Biological robustness is a property of a biological system that maintains its phenotypic stability in the face of uncertain perturbations such as environmental change, random events (or intracellular noise), and genetic variation. Biological robustness is best expressed in terms of an organism's adaptation to its environment and is a pervasive, evolved, and inherent feature of biological systems. It is a natural characteristic that has evolved in biological systems. Biological fragility, on the other hand, refers to a biological system's sensitivity to external perturbations or internal parameter uptake and other uncertainties that prevent the system from maintaining structural and functional stability, leading to disease or even death.

This biological robustness feature can be found in a wide range of biological examples. Chemotaxis is capable of Escherichia coli over a wide range of chemical elicitor concentrations, for example. However, organisms are frequently vulnerable to unexpected mutations; for example, the immune system, while providing robustness against pathogenic threats, is vulnerable to unexpected failures, such as the dysfunction of the non-redundant core element MyD88.

Biological robustness is an essential component of living organism survival. To begin with, robustness is a universal property of biological systems. It ensures that a system's specific functions are preserved in the face of external and internal perturbations. The underlying mechanisms that generate robustness are system control, substitution (or fail-safe) mechanisms, modularity, and decoupling. Biological robustness enables organisms to adopt appropriate response mechanisms in response to externally imposed stresses, such as the barrier role of cell walls and cell membranes, including cell wall remodelling and altered cell membrane fluidity; and the clearance of toxic substances by transport systems, as well as the activation and cascade regulation of signal transduction systems and the regulation of metabolic levels. In addition, robustness encourages the evolution of complex dynamic systems. Robustness promotes organisms' ability to evolve, and document traits are typically selected by evolution. Evolution selects a robust trait that is resistant to environmental perturbations over a long period of time. This connects the characteristics of robustness and evolvability. Robustness is present in all evolved biological systems.

It is possible to consider the onset of disease as a manifestation of a biological system's biological fragility. Diabetes, cancer, and HIV infection are a few common examples of how delicate biological systems are. Systemic responses, such as systematic interventions (to control the dynamics of the system), attacking vulnerabilities, or introducing decoys to re-establish control, are required to cope with the onset of disease and control the robustness of the organism. We also need a thorough understanding of the pathogenesis of systemic failure modes, which will help us comprehend complex diseases and offer guiding principles for treatment planning.

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