

Question 1

Biological robustness and fragility are two characteristics of biological systems. According to Kitano [1], biological robustness means that the biological system can maintain a normal working state under the condition of external or internal. These perturbations include genetic mutations, local random fluctuations in molecular concentrations, loss of structural integrity, endogenous threats such as infectious diseases, cancer, temperature fluctuations, altered species interactions, and state transitions in the physical environment. According to Fielding [2], biological fragility points out that no matter how strong the health status of an individual organism is, it may be affected by disease in the future and lead to a decline in health status.

There are many examples of biological robustness, a common example is the body's ability to repair skin trauma. When organisms are physically injured and bleed, platelets will be stimulated by activating factors at the damaged site, and platelets will aggregate and become platelet clots, which play a primary role in hemostasis. This causes a layer of blood scab to form on the wound, thereby preventing the wound from becoming infected or worsening in subsequent activities. This recovery function basically takes effect at any time, greatly improving the survivability of creatures. An example of biological fragility is organic disease of biological organs. In this case, pathological changes have occurred in the tissue structure of the organ, and the function of the affected organ has decreased or lost, and severe cases may cause death. It should be noted that organic diseases are caused by many factors. It is not a short-term process, but a disease that accumulates over a long period of time. Although living things appear healthy in their daily lives, they do not know when they will get sick or even die. These diseases cause organs to lose their functionality and are therefore quite fatal. However, in the observation of daily life, it is difficult for us to find the signs of disease, which is a manifestation of biological fragility.

The reason biological robustness is integral part of survival is that without biological robustness, organisms would be so fragile that they would not be able to survive small injuries or diseases. With the help of biological robustness, the self-healing ability of organisms has an elastic range, which enables organisms to survive through self-repair when they receive a certain degree of internal or external interference. If biological robustness does not exist, then the damage received by each individual organism will be retained and will kill the organism after continuous accumulation.

The consequences of fragility basically include injury, diseases, and death. The fragility of individuals is generally manifested in poor health or low immunity, which will make biological individuals more vulnerable to injury or disease, or even death. People can avoid becoming fragile by exercising more and boosting their immunity. Likewise, having a healthy diet and lifestyle contributes to strong health.

Reference

- [1] Kitano, H. Biological robustness. *Nat Rev Genet* 5, 826-837(2004).
<https://doi.org/10.1038/nrg1471>
- [2] Fielding R. A. (2015). A Summary of the Biological Basis of Frailty. *Nestle Nutrition Institute workshop series*, 83, 41–44. <https://doi.org/10.1159/000430966>