

Biological Robustness and Fragility

Introduction

Biological robustness refers to the ability of a biological system to maintain its stability and functions in response to changes in the external and internal environment. Biological fragility is the opposite of robustness. It represents the disruptions of biological systems caused by changes in conditions. These two main features of biological systems have a significant impact on the survival of organisms and ecosystems. Due to its significance, the study of this field will assist us in putting various biological phenomena into perspective.

Biological Robustness

From my perspective, the term "maintain stability" describes the core of biological robustness, which is the ability of an organism to maintain its functions in the face of random changes or disturbances from uncertainty. The changes may include physical, chemical, or biological stressors, as well as genetic mutations or changes in the internal environment. This is particularly evident in the adaptability of organisms to their environment, which is a universal and indispensable characteristic of biological systems. For individual survival, robustness allows organisms to withstand stressors and continue to grow and reproduce, increasing their chances of survival. For biological systems, a system must be resilient to work in uncertain situations with untrustworthy components. In addition to helping organisms stabilize and survive their functions, robustness can also help them evolve and maintain the stability of ecosystems.

It is evidence of the robustness of the human body that certain organs and tissues, such as the skin and the liver, can heal and renew themselves. Because of this, the body can recover from trauma or illness while continuing to carry out its normal duties. At the same time, the robustness of a pathogen is essential to its continued existence. For example, antibiotic resistance in bacteria and radioresistance in tumour stem cells are both examples of this trait. These demonstrate that the study of resilience in the medical field has important implications to consider.

Biological Fragility

Robustness is essential because it allows for the evolution of complex systems, yet the diversity and homeostasis of ecosystems entail trade-offs by causing instability in the face of unexpected shocks, which can lead to catastrophic collapse, which is called biological fragility. This can frequently destroy organisms and cause substantial injury, as well as a cascade of side effects. For starters, fragility can damage the well-being and survival of organisms and ecosystems. In addition, environmental factors may hurt reproductive success or increase mortality. Negative consequences for these species' populations, may lead to their decline or extinction. Finally, fragility can have a detrimental influence on ecosystem function and stability, disrupting their equilibrium.

Continue with the previous example and illustrate the biological fragility of the biological immune system and pathogens: the damage caused by particular populations to infectious illnesses. People with weakened immune systems, such as those with HIV/AIDS, cancer, or diabetes patients receiving SARS-CoV-2, are more likely to catch infectious infections and suffer severe sickness or death as a result. Pathogens can also exhibit fragility, or susceptibility to environmental factors that can affect their survival and ability to cause disease. For example, SARS-CoV-2 is sensitive to changes in temperature and humidity and can be inactivated by high heat or by drying out. This means they may not survive as long in certain environments and may be less likely to spread. This outlines some measures that can be taken to exploit biological fragility for pathogen elimination and tailored therapy.

To avoid biological vulnerability, first, sustainable practices are needed to minimize the negative impact of human activities on the environment. This can include measures such as reducing greenhouse gas emissions, conserving natural resources, and promoting conservation efforts. In addition, it is important to understand the specific requirements and tolerances of a biological system and to provide the necessary conditions for it to thrive. Other strategies could include the development of more resilient species or systems through genetic modification or engineering to reduce the impact of stressors on fragile systems.

Conclusion

Overall, biological robustness and fragility are integral concepts that describe

a biological system's ability to retain function and structure under perturbations. These two properties have many important inspirational roles in many fields like machine learning, neural networks. We can work to create a more resilient and sustainable world by expanding the theory of them.

Reference

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