



GeneLab: “Omics” Data System for Space Biology Research

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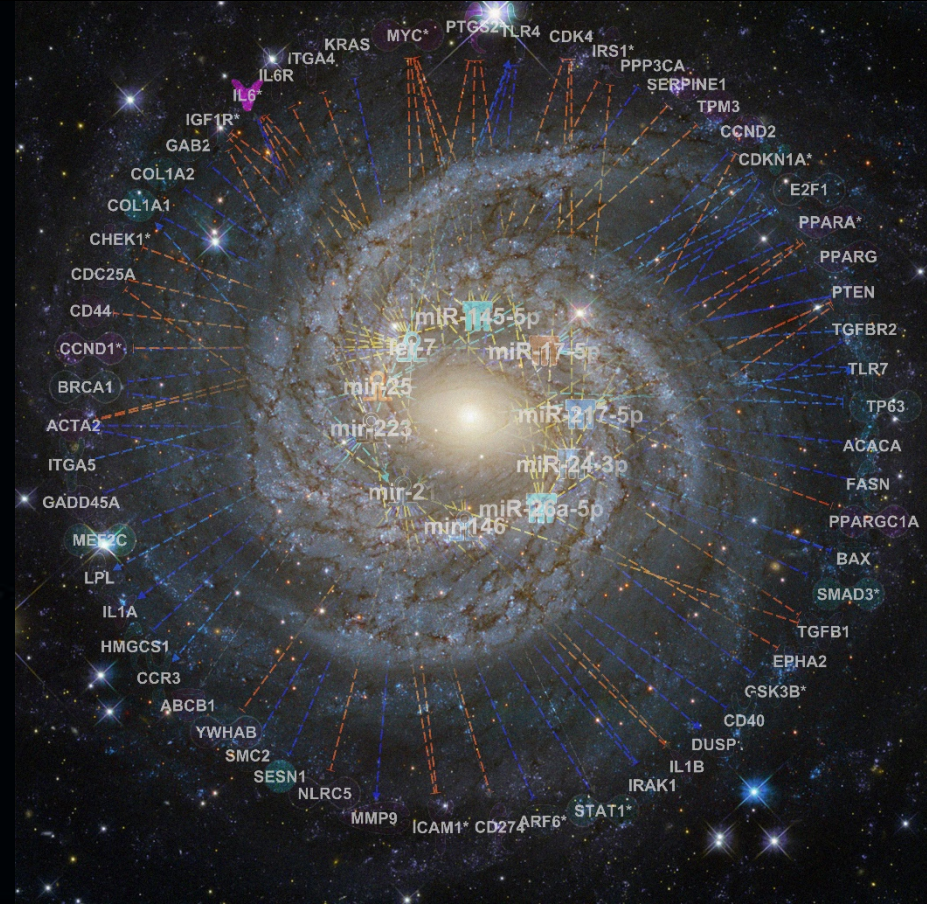
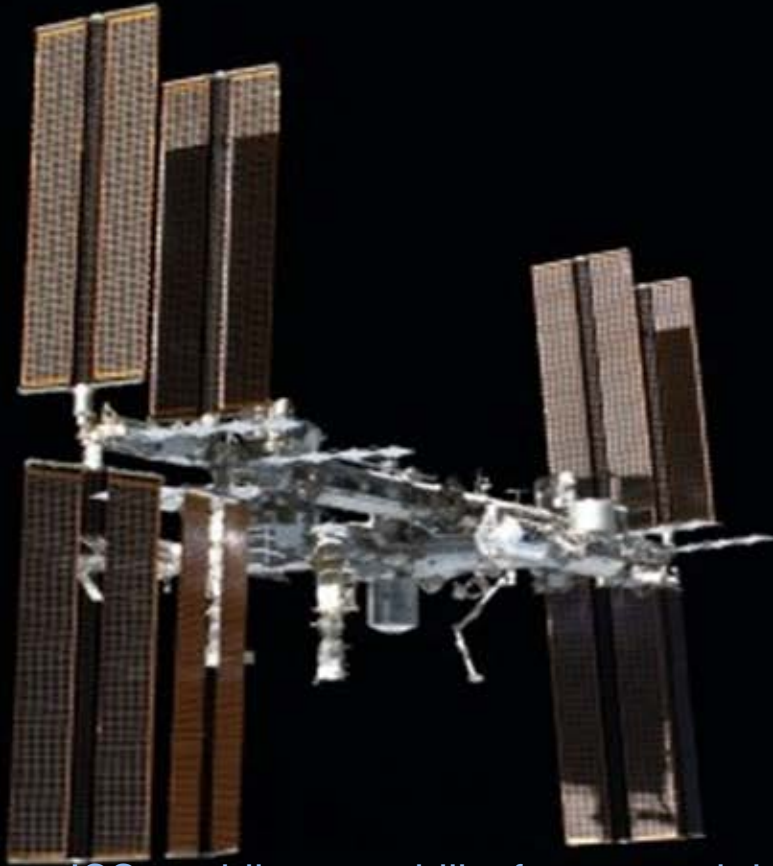
Marla Smithwick, MSc, PMP: Deputy Project Manager
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Space Biosciences Division
NASA Ames Research Center, Moffett Field, CA

Sylvain Costes, PhD: Project Manager

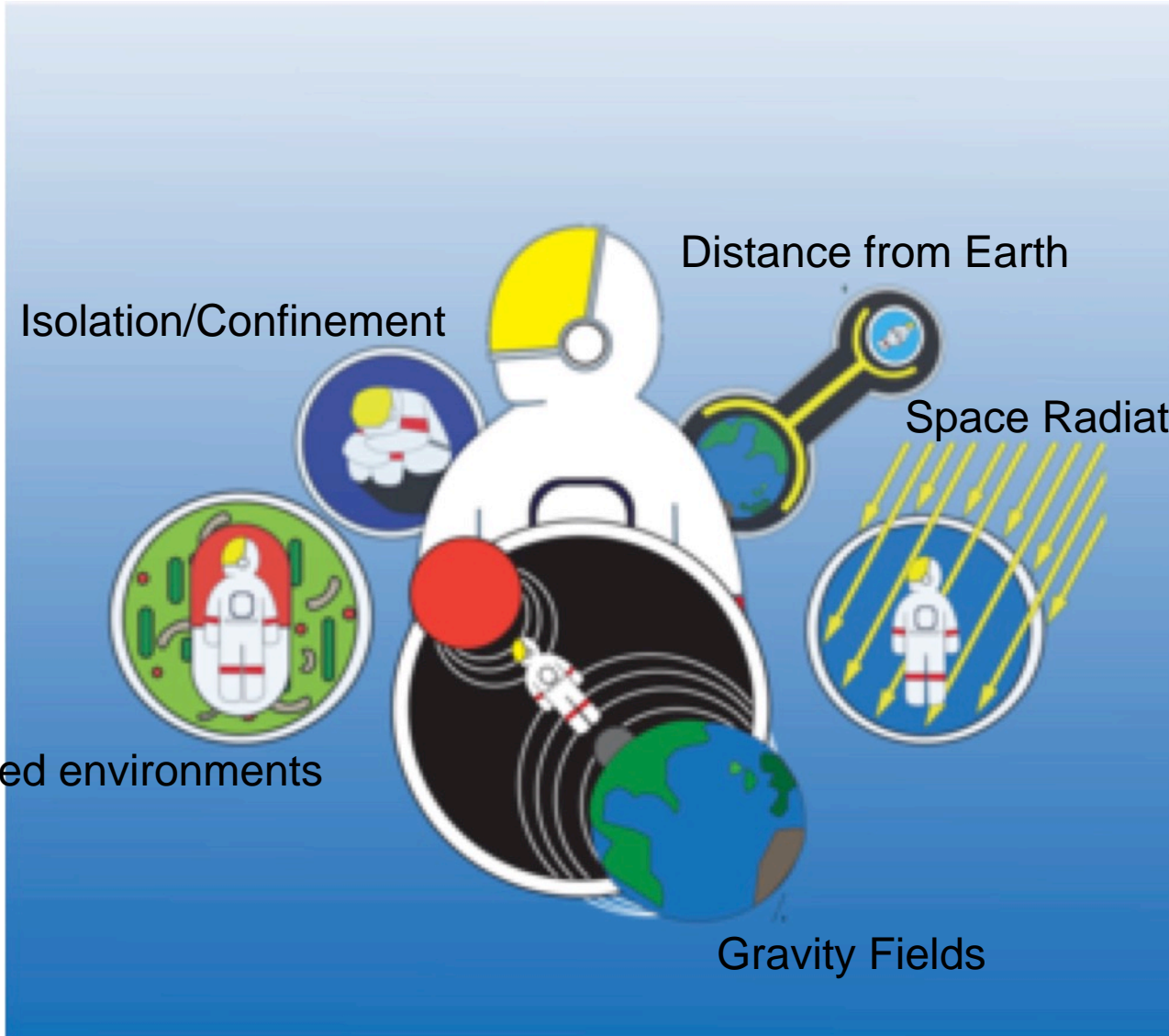
Jonathan Galazka, PhD: Project Scientist

The GeneLab Team



ISS enabling capability for research in cellular and molecular biology includes equipment for *in situ*, on-orbit analysis of biomolecules

Applications of this growing capability range from biomedicine and biotechnology to the growing field of Omics

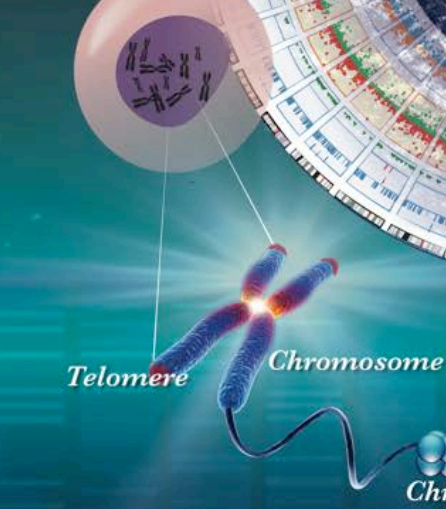




OMICS

A Circular
Genome
Visualization

Human Cell



Telomere

Metabolites

Proteins

RNA

Telomere

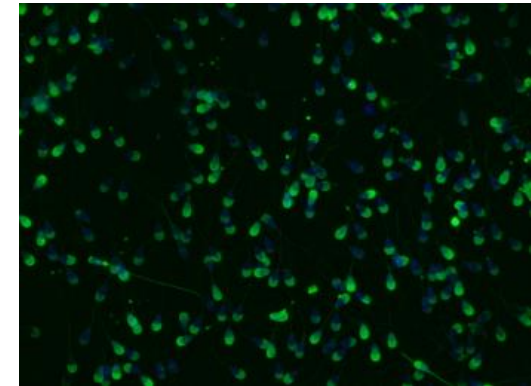
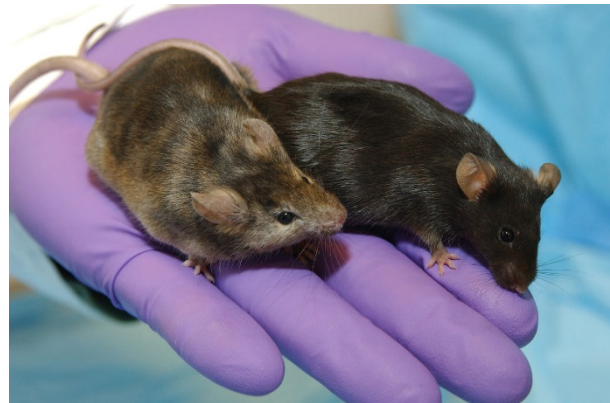
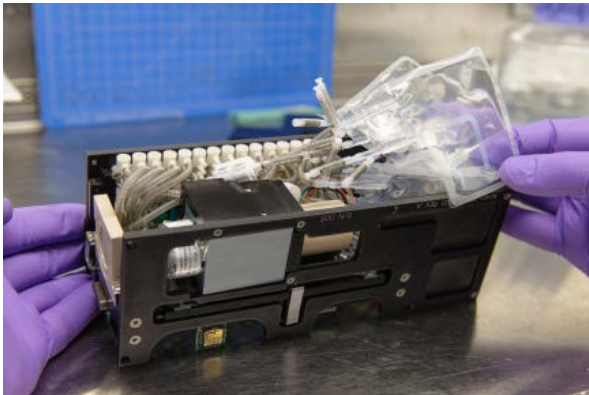
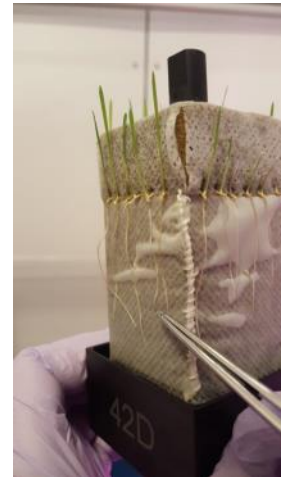
Methyl
Groups

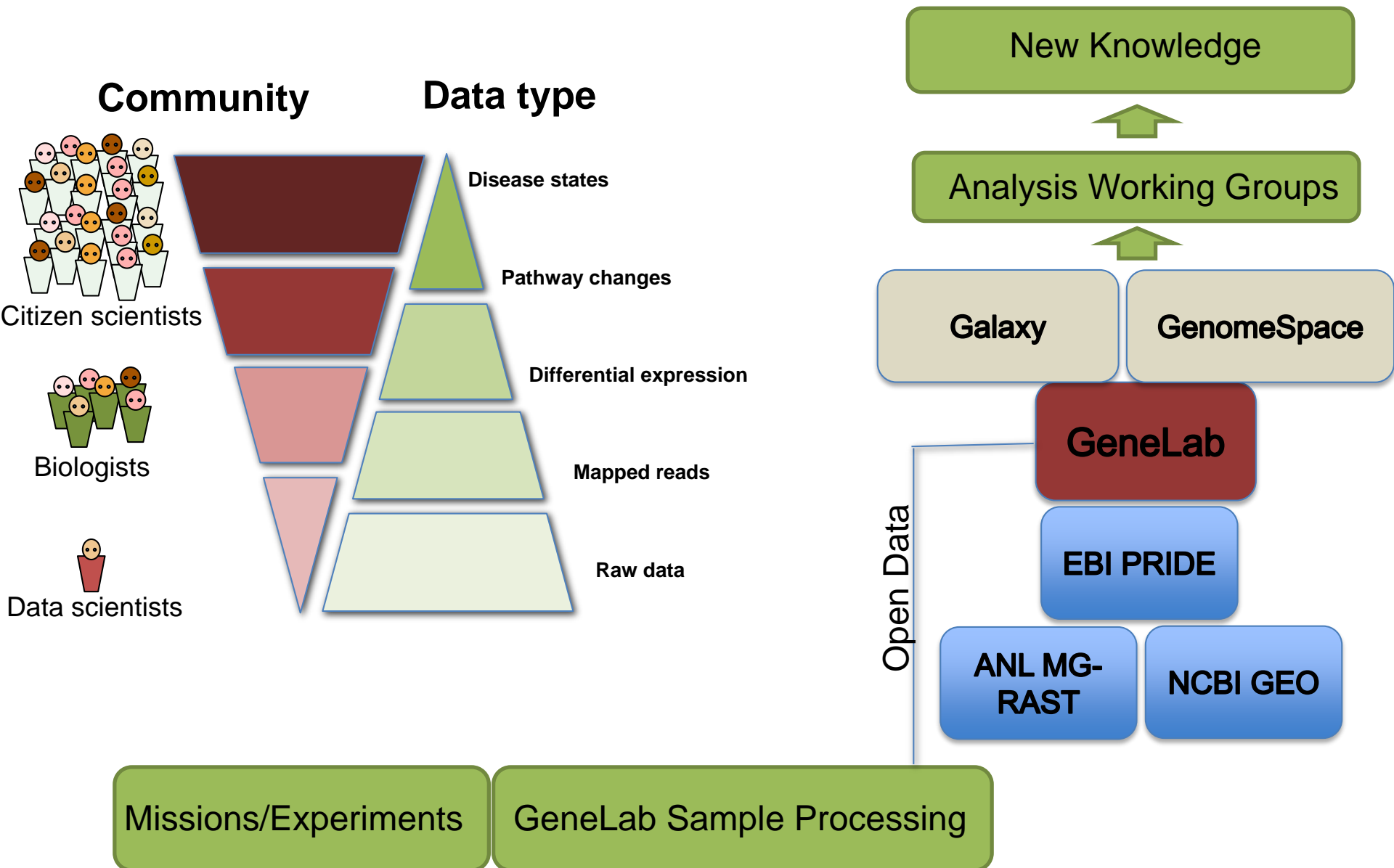
DNA

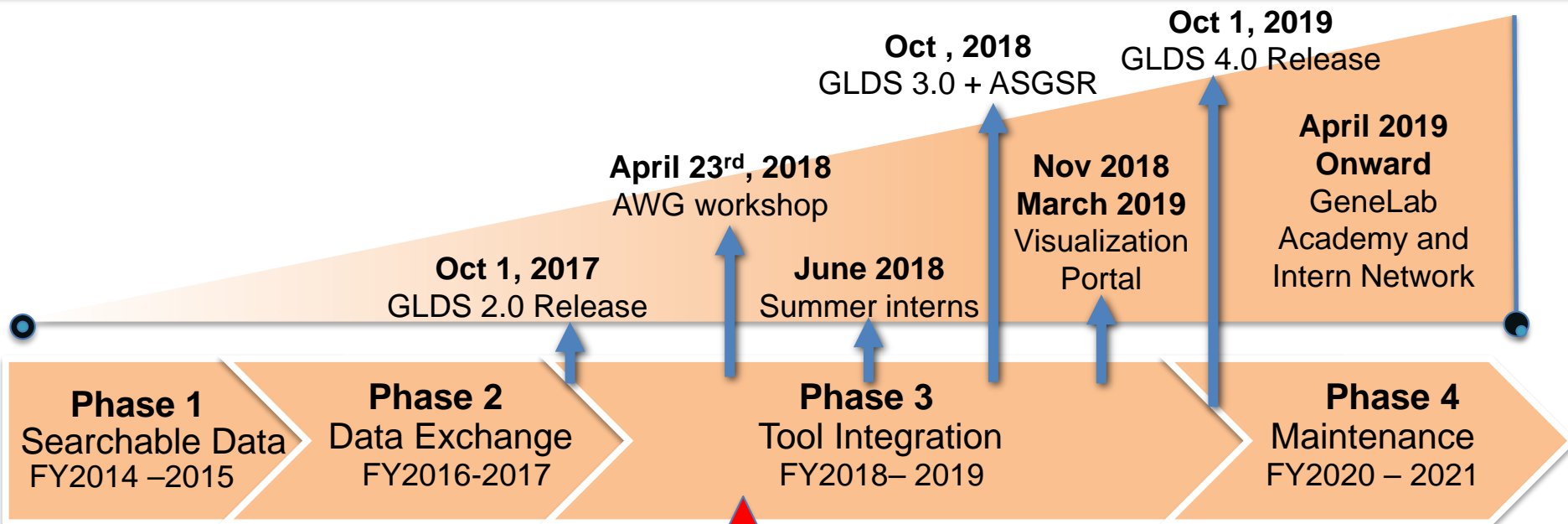
A Journey to See More Than Ever Before

◆ Space Biology Payloads Launched on SpX-13

- Rodent Research-6
- Cell Science Validation
- Plant Gravity Perception
- Microbial Tracking – 2
- APEX-06
- Fruit Fly Lab
- Micro-11





**Data System**

- ✓ Public Website
- ✓ Searchable Data Repository
- ✓ Top Level Requirements
- ✓ New Data and Legacy Data

Data System

- ✓ Link to Public Databases via Data Federation
- ✓ Integrated Search (e.g., data mashup)

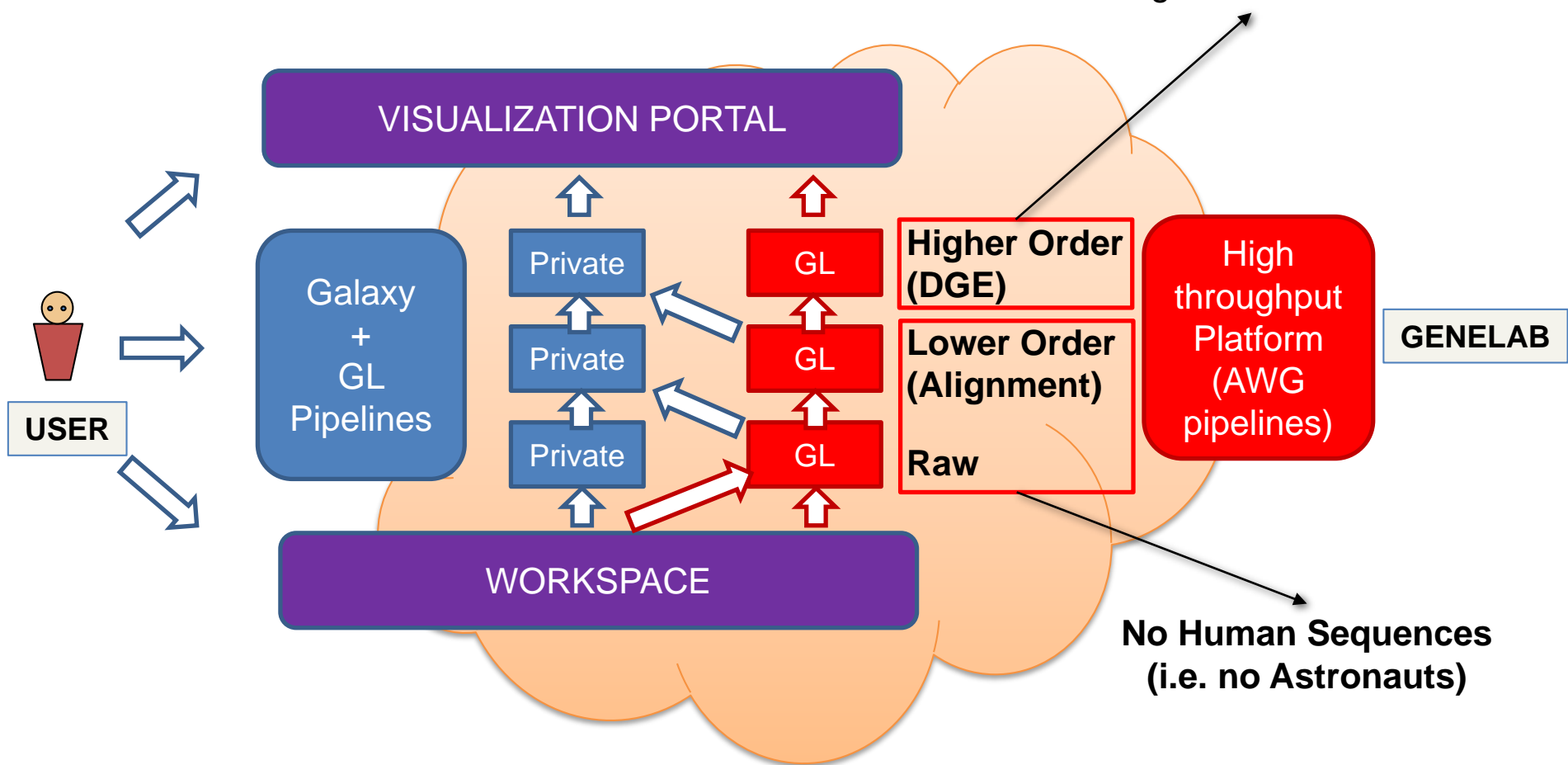
Data System

- Integrated Platform across model organisms
- Build Community via AWG
- Provide access to biocomputational tools for omics analysis
- Provide collaboration framework and tools

Open Source Maintenance

- User community becomes primary provider of new tools/knowledge
- Maintain integrity of data, and data system

**Astronaut Data should be possible
for Higher Order Data**
Providing minimum metadata





- Analysis Working Group Participation
 - We are actively recruiting individuals and groups with varying degrees of experience to participate, learn, publish!
- Workspace - Upload your own data, use our workspace to compare against our data sets
 - Set up an account, Galaxy tool suite available Oct 2018
- Visualization – create your own visualization tool and pull using our API
- Student interns
 - We bring in students every summer including some spots reserved for international students. We provide funding!
- LSDA allows tissue requests from international labs
 - One source of our tissues is the Life Sciences Data Archive. They have archived tissue samples that can be obtained via an application request available here:
 - <https://lsda.jsc.nasa.gov/Request/dataRequest>

Data federation/integration with heterogeneous bioinformatics external databases (GEO, PRIDE, MG-RAST)

Home Repository Data Data Mining Tools Submit Data Help Workspa

mouse myostatin x Q

All GeneLab NIH GEO EBI PRIDE ANL MG-RAST

Search results for: **mouse myostatin** using filter(s):

Sort by Relevance 25

Myostatin inactivation effects on myogenesis in vitro and in vivo
http://www.ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE28986

Key words: dystrophin, mdx mouse, Duchenne, fibrosis, dystrophy ABSTRACT Strm (MDSC) into myogenic, as opposed to lipofibrogenic, lineages is a promising therapeutic counteracting myostatin, a negative regulator of muscle mass and a pro-lipofibrotic fibrogenic capacity of MDSC from wild...

Organism: *Mus musculus* Accession: GSE28986 PI/Contact: Robert Gelfand Re

The transcriptomic signature of myostatin inhibitory influence on the differentia
http://www.ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE59674

GDF8 (myostatin) is a unique cytokine strongly affecting the skeletal muscle phenoty molecular mechanism of myostatin influence on the differentiation of mouse C2C12 m technique. Treatment with exogenous GDF8 strongly affected the growth and develo proliferation and differentiatio...

Organism: *Mus musculus* Accession: GSE59674 PI/Contact: Zofia Wick Relea

Development of gene expression signature for defining the cell potency of mu
genotypes
http://www.ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE39765

In order to determine the cell potency, by identification of genes responsible for plur isolated from five week old male wild type(WT), C57B6J and another hypertrophied microarray analysis and compared this gene expression to that of a standard mouse and Mstn null mice using an esta...

Organism: *Mus musculus* Accession: GSE39765 PI/Contact: Bipasha Bose Rele

Rodent Research-3-CASIS: Mouse liver transcriptomic proteomic and epigen
https://genelab-data.ndc.nasa.gov/genelab/accession/GLDS-137

The Rodent Research-3 (RR-3) mission was designed to study the effectiveness of occurs during spaceflight. Myostatin is a protein secreted by myoblasts that inhibits block myostatin cause increases in muscle mass. The RR-3 experiment was sponsio Advancement of Science in Space and ass...

Organism: *Mus musculus* Factor: Microgravity Treatment Assay Type: transcription profile o... Accession: GLDS-137

Federated Search

Search Filters for GeneLab

Home Repository Data Data Mining Tools Submit Data Help Workspace

mouse x Q

All GeneLab NIH GEO EBI PRIDE ANL MG-RAST

Search Filters (GeneLab Only)

Project Type	Factors	Organisms	Assay Type
<input checked="" type="checkbox"/> Ground	<input checked="" type="checkbox"/> Age	<input checked="" type="checkbox"/> <i>Mus musculus</i>	<input type="checkbox"/> deletion pool profiling
<input type="checkbox"/> Spaceflight	<input type="checkbox"/> Anatomical Stru	<input type="checkbox"/> <i>Mycobacterium ma</i>	<input type="checkbox"/> DNA methylation profiling
<input type="checkbox"/> Spaceflight	<input type="checkbox"/> Antibiotic conce	<input type="checkbox"/> <i>Oryzias latipes</i>	<input type="checkbox"/> environmental gene survey
<input type="checkbox"/> Spaceflight	<input type="checkbox"/> Atmospheric Pre	<input type="checkbox"/> <i>Pantoea conspicua</i>	<input type="checkbox"/> genome sequencing
<input type="checkbox"/> Spaceflight	<input type="checkbox"/> Bed Rest	<input type="checkbox"/> <i>Pseudomonas aeru</i>	<input type="checkbox"/> metabolite profiling
<input type="checkbox"/> Spaceflight	<input type="checkbox"/> Bleomycin Treat	<input type="checkbox"/> <i>Rattus norvegicus</i>	<input type="checkbox"/> protein expression profiling
<input type="checkbox"/> Spaceflight	<input checked="" type="checkbox"/> cage	<input type="checkbox"/> <i>Rhodospirillum rubr</i>	<input type="checkbox"/> RNA methylation profiling
<input type="checkbox"/> Spaceflight	<input type="checkbox"/> CANONT:Part	<input type="checkbox"/> <i>Saccharomyces ce</i>	<input type="checkbox"/> transcription profiling
<input type="checkbox"/> Spaceflight	<input type="checkbox"/> cell culture	<input type="checkbox"/> <i>Staphylococcus</i>	
<input type="checkbox"/> Spaceflight	<input type="checkbox"/> clinical treatment	<input type="checkbox"/> <i>Staphylococcus aureus</i>	

Factor Name = Age' OR 'Study Factor Name = cage'

Total Search Results Found: **3**

1

cinogenesis Risk

modeling the carcinogenesis process or estimating cancer risks. ance increases with age. This effect is commonly attributed to a lifetime

g middle-age the incidence begins to decelerate and for many tumor sites it actually

tion profiling Accession: GLDS-88 PI/Contact: Christine Afshin Edward L...

User Account Mgmt., Access Controls (e.g., Private, Shared, Public Folders)

The image displays three overlapping screenshots of the GeneLab web application interface.

Top Left Screenshot: Shows the main GeneLab homepage. It includes a search bar, navigation tabs (Home, Repository, Data, Data Mining Tools, Submit Data, Contact Us, Workspace), and a list of studies. Two study entries are visible:

- GLDS-136:** Dissecting Low Atmospheric Pressure Stress: Transcriptome Responses to the Components of Hypobaria in Arabidopsis [Experiment 2]. Organisms: Arabidopsis thaliana. Factors: Atmospheric Pressure. Assay Types: Transcription profiling. Release Date: 11-May-2017.
- GLDS-137:** Global gene expression analysis highlights microgravity sensitive key genes in longissimus dorsi and tongue of 30 days space-flown mice. Organisms: Mus musculus. Factors: Microgravity. Assay Types: Transcription profiling. Release Date: 23-May-2017.

Top Right Screenshot: Shows the login page for NASA GeneLab-GenomeSpace OpenID Login. It includes fields for USERNAME and PASSWORD, Sign In and Cancel buttons, and a link to Register new NASA GeneLab user.

Bottom Screenshot: Shows a file browser view of the GeneLab Data Repository. The path is Home > Public > genelab > genelab-data. The browser displays a list of files:

Filename	Tags	Owner	Size	Last Modified
GLDS-1		genelab		
GLDS-10		genelab		
GLDS-100		genelab		
GLDS-101		genelab		
GLDS-102		genelab		
GLDS-103		genelab		
GLDS-104		genelab		
GLDS-105		genelab		
GLDS-106		genelab		
GLDS-107		genelab		
GLDS-108		genelab		
GLDS-109		genelab		
GLDS-11		genelab		
GLDS-110		genelab		
GLDS-111		genelab		
GLDS-112		genelab		
GLDS-113		genelab		

Barriers to reproducible analysis of omics data:

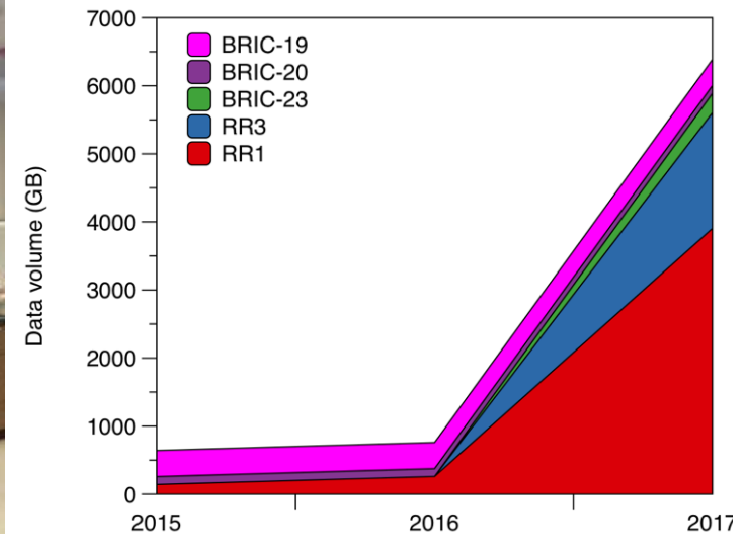
1. Large files are difficult to move around and process
2. Workflows vary from user to user and details are sometimes poorly documented

Galaxy platform:

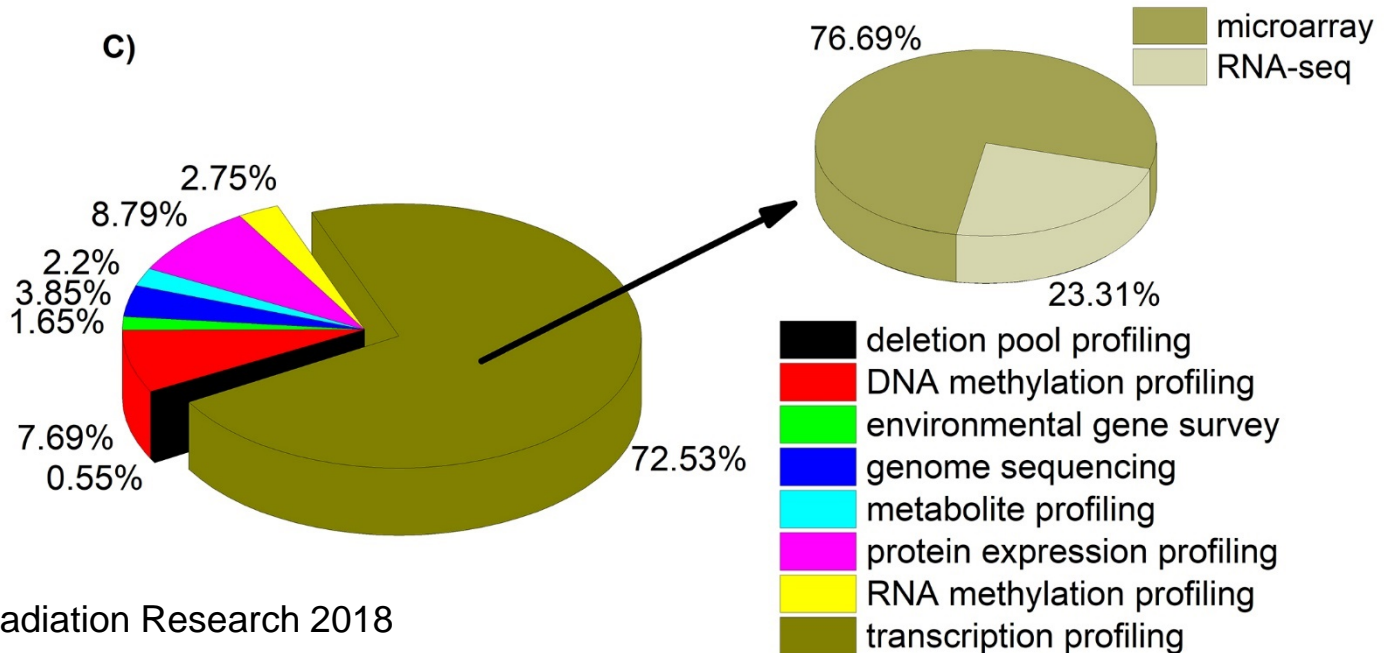
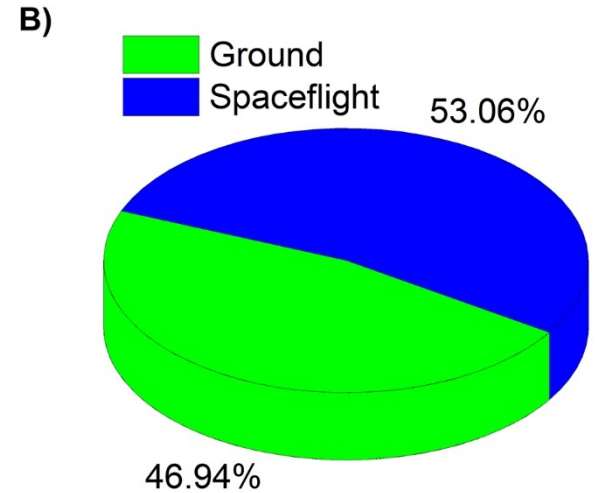
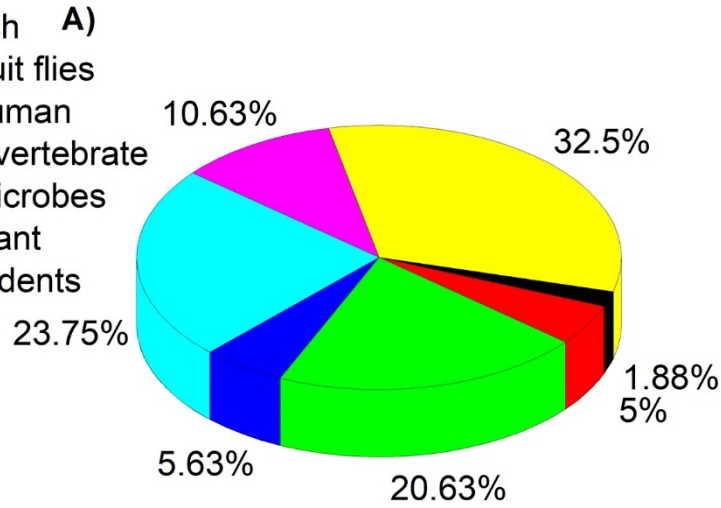
1. Open source, extensible platform for cloud based analysis of omics data
2. Allows scripts to be run and chained together into workflows
3. Workflows can be published, shared and downloaded



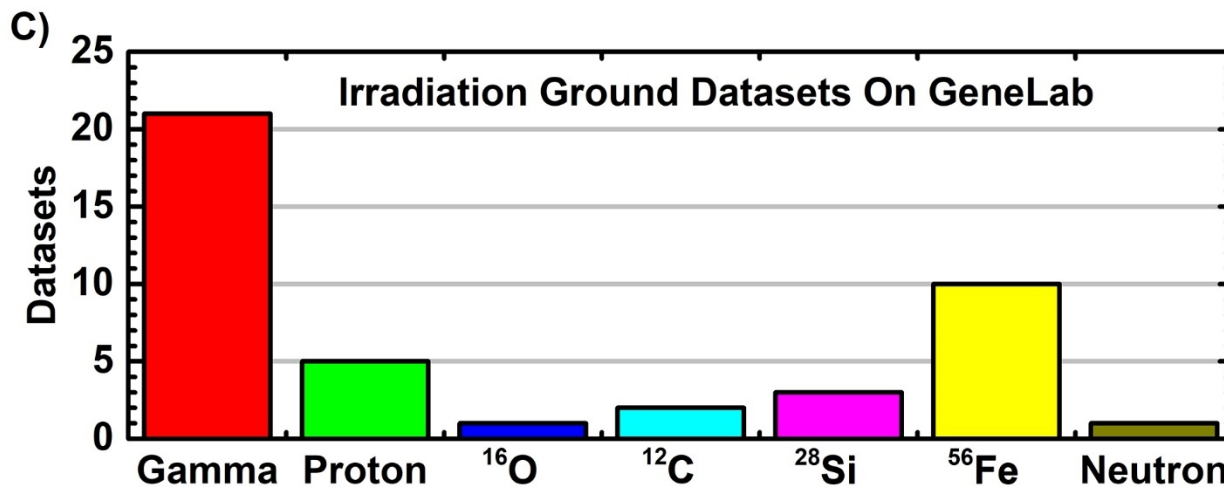
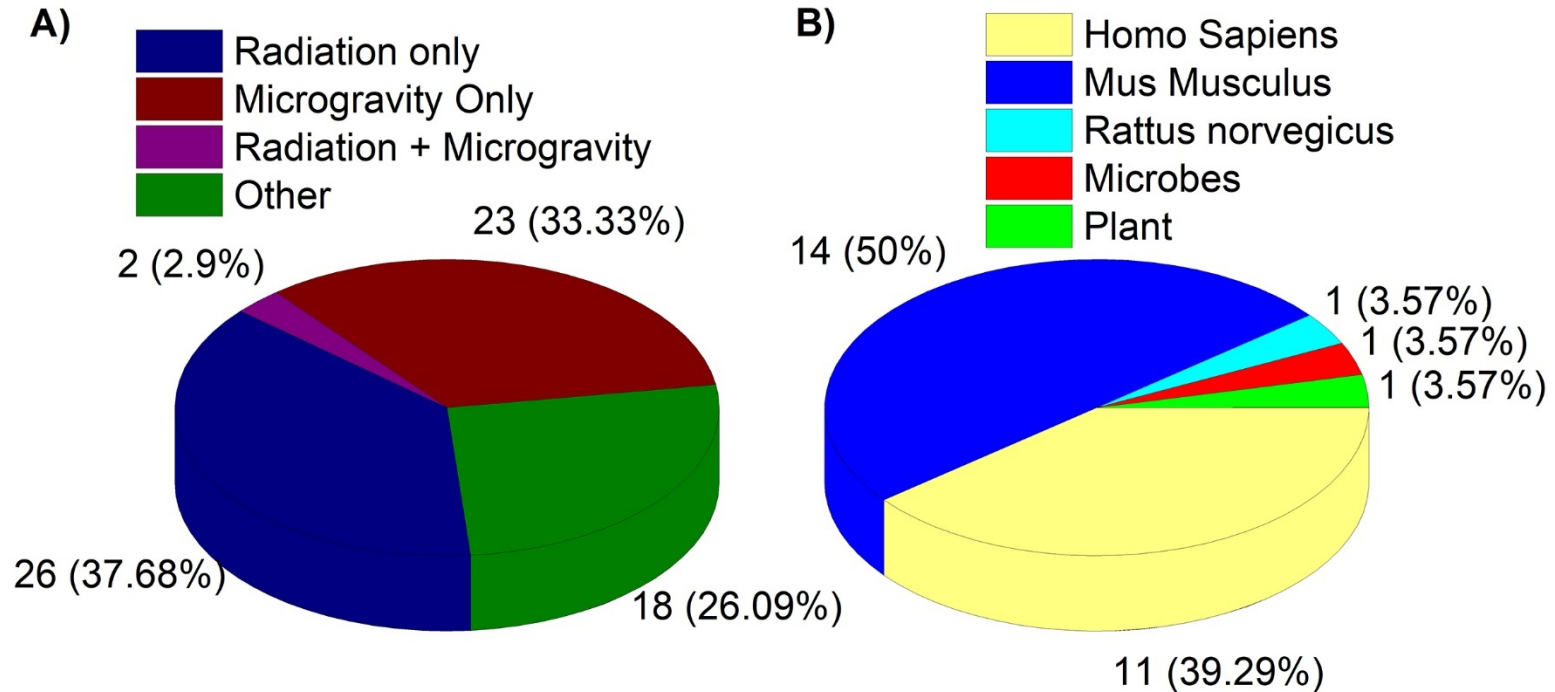
- Expertise:
 - DNA/RNA/protein extraction
 - Animal work
- Develop standards for sample processing (species dependent)
- Responsible for ~50% of GeneLab data by volume

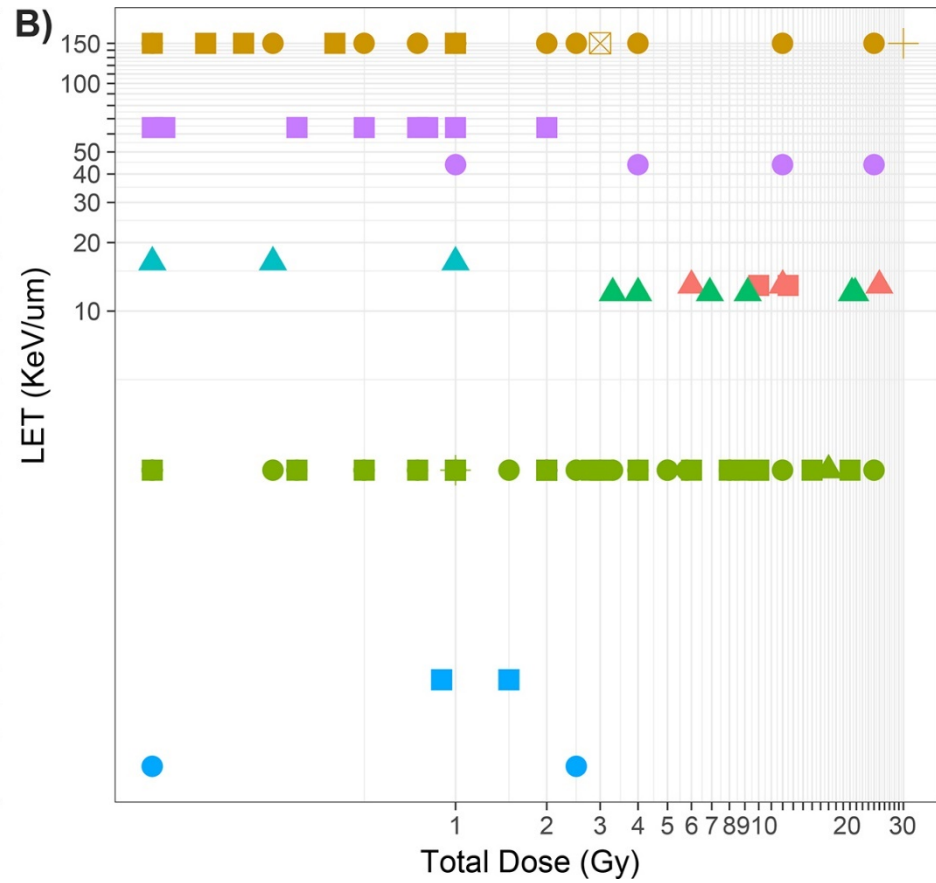
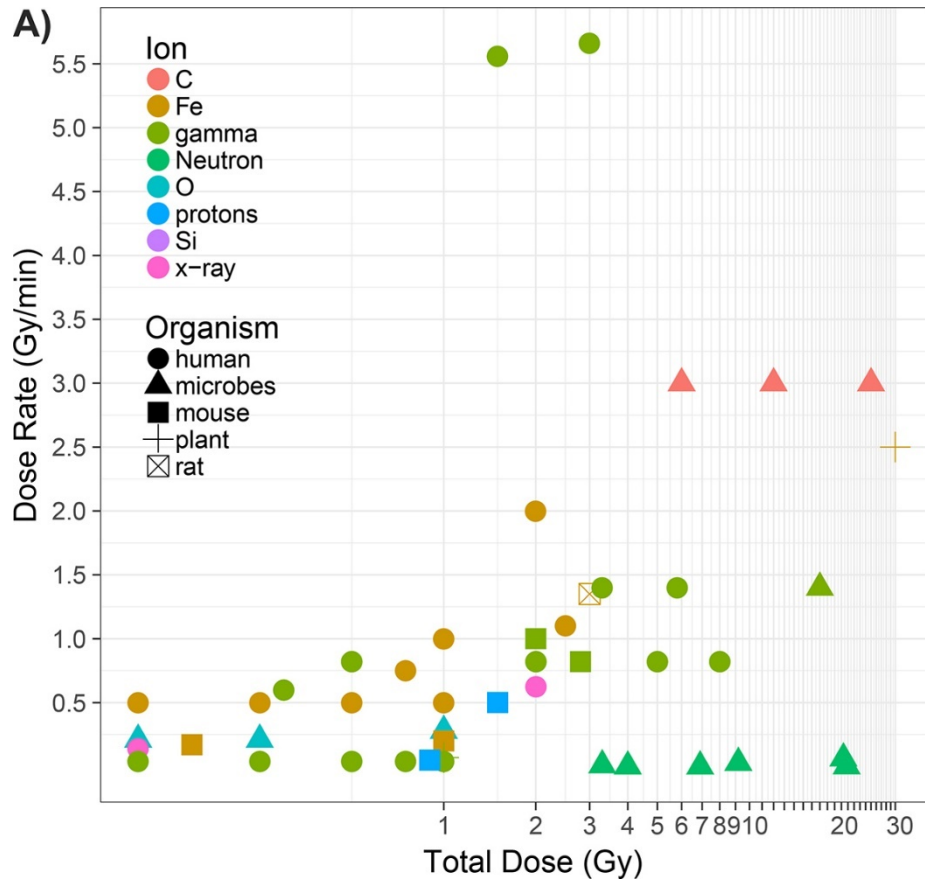


- fish
- fruit flies
- human
- invertebrate
- microbes
- plant
- rodents

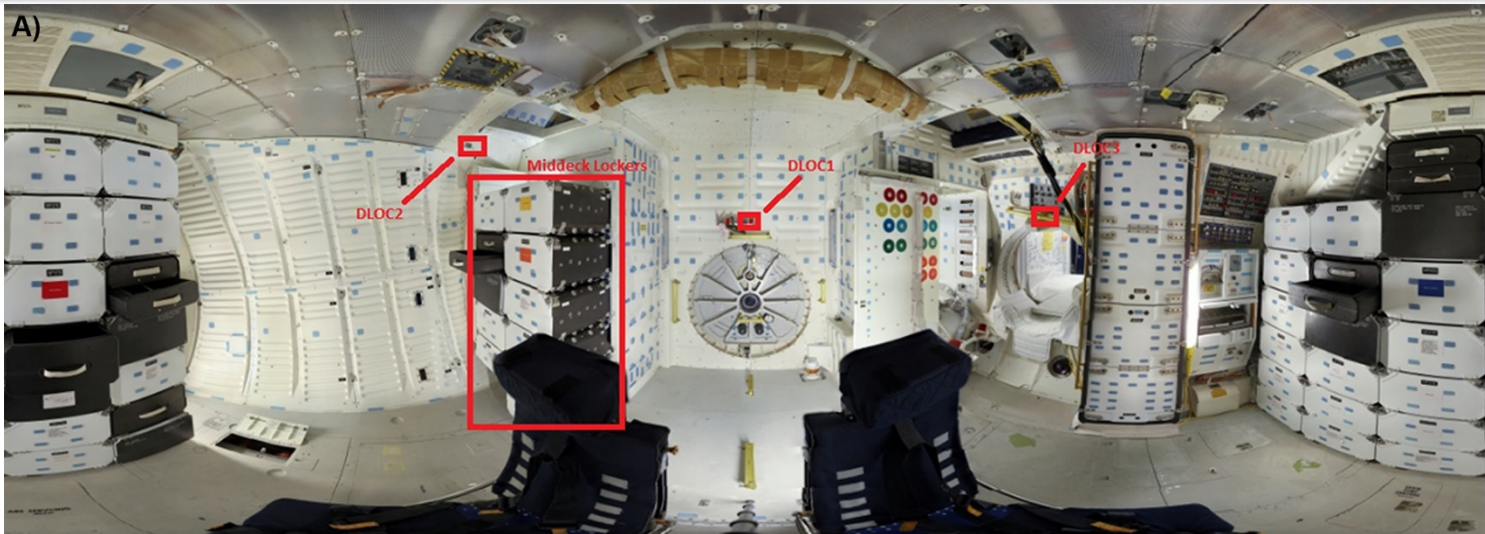


69 Ground Data Sets: Radiation and simulated microgravity

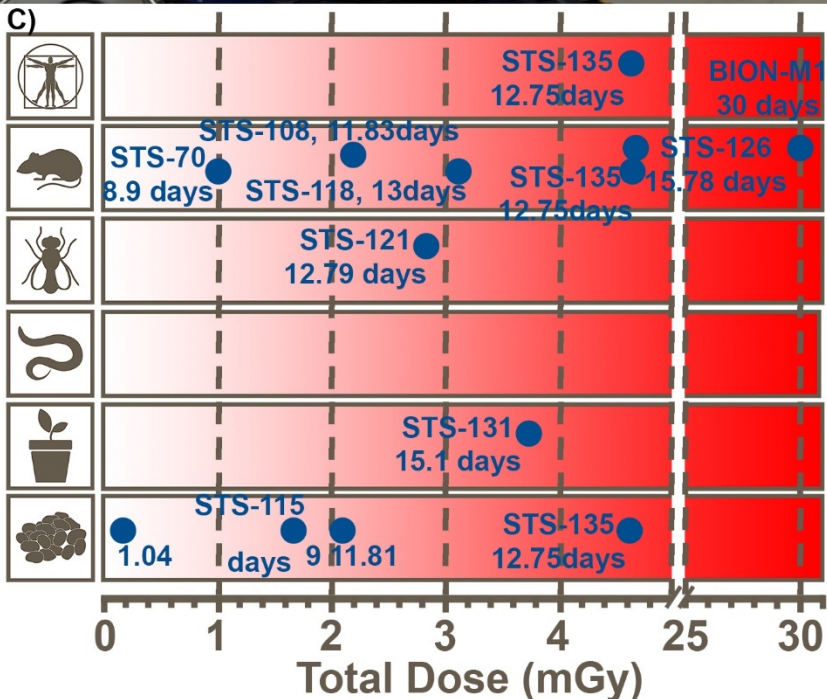
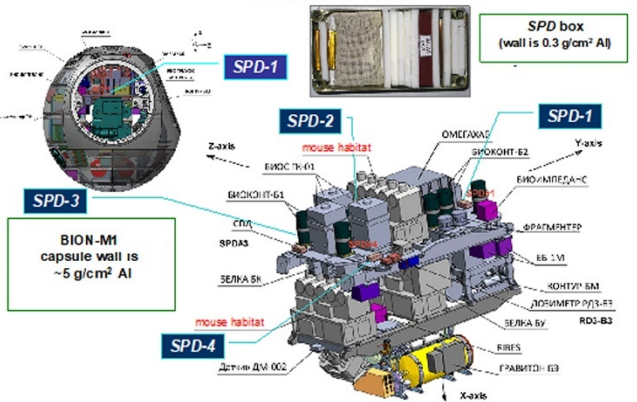




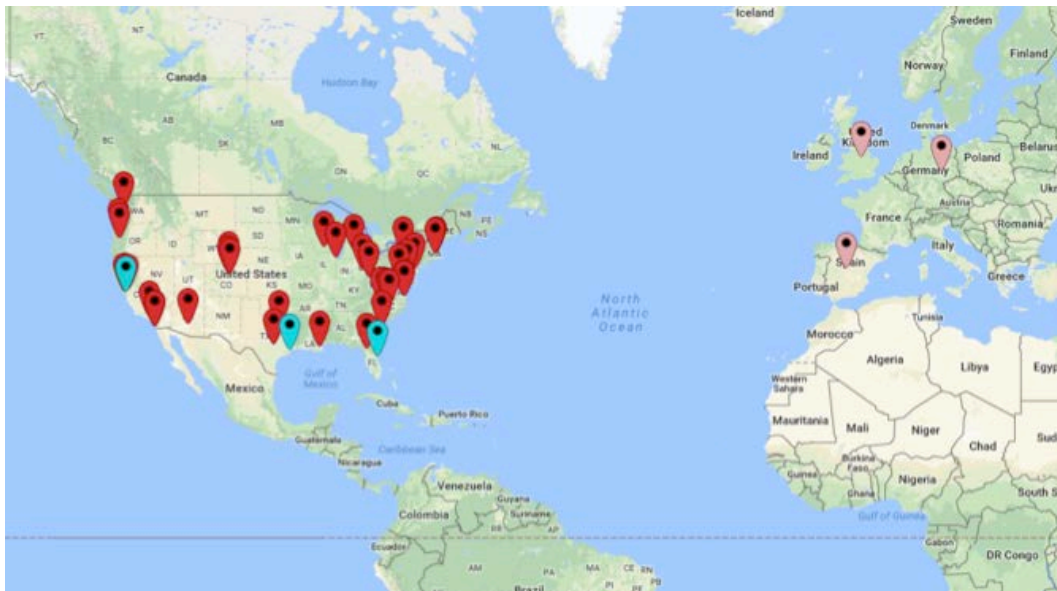
Radiation Dosimetry for STS samples (ISS to follow)



B) Locations of Radiation Detectors and Animal Holders inside BION-M1



- ~60 individuals
- 4 Groups: Plants, Microbes, Animals, Multi-omics
- Monthly meetings
- Deliverables:
 - Consensus pipelines for primary analysis of data (Microarray, RNASeq, Bisulfite sequencing, Proteomics, 16S metagenomics, Whole genome metagenomics)
 - Recommendations for visualization of data





AWG (now)

Analysis Pipelines

Goal is to identify the best pipeline

Data to be added to GLDS or AWG scope

What additional data do you require to answer your scientific questions?

Metadata to be added to GLDS

What environmental or other metadata do you need to answer your questions?

Student interns (June - Aug)

Implementation
(ideally in Galaxy)

Processed data
for posting on GeneLab

Post processed data to GeneLab

Public portal for visualization of GeneLab data

AWG (July - ?)

Visualization requirements and systems

Peer reviewed publication (s)

Questions

What questions can we answer with these datasets?

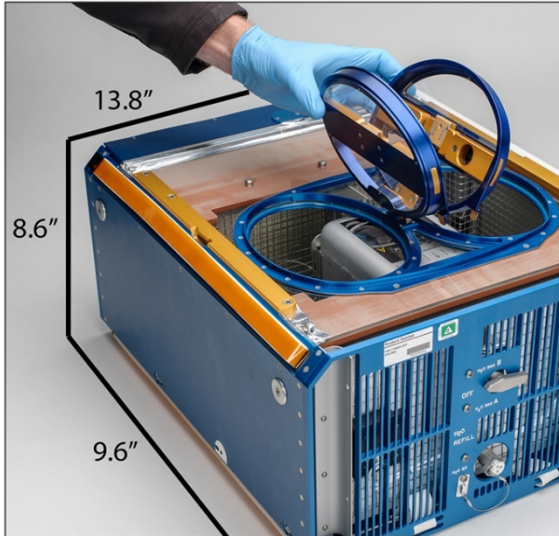


- Cage Effects with rodent experiments: Carbon Dioxide as an Environmental Stressor in Spaceflight
- Systems Biology analysis reveals biological spaceflight master regulators
- Space Radiation induces long term impact on the cardiovascular system by the activation of FYN through Reactive Oxygen Species
- AWG related work determines novel systemic biological factors causing damage due to spaceflight

Cage Effects with rodent experiments: Carbon Dioxide as an Environmental Stressor in Spaceflight

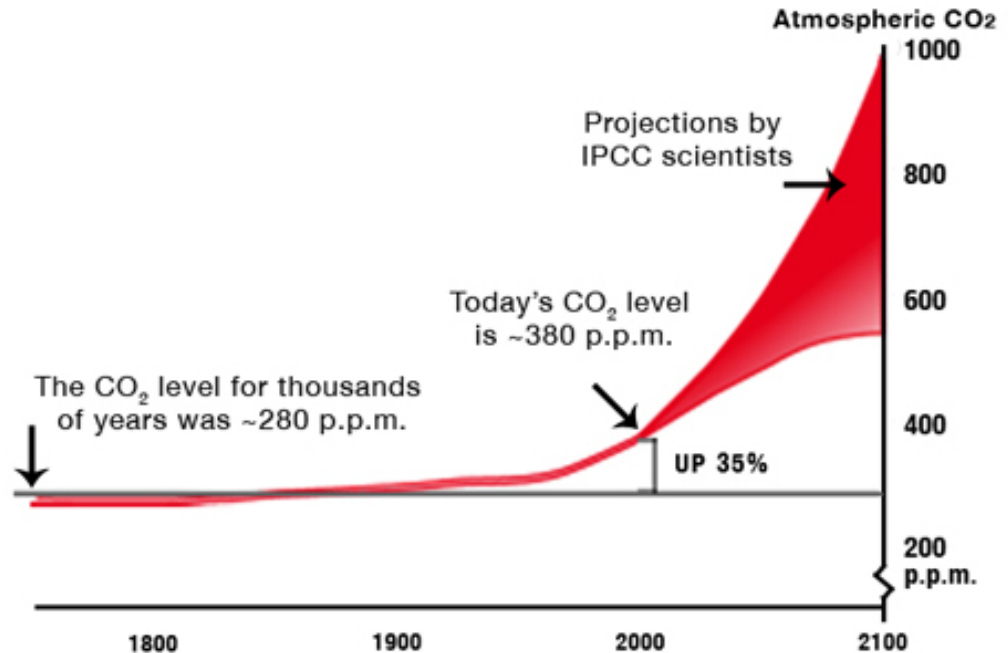
Beheshti A, Cekanaviciute E, Smith DJ, Costes SV. Global transcriptomic analysis suggests carbon dioxide as an environmental stressor in spaceflight: A systems biology GeneLab case study. *Sci Rep.* 2018;8(1):4191. doi: 10.1038/s41598-018-22613-1. PubMed PMID: 29520055; PMCID: PMC5843582.

A) Cage Types



Animal Enclosure Module (AEM)

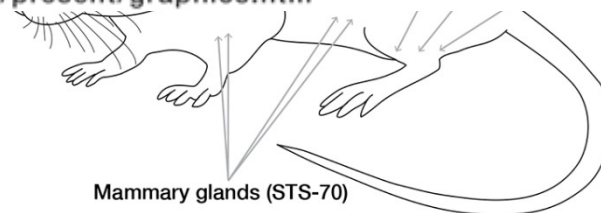
Historic and Projected CO₂ Atmospheric Concentrations

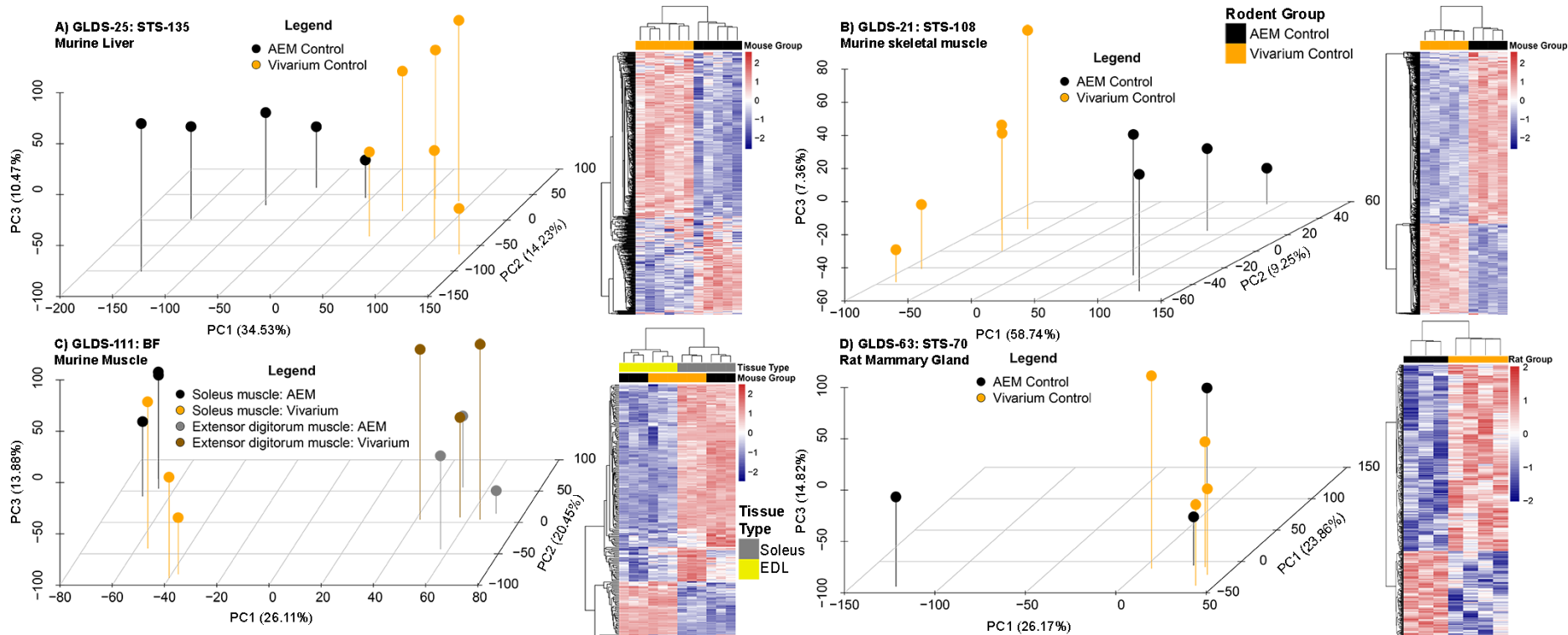


Source: IPCC
<http://www.ipcc.ch/present/graphics.htm>

B)

GeneLab Study	Mission	Species	CO ₂ (ppm)	Du (d)	
GLDS-21	STS-108	mouse	~3000		
GLDS-111	BF	mouse	~600		
GLDS-111	BF	mouse	~600	30	extensor digitorum
GLDS-25	STS-135	mouse	~3000	13	liver
GLDS-63	STS-70	rat	~3000 (est)	9	mammary gland



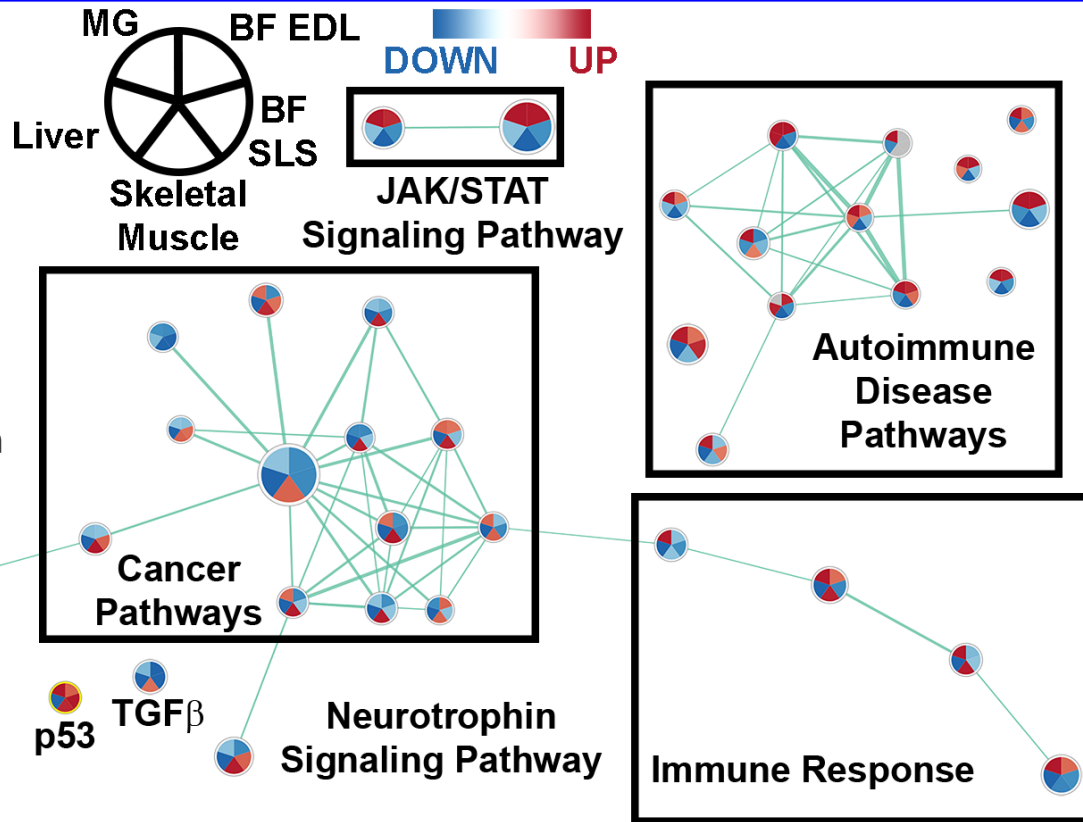


AEM = Animal Enclosure Modules (now referred to as Rodent Habitats)
Vivarium = normal ground based rodent cages

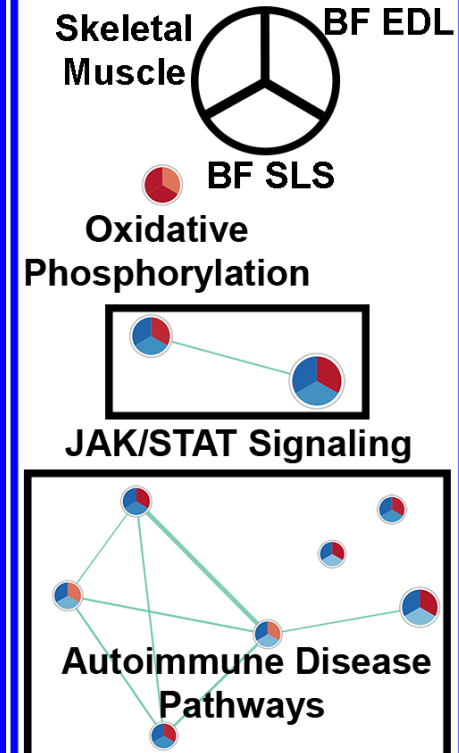
Major Pathways Regulated between Cages



A) All Tissues Kegg Pathways



B) Only Muscle Tissue



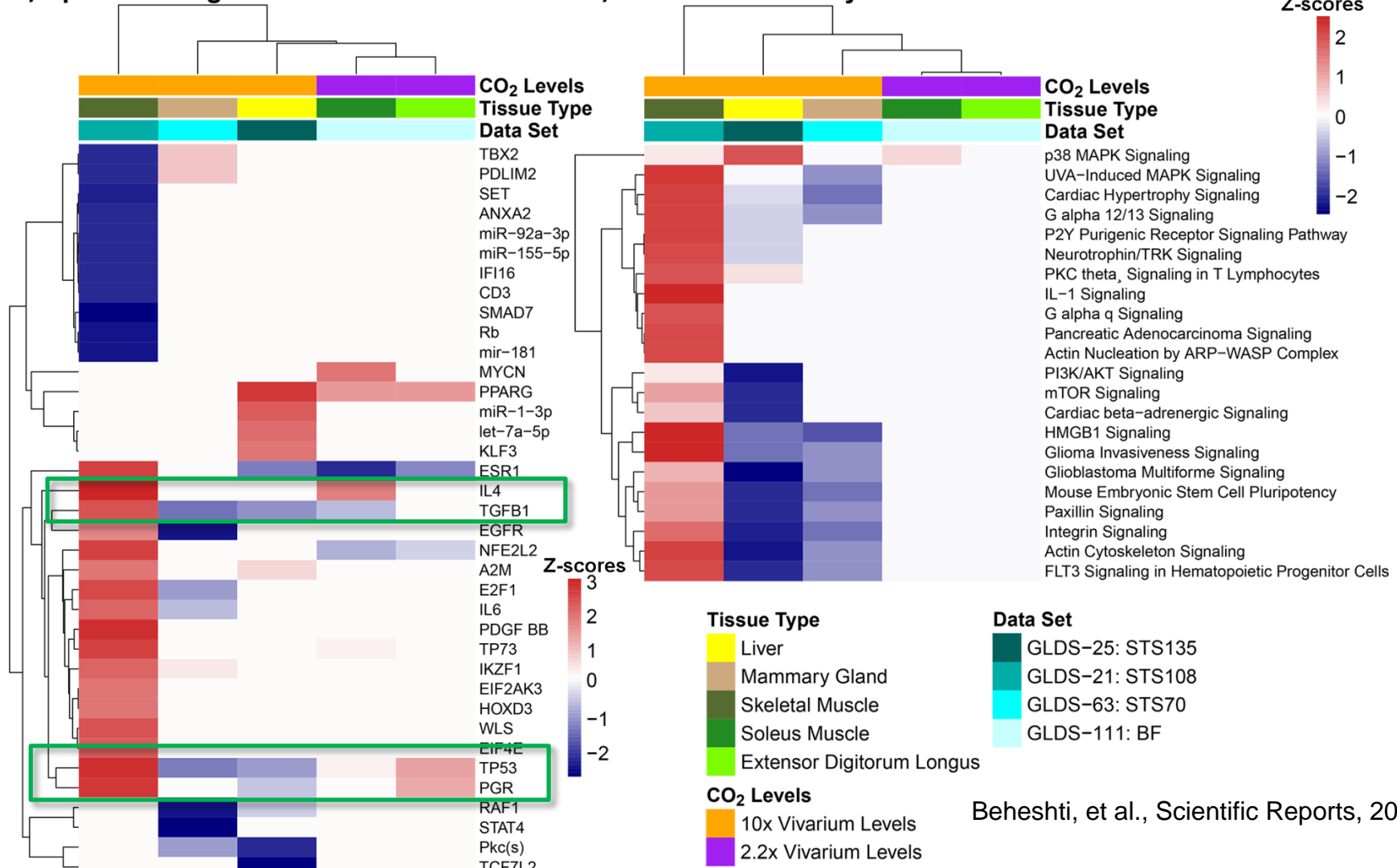
GSEA: Kegg Pathways (network displayed using EnrichmentMap plugin for Cytoscape)

Upstream regulators and canonical pathways show response is tissue specific and highest for high CO₂



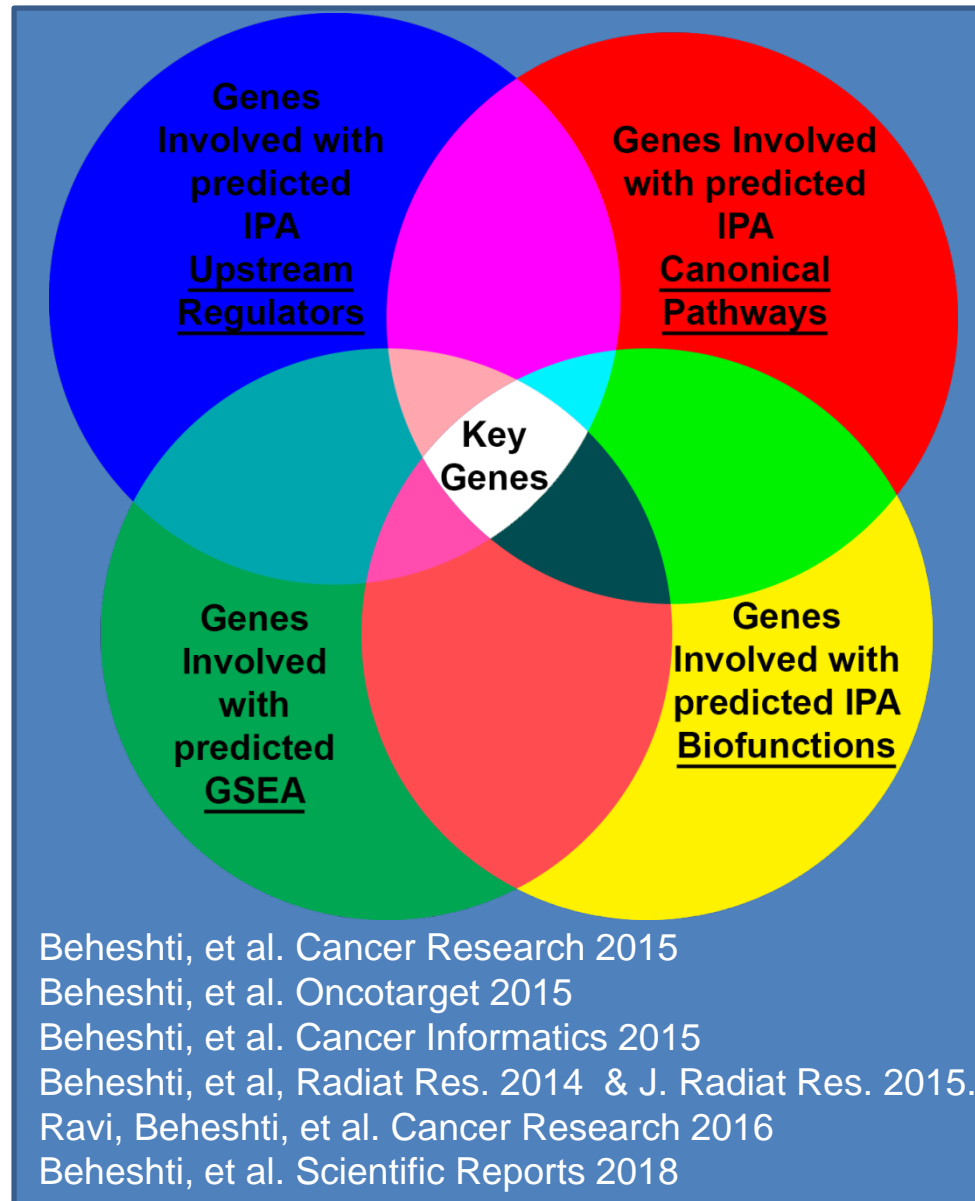
A) Upstream Regulators: AEM vs Vivarium

B) Canonical Pathways: AEM vs Vivarium

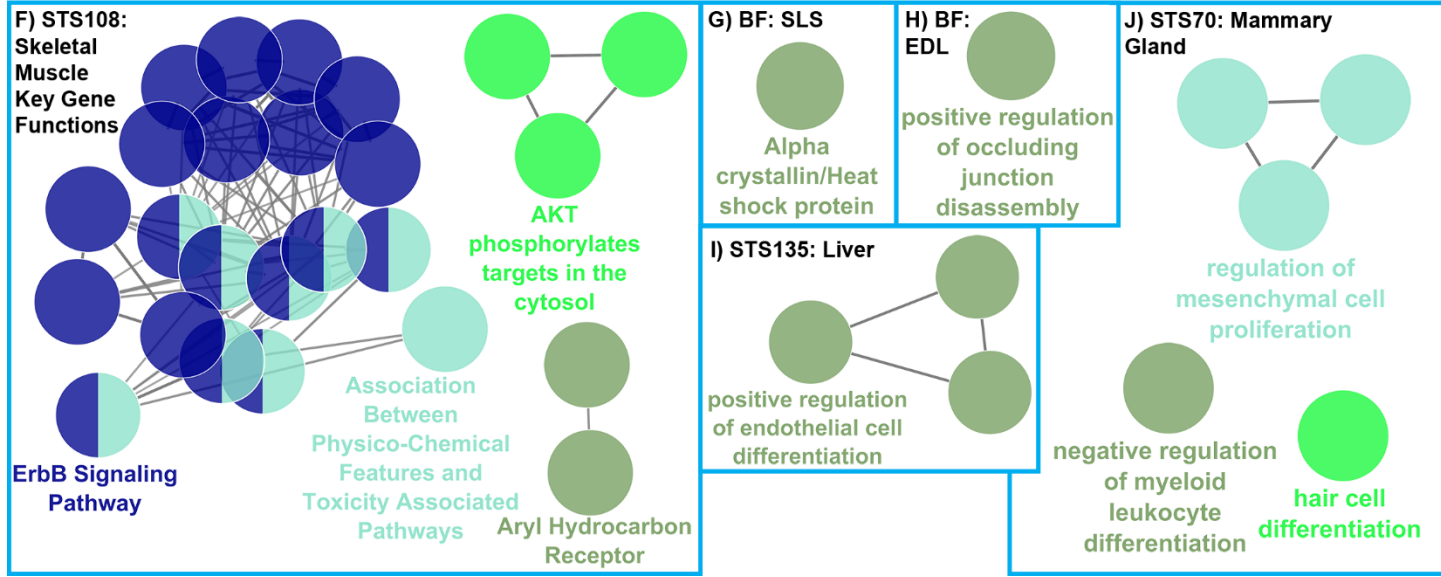
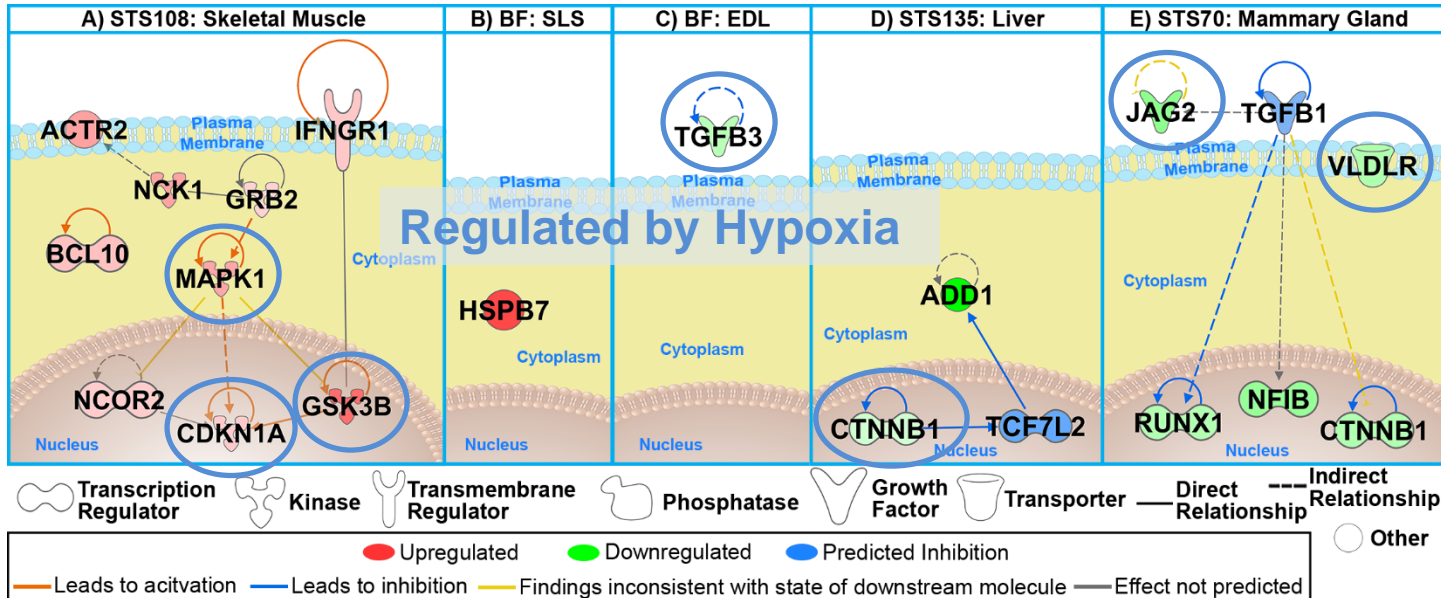


Beheshti, et al., Scientific Reports, 2018

Mild chronic hypoxia due to increased CO₂ levels could explain both the increase in immune responses and a reduction in metabolism – **Need to confirm with AEM experiments at ambient CO₂ levels.**



Identifying Key Cage-Dependent Drivers





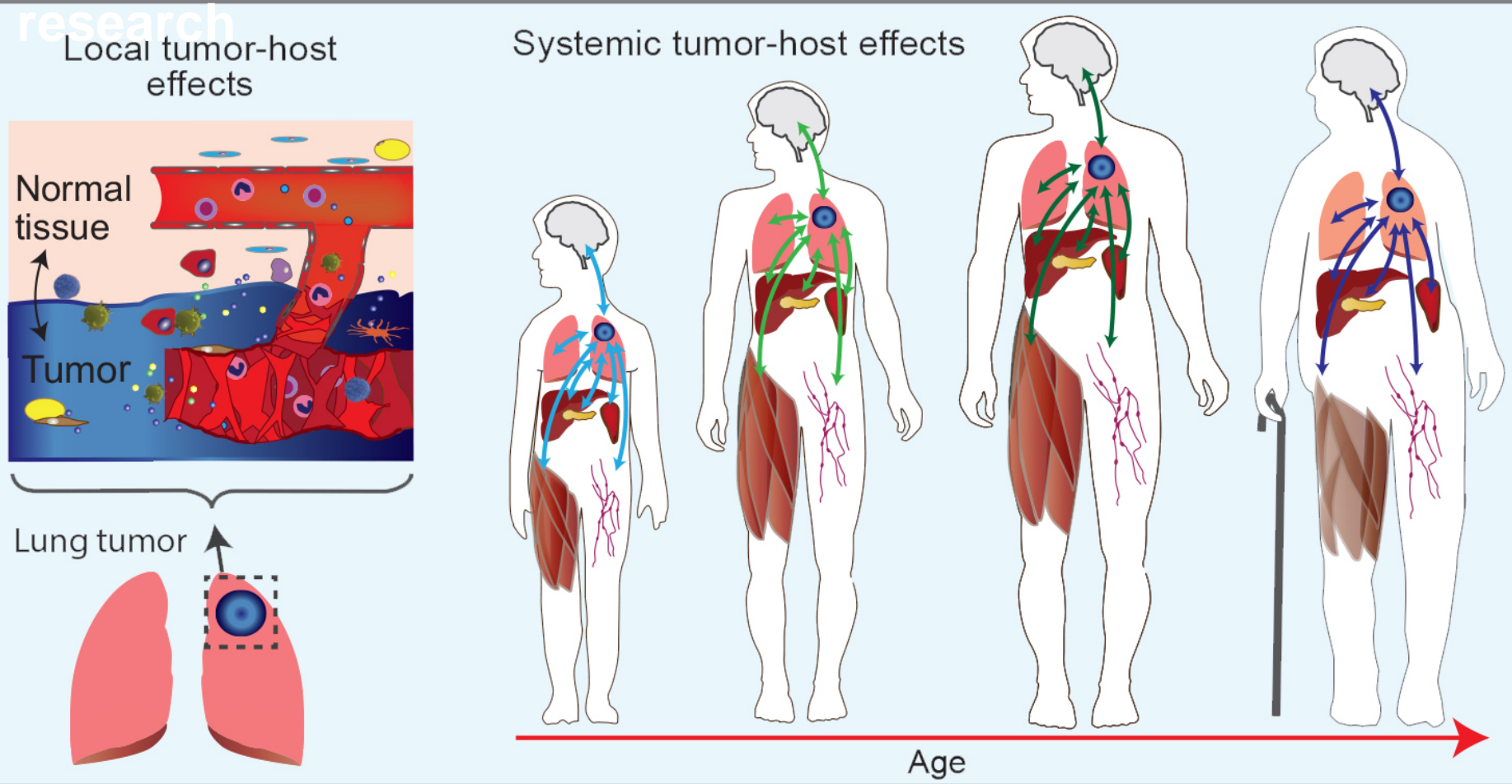
- Through a systems biology approach we observed global transcriptomic changes in rodents induced by spaceflight-matched environment in AEM cages.
- Identify spaceflight CO₂ levels as a potential environmental stressor that merits experimental investigation
- Systematically changing one environmental aspect at a time (gas concentration, radiation, microgravity, etc.) and analyzing and comparing transcriptional responses could be used to create a network that could predict the most relevant causes and countermeasures for spaceflight-associated conditions, as well as confounding factors for spaceflight experiments.

Systems Biology analysis reveals biological spaceflight master regulators

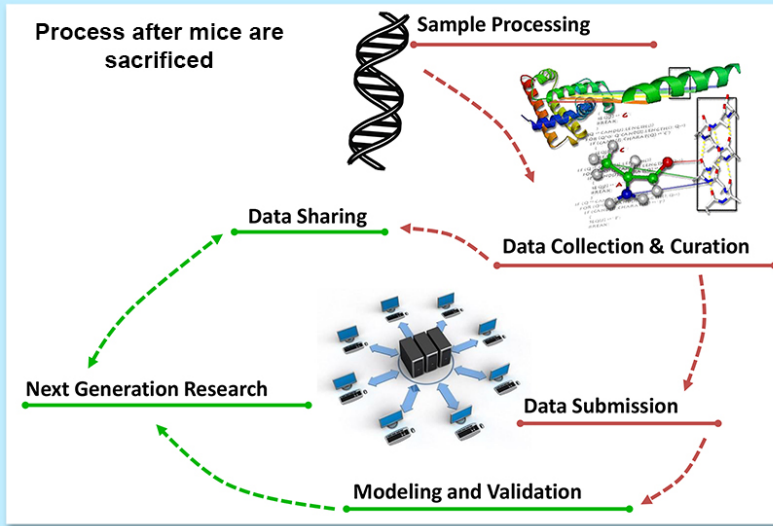
Beheshti, et al., PLOS One, in press

General Approach to Studying a Systematic Response in the Host

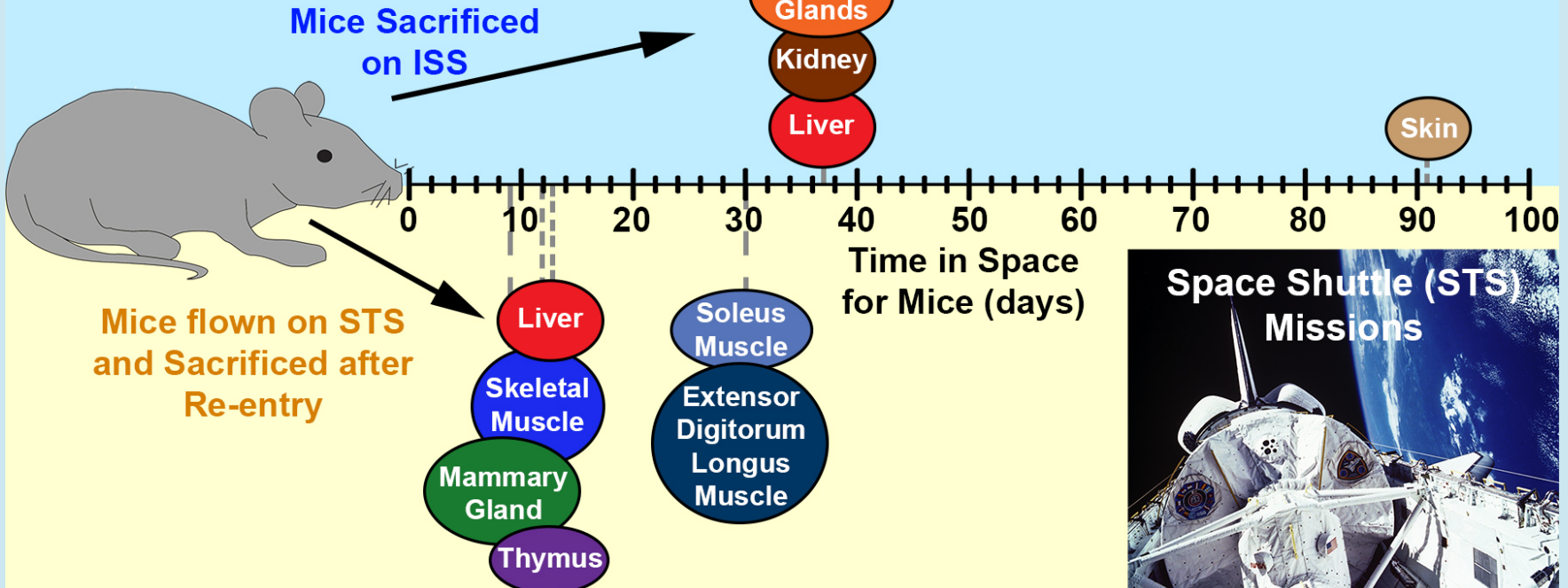
An example for cancer



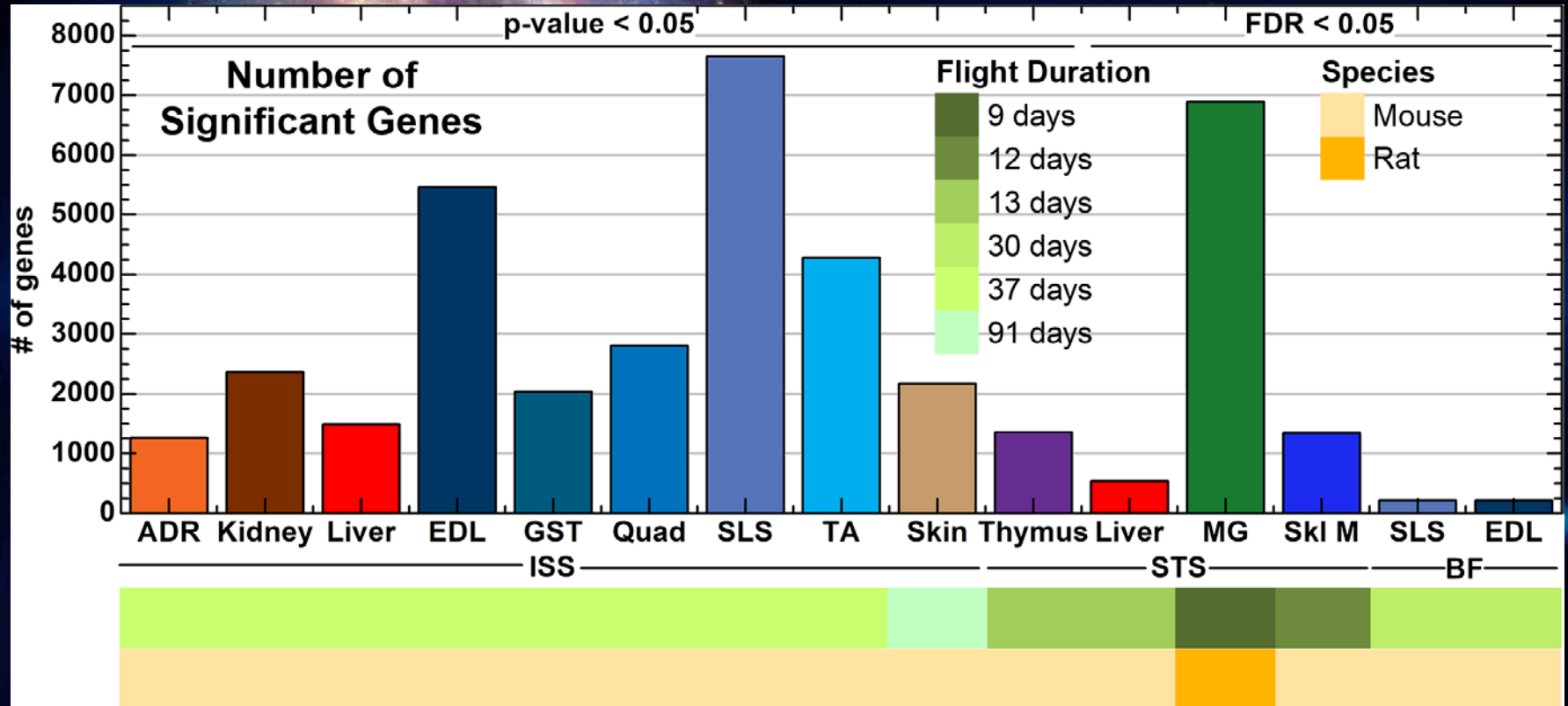
GeneLab Data Used to Generate Results



- Extensor Digitorum Longus Muscle
- Soleus Muscle
- Gastrocnemius Muscle
- Quadriceps
- Tibialis Anterior Muscle
- Adrenal Glands
- Kidney
- Liver

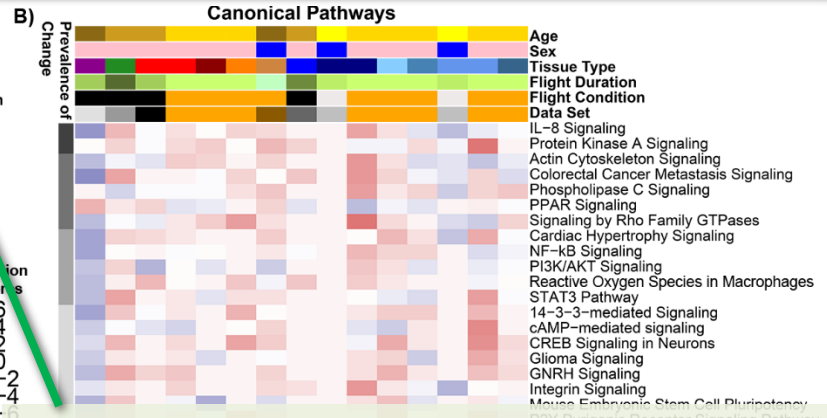
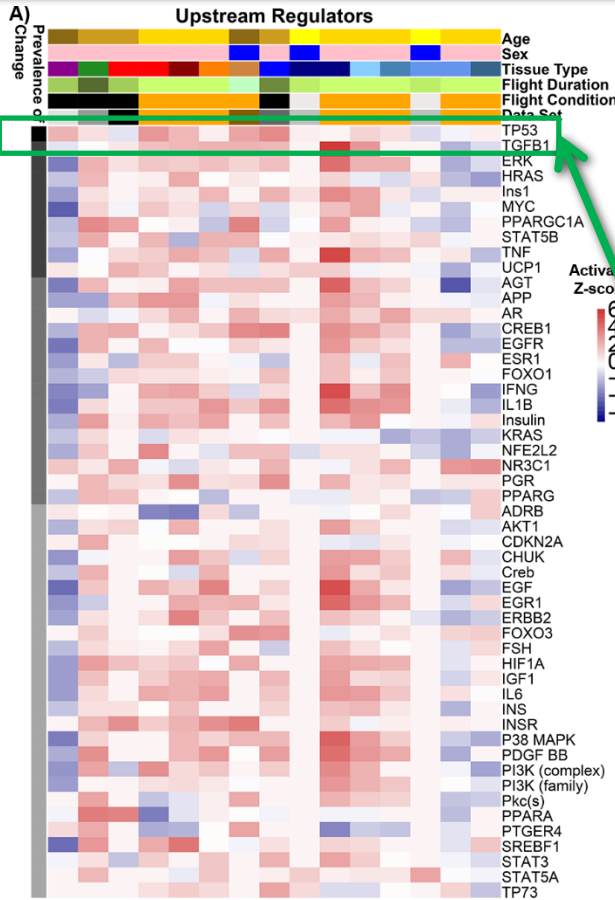


Number of Significant Genes from Each Dataset

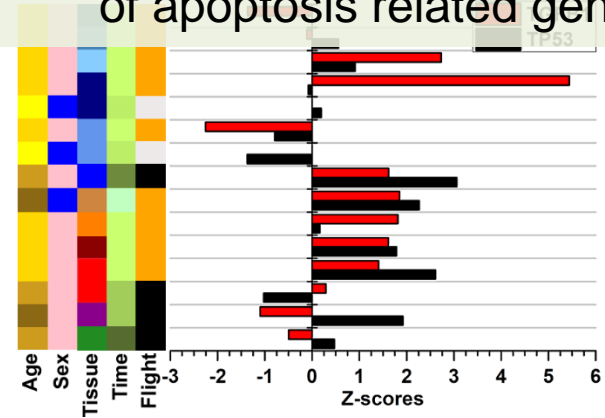
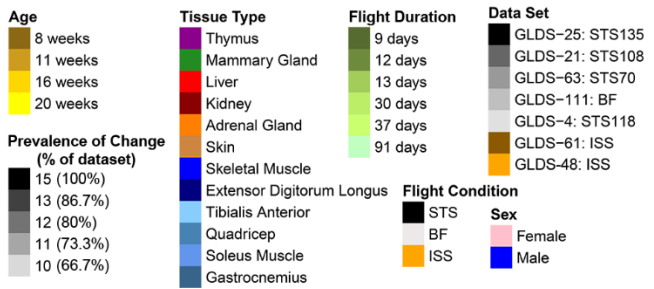


Fold-Change \geq
| 1.2 |

Pathway/Functional Predictions:
Ingenuity Pathway Analysis (IPA)
Gene Set Enrichment Analysis (GSEA)



- **p53 found in all tissues**
 - p53 is a transcription factor and in response to genotoxic stress, DNA damage, oncogene activation, and hypoxia, it is recruited to sites in chromatin, thus promoting transcription of apoptosis related genes

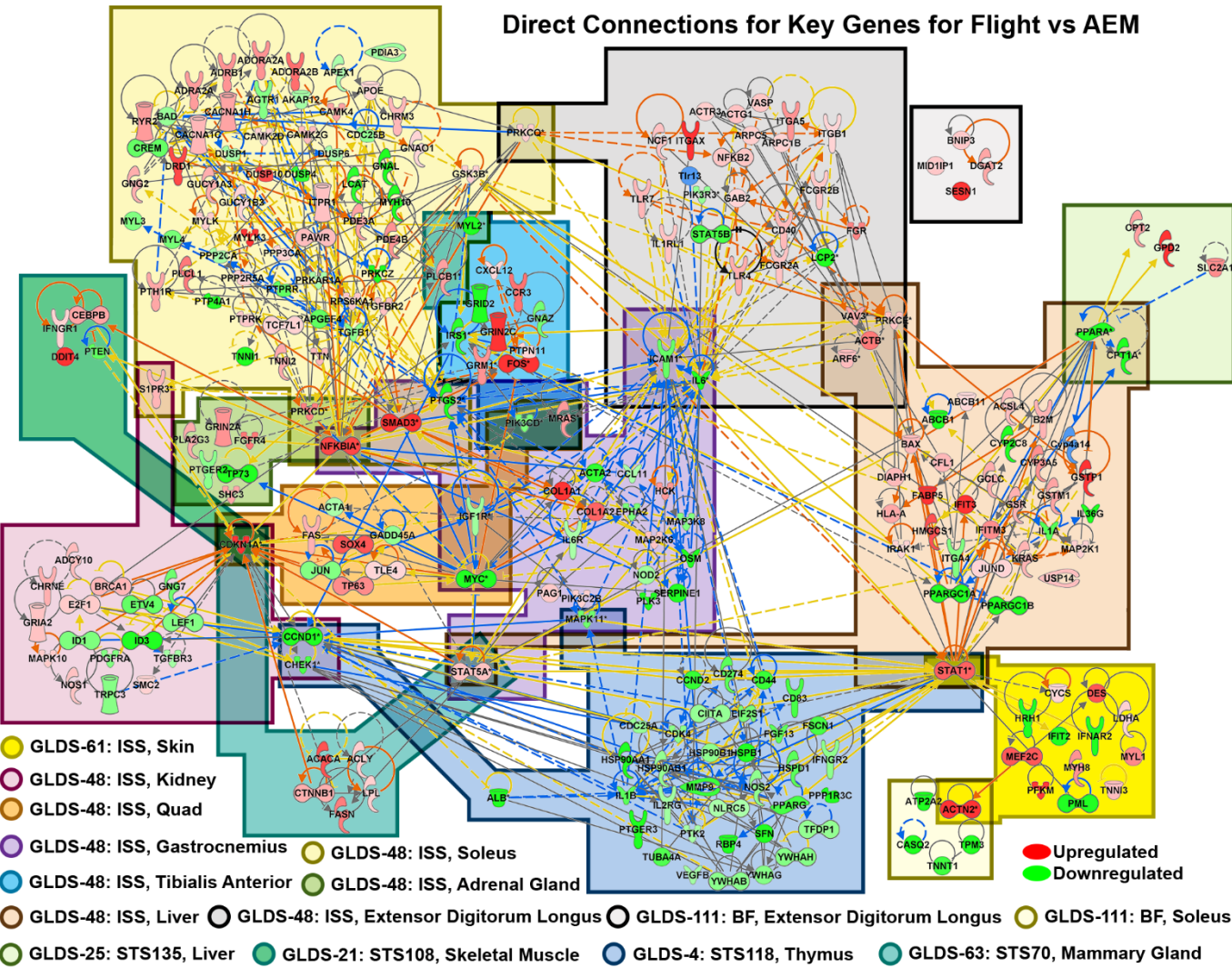


Beheshti, et al.,
PLOS One, in
press

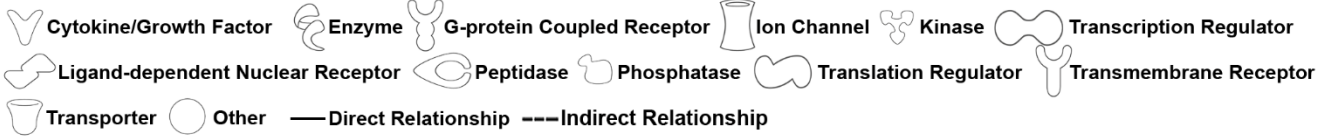
A) Direct Connections for Key Genes for Flight vs AEM

- **TGFβ1 found to be critical for maintaining tissue differentiation, cell homeostasis and growth using TGFβ1 and endothelin-1 and**
- **TGFβ is known to diminish TGFβ1-carcinoembryonic**
- **Previous Studies to diminish TGFβ1-carcinoembryonic**
- **In another study, growth using TGFβ1 identified in mod and late apoptosis**

Direct Connections for Key Genes for Flight vs AEM

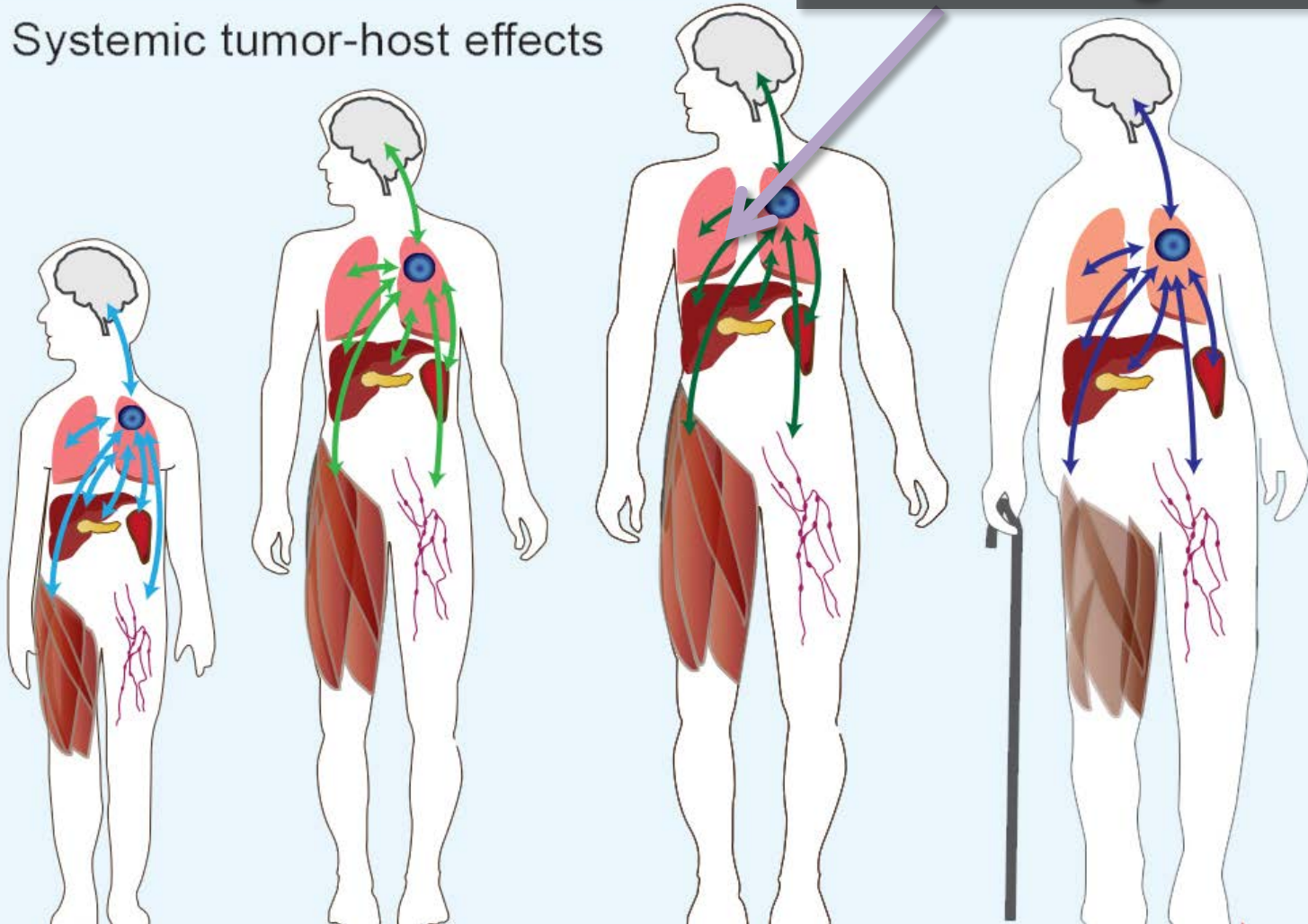


- GLDS-61: ISS, Skin
- GLDS-48: ISS, Kidney
- GLDS-48: ISS, Quad
- GLDS-48: ISS, Gastrocnemius
- GLDS-48: ISS, Soleus
- GLDS-48: ISS, Tibialis Anterior
- GLDS-48: ISS, Adrenal Gland
- GLDS-48: ISS, Liver
- GLDS-48: ISS, Extensor Digitorum Longus
- GLDS-111: BF, Extensor Digitorum Longus
- GLDS-111: BF, Soleus
- GLDS-25: STS135, Liver
- GLDS-21: STS108, Skeletal Muscle
- GLDS-4: STS118, Thymus
- GLDS-63: STS70, Mammary Gland

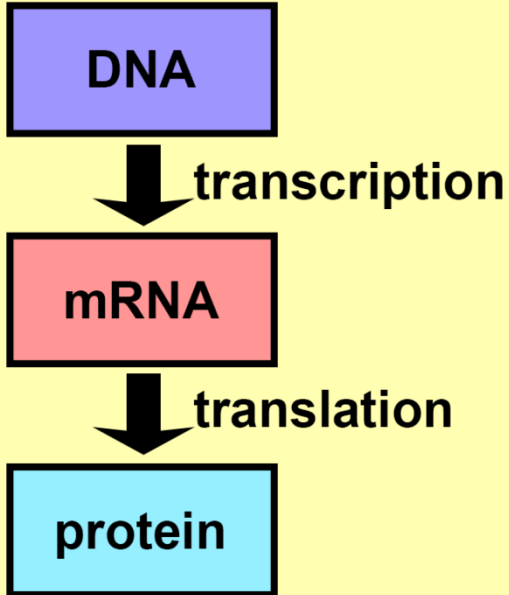


Circulating miRNAs

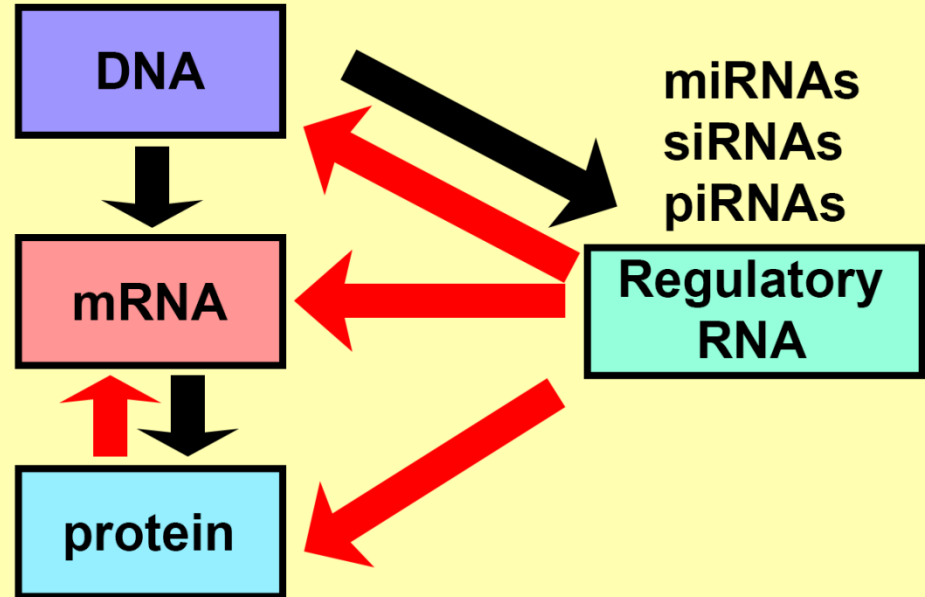
Systemic tumor-host effects



Classical View of Molecular Biology

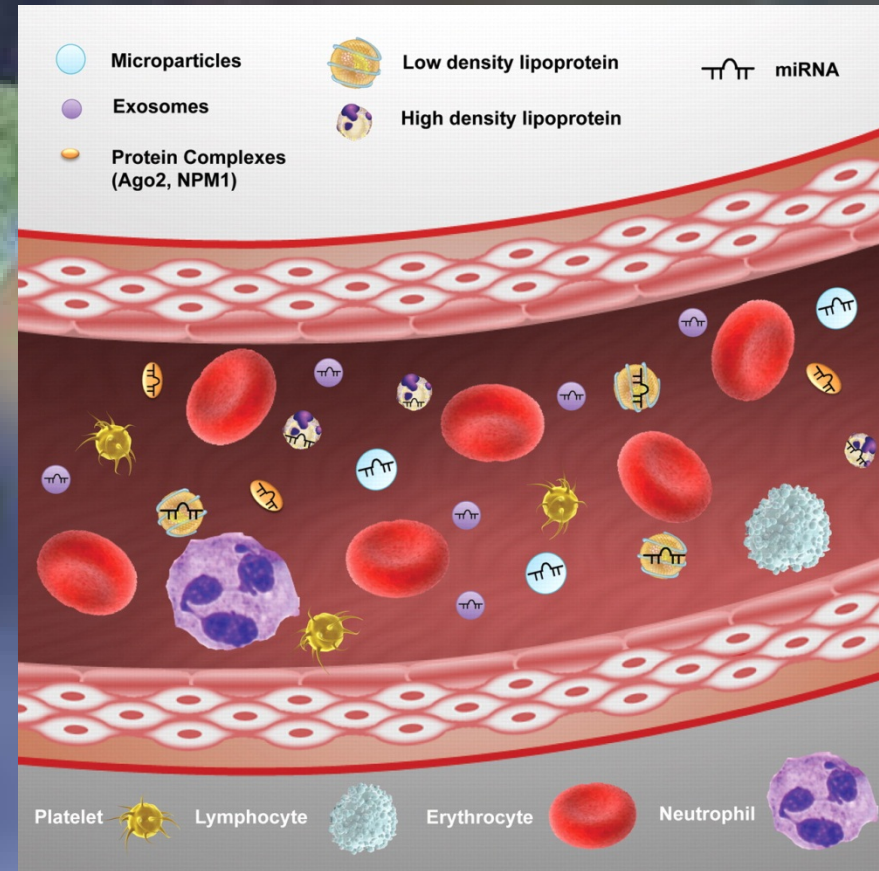


New Understanding of Molecular Biology



- A single miRNA has been estimated to regulate up to 500 mRNAs
- miRNAs are single-stranded RNA sequences, of about 22 nucleotides in length, processed from longer transcripts.
- miRNAs are important regulators that repress the translation of mRNA transcripts

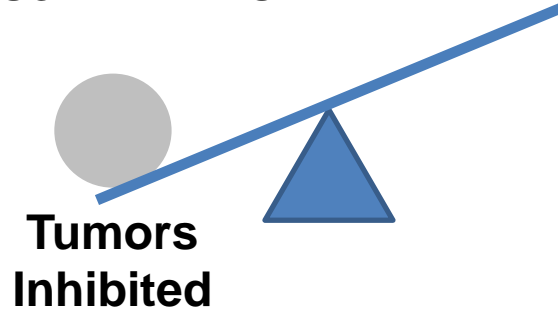
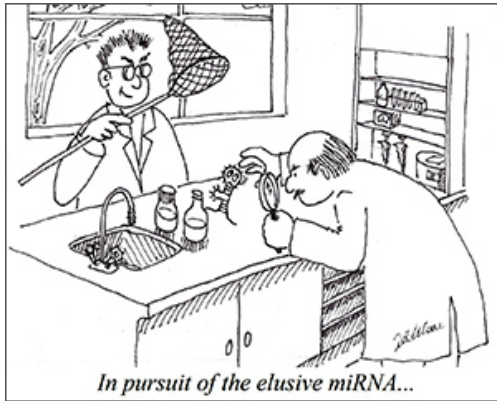
- Circulating miRNAs can carry signals from organs to other various parts of the body through the blood stream.
- The miRNAs can be transported in Exosomes, microparticles, lipoproteins, and outside any type of packaging.
- Our preliminary data shows that a miRNA signature is carried over from the spleen to the tumor with age.
 - Beheshti, et al. *PLoS ONE* 2017



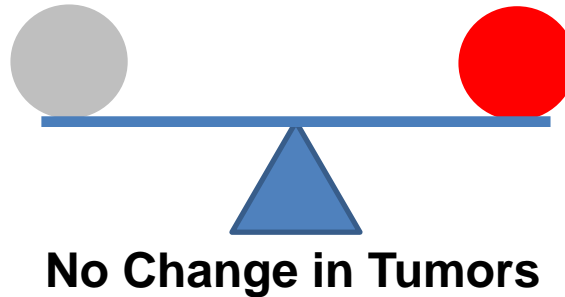
Profiling of circulating microRNAs: from single biomarkers to re-wired networks Anna Zampetaki, Peter Willeit, Ignat Drozdov, Stefan Kiechl, Manuel Mayr. *Cardiovascular Research*, 2011.

● Tumor Suppressor miRNAs

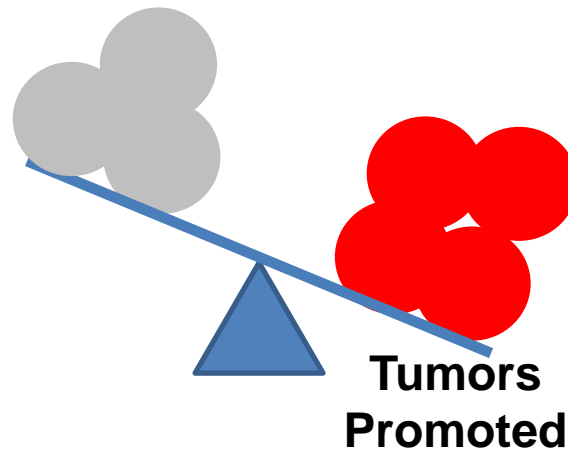
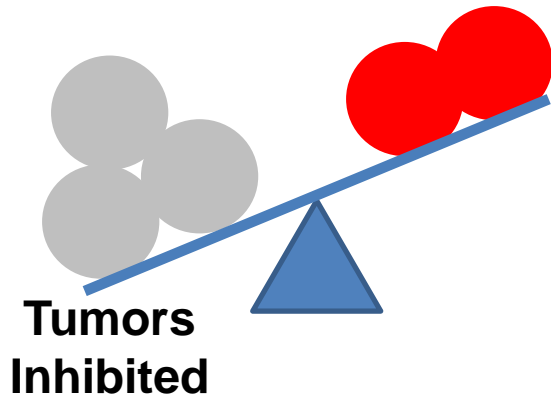
● OncomiRNAs



Only looking at a single miRNA



looking at a pair of miRNAs

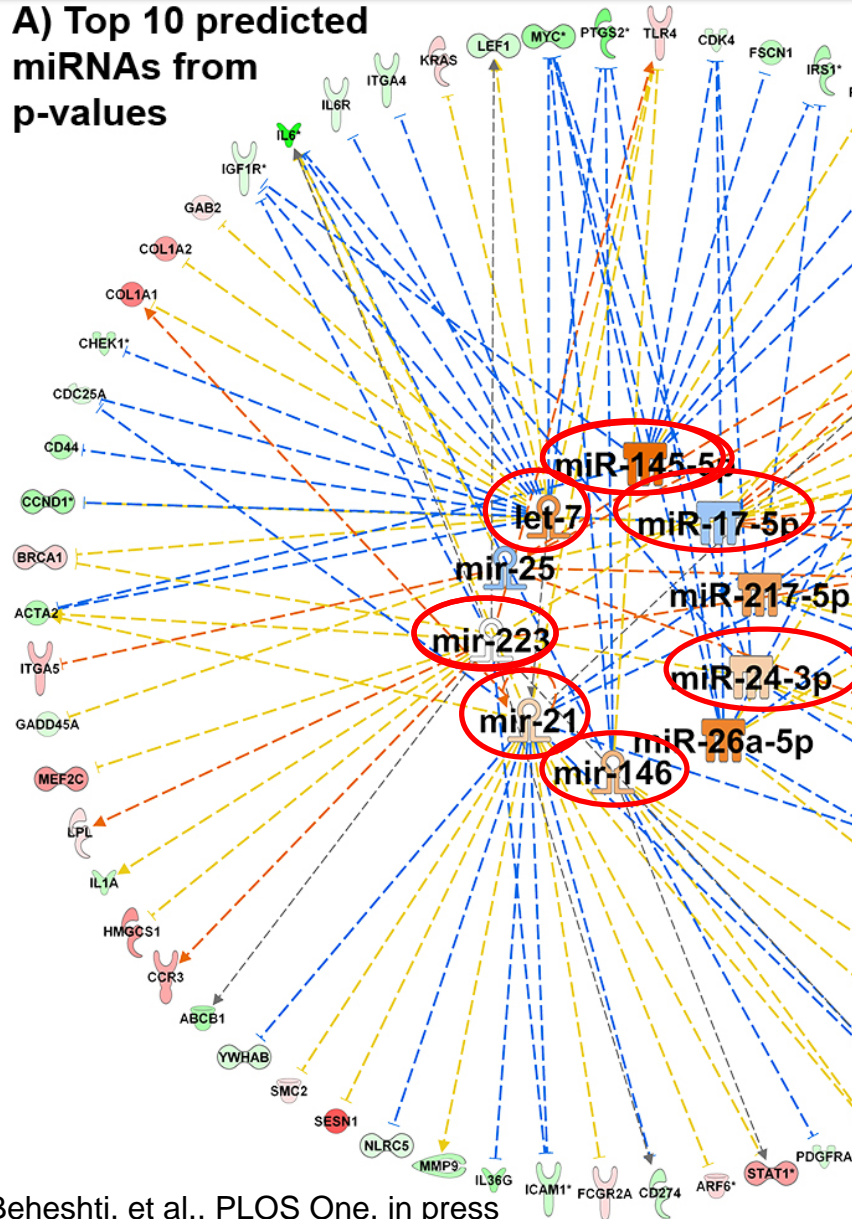


Systems Biology Approach: Looking at how the entire system impacts the most important miRNAs

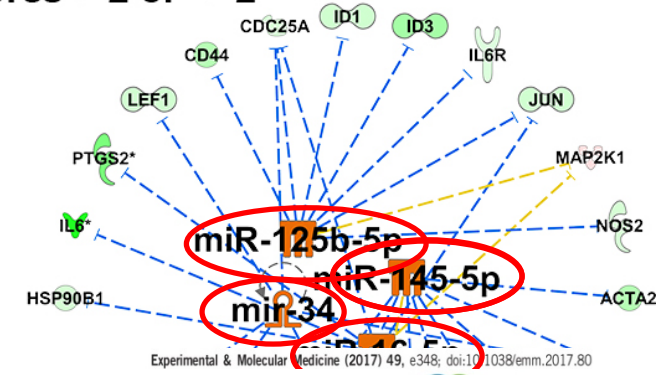
Predicted miRNAs Involved with Microgravity Effects



A) Top 10 predicted miRNAs from p-values



B) All miRNAs with Z-scores > 2 or < -2



OPFN
Hindawi Publishing Corporation
BioMed Research International
Volume 2014, Article ID 296747, 16 pages
<http://dx.doi.org/10.1155/2014/296747>

Experimental & Molecular Medicine (2017) 49, e348; doi:10.1038/emm.2017.80



Research Article
Integration Analysis of MicroRNA and mRNA Expression Profiles in Human Peripheral Blood Lymphocytes Cultured in Modeled Microgravity

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We analyzed miRNA and mRNA expression profiles in human peripheral blood lymphocytes (PBLs) incubated in microgravity condition, simulated by a ground-based rotating wall vessel (RWV) bioreactor. Our results show that 42 miRNAs were differentially expressed in MMG-incubated PBLs compared with 1 g incubated ones. Among these, miR-9-5p, miR-9-3p, miR-155-5p, miR-150-3p, and miR-378-3p were the most dysregulated. To improve the detection of functional miRNA-mRNA pairs, we performed gene expression profiles on the same samples assayed for miRNA profiling and we integrated miRNA and mRNA expression data. The functional classification of miRNA-correlated genes evidenced significant enrichment in the biological processes of immune/inflammatory response, signal transduction, regulation of response to stress, regulation of programmed cell death, and regulation of cell proliferation. We identified the correlation of miR-9-3p, miR-155-5p, miR-150-3p, and miR-378-3p expression with that of genes involved in immune/inflammatory response (e.g., IFNG and IL17F), apoptosis (e.g., PDCD4 and PTEN), and cell proliferation (e.g., NKX3-1 and GADD45A). Experimental assays of cell viability and apoptosis induction validated the results obtained by bioinformatics analyses demonstrating that in human PBLs the exposure to reduced gravitational force increases the frequency of apoptosis and decreases cell proliferation.

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Predicted miRNAs Involved with Microgravity Effects

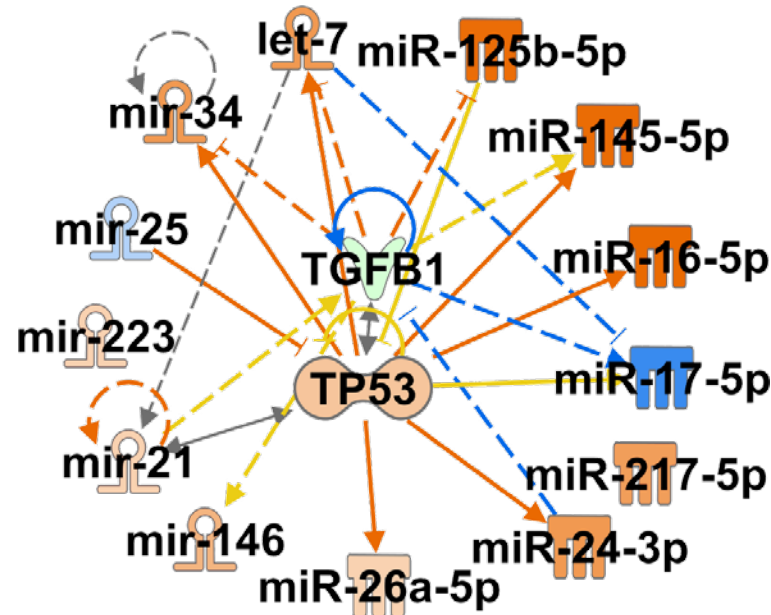


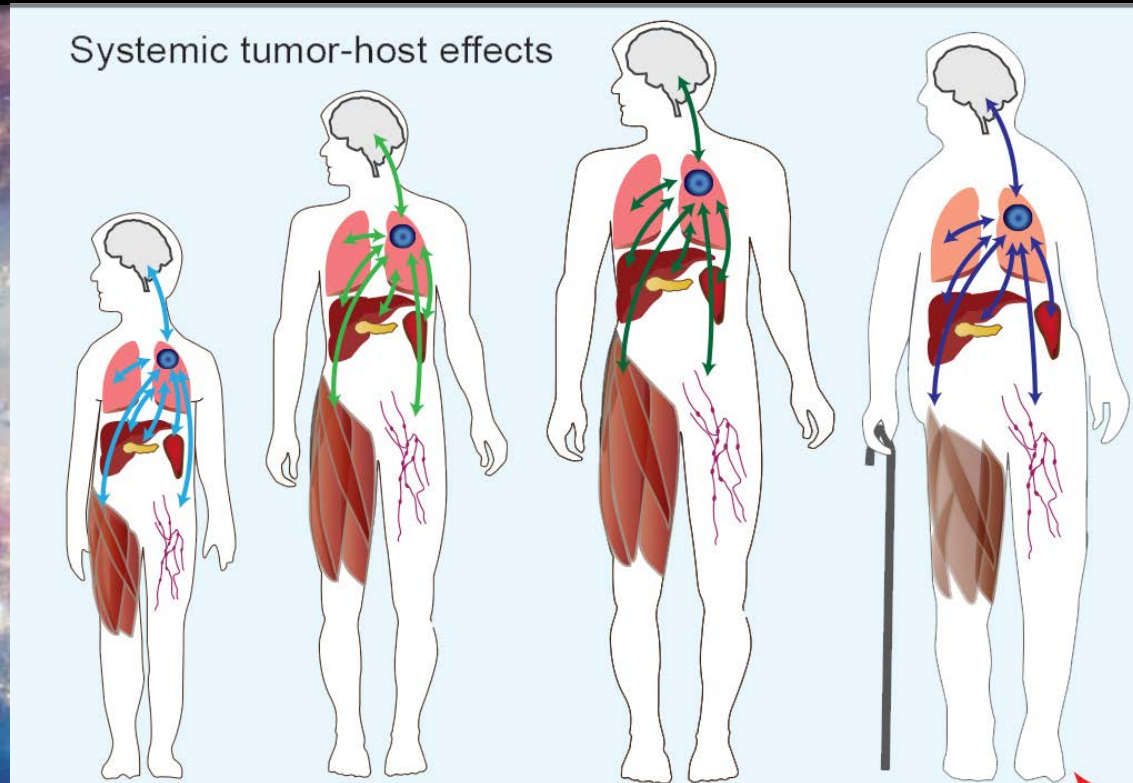
Health Risk Due to miRNAs



- A recent report showed that inactivation of p53 altered TGF- β signaling, which ironically displayed both tumor-suppressive and pro-oncogenic functions. p53 functions to integrate crosstalk between Ras/MAPK and TGF- β signaling via binding to Smad3, dislocating the Smad3/Smad4 complex formation and differentially regulating subsets of TGF- β target genes

*Biological Health
Risk Increased*

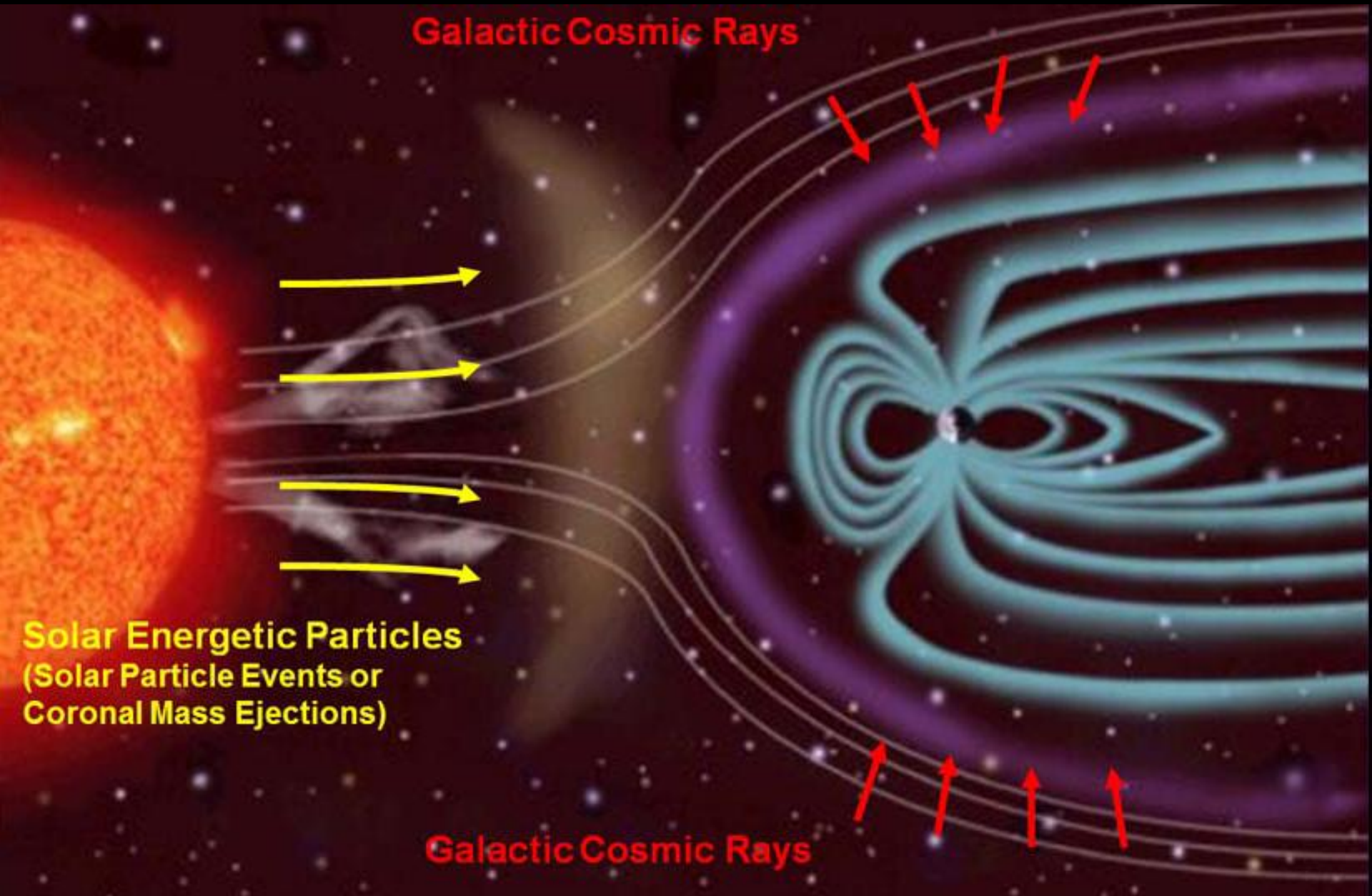




- **Systems biology approach allows for systemic understanding of the impact of Microgravity.**
- **Circulating miRNAs can influence overall progression of health risk to the host.**
- **miRNAs can potentially be used for novel minimally invasive therapeutics and countermeasures**
- **GeneLab (genelab.nasa.gov) is a powerful tool to generate hypotheses and direct future space research**

Space Radiation induces long term impact on the cardiovascular system by the activation of FYN through Reactive Oxygen Species

Work in progress

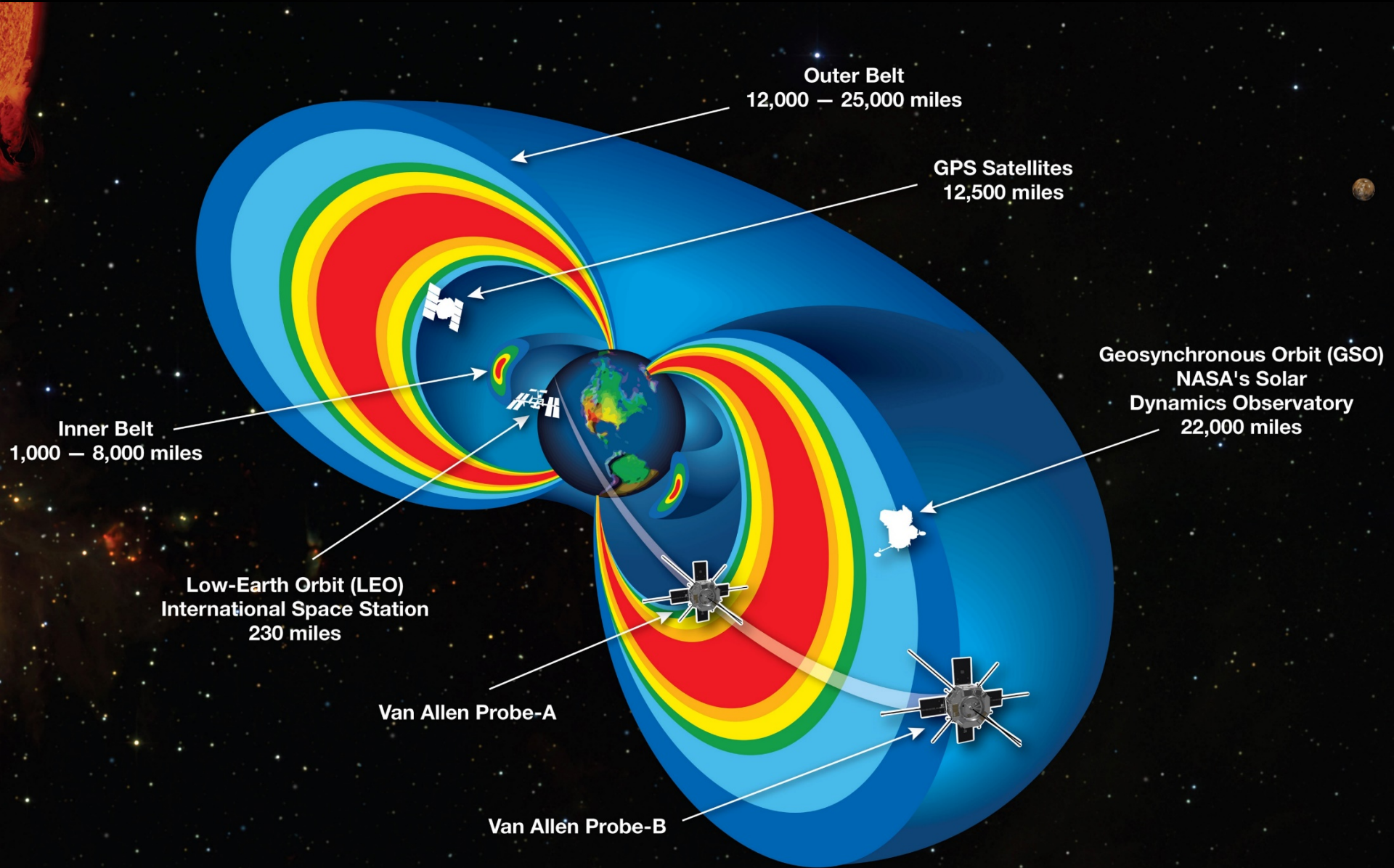


Galactic Cosmic Rays

Solar Energetic Particles
(Solar Particle Events or
Coronal Mass Ejections)

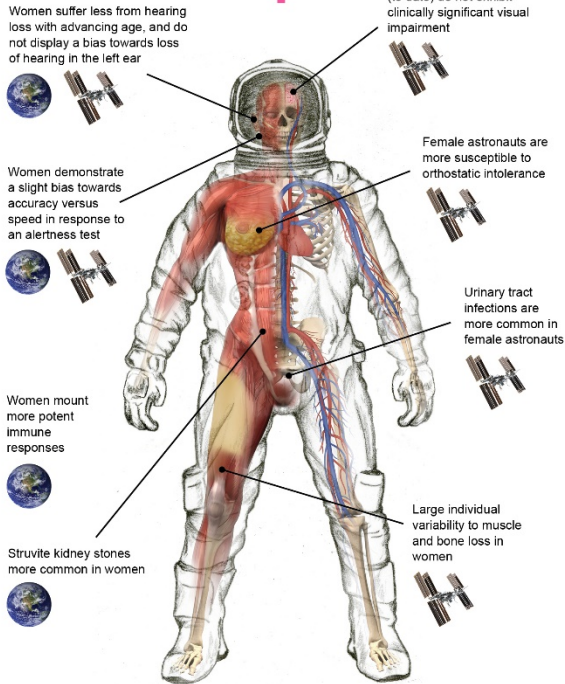
Galactic Cosmic Rays

Space Radiation: Van Allen Belt



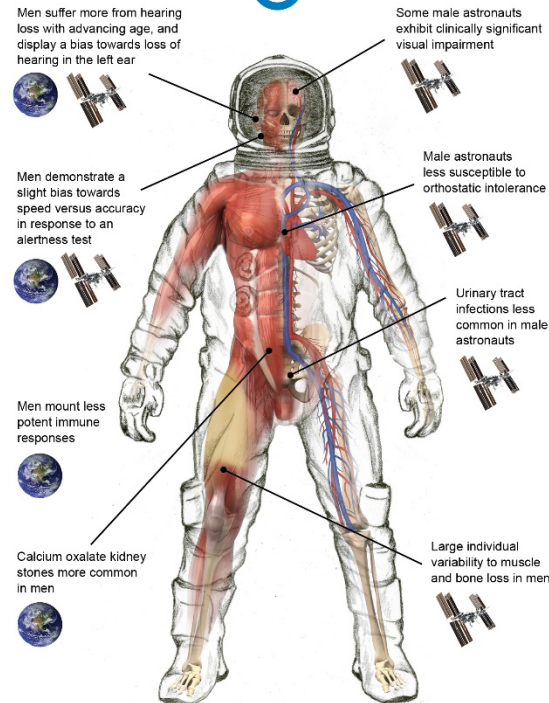


FEMALE ASTRONAUT



Health effect observed on Earth

MALE ASTRONAUT



Health effect observed in space

EFFECTS OF SPACE ON THE HUMAN BODY

SENSORIMOTOR

Sensorimotor disturbances can impair a person's movement control.

SPINE

A body gets a little taller in space due to the expansion of the vertebrae. Could cause back pain on return to Earth.

BONES

Prolonged exposure to space can cause loss of bone mass and bone minerals.

CARDIOVASCULAR

Decreases in vascular function may reduce oxygen intake, which could lead to poor performance of physically demanding tasks.

MUSCLE

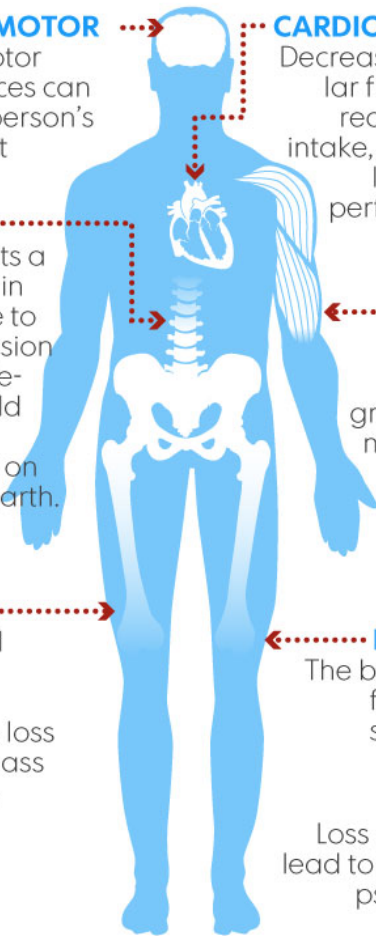
Lack of gravity causes muscle fibers to shrink, leaving a person weaker.

RADIATION

The body is at risk for radiation sickness and cancer.

SLEEP

Loss of sleep can lead to fatigue and psychological problems.



SOURCE: NASA
Janet Loehrke, USA TODAY



- Analyze

- GLD

- Ar 90

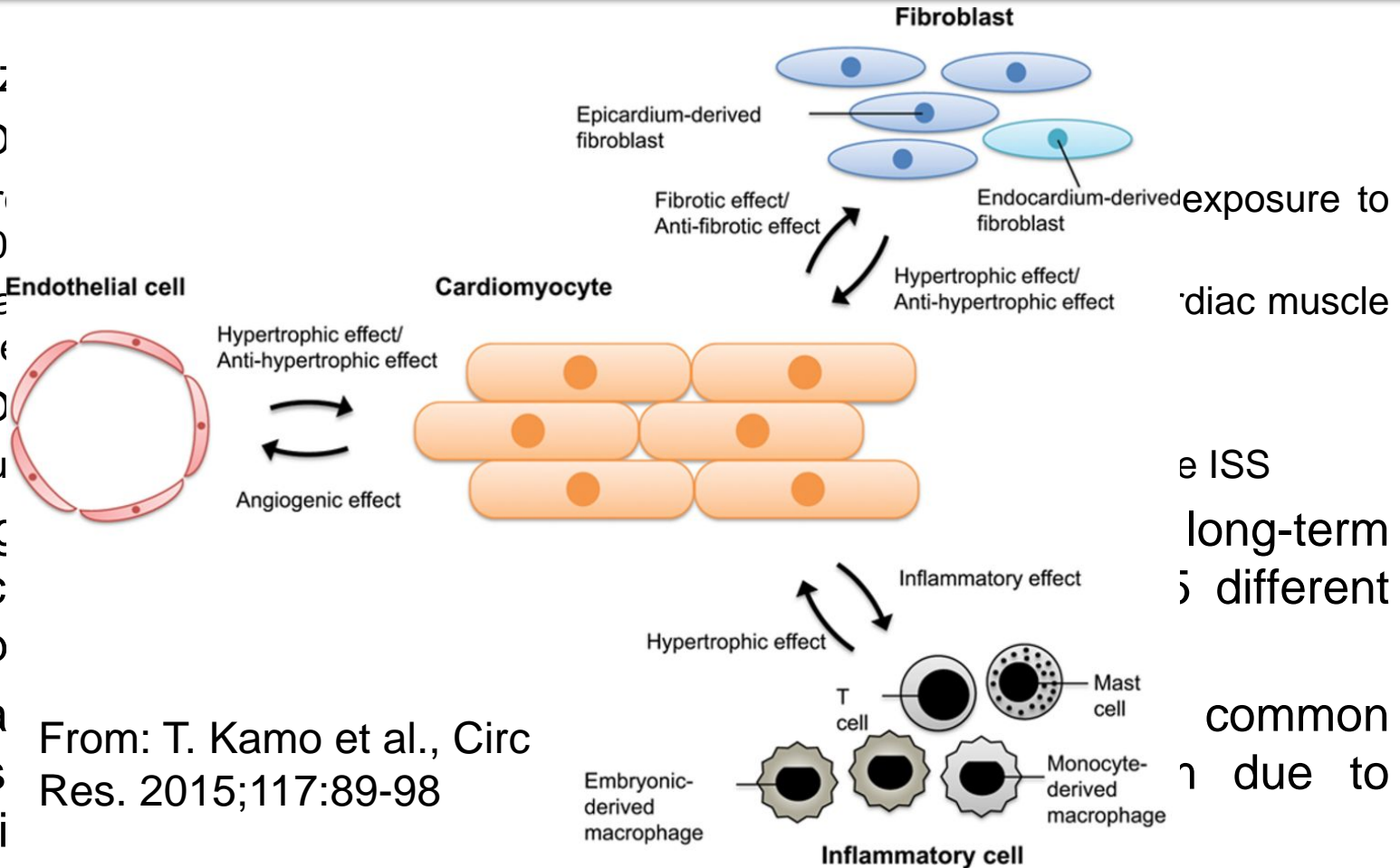
- Ca²⁺ (hr)

- GLD

- hu

- The impact on time point

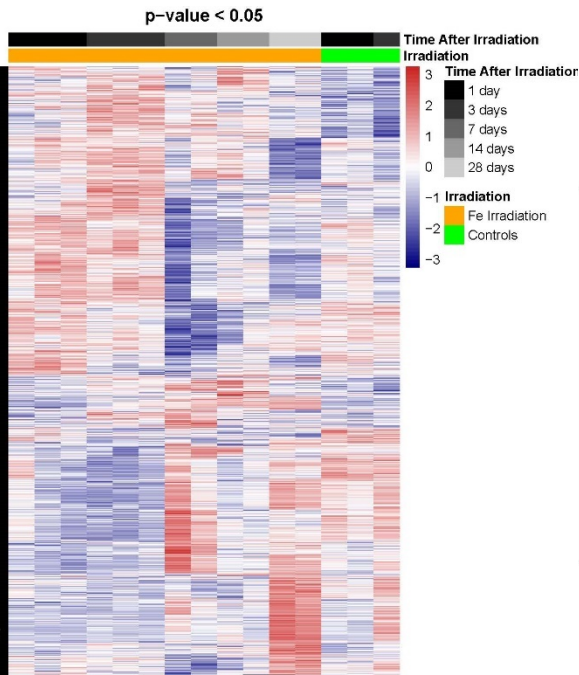
- Our analysis persists radiations



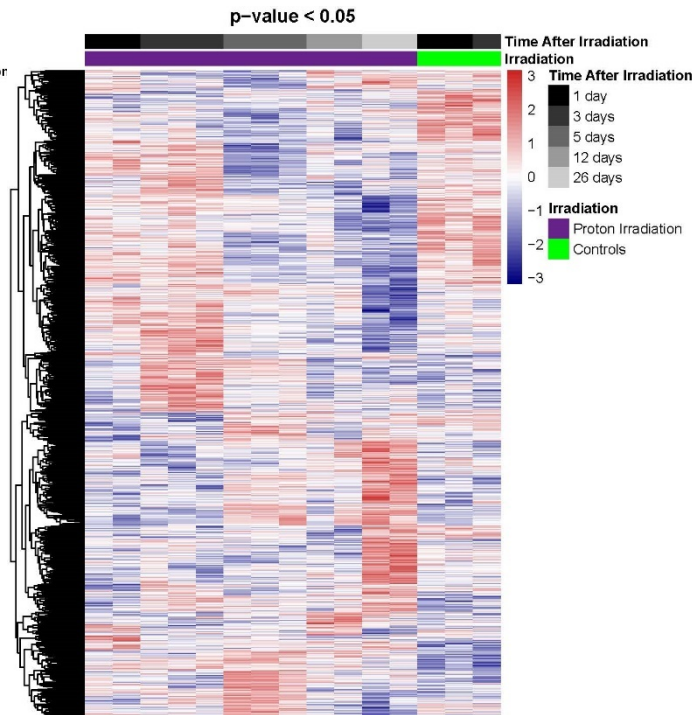
From: T. Kamo et al., Circ Res. 2015;117:89-98

- **Endothelial cells are known to directly regulate the development and activity of cardiomyocytes, and thus their response to spaceflight should be highly correlated with cardiomyocytes.**

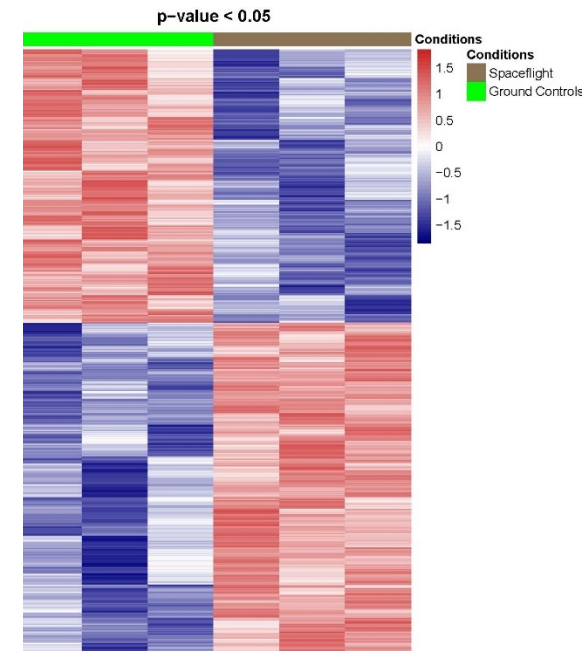
GLDS-109: ^{56}Fe



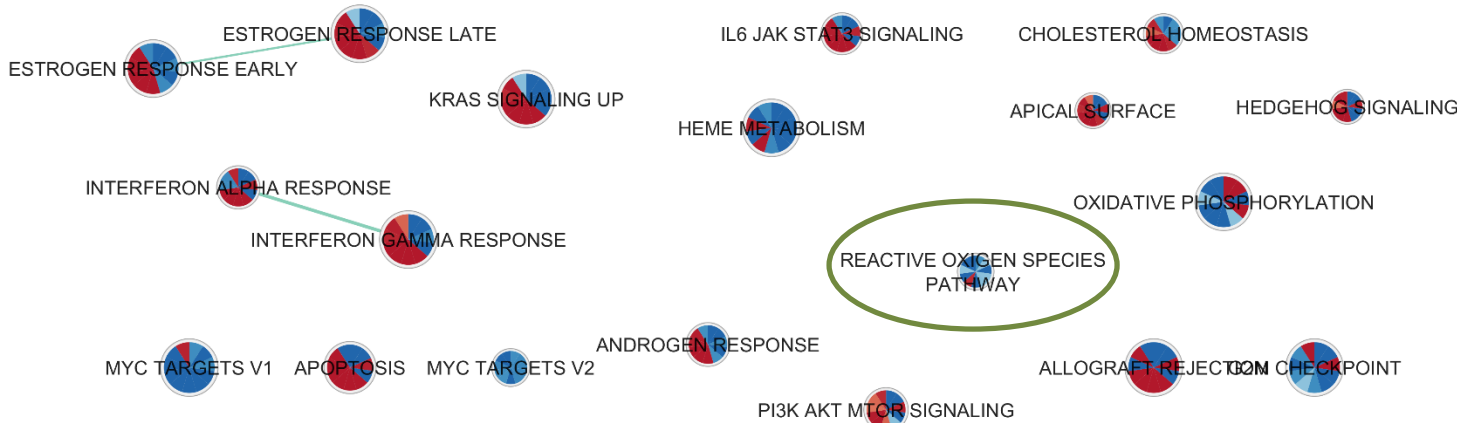
GLDS-117: Proton



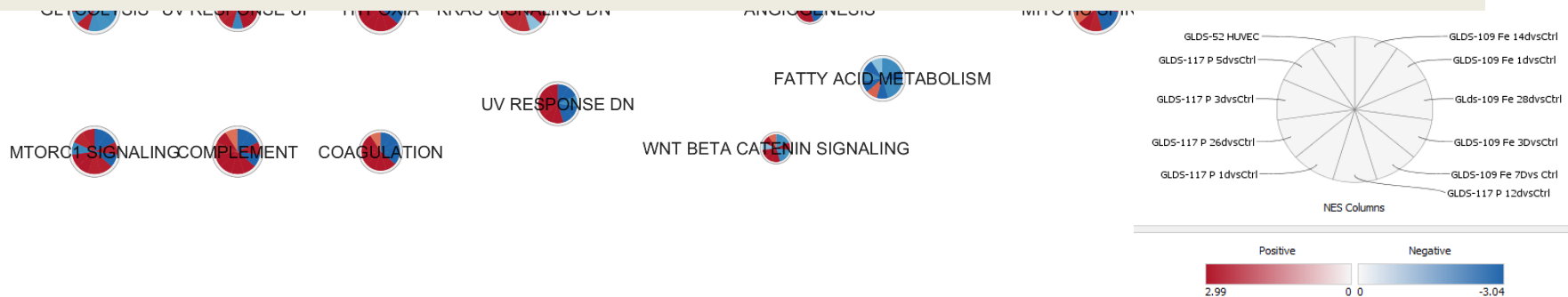
GLDS-52: HUVEC



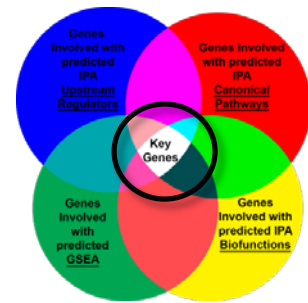
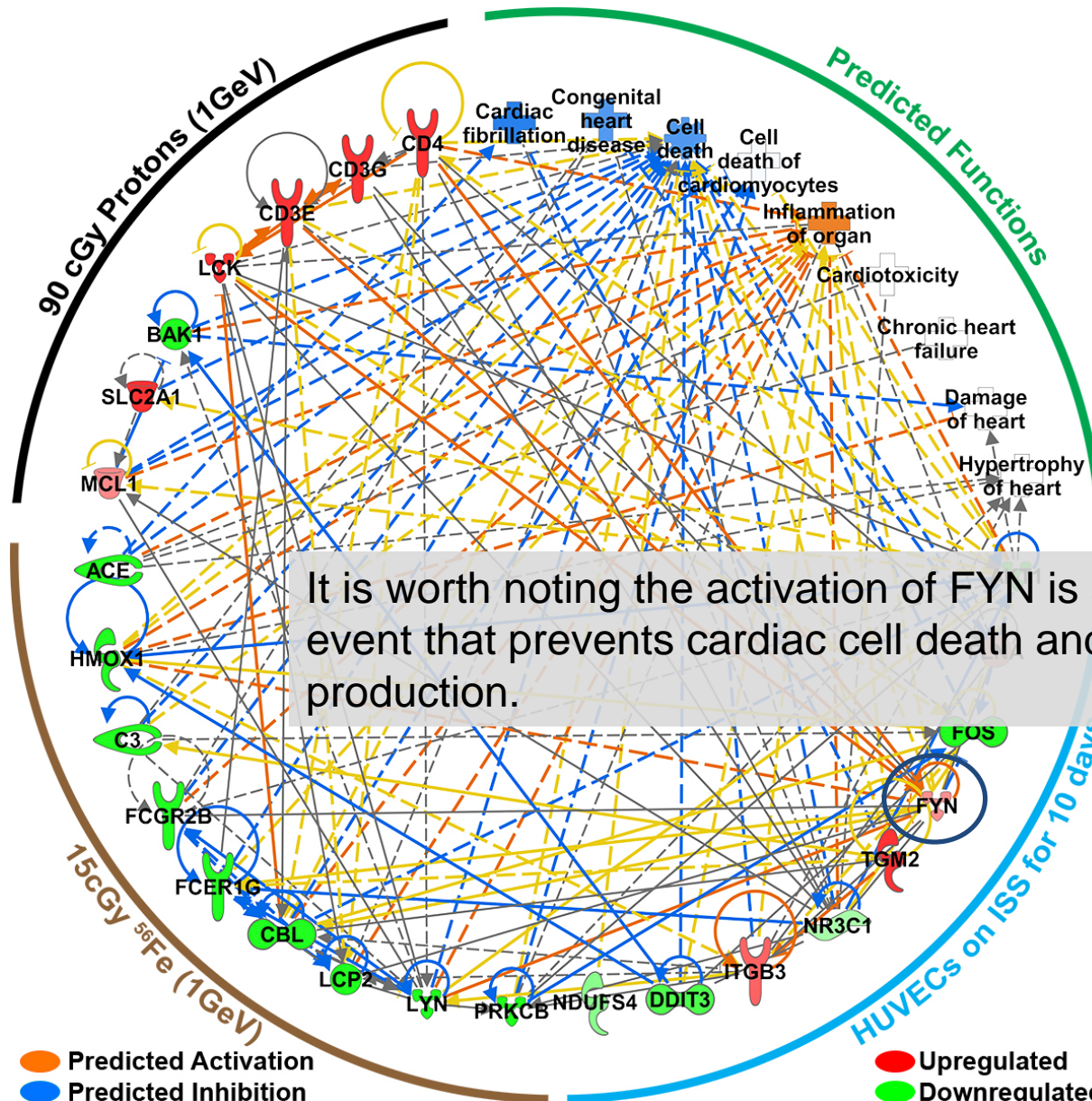
Focused on biological factors that will continue to have impact for all time points after irradiation.

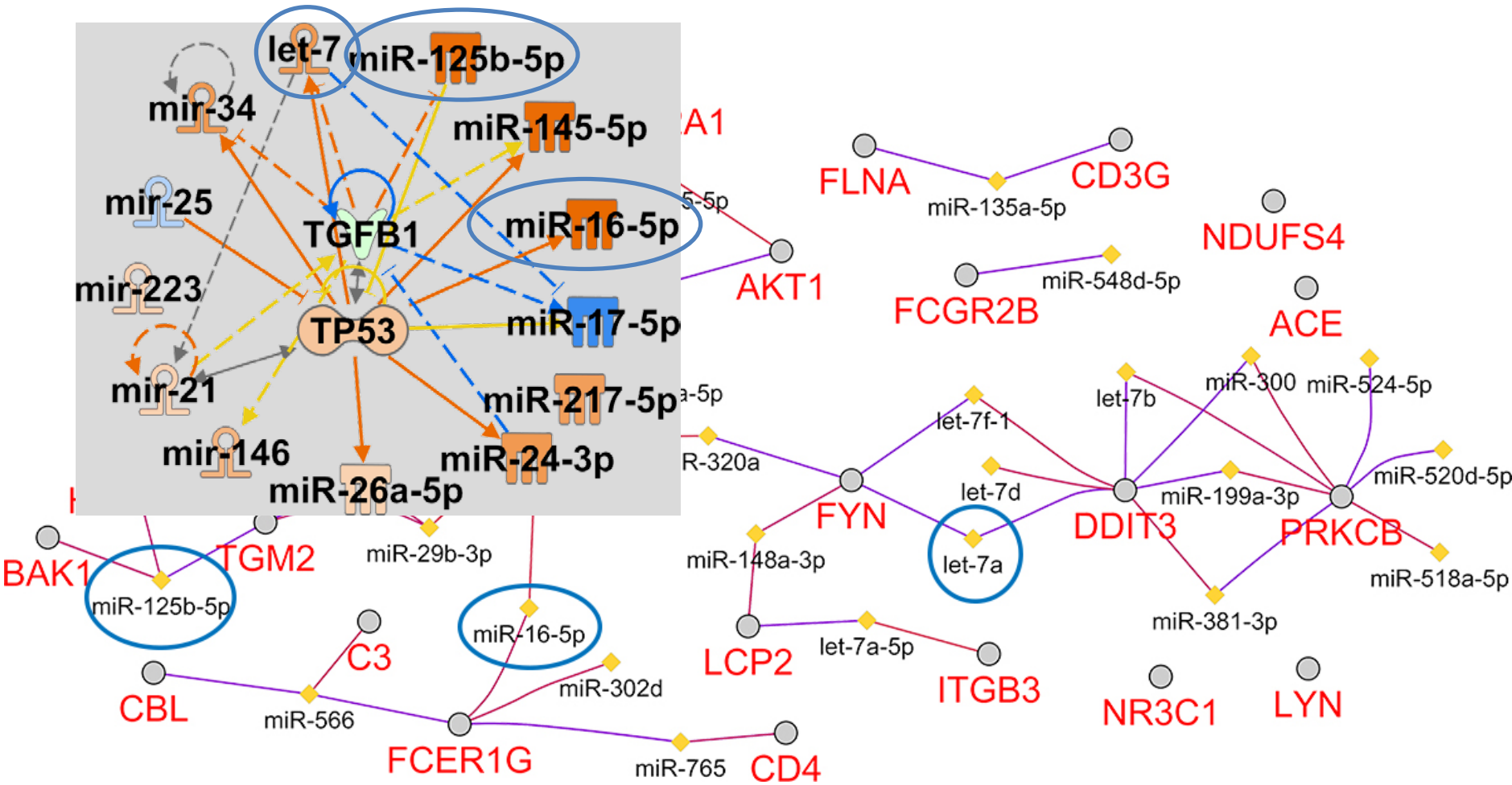


- ROS are formed as a natural byproduct of the normal metabolism of oxygen and have important roles in cell signaling and homeostasis.
- During times of environmental stress (e.g., radiation exposure), ROS levels can increase dramatically.
- This may result in significant damage to cell structures.
- Cumulatively, this is known as oxidative stress.
- ROS are also generated by exogenous sources such as ionizing radiation



Key Drivers Involved with Space Radiation Induced Cardiovascular Risk





- Space radiation downregulate ROS functions
- Key/driving genes: FYN, LCK, AKT1 are upregulated and LYN and FOS are downregulated with FYN being the central driver/hub for the cardiovascular response to space radiation.
 - FYN is a key event that prevents cardiac cell death and ROS production.
- From our study we thus hypothesize that a feedback loop occurs from the oxidative stress caused by space radiation that upregulates FYN which in turn reduces ROS levels and thus ROS pathways, preventing cardiomyocyte and endothelial cell death and thus protecting the cardiovascular systems.
- We believe that this is a novel mechanism for space radiation induced cardiovascular risk directly linking radiation ground studies to spaceflight.

Analysis Working Group (AWG) Member related work determines novel systemic biological factors causing damage due to spaceflight

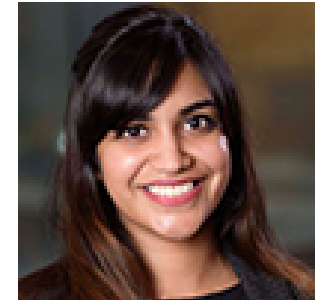
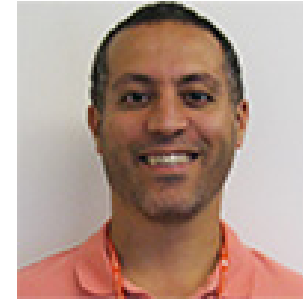
Work in progress



Kathleen Fisch Brin Rosenthal



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SCHOOL OF MEDICINE



Deanne Taylor Hossein Fazelinia Komal Rathi



Children's Hospital
of Philadelphia™



Perelman
School of Medicine
UNIVERSITY of PENNSYLVANIA



Helio Costa Kathryn Grabek



STANFORD
UNIVERSITY



J. Tyson McDonald



HAMPTON
UNIVERSITY
THE STANDARD OF EXCELLENCE



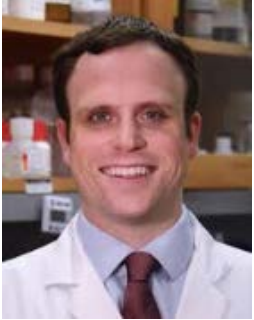
Gary Hardiman



Willian da Silveira



MUSC Health
MEDICAL UNIVERSITY of SOUTH CAROLINA



Chris Mason



Cem Meydan



Jonathan Foox



Flavia Rius



Cornell University



Yared Kidane



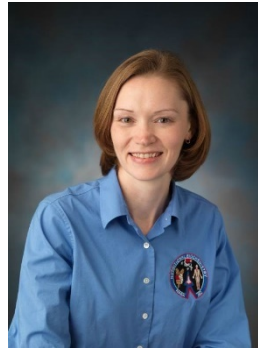
TEXAS
SCOTTISH RITE HOSPITAL
FOR CHILDREN



Susana Zanello



Scott Smith



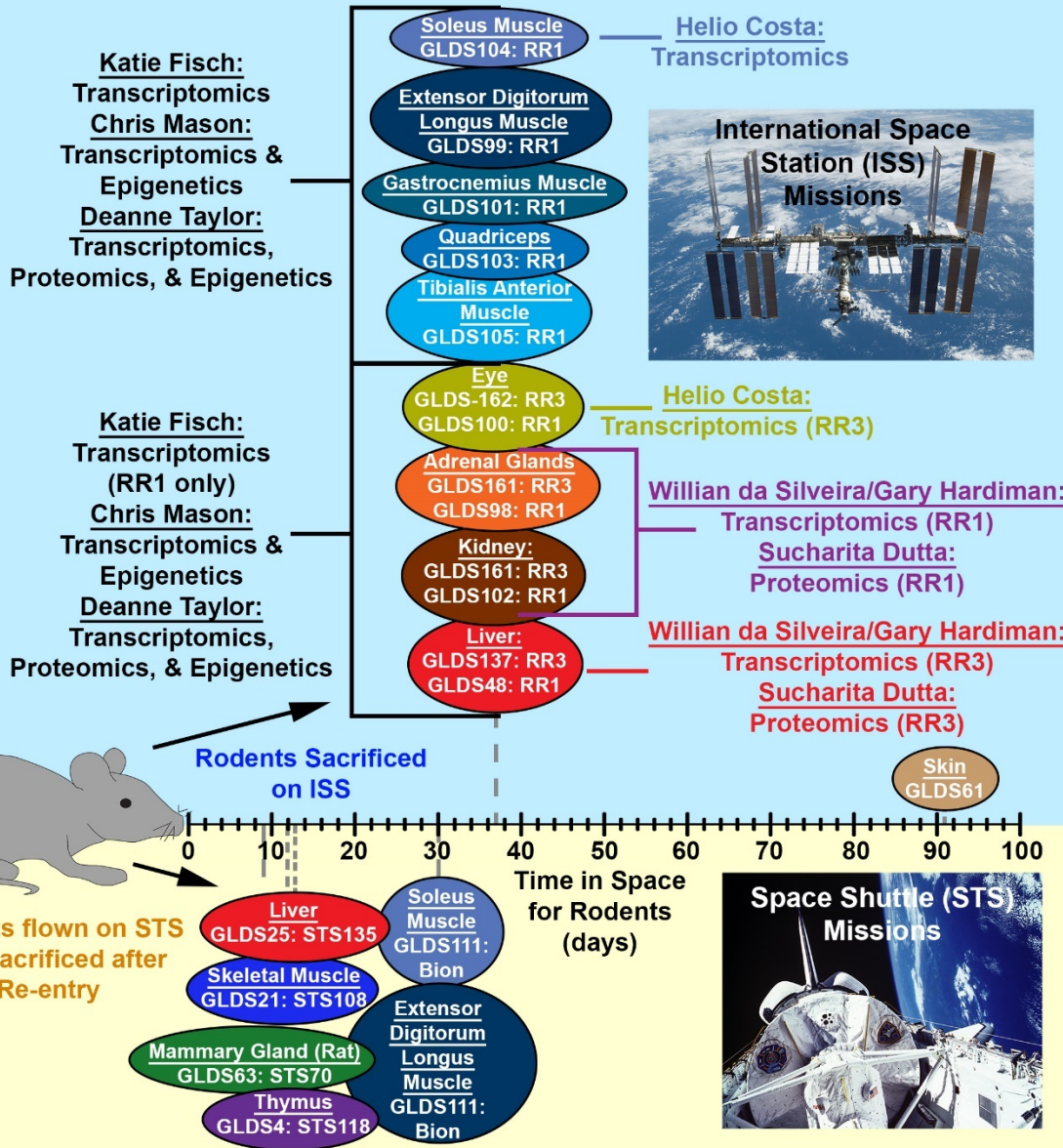
Sara Zwart



Afshin Beheshti Sylvain Costes



Specific Datasets and Tissues AWG Members Analyzed

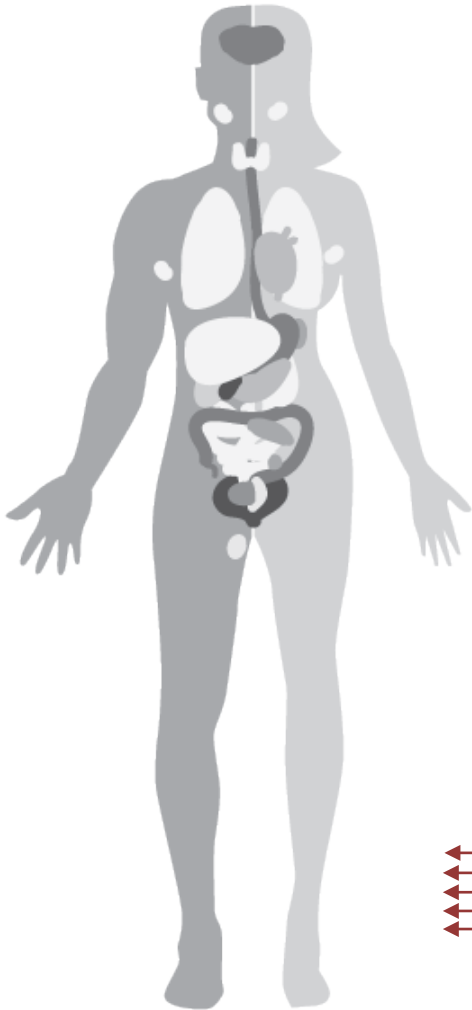


- Additional Datasets that are being analyzed:
 - Human datasets
 - GLDS-54, GLDS-174, GLDS-86, GLDS-118, GLDS-53, GLDS-54, GLDS-13. GLDS-52, or GLDS-114 (Tyson McDonald and Yared Kidane)

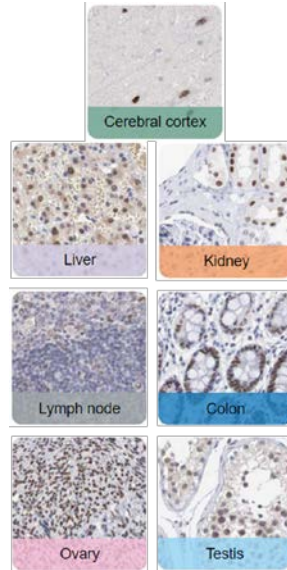
Structural Hierarchy of the Human Body



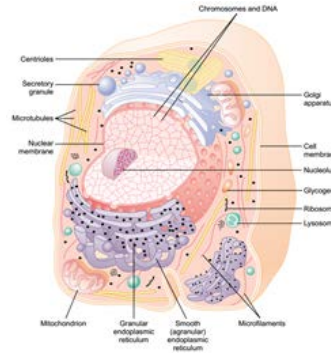
Level 7: The Body
Level 6: Organs



**Level 5:
Tissues**



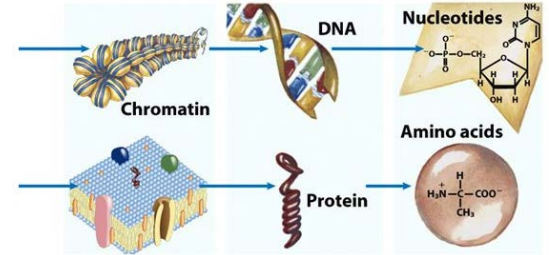
**Level 4:
The Cell and its
Organelles**



**Level 3:
Supra
molecular
Complexes**

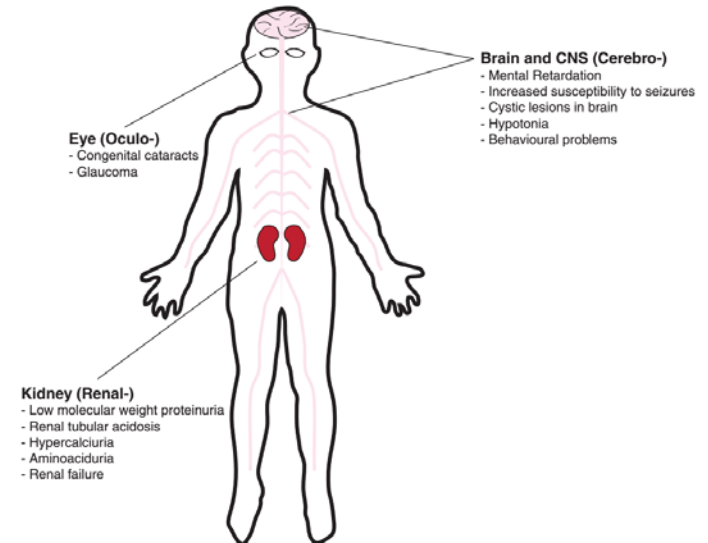
**Level 2:
Macro
molecules**

**Level 1:
Monomeric
Units**



- Spaceflight changes the physical properties of the cell components impacting from the molecular to the whole body level.
- The Mitochondria are the principal cellular component affect.
- The Liver is the principal organ affected in issues related to the metabolism.
- Possible disease that can be associated with liver damage and pathways is: Oculocerebrorenal Syndrome of Lowe
 - “Extensive research has demonstrated that OCRL-1 is involved in multiple intracellular processes involving endocytic trafficking and actin skeleton dynamics. This explains the multi-organ manifestations of the disease.”
 - “The classic form of the oculocerebrorenal syndrome of Lowe (OMIM #309000), first described by Lowe et al. in 1952 [1], is characterized by the triad of congenital cataracts, severe intellectual impairment, and renal tubular dysfunction with slowly progressive renal failure”
 - Patients with this disease manifest Cataract, Glaucoma and Muscle hypotonia.

Schematic diagram showing the organs affected in Lowe syndrome



LATEST NEWS
NASA GeneLab Project: Bridging Space Radiation Omics with Ground Studies
Accurate assessment of risks of long-term space missions is critical for human space exploration. It is essential to have a detailed understanding of the biological effects on humans living and working in deep space. Ionizing radiation from galactic cosmic rays (GCR) is a major health risk factor for astronauts on extended missions outside the protective effects of the Earth's magnetic field. Currently, there are gaps in our knowledge of the health risks associated with chronic low-dose, low-dose-rate ionizing radiation, specifically ions associated with high (H) atomic number (Z) and energy (E). The NASA GeneLab project aims to provide a detailed library of omics datasets associated with biological samples exposed to HZE... [Read more](#)

Access GeneLab Omics Data
Home Repository Data Data Mining Tools Submit Data Help Workspace
Search Data
GeneLab NIH GEO EB PRIDE ANL NSI PRISM

ANALYSIS WORKING GROUPS
Analysis Working Groups Reach Consensus on Pipelines Needed to Generate Higher-order Data

SPOTLIGHT ON RADIATION
Radiation Dosimetry Measurements Added to Data Repository
Low-Earth Orbit (LEO) International Space Station (ISS) Mission
Completed: Over 6000 HZE Events
Recorded: Approximately 25,000 ions

RESEARCH ANNOUNCEMENT
NASA Research Announcement: Topics in Human Health Countermeasures, Human Factors, and Behavioral Performance

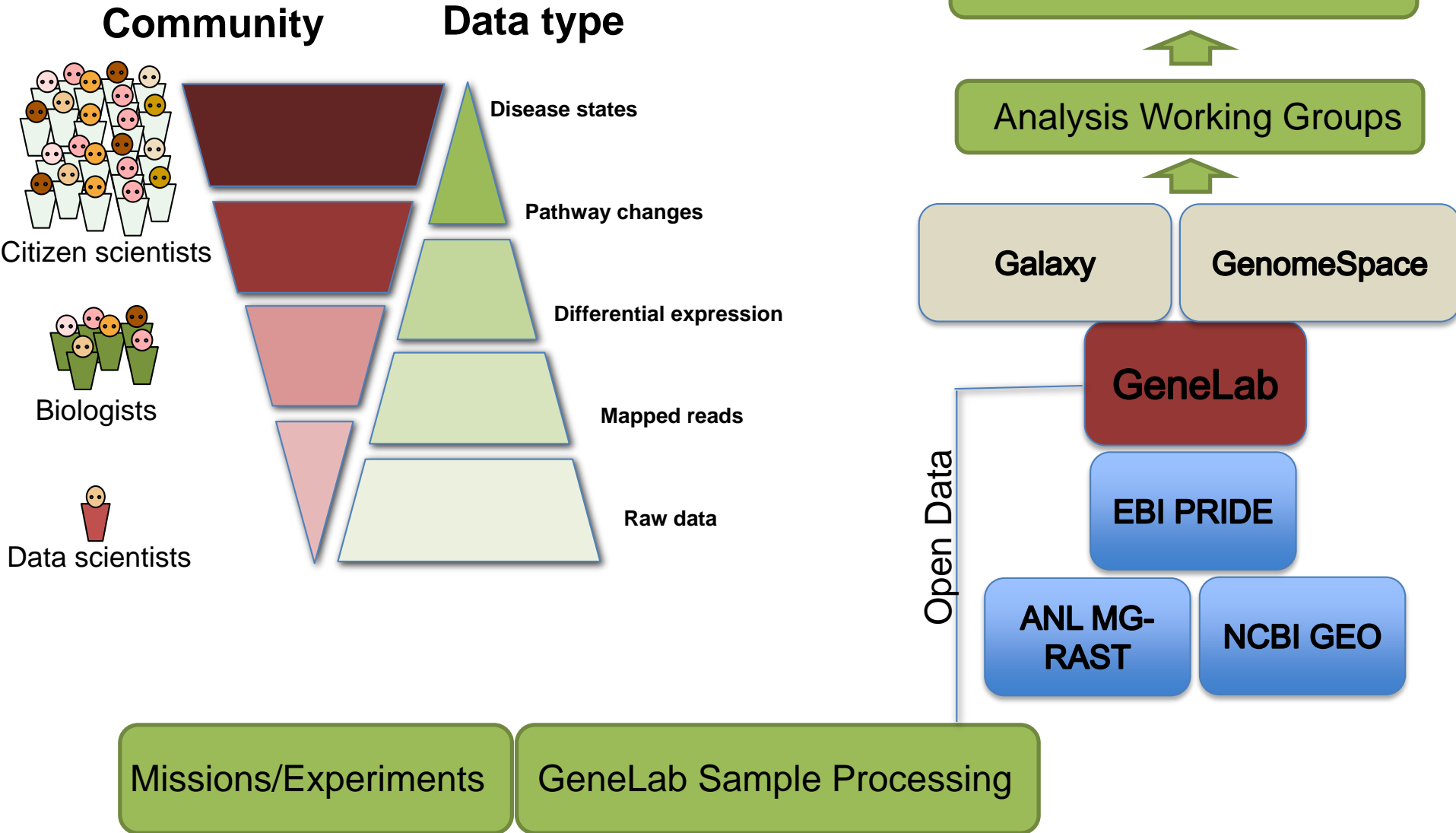
LabRoots: A Conversation with Sigrid Reinsch – Public Access to Spaceflight Omics Data

Marianne Sowa and Jack Miller Discuss Radiation Science Using GeneLab

<https://genelab.nasa.gov>

Participate in GeneLab Analysis Working Groups

- Social media :
 - @NASA Ames **Facebook**
 - **Twitter** #GeneLab
 - **ResearchGate**: <https://www.researchgate.net/project/Omics-for-Space-Biology-The-GeneLab-project>



Chris Barreras
Afshin Beheshti
Dan Berrios
Valery Boyko
Sonja Caldwell
Jairon Camarillo
Egle Cekanaviciute
John Costa
Sylvain Costes (PM)
Marie Dinh
Sandy Dueck
Homer Fogel
Jon Galazaka (PS)
Samrawit Gebre
Dennis Heher
Lynn Hutchison
Yared Kidane
San-Huei Lai Polo
Tristan Le
Qiang Li
Shu-Chun Lin
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Sigrid Reinsch
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