



Exploring the Biology of Deep Underground Mining

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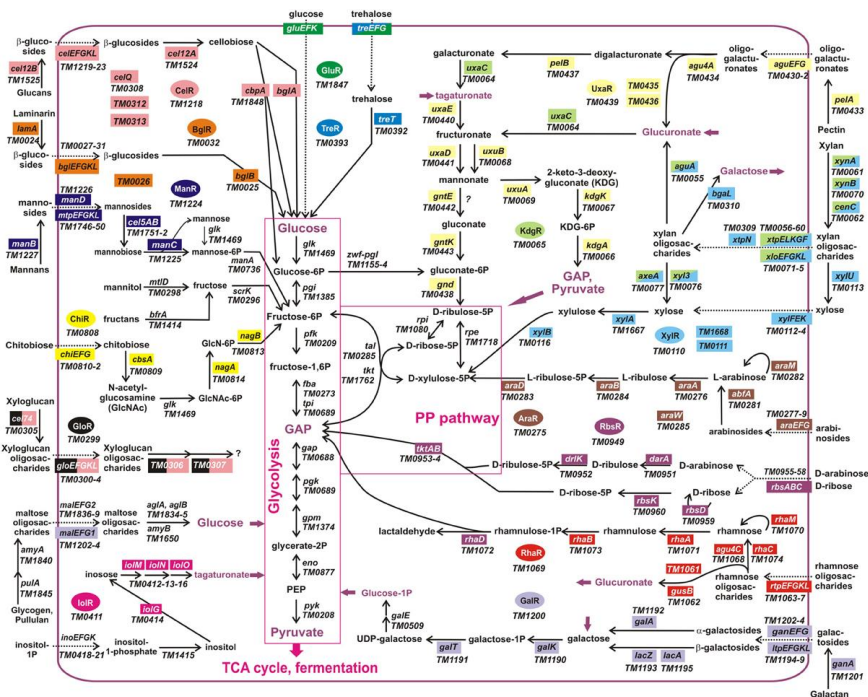
 @tjsmerritt



LaurentianUniversity
Université **Laurentienne**

Mining Environment

- Miners have to work in depths as great as 3.9 km.
- Atmospheric pressure over 20% greater than surface.
- Physically Strenuous Job

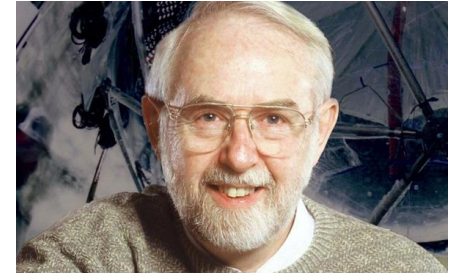


(Koven, 2010)



Explore the physiology of working deep underground environment

Important differences is likely pressure – but is it?

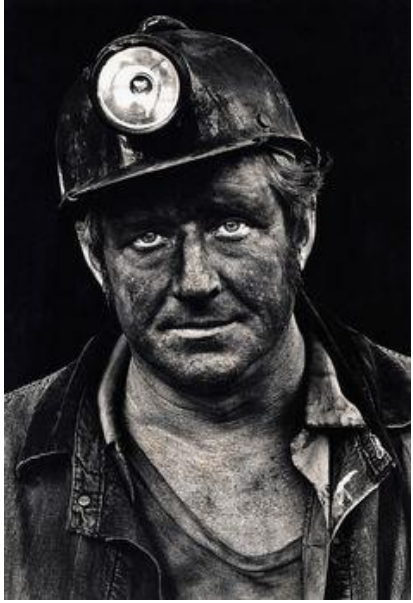


Won a Nobel Prize



Allowed others to win 7 Nobel Prizes

Why flies



Miner



Fly

Similar Biochemistry and Metabolism

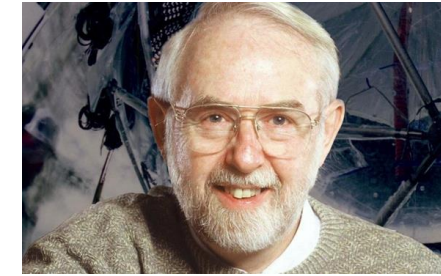
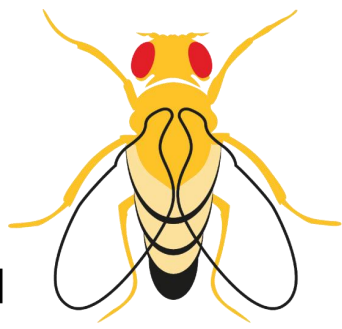
Up to 80% of human disease genes are found in flies

Ease and utility

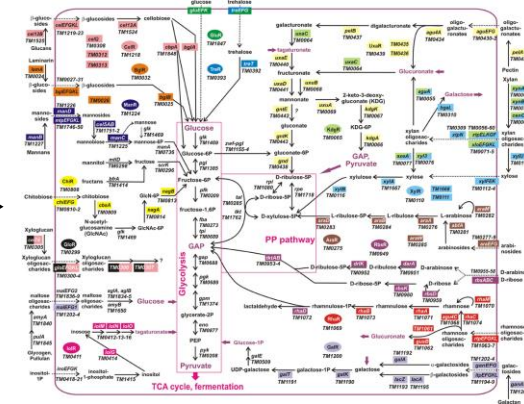
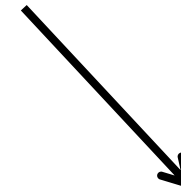
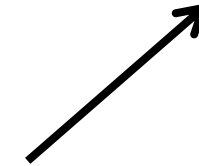


FLAME

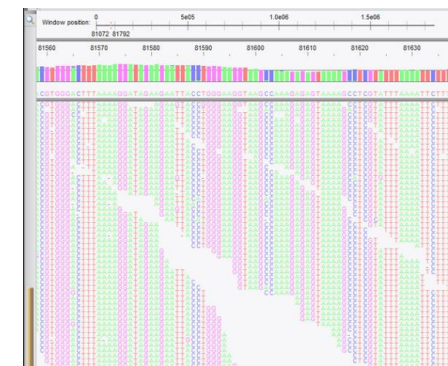
FLIES IN A MINE



Longevity



Metabolism

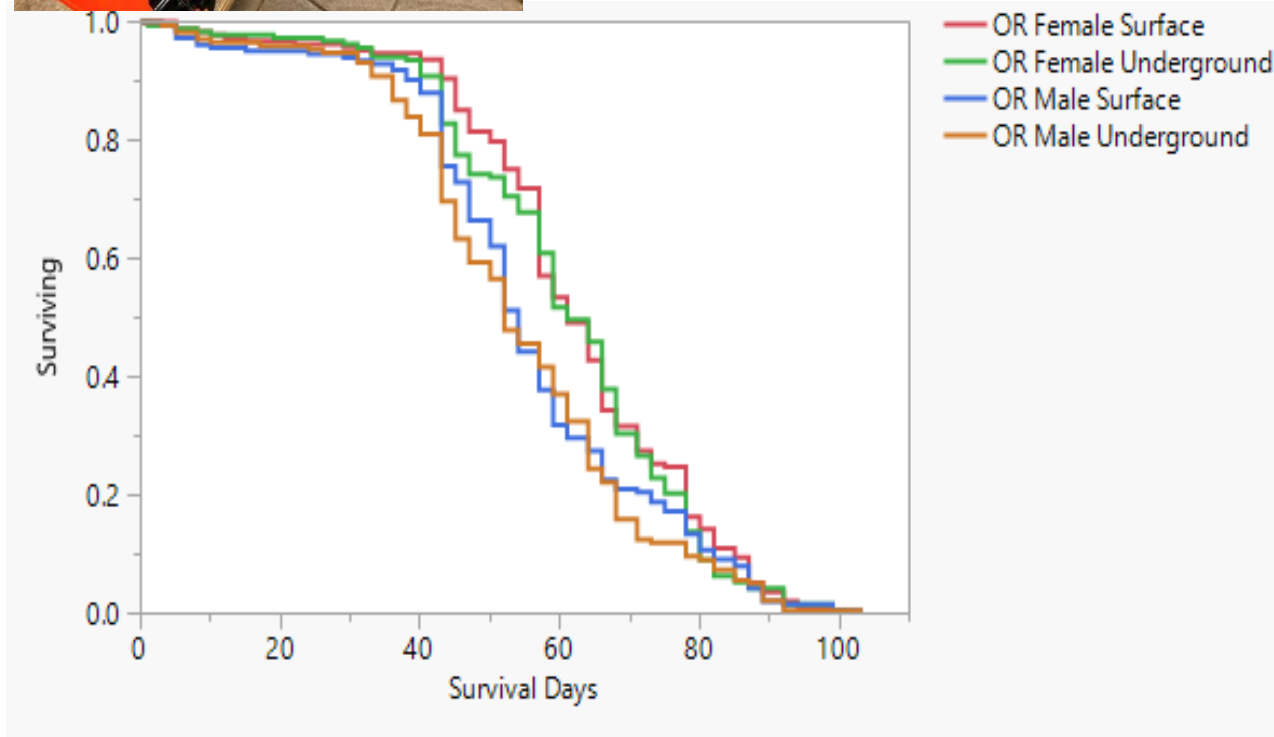


Gene activity



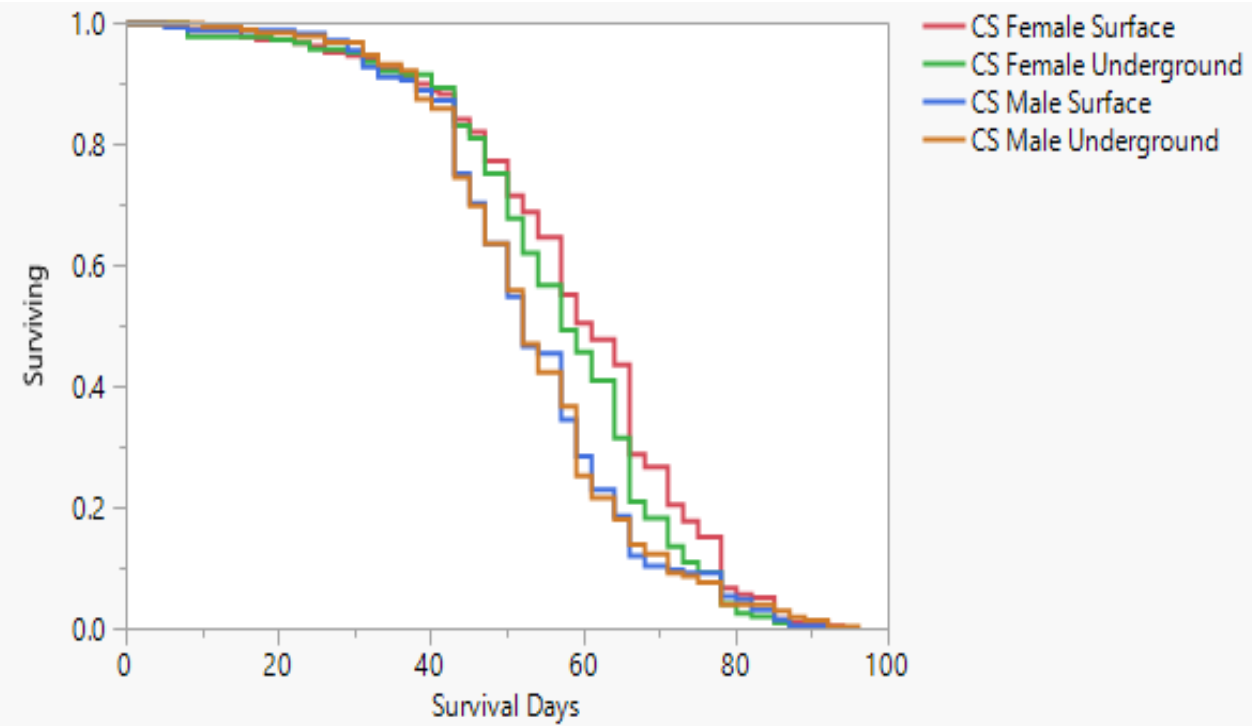
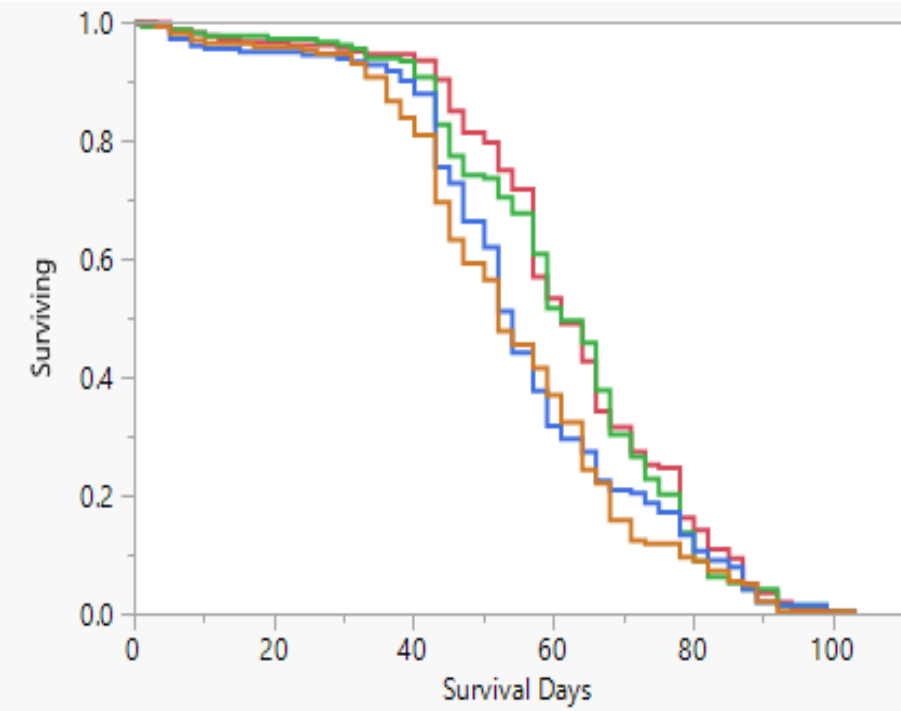
Longevity assay

Count the dead

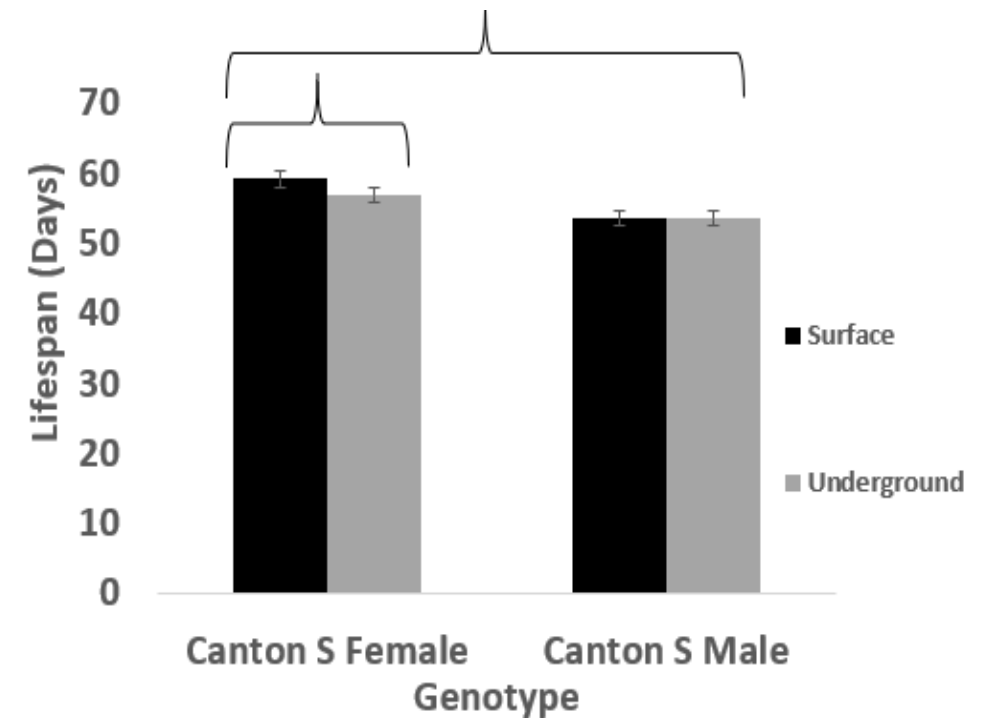
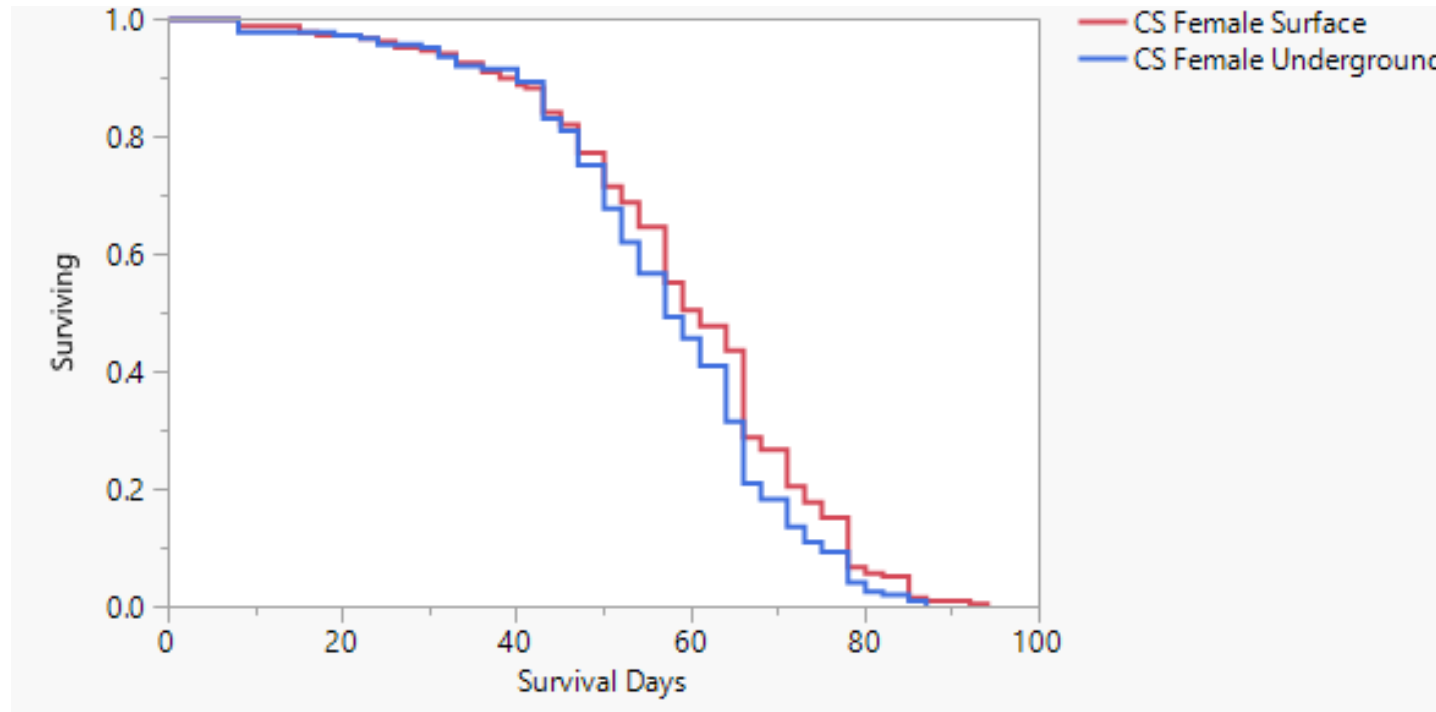


- How long do flies live on surface and underground?
- A very holistic measure of health
- 200 flies stayed on surface, 200 flies went underground until all were dead
- Calculate % dead every 2 days

Longevity Results



Underground Treatment Significantly Decreases CS Females Lifespan



Fly Treatments

Underground Exercise



Underground Control



Surface Exercise



Surface Control



Flygometer 2.0 In Action

How does one exercise a fly?

Not surprisingly, different flies take to the treadmill differently

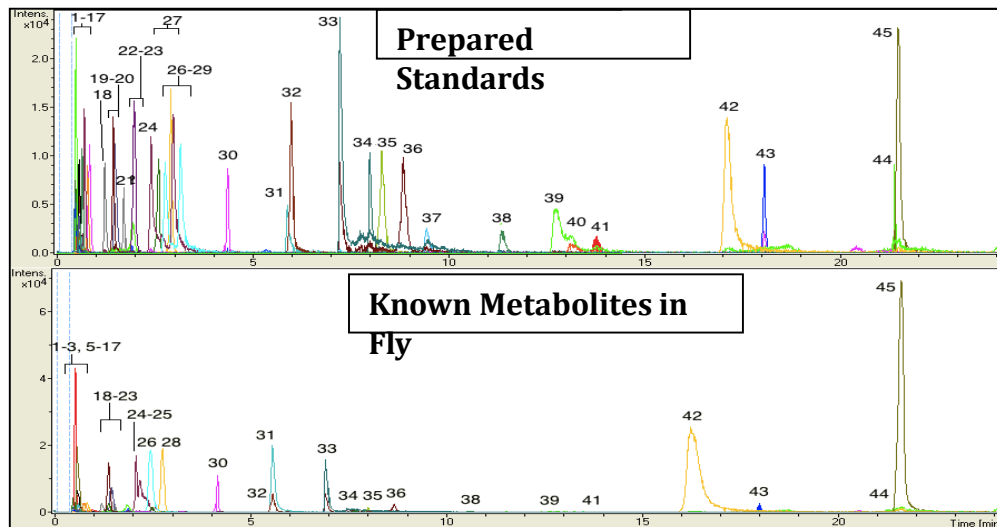




Broad-Based Metabolomics

Known metabolites as standards and in fly homogenate

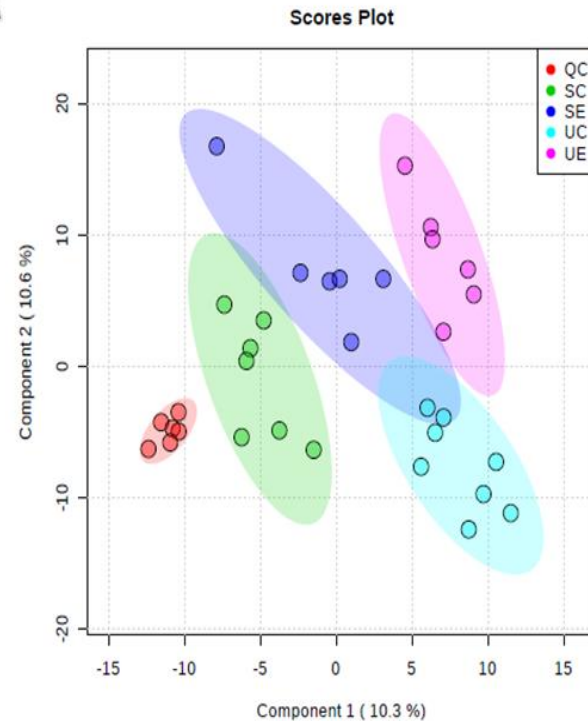
- Identify as many metabolites as possible
- Liquid chromatography / mass spectrometry based metabolomics
- LC separates complex biological sample into individual metabolites
- Mass spec identifies metabolites based on extremely accurate molecular weight
- No, its not that easy



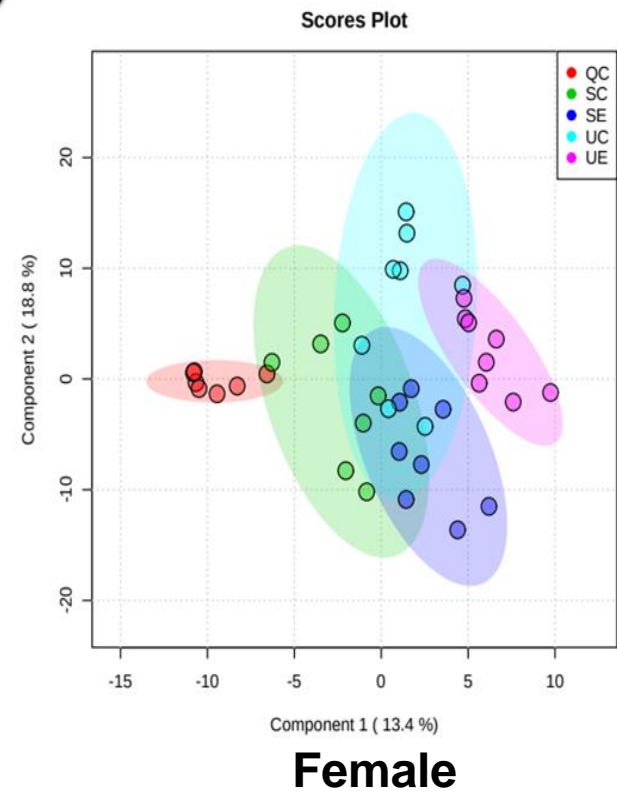
Metabolomic Shift Caused by Underground Exercise

- LC-MS – almost 20,000 potential metabolites
- Almost 4% of metabolites differ between Surface and Control
- PLS-DA Plot

A

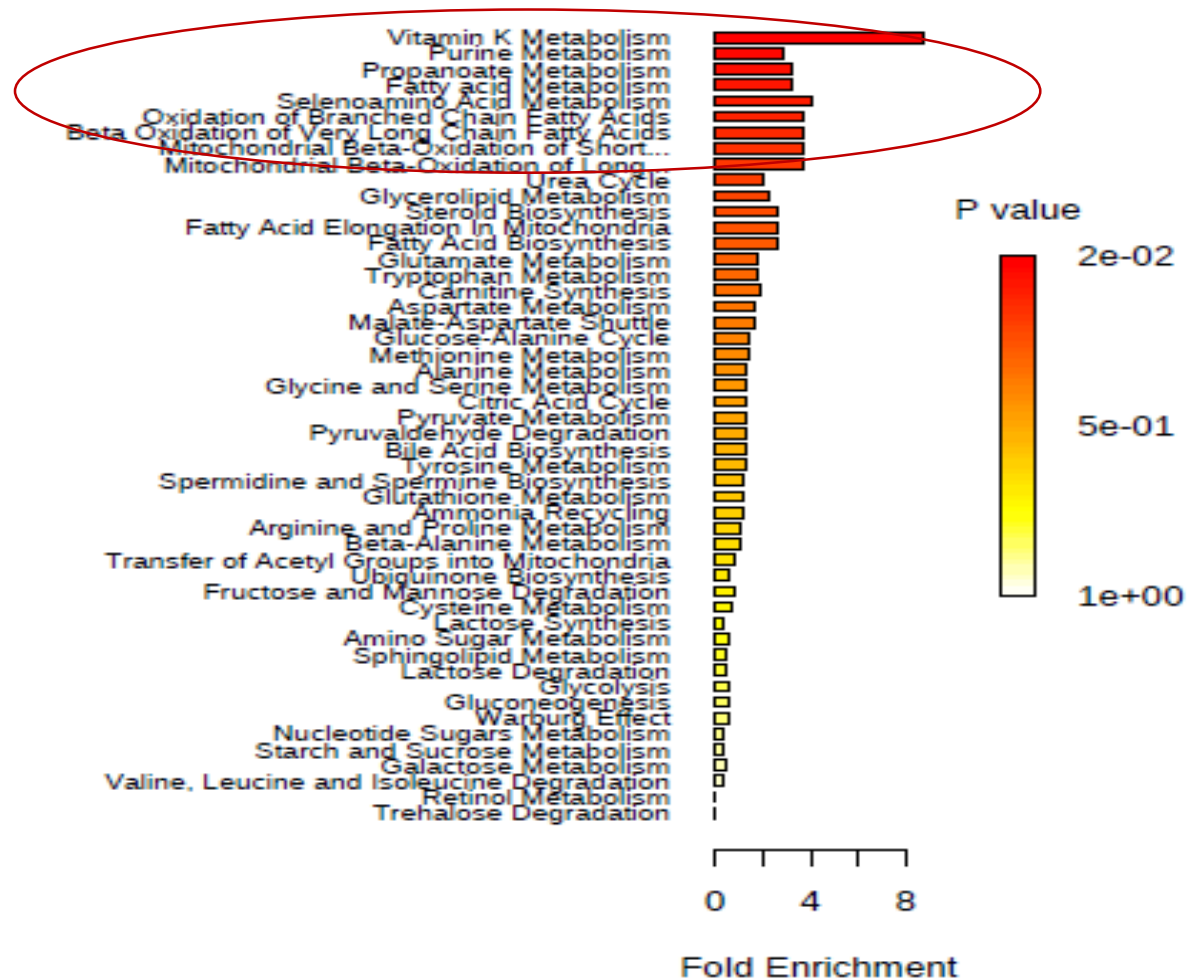


B



Vitamin K, Fatty Acid, and Nucleic Acid Metabolism Enriched

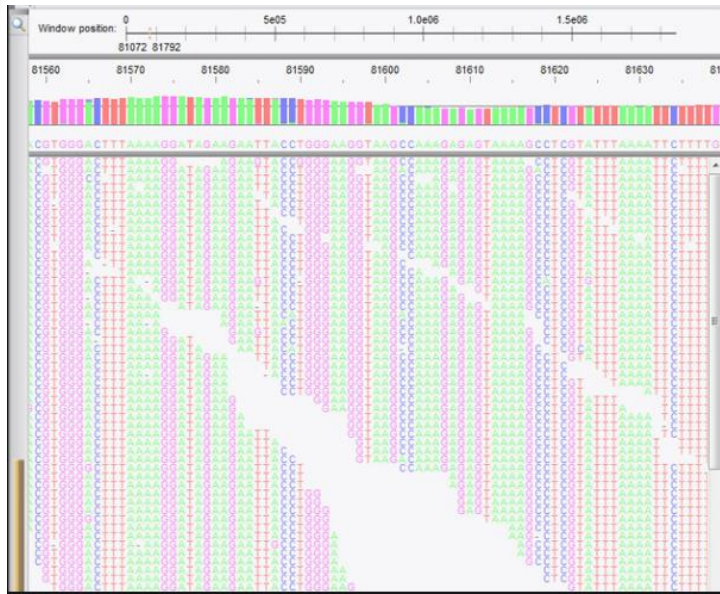
Enrichment Overview (top 50)



Broad-Based Transcriptomics



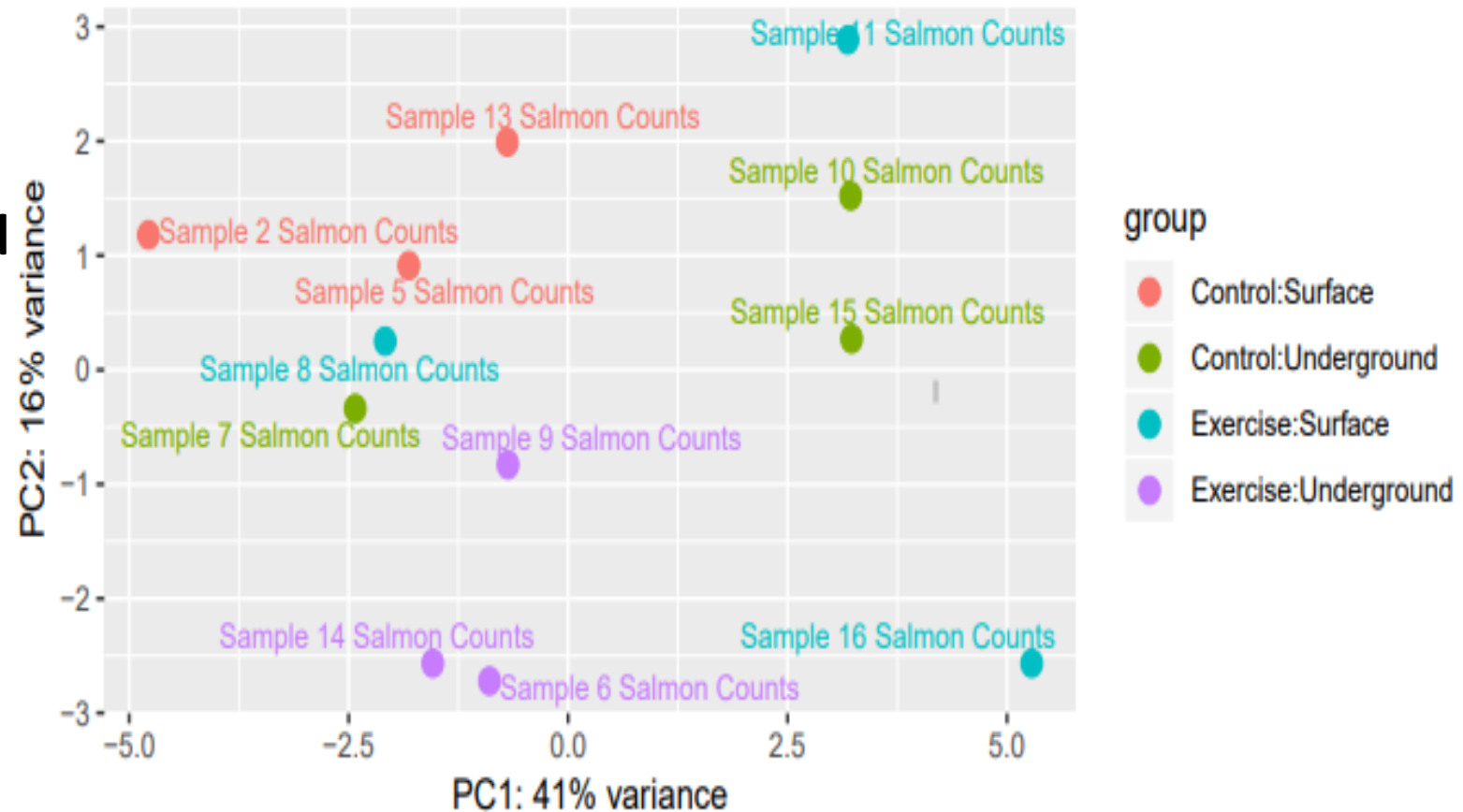
Compare with
established databases



- Identify as many expressed genes as possible
- “Next Generation” sequencing of transcripts
- Computationally identify expressed genes
- No, its not that easy (OK – it sort of is this easy)

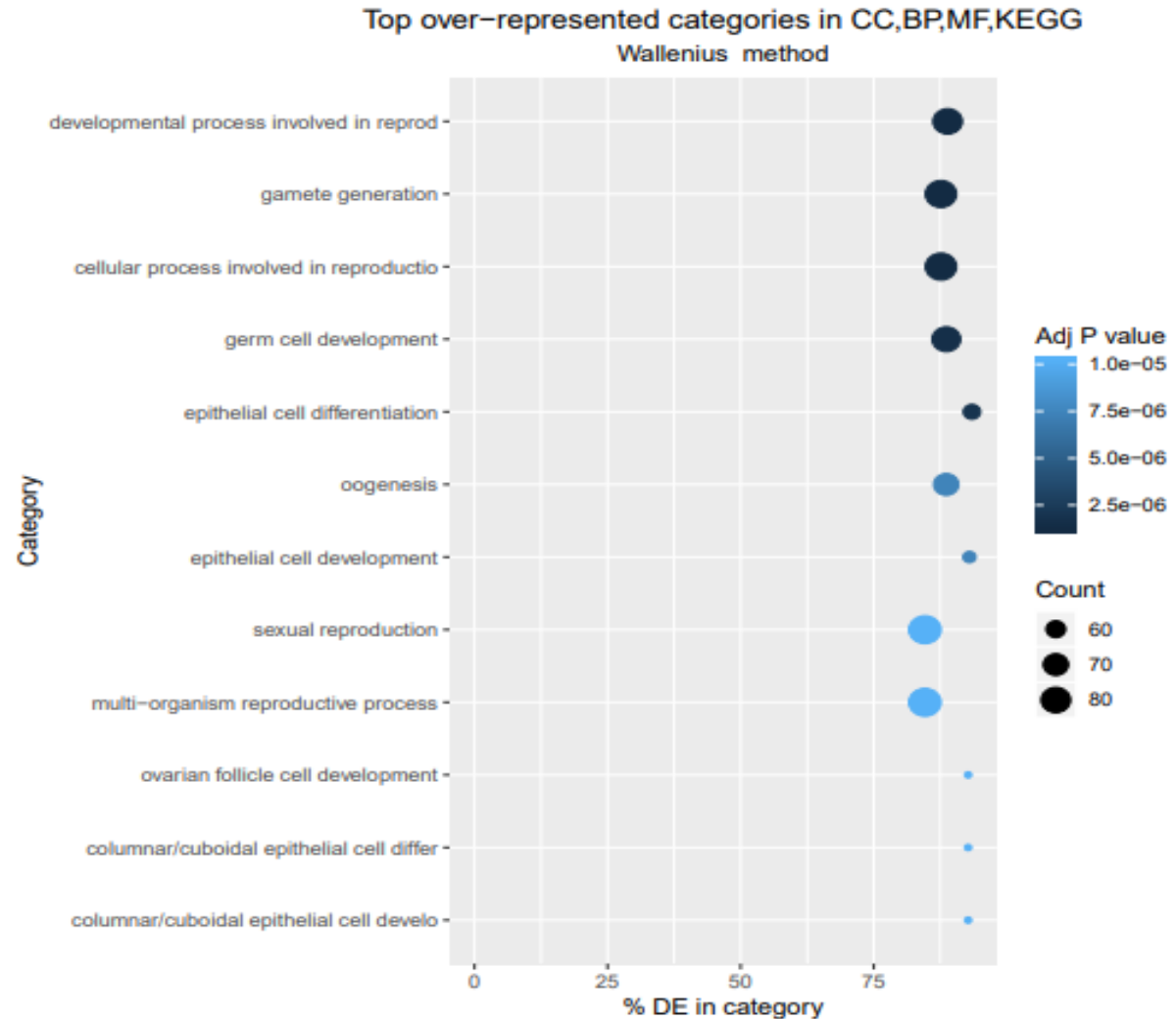
Underground Exercise Shows Transcriptomic Shift

- NovaSeq mRNAseq 100 bp reads
- 71.3 million reads, from ~13,000 genes - ~800 genes differed between surface and underground (~6%)
- CS females, 1 week treatment
- PCA Plot Comparing Treatments
- Largest Shift Between Surface Control and Underground Exercise



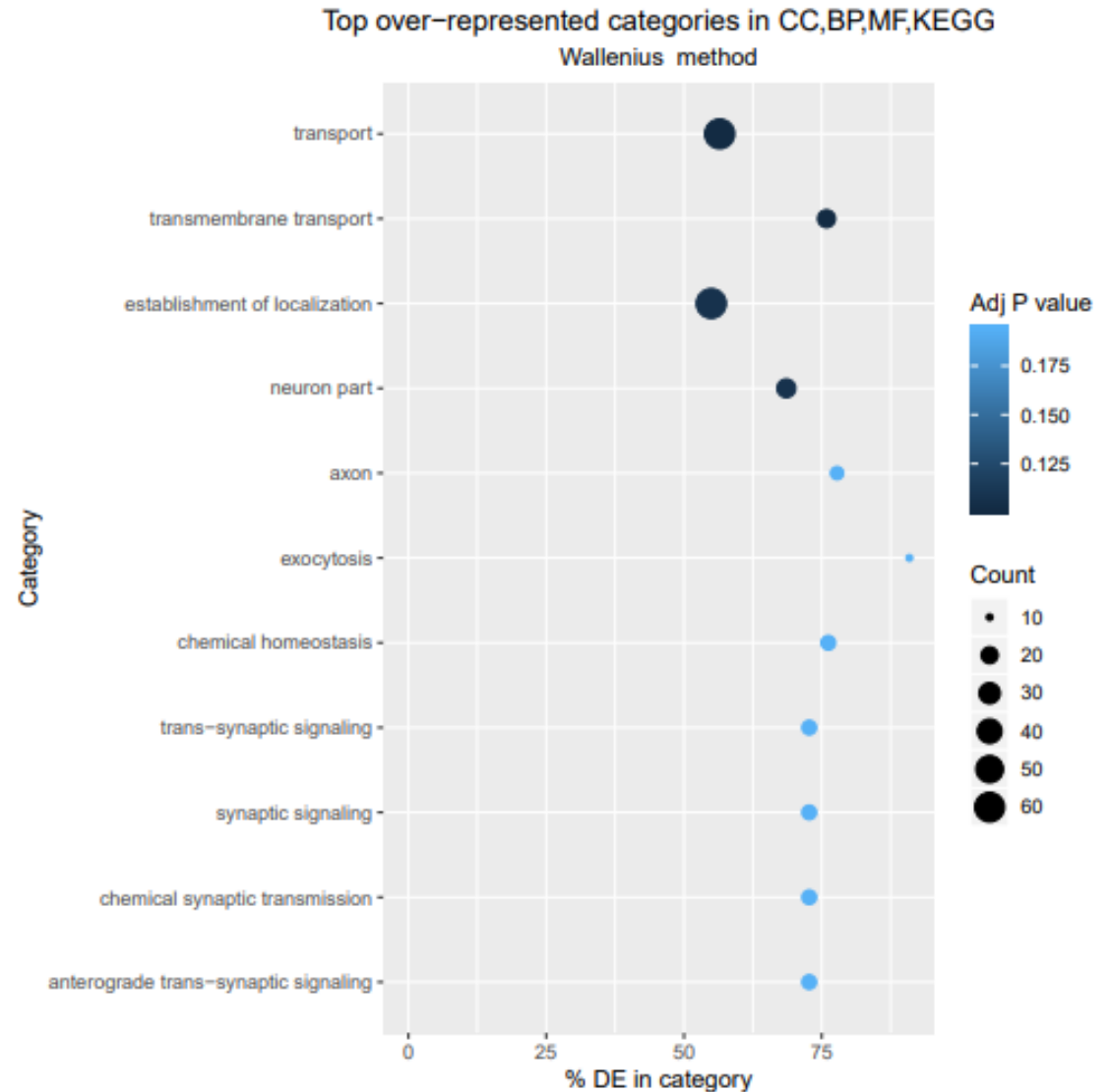
Underground Exposure Upregulates Reproductive Gene Pathways

- Gene Ontology Analysis
- Canton S Female
- Weeklong Exposure
- Surface Control vs Underground Exercise
- Over-represented Categories in Female Reproductive Processes



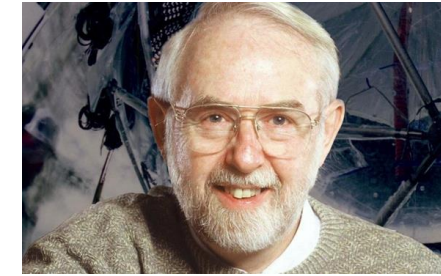
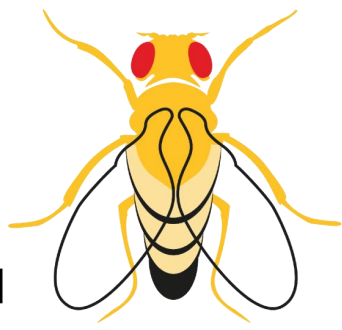
Underground Exposure Downregulates Gene Pathways

- Gene Ontology Analysis
- Canton S Female
- Weeklong Exposure
- Surface Control vs Underground Exercise
- Over-represented Categories in Transportation and Signalling

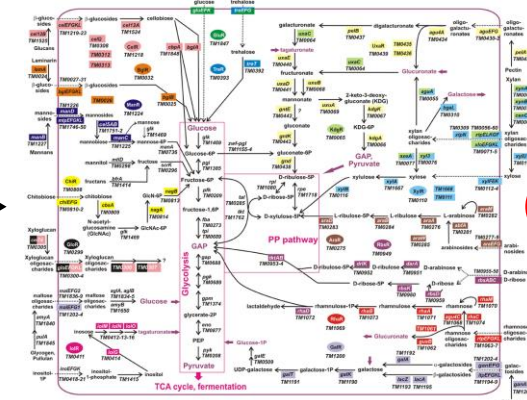


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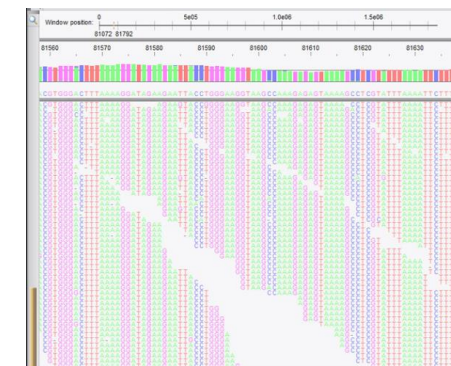
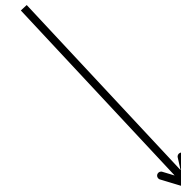
FLIES IN A MINE



Longevity



Metabolism



Gene activity



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Don't underestimate
the Gee-Whiz factor!



Cue the CBC



Art MacDonald
signed Fly Vial



LAB SPACES / S1 EP7
Inside the Dark Matter Lab Buried
Over a Mile Underground



We have a responsibility to explain what we do and why its important



Acknowledgments

- Merritt Lab
- Dr. Heath MacMillan
- SNOLAB Staff



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