Ten misconceptions about how the DNA changes

In 2015, the Nobel Prize for Chemistry was awarded for the discovery of the mechanisms for mutation protection and repair that are present in every cell. Because of this, in the media and on internet fora (e.g. SKEPP.be) a discussion has arisen on the question "Can mutations produce mutation protection?" and the question "Does mutation protection break down evolutionary theory?". In these discussions, many misconceptions on how the DNA changes become evident. Below a survey.

1. In organic molecules and in the DNA a hidden power is present

Many people think that in organic molecules an intrinsic desire is present arrange themselves into ever more complex substances, and that the DNA possesses a natural drive to expand itself further and further. This 'alchemistic' thought is a misconception. The natural course of events (as described by the laws of physics) is that sooner or later any molecule falls apart into the smallest possible units. For the conversion of simple molecules into complex molecules, factories are required.

2. DNA is stable

Many people think that DNA is a stable molecule that can keep the nucleotide code for the construction, maintenance and replication of an organism unchanged for a long time, just like a DVD or memory stick can for the digital code of a computer program. The opposite is the case. DNA is a very large molecule and therefore very unstable. Every day, in every cell (including the germ cells), thousands of damages occur in the DNA. Fortunately, these damages are continually repaired or eliminated by extensive mutation protection and –repair mechanisms, the discovery of which the 2015 Nobel Prize for Chemistry was awarded. The award letter from the Swedish Academy of Sciences: http://bit.ly/1LhCGGC gives a good overview of the basic scientific facts about the instability of the DNA and the extent and complexity of the mutation protection and repair.

3. The living nature adapts by mutations

Many people think that living nature continuously adapts to changing circumstances by mutations in the DNA. That is a misunderstanding. Living nature constantly adapts (for instance, the change of the beaks of finches) by the mechanism of recombination of gene variants ('alleles') and selection, and by gene regulation. These mechanisms operate within the boundaries of the DNA mutation protection and –repair, and do not produce new alleles nor expand the length of the nucleotide code. See DeJong & Degens (2011) "The evolutionary dynamics of digital and nucleotide codes", in: *The Open Evolution Journal*, 5 1-4 http://bit.ly/1P37x9r . Prof. Dr. Ronald Plasterk pointed out this misunderstanding already 20 years ago in his column on October 25, 1996 in the magazine Intermediair: "*There are hordes of biologists who believe that evolution happens because somewhere in species a mutation occurs that produces selective advantage. Already half a century it is known that it does not work like this, and cannot work like this. ... Speciation operates by the selection of combinations, not of mutations.* " It is sad that the basic scientific facts about how populations adapt to changing circumstances (i.e. by recombination of alleles and selection and by gene regulation) are not taught well in schools and universities; and it is also sad that Ronald Plasterk later as Minister of Education, did not bother about this.

4. Many small changes always lead to a big change

Many people think that all changes are the same, and that many small changes always add up to big changes. That is incorrect. There are two types of change: (1) *Variation* (a1, a2) -> (b1, b2), and (2) *Innovation* (a1, a2) -> (b1, b2, b3). Billions steps of variation, will never lead to innovation. Within the theory of evolution these two very different kinds of change both play a role, but are not distinguished from one another. In any branch of science, a theory in which two completely different mechanisms with completely different outcomes play a role, will be formulated more precisely. That will also happen for the theory of evolution.

5.Mutations lead to improvement and expansion of the DNA

Many people think that mutations to the DNA lead to improvement and expansion of the functionality of the DNA (innovation). The opposite is the case. Irreparable mutations of the DNA lead tot hereditary diseases and cancer, as the massive databases of researchers of cancer and hereditary diseases show. See for example, COSMIC, Catalogue of Somatic Mutations in Cancer http://cancer.sanger.ac.uk/cosmic .

6. DNA easily absorbes small mutations.

Many people think the DNA easily absorbs small mutations. The opposite is the case. The nasty disease Cistic Fibrosis, for example, is caused because in the so-called CFTR-gene of 1480 nucleotides only 1 nucleotide has been damaged. It is a myth that the DNA can flexibly absorb nonrepairable mutations without detriment to the organism, and that after thousands of generations the accumulation of these nonrepairable mutations will result in beneficial expansions of the functionality of an organism.

7. Evolutionary theory provides an accurate description of the DNA changes.

Many people think that the theory of evolution is finished and provides an accurate description of how the DNA changes. That is a misunderstanding. After over a hundred years the theory of evolution still throws two completely different mechanisms of change on one heap. Therefore DeJong & Degens (2011) have made a distinction between these two entirely different mechanisms: (1) the mechanism of recombination and selection of gene variants and gene regulation, which provides for the continuous adjustment of living nature to changing circumstances (for instance the adaptation of the beaks of finches) and (2) the mechanism of accumulation of inheritable, advantageous, irreparable, code-expanding mutations, which would produce the growth of the DNA of a bacterium into that of a human. In mechanism 1 (the *'variation engine'* of the theory of evolution), the size of the DNA does not expand; the engine is operating within the boundaries of the mutation protection. Through the variation motor, living nature constantly adapts to changing circumstances (for example, the beaks of finches) and viruses and bacteria become immune to a vaccine or an antibiotic. This form of evolution, therefore, exists.

In mechanism 2 (the *'innovation engine'* of the theory of evolution), the length of the nucleotide code expands. The supposed innovation engine operates beyond the boundaries of the mutation repair and -protection, and would ensure that the DNA of a bacterium can be expanded to that of a human being. The innovation engine, however, can only work if mutation protection and repair protection is switched off or at least dysfunctions, leading to severe selective disadvantage due to cancer and hereditary diseases. This is the 'mutation protection paradox' identified by DeJong & Degens (2011) .

8. Mutation protection and repair only slow down the process of evolution

Many people think that mutation protection and repair is not a problem for the supposed evolution of bacteria into humans by the accumulation of irreparable mutations, and only slows down the speed of this process. But this is a misconception.

Thought Experiment:

Let P be a population of organisms, and P1 and P2 be sub-populations of P. Let P1 be provided with well-functioning mutation protection and repair, and P2 with dysfunctioning mutation protection and repair. In theory P2 will develop new advantageous functionalities after thousands of generations, as the result of accumulation of irreparable, code-expanding, inheritable mutations. But as dysfunctioning mutation protection and repair leads to cancer and hereditary diseases, P2 encounters a severe selective disadvantage when struggling with P1 for survival. As a result, P2 loses this struggle within one or two generations, and dies out.

The thought experiment proves that the combination of mutation protection and repair with Darwin's principle of 'survival of the fittest' disables the innovation engine of evolutionary theory.

9. Mutations of the DNA can produce the mutation protection of the DNA

The core of the theory of evolution is that any element of living nature has been produced by natural processes of mutation and selection. As a consequence, the mutation protection and repair of the DNA must have been produced as well by mutations of the DNA. This, however, is both logically and physically impossibility, since a process P can not simultaneously produce M ánd NON-M.

10. The fact that mutations of the DNA can not produce the mutation protection and repair of the DNA, forces to introduce a creator

It is true that mutations of the DNA cannot produce the mutation protection and repair of the DNA. But it is a misconception that this fact proves that the DNA mutation protection and repair mechanisms are established by a creator. The theory: "*The mutation protection and repair of the DNA is the work of a creator*" is not testable and thus not falsifiable and therefore not scientific. It is a belief. Scientists can answer the question of how the DNA mutation protection and repair has been established, only by: "We do not know (yet)," or "We have currently no testable theory." In any branch of science, this is a perfectly normal and acceptable position. Not knowing things and seeking testable explanations, are in the center of the daily work of a scientist, and are the driving force for the progress of science. Of course everyone is free to believe that mutations can indeed produce mutation protection and repair, but such a belief is contrary to our physical reality and common sense. Therefore, it is an *irrational* belief.

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