HI FFAM (Hypoxia In Fruit Flies And Mice)

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Introduction:

- Earth's atmosphere containing 78% nitrogen, 21% oxygen, 1.0% argon, 0.04% carbon dioxide, and a small amount of other gasses
- Mars' atmosphere contains 95% carbon dioxide, 3% nitrogen, 1.6% argon, and it has only traces of oxygen, carbon monoxide, water, methane, and other gasses
- With the common fruit fly and mice, their genetic basis to hypoxia tolerance can connect with responses to hypoxia in humans by the hypoxia-inducible factor (HIF) and how both HIF-1a and HIF-2a could be the solution to the hypoxic gene regulation
- In this experiment, mice and the common fruit fly will be used to properly explore and better grasp how levels of oxygen can ultimately affect them and how these symptoms can correlate to humans and provide a solution for avoiding hypoxia by improving the tolerance of human cells.

Hypotheses:

Hypothesis #1: With the usage of fruit flies, we can find the long term effects of hypoxia and see how a pattern of hypoxic environmental change can change the phenotype of a fruit fly to then find an approach to alter our own human phenotype to better resist hypoxia.

Hypothesis #2: By using mice, we can figure out the changes towards their genes by targeting the general hypoxia responses and see the effect it has on the mice metabolic rate and how HIF-1a can correlate to possibly reducing such rate. With the results, we could incorporate the findings to then have a better and more suitable resistance for interstellar space travel to then colonize Mars.

Research:

- With NASA' s growing curiosity for interstellar travel and the major part being colonization on the planet Mars, there should be a better means and understanding of the major risk that can lead to the people wanting to go to space: hypoxia being one of the most critical factors.
- The effects on the brain and ocular physiology are a concern because of the lack of knowledge as to how a decrease in ambient oxygen partial pressure in space might affect the brain and eyes and thus human performance [5].
- Exercise is a primary countermeasure for many of the negative physiological changes, but with exposure to hypoxia, there is an impairment in exercise performance due to decreased cardiac output and with the decrease of performance, especially in an early flight ascent, can lead to negative consequences, specifically in strength and muscle atrophy [5].
- Several studies have already been done on the effects hypoxia has on fruit flies and mice, which get into great detail of genes and phenotypes actually undergoing a different affect and having the ability to differentiate between HIF-1a and HIF-2a along with having the ability to withstand minimal amounts of oxygen, but also maintaining the ability to live under such conditions.

Fruit Flies

Photo credit: www.bing.com
Example: *Drosophila melanogaster*

Experimental Design for Fruit FLies:

Control Group: represents Earth's normal atmosphere and the conditions
Experimental Group 1: represents Mars' atmosphere
Setup: simulate Mars' atmosphere, pressure and temperature to expose what astronauts might handle if and when on Mars

Mode of Execution:

The fruit flies should contain an equal grouping of male and female flies and they should be put into the behavioral analysis that would be equivalent to that of Mars atmosphere: pressure, temperature and (if possible) gravity

Closely monitor fruit flies and their activity while they deal with the exposure to the lack of oxygen, keeping a close count to also see the mortality rate of the flies, along with checking on the flies exposed to hypoxia and the characteristics set of behaviors while they are in that duration [3].

Mice

Photo credit: www.bing.com
Example: *Mus musculus*

Experimental Design for Mice:

Control Group: will represent Earth's atmosphere and it's normal conditions
Experimental Group 1: will represent Mars' atmosphere
Setup: simulate Mars' atmosphere, pressure and temperature to expose what astronauts might handle if and when on Mars

Mode of Execution:

With the mice, it should at least contain equal grouping of both male and female mice, which then they would be admitted to have intermittent exposure to hypoxia with the oxygen levels being equivalent to Mars own oxygen levels

The mice should be closely monitored to see the levels and see if the rate of HIF-1a translation and the rates of HIF-1a mRNA translation (which could be greatly increased) and in turn increasing levels of the HIF-1 complex within the cell [7]

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Conclusion:

- With fruit flies, it is notable that they have a remarkable ability to recuperate from normal metabolic functions in the face of numerous environmental insults of long-term exposure to hypoxia reperfusion [5]. Even throughout the gradual descent of oxygen from the chambers, all of the flies were still alive due to the insect having a lower metabolic response to hypoxia, compared to mammals who have a higher metabolic rate, and only smaller mammals have that reduced metabolic response (such as mice).
- With the mice, it should be noted that with the induced and intermittent hypoxia while they are asleep, the metabolic adaptations should be distinctive to the mice. Due to the intermittent hypoxia, the understanding of metabolic regulation and deregulation in diseases associated with hypoxia, can show results to the impairment hypoxia leads to the mice, and should show that the longer durations of exposure of lower intermittent hypoxia (IH) appear to alleviate metabolic dysfunction induced by IH [2].
- The provided researches shows the exposure of fruit flies and mice to these environments that are equivalent to a possible interstellar ones (such as Mars), can be achievable, it's only a matter of time before humans are able to unlock the ability to have a reduced metabolic rate that can then respond to hypoxia in a more useful rate to then colonize on Mars.

Future

- The information provided will be presented to the NASA State Meeting.
- The research that is provided is nowhere near completed, since there are many difficult obstacles that need to be overcome in order to allow astronauts proper and more importantly safe travels to Mars, and any other interstellar exploration.
- The information provided may be useful for NASA to then expand on a problem and possibly provide some possible solutions to then expand on the knowledge obtained and go beyond Earth.

References:

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