DAGSI Research Topic

1. **Research Title:** Airmen Stress Scenario Simulation using Cultured Cells: Mitochondrial Health & Organ-Level Effects

2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level**
Molecular Biology/Pharmacology/Bioengineering/Computer Science (BS, MS or PhD level)

4. **Objectives:** 1) Simulate Airmen stress scenarios using cultured mammalian cells. 2) Develop a biometric analysis based on measuring mitochondrial structure/function in response to simulated operational stress 3) Develop mitochondrial morpho-functional fingerprint algorithms to build a model using artificial intelligence & machine learning tools to predict Airmen stress responses & mission performance to emerging stress scenarios.

5. **Description:**
Airmen constantly endure an evolving spectrum of operational stress scenarios that are vital to the continued success and achievement of the Air Force mission directives. These stress scenarios can include extreme physical exertion, high temperatures, excessive G-Force, pressure changes, low oxygen environments, or exposure to chemical or particle contaminants. Further, various stress factors induce changes in physiological or psychological attributes that affect performance through metabolic mediators that cause structural and functional recalibrations of mitochondria. Mitochondria are always in constant flux by changing their morphology and energy production in response to the energy (ATP) needs of the cell. The dynamic nature of the mitochondria allows for rapid detection of physical or cognitive impairment by characterizing the structure and the function of the mitochondria. The structure of the mitochondria is directly related to energy production efficiency, which allows recent advances in the field of microscopy (i.e. 3D electron microscopy, flow cytometry & high content live cell imaging) to capture minute changes in mitochondrial morphology that are characteristic to a certain injury state. Furthermore, cutting-edge molecular biology techniques such as extracellular flux analysis compliment microscopic data to bridge cellular mitochondrial health to metabolic health and ultimately Airmen organ-level effects. The information from both microscopic and molecular biology analysis provides a

strong correlation that can be fed into *in silico* simulations which utilize artificial intelligence to rapidly extrapolate Airmen performance outcomes from early stage mitochondrial changes due to operational stress responses.

6. **Research Classification/Restrictions:** NA

7. **Eligible Research Institutions:**

☒ **DAGSI** (Wright State University, AFIT, Ohio State University, University of Dayton, Miami University, Ohio University, University of Cincinnati, and all other Ohio Universities)

☒ **Topic can be submitted for public release**

☐ **AFIT** (only)

☐ **USAFA** (only)

PA Approval # 88ABW-2020-2884 CLEARED on 17 Sep 2020