Biological Robustness and Fragility

1. The definition and relationship between robustness and fragility

Robustness is one of the fundamental characteristics of biological systems. In biology, robustness refers to the stability of structure and function of a biological system when it is disturbed by uncertain factors such as external perturbation or internal parameter perturbation. Biological robustness can be best reflected in the adaptation of organisms to the environment and is a universal feature in biological systems[1].

Biological fragility refers to the ability of a biological system to resist changes in external conditions. The more fragility the biological system is, the more susceptible it is to changes caused by external conditions.

studies showed that robustness and fragility of biological networks are correlated with each other. Carlson and Doyle in particular discussed how complex systems, which have evolved to be resilient against widespread disturbances, can be exceedingly fragile against some sorts of uncommon perturbations[2]. Csete and Doyle have pointed out a theoretical result that is well-known in control theory, in which the robustness of a system is conserved so that the system being more robust in some aspect is essentially paid for by increased fragility elsewhere[3].

2.Examples

An example of biological is the fate decision of a bacteriophage life cycle is robust against point mutations in the promoter region. This was previously thought to be influenced by the combination of the promoter and the corresponding regulator. This is achieved by the positive and negative feedback of the network. Finally, it is found that this is actually decided by the positive and negative feedback of the network. It turns out that the fate of phage is actually determined by the positive and negative feedback of the network[4].

An example of biological robustness is that our bodies are fragile to unhealthy lifestyles. We are robust to unstable food and infection. But it is fragile to less common distractions, such as high-energy foods and low-energy utilization lifestyles. These disturbances leave us fragile to various chronic diseases[5].

3. Why is biological robustness important

The ability of complex dynamic systems to evolve is facilitated by robustness. If given enough time, evolution may choose a sturdy characteristic that is resistant to environmental changes. The qualities of robustness and evolvability are linked by this. All biological systems that have evolved exhibit robustness. Complex biological systems must be robust to environmental and genetic perturbations in order to evolve. Evolution often selects for traits that enhance an organism's robustness[1].

Robustness also allows organisms to maintain relative stability under changes in the external environment and internal environment, ensuring the balance and stability of organisms.

According to recent research, mutational robustness plays a crucial role in the adaptive diversification of populations because it permits the accumulation of cryptic genetic variation (CGV) in populations, which may then be co-opted in new environment[6].

4. Consequences of fragility and how to avoid

Any strong system has its fragile side, and biological fragility will lead to many consequences, such as the occurrence of diseases, which reflects the fragility of our human system. Although we can resist the viruses and bacteria that we come into contact with in our daily life, we are susceptible to diseases caused by viruses that are highly infectious, or by strong changes in the outside world. More often, the biological robustness leads to physiological disorders of the individual organism.

So how to avoid biological fragility is very important. Try to avoid drastic changes in the environment, to ensure their body physiological and biochemical balance. Exercise can also make the human body more robust, so as to avoid the occurrence of physiological vulnerability. During influenza, wearing a good mask and washing hands frequently can avoid the invasion of the virus in time, which can also avoid fragility.

References

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