is to be expected that evolution of a new Bauplan for transition from a class, such as fishto amphibians, requires evolution of a still larger number of genes and longer periods of time. Have we proven this? Certainly not. It is true that amphibians and fishes differ in their genes, but the occurrence of evolution of amphibian (and fish) genes is not proof that they have determined the evolution of Amphibia. Remember West−Eberhard: genes may be followers, not leaders of evolution: all the observed evolution of their genes may have taken place after the evolution of the class of amphibians.

Indeed, why on the earth would evolution of those animals require changes in their genes when with the same set of genes they are able, within their life cycle, to not only modify a structure or form a new organ but create two different Bauplaene (fish and amphibian or worm and insect)?

Here in sbe differences of views also exist on the relative role of genes.

In my opinion, an objective examination of the epistemological status of the gene theory clearly shows that it has failed in explaining:
− How could genetic information that determines amino acid sequence also determine the complex and highly specific spatial arrangement of cells of various types from which metazoan morphology arises?
− Where the enormous amount of information (of the order of trillions of bits) necessary for erecting a metazoan structure comes from?
− Where the information for turning on/off nonhousekeeping genes that determine cell differentiation during the development comes from.

The best we have heard so far are tautological speculations of the type of self−assembly etc., which require explanations themselves.

What I propose here, instead, is an alternative theory of heredity in metazoans, whose main theses could be summarized as follows:

1. Any material system, however simple it might be, sooner or later will lose their identity if not externally regulated. Man−made systems also need human intervention or appropriate control systems in order to maintain their structure. Being incomparably more complex than any other material system and than any system human genius has been able to create, metazoans also need and have control systems for maintaining their structure and function.
2. A system of heredity, by definition is a control system that maintains the structure and function of living systems.
3. The control system in unicellulars is represented by the genome (acting as controller of the control system), the apparatus for transcription and translation of genetic information, and the metabolic machinery of the cell.
4. During the reproduction in unicellulars, their control system functions as a genetic (Watson−Crick) system of heredity.
5. An integrated control system (ICS), with the central nervous system (CNS) as its controller, maintains the structure and functions in metazoans
6. During reproduction, in metazoans that system also functions as their epigenetic system of heredity; it controls and regulates all the stages of individual development (gametogenesis, early embryonic development, and postphylotypic development).

The hypothesis, in which form this theory was first presented, allowed to make the following predictions:
1. Expression of nonhousekeeping genes in metazoans is controlled and regulated

by signal cascades originating in the CNS
2. Initial signals, or the information, for starting signal cascades in the CNS are not of genetic, but of computational, i.e. epigenetic, origin.
3. The reproduction cycle and gametogenesis, production of egg− and sperm cells, in metazoans are under control of the epigenetic system of heredity, with the CNS as generator of epigenetic information.
4. The transfer of the epigenetic information (maternal cytoplasmic factors and geneimprinting) in gametes is under control of the parental epigenetic system(s) of heredity.
5. At the phylotypic stage, when the function of maternal cytoplasmic factors terminates, the embryonic CNS is operational and takes over the control of embryonic development.
6. All signal cascades determining the postphylotypic development up to adulthood originate in the CNS.

Ever since, I have found that all those predictions can be substantiated by adequate empirical evidence. Now, the epigenetic theory of heredity offers a novel and empirically validated explanans for the inheritance in metazoans. The theory makes possible rational explanations of most of the phenomena that the gene theory has clearly failed to do so far (the sudden morphological changes without changes in genes, the widespread phenomena of alternative phenotypes, sudden speciation, sudden reversion to the ancestral traits of million years ago, evolutionary convergence, etc.)

Even though adequately verified, the epigenetic theory of heredity is open to scientific inquiry and can be further experimentally verified/falsified.

Constrained by limitations of postings in sbe, I have only presented herein the theoretical pillars of the epigenetic theory of heredity, which offer but the most general idea on the nature of the theory and pointed out the fundamental distinction of this theory from the prevailing genetic theory of heredity. I hope that here in sbe the main features of the epigenetic system of heredity may be unfolded in the course of discussions on the theory and the following (undoubtedly) controversial comparison of the explanatory power of both theories.

A basic comparison between the genetic and epigenetic theories of heredity seems to demonstrate that the latter has essentially succeeded, while the first fails, to provide experimentally verifiable answers to the following basic requirements for any system of heredity:

1. To present a discrete mechanism, showing the origin of signal cascades leading to formation of an organ or another structure, in the process of individual development is necessary for validating any theory that claims to be a theory of heredity. The present genetic theory has clearly failed to do that (any book of developmental biology will prove that). The epigenetic theory of heredity can show that mechanism in action in number of morphological and life history characters (the development of mammary gland, production of egg cells, development of blood vessels and, to a adequate degree in other developmental processes such as formation of muscles, bones, regeneration, etc).
2. To present a discrete mechanism of the generation and deposition in the egg

cell of the epigenetic information (=maternal factors + gene imprinting). The gene theory has failed. The epigenetic theory of heredity has shown how that information is generated and how that information flows into the gametes.
3. To show where the information for activation/inactivation of nonhousekeeping genes comes from. As put by J. Maynard Smith (1998) "It is not enough to say that different genes are switched on in different places, although it is true. We also need to know how the local action of specific genes is brought about." The gene theory has clearly failed to do that in more than half a century since the discovery of the chemical nature of the gene. The epigenetic theory of heredity proves that all the information for activating/inactivating nonhousekeeping genes is of neural origin. Related to this,
4. To show the material structure where the immense information for erecting metazoan organisms. The gene theory has clearly failed to do that too (depending on the species, the amount of genetic information in the whole genome of metazoans, in the best case, hardly would represent more than one thousandth of information for building a metazoan organism). The epigenetic theory of heredity shows where that structure is and what it consists of.

I am looking forward to answer all the possible questions that would arise from the comparison of the genetic and epigenetic theories of heredity and any other question that might arise in relation to the epigenetic theory of heredity.

Thank you,

Nelson R. Cabej