Reading Guide 5

Nested Similarities (part 2)

This week, we resume our discussion of hierarchy in nature, focusing now on the period from the 1980s onward. In these decades, the focus shifted to molecular data. We will see how Michael Denton used molecular data to attack evolution. The thrust of his argument is that the "molecular clock" is a tautological or circular argument. We will also read Daniel Fairbanks's chapter on molecular evolution. Your goal, as you read this, is to evaluate Denton's argument about tautology.

You'll need some background in molecular biology. You probably had all this in high school, but in case you didn't, here's a refresher:

Modern genetics is all about molecules: proteins, RNA, and DNA. Protein is the stuff your body is mostly made of—muscle, skin, whatever—it's all mostly protein. A protein is a chain or sequence of smaller molecules called *amino acids*. Connect the right amino acids together in the right order, and you've got a protein.

To do this, your body needs to know which amino acids to use and in what order to connect them. It gets this information from another biological molecule, called RNA. Each RNA molecule is a sequence of even smaller molecules called *nucleotides*. The sequence of nucleotides in the RNA molecules determines the sequence of amino acids in the protein.

But RNA is not the ultimate source of information about proteins. Each RNA molecule is constructed by copying the information in a segment of yet a third type of molecule, called DNA. DNA is the stuff of heredity—what you inherited from Mom and Dad. To make protein, your cells first transcribe DNA into RNA then translate that RNA into protein.

In all three cases, the molecule is a chain of smaller molecules. DNA molecules are called *chromosomes* and consist of long chains of nucleotides. The DNA in a single human sperm or egg consists of about 3.5 billion nucleotides. There is twice this number in other cells, because nucleotides come in pairs—one from each parent. A *gene* is piece of a chromosome that encodes a single protein.

Denton [1985, ch. 12]: The biological echo of typology

Denton's chapter was published in 1985 but reflects the state of affairs a few years earlier, before geneticists had begun generating extensive data on DNA sequences. Throughout the 1960s and 1970s, a great deal of attention was focused on the amino-acid sequences of proteins. Denton deals with data published by Margaret Dayhoff in 1972.

1. How does Denton's discussion relate to the two arguments summarized at the top of Reading Guide 4?

2. How does Denton the measure differences between pairs of protein sequences?

3. Describe the pattern that Denton observes in the protein cytochrome C.

4. Summarize Denton's argument about the absence of intermediate forms in the molecular data. For reference, here is what Darwin [1872, p. 407] had to say:

   > With respect to existing forms, we should remember that we have no right to expect (excepting in rare cases) to discover directly connecting links between them, but only between each and some extinct and supplanted form.

5. Denton was also concerned about the quantitative pattern. For example,

   > All the many diverse vertebrate types, including cyclostomes and mammals, are uniformly distant from the insects. [Denton, 1985, p. 282]

   Why does Denton view this as a problem?

6. Would it have surprised Darwin?

7. Denton argues that two biological theories are tautological—the molecular clock hypothesis, and the related idea of functional constraint.[1] What does he mean? Is he right? Why or why not?

Fairbanks [2007, ch. 5]: Darwinian DNA

Your goal, as you read this chapter, is to decide whether Denton is correct in arguing that the molecular clock and the idea of functional constraint are tautological. In a tautological argument, the conclusion is just a restatement of the premises: because all geese are white, it follows that there are no geese that are not white. So to evaluate Denton's claim, we need to decide whether the clock hypothesis and the idea of functional constraint have implications that go beyond the data that suggested them to us in the first place. Ponder that as you read Fairbanks.

You may ignore pp. 73–78, in which Fairbanks summarizes the argument that Darwin made in *The Origin of Species*.

Fairbanks discusses a family of transposons called *Alu* elements. You can read about transposons in my book, *The Evidence for Evolution*. This is the same family of transposons that I discuss in the chapter on human evolution.

Fairbanks discusses the structure of genes in more detail than Denton does. Here is what you need to know: most genes have several sequences, called *exons*, that are transcribed into protein, and several intervening sequences, called *introns*, that are not transcribed. During protein synthesis, the introns are edited out and thrown away. The exons are then spliced together and translated into a continuous protein. The boundaries between exons and introns are called *splice junctions*, as shown in figure 5.1.

[1] A tautology is statement that are true of necessity, because of its logical form. For example: "John is John." Tautologies never provide information; they are circular nonesense.

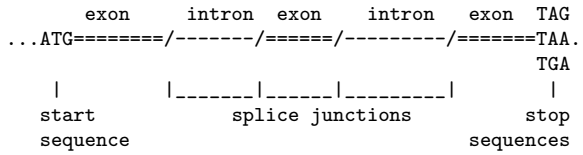

Figure 5.1: Gene structure

1. What does Fairbanks mean by *selectively relevant* and *selectively neutral* mutations? In comparisons between species, why should we see more of the latter than of the former?

2. Be familiar with the terms *gene*, *exon*, and *intron*, which I define briefly above. Which are selectively relevant? Which are selectively neutral?

3. Many introns contain transposons, but exons almost never do. Why should this be?

4. In comparisons between species, do we find more differences in exons or in introns? Why?

5. The comparison between exons and introns can also be made using *pseudogenes*—genes that are broken and no longer make protein. What do we learn from this exercise?

Bibliography

Charles Darwin. *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*. John Murray, London, 6th edition, 1872.

Michael Denton. *Evolution: A Theory in Crisis*. Alder and Alder, Chevy Chase, Maryland, 1985.

Daniel J Fairbanks. *Relics of Eden: The Powerful Evidence of Evolution in Human DNA*. Prometheus Books, 2007.