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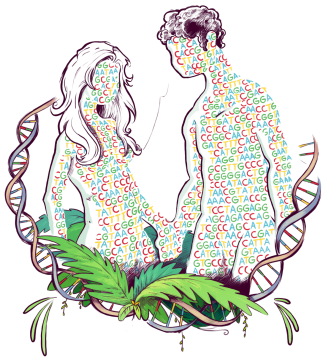
ARTICLE

Can Simple Organisms Overcome Genetic Entropy?

Refuting arguments against genetic entropy

by **Donny Budinsky**



WHAT IS GENETIC ENTROPY?

Genetic entropy is a concept developed from the observation that the mutation rate is high—and that most mutations are too subtle to be removed by natural selection (differential reproduction). Genetic degeneration applies the greatest to the long-term persistence of complex organisms—such as higher mammals (humans and elephants). Complex life forms such as humans have relatively small population sizes (especially when compared to mice and bacteria). They also have slow reproductive rates. These organisms will have the most challenging time surviving the consequences of genetic entropy, since deleterious mutations affect higher (more complex) organisms the most.

Every time the cell divides, more mistakes are added to the genome (changes in the nucleotide sequence of DNA). Most of the mutations we accumulate in a lifetime occur in somatic cells (skin cells for example). Fortunately, these are not passed on. But they are a primary reason why biological organisms age—and eventually die. Although mutations in somatic cells are not passed on to the next generation, mutations that occur in reproductive cells (egg or sperm cells) can be passed on to the individual's progeny. The mutation rate in humans is roughly 60-100 mutations per person per generation (1):

> Thus, keeping in mind that some mutations in repetitive DNA likely go undetected owing to mapping difficulties in genome-sequencing projects, with a diploid genome size of ~6~6

> billion bases**, an average newborn contains ~100~de novo mutations.**

To prevent genetic decline and eventual extinction—*there has to be a type of selection that can filter out these harmful mutations accumulating each generation.* Population geneticists struggle to explain how species (not just in humans) can survive for long periods of time in light of this high mutation rate. Even evolutionary population geneticists recognize that most mutations are deleterious. As a matter of fact, they admit that *this is one of the most well-established principles of evolutionary genetics* (2):

> In summary, **the vast majority of mutations are deleterious.** This is one of the most **well-established principles of evolutionary genetics**, **supported by both molecular and quantitative-genetic data.** This provides an explanation for many key genetic properties of natural and laboratory populations.

(Emphasis mine)

Natural selection simply can't eradicate the majority of mutations that are accumulating in populations over time. Selection can only remove the detrimental mutations (a point mutation that kills an individual). But selection is powerless against most mutations—since most mutations are low-impact and are therefore too subtle to be seen. Selection can remove the really bad mutations—and amplify the rare "beneficial" one, but much like rust molecules building up on a car over time, nearly neutral mutations accumulate continuously.

High mutation rates in populations over time (as we see with humans) means that offspring will be more mutant than parents and grandparents. Every person will be more mutant than their parents. Even with intense selection, genetic degeneration cannot be stopped. This is because even the most "fit" individuals are still more mutant than their parents, and their grandparents. Since every single human being has inherited deleterious mutations from their parents, a high genetic load exists that selection can't solve. It is arbitrary to ask, "who is the most mutant?" This is because the entire population has accumulated mutations from previous generations. The population in general is "multiply mutant." Some may be "less mutant" than others, but they are mutant nonetheless—since they have inherited mutations from their parents and grandparents.

DOES THE PERSISTENCE OF BACTERIA REFUTE GENETIC ENTROPY?

What about an organism that has a large population and a substantial die-off rate? I am thinking specifically of bacteria. Bacteria have reproduction rates that are exceedingly fast, and they have very simple genomes when compared to complex organisms such as mammals. Bacteria also have extremely high population sizes or numbers. If any living organism is going to be able to evade the consequences or impacts of genetic degeneration—and eventual population wide genetic sickness—it is going to be bacteria.

There are many reasons why bacteria could possibly escape the ravages of genetic degeneration or entropy. Firstly, they have a very low mutation rate. The DNA polymerases that copy the bacterial DNA make an error approximately 1 every 10 million letters. The E. coli genome is only 4-5 million letters long. This means there is less than 1 mutation per generation per bacterium. This is not true in humans.

As I covered earlier, humans have a very fast mutation rate. Again, the human mutation rate is roughly 100 new mutations per person per generation. Most of these mutations are deleterious—like typographical errors in a text. In addition to this—the majority of these mutations are low-impact—which means they are subtle. They are invisible to selection. Therefore, they accumulate unchecked. Since they persist in populations unchecked and unnoticed, they build up, spread, and degenerate. This is a major problem in evolutionary theory.

Bacteria are not considered long-lived complex organisms. There may exist a recipe for natural selection to see more of the mutations that accumulate in bacteria over time and more effectively act upon them. In other words—purifying selection could work better on bacteria. This is why it's important that we examine this question.

Since bacteria have a very low mutation rate with overall smaller genomes—there exists the possibility for some bacteria today having nearly the exact same genome as they did at creation. It is important to note that not every single E. coli in the world has the exact same genome—and therefore we should consider the E. coli genome in its entirety as a

pan-genome. It is certainly feasible that there exists non-mutant bacteria somewhere on this planet (for example, bacteria acting in somebody's gut).

Another reason why bacteria might be more resistant to the devastations of genetic degeneration than humans would be is because of their exceptionally large population sizes. It is incredibly difficult to put a number on how many bacteria exist on the planet today. It's easily more than 1 quadrillion. It is also true that bacteria reproduce extremely rapidly. If bacteria reproduce every 30 minutes, more than a quadrillion E. coli are dying.

Let us imagine humans reproduced in the same way bacteria reproduced. Most bacteria depend on a process called **binary fission** to reproduce or propagate (3).

> Most bacteria rely on binary fission for propagation. Conceptually this is a simple process; a cell just needs to grow to twice its starting size and then split in two.

In humans (in our imagined scenario), 1 human would become 2 humans every 30 minutes (assuming the generation time of bacteria is 30 minutes). Today there are 7-8 billion people on the planet. If the human population doubled every 30 minutes, 7-8 billion people would have to be removed from the equation. This type of reproduction is outstanding for natural selection. We know humans do not actually reproduce this way. But what we do know is that bacteria do. What this means for bacteria is that if there is a minor difference (created through mutation) between 1 bacterium to

another—there is a better chance at having a healthy long-term reproduction and overall status.

To recap—bacteria have low mutation rates, massive population sizes, a fast population turnover, and simpler genomes. When we consider these important factors, we can understand why bacteria may just be more impervious to the concerns of genetic entropy than mammals (humans, elephants, whales, etc.).

Human genes have both a start and a stop element. They have places where the DNA letters are coded to bond to a protein (histones) that the DNA wraps around (4). If one of these highly complex DNA letters are altered through mutation, the histone binding pattern could be changed, which could result in a difference in the folding of the DNA. As a result of this, gene expression could be adversely affected. The DNA of complex organisms is highly sophisticated.

> ***Most DNA is found inside the nucleus of a cell, where it forms the chromosomes. Chromosomes have proteins called histones that bind to DNA.*** DNA has two strands that twist into the shape of a spiral ladder called a helix. DNA is made up of four building blocks called nucleotides: adenine (A), thymine (T), guanine (G), and cytosine (C). The nucleotides attach to each other (A with T, and G with C) to form chemical bonds called base pairs, which connect the two DNA strands. Genes are short pieces of DNA that carry specific genetic information.

(Emphasis mine)

The information systems that make up life are sensitive to these subtle changes due to low-impact mutations. Bacterial genomes do not exist at this level of sophistication. They do not have histones. Their genomes are very small. Humans have what are called introns in the middle of genes. To make a protein, the introns need to be cut out (through genetic mechanisms) and thrown away (5).

> In some genes, not all of the DNA sequence is used to make protein. Introns are noncoding sections of an RNA transcript, or the DNA encoding it, that are spliced out before the RNA molecule is translated into a protein.

It turns out that at the location where the intron joins the regular part of the gene, there are intricate signals that mark the cutting-out process—and if that letter is modified, the entire protein could be damaged. Fortunately for bacteria, they do not have this problem. The target for deleterious mutations is much smaller in bacteria. Most of the genome of a bacteria is coding—and not non-coding (doesn't code for a protein) (6).

If natural selection can see a mutation more clearly—like a mutation in a bacteria—selection will have a better chance at being able to filter it out—and remove it from the equation. The major problem with genetic entropy in more complex organisms is the fact that most mutations are only marginally harmful. This means selection can't see the mutations that are flowing into the genomes of higher

organisms' generation after generation. These low-impact mutations are essentially invisible to selection. But in the case of bacteria, selection will be more efficient since it can see many more mutations than can be seen in humans. If selection can see a slightly deleterious mutation in a bacterium more clearly than it can see in a human genome, it will therefore be able to eliminate it.

I want the reader to picture bacteria as a bicycle—and a human as a fancy sports car. There are changes that can be done to a small bicycle (that only has a few parts to begin with) that would be devastating to the bike. With a bicycle, you can't lose the chain, you can't lose the tires, and you can't lose the handle bars. A loss to any of these important features to a bike will result in the failure to ride the bike. The bike will no longer be able to do the job it was meant to do. Its function will be ruined. An automobile on the other hand has numerous different working parts and aspects to it that many of those parts have very little to do with getting the car to function. There is a great multitude of parts to a sports car that can be altered and damaged that will not automatically wreck the car. It will still be drivable. In fact—there are parts of a car that can be broken down or damaged that the driver may not even recognize right away.

WHAT ABOUT MICE?

There are 100s of variations of the common mouse in the world today. And these mice populations have numerous

karyotypic differences. A karyotype is an individual's complete set of chromosomes (7).

> **A karyotype is an individual's complete set of chromosomes.** The term also refers to a laboratory-produced image of a person's chromosomes isolated from an individual cell and arranged in numerical order. A karyotype may be used to look for abnormalities in chromosome number or structure.

(Emphasis mine)

In other words, we find varying numbers of chromosome counts in the different mouse species around the globe. And in many cases, they are reproductively incompatible. A subset of mice can branch off from a parent population and become isolated. This isolation inhibits gene exchange. This isolation will result in chromosomal differences between various species of mouse. These differences are due to mutations that accumulate in the various species. Mice also have both an extremely high reproductive and die-off rate. As I have explained, in cases where we find large populations and high die-off rates, selection might be able to continue purifying the species. This purification process can prevent certain species from descending into complete genetic meltdown and extinction. And yet, with all these large numbers of karyotypic differences in variations of mouse, it is clear that mice have not avoided the detrimental effects of genetic degeneration and mutation accumulation. In his article titled *"Genetic entropy and simple organisms"*, Dr. Robert Carter sums it up nicely (8):

One might reply, “But mice have genomes about the size of the human genome and have much shorter generation times. Why do we not see evidence of GE in them?” Actually, we do. The common house mouse, *Mus musculus*, has much more genetic diversity than people do, including a huge range of chromosomal differences from one sub-population to the next. They are certainly experiencing GE. On the other hand, they seem to have a lower per-generation mutation rate. Couple that with a much shorter generation time and a much greater population size, and, like bacteria, there is ample opportunity to remove bad mutations from the population. Long-lived species with low population growth rates (e.g. humans) are the most threatened, but the others are not immune.

THE REALITY OF GENETIC ENTROPY

The reality of genetic entropy is best understood as rust on a car or a single spelling mistake in a book the size of an encyclopedia. A single rust molecule (on a car), or a single spelling mistake (in a book), may not be consequential on its own, but as these problems build up over time, the car—and the book—will slowly crumble. Genetic entropy is the build up of nearly neutral mutations (slightly deleterious) over time in populations where selection is weak. For example, most mutations in mammals will not be visible to selection. They

will go unnoticed and therefore unchecked. These populations will descend more and more into genetic sickness over time. And by the time selection can see the genetic damage, it is too late, since the damage is population wide. Selection is extremely limited. This is simply because selection has to do with reproduction—and you can't remove too much of the population or else the population will go extinct. Even if you were to remove 50% of the most-mutant individuals (let's say in a population of 7.5 billion), you would be left with 3-4 billion people that are more mutant than the generation before it. Selection (even intense selection) can only slow down the degeneration process—it cannot stop it. Genetic degeneration is inevitable—and there are no plausible mechanisms available that can solve this problem.

Just because bacteria may be the most resistant organism to genetic entropy does not mean that genetic entropy does not exist. There are many reasons (as we have covered) why bacteria might be able to survive the effects of mutation accumulation—but that does not mean that more complex organisms—such as humans and other mammals—can withstand the devastating effects of deleterious mutation accumulation.

All things are going downhill—even bacteria. Even considering the factors discussed above, we have observed real-time genetic degeneration—and reductive evolution—in bacterial populations. I am referring to the long-term evolutionary experiment known as the Lenski experiment. Richard Lenski's bacterial populations have undergone reductive evolution. They have all shrunk in functional genome sizes, and they have all experienced deleterious

mutations that have been functionally compromising to the bacterial populations. The bacteria in this specific experiment have experienced adaptive degeneration. The type of advantages observed are similar to what you would attain in your vehicle by removing weight for a temporary improvement in gas mileage. You could rip out the seats, remove the carpets, tear off the doors, and remove the mirrors of your automobile, and as a result, you will get better gas mileage (since weight has been removed from the car). But this is not improving the vehicle. It is degrading. It is not ultimately improving the car. And this is what we see in Lenski's bacteria. They have become lazy, and they have been backed into a corner. If these bacterial species were put back into the natural environment, they would be dead on arrival. They have lost a lot of essential genes, and they have degenerated significantly from their original state. Basically, these bacterial populations have lost genes for short-term adaptive purposes. But these short-term adaptive episodes only lead to long-term genetic degeneration. This is strong evidence that even bacteria cannot fully escape the devastating effects of genetic entropy.

Genetic entropy or genetic degeneration is a very real reality. Species have picked up a lot of deleterious mutations over time. This reality of mutation accumulation puts shelf lives on genomes. This means that species cannot persist for millions of years into the future—since the increasing influx of deleterious mutations prevent organisms from experiencing any real forward evolution. Biological organisms are going downhill over time—and not uphill. This also means that species have not undergone forward evolution in the past. The

existence of genetic entropy is a demonstration that species have not endured for millions of years into the past. Proponents of evolution and common descent frequently look to the fossil record as evidence for large-scale evolution and universal common ancestry. But since fossils are a reflection of biology—because fossils are of dead biological organisms in the past—the fossil record cannot be old. The fossil record is young. Genetic entropy is testimony of young biology (both extant and extinct).

It turns out that most "beneficial" mutations are reductive and functionally compromising to the organisms that experience them. It also turns out that these types of adaptive mutations are rare. There is no way to counterbalance the degeneration that has been done by mutation accumulation. The reason we as humans are not extinct is because we are not the product of evolutionary processes. We are a product of *special creation*. Since man was created thousands of years ago, it makes sense that we have not had the necessary time to go extinct through deleterious mutation accumulation. If humans have been evolving, and adding mutations to the gene pool every generation for millions of years (evolving through primate ancestors), we should not be here. We would have gone extinct a long time ago.

I want the reader to remember: our hope is not in this fallen world. Our hope is in heaven. Our hope is in Jesus Christ. If you have not yet put your faith and trust in the finished work of Jesus Christ—I urge you to do so today!

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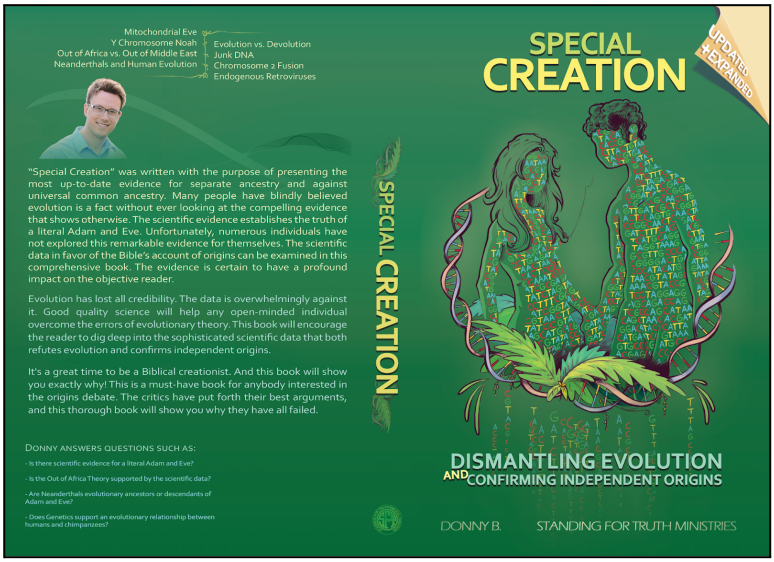

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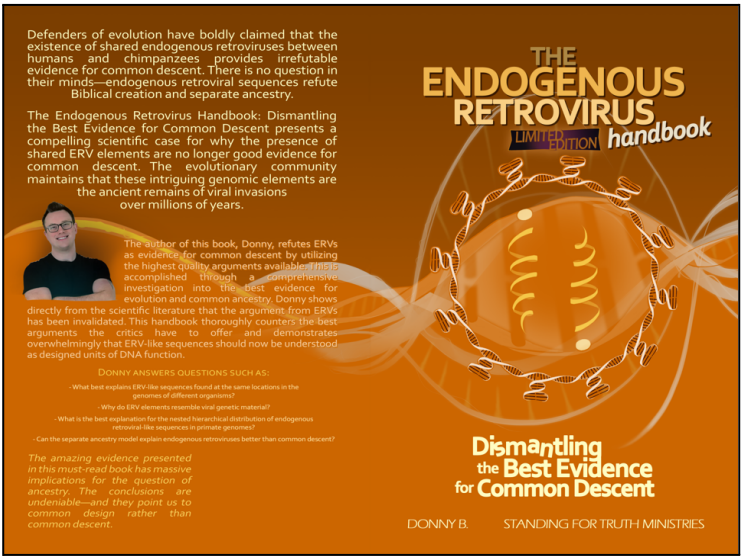

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