

### Question 1:

Stress conditions within the biological system can result in two states. Biological robustness is the ability of the body to maintain its functionality and stability when under duress by either internal or external interactions caused by body reactions. In tandem to robustness, biological fragility is the state when conditions within the body results in the breakdown of biological processes.

One example of biological robustness is that of the body's wound healing process. When the body is damaged, like the surface of the skin, it undergoes the 4 main phases to repair the damaged site. Platelets release signals that attract inflammatory cells to the site. During this phase, damaged tissues and cells are removed while foreign bodies are eliminated by phagocytosis. New cells are also called to the site to aid with wound repair resulting in inflammation. After, tissues are formed to fill the wound by fibroblasts and collagen.

An example of biological fragility is that of the formation of cancer cells. This occurs when cells undergo uncontrolled mitosis. Similarly, to that of wound healing, the cells signals when the cells divide to create more cells. With faulty signals that may be caused by DNA damage, the cells start to divide uncontrollably resulting in the formation of a tumour [1].

Due to many processes occurring within the body, it is of paramount importance that many of its functions continue to perform to maintain the overall system of the body. The robustness of the biological system enables it to continue to function properly and eliminate the issues present at the same time. If the system does not have the robustness to be resilient and rid the body of unwanted interactions or foreign bodies, it may ultimately result in the collapse of the entire biological system.

With fragility, this could lead to many biological repercussions. When a certain biological system is fragile, it leads to a plethora of unwanted outcomes. Such in the case of the formation of cancer cells. The body is unable to rid itself of the effects as some cases creates an endless cycle until interrupted by external aid.

Some fragility can be avoided by partaking in activities that reduces the stress of the system or the cells. For example, limiting the amount of ultraviolet radiation (UV) that the body receives would reduce the chances of developing skin cancer. As the cells receive more UV radiation, there is an increase probability that the cells undergo oxidative stress or cell damage which could result in cancer formation [2].

However, if there is already the formation of such damaged cells, introduction of nanoparticles (NPs) may aid in alleviating the effects or eliminate the damaged cells depending on the application of the NPs.

## References:

- [1] Cancer Research UK, “How Cancer Starts,” Cancer Research UK, Jul. 01, 2020.  
<https://www.cancerresearchuk.org/about-cancer/what-is-cancer/how-cancer-starts>
- [2] S. Goswami, S. Sharma, and C. Haldar, “The oxidative damages caused by ultraviolet radiation type C (UVC) to a tropical rodent *Funambulus pennanti*: role of melatonin,” *Journal of Photochemistry and Photobiology. B, Biology*, vol. 125, pp. 19–25, Aug. 2013, doi: <https://doi.org/10.1016/j.jphotobiol.2013.04.008>.
- [3] Y.-K. Kwon and K.-H. Cho, “Quantitative analysis of robustness and fragility in biological networks based on feedback dynamics,” *Bioinformatics*, vol. 24, no. 7, pp. 987–994, Feb. 2008, doi: <https://doi.org/10.1093/bioinformatics/btn060>.