According to Kwon and Cho from Oxford University, biological substances can be robust against most perturbations but also, at the same time, could be extremely fragile regarding specific perturbations (Kwon & Cho, 2008). Based on researchers from Frontiers, if a biological system continues to operate in the face of disturbances, it is said to be robust and resilient (Young et al., 2021). They defined genetic robustness as an organism's ability to endure mutations, which results in little or no phenotypic or reduced survival. Specifically, researchers claim that the fundamental feature of biological systems is wired in the genomic and proteomic interactome and increases individuals' chances of survival in the face of mutations.

The covid virus is robust against other vaccines but fragile to the corresponding covid vaccines. A specific vaccine is effective because it can stimulate the immune system to produce a particular type of antibody against hemagglutinin (HA), the head of the virus's surface protein (Cohen, 2017). In other words, if we switch to another virus, such as covid virus, the head of the covid virus's surface protein will be different. We would need another vaccine that produces a specific type of antibody in order to target the covid virus. That is why the covid virus is robust when other vaccines cannot target its specific HA. For another instance, the HIV virus is robust against other medicines or chemicals. But when it comes to prevention, HIV virus is fragile to HIV blocker, which is called pre-exposure prophylaxis (PrEP) based on the Centers for Disease Control and Prevention (CDC). The article from Washington Health Institute proposed that PrEP medication works by inhibiting the body's ability to reproduce HIV (Washington Health Institute, 2021). According to the article, PrEP, as a catalyst, aids in the body's production of antibodies that help fight against disease-causing bacteria and viruses. Specifically, the article claims that tenofovir and emtricitabine prevent the virus from replicating by blocking the enzyme after initial viral

interaction. The result of using PrEP is significantly effective. According to CDC reports, after taking PrEP medicine, the risk of getting HIV from sex and injection will be reduced by 99% and 74%, respectively (Centers for Disease Control and Prevention, 2022). Thus, the covid virus could be robust when the vaccines cannot target its surface protein; HIV virus can also be fragile when the PrEP blocks the enzyme for HIV virus to replicate.

Biological robustness is an integral part of survival. For example, if a person eats expired food, that person may have diarrhea, which helps to discharge the expired food. According to ScienceDaily, diarrhea protects people from the risk of absorbing expired food and getting sick (Brigham and Women's Hospital, 2017). Another example that can provide support to biological robustness is the covid virus. If the covid virus cannot be robust against most medicines, it cannot stay on the infected people to spread the disease around the world. In order to preserve its RNA and the possibility of future variety, the covid virus needs to be robust against most chemicals. As a result, biological robustness is critical for biology to survive.

The consequences of fragility could be severe and lead to the elimination of a specific kind of virus or even a biological life. Using the example from above, if a person eats expired food, diarrhea can protect against the risk of digesting slightly rotten food. However, when someone eats a large quantity of hypertoxic mushrooms, the human body would be frangible to those poisonous mushrooms, which can hardly be discharged by diarrhea. According to Hilary N. Karasz from Public Health Insider, poisonous mushroom, such as death cap mushroom, can cause liver and kidney organ failure and even leads to death (Karasz, 2019). But how could we avoid the fragility? Of course, human beings, as intelligent creatures, can avoid eating wild mushrooms and increase their knowledge of poisonous mushrooms. However, the flu virus could

be a better instance to take as an example for non-intelligent lives. If the flu vaccines target the surface protein of a specific flu virus, the flu virus would be killed by the immune system, which learns the pattern of that specific flu virus. However, Pfizer claims that “As a virus replicates, its genes undergo random ‘copying errors’ (i.e. genetic mutations). Over time, these genetic copying errors can, among other changes to the virus, lead to alterations in the virus' surface proteins or antigens” (Pfizer, 2022). In other words, by genetic mutations, the virus changes the surface proteins and has a lower chance of being targeted by the former vaccines developed based on the original surface protein. As a result, fragility results could be severe, but intelligent creatures can learn to avoid dangerous decisions; As for non-intelligent particles, such as the virus, genetic mutations could be a great way to overcome its fragility to its targeted vaccines.

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