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Biological Robustness is one of the characteristics of biological network, which refers to a property in which a biological system remains structurally and functionally stable when disturbed by some uncertainties such as external disturbances or perturbation. This property enables organisms to maintain the stability of the internal environment and increase the ability of environmental adaptation under the condition of changes in the external environment.

Biological Fragility is that the biological network is sensitive to interference from the outside world, and are damaged under the stress of partial disturbances and environmental factors, and is difficult to recover.

Studies (Kitano, 2004) have shown that cancer cells show robustness to a variety of different chemical agents while showing a very obvious fragility to a particular perturbation, resulting in a subtle trade-off between the two properties. Kitano explained that there are a variety of gene-regulated feedback control systems in cancer cells in response to different changes in the external environment. For example, under the condition of tissue hypoxia, the tumor can resist hypoxia disturbance by activating a feedback loop through the transition from the TCA cycle to EMP pathway and HIF1 upregulation. HIF1 can upregulate VEGF (vascular endothelial growth factor) to promote vascular growth, and can also upregulate MMP (matrix metalloproteinases), uPAR (urokinase-type plasminogen activator) and CPCX4 (chemokine receptor) to promote tumor cell metastasis. Early studies have shown that during chemotherapy on cancer cells, they turn on the multidrug resistance 1 (MDR1) gene, through the P-glycoprotein, an ATP-dependent efflux pump, the drug is expelled from the cells to obtain drug resistance.

The article (Kitano, 2004) also pointed out that HIF1 as an important regulator of cell which response to changes in oxygen concentration, in some stages of the regulatory process may be able to show the fragility of tumor cells; On the other hand, chemicals that some tumor cells are rarely exposed to may also be the key to showing cell fragility. But the ultimate search is the fundamental mechanism and principle of cell robustness.

More and more intuitive manifestations of fragility are concentrated in ecology. The changes of interspecific relationships, community characteristics and population structure in biodiversity caused by climate change, land use and environmental pollution. Studies (Erasmus 2010) have shown that if the temperature rises by 2 °C, 17 % of the species range of animals in South Africa will expand, 78 % of the species range will be reduced, the degree of 4 % -98 %, 3 % of the species range will not change, and 2 % of the species will completely lose their habitat.

Robustness and fragility are ubiquitous features in biological systems. Therefore, we

need to discuss this issue from different perspectives. Under the premise of temperature change, the habitat range of South African species mentioned above changes, which eventually leads to the disappearance of some species. At the same time, it is also mentioned that the fragility of tumor cells may become a breakthrough in cancer treatment. It can be seen that the results of the manifestation of fragility to a species or an organism are serious, even destructive. Therefore, the in-depth research on robustness and clarification of its fundamental principle are the essential strategies to increase the adaptability of organisms to the environment. It can also reveal the vulnerability of organisms and promote the research process of related disease treatment methods at the same time.

Reference

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