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The Odds Against Proteins With Only Left-Handed Components

> *All possible knowledge, then, depends on the validity of reasoning.*[1]
>
> —C. S. Lewis

FROM EVIDENCE DISCUSSED in the preceding chapter, it is clear that nothing other than chance has been discovered that can adequately account for the all-left-handed phenomenon. It is logical, therefore, to apply the laws of probability, to see if proteins could have by chance used only left-handed amino acids.

To be completely fair, we will figure the chances for the two outer limits of what may be the true situation. As noted earlier, those limits are as follows: (1) either there is equal probability, on the average, of opposite hands linking, under the presumed conditions on earth prior to life, or (2) a preference of 6/7, at the most, in favor of amino acids of the same hand joining. Because it is simpler, the odds will first be figured for equal probability.

The Simplest Possible Living Thing

Dr. Harold J. Morowitz of Yale University has done extensive research for the National Aviation and Space Agency to discover the theoretical limits for the simplest free-living thing which could duplicate itself, or, technically, the minimal biological en-

[1] C. S. Lewis, *Miracles, A Preliminary Study* (New York: Macmillan Co., 1947), p. 19.

tity capable of autonomous self-replication. He took into consideration the minimum operating equipment needed and the space it would require. Also, attention was given to electrical properties and to the hazards of thermal motion. From these important studies, the conclusion is that the smallest such theoretical entity would require 239 or more individual protein molecules.[2]

This is not very much simpler than the smallest actually known autonomous living organism, which is the minuscule, bacteria-like *Mycoplasma hominis H39*. It has around 600 different kinds of proteins.[3] From present scientific knowledge, there is no reason to believe that anything smaller ever existed. We will, however, use the lesser total of 239 protein molecules from Morowitz' theoretical minimal cell, which comprise 124 different kinds.[4]

It was noted earlier that there obviously can be no natural selection if there is no way to duplicate all of the necessary parts. In order to account for the left-handed phenomenon, chance alone, unaided by natural selection, would have to arrange at least one complete set of 239 proteins with all-left-handed amino acids of the universal 20 kinds. There is reason to believe that all 20 of these were in use from the time of life's origin.

Using figures that were furnished by Morowitz,[5] it can be calculated that the average protein molecule in the theoretical minimal living thing would contain around 445 amino acid units of the usual 20 kinds. One of the 20 types of amino acids, glycine, cannot be left- or right-handed, because its "side chain"

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[2] This data via personal communications from Morowitz, October and November, 1971.

This reflects Morowitz' most recent estimate from continuing research with co-workers at Yale. Earlier estimates were that the smallest possible living thing would be much less complex. (Harold J. Morowitz and Mark E. Tourtellotte, "The Smallest Living Cells," *The Living Cell*, ed. Donald Kennedy [San Francisco: W. H. Freeman and Co., 1965], pp. 31-39. Also: Harold J. Morowitz, "Biological Self-Replicating Systems," *Progress in Theoretical Biology*, ed. Fred M. Snell, Vol. 1 [1967], pp. 52-57.)

[3] Hans R. Bode and Harold J. Morowitz, "Size and Structure of the *Mycoplasma hominis H39* Chromosome," *Journal of Molecular Biology*, Vol. 23 (1967), p. 198. For number of proteins, Morowitz, personal communication, November, 1970.

[4] Although recognizing that there are hypotheses of origin from simpler forms than this, Dr. Morowitz agreed that *in actual experimental evidence*, there is no assurance that anything simpler could meet the test of autonomous replication and viability (personal communication, 1971).

[5] Harold J. Morowitz, *Energy Flow in Biology* (New York: Academic Press, 1968), p. 84. Also data by personal communication, 1971.

The total molecular weight of 239 protein molecules is 11.6×10^6. The average molecular weight per amino acid residue is around 109 in some bacteria.

is not really a chain, but merely a hydrogen atom like the one opposite it. It can be presumed that this minimal theoretical cell would in many ways resemble bacteria in its make-up. In some bacteria, glycine accounts for just over 8 percent of the total amino acid molecules,[6] so we will estimate that in the average protein of the minimal cell, there will be 35 glycine units in the chain. That will leave 410 of the total 445 which could be either left- or right-handed.

If amino acids had been formed naturally in the "primitive" atmosphere, they would have occurred in statistically equal amounts of the left- and right-handed isomers. This became clear from experiments described in the preceding chapter.[7] That means, then, that if a protein chain is to form by random linkups,[8] all 410 of the nonglycine sites could be occupied with equal ease by either L- or D-type amino acids.

The first one has a 1 out of 2 chance of being left-handed. The same is true for each of the other 409. Since we are now figuring this at equal probability for either hand, the probability at any one site is not affected by the amino acid before that one in the chain.

To calculate the probability in such a case, the formula to use is the multiplication rule, the heart of probability theory. Mathematician Darrell Huff said it thus: "To find the probability of getting all of several different things, multiply together the chances of getting each one."[9]

To get the probability of all 410 of the isomeric or handed amino acids of just one protein chain, we must multiply the 1/2 probability which is the case for each position in the chain. It is like flipping a coin 410 times, hoping to get all heads. For each step, there is 1 chance in 2, so we must multiply the 2 by itself (2 x 2 x 2 x . . . x 2). using the figure 410 times. That is 1 chance in 2^{410}. (The exponent means: Multiply together 410 two's.)

It will be easier to work with this figure if we translate it

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6 Harold J. Morowitz, *Life and the Physical Sciences* (New York: Holt, Rinehart and Winston, Inc., 1963), p. 35.

7 Also in Appendix 1, p. 243.

8 We're assuming linkup automatically without enzymes, etc., since we are here interested only in the L- and D- probability matter. (This is an exceedingly generous assumption, making it easier for chance to succeed.)

9 Darrell Huff, *How to Take a Chance* (New York: W. W. Norton and Co., Inc., 1959), p. 22.

to powers of 10 instead of powers of 2. As you know, multiplying 10 by itself is just adding another zero.[10] The equivalent of 2^{410} is roughly 10^{123}.

The probability that an average-size protein molecule of the smallest theoretically possible living thing would happen to contain only left-handed amino acids is, therefore, 1 in 10^{123}, on the average.

That is a rather discouraging chance. To get the feel of that number, let's look at it with all the 123 zeros: There is, on the average, 1 chance in 1,000,000,000,000,000,000,000,000,000,000, 000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000, 000,000,000,000,000,000,000,000,000,000,000,000,000,000,000 that all of the amino acids of a particular protein molecule would be left-handed!

Using All the Proteins That Ever Existed on Earth

Professor Murray Eden at Massachusetts Institute of Technology estimated that the total number of protein molecules that ever existed on earth might be 10^{52} as an extremely liberal approximation.[11] If we assume for the moment that all these were the same size as the average protein in the smallest possible autonomous living thing, we can then figure the probability, on the average, that any one protein that ever existed on earth would have only left-handed amino acids just by chance:

The answer is 1 in 10^{71} (which is 10^{123} divided by 10^{52}).[12] Written out, that is only 1 chance in 100,000,000,000,000,000, 000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000, 000,000 that even a single one of all these protein molecules that ever existed on earth would on the average happen by chance alone to have only L-amino acids. Saying it another way, *the*

[10] For the nonmathematician (as most of us are), there is a simple way to change from 2 to 10 as a base. If we multiply 2 by itself until the total is about equal to a power of 10, we find that 2^{10} is about the same as 10^3. The convenient formula, then, is to take the exponent of 2 and multiply it by .3 in order to obtain the power of 10 which is approximately equal to it. Applying this to our figure of 2^{410}, we multiply the exponent by .3, and the result, the figure 123, is the proper power of 10. 2^{410} is therefore roughly 10^{123}. If tables of common logarithms are available, one need merely look in the first column opposite 2.

[11] Murray Eden, in *Mathematical Challenges to the Neo-Darwinian Interpretation of the Theory of Evolution*, ed. Paul S. Moorhead and Martin M. Kaplan (Philadelphia: Wistar Institute Press, 1967), p. 17.

[12] As you may remember from mathematics in school, to multiply large numbers which are written with exponents or powers, you merely add the exponents. To multiply 10^3 x 10^4 would be $10^{3+4} = 10^7$. To divide, all that is necessary is to subtract one exponent from the other. 10^{123} divided by 10^{52} is 10^{71}.

odds[13] *are a hundred billion trillion trillion trillion trillion trillion to one against that happening!*

That isn't all. Even if one *did* occur, 238 more all-left-handed ones would be needed to work with it, or all would be lost. Since all 239 would have to be together in space and time, the probability of each of the remaining 238 would be $1/10^{123}$. Those huge numbers would then have to be *multiplied* together and with the $1/10^{71}$ probability of the first one, according to the multiplication rule. This would give the probability of the needed group of 239 protein molecules being all left-handed.

The number is beyond all comprehension, namely 1 in 10^{29345}. Even if we allow for overlapping groups, it cuts the exponents only a few "orders of magnitude" (powers of 10). And, if we had all of them, they still could not duplicate themselves, so it would be the end of the line, unless chance could also produce the DNA code and the entire translating system. The code, moreover, would have to specify that amino acids would be manufactured in the left-handed form, and the coding for all the enzymes would have to match.

For comparison, the number of inches across the known universe from one side to the other is only about 10^{28}. The odds against even one average-size protein having all left-handed amino acids is a figure 10 million trillion trillion trillion times that big, namely, 1 in 10^{71}. Remember, that is out of all the protein molecules that ever existed on earth. The foregoing calculations were on the assumption of equal likelihood that either hand would link up.

Probability Figured If 6/7 Preference for the Same Hand

Now, the probability is to be computed if this extreme is assumed, namely, a preference factor of six chances in seven that the same isomer will link up next.

If a handed amino acid happens to be first in the chain, no preference would be exerted upon it, since there would be none preceding it. We will assume the same to be true whenever another amino acid follows a glycine residue in the chain, since glycine is neither left- nor right-handed. For all the rest, we

[13] The common expression, "the odds," may be defined as the ratio of failures to successes. If there is one chance in ten of success, then there are nine chances in ten of failure. The odds against success in that case are nine to one. When the probability of success is one in a very large number, then it is approximately correct to use that same large number also when speaking of the odds against that event. Otherwise, one would have to write out the entire figure in nines, to get the exact number, which is one less than the probability figure.

are to consider that the probability is 6/7 that the same hand will link up next as the one just preceding.[14]

Let it be supposed that there are 32 sites in the chain of 445 where an isomeric amino acid either follows a glycine or comes first in the entire chain. Each of these 32 will therefore have a probability of 1/2 of being left-handed, as there is no handed amino acid preceding it to exert any preference. Each of the other 378 sites will have a probability of 6/7 that the position involved will be occupied by the same hand as the one just before it. When we remember the 35 glycines, this accounts for all 445.

Computing this for the 32 sites at 1/2 probability and for the 378 sites at 6/7 probability, we arrive at a probability of 1 in 8.7×10^{34} that a particular protein would have only L-amino acids.[15] Since a minimum of 239 such proteins is required before there are enough for the theoretical minimal living entity, and each would have the same probability, by the multiplication rule, we conclude that on the average the probability would be around 1 in 10^{8350} that any given set of 239 would be all left-handed.

Going back to the 10^{52} protein molecules that ever existed according to Dr. Eden, we may divide these into contiguous sets of 239 for such a minimal cell. There are 10^{49} such sets, rounded. By dividing this figure into 10^{8350}, and further dividing by a million to allow for overlapping sets, we arrive at the astounding conclusion that there is, on the average, one chance in 10^{8295} that of all the proteins that ever existed on earth there would be a set of 239 together which were all left-handed, the minimum number required for the smallest theoretical cell. Another concession was given to make it easier for chance, in that we did not consider the time factor for the 10^{52} proteins that ever existed, and calculated as if they all existed at the same time.

Out of all the protein molecules that ever existed on earth, the odds against there being even one set with only left-handed components sufficient for the smallest theoretical living entity are 10^{8295} to 1. This is the conclusion when it is assumed that

[14] In this, a concession is being given to chance, in that we are figuring the preference at 6/7 even before there are several of the same hand in consecutive order. This would perhaps more than balance any steric selectivity that might conceivably be exerted by any helical section prior to a glycine residue in the chain.

[15] $1/2^{32} \times 6^{378}/7^{378} = 1$ in 8.7×10^{34}.

there is a 6/7 selectivity factor for the same enantiomorphic form. Compare that with the number of seconds since the universe began, which is 10^{18} for about the longest such estimate—about 15 billion years.

Even if the L-amino acids were 100 times as likely to link with L- as with D-, the odds would be 184 billion to 1 against an average size protein molecule having only L-amino acids. To get the required set of 239 would make the probability slimmer than 1 in 10^{2642} out of all the proteins that ever existed on earth. And, even if we also allowed 100 to 1 preference in the case of the 32 amino acids which follow glycine—supposing that the preceding portion of the chain could exert such selectivity—the probability would still be astronomical beyond the ability of the human mind to conceive, namely, 1 chance in 5×10^{373}, using all the proteins that ever existed on earth.

To be more realistic, however, let's go back to the figure for one minimum set if the preference is assumed to be 6/7. That was a probability averaging 1 in 10^{8295}. Just to print the number would require more than four full pages. It would take six minutes to say the number in billions, speaking rapidly all the while. These numbers are too fantastic to understand. Chapter 7 on large numbers will offer comparisons that will help.

What if we suppose, contrary to any actual evidence, that at the start there were only forty proteins required, of only forty units in length,[16] with 6/7 preference for the same hand? Considering three of these to be glycine, the odds would be sixty billion trillion trillion trillion trillion trillion to one that no single set of protein molecules out of all that ever existed would have only left-handed amino acids. (That is 60×10^{69} to 1.)

Conclusion: No Conceivable Probability

No natural explanation which can adequately explain this left-handed mystery is in sight. We have just seen that the odds against its happening by chance are so tremendous as to be completely incomprehensible.

If, on the other hand, there was a Creator of living things, He could have decided for reasons of His own to use just L-amino acids in proteins. He would have placed the proper L-enzymes and coding in the cells which would form only left-handed amino acids for use in proteins.

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[16] As will be seen later (page 113) there may be a lower limit of fifty units, under which proteins are not stable in solution.

These created enzymes would thereafter be replaced as needed at the orders of the DNA code. The same Creator would be the Author of that amazing code which carries complete instructions that are incredibly comprehensive and detailed in the genes of every living thing on earth.

For those whose philosophy is evolution, this left-handed matter is an embarrassing problem. The many efforts at solutions that have been made are noteworthy for the questions they bring up rather than for answers. It is not likely that this mystery will ever be adequately explained, as long as the evidence of intelligent planning is ignored.

But what if some day we happen to find a really adequate natural solution to this question? It has frequently happened that in discovering "natural" explanations for mysteries, we uncover other complex new systems which only deepen the underlying mystery of this intricate universe. Here is just one such example:

It has been a puzzle that eggs of some birds all hatch so close to the same time. Now scientists actually have tape recordings of quail eggs "talking" to each other by clicks and vocal sounds to synchronize hatching.[17] Thus, a greater mystery appears.[18]

The amino acids in proteins are not the only one-handed molecules. The stereo-selective phenomenon is found throughout living nature. We have noted that vitamin C, which is L-ascorbic acid, is always left-handed in its natural form in foods. This compound can be made in the laboratory in both D- and L-isomers, but only L-ascorbic acid has vitamin C activity.[19] Glucose sugar molecules, conversely, are habitually D-, or right-handed.

Remembering the weakness of chance is an important and logical step in deciding what philosophy of origins one will believe, evolution or creation. Blind chance requires an average of ten billion tries to count to ten. Can this pathetic source account for the intricacies of the eye, a beehive, the song of a mockingbird, or the metamorphosis and 1000-mile migration of

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17 "Biological Sciences," *1971 Britannica Book of the Year*, p. 166, regarding tape recording by biologist Margaret A. Vince of Cambridge University.

18 "As in other areas of science, attempts to answer questions have usually revealed only another, more sophisticated set of questions." Philip Handler, ed., *Biology and the Future of Man* (New York: Oxford University Press, 1970), p. 130.

19 Linus Pauling, *Vitamin C and the Common Cold* (San Francisco: W. H. Freeman & Co., 1970), p. 89.

the monarch butterfly? In the next chapter, we will discover that natural selection is completely inadequate as a solution.

The Wisdom Built In

We find that there is no lessening of confusion until one accepts the logic that "intelligent" systems could not arise without an intelligent Designer.

In Genesis, chapter one, we are given the idea that God decided how each living creature would be assembled. To construct proteins, he apparently used L-amino acids, formed by himself, for reasons unknown to us. We may some day discover those reasons. It is the privilege of scientists to experiment in our well-equipped cosmic laboratory, studying to find out how the Creator put things together, trying to understand the wisdom built in. "It is the glory of God to conceal a thing: but the honour of kings is to search out a matter."[20]

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[20] Proverbs 25:2.