

COMMUNICATIONS

An Evolutionary Understanding of Aging

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The art of intervention for rejuvenation is a major area in cosmetic surgery, and as Korea moves rapidly into an aging society, this area will gain more momentum. Human beings recognize the inevitability of their deaths; nevertheless, they still yearn for immortality and will not cease to strive to transform their aging appearance into youthful looks. However, we are not capable of the art of making faces look younger until we comprehend not only the anatomy of the face but also, more importantly, the aging process of the face. This is likewise true of the rest of the anatomy.

It is natural to pose questions about what the fundamental reason is for aging and why it occurs in the first place. In addressing the causes of aging, human beings have been seeking ways of increasing longevity, and preventing or delaying the aging process, even if immortality cannot be achieved. Therefore, since the inception of civilization, evidence of human efforts to reach those goals has been found in every human society. These efforts have been sustained from the recent past up to the present era.

However, despite the long history of human aspirations for perpetual youth, not a few scientific studies have shown that increasing longevity and the prevention of aging remains *terra incognita*. From the mythical secrets of ancient figures such as King David, Alexander the Great, and Shih Hwang Ti of the Chin Dynasty, to the Philosopher's Stone and alchemy in the Middle Ages, the stories of Prester John in the eleventh and twelfth century, to the search for the fountain of youth that motivated the voyages to the Caribbean in the sixteenth century, to hormonal treatments and the transplantation of animal testicles and ovaries into humans, a wide variety of methods of rejuvenation have been attempted in conjunction with corre-

sponding medical developments. Hope is always directed toward the future, and giving up on finding a treatment method is tantamount to renouncing our future.

Furthermore, the scientific mindset, which essentially casts fundamental principles into the shadows of doubt, has seen a transformation from a world governed by "determinism" designed by Newton, to a world based on "principles of uncertainty" provoked by Heisenberg. Despite the paradigm shift in the understanding of some physical phenomena, some fundamental laws governing the physical world, such as the law of conservation of mass and energy, are not presumed to be subject to change. It is possible for modern science to lengthen the lifespan of fruit flies by intervening in the fruit fly genome. But even launching research on the lengthening of the lifespan or the prevention of aging of human beings is a herculean task. Although we may eventually solve every mystery of the mechanisms of the human body at some point in the future, at the moment, the physicality of a human being is a complex system, which stubbornly refuses to be unraveled.

An organism is the product of evolution

What is at stake in the human effort to overcome the aging phenomenon is a biological idea. One of the most profound paradoxes of life is that all creatures are destined to die, but the lifespan varies from species to species. Some trees grow for thousands of years. A turtle, 150 years old, can be killed in a moment by an accident. Mayflies are born without a mouth, digestive organs, or anus, precisely because they do not need to digest new foods during their short lifespan. The reason why the lifespans of species varies derives from their biological characteristics. These characteristics are the outcomes of the creatures' ways of adapting to a changing evolutionary environment, and so is the pace of aging. For instance, flies never get tumors, which is surprising mainly because it is rare that creatures composed of cells are never susceptible to cancer. However, that seemingly incredible characteristic makes sense when we take into account that adult flies do not undergo cell division. Flies are equipped with all the necessary cells when they develop from a larva. As there are not any living cells in the corneous tissue of the wings, legs, and antennae, flies are not able to cure their damaged parts by means of cell division in the same way that humans heal after injury. When flies suffer purely mechanical damage, they eventually die as a result of the accumulation of damage. The biological mechanism of human beings, in this respect, is different than that of flies. Human beings have a capacity to repair themselves to some extent, but not so much as lizards do. Depending on the part of the body, human cells are replaced by new cells at least every two or three years. In exchange for such a capacity of self-repair, human beings are susceptible to cancer.

Evolution of aging

Aging can be examined in two ways: why and how. There are several theories on how the aging process proceeds: (1) the random mutation of the genes; (2) the accumulation of damage by free radicals; (3) the degeneration of the functions of immunity; (4) the theory of hormones and neurosecretion. Each of these theories may have local validity, but a unified theory has yet to be found to explain the overall transformation taking place in the organs of the body. However, this kind of explanation is no more than a scientific explanation about the phenomena of life, which means that it sheds light on only a chapter of the whole narrative of life in terms of the contemporary level of scientific understanding.

The “Why” theory seeks to find the causes of aging in terms of their necessity in the process of species’ survival. Traditionally, aging is regarded as a process of wearing out just like other things. It is conceived as “natural” that such constituents of the human body, whether they are cells, organs, or systems, are subject to the process of wearing out proposed by Weismann at 1889. The hypothesis of the accumulation of random mutations came next, proposed by Peter Medawar in 1952. He argued that the reason why natural selection has not eliminated fatal hereditary traits of aging is that most creatures pass away at a relatively young age compared to their potential lifespan. In 1957, George C. Williams, a distinguished biologist, came up with the concept of antagonistic pleiotropy, which claims that some traits offer benefits to creatures during their growth period; however, expression of the same genes precipitate negative effects once these creatures have passed the reproductive period of their lives. This hypothesis is based on the combination of the theory of J.B.S. Haldane, who claimed that those genes which do harm to creatures long after reproductive age are never subject to the pressure of natural selection, and the theory of mutation accumulation of Peter Medawar. An example of antagonistic pleiotropy would be genes that rapidly solidify the bones by modifying the metabolism of calcium. These genes confer the benefits of rapid growth on young creatures; however, they cause the hardening of the arteries at an older age. The crux of the theory is that the phenomena of antagonistic pleiotropy occur precisely because natural selection cannot eliminate certain genes that are lethal in old age because the same genes play a beneficial role in reproduction at a young age. In light of all this, George C. Williams considered any alteration of the aging process to be impossible, because aging was a side effect of necessary functions.

One of the most influential hypotheses today is the disposable soma hypothesis proposed by Thomas Kirkwood in 1977. The gist of the hypothesis is that the essence of the aging phenomenon lies in the accumulating damage to the body, reducing its finite resources

available to repair damaged parts. The repair capacity in biological life requires time and resources necessary for growth and reproduction. Thus, ongoing repair causes aging as the course of living results in accumulated damage to the body. The body must budget the amount of energy available to it. The disposable soma theory says the system of allocating energy to the repair function causes the body to gradually deteriorate with age. This means that the purpose of living for an individual entity is reproduction. Thomas Kirkwood wrote in *Nature* in 2009 that “Although the distinction between the pleiotropy and disposable-soma concepts is sometimes blurred, the latter can be viewed as focusing specifically on mechanisms, particularly the role of somatic maintenance and repair, whereas the former is formulated in terms of a general pattern of gene action and may involve pleiotrophic genes of various kinds.” This hypothesis, then, is an evolutionary explanation of the grounds of Weismann’s theory of wearing out. When we take into consideration the fact that all of the biological traits of human beings are the results of compromises in the evolutionary environment, it is safe to state that the hypothesis of antagonistic pleiotropy attempts to explain the patterns of behavior of genes, while the disposable soma hypothesis sheds light on aspects of the maintenance of the body and its repair system. However, the disposable soma hypothesis is not compatible with antagonistic pleiotropy. While the hypothesis of antagonistic pleiotropy ascribes the process of aging to genes beneficial to reproduction, the disposable soma hypothesis traces the onset of aging to an early stage in which repairing the body takes place. Thus we have surveyed biological research on the reason why the process of aging takes place.

Aging is the product of natural selection

The “why” theories are predicated on the premise that creatures are genetically programmed for a relatively short lifespan even when they are capable of aiming for immortality (DNA as self-replicators have eternal life). Based on these hypotheses, aging, programmed into genes as the result of a long evolutionary process, defies any easy intervention by human beings. Why is it that almost all living things weaken and die with age? Aging is the product of natural selection. Organisms allocate resources to reproduction, rather than the maintenance of the body, because living things function biologically as a means of maintaining the existence DNA. If this is true, aging is not an avoidable property of life. Instead, it is the result of a genetic program.

Cosmetic surgeons do not have the capacity to perform research into the secrets of aging, nor is it desirable for them to attempt to do so. We aim to raise the quality of life in the final stage of life by changing the appearance. It may be possible to control some biological phenomena, including aging, if the future brings new scientific dis-

coveries in this area. However, at the moment, we are left with a few hypotheses on the issue. Cosmetic surgeons will continue to engage themselves in procedures and treatments geared toward reforming some partially deformed parts of the body; sometime in the future, however, they can hope for a more holistic and fundamental cure for aging. Human beings have been dreaming of finding a cure for aging, but we have not found the keys to do so. Developments in the patho-

physiological understanding of the face may bring about changes in methods of facial rejuvenation. In the same vein, understanding of foundational biology will provide crucial background information on the mechanism of the aging of the body and the face. More importantly, the understanding of aging protects us from falling into bogus pseudo-scientific discourses which thrive on empty promises.