

C. elegans under simulated microgravity: what happens to their gene expression?

¹Ling-Fei Tee, ¹Hui-min Neoh, ²Sue Mian Then, ¹Nor Azian Murad,
³Mohd Fairos Asillam, ³Mohd Helmy Hashim,
⁴Sheila Nathan, ¹Rahman Jamal

¹UKM Medical Molecular Biology Institute, Universiti Kebangsaan Malaysia, Malaysia,

²Department of Biomedical Sciences, The University of Nottingham, Malaysia,

³National Space Agency, Ministry of Science, Technology & Innovation, Malaysia,

⁴Faculty of Science & Technology, Universiti Kebangsaan Malaysia, Malaysia.



Worms in space

- ✓ At least **60-80%** of genes are homologous with human.

Leung et al. 2008

- ✓ First multicellular organism to have its **genome fully sequenced.**

C. elegans Sequencing Consortium 1998

Caenorhabditis elegans





C. elegans flown to
outer space before



Previous spaceflight experiments with *C. elegans*:

STS-42, STS-76, STS-95, STS-107,
ICE-FIRST, CERISE

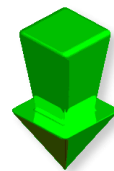
UMBI's Spaceflight Experiment onboard STS-116

Then et al. 2014

Alteration in gene expression



Longevity



DNA repair



Locomotion

A few concerns from previous microgravity experiments:

↗ Culture medium of *C. elegans*

↗ Different effect exerted by agar and liquid medium
I. 2003

↗ Multi-generational studies of *C. elegans*

↗ Mi... worms
↗ ... of larvae and adult worms
all...
Kim et al. 2013

↗ Difficult to reproduce

↗ Space mission is needed

Studies remain few

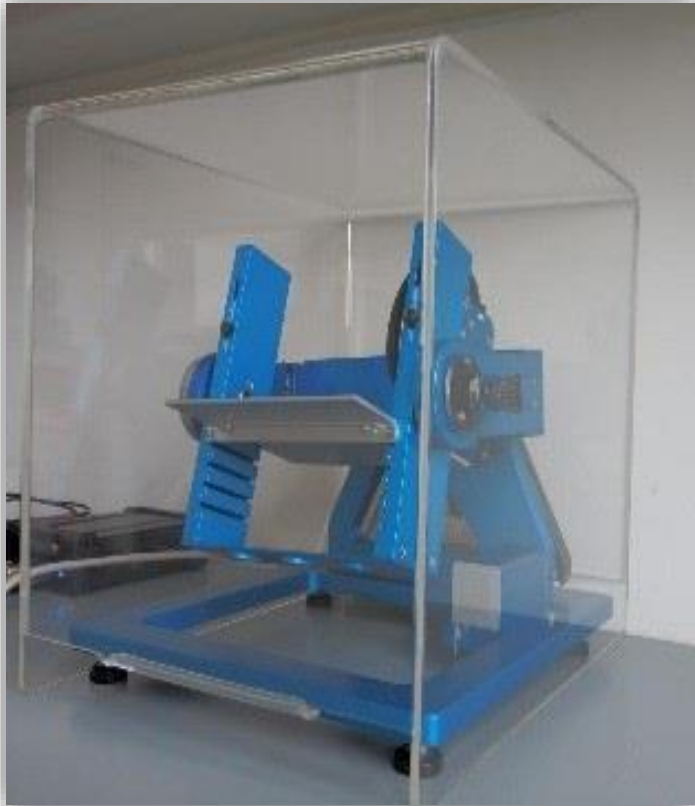
To understand microgravity effects on *C. elegans*:

1. Need an **equipment** to simulate microgravity on Earth.

2. Need to **control life stages** of *C. elegans* in a single generation for accurate gene expression.

3. Experiments needed to be conducted on **both agar and liquid medium**.

Simulation of microgravity on Earth: the Random Positioning Machine (RPM)



UMBI-ANGKASA Microgravity Lab



**3D microgravity simulator (Airbus
Defence and Space Netherlands B.V.)**



Principle of gravity vector averaging

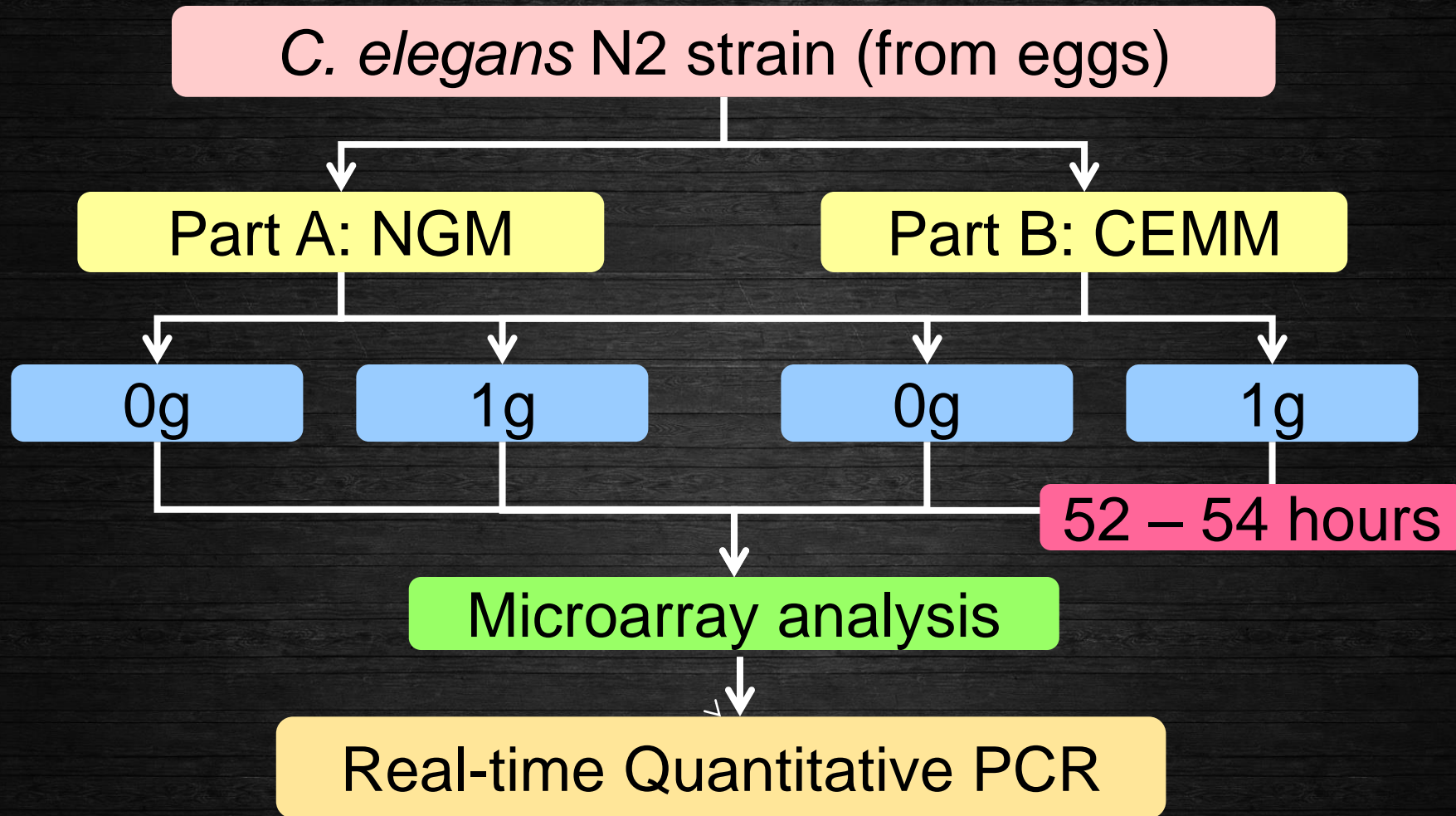


**enables microgravity experiments
on earth before space missions**

Research Objectives

- To investigate effects of simulated microgravity on *C. elegans* gene expression profile (cultured on both liquid and agar medium)
- To establish a gene expression profile baseline data of microgravity-simulated *C. elegans* for future research

Research Flow Chart



* 0g: Microgravity simulated, 1g: Ground control

Results & Discussion

Microarray Analysis of NGM Samples

Transcript Cluster ID	Gene Symbol	Fold Change	ANOVA p-value	Description
18514249	R01H2.2	-2.05	0.042105	Protein R01H2.2

- 1 gene was down-regulated

** Conditions of samples:

Microgravity simulated (3 replicates) & Ground control (3 replicates)

Results & Discussion

Microarray Analysis of CeMM Samples

Transcript Cluster ID	Gene Symbol	Fold Change	ANOVA p-value	Description
18478864	C07E3.15	3.05	0.032504	Non-coding RNA
18621168	C34H3.21	2.45	0.000593	Non-coding RNA
18480249	C32D5.16	2.38	0.041260	Non-coding RNA
18483687	F35H8.9	2.29	0.011386	Non-coding RNA
18495546	C34F11.17	2.17	0.028529	Non-coding RNA
18506565	-	2.14	0.049783	-
18460973	-	-2.25	0.019820	-
18586917	F11A5.13	-2.38	0.030466	Protein F11A5.13

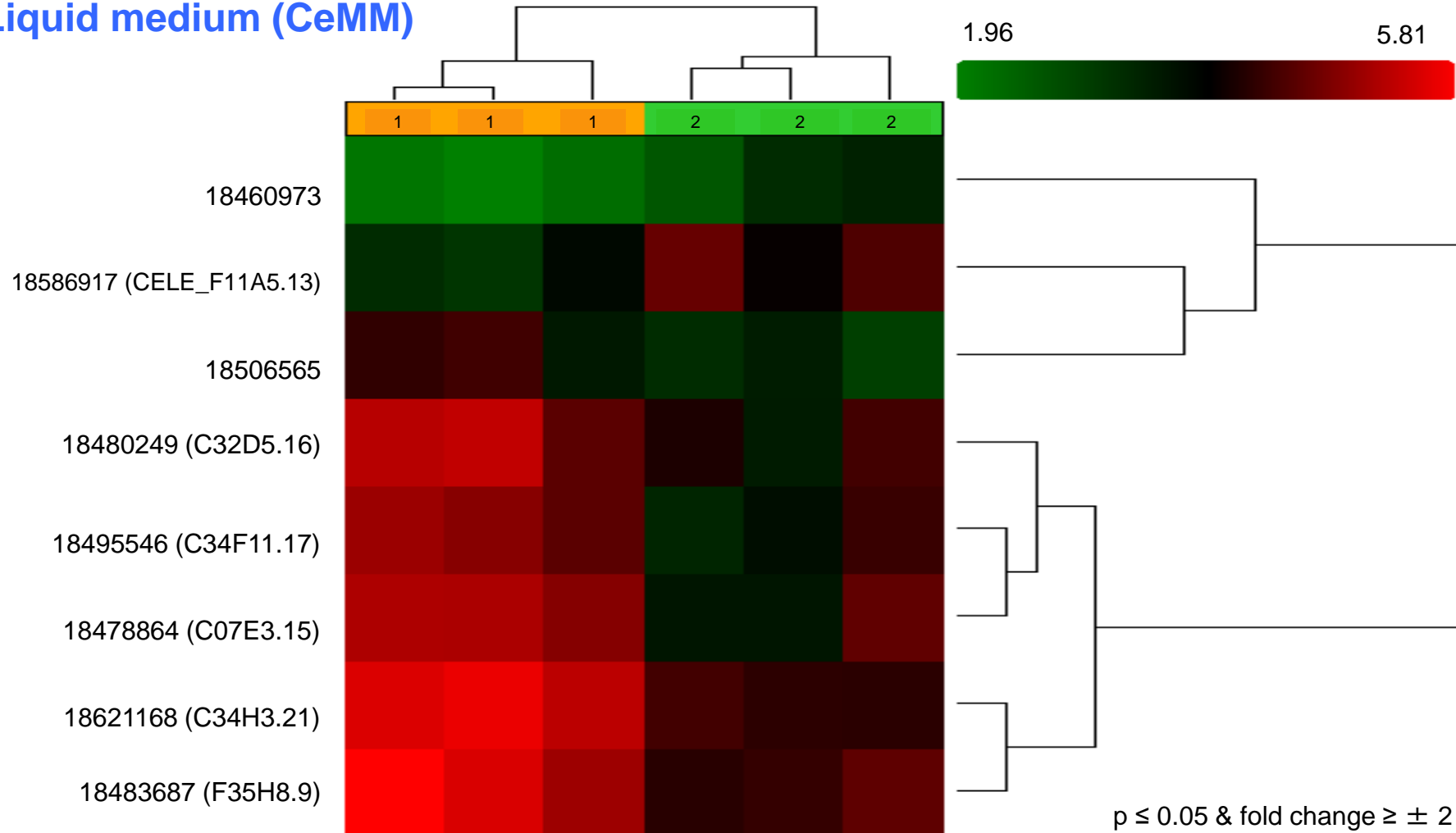
- 6 genes were up-regulated
- 2 genes were down-regulated

**** Conditions of samples:**

Microgravity simulated (3 replicates) & Ground control (3 replicates)

Results & Discussion

Liquid medium (CeMM)



Non-coding RNAs

Genes

glc-4, unc-17, gar-3

Honda et al. 2012

dod-19, dod-3

Then et al. 2014

rad-51, him-6

Then et al. 2014

him-6, air-2, cdh-3,

Gao et al. 2015

dys-1, hlh-1, unc-54

Wang et al. 2008

mua-3, col-113

Then et al. 2014

Functions

Longevity

DNA Repair

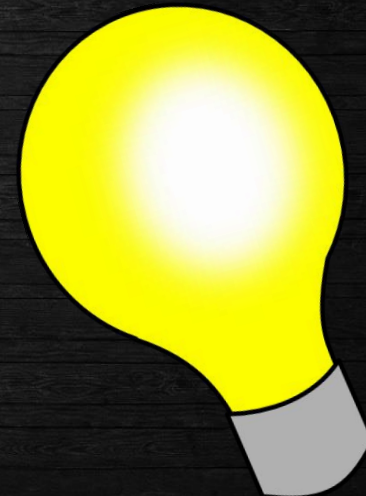
Locomotion

An after thought...

Minimal changes in
gene expression profiles

An indicator that single-generation exposure to
microgravity is not harmful?

Further confirmation needed....



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