Objectives

• Address significant lack of data regarding immune status *during* flight.
• Replace several recent immune studies with one comprehensive study that will include in-flight sampling.
• Determine the in-flight status of immunity, physiological stress, viral immunity/reactivation.
• Determine the clinical risk related to immune dysregulation for exploration class spaceflight.
• Determine the appropriate monitoring strategy for spaceflight-associated immune dysfunction, that could be used for the evaluation of countermeasures.
ASSAYS FOR INTEGRATED IMMUNE

JSC Immunology Laboratory
- Leukocyte subsets
- T cell function
- Intracellular/secreted cytokine profiles

Mercer University
- Plasma cytokine balance
- Leukocyte cytokine RNA

Microgen Laboratories
- Virus specific T cell number
- Virus specific T cell function
- Plasma stress hormones

JSC Microbiology Laboratory
- Latent herpesvirus reactivation (saliva/urine)
- Saliva/urine stress hormones
- Circadian rhythm analysis
SUBJECTS

Completed to date:

10 Short duration
5 Long duration

Total ‘n’:

17 Short duration
17 Long duration
A. Immunophenotype, T cell function, intracellular/secreted cytokine profiles.
• No in-flight changes in bulk leukocyte subsets
• Post-flight granulocytosis
• Late in-flight/postflight elevated B cells, reduced NK cells
• In-flight, post-flight trend towards elevated CD4:CD8 ratio, elevated memory T cell subsets
• Elevated effector memory, central memory in-flight
• No change in peripheral constitutively activated T cells
CD8+ T CELL FUNCTION: A+B 24 hours

ISS

SEA+SEB 24hr

CD4/CD69

CD8/CD69

CD4/CD69/CD25

CD8/CD69/CD25

CD8+ T CELL FUNCTION: A+B 24 hours

CD69+

CD25+
CD8+ T cell – Intracellular IFNγ

Secreted Cytokine Profiles (CD3/CD28 48hr)
B. Leukocyte cytokine mRNA
Gene Expression of Markers of Innate (A) and Adaptive (B) Immune Responses (short-duration flights).

A. Gene expression graphs for TNF-α, IL-1, and IL-6, showing changes in expression levels across different time intervals (L-180, L-45, IN, R+0, R+30) for subjects Subj 1, Subj 2, Subj 3, and Subj 4.

B. Gene expression graphs for IFN-γ (Th1 clones), IL-4 (Th2 clones), and IL-10 (Treg clones), showing changes in expression levels across different time intervals (L-180, L-45, IN, R+0, R+30) for subjects Subj 1, Subj 2, Subj 3, and Subj 4.
Gene Expression of Markers of Innate (A) and Adaptive (B) Immune Responses (long-duration flights).

### Intervals of sample collection

- **L-180**
- **L-45**
- **early**
- **late**
- **R+0**
- **R+30**

### A. TNF-α

- **Subj 6**
- **Subj 7**
- **Subj 8**

### B. IL-1

- **Subj 6**
- **Subj 7**
- **Subj 8**

### C. IL-6

- **Subj 6**
- **Subj 7**
- **Subj 8**

### D. IFN-γ (Th1 clones)

- **Subj 6**
- **Subj 7**
- **Subj 8**

### E. IL-4 (Th2 clones)

- **Subj 6**
- **Subj 7**
- **Subj 8**

### F. IL-10 (Treg clones)

- **Subj 6**
- **Subj 7**
- **Subj 8**
C. Virus specific T cell number, function, plasma stress hormone levels.
Plasma cortisol levels - ISS

![Graph showing cortisol levels over time on the International Space Station (ISS).]
EBV T cell function - ISS

% CD8 T-cells

Collection Time

L-180 L-45 14d 2-4m 6m R+0 R+30

EBV T-cell function - ISS
D. Latent herpesvirus reactivation (saliva/urine), saliva/urine stress hormones, circadian rhythm analysis.
Urine CMV Assessment

SHUTTLE

CMV copies/ml

L-180  L-45  R+0  R+30

Sub 3  Sub 5  Sub 2  sub 11  sub 13
Urine CMV Assessment

ISS

CMV copies/ml

CMV copies/ml

L-180  L-10  R+0  R+14

sub 7  sub 15  sub 12  sub 9  sub 8  sub 14  sub H
Saliva VZV Assessment

SHUTTLE

VZV copies/ml

Pre flight  During flight  Post flight

-200  -180  -160  -10  0  10  16  24

Sub 7  Sub 15  Sub 12  Sub 9  Sub 8  Sub 14  Sub H
Saliva VZV Assessment

ISS

VZV copies/ml

Pre flight

During flight

Post flight

Sub 3
Sub 5
Sub 2
Sub 11
Sub 13
Questions?