## Question 1:

### 1. Biological robustness

Biological robustness is one of the whole traits of the biological system. It refers to the property that a biological system maintains its structure and function stability when it is disturbed by uncertain factors such as external disturbance or internal parameter perturbation. Despite the fact that organisms' external environment is always changing, they can maintain a relatively stable internal environment that allows them to survive in a variety of environments [1].

### 1.1 One example of biological robustness

With the history of industrial development over the past 100 years and the ongoing expansion of production scale, industrial microorganisms need to be exposed to more complex and harsh industrial environmental circumstances to complete high-yield and high-efficiency production tasks. The robustness of industrial microorganisms is reflected in their ability to cope with complicated and diversified poor industrial environments, and it can help enterprises obtain comparable production performance with normal environments.

### 1.2 The reason for biological robustness is integral part of survival

Because the robustness of the biological system is very extensive, it exists universally in the biotic population, organ, cell, molecule and other levels. Hence, the robustness of the biological system is of great significance to the organisms' survival, growth, environmental adaptation, disease occurrence, disease development, disease treatment and other aspects. Most biological systems achieve system function and maintain system robustness through the joint action of positive and negative feedback mechanisms. Negative feedback plays a major role in resisting interference and maintaining robustness, while positive feedback enhances system robustness by strengthening stimulus intensity. For example, the chemotaxis phenomenon formed by bacillus coli through feedback regulation allows it to be well-adapted to its environment [2, 3]. During the cell cycle, positive feedback from cyclin formation enhances the robustness generated by negative feedback [4].

### 2. Biological fragility

Biological fragility refers to the ability of biodiversity to endure changes in external conditions. Higher fragility means that environmental factors can easily alter biodiversity.

### 2.1 One example of biological fragility

The ecosystem in some arid regions or limestone areas is often very fragile, and it is difficult to recover or even change irreversibly once it is disturbed by external factors (such as man-made destruction of vegetation). While the mimosa is particularly sensitive to some external interference, it is not vulnerable, because it will revert to its original state once the interference is no longer there.

### 2.2 Consequences of biological fragility

Such as earth climate change, biodiversity, threats to human health, etc., which will result from biological fragility. Previous research has revealed that three-quarters of the ice-free land surface and two-thirds of the marine environment on earth have undergone severe changes, including agriculture, pasture, felling, mining, urbanization, industry and fisheries [5]. One million plant and animal species face extinction. Since 1970, global wild vertebrate populations have declined by 69% and insects by 45% [6]. Since 1960, half of all tropical forests have been destroyed, and the world's forests are losing 3.36 million hectares (namely 8.3 million acres) each year, an area the size of Belgium [6]. More than 85% of the global's wetlands and 35% of mangroves have vanished [6]. In terms of human health, about 200 pathogens, including HIV/AIDS, Ebola virus, SARS, Nipah virus, West Nile virus, MERS, Monkeypox, and of course, SARS-CoV-2 from horseshoe bats, which causes COVID-19, have spread

from wild animals to humans since 1970 [6]. These pathogens are typically infected through an intermediate host [6]. The ultimate consequence of biological fragility may be to destroy the robustness of the organism.

### 2.3 How to avoid biological fragility

#### 2.3.1 International organizations need to formulate new policies

Such as expanding nature-based climate change solutions; maintaining WTO rules consistent with environmental management; enhancing the sustainability of development cooperation; supporting the Convention on Biological Diversity; formulating a new United Nations Treaty on High Seas Biodiversity; and eventually negotiating a Global Environmental Treaty.

#### 2.3.2 Making harmony with nature

In order to avoid biological fragility, individuals must first recognize that they must coexist peacefully with the biosphere. In addition to curbing climate change, this effort must safeguard biodiversity and the myriad advantages we derive from healthy ecosystems. "Biodiversity as a whole constitutes a shield to protect every species that makes it up, including ourselves," observed the late, eminent evolutionary biologist E. O. Wilson [7].

**Total words:** 699

**References:**

[1] Bing Zhu, Jiali Bao, Lei Ying. Research progresses in biological robustness[J]. Journal of Biophysics, 2007(05): 357-363.

[2] Barkai N, Leibler S. Robustness in simple biochemical networks. Nature, 1997, 387: 913-917.

[3] Alon U, Surette MG, Barkai N, Leibler S. Robustness in bacterial chemotaxis. Nature, 1999, 397: 168-171.

[4] Cross FR, Siggia ED. Shake it, don't break it: positive feedback and the evolution of oscillator design. Developmental Cell, 2005, 9: 309-310.

[5] The premier global authority on the state of global biodiversity is the ungainly-titled Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), established in April 2012. The IPBES, which draws on the work of thousands of scientists, plays a role analogous to the Intergovernmental Panel on Climate Change (IPCC). See “About,” IPBES, https://ipbes.net/about.

[6]https://carnegieendowment.org/2022/11/28/to-prevent-collapse-of-biodiversity-world-needs-new-planetary-politics-pub-88473.

[7] Edward O. Wilson, Half-Earth: Our Planet’s Fight for Life (New York: W. W. Norton, 2016).