Task Book Report Generated on: 04/23/2024

Fi Name: Spichann, Gullaume Ph.D.  Project Title: The Impuse of Long Duration Spaceflight on the Function of B-cells and Bornarkers of Inflammation  Division Name: Human Research  Program/Dicipline:  Element/Subdiscipline: IIIUMAN RESEARCH—Bornedical countermeasures  Element/Subdiscipline: IIIUMAN RESEARCH—Bornedical countermeasures  Element/Subdiscipline: No  Joint Agency Name: TechPort: No  Human Research Program Elements: (J HHC-Human Health Countermeasures  Human Research Program Elements: (J HHC-Human Health Countermeasures)  Human Research Program Elements: (J HHC-Human Health Countermeasures)  Human Research Program Elements: (J Immune/Risk of Adverse Health Event Due to Altered Immune Response  Space Biology Element: None  Space Biology Element: None  Space Biology Element: None  Space Biology Element: Biology El	Fiscal Voor	EV 2010	Tools I and II and I	EV 09/21/2019
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Elements Subdiscipline:  Joint Agency Name:  Irech Port:  No  Minama Research Program Elements:  Human Research Program Elements:  Human Research Program Elements:  None  Space Biology Element:  None  Space Biology Special Category:  None  PI Email:  Canielmann@bas.edu  Fax: FY  PI Organization Type:  UNIVERSITY  Phone: 225-578-2926  Organization Name:  Louisiana State University  PI Address 2:  School of Kinesiology  PI Web Page:  City:  Baton Rouge  State:  LA  Zijf Gode:  Organization Fypei:  Project Type:  FLIGHT  Solicitation Funding  Project Type:  FLIGHT  Solicitation Funding  No. of Pabc Duces:  No. of Pab Deardidates:  No. of Pabc Candidates:  No. of Bachelor's Can	Program/Discipline:			
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Space Biology Cross-Element         None           Space Biology Cross-Element         None           Space Biology Special Category:         None           Space Biology Special Category:         None           PI Email:         Gsniclmann@law.edu         Fax:         FY           PI Organization Type:         UNIVERSITY         Phone:         25-578-2926           Organization Name:         Louisiana State University         Phone:         25-578-2926           PI Address 1:         112 Long Fieldhouse         Proper Section of Kinesiology         Proper Section of Kinesiology           PI Address 2:         School of Kinesiology         State:         LA           Pi Address 2:         School of Kinesiology         State:         LA           Pi Address 3:         School of Kinesiology         State:         LA           Pi Address 1:         112 Long Fieldhouse         State:         LA           Cly         8000         Congressional District:         6           Comments:         LA         A           Project Type:         FLIGHT         Solicitation / Funding Indiffer LACSIIIP. NSIRI, Julian / Funding Indiffer LACSIIIP. NSIRI, Appendix Progress:         Solicitation / Funding Indiffer LACSIIIP. NSIRI, Appendix Propertion Spaces (Content Plub Propertion Spaces (Content Plub Propertion Spaces (Content Plub P	<b>Human Research Program Elements:</b>	(1) <b>HHC</b> :Human Health Countermeasures		
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PI Email: Capicimannoribut edu PI Organization Type: UNIVERSITY Phone: 225-578-2926  Organization Name: Louisiana State University PI Address 1: 112 Long Fieldhouse PI Address 2: School of Kinesiology PI Web Page: City: Baton Rouge State: LA  Zip Code: 70803-0001 Congressional District: 6  Comments:  Project Type: FLIGHT Solicitation / Funding Barbit (FLIGHT) Solicit	Space Biology Cross-Element Discipline:	None		
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PI Address 1: 112 Long Fieldhouse PI Address 2: School of Kinesiology PI Web Page:  City: Baton Rouge State: LA  Zip Code: 70803-0001 Congressional District: 6  Comments:  Project Type: FLIGHT Solicitation / Funding Health (FLAGSHIP, NSBRI, ONNIBUS). Source: Appendix A-Crew Health, Appendix PSSBRI, Appendix A-Crew Health, Appendix PSSBRI, Appendix C-Ommibus  Start Date: 11/01/2016 End Date: 10/31/2018 No. of Post Docs: 0 No. of PhD Degrees: 0  No. of Post Docs: 0 No. of Master' Degrees: 0  No. of Master's Candidates: 0 No. of Master' Degrees: 0  No. of Bachelor's Candidates: 0 No. of Bachelor's Degrees: 0  No. of Bachelor's Candidates: 0 Monitoring Center: NASA JSC  Contact Monitor: Norsk, Peter Contact Phone:  Contact Email: Peter.norsk@nasa.gov  Flight Program: SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS	PI Organization Type:	UNIVERSITY	Phone:	225-578-2926
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PI Web Page:  City: Baton Rouge State: LA  Zip Code: 70803-0001 Congressional District: 6  Comments:  Project Type: FLIGHT Solicitation / Funding Health (FLAGSHIP, NSBR1, OMNIBUS). Source: Appendix A-Crew Health, HEADGSHIP, NSBR1, Appendix C-Omnibus  Start Date: 11/01/2016 End Date: 10/31/2018  Start Date: 11/01/2016 End Date: 10/31/2018  No. of PbD Candidates: 0 No. of PbD Degrees: 0  No. of PhD Candidates: 0 No. of Bachelor's Degrees: 0  No. of Master' begrees: 0  No. of Master's Candidates: 0 Monitoring Center: NASA JSC  Contact Monitor: Norsk, Peter Contact Phone:  Contact Email: Peter.norsk@nasa.gov  Flight Program: ISS  Flight Assignment: Peter.norsk@nasa.gov  Flight Assignment: Campbell, John Ph.D. (Louisiana State University and A&M College)  COI Name (Institution): Campbell, John Ph.D. (Louisiana State University and A&M College)  Crucian, Brian Ph.D. (NASA Johnson Space Center)  Laughlin, Mitzi Ph.D. (University of Houston)  Grant/Contract No.: NNX17AB16G  Performance Goal No.:	PI Address 1:	112 Long Fieldhouse		
City:         Baton Rouge         State:         LA           Zip Code:         78803-0001         Congressional District:         6           Comments:         Comments:         2015-16 HERO NNJ15ZSA001N-Crew Health (FLAGSHIP, NSBRI, OMNIBUS).           Project Type:         FLIGHT         Solicitation / Funding Funding Health (FLAGSHIP, NSBRI, OMNIBUS).           Appendix A-Crew Health, Appendix C-Omnibus         Nappendix A-Crew Health, Appendix C-Omnibus           Start Date:         11/01/2016         End Date:         10/31/2018           No. of PbD Degrees:         0         No. of Master' Degrees:         0           No. of Master's Candidates:         0         No. of Bachelor's Degrees:         0           No. of Bachelor's Candidates:         0         Monitoring Center:         NASA JSC           Contact Monitor:         Norsk, Peter         Contact Phone:           Contact Email:         Peter.norsk@nasa.gov           Flight Program:         ISS           Flight Program:         ISS           Key Personnel Changes/Previous PI:         Campbell, John Ph.D. (Louisiana State University and A&M College) Crucian, Brian Ph.D. (Na/SA) Johnson Space Center)           COI Name (Institution):         Campbell, John Ph.D. (University of Houston) Simpson, Richard Ph.D. (University of Houston)	PI Address 2:	School of Kinesiology		
Zip Code: 70803-0001 Congressional District: 6  Comments:  Project Type: FLIGHT Solicitation / Funding Source: Appendix A-Crew Health, Appendix C-Omnibus  Start Date: 11/01/2016 End Date: 10/31/2018  No. of Post Docs: 0 No. of PhD Degrees: 0  No. of PhD Candidates: 0 No. of Master' Degrees: 0  No. of Master's Candidates: 0 No. of Bachelor's Degrees: 0  No. of Master's Candidates: 0 Monitoring Center: NASA JSC  Contact Monitor: Norsk, Peter Contact Phone:  Contact Email: Peter.norsk@nasa.gov  Flight Program: ISS  Flight Assignment: Source: Peter.norsk@nasa.gov  Flight Assignment: Campbell, John Ph.D. (Louisiana State University and A&M College)  Crucian, Brian Ph.D. (NASA Johnson Space Center)  Laghlin, Mitz i Ph.D. (University of Houston)  Simpson, Richard Ph.D. (University of Houston)  Grant/Contract No.: NNX17AB16G  Performance Goal No.:	PI Web Page:			
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Long duration spaceflights reportedly induce dysregulation of the immune system, which is considered a risk to

astronaut safety and mission success. Recent studies have examined the impact of long-duration spaceflight on specific markers of adaptive and innate immunity, but no study to date has comprehensively evaluated humoral immunity and serological markers of B-cell function. The aim of this study was to characterize changes in B-cell numbers and phenotypes, along with plasma immunoglobulins and polyclonal free light chains (FLC) - near 'real-time' biomarkers of immunoglobulin synthesis – in response to a ~6-month mission to the International Space Station (ISS). Methods: Whole blood and plasma samples were collected before flight, during ("Early flight", "Mid-flight" and "Late flight"), immediately upon return, and during a recovery period (R+18, R+30/R+33 and R+60/R+66) from 23 ISS crewmembers and 6 healthy ground-based controls. Total plasma immunoglobulin (Ig) and FLC levelss were measured throughout the duration of the mission **Task Description:** Results: There was no effect of spaceflight on kappa FLC concentrations (p>0.05), and only a marginal reduction was observed in lambda FLC levels upon return to Earth (p<0.05). Furthermore, IgG and IgM remained unchanged during and after spaceflight, when compared to pre-flight values (p>0.05). Of note, plasma IgA concentrations were elevated in-flight when compared to baseline and recovery values (p<0.05). Conclusion: These results indicate that B-cell homeostasis is maintained during long duration spaceflight in astronauts, advocating for potential in-flight vaccination as viable countermeasures against viral reactivation during exploration-class missions. Rationale for HRP Directed Research: This project bolstered our understanding of how physical and psychological stressors impact our immune system. We found that spaceflight-induced physical and psychological stressors led to an increase in serum IgA concentration, and that B-cell and plasma cell homeostasis were not affected by long duration spaceflight. Furthermore, this project **Research Impact/Earth Benefits:** highlighted the use of novel biomarkers of immune activation, plasma Free Light Chains, to monitor immune function in special populations (children, first responders, soldiers, elderly, etc.). The task is completed. This study investigated the impact of long duration spaceflight on plasma immunoglobulin Free Light Chains (FLC), IgA, IgG, and IgM. Additionally, we correlated changes in plasma FLC with salivary FLC, to identify non-invasive methods aimed at assessing changes in immune function during spaceflight. There was no change in plasma IgG and IgM concentrations in astronauts and ground-based controls throughout the mission (p>0.05). Astronauts exhibited an increase in plasma IgA during flight, when compared to baseline values (L-60/45). Upon return on Earth, plasma IgA concentrations decreased from in-flight levels, and were back to pre-flight values (L-60/L-45) during recovery (R+30) (p=0.047). All changes withstood adjustment for latent viral reactivation status and DNA load, along with estimated Glomerular Filtration Rate, an estimated measure of kidney function. There was no effect of spaceflight on plasma Kappa FLC (p>0.05), and only a minor decrease in the concentration of plasma Lambda FLC was observed immediately upon return on Earth (R+0) in crewmembers when compared to in-flight plasma Lamnda FLC concentrations (Early: p=0.03; Mid: p=0.005 and Late/R-1: p=0.012). The preferential reduction in plasma Lambda FLC at landing without any change in plasma Kappa FLC concentration led to a minor decrease in Kappa/Lambda ratio at the Mid-flight timepoint when compared to baseline L-60/L-45 and return R+0 and R+30 / ratio (pL-45= 0.029; pR+0= 0.037; pR+18=0.053; pR+33=0.037). As plasma FLC levels can be impacted by altered production from plasma cells and/or impaired clearance from renal metabolism, Cystatin C was measured to Task Progress: calculate estimated glomerular filtration rate (eGFR) and account for variation in renal function during spaceflight. There was no change in kidney function during flight (p>0.05), however post-flight eGFR values (R+30) were significantly lower than pre-flight values (L-60/L-45) (p=0.015). Subtle changes in plasma FLC withstood adjustment for eGFR. There was no effect of spaceflight on salivary flow rate (mL/min), and salivary Kappa FLC (mg.L) level (p<0.05). Interestingly however, reductions in salivary Lambda FLC (mg.L) levels upon return on Earth, mimicked changes observed in plasma FLC levels. As such, real-time measurement of salivary FLC could be used as a less-invasive alternative to assessing changes in immune function than plasma FLC measurements. In conclusion, this is the first study to comprehensively show that long-duration spaceflight in human astronauts has no - or very limited - effect on plasma cell antibody output. These important results suggest that plasma immune competency is maintained in microgravity, and that future in-flight vaccine-based countermeasures are likely to be efficient at further protecting astronauts from immune dysregulation and symptomatic latent viral reactivations during prolonged exploration class missions. A manuscript detailing the work supported by this research grant is currently under review by the Journal of Applied Physiology. **Bibliography Type:** Description: (Last Updated: 02/03/2020) Spielmann G, Campbell J, Crucian BE, Laughlin MS, Simpson RJ. "The Impact of Long Duration Spaceflight on the Function of Plasma Cells." American College of Sports Medicine 65th Annual Meeting, Minneapolis, MN, May Abstracts for Journals and 29-June 2, 2018. **Proceedings** Medicine & Science in Sports & Exercise. 2018 May;50(Suppl 1 5S):336. https://doi.org/10.1249/01.mss.0000536188.85345.86, May-2018 Spielmann G, Agha NH, Kunz HE, Simpson RJ, Crucian BE, Mehta SK, Laughlin M, Campbell J. "B-cell homeostasis is

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maintained during long duration spaceflight." J Appl Physiol (1985). 2019 Feb 1;126(2):469-476. Epub 2018 Nov 29.

https://doi.org/10.1152/japplphysiol.00789.2018; PubMed PMID: 30496712; PubMed Central PMCID: PMC6397409,