Biological robustness comes from the term robustness. Biological robustness refers to the ability of organisms to maintain their own structural and functional stability under continuous internal or external disturbances. At the non-biological level, mechanical systems and algorithms require robust design if they need to run stably. In the long evolution, organisms have been subjected to more, more random, and more continuous random disturbances, such as gene mutations. If any mutation can lead to the failure of the original biological function, the survival of the species becomes extremely difficult. In the continuous evolution, organisms have developed a strong biological robustness, the main ways are feedback, redundancy, modularity and structural stability.

Biological networks, on the other hand, are often vulnerable to accidental mutations, a phenomenon known as biological fragility. [1] Biology must use the vulnerability of some places to enhance the robustness of other perturbations. [2]

For example, regarding biological robustness, genes show obvious biological robustness in evolution. There are a large number of repeated segments in the gene segment. When a gene mutation occurs in one copy, the other gene copies can function normally. Moreover, similar genes can perform complementary functions to each other, mitigating the impact of the loss of another gene. [3] Moreover, the gene contains a large number of introns to regulate gene expression[4], which greatly reduces the impact of gene mutations.

With regard to biological fragility, the segmental polarity gene network of Drosophila exhibits robustness to perturbations under its initial conditions, but very short synthesis and decay times tend to disturb the original trait pattern, showing fragility. [5]

Biological robustness is an indispensable property for living things. In the process of biological evolution, the population level will be affected by various random effects, such as global climate change and geological activities. At the individual level, it may be randomly affected by food sources and lifestyles, while at the cell level, there are unpredictable random effects such as gene mutations and changes in the internal environment. Biological robustness keeps organisms stable in a certain degree of random disturbance, greatly improving their ability to survive and adapt to new environments. Moreover, biological robustness ensures more non-lethal mutations, allows stealth mutations to be transmitted in the population, increases the diversity of traits[6], and increases the speed of biological evolution.

The results of biological fragility are often more serious. Similar to circuit robustness, biological robustness enhances a certain level of robustness at the cost of being more vulnerable outside the range. [7] If the environment and food web in a region are artificially destroyed, beyond the maximum regulation of the system, it is difficult to restore itself to its original state. As well as disruption of biological clocks[8], disruption of metabolic networks[9], etc. In addition, when the balance is disturbed, cancerous tumors may instead exploit biologically original robust mechanisms, making them difficult to eradicate. [10]

To avoid biological fragility, at the ecosystem level, humans need to avoid excessive damage to the environment; at the individual level, we need to pay attention to avoid unhealthy lifestyles, and check regularly to prevent the self-regulation ability from breaking through the limit; at the micro level, such as microorganisms Breeding needs to pay attention to the cultivation environment and increase the number to prevent the degradation of traits caused by biological fragility.

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