The STEM Presidential Management Fellows Program

Lucas Citro, Ph.D.

Interdisciplinary Graduate Programs Career Day
The Ohio State University
June 12th, 2015

Nasa Logo Transparent Background; cited 2015 May 26th; http://logo-kid.com/nasa-logo-transparent-background.htm

Who Am I?

- B.S. (2007): Physics, Kent State University
- M.S. (2012): Biophysics, The Ohio State University
- Ph.D. (2013): Biophysics, The Ohio State University
- Currently: 2014 Presidential Management STEM Fellow; Aerospace Technologist, NASA's Johnson Space Center
  - Biomedical Research and Environmental Sciences Division of Human Health and Performance Directorate
  - Member of Bone Mineral Laboratory and Cardiovascular Laboratory

Outline

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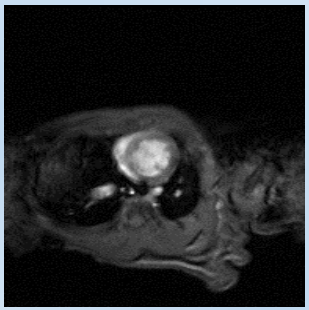
- Overview of Biophysics graduate research (very brief)
- The Presidential Management Fellows Program
  - Overview, application process, STEM track
- My research interests at NASA's JSC
  - Bone Mineral Laboratory
  - Cardiovascular Laboratory

Biophysics Graduate Research

- Dissertation title: “High-field cardiac magnetic resonance imaging in small animal models of cardiovascular disease” (2013)
- Utilized high-field, non-clinical MRI systems: 9.4 tesla (T) and 11.7 tesla (T)
- Examined murine models of heart disease: myocardial infarction (IR injury, permanent LAD coronary artery ligation), pulmonary hypertension, diabetic cardiomyopathy
  - Therapies: cell-based (MSCs, iPSC-CMs), hyperbaric oxygen treatment, exercise



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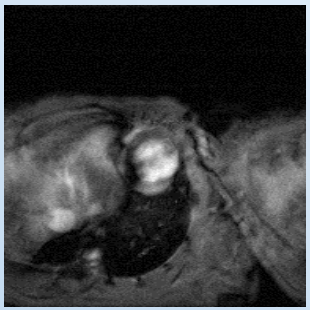
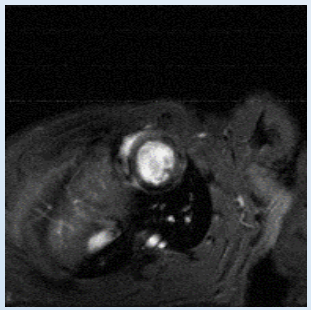


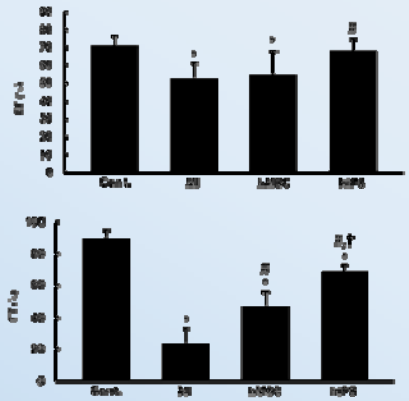
MI



MSC

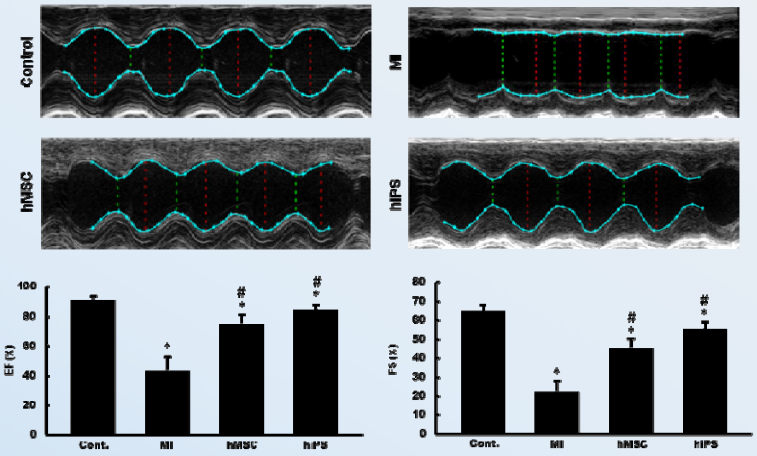
hiPS

iPSC-CM: Cardiac Function (MRI and Echo)



- Wk. 4 ejection fraction of iPSC group larger than MI ($p<0.05$) and approximately equal to control
- Wk. 4 fractional wall thickening (FT) of iPSC group larger than hMSC ($p<0.05$)

- Wk. 4 ejection fraction and fractional shortening of hMSC and iPSC groups larger than MI ($p<0.05$)
- Wk. 4 EF, FS of iPSC group larger than that of hMSC group



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Entering the Federal Workforce

- General announcements: specific positions in specific locations posted on usajobs.gov when available
- Post-doctorate: length not explicitly defined, conversion to term or permanent position not guaranteed
- Recent grad position: graduation within two years prior to application required, one-year position, conversion based on performance (not guaranteed)
- Presidential Management Fellows Program: graduation within two years prior to application required, advanced degree required, conversion based on performance (not guaranteed)

The Presidential Management Fellows Program

- The flagship leadership development program for advanced degree applicants (within past two years) wishing to begin a career in the United States Federal Government[1-2]
- Highly competitive, prestigious two-year program aimed at developing tomorrow's government leaders
- Created under Executive Order by President Carter in 1977[3]
- Post-fellowship career options for PMF's: federal service, academia, private sector, nonprofit organizations[2]

PMF PRESIDENTIAL MANAGEMENT FELLOWS PROGRAM
U.S. OFFICE OF PERSONNEL MANAGEMENT

1) Overview: Presidential Management Fellows (PMF) Program; cited 2015 May 26th; http://tinyurl.com/cvjnnns. 2) What do you want to change about government; cited 2015 May 26th; http://www.pmf.gov/opportunity/index.aspx. 3) History; cited 2015 May 26th; http://pathtopmf.com/pmf-program/. 4) Presidential management fellows: SPEA info session; cited 2015 May 26th; http://tinyurl.com/qzeqgdl.

PMF: Selection Process

- Very difficult two stage selection process[5] (6 months between applying and selection)
  - Phase 1 (October): application (resume, transcripts, etc.) and online assessment (situational judgment evaluation; questionnaire; essay questions)
    - Notified of semi-finalist status in November
  - Phase 2 (February): half-day in-person assessment (behavioral interview; group exercise; written exercise)
    - Notified of finalist status in April
- Desired qualities
  - Hard skills (problem-solving, oral communication, written communication)
  - Soft skills (interpersonal skills, adaptability, motivation to serve, personal accountability)

5) Introduction; Presidential management fellows (PMF) program 2015 assessment preparation guide; cited 2015 May 26th.

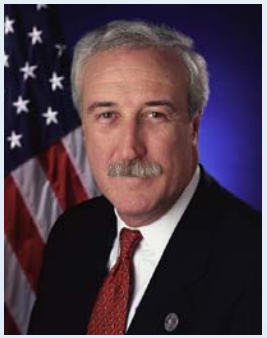
PMF: Securing a Position

- Nearly 7,000 applicants in 2014 → 609 Finalist (91 STEM)[6]
- Finalists have one year to secure position
  - Finalist can apply to any participating federal agency (TAS)
  - NASA has committee that selects finalists and sends their information to relevant centers (center's review committee reviews finalist and selects interviewees)
  - Participating departments and agencies
    - Departments: DOD, DOE, USDA, DOJ
    - Agencies: EPA, USAID, NASA

6) Official list of finalist for the PMF class of 2014; cited 2015 May 26th.

PMF: Opportunities and Alumni

- Programs offers[2]
  - 160 hours interactive training (leadership, management, etc.; 80 h/y)
  - Challenging work assignments (at least one 4 to 6 month developmental assignment)
  - Individual development plan (with evaluations)[7]
  - Promotions
  - Completion allows conversion to permanent or term position
- Alumni[8]
  - Colleen Hartman[9]: Deputy Director for Science, Operations, and Program Performance (Goddard Space Flight Center)
  - Sean O'Keefe[10]: former NASA Administrator



7) Current PMFS: owning your experience; cited 2015 May 26th; http://www.pmf.gov/current/index.aspx. 8) Presidential management fellows program; cited 2015 May 26th; http://en.wikipedia.org/wiki/Presidential_Management_Fellows_Program. 9) News; cited on 2015 May 26th; http://www.nasa.gov/centers/goddard/news/releases/2012/12-59.html. 10) Sean O'Keefe; cited on 2015 May 26th; http://en.wikipedia.org/wiki/Sean_O%27Keefe.

The PMF Program: STEM Track

- 2012: President Obama directed agencies to advance the development of science, technology, engineering, and mathematics (STEM) occupational disciplines[11]
- 2014: PMF Program piloted STEM Track
- Eligible advanced degrees: biological sciences, physics, medicine, chemical engineering, etc.[11]
- Following fellowship, STEM PMFs manage R&D programs, perform world-class science and engineering R&D, develop informed policies, lead federal science enterprise[11]

11) The opportunity: PMF STEM; cited 2015 May 26th; http://www.pmf.gov/the-opportunity/pmf-stem.aspx.

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NASA's Human Research Program: Risks

- NASA's HRP charged with understanding and mitigating, through applied research, the 31 human health risks associated with spaceflight
- Behavioral and physical risks exist[12]
  - Risk of adverse health event due to altered immune response
  - Risk of radiation carcinogenesis
  - Risk of adverse cognitive or behavioral conditions and psychiatric disorders
  - Risk of bone fracture due to spaceflight-induced changes to bone
  - Risk of spaceflight-induced intracranial hypertension/visual alterations

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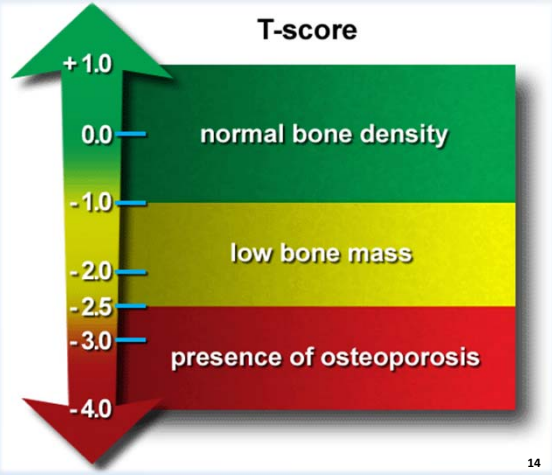
12) Human research roadmap; cited 2015 May 27th; http://humanresearchroadmap.nasa.gov/explore/. 13) Human research program; cited 2015 May 27th; http://en.wikipedia.org/wiki/Human_Research_Program.

Risk of Bone Fracture Due To Spaceflight-induced Changes To Bone

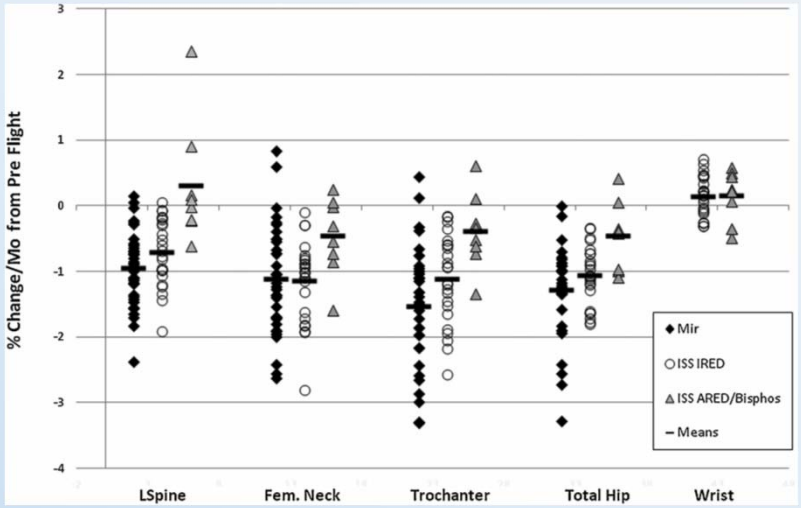
- Osteoporosis is associated with decreased bone strength and increased risk of bone fracture
- Spaceflight-induced bone loss occurs at much higher rate than terrestrial bone loss: 2-3%/y in postmenopausal women[15], 1.06 – 1.56 %/mo in Mir cosmonauts[16]
- NASA has adopted terrestrial-based test and scoring system to evaluate whether or not an astronaut has osteoporosis: dual-energy x-ray absorptiometry-based areal bone mineral density (DXA-based aBMD) and T score

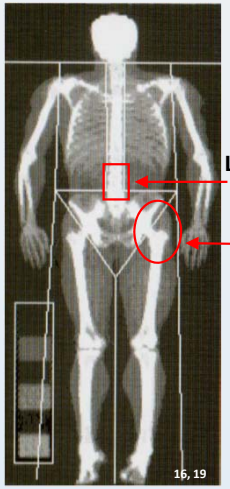


14) Bone mineral density (BMD); cited 2015 May 28th; http://tinyurl.com/onh6lap. 15) Riggs, et al.; 1986; New Eng J Med. 16) LeBlanc, et al.; 2000; J Musculoskel Neuron Interact. 17) DEXA Scans; cited 2015 May 28th; http://allwomenobgyn.com/in-office-scans/dexa-scans/.

ARED and Bisphosphonates

- Advance resistive exercise device (ARED), bisphosphonate have prevented spaceflight-induced decrease in aBMD (DXA)[18]





Lumbar Spine
1% / mo

Hip
1.5% / mo

- BMD is not the only component of bone quality that describes a bone's ability to resist fracture[20]

18) Orwoll, et al.; 2013; JBMR. 19) Courtesy of Jean Sibonga (adapted by Lucas Citro). 20) Bouxsein; 2003; Osteoporos Int.

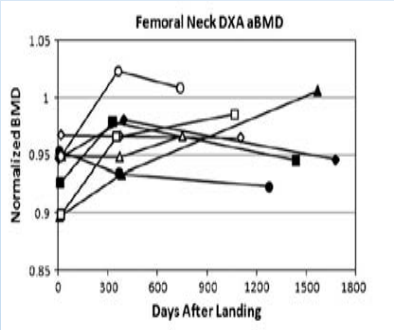
Spaceflight as a Rare Disease

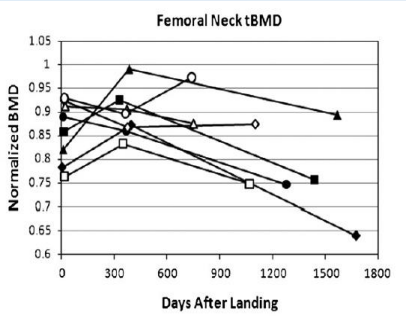
- Bone is lost from bone compartments during spaceflight at rates different than rates associated with aging (DXA can not detect)
  - Decrease in hip trabecular vBMD[21]: cosmonaut = 2.2 – 2.7%/mo; age-related = 14.8 – 23.9% for 5.05 y[22]
  - Strength associated with specific astronaut BMD may not be equivilent to strength associated with the same BMD for terrestrial population
- Adjuvant therapy with bisphosphonates and ARED: prevents loss of bone strength in most, but not all astronauts → individualized care with sensitive technology necessary

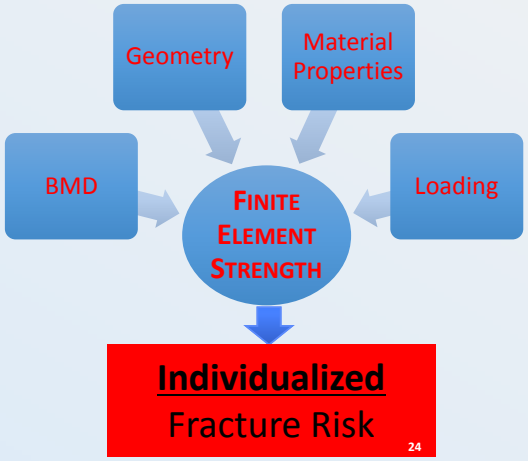
21) Lang, et al.; 2004; JBMR. 22) Lang, et al.; 2012; Bone.

QCT and FEA

- Quantitative computed tomography (QCT): provides additional information not available using DXA (long-duration ISS astronaut data shown)[23]





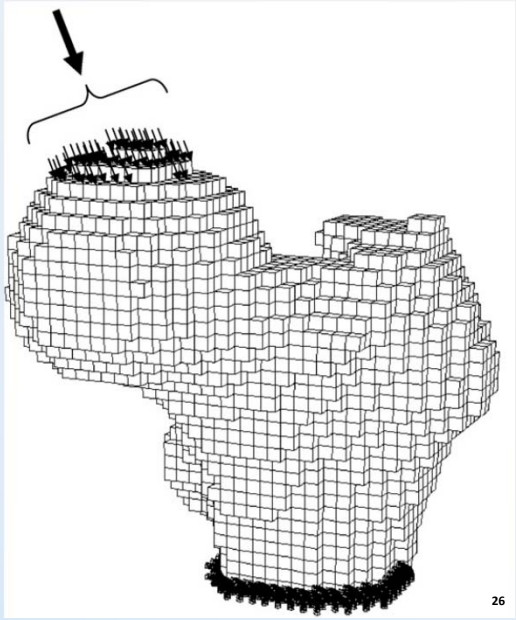


- QCT-based finite element analysis (FEA): QCT hip images analyzed to yield bone strength information
- JSC's Bone Mineral Laboratory: working to adopt QCT as additional technology to monitor crew health

23) Carpenter, et al.; 2010; Acta Astronautica. 24) Courtesy of Jean Sibonga.

QCT-based FEA

- Calibrated density of each voxel in QCT image is estimated based upon image contrast[25]
- Ash density of each voxel derived from calibrated image voxel density[25]
- Material characteristics of bone, such as elastic modulus, can be calculated from ash density[25]
    - Bone strength can be modeled in stance and posterior-lateral simulated fall orientations[25-6]
        - Maximum bone strength: maximum reaction force of bone when external force applied to bone, during modeling[26]



25) Keyak, et al.; 2005; Clin Orthop Relat Res. 26) Keyak, et al.; 2009; Bone.

MRI-based FEA

- Terrestrially, high field MRI (3 T, 7 T) has recently been proposed as non-invasive, non-radiative method to assess bone microarchitecture, in both distal (wrist, distal femur) and proximal (proximal femur) sites[27-9]

- MRI-based FEA has shown promise as tool to quantify the decreased elastic moduli observed in the hips of fracture patients with DXA T-scores similar to those of non-fracture patients[30]
  - Three dimensional FLASH scan used: TR/TE = 31/4.92, α = 25^{o}, 512x512, 0.234 mm x 0.234 mm voxel size, 25 min scan time (3 T)

- JSC's Bone Mineral Laboratory: will examine utility of MRI (and MRI-based FEA) in spinal cord injury (SCI) patients (from bone perspective, SCI is surrogate of spaceflight)

27) Chang, et al.; 2011; Magn Reson Mater Phy. 28) Chang, et al.; 2012; J Bone Miner Metab. 29) Chang, et al.; 2013; J Magn Reson Im. 30) Chang, et al.; 2014; Radiology.

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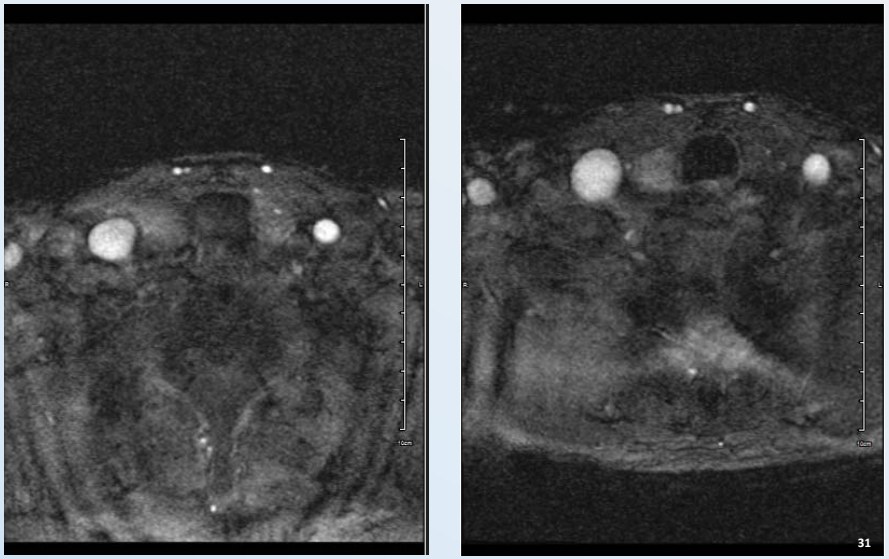
Risk of spaceflight-induced intracranial hypertension/visual alterations

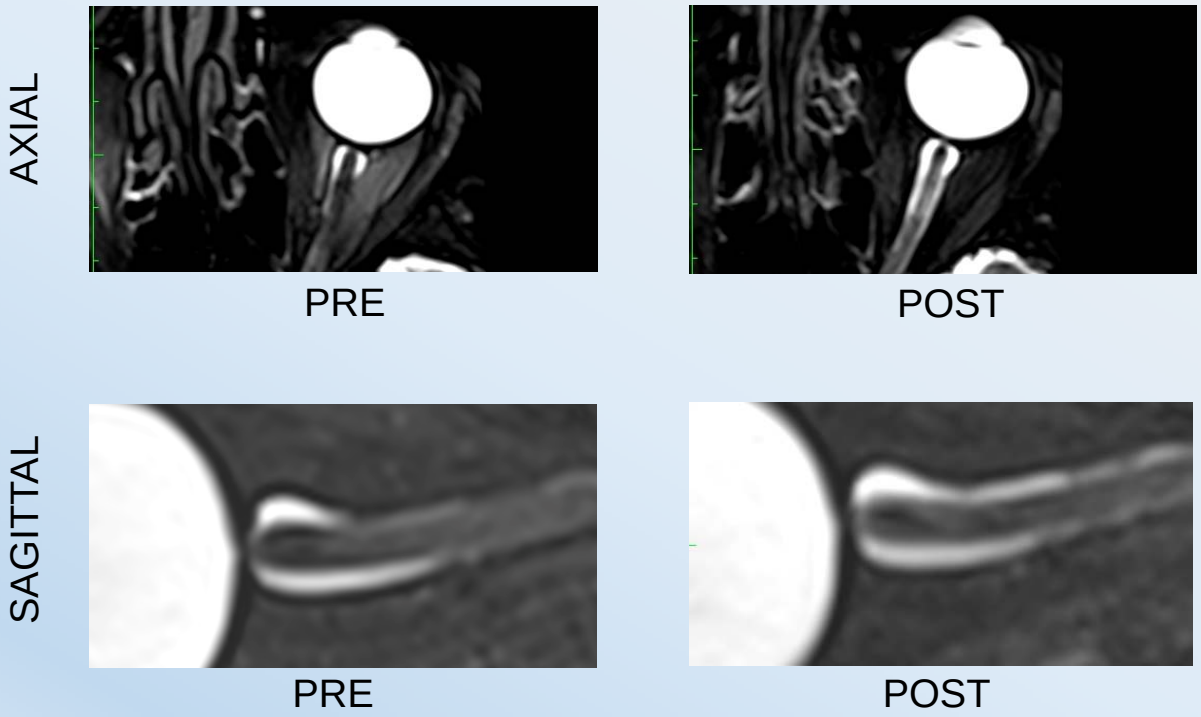
- Our body's blood supply is unevenly distributed under normal influence of gravity
- Spaceflight induces a cephalad fluid shift: thought to be related to visual impairments experienced by long-duration astronauts
- Presents as globe flattening, increase in optic nerve sheath diameter, and visual impairment
- JSC's Cardiovascular Laboratory: seeks to characterize and understand phenomenon through ultrasound and MRI studies (supine and 15^{o} head-down tilt)



31) Courtesy of Michael Stenger.

Ocular MR Images

- T2-weighted, fat saturation MR images of left eye before and after 15º head-down tilt (fluid: bright)[31]



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All of You

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The Ohio State University

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- Ralf Bundschuh, Ph.D.
- Charles E. Bell, Ph.D.
- Mithila V. Agnihotri
- Lakisha M. Mays

My Family

God

Questions

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PMF Program

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Thank you! I am excited to answer your questions (albeit not as excited as these guys)!