Genomics Experiments in Human-Tended Suborbital Spaceflights: Using Shuttle and ISS Legacy Sample Handling

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Abstract

Commercial suborbital vehicles present the opportunity to explore the earliest biological adaptations to microgravity. For the first time in spaceflight, the first few minutes of transition from high *g* loads to microgravity will be accessible to human tended experimentation. To bring the operational benefits of human tended experimentation to the study of spaceflight, genomics and gene expression, we have proposed and been awarded a project to use of Kennedy Space Center Fixation Tubes (KFTs) for preserving biological samples during suborbital flight (NASA/FO award 80NSSC18K1294).

In preparation for those flights, we have conducted gene expression analyses of plant samples taken before and after flights on Virgin Galactic (December, 2018) and Blue Origin (P9, December, 2019) suborbital flights. These pre- and post-flight gene expression data are being compared to other forms of short duration microgravity, including parabolic flight data, with the goal of providing data that book-end and outline the molecular data that might be expected from samples taken at different time points within a suborbital flight.

The data are consistent with, though distinct from, long term microgravity gene expression data derived from ISS experiments. The data clearly suggest that gene expression changes are very likely to occur during the timeframes associated with physiological adaptation to suborbital flight, and further support the notions of suborbital flights being informative to biological acclimation to spaceflight.

Funding was provided by NASA/SLPSRA grant NNX15AB12G, NASA/FO awards AF4ONOCT110 and 80NSSC18K1294.

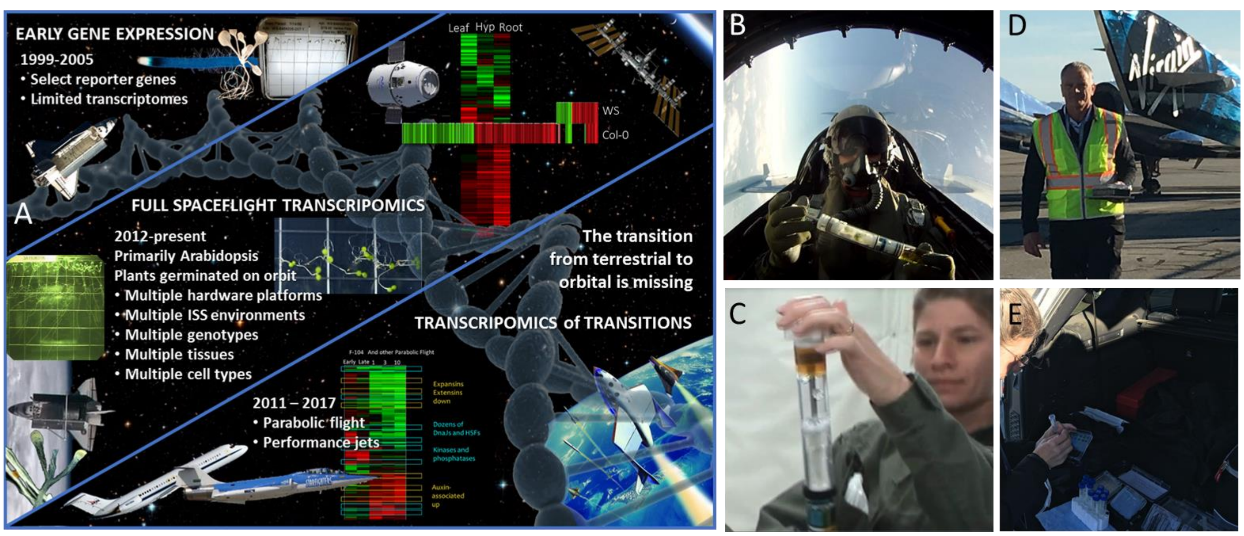

Figure. (A) A diagrammatic representation of the heritage of spaceflight and genomic sciences. Gene expression profiles have proven to be critical tools for understanding adaptation to spaceflight. Yet no data exist on the early adaptive responses to and from space. Suborbital flights provide access to those first minutes of transition. Humans are already in the experimental loop in other exploration vehicles, such as performance jets like the F104, which can mimic some aspects of a suborbital flight profile (B), and in parabolic aircraft, which provide discontinuous microgravity environments. Currently, molecular profiling of suborbital flight environments are limited to harvests post flight (D and E), which, while valuable, the gene expression profile captured will be largely associated with the recovery phase, not the molecular response to the transition from a gravity environment to a sustained microgravity environment.