

The understanding of biological robustness and fragility

Biological robustness is one of the overall characteristics of a biological system, which refers to the fact that a biological system remains structurally and functionally stable when disturbed by external perturbations or internal parameter uptake and other uncertainties such as external perturbations or internal parameter uptake, the system maintains its structural and functional stability. It is a property of a biological system that maintains its structural and functional stability when disturbed by external disturbances or internal parameter uptake. An organism is always in a changing environment, but it can maintain a relatively stable internal environment that allows it to survive in a variety of environments. It is therefore best described as an organism's ability to adapt to its environment.

I believe that biological fragility is the opposite concept of biological robustness, which means that a biological system can't remain structurally and functionally stable when disturbed by external perturbations or internal parameter uptake and other uncertainties such as external perturbations or internal parameter uptake, so the system will not have abilities to prevent the changes to the internal environment caused by the changing environment. It is therefore best reflected in an organism's maladaptation to its environment.

One example of biological robustness is bacterial chemotaxis.^{[1][2]} Bacterial chemotaxis is a directional movement of bacteria, which is a fundamental property of bacteria to survive environmental changes, it gives bacteria a competitive advantage in survival by giving them the ability to find food sources and escape toxic environments. Bacteria can adapt to changes in chemical inducers over a wide range of concentrations and always regulate their behavior in response to changes in chemical inducer concentration.

As for the example of biological fragility, I think that the elder is a good example. Nowadays, because the elder doesn't have a strong immune system like the young, they are more easily exposed to COVID-19 and more badly influenced by diseases. What's more, the changing environment like changing temperatures and weather will put a big threat to them. So the elder's body is a fragile biological system, they don't have a strong ability to retain their structural and functional stability when disturbed by external perturbations or internal parameter uptake and other uncertainties.

Without biological robustness, which regulates the dynamic stability of biological systems, organisms would gradually fail to adapt to the changing environment and lose their chances of survival. At the same time, in my view, biological robustness provides the opportunity for organisms to evolve in response to environmental change, allowing them to survive in more rapidly changing environments.

As I said before if an organism is defined as having biological fragility, it is impossible to survive in the changing environment which would disturb its structurally and functionally stable biological system. Then it will get into disorders, It will gradually lose its normal survival

skills and be the way toward distinction. I think there are several ways to avoid it. First, I think biological fragility is a relative concept, so an organism can migrate from a changing environment where the organism can't remain structurally and functionally stable to a relatively stable environment where this organism can reach biological robustness, for example, migratory birds such as geese have a long-range migration habit in autumn and spring in order to cope with changes in temperature and vegetation. Secondly, the organism can spend time developing a new function or skill to prevent disturbance from the outside to adapt to the changing environment, for example, plants growing in arid deserts or barrens have specialised needle-shaped or spiny leaves and particularly well-developed root systems in order to prevent water loss and access to water, e.g. cactus, camel's thorn.

References:

- [1] Barkai N, Leibler S. Robustness in simple biochemical networks. *Nature*, 1997,387:913~917
- [2] Alon U, Surette MG, Barkai N, Leibler S. Robustness in bacterial chemotaxis. *Nature*, 1999,397:168~171