Translational Research Institute for Space Health
Red Risk 2019

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1. The goal
2. Red Risks!!
3. TRISH...Translational Research Institute for Space Health
   - Our mission
   - Areas of interest
   - Our portfolio
   - Recent Solicitations
4. How to get TRISH funding
Delayed Communications
Limited Supplies + No Resupply
No Immediate Return
More Radiation
Confined space
WHAT IS TRISH?

A partner to NASA HRP that takes risks

Focused on translating disruptive approaches to reduce risk during deep-space exploration — Health and Performance

Committed to supporting a diverse and intellectually-rich expert community

A lean virtual institute

A Consortium

Funded through a Cooperative agreement with NASA to Baylor College of Medicine

• 6-year performance period + 6 more?

In its 3rd year of operations (Established 10/1/16)
1. Translational Research Program
   Portfolio of science and technology projects

2. Scientist Program
   Supports outstanding researchers and scientists at all stages
   - Postdoctoral Fellowships
   - Academy of Bioastronautics
   - Research Opportunities for Future NASA Flight Surgeons
   - Visiting Scientists
   - Senior Science Managers

3. Supporting Program
   Workshops
   - Red Risk School (March 2018 and 2019)
   - Spaces in Space — Enhanced Environments (Feb 2019)
   - A. I. Workshop (July 2018)
   - VR / AR Workshop (Jan 2019)
TRISH Website: News & Events

Click on the workshop in the banner

Augmented/Virtual/Extended Reality for Improving Health in Space

Spaces in Space Workshop
TRISH DELIVERABLES

1. Knowledge
2. Software
3. Hardware
4. Methods
5. Procedures
6. Therapeutics
7. Trained Scientists
Endow our astronauts with tools and knowhow, so they can -

- Perform self-reliant medical care
- Mitigate damage from space radiation and other environmental hazards
- Maintain Physical and Behavioral Health

www.bcm.edu/spacehealth
47 projects

55% are led by principal investigators new to NASA HRP

30% are led by companies or are collaborating with companies

TRISH portfolio mix by grant type
13 HRP Risks Addressed

Percent of Portfolio Funding Obligated by Risk

- BMed: 15%
- Cancer Biological CMs: 2%
- Degen/ CVD: 17%
- Food: 8%
- HSID: 8%
- Immune: 6%
- Late CNS: 2%
- Medical: 14%
- Microhost: 6%
- Osteo: 4%
- SANS: 12%
- SM: 4%
- Stability: 2%

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SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME (SANS)

Hyperopic Shifts
Up to +1.75 diopters

“Cotton wool” Spots

Choroidal Folds

Optic Disc Edema

Scotoma

Globe Flattening

Normal Globe
Flat Globe

Increased Optic Nerve Sheath Diameter

+ICP

Optic nerve

Sclera
Cornea
Retina
Pupil
Lens
Iris
Ciliary body
Choroid
Fovea

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Increased Optic Nerve Sheath Diameter

+ICP
FLUID SHIFTS IN REDUCED GRAVITY

Image adapted from Hargens & Richardson, Respiratory Physiology & Neurobiology, 2009
COMPLETED: SELF-OPERATED IMAGING OF RETINA

Single Person Operation (Saves Astronaut Time)
No Skill Needed
Idle Until Eye Detection (Low power consumption)
Pupil Auto-Alignment (No Dilation)
Retinal Auto-focusing
No dilation
Auto-Image Capture (50+ degrees wide image)
Software for Image Management/Storage

Planning Phase 3 = Flight Ready
Compact + Smart Analysis of Image
Photoacoustic Lymphatic Imaging

Simulated

Flow

Experimental

Time: 0 s

Lihong Wang
Xiaoming Wei
Caltech

Label Free

TUT: tagging ultrasonic transducer
UTA: ultrasonic transducer array

Temperature

37
36.9
36.8
36.7
36.6
36.5
36.4
36.3
36.2
36.1
36

PA amplitude

0.5
1
Complex Human \textit{In-vitro} Models – SANS

- Replicate SANS \textit{in-vitro}
- Study mechanisms
- Modify genetics, structure, pressure, gases
- Study optic nerve-retinal interface

3D biomimetic cell-based nerve model

https://axosim.com

https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20170009173.pdf

ON THE HORIZON…
Putting State-of-the-art Diagnostic Tools in the Hands of Mars Explorers

VisualDx
- healthcare informatics
- Improves diagnosis

Combines a knowledge base, image collection, and machine learning to improve medical decision-making.

50K+ Active Users
77M Images viewed in 2018
41K Image database

Used by over 2,300 hospitals, clinics, 90+ medical schools worldwide.

www bcm edu/spacehealth
Easily measure multiple biomarkers from a finger stick of blood directly in front of the patient

Obtain laboratory quality results in less than 15 minutes

Detect disease early

Monitor patient health

Share data. HL7 FHIR integration with patient care systems.

<table>
<thead>
<tr>
<th>Test</th>
<th>Clinical Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>NT-proBNP</td>
<td>Heart</td>
</tr>
<tr>
<td>D-Dimer</td>
<td>Cardiovasc</td>
</tr>
<tr>
<td>Troponin T</td>
<td>Heart</td>
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<td>hsCRP</td>
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<td>Creatinine</td>
<td>Kidney</td>
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<tr>
<td>ALP</td>
<td>Liver</td>
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<tr>
<td>AST</td>
<td>Liver</td>
</tr>
</tbody>
</table>

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Human Radiation-Protection Approaches

DNA-Damage-Suppressing Proteins (DDSPs) identified by similarity to *E. coli* homologs

Overproduction reduces cellular endogenous DNA damage

A Human DNA damage-down candidate validation scheme

- HEK293T
- 72h
- transient expression

B DNA damage analysis
- HEK293T
- 72h
- assay I, γH2AX
- assay II, p-p53

C Level of GFP-fusion protein produced

- HEK293T
- 72h
- transient expression

- DNA damage

- γH2AX intensity (au)
- GFP intensity (au)

- untransfected
- TUBULIN
- TXNDC15

- Human DNA damage-down candidate genes
- 80+ candidate genes

- approved
- DNA damage analysis
- Flow cytometry

- tested candidate human DNA damage-down genes

(cyan: mTOR genes, grey: *E. coli* damage-down homologs, purple: Tubulin)
Mining biology's extremes for new space radiation resistance strategies

96 transgenic fly lines, each expressing a single Tardigrade gene — Tested for Heavy Ion Radiation Resistance

An unbiased screen for genes that enhance radiation resistance in the *Drosophila* hindgut.

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Radiation Countermeasures Program

1. Can we use, for the first time, these technologies to study GCR on HUMAN tissue to understand impact on tissue and function?
   - Cerebrovascular
   - Cardiovascular
   - GI
   - Bone Marrow
   - Skin

2. Can we use novel countermeasures from our portfolio to test in these models?

Transdisciplinary team grant: human in vitro models, modeling/simulation, stem cells, pathologist, radiation biologist, radiation physicists
Recently Selected Projects for BRASH1801

Non-Pharmacological Improvement of Human Performance

Photobiomodulation
Allen: U. Arkansas
Dmchowski: CCNY

Stochastic Resonance
Anderson: U. Colorado

Transcranial Magnetic Stimulation
Roberts: U. Arkansas

SmartSleep
Dinges: U. Pennsylvania
Tononi: U. Wisconsin

Focused Ultrasound
Yoo: Brigham & Women's Hospital

Auditory / Vestibular Noise

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Recently Selected Projects

Algorithms for Health Prediction

Cognitive/Behavioral Conditions
Basner: U. Pennsylvania

Personal Omics Profiling
Mias: Michigan State

Environmental Stressors
- CO₂ and O₂ Levels
- Radiation Levels
- Temperature Levels
- Noise Levels

Operational Variables
- Slam Shifts
- Dockings
- EVAs
- Crew Size

Sleep & Drugs
- Sleep Duration
- Sleep Quality
- Sleep Onset Latency
- Awakenings
- Medication Use
- Caffeine Consumption

Self-Reports
- Tiredness
- Mental Fatigue
- Physical Exhaustion
- Stress
- Workload
- Test Difficulty

Performance

Enhanced Food

Duckweed
Demmig-Adams: U. Colorado

SPACE Tomatoes
Jinkerson: UC-Riverside

↓ Biomass  ↓ Required inputs  ↑ Nutrition  ↑ Taste test

↑ CO₂ use  ↑ Nutrition  Taste test
Recently Selected Projects

Counteracting Radiation Effects

miRNA Markers & Therapy
Beheshti: NASA AMES

Gene Therapy
Bowles: Duke
Proteins → Plasmids
AIF1, GRP75, GRP78, Dsup

Adeno-associ. Viral Vector
C57BL/6 strain

Medication Shielding
Kaplan: Tufts Univ.

Peptide Nucleic Acid Therapy
Chatterjee: U. Colorado

Medication
Water
Silk
RECENT TOPICS TO BE FUNDED THROUGH BRASH1901

TOPICS
1. Ophthalmic Imaging as a Means of Assessing Overall Health
2. Physical Health Surveillance of Astronauts on Deep Space Missions
3. Enriched Spaceflight Environments for Behavioral Health
4. Augmented Medical Knowledge and Guidance on Deep Space Missions
5. Personalized Detection of Space Radiation-Induced Biological Damage
6. “Just in Time” Medications

FUNDING
Budget up to $400,000 annually with a project duration of 2-years

KEY DATES
March 19 - Notifications Sent
May 10 — Step-2 Proposals due by 5:00 p.m. ET
September 26 or 27 — SAB virtual meeting for selection recommendations
October - Selections Announcement

Examples of TRISH R&D academic, some industry
INDUSTRY TRI-IND-1901 SOLICITATION

Facilitated by Consortia for Improving Medicine with Innovation In Technology (CIMIT), TRISH is sought proposals on the 8 topics below. TRISH invites all categories of U.S. companies to submit proposals to develop space-compatible health solutions. Requires 100% cost sharing. Can be in-kind.

TOPICS

1. Multiparameter health assessment through ophthalmic imaging
2. Components of an integrated physical health surveillance system
3. Gaming tools for behavioral health and beyond
4. Advanced medical training and guidance system for spaceflight
5. Advanced human-computer interfaces (HCI)
6. Onboard manufacturing of medication active ingredients
7. Lab-tests-to-go... into space
8. AI-supported medical diagnostics

FUNDING

Budgets up to $250,000 annually with a project duration of 1-year

KEY DATES

April - Selection Announcement
FOCUSED INVESTIGATION PROJECTS

Projects can include:
1. Investigator-initiated projects that represent timely and exciting opportunities but whose focus fall outside recent or planned topic-focused solicitations; or
2. Projects requested by TRISH management of investigators with specialized knowledge or resources.

FUNDING and TIMELINE
Flexible

KEY DATES
Open year round

TRISH is exploring a change in the FIP policy to capture more R&D opportunities...stay tuned!!!
GETTING FUNDING THROUGH TRISH

Step 1

Does it fit the TRISH mission?

Perform self-reliant medical care
Maintain Physical and Behavioral Health
Mitigate damage from space radiation and other environmental hazards

Step 2


Step 3

Look for open solicitations (academic and industry)
OR
FIPs (open call, HIGHLY competitive)

Step 4

Are we missing something?...

Send us ideas, topics areas of interest for deep space biomedical research!!! It could end up as a topic for solicitation!

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