Misrepair mechanism: a mechanism essential for individual adaptation, species’ adaptation and species’ evolution

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Abstract

In Misrepair-accumulation theory, we have proposed a Misrepair mechanism for interpreting aging. Misrepair is a strategy of repair for increasing the surviving chance of an organism when it suffers from severe injuries. As a surviving strategy, Misrepair mechanism plays also an important role in individual adaptation, species’ survival, and species’ differentiation. Firstly, Misrepair of an injury is one of the manners of individual adaptation; and Misrepair mechanism gives an organism a great potential in adapting to changeable and destructive environment. Secondly, Misrepair mechanism is important in maintaining and enlarging the diversity of genome DNAs of a species; and a large diversity of genome DNAs is essential for the adaptation and the differentiation of a species in different environments. On one hand, somatic Misrepairs are essential for maintaining the sufficient number of individuals in a species, which are the carriers of different genome DNAs. On the other hand, Misrepair of DNA is a source of DNA mutations and the DNA Misrepairs in germ cells contribute to the diversity of genome DNAs. In conclusion, Misrepair mechanism is a mechanism essential for individual adaptation, species’ adaptation, and species’ evolution.

Keywords

Misrepair mechanism, individual adaptation, species’ adaptation, species’ evolution, somatic Misrepairs, diversity of genome DNAs, DNA Misrepairs, DNA mutations, and differentiation of a species

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Adaptation to environment for survival is a phenomenon universal in biological world. Individual adaptation is the phenomenon that an organism is able to make suitable responses to the changes in environment for survival. Species’ adaptation is the phenomenon that all individuals of a species have special properties to survive in certain environments. Species’ stability and the increase of number of individuals are the results of species’ adaptation. A large diversity of genome DNAs is the basis for species’ adaptations and for species’ differentiation in different environments. In Misrepair-accumulation theory, we have proposed a Misrepair mechanism for explaining aging: aging is a process of accumulation of Misrepairs (Wang et al, 2009). Misrepair mechanism is essential for the survival of a species; and aging of individuals is a sacrifice. In fact, Misrepair mechanism is also essential for maintaining the diversity of genome DNAs in a species. In the present paper, we will discuss the importance of Misrepair mechanism in individual adaptation, species’ adaptation, and species’ differentiation. Our discussion tackles the following issues:

I. A generalized concept of Misrepair

II. Somatic Misrepair: a strategy for individual adaptation

III. Misrepair mechanism in species’ adaptation and in species’ evolution

3.1 Somatic Misrepairs: essential for maintaining the diversity of genome DNAs of a species

3.2 DNA Misrepairs in germ cells: contributing to the diversity of genome DNAs

IV. Summary

I. A generalized concept of Misrepair

For explaining aging changes, we have proposed a generalized concept of Misrepair in our novel aging theory, the Misrepair-accumulation theory (Wang, 2009). The term of Misrepair in this theory is different from that one in the “Misrepair of DNA”. Our new concept of Misrepair is defined as an incorrect reconstruction of an injured living structure and is applicable to all living structures including molecules (DNAs), cells, tissues, and organs. For severe injuries occurred to an organism, when a complete repair is impossible to achieve, Misrepair is a way of repair that is essential for maintaining the structural integrity and increasing the surviving chance of an organism. It is important to distinguish three concepts: damage, injury and Misrepair. For avoiding confusions, in our theory, the term of damage is referred to an overload to a structure, which can result in an injury of the structure. An injury is a lesion of a structure before repair. Misrepair is an incorrect reconstruction of an injured structure, resulting in an alternation of the structure (Figure 1). In our discussion, the term of Misrepair is referred to not only the process but also the result of Misrepair, namely the alteration of a structure after repair.

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Figure 1. The relationship between damage, injury and Misrepair

For understanding aging, it is important to distinguish three concepts: damage, injury and Misrepair. For avoiding confusions, in Misrepair-accumulation theory, the term of damage is referred to an overload to a structure, which can result in an injury of the structure (Damage). An injury is a lesion of a structure before repair (Injury). Misrepair is an incorrect reconstruction of an injured structure, resulting in an alternation of the structure (Misrepair).

Misrepairs are irreversible and irremovable; therefore they accumulate and deform gradually a living structure, appearing as aging of the structure. Aging of an organism is therefore a process of accumulation of Misrepairs. Without Misrepairs, an individual could not survive till the age of reproduction; thus Misrepair mechanism is essential for the survival of a species. Aging of individuals is a sacrifice for species’ survival. Being beneficial for species’ survival is the evolutionary advantage of aging mechanism. In an organism, Misrepairs have a tendency to accumulate to the area of a tissue where an old Misrepair has taken place, because this part of tissue has increased damage-sensitivity and reduced repair-efficiency. Accumulation of Misrepairs is thus self-accelerating and focalized. The process of aging is self-accelerating, and the distribution of aging changes is inhomogeneous.

II. Somatic Misrepair: a strategy for individual adaptation

A living organism is able to maintain its internal stability and adapt to changeable environments. A change in environment exerts effects to an organism as a stress or as an injury. There are three manners of responses: stress response, complete repair of an injury, and Misrepair of an injury. When an environment change does not cause injuries to an organism, it functions as a stress. Cells and tissues can make suitable responses to the stress to avoid death of cells, and this is called stress response or irritability. Stress response is a physiological process, and the changes in cells/tissues will be restored when the stress is withdrawn. In hot weather, perspiration of animals is a way to maintain the body temperature. An injury of a structure is a lesion in a cell or a tissue. Complete repair takes place when the lesion is small, but Misrepair has to be promoted when the lesion is too large. In the adaptation by stress response and that by complete repair, the change of a cell/tissue is reversible; whereas in the adaptation by Misrepair, the change is irreversible (Figure 2). In destructive environments, Misrepair mechanism gives a living being a great potential of environment-adaptation.

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Figure 2. Three manners of adaption: stress response, complete repair and Misrepair

A change in environment exerts effects to an organism as a stress or as an injury. An organism has three manners of responses: stress response, complete repair of an injury, and Misrepair of an injury. Stress response is a physiological process, and the changes in a cell/tissue will be restored when the stress is withdrawn (A). Complete repair takes place when an injury is small (B), but Misrepair has to be promoted when an injury is too large (C). In the adaptation by stress response and that by complete repair, the change of a cell/tissue is reversible (A and B); whereas in the adaptation by Misrepair, the change is irreversible (C).

For example, scar formation is a result of Misrepair, which is essential and irreversible. Scar formation is an adaptive response, and it makes the local skin more resistant to chemical and physical damage. Esophagus intestinal metaplasia is also an adaptive change by Misrepair. Replacement of a part of squamous epithelium of distal esophagus by metaplastic glandular epithelium can increase the resistance of local esophagus mucosa to some chemical damage. In arteriosclerosis, myofibers have two kinds of responses, one is enlargement of some myofibers, and the other is proliferation of myofibers. In our view, these two changes are promoted by different degrees of load to myofibers by cell deformations: the enlargement of...
myofibers is promoted by an endurable load (stress) for functional compensation; whereas the proliferation of myofibers is promoted by death of myofiber cells.

Adaptation is for survival; however the adaptive Misrepairs result in irreversible changes of the structures of cells/tissues, leading to aging of the cells/tissues. Adaptation delays the death of an individual, by which the individual is able to survive till the reproduction age. In this way, genome DNAs of a species can be maintained and transmitted generation by generation. The potential of individual adaptation is built in structural complexity of an organism, which is finally determined by the gene configuration of the species. The organisms that have higher structural complexity will have higher potential of adaptation, and such a species is more stable than simpler organisms in changeable environments. Single-cell organisms such as bacteria have low potential of individual adaptation, and the species’ of bacteria are not stable.

III. Misrepair mechanism in species’ adaptation and in species’ evolution

Existence of a species is a result of survival of its individuals in changeable environments through adaptation. Species’ adaptation is marked by the increase of the number of its individuals and the species’ stability in certain environments. Survival of a species is based on the individual adaptation and the reproduction of individuals. Misrepair mechanism plays an important role in species’ adaptation and species’ evolution. On one hand, somatic Misrepairs are essential for maintaining the sufficient number of individuals in a species, and for maintaining and transmitting the diversity of genome DNAs. On the other hand, Misrepairs on DNA in germ cells contribute to the diversity of genome DNAs in a species.

3.1 Somatic Misrepairs: essential for maintaining the diversity of genome DNAs in a species

A large diversity of DNAs is important for a species on two aspects: one is it is beneficial for the survival of a species in changeable environments, and the other is it provides the possibility of species’ differentiation. Like that for a supermarket, the bigger a supermarket is, the more customers it can have. Individuals of a species are the carriers of genome DNAs, and a large diversity of DNAs needs a large number of carriers. These carriers have similarity and difference to each other on properties, by which they are able to survive in different environments. Somatic Misrepairs reduce the risk of death of an organism before reproduction age; therefore they are important in maintaining the sufficient number of individuals in a species. In another word, somatic Misrepair plays an important role in maintaining the stability of a species.

In an isolated environment, when some individuals with certain genetic backgrounds and adaptive properties have higher chance than others for survival and reproduction, they will gradually develop into a sub-group of the species, and this leads to the differentiation of the species. Differentiation of skin color makes the species of human being be able to survive in different climates; and a large diversity of color genes is the substantial basis. In nature, a species with larger diversity of DNAs and bigger population of individuals has higher chance than other species to survive and differentiate.
3.2 DNA Misrepairs in germ cells: contributing to the diversity of genome DNAs

Enlarging of the diversity of genome DNAs in a species has two sources: gene recombination and DNA mutation. Gene recombination including the homologous and the non-homologous recombination is a part of the functionality of an organism. Differently, DNA mutations are promoted by DNA injuries. For example, an entire chromosome can be lost or gained during cell mitosis. Large-scale mutations with loss or gain of a fragment of chromosome can be results of virus-integration or dysfunction of chromosomes. Small-scale mutations including point mutations can be results of broken of DNA strands. For a cell, a big change on chromosomes and on DNA sequences can cause cell death. Differently, a point-mutation is often mild, not essentially altering cell phenotype; therefore it can “survive” in a survived cell. In another word, those DNA mutations that can remain in a cell and can be transmitted to next generations of cells are mainly point-mutations.

An injury of DNA is in fact a physical or a functional lesion of a DNA fragment, and reconnecting the broken fragments of DNA is essential for the survival of the cell. Severe DNA injuries are the triggers for DNA mutations; however Misrepair of DNA is an essential process for transforming a DNA injury into a “survivable and inheritable” DNA mutation. Many studies have shown that Misrepair of DNA is the main origin of DNA mutations (Natarajan, 1993; Bishay, 2001). Virus integration can be understood also as a result of DNA Misrepair: since without the DNA ligase of host cells, viral DNA cannot be integrated into the host DNA. For the single-cell species that reproduce through cloning, all of the cells are germ cells, and Misrepair of DNA is an important source for the diversity of genome DNAs in these species. Single-cell organisms have high fertility however with high frequency of DNA mutations; therefore these species’ are unstable and they evolve fast. In contrast, the species’ that have complex structures of organisms such as animals have low fertility and low frequency of DNA mutations in germ cells; therefore they are more stable and they evolve slowly. Nevertheless, no matter it is in a simple or in a complex organism, important is that DNAs are maintained and transmitted in a great amount of copies and in a large diversity. Survival of DNAs is finally the symbol of survival of lives (Dawkins, 2006).

IV. Summary

Misrepair mechanism, as a surviving mechanism, plays an important role in individual adaptation, species’ adaptation and species evolution. On one hand, the somatic Misrepairs on individuals are essential for individual adaptation and for maintaining the number of individuals, which are the vectors of different genome DNAs in a species. On the other hand, the DNA Misrepairs in germ cells contribute to the diversity of genome DNAs (Figure 3). Taken together, Misrepair mechanism is important in maintaining the diversity of genome DNAs, which is the basis for the adaption and the differentiation of a species in nature.
Figure 3. Misrepair mechanism: important in species’ adaptation and species’ evolution

Misrepair mechanism, as a surviving mechanism, plays an important role in individual adaptation, species’ adaptation and species evolution. On one hand, the somatic MisrepaIrs on individuals are essential for maintaining the sufficient number of individuals, which are the vectors of different genome DNAs in a species. On the other hand, the DNA Misrepairs in germ cells contribute to the diversity of genome DNAs. Taken together, Misrepair mechanism is important in maintaining the diversity of genome DNAs, which is the basis for the adaption and the differentiation of a species in different environments.

In summary, Misrepair-accumulation theory does not only help us better to understand aging, but also better to understand species’ evolution. In this aspect, Misrepair-accumulation theory is an important support and supplementary for Darwin’s Evolution Theory.

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