Biological Robustness and Fragility.

Robustness is a property that allows a system to maintain its functions against internal and external perturbations[1].Fragility is the opposite. So ,it can infer from that Biological Robustness is an ability for biological system to keep steady (a new steady state or original state) after they suffer from random perturbations. Biological Fragility means that biological system can not defeat some special perturbations ,and the stable system will be broken .

Take the human body as an example. The heart rate is 60-100 in the normal state. If people hear something exciting, the heart rate will increase, can reach 120 or even higher, but after a period of time, the surprise decreased, the heart rate will reduce back to normal. This is the embodiment of biological robustness. Similarly, the human immune system can deal with most viruses, but it is unable to do anything about AIDS. The human body will eventually be infected by other viruses due to the reduction of immunity due to HIV, and finally die. This is a manifestation of biological fragility.

Whether in the process of individual survival or the normal operation of the ecosystem, there are always unavoidable perturbations, which are regardless of time, occasion, or size, can hinder the functioning of complex biological systems. If we simplify the biological system as an open-loop control model （ without robustness）, and take the output of the open-loop control as the survival index (the system collapses after exceeding the index), then the open-loop control cannot output the feedback input after the perturbation, and the long-term change of the output after the perturbation will lead to the death of the organism. But in fact, most biological systems are more similar to closed-loop control models(exist robustness), in which the output participates in the control. Even if there is a perturbation in the process, the system can adjust itself through the loop to make the output return to the normal value

within a certain period of time.Therefore, the survival of organisms is inseparable from biological robustness.

Fragility in a computer is a program crashes or a computer freezes. Similarly, in organisms, fragility eventually leads to an inability to maintain homeostasis through self-regulation or to death. There are several ways to avoid these results: on the one hand, to improve the robustness ; first of all , the biological system is given a way to resist the interference in advance when it knows the specific perturbation, so that it can deal with the perturbation faster and more efficiently when it encounters the corresponding perturbation.This is similar to getting a flu shot or using a noise-canceller to remove white noise from system inputs. Second, anticipating unknown risks and making appropriate strategies are necessary to minimize losses in a disaster. For the unknown danger, the biological system model can be established first, and the computer can be used for simulation, setting the perturbation is random, the system will collapse in what range of perturbation and record it , select the collapse range that can be treated for system upgrading and iteration, and finally feedback to the actual environment.This approach needs to be based on a lot of accurate data and sound modeling.On the other hand, the reduction of perturbations from the source, which applies only to perturbations that can be eliminated. When the cause of the perturbation is clear, appropriate methods are used to prevent it from affecting the organism, such as alcohol to inactivate the virus, appendectomy to prevent appendicitis, etc.

In summary, biological robustness and vulnerability represent the ability of a biological system to maintain relative stability in response to perturbation and the inability to maintain a steady state in response to perturbation, respectively. Biological robustness is an important part of maintaining the survival of organisms, which can cope with most perturbations. However, for some special perturbations, vulnerability is also exposed at the same time. Some of these vulnerabilities can be prevented by improving robustness and eliminating perturbation.

[1] Kitano Hiroaki."Towards a theory of biological robustness.." Molecular systems biology 3.(2007).