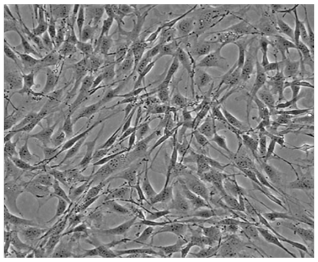
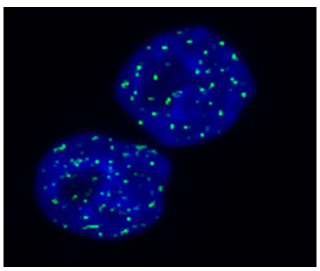
Bioinformatics

Researching the effects of the absence and presence of ionizing radiation (REPAIR)



Microscopic view of cultured human cells.



DNA double strand breaks (green spots) which can result from radiation exposure can be quantified in cell cultures.

Embryogenesis in lake whitefish represents an excellent model for examining the effects of radiation on whole-organism development.

Where does natural background ionizing radiation come from?

Living organisms are continually exposed to background levels of ionizing radiation on a daily basis. There are two main sources of natural background radiation (NBR); cosmic radiation from space and terrestrial radiation from elements in rocks, soil, water and air. Cosmic radiation consists mainly of high-energy particles, positively charged ions, and larger nuclei. These cosmic particles produce secondary radiation in the atmosphere which can reach the earth and interact with organisms. Terrestrial radiation is composed mainly of naturally occurring isotopes of radon, uranium, thorium, potassium, and carbon.

What are the biological effects of ionizing radiation exposure?

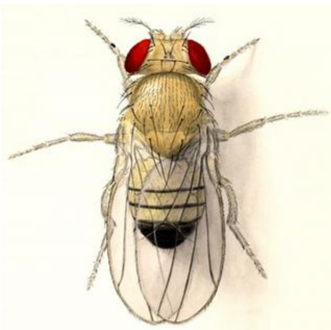
It is well known that high-doses of ionizing radiation are harmful to living systems. However, at low-doses, which is what humans are exposed to on a daily basis, the effects remain poorly understood. There is growing experimental data to suggest that low-dose radiation can have beneficial biological effects. Oxidative stress produced by low-dose radiation can stimulate cellular repair and defense mechanisms, which in turn can protect organisms from future damage. Very few studies, however, have examined what happens in the complete absence of ionizing radiation. Background radiation is ubiquitous on earth and is extremely difficult to shield against. Because it is located 2 km underground, SNOLAB is one of the few facilities in the world where background radiation can be almost completely eliminated.

REPAIR PROJECT:

The REPAIR project, run by the Northern Ontario School of Medicine and Laurentian University, is currently examining the biological effects of prolonged growth and development in SNOLAB. It is hypothesized that organisms have adapted to oxidative stress produced by natural background radiation, which promotes and maintains DNA stability, and that removal of background radiation will be detrimental to living systems. Several different model systems are being utilized to test this hypothesis. Human cell cultures[1] grown in SNOLAB will be examined for cancer risk, oxidative stress, and genomic damage such as DNA double strand breaks[2]. Lake whitefish embryos[3] raised in SNOLAB will be examined for whole-organism survival, growth and development.

Genomics

FLies in A MinE (FLAME)



Fruit flies *Drosophila melanogaster*, are an ideal organism to study the effects of working deep underground.

Fruit flies may not be the first thing that comes to mind when you think of a lab focused on sub-atomic particles and located two kilometres underground, but recent work from Laurentian University's Thomas Merritt may change that. Merritt's research group uses flies to study genetics and metabolism and has recently turned their attention to the effects of working in a mine, specifically working deep underground.

The unique features that make SNOLAB an ideal location for studying subatomic particles, a controlled environment deep underground, also make it an ideal location for studying the biological response to pressure.

Test tubes of fruit flies that are packed up and ready for transport to the underground lab.

Working underground means working under higher atmospheric pressure and the deeper we mine, the higher the pressure – and mines are going deeper and deeper in search of resources. Mining companies are interested in understanding physical responses to working under higher pressure in order to address the effects and support a healthier workforce.

FLAME EXPERIMENT

In SNOLAB, the atmospheric pressure is approximately 20% greater than on the surface. Merritt and his students have been taking flies down to SNOLAB to mimic working in a mining environment. Taking a broad "*metabolomic*" approach, they have developed techniques for studying metabolic responses in flies and are measuring the response to mining pressures across 1000s of individual metabolites (sugars, amino acids, lipids, etc). The work is in the early stages, but suggests that at least 10% of metabolites change with even a single trip down to mining depths. Interestingly, the response appears to change with repeated trips and is most noticeable in active flies. The long-term effects of this change, and any large-scale changes in the biology of the fly aren't known, and are central questions in Merritt's work.

Fruit flies working on a special fly treadmill or *flygometer* at SNOLAB.

Ultimately, Merritt and his students hope that through understanding this response in flies they can help to develop strategies to address the changes observed to make mining, and any work done under high atmospheric pressure, safer and healthier.