Thermal Imaging of *C. elegans* Aging

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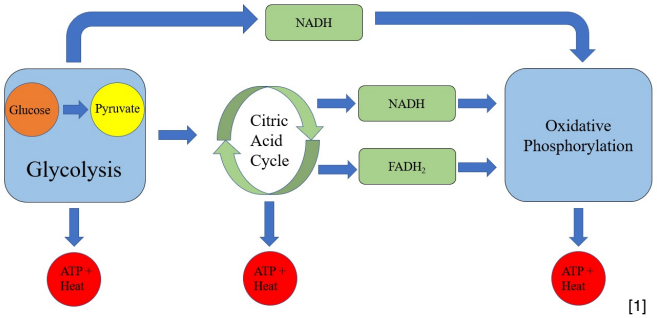
Central Question

Can metabolic waste heat be measured directly Using Thermal Imaging in C. elegans, if so does output differ by age?

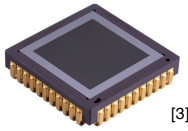


[1]

- *C. elegans* has never been imaged directly in the infrared spectrum before.
- Imaging in this spectrum provides a non-invasive way to measure metabolic output of individual worms.
- A new proxy for metabolic output provides a useful avenue of investigation into known metabolic pathways, as well as a new way to screen for novel metabolic mutants.

Metabolism is the series of reactions used to recover usable chemical energy from the nutrients an organism takes in. These pathways are not perfectly energetically efficient, so some heat is released as a waste product along with ATP [2].

I. Background on Thermal Imaging



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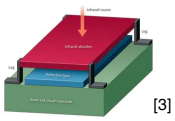

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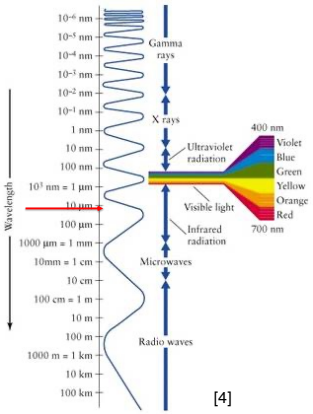
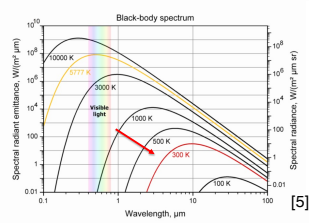


[4]

Thermal imaging works by measuring a change in resistance of a sensor material as its temperature changes with exposure to infrared photons.

II. Imaging Principles and Setup



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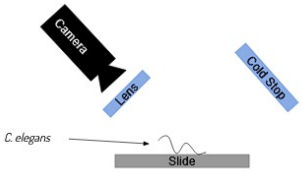
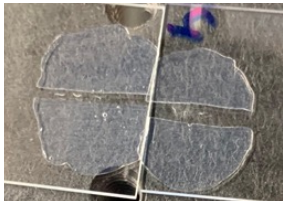
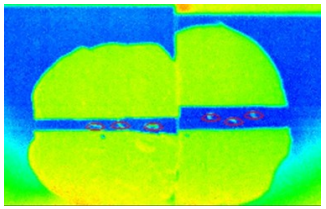


- *C. elegans* are approximated as a black body. This means that they emit based solely on their temperature and not their makeup.
- *C. elegans* of different ages were compared to each other across multiple trials. 8 and 10 day adults were compared to 2 day adults as well as each other.

C. elegans emit in the near infrared portion of the electromagnetic spectrum, around 10μm. A diagram of the imaging setup used is shown.

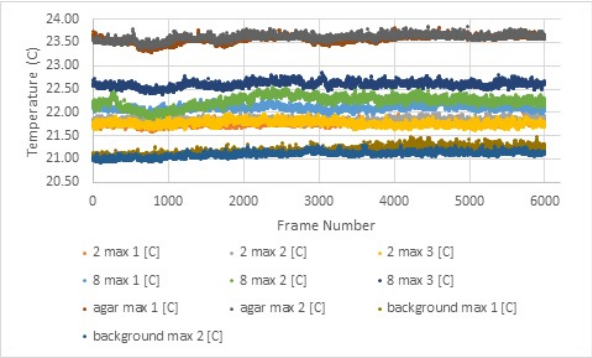
III. Sample Preparation





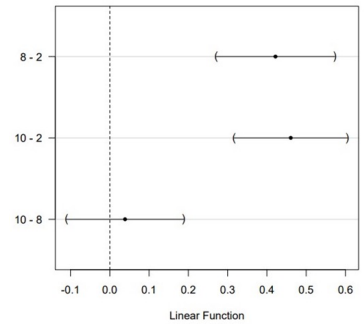
C. elegans were placed into a channel between two pieces of agar to prevent desiccation. Worms were placed lengthwise, which allowed for easy identification and image analysis. *C. elegans* are visible within their regions of interest in the IR image on the right.

IV. Data Collection and Analysis



This graph shows a comparison of the background to the agar and the worms, highlighting that they are distinct. This is a sample of one age comparison, all others looked similar to this one.

V. Results



	Estimate	Std Error	z Value	Pr(lzl)
8 – 2	0.4219	0.06443	6.549	$1x10^{-5}$
10 – 2	0.4609	0.06145	7.500	$1x10^{-5}$
10 – 8	0.03897	0.06369	0.612	0.814

There is a clear difference between old and young worms that is significant. Additionally, the confidence intervals of old vs. young age groups do not overlap, making this difference very clear.

Conclusions

- *C. elegans* are clearly visible above the background when imaged in the IR.
- There is a measurable difference between worms of different ages that is statistically significant.
- This measured difference shows that older worms consistently emit more metabolic waste heat than younger worms.

References

1. McLaughlin, 2020: https://biologydictionary.net/aerobic-respiration/
2. Seebacher and Franklin, 2005: doi:10.1007/s00360-005-0007-1
3. Hecht, 2012: https://www.laserfocusworld.com/detectors-imaging/article/16549566/photonic-frontiers-roomtemperature-ir-imaging-microbolometer-arrays-enable-uncooled-infrared-camera
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5. Sun.org, 2020: https://www.sun.org/encyclopedia/black-body-radiation

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