

Biological robustness is a property that allows a biological system to maintain its functions despite external and internal perturbations. Biological robustness does not mean staying still to stimuli or mutations and it often 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.

On the contrary biological fragility refers to the property that a biological system unable to function as usual while facing unexpected external and internal perturbations. Though sounds quite opposite, they really connect with each other closely.

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.

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.

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. 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. 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.

Though with robustness in biological systems, there is fragility as well. When the fragility exposed, the robustness system may be quite vulnerable facing with little perturbations. As the consequences of fragility, biological systems could be quite sensitive to certain mutations. For example, the energy control system of humans may has quite big reactions to high-energy content foods or low-energy utilization lifestyle. As following consequences, the energy control

system may have problem dealing with unusual situations which may lead to the energy problems of biological systems. With problems in energy, there may be greater threats to biological systems. There are proper ways of avoiding the fragility of biological systems. Firstly, try not to expose the fragility. The fragility do exist in biological systems, but it is also possible to try to avoid chances where the fragility may be exposed. It is easy to do like avoiding places where is not the usual living environment. Secondly, try to improve the robustness of the biological systems so that less fragility may be used. With a better and more robust system, the system may be able to handle more situations including those which may seem to be the fragility part in the past. For example, one can try to do more exercise to improve his immune system so that there will be a more robust system and less chance of fragility.

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