

# Biological Robustness and Fragility

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Biological robustness is a characteristic that allows a system to maintain its functions against external and internal perturbations<sup>[1]</sup>. It is often misunderstood that the function of the robustness is to remain unchanged regardless of any stimulation or mutations, so that the structure and components of the system are not affected. Actually, robustness refers to keeping the specific functions of the system undisturbed, which usually requires the system to change its mode of operation in a flexible way. In other words, robustness allows changes in the structure and components of the system owing to perturbations, but specific functions are maintained<sup>[2]</sup>.

PH value in the stomach of human usually stays between 0.9 and 1.5 to make sure the fully function of digesting. When food gets down to the stomach, the appropriate PH value which indicates the right amount of acid in the stomach will corrode the food to make sure the food get digested. However, the PH value in the stomach will not change much when you drink a lot of water. If you try to dilute a bottle of acidic liquid, the PH value may greatly change to get higher. Obviously there is a difference between the human stomach and acid in other environment. Biological robustness helps with the stability of the digesting function of stomach which means the stability of acid amount.

On the contrary biological fragility refers to the instability of a biological system to keep its functions when there is an internal or external disturbance. Though sounds quite opposite, they really connect with each other closely<sup>[2]</sup>.

Diabetes mellitus will do as an example of biological fragility. As is known, insulin is an important hormone regulating blood glucose concentration in the body. After meals or food intakes, there will be a strong regulation by insulin which helps balance the blood glucose concentration. The body system has acquired robustness against near-starvation, a high energy-demand lifestyle and high risk of infection, but it is unusually perturbed by over-nutrition and a low energy-demand lifestyle<sup>[4]</sup>.

Biological robustness is integral part of survival. Firstly, robustness facilitates evolvability. With robustness, traits in individuals which is beneficial to the species gets stably passed down to generations without sudden or great changes<sup>[3]</sup>. For example, if the DNA in species is not robust enough, there may be great changes in the properties of the next generations. What has been proven as useful and helpful traits for the survival of the species may not be able to express again. Secondly, robustness help to deal with dynamic environment. As we know, in the world we live the only thing that never changes is change itself. To live well in this dynamic world, a robustness system which responds to different variables with a stable function working well for the lives is certainly integral. If a system is not robust enough, there may be lots of functions unable to function well which may fail to support the living<sup>[3]</sup>. For example, the digesting system, the immune system and so on. Any failure of those functions will bring great damage to the well being of humans.

The consequence of fragility may be insensitivity to external or internal mutation and disturbance, which in turn leads to extinction or ecosystem destruction. For instance, it is reported that over 267 species worldwide are being affected by plastic pollution and 700 species are at risk of becoming extinct<sup>[5]</sup>. Microplastics were found in dead whales, seals and dolphins, indicating that their ingesting system has fragility facing non-biodegradable substance. One way to avoid the biological fragility is to monitor feedback loops in small network. For relatively small networks, a feedback loop has been considered as an

important motif for realizing the robustness<sup>[2]</sup>. Research showed that the number of feedback loops is also an indicator of the fragility.

In conclusion, biological robustness and fragility are special features in a system. Biological robustness is of great significance to the survival of organisms, and meanwhile the biological fragility can cause severe consequences.

## Reference

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