

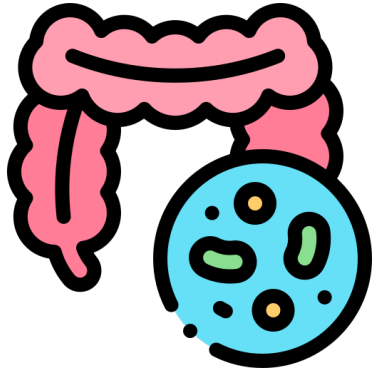
RADIOBIOME: HOST-GUT MICROBIOME FUNCTIONAL RESILIENCE TO RADIATION

BY MICHAELA WALSH

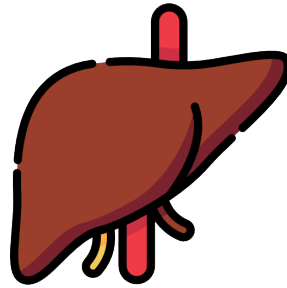
SUPERVISORS: DR. NICHOLAS J.B BRERETON, ASSOC.
PROF LUIS LEON-VINTRO, PROF. BRENDAN
MCCLEAN



GUT MICROBIOME AND HUMAN HEALTH



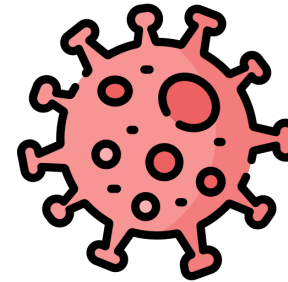
Gut microbiome important for human health functions



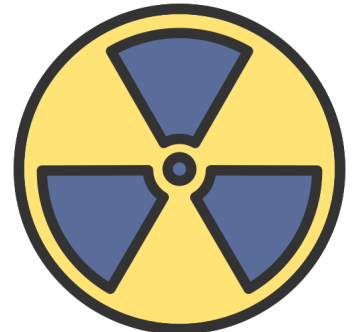
Bile acid metabolism



Energy metabolism



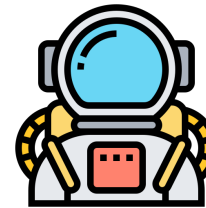
Immunity



RADIOTHERAPY AND SPACEFLIGHT



Radiotherapy
patients



Astronauts

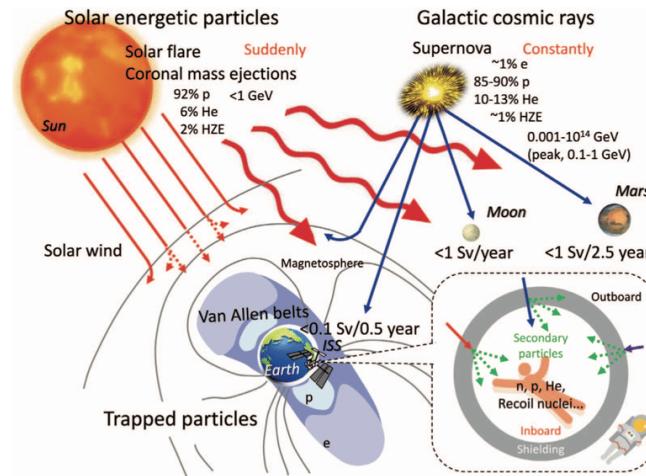


LINAC

- X-rays
- Electrons

Tumour site

- Dose per fraction: 2 Gy
- Total treatment dose:
50 - 80 Gy



- SPE – protons
- GCR – alpha particles, heavier nuclei
- Radiation Belts – electrons, protons

Whole body irradiation

- 6-months ISS: 30 mGy
- 3-year mission to Mars: 450 mGy

- Chancellor, Jeff & Nowadly, Craig & Williams, Jacqueline & Aunon-Chancellor, Serena & Chesal, Megan & Looper, Jayme & Newhauser, Wayne. (2021). Everything You Wanted to Know About SpaceRadiation but Were Afraid to Ask. 10.48550/arXiv.2103.17153.
- NCRP Report No. 183 – Radiation Exposure in Space and the Potential for Central Nervous System Effects: Phase II (2019)

CHALLENGES - RADIOTHERAPY PATIENT AND ASTRONAUT HEALTH

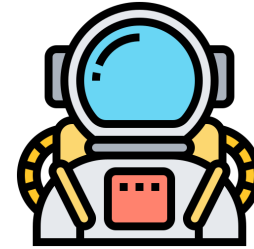
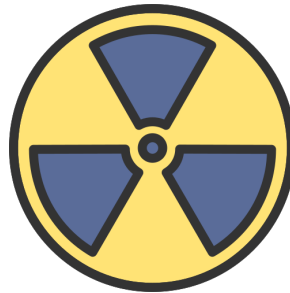


Variable response + recovery

Treatment side-effects

Decrease in commensal
microbial populations

CHALLENGES



Spaceflight pathology

Metabolic disruption

Decrease in commensal
microbial populations

Research Question

How are specific gut microbiome bacterial functions
affected by ionising radiation exposure?

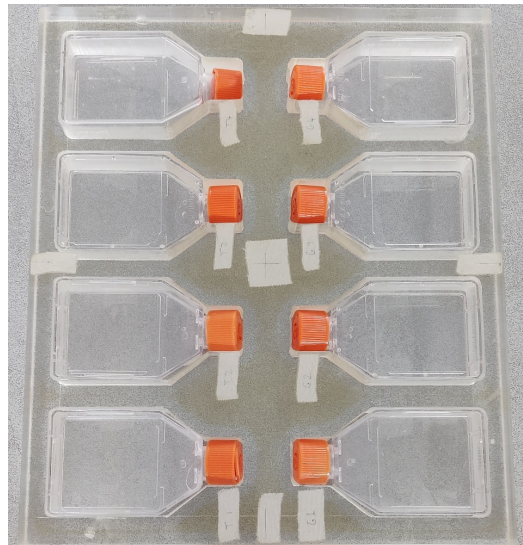
TRACTABLE SYSTEM TO IRRADIATE BACTERIA?

Research Question

How are specific gut microbiome bacterial functions affected by ionising radiation exposure?



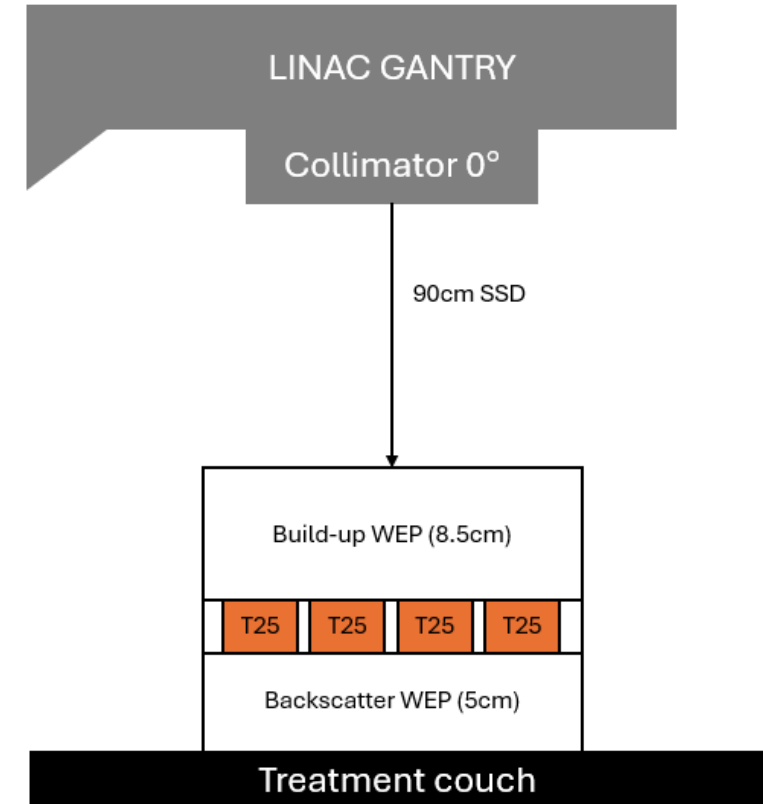
LINAC



Flask phantom

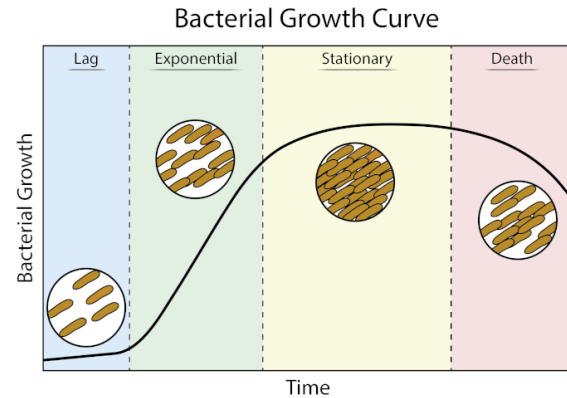


Bacterial irradiation



HOW ARE BACTERIA AFFECTED BY RADIATION?

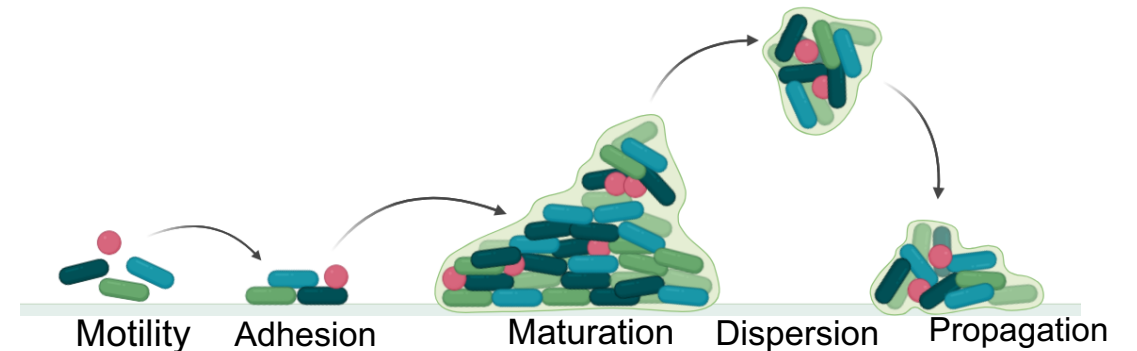
First question: Is growth compromised?



- Indicative of viability and basic function
- Implications for bacterial populations

Measure growth over time -
spectrophotometer

Second question: Is structure compromised?

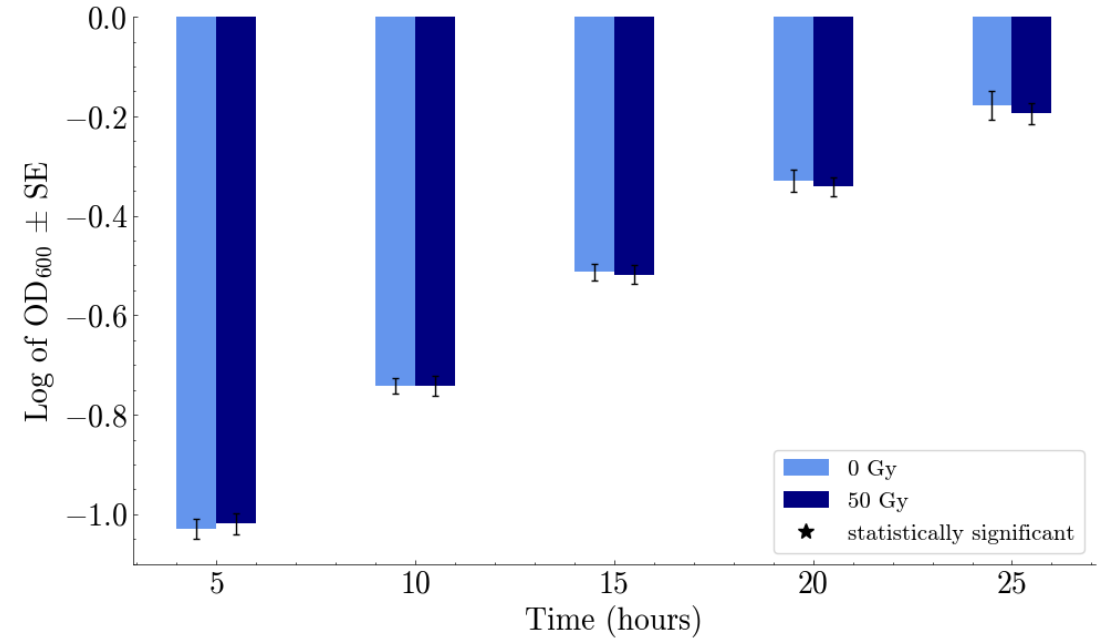
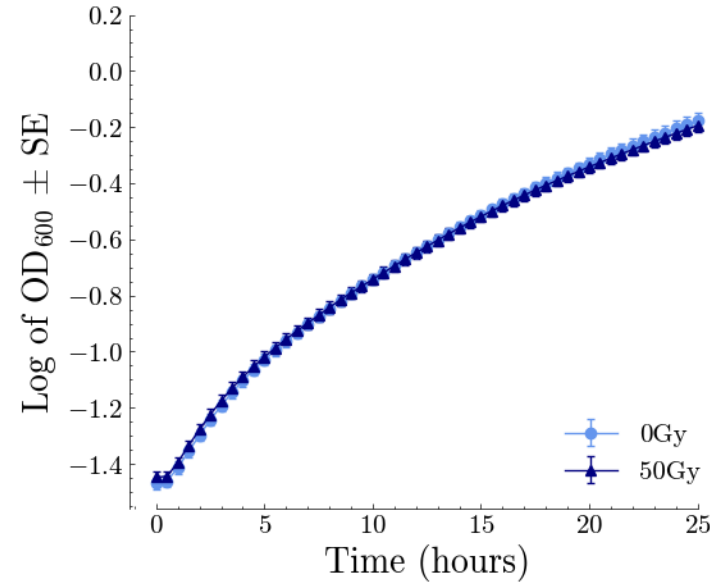


- Biofilm formation and structure
- Quorum sensing
- Are biofilms more resilient to radiation vs planktonic cells?

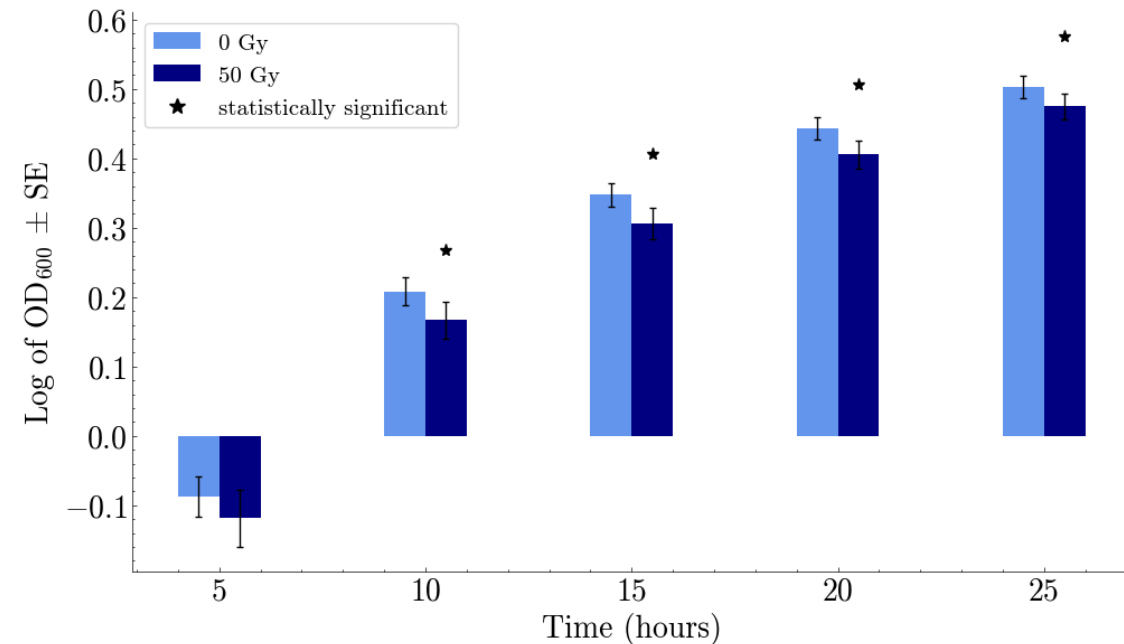
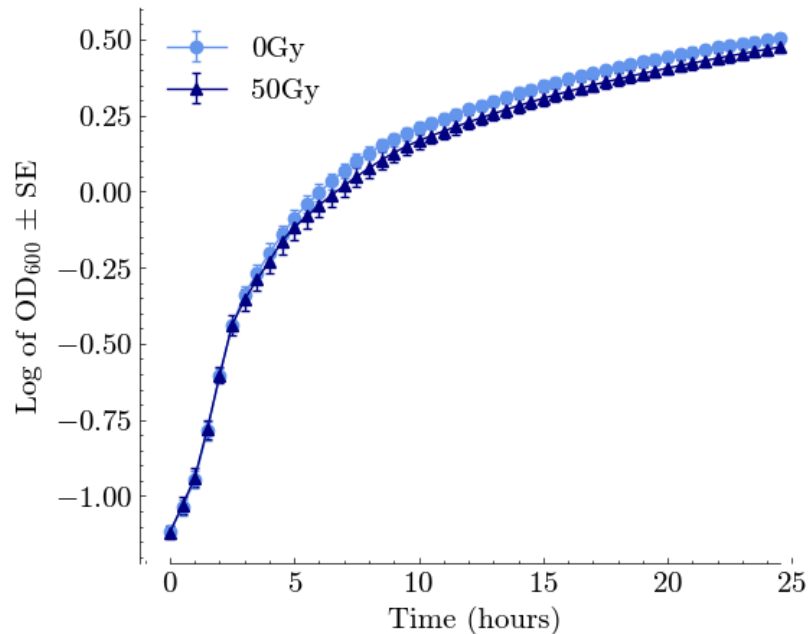
Visualise biofilm structure via
Fluorescent microscopy

GROWTH OF BACTERIA AFTER IRRADIATION

L. acidophilus



L. paracasei



Difference in response
between species

Functional affect
unknown

IS BIOFILM GROWTH AFFECTED BY RADIATION?

Biofilm: Community of bacteria that form an extracellular matrix

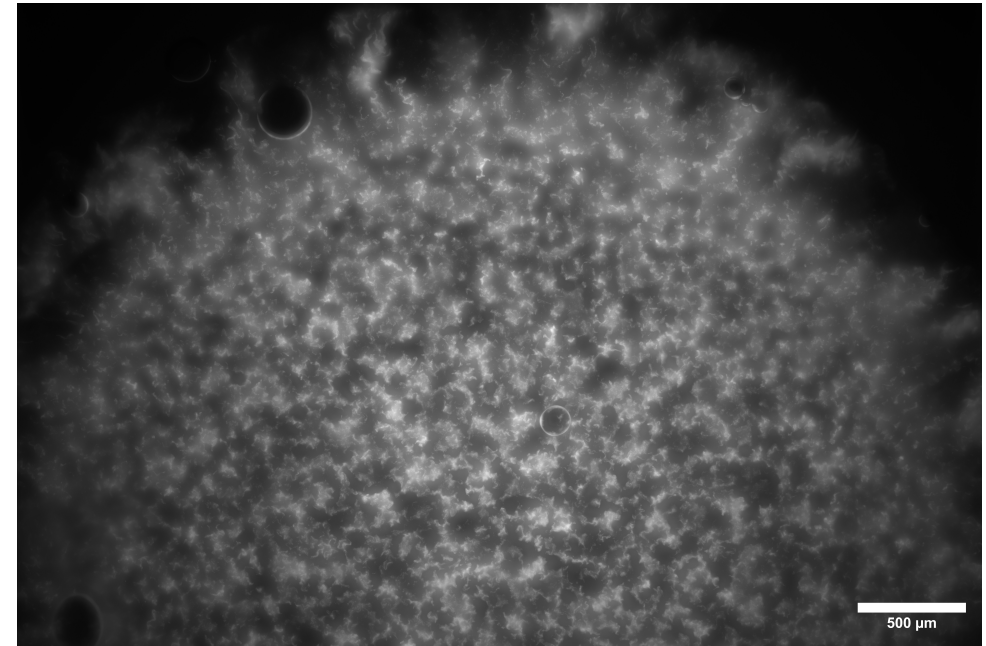
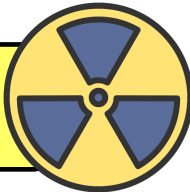
Biofilm beneficial properties

Protection from stressors
e.g., UV radiation

Resource management
Nutrient acquisition

Adaptation
To changing environment

**More resilient to radiation
vs planktonic cells?**



- Fluorescence microscopy - *E.coli* - HcRed
- Liquid culture – 50 Gy irradiation
- Assess biofilm growth after irradiation

No change in structure from radiation
Proof-of-concept – more strains needed

DISCUSSION AND FUTURE WORK

Development of tractable culture and irradiation system

- **Growth compromise**
 - No compromise in *L. acidophilus*
 - Different to initial results - difficult to capture
 - *L. paracasei* – slight compromise, repeat
- ***E. coli* biofilm formation resilient to radiation**
 - Proof of concept for other strain investigations

Advance the patient treatment pathway
Gut microbiome led radiotherapy

Next questions

- **Different response between species?**
 - *Clostridium scindens*
 - *Bifidobacterium adolescentis*
- **Functional compromise?**
 - Bile acid metabolism (BSH, 7 α -dehydroxylase)
 - Carbohydrate metabolism (CAZymes)
- **Radiation type, dose and dose rate?**
 - Low vs high dose rate
 - Space radiation
 - Monte Carlo modelling

Maintain astronaut health
Long-duration spaceflight

SPECIAL THANKS TO



Brendan McClean

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Guerrino Macori

Fiona O'Neill

Oran McElligott

Katherine Baxter



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