Using your own understanding write a 700-word essay on Biological Robustness and Fragility.

* In this essay define what is biological robustness and fragility.
* Give 1 example of robustness and 1 for fragility.
* Explain why biological robustness integral part of survival is.
* What are the consequences of fragility and how one could avoid it?
* Provide citations, where necessary, to justify your statements.

Robustness – cell cycle checkpoints

Fragility – cancer

Robustness internal – cell cycle integrity for continuation of life

Citations

* Feedback loops with temperature and other physiological systems
* Highly optimised tolerance theory system designs to cope with perturbations, first designed for internet, but highly applicable for evolution an biological systems
* Cell cycle
* Mutations in genome cause fragility -> disease -> cancer
* ‘Feedback control enhances robustness against possible therapeutic efforts. This control which protects normal cells by making them robust against perturbations, is an obstacle in tumour therapy’
* Cell growth, decisions, apoptosis
* Maybe a diagram
* H Kitano argues that ‘robustness is the fundamental feature of evolvable complex systems’, robust means evolvable
* Biological systems are more robust than machines
* Homeostasis
* Parallelism provides a level of robustness and makes the system more reliable
* Computer machines were once inspired by the way that brain works – death of one neurons doesn’t break the brain down - > it finds new ways to compensate for the failure
* ‘ Trait robustness is pervasive in biology throughout at all organizational levels including protein folding, gene expression, metabolic flux, physiological homeostasis, development, organism survival, species persistence, and ecological resilience (Holling, [2001](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3350086/#B61); de Visser et al., [2003](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3350086/#B33); Kitano, [2007](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3350086/#B82)).’

Biological robustness and fragility

Biological systems have to be able to resist external stimuli to be able to preserve their integrity and pass on their information to their offspring. Those traits oof robustness are specifically seen through evolutionary preserved mechanisms of DNA replication and gene expression, protein folding and metabolism (cite) which are an integral part of survival, flow of information and continuation of life. The robustness is usually preserved through extra checkpoint. steps or extra scaffolding molecules which are able to assist the process and minimise potential mistakes, meaning they have internal capability to self-maintain the process and avoid perturbations (cite). However, there is a traif-off in these between robustness, fragility, eclll and performance, which makes these mechanisms robust-yest-fragile (ccite). The causes of fragility can be exogenous factors but also endogenous factors when the process is progresses out of control or the proof-check step is not initiated or was corrupted.

The process I want specifically focus on in this case is cell cycle and cancer. The core information flow occurs at a cellular level, with the process of DNA replication. The replication of genetic information is the core of cell cycle process. However, although the replication of cells is an important process in growth of an organism, it is important that the growth is controlled, and any faulty by products of the growth, such as mutated cells, are illuminated from the system through the process of apoptosis. Even in the case of accumulation of mutations, which is the initial cause of cancer tumour formation, the organism still functions and only when the tumour becomes spread and disturbs the work of all human systems through metastasis (citation).

Cell cycle control and progression is one of the most underestimated controls of continuation of life and transfer of information. Each cell in the body divides in parallel and destruction of one cell does not destroy the growth and division of an organism, whether the cell is in the brain or the heart. The cell cycle has 4 stages, M- mitosis, G1 - growth, S - DNA synthesis and G2 growth and preparation for mitosis. These steps are sequential, and between each step the cell has to monitor the order and integrity of the steps taken, otherwise the DNA replication process will be corrupted and the information flow will be haulted. This is why surveillance system of 3 checkpoint exists: G2/M checkpoint, M/G1 checkpoint and G1/S checkpoint. Eachc phase has a specific perpuse, for eaxmaplle, G2/M phase sssupervises eclls intry into mitosis – the has t obe commited to align DNA, complete DNA replication, resolve any present DNA damage and make sure the ecll is prepared for th eclll cycle by checkcing itss size and the quantity of synthesised mmoleucles. How does a this survaillane system actually work? The checking occurs throuogh ssignalling pathways and special molecules called cyclins, whicih are names after the step when they are signalling and ciclin dependant kinases of CDKs.

However, although most robust biological systems, such as humans, have limits. Cell cycle can indegro repliactiion stress

* Unrepaired nicks and gaps: DNA damage tolerance tolegrates some nicks but may go out of control
* External and internal factors
* Repliatiion forc restart
* <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4354890/>

All in all…