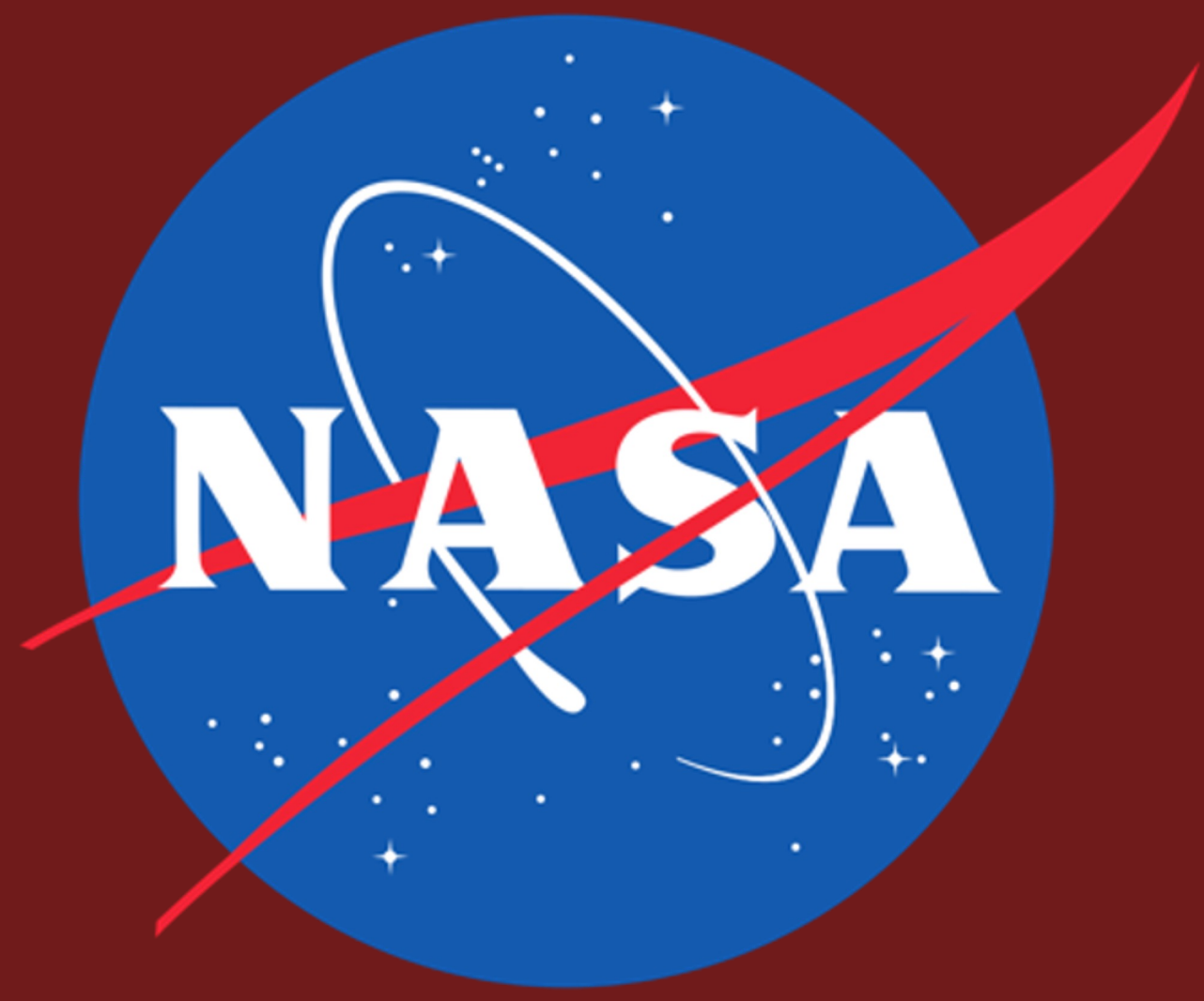




Long-term Effects of Simulated Spaceflight on Lymphatic Biology

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Background

Over the last 70 Years Humans have been venturing out into space. By doing so this exposes them to:

- Deep Space Radiation
- Microgravity Environments
- Extreme Temperatures

Astronauts who have who have travelled in deep space environments have recently reported various ailments related to the circulatory system. This is hypothesized to be due to these extreme conditions which they are exposed to during their time in space.

Previous studies in this subject matter had focused entirely on the alteration of the arteries and veins in the cardiovascular system.

Our hypothesis is that extended exposure to Deep Space Radiation, Microgravity, and extreme temperature alters the physiology of the lymphatic vessels in a significant manner.

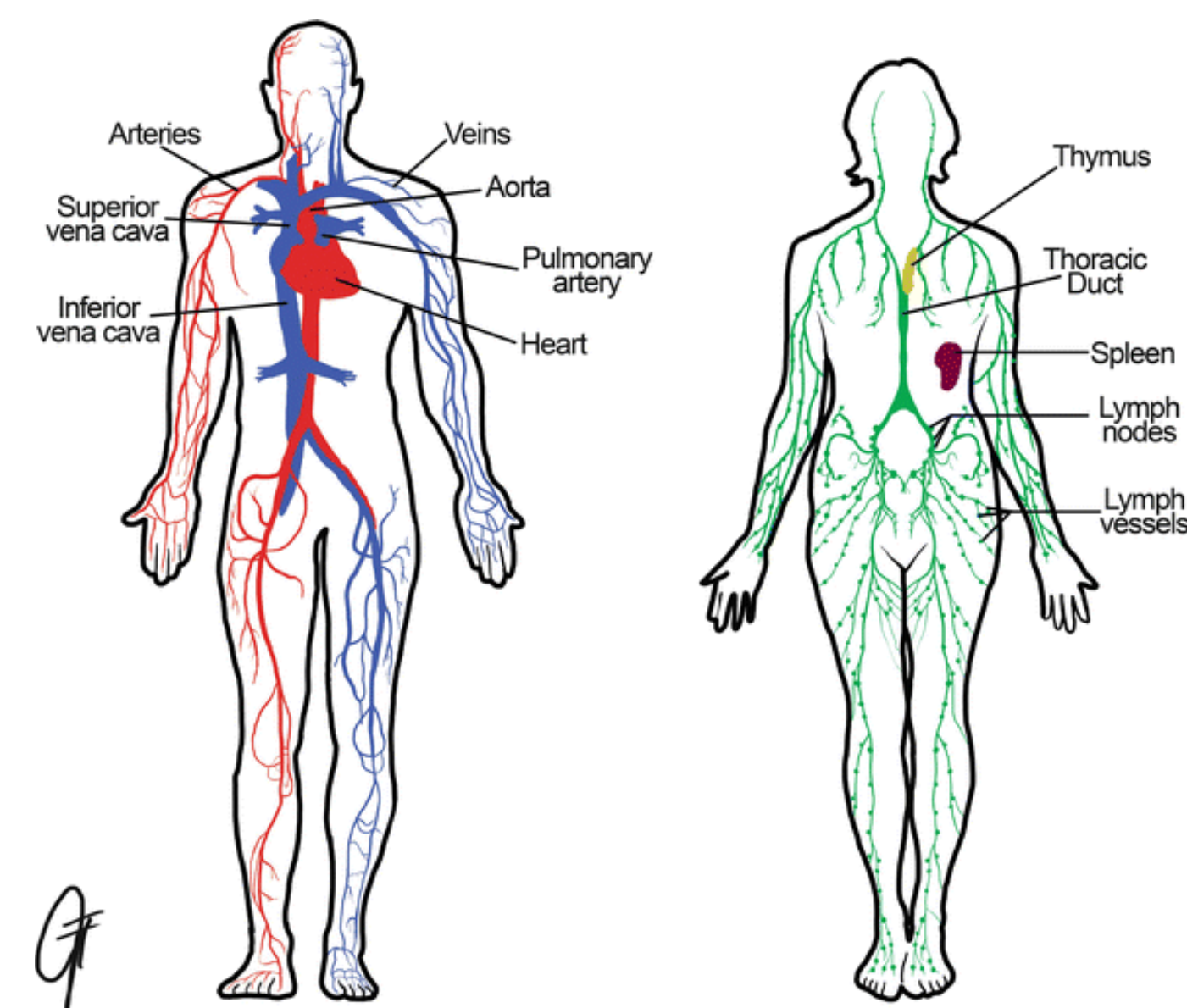


Figure 1: Image showing the two body systems associated with the circulatory system: the cardiovascular (left) and lymphatic system (right).



Figure 2: The Artemis Program is designed help establish a human presence on the moon and to also conduct missions to mars and other places beyond earths orbit.

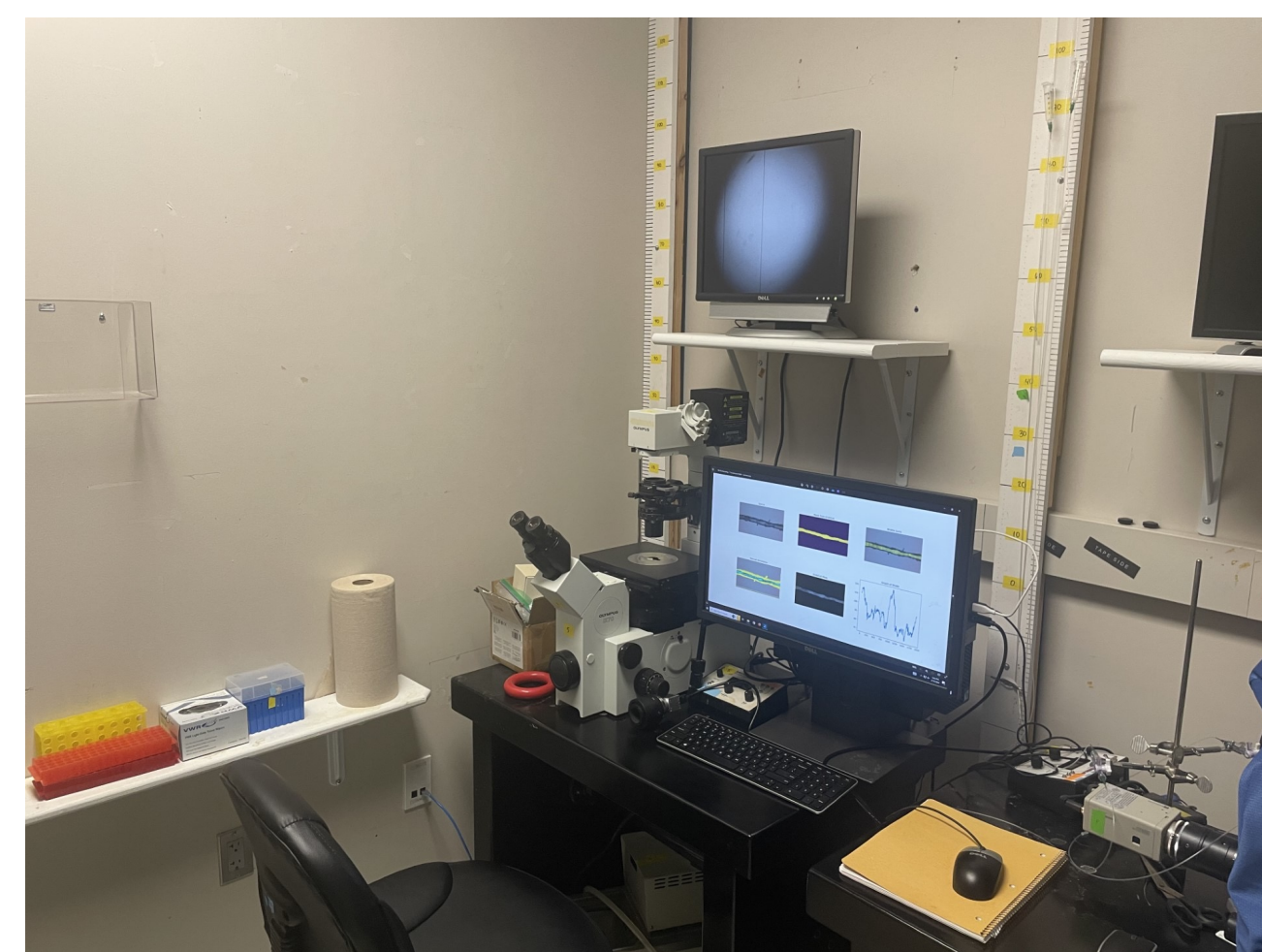


Figure 3: Shows experimental setup for how lymphatic vessels had the pressured altered, and the diameter of the vessels were measured and recorded.

Methods

Rat lymphatic vessel samples were first collected from these groups of model organisms:

EXPERIMENTAL GROUPS	Rats/Group
Sham Irradiation	18
Hindlimb Unloading (HLU)	18
Space Radiation - 0.75 Gy	18
Space Radiation - 1.5Gy	18
HLU+Space Radiation, 0.75 Gy	18
HLU + Space Radiation, 1.5 Gy	18
Total Animals	108

Extracted lymphatic vessels were attached to an apparatus allowing for alteration of the pressure that exists within the lymphatic vessel to examine the differences in diameter of lymphatic vessels.

These samples were then run at different measures of pressure (1cm, 3cm, 5cm, 7cm and 9cm) and were photographed with every contraction and dilation of the lymphatic vessel for 30 seconds.

Using a computer program, the outside wall of the vessel was mapped, and the diameter was calculated and plotted using excel to measure structure

Results

1cm Pressure Measurements

Time stamp	Average Diameter (µm)
0	80.78
2	66.80
4	73.84
10	65.14
12	80.07
18	65.91
20	77.74
26	69.46
28	73.26

7cm Pressure Measurements

Time (s)	Average Diameter (µm)
0	110.15
1	100.19
3	110.844
7	102.83
9	106.2
13	102.55
14	111.29
19	103.29
21	107.36
25	100.89
26	106.19

Table 1 & Table 2: shows the computer computed average values of the diameter of lymphatic vessels at 1cm and 7cm respectively

Discussion

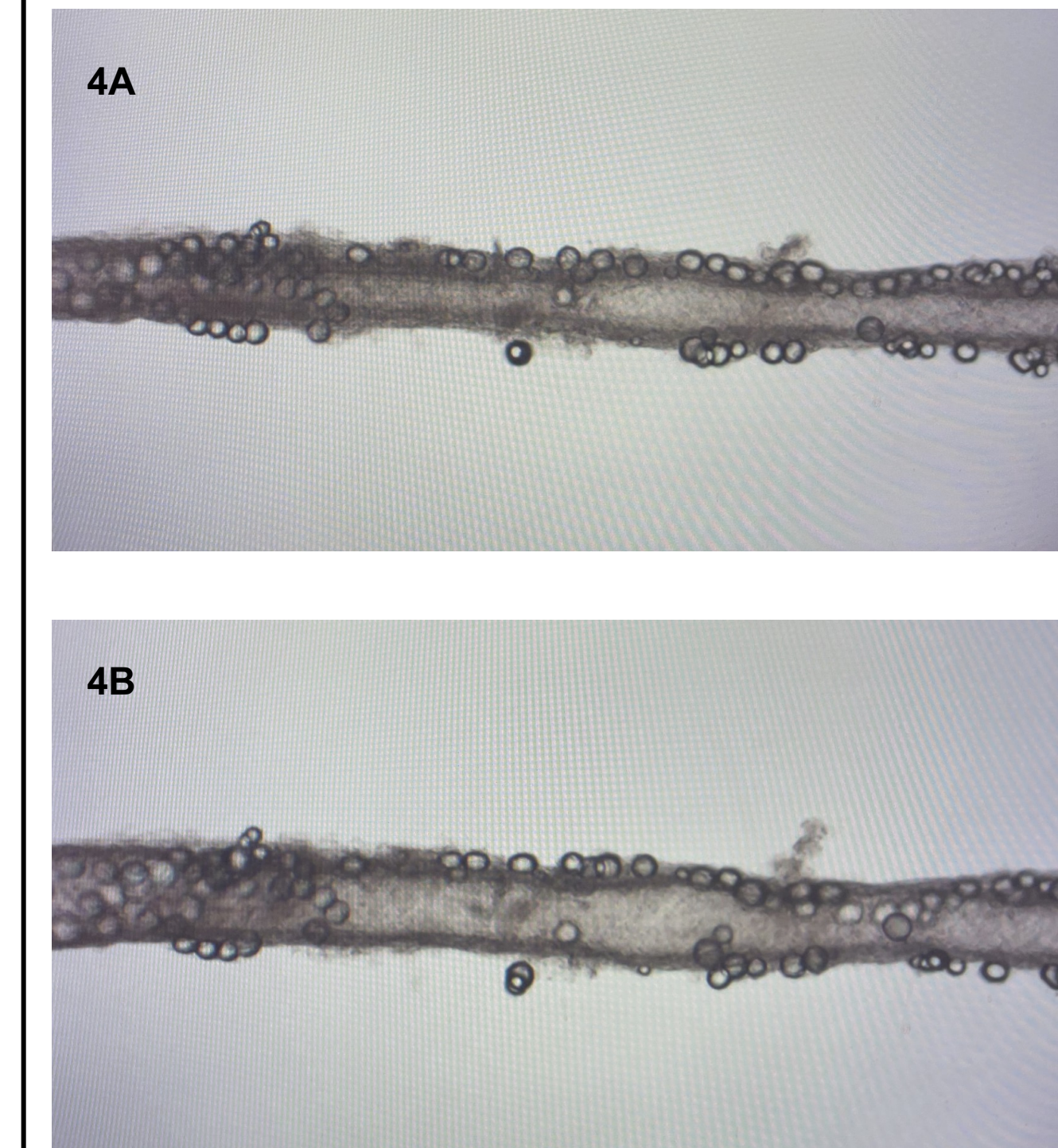


Figure 4: shows cross sectional image of lymphatic vessel in relaxed state at 1cm of pressure (Fig. 4A) and at 7cm of pressure (Fig. 4B). These images are then run on a computer program allowing for calculation of vessel diameter.

From Tables 1 and 2, the data given shows the alternating patterns between contracting and relaxing lymphatic vessels. Furthermore, it shows the elastic nature of lymphatic vessels, as by increasing the pressure within the lymphatic vessel the diameter of the vessel also increased.

The data that we gathered during this research project involved using a computer program to calculate the average diameter of lymphatic vessels.

Future Directions

This study examining the changes lymphatic vessels undergo in response to space flight conditions is still ongoing. Following the completion of all current samples, a definitive conclusion can be drawn regarding the effect space flight has on the physiology of lymphatic vessels.

Acknowledgements

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