21. **Effectiveness of mutations**

A mutation is a permanent alteration of the nucleotide sequence in DNA which results in protein coding errors. Mutations can be caused by external or internal factors, or they may be caused by errors in the cellular machinery. Physical or chemical agents that induce mutations in DNA are called mutagens.

External mutagens include ultraviolet, especially UVB radiation from the Sun, and other radiation frequencies, including x-rays, gamma rays, high temperature, certain plant toxins, viruses and human-made mutagenic chemicals. Internal factors include errors during DNA replication which can lead to genetic changes.

Most mutations have a destructive effect and one test had shown that out of all gene changes, 39.6% were lethal, 31.2% were non-lethal deleterious, 27.1% were neutral and 2.1% were slightly beneficial. Under these circumstances, life would need mechanisms to protect organisms against the effects of mutations.

We tend to exaggerate the importance of mutations on the changes of organisms. Due to cell repair mechanisms mutations do not happen that often and for human DNA the mutation rate is approximately 2.5×10^{-8} per base pair (base pair corresponds to one nucleotide in the DNA code) per generation. Such a low mutation rate makes the process of evolution very slow. To ensure that specific beneficial mutations become fixed, the population must be very large.

This can be illustrated by calculating mutations in bacteria.

Let us assume that we start with 10 trillion bacteria (10^{10}), a mutation rate 10^{-10} per base pair per generation. Statistically, out of these 10 trillion bacteria only one will gain one specific beneficial mutation. These bacteria begin to divide and we have to wait approximately 33 generations until the population with one specific beneficial mutation reaches about 10^{10} bacteria. As a result of the mutation of these bacteria, one of them will receive one additional specific beneficial mutation. Therefore they will have two beneficial mutations out of a total of 10^{20} bacteria. To obtain one bacterium with 3 specific beneficial mutations we would have to wait approximately 67 generations for the population to reach 10^{30} bacteria.

This example illustrates that to accumulate two or three specific beneficial mutations the population must be very large. This is normally possible only with bacteria and parasites.

For a smaller and constant population of animals, for example 1million, to obtain one specific beneficial mutation will need 10,000 generations. However, to fix two beneficial mutations will need one billion generations. This example shows how difficult would be for two or more mutations to be fixed in a small population of larger animals.

Such a low efficiency of evolution is confirmed by arising of resistance of bacteria and parasites to medication. It was shown that bacteria needs only one or two mutations to be resistant to some antibiotics. Because the population of bacteria is extremely large resistance to medication can take place. A medication which needs 3 mutations of bacteria would solve the resistance to antibiotics problem because it would take a very long time for bacteria to have 3 specific mutations.

One parameter, which is frequently used to support the theory of evolution, is time. Evolutionists have managed to persuade the general public to believe that if the process of evolution is long enough anything could happen. It is not easy for the average person to estimate what biological structural changes are possible during say, 10 million years. Therefore evolutionists frequently use the argument, “this was such a long period of time that the evolution of this component was possible”. However this argument is very deceptive because what actually matters is not only length of time but also population size. To estimate how quickly evolutionary changes could take place, the mutation rate must be multiplied by the size of the population.

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