

# Effects of Radiation on Eukaryotic Cells

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Joint Science and Technology Institute, Virtual 2021

## Introduction

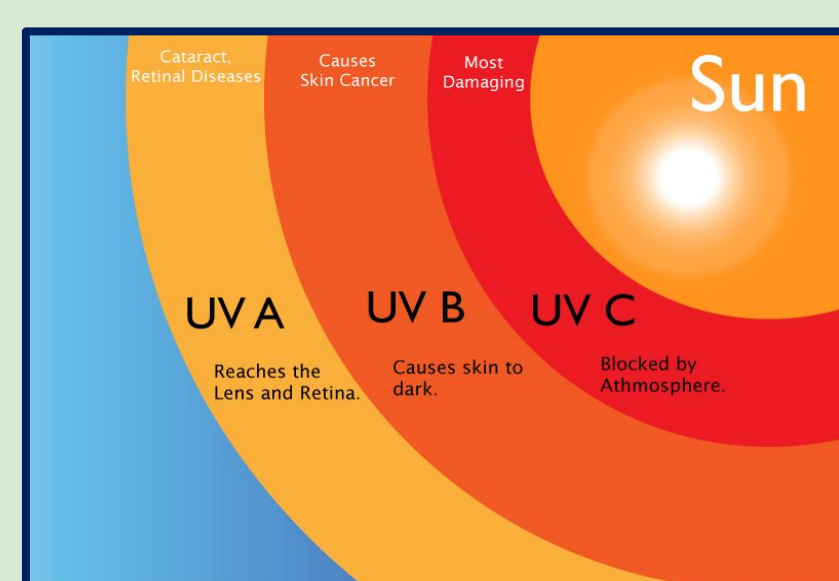
Radiation is energy that comes from a source and travels through space at the speed of light. Although it is usually seen as harmful and dangerous, it has beneficial uses as well. Not only can it help fight cancer, but it can also be used as fuel for space explorations, sterilize large populations of insects, power smoke detectors, etc.

- Two experiments were conducted in order to observe the effects of radiation on eukaryotic cells. In one experiment, the effects of ionizing gamma radiation on radish seeds were observed. In the second experiment, yeast was used to test various materials for their protective attributes against UV radiation.
- Radish Experiment Hypothesis:** The lower exposure to radiation as a seed will have a higher average height and the inverse would also be true.
- Yeast Experiment Hypothesis:** The car windshield would be the most protective (based on previous experiments with UV beads) while the cloth would be the least protective.

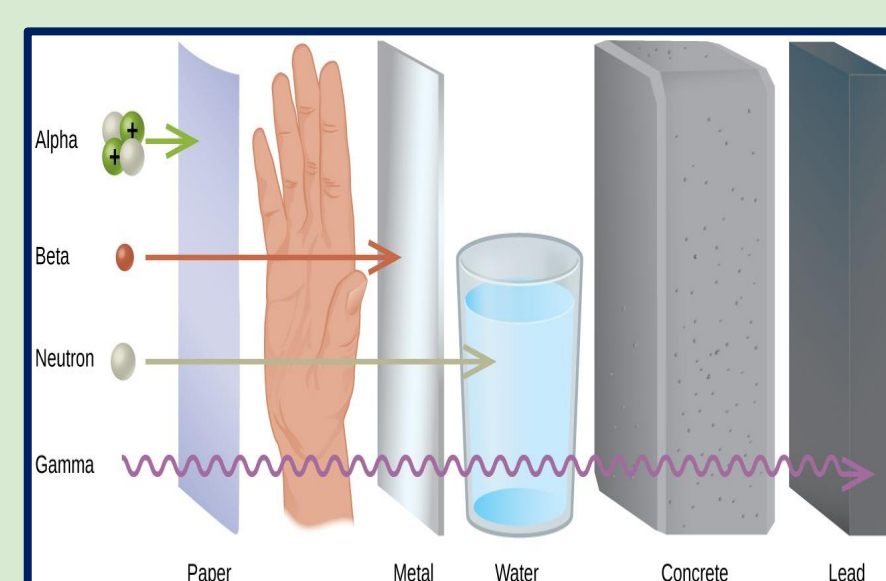
## Background

Radiation is the spreading of energy from a source in the form of waves or particles, throughout space. There are two forms of radiation:

- Non-ionizing radiation occurs when energy is released solely through waves.
- Ionizing radiation occurs when energy is released through waves or particles. Ionizing radiation is more damaging as it has enough energy to damage DNA and tissue.

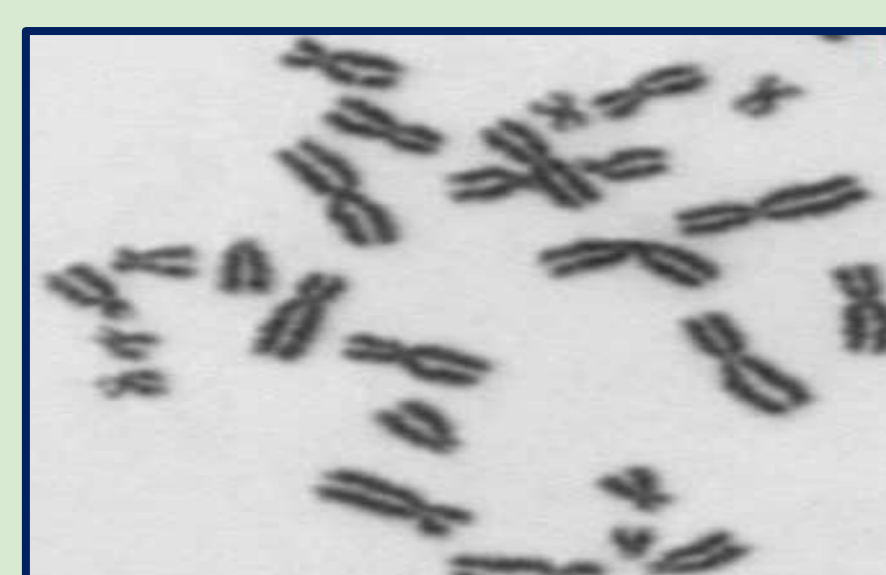


**Figure 1.** Penetration of various UV types, a non-ionizing radiation, in the atmosphere. The following is the percentage of UV blocked in the atmosphere: UVA- 0%, UVB-90%, UVC-100%

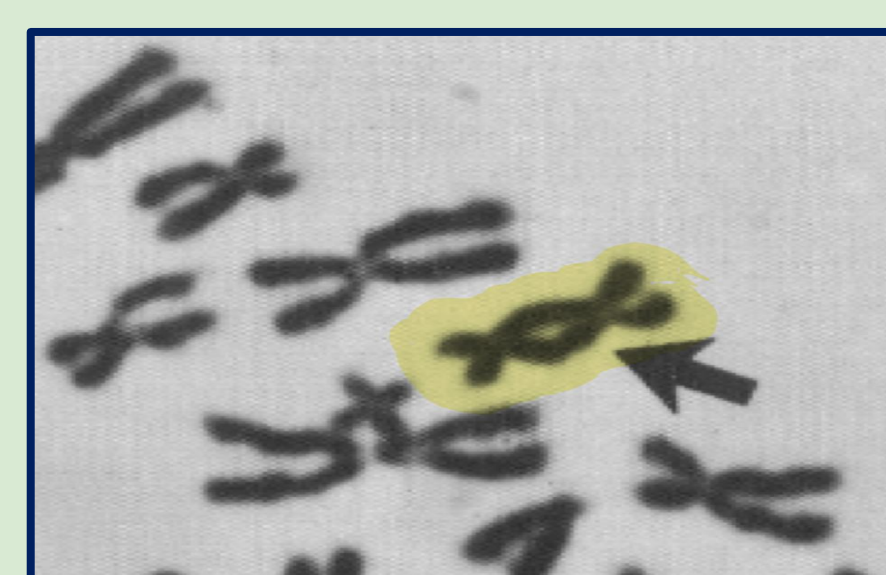


**Figure 2.** All of the particles and rays above are types of ionizing radiation, each with different penetration abilities.

- Organisms could be exposed to radiation through radon in the soil, sunlight, having an x-ray or other medical procedures done, etc.
- Ionizing radiation can result in mutations in the DNA.
- Single and double strand breaks in DNA are also a result of ionizing radiation (Figures 3 and 4)



**Figure 3.** Regular chromosomes each consist of a singular centromere as seen above.



**Figure 4.** When exposed to ionizing radiation, dicentric chromosomes are created, each made up of two centromeres.

- Cells undergoing rapid cell division are most sensitive to radiation exposure. Thus, all organs are affected to a varying degree by different doses of radiation.
- At high doses, radiation is capable of killing cancer cells, which are rapidly dividing cells in the body.

## Radish Experiment

Water was poured into a soil tray. Each pellet was allowed to expand and excess water was drained.

Radish seeds with varying levels of exposure to gamma radiation (0, 50, 150, 500 and 4000 Krads) were placed in the tray. (Figure 5)

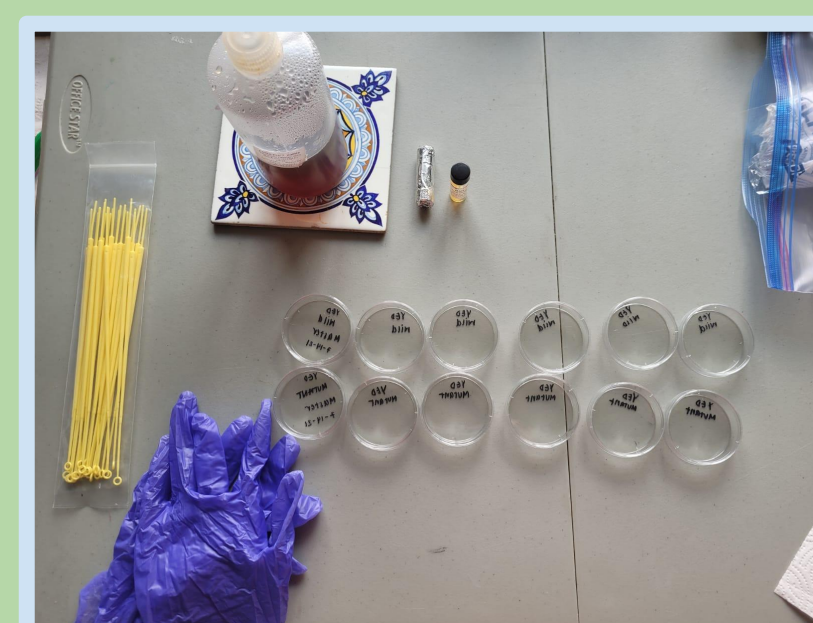
The tray was kept in a cool, dark place. It was watered to keep the soil damp.

Once the seeds germinated, the tray was kept in sunlight.

The growth was measured daily for 9 days and results were recorded in a table.



**Figure 5.** Set up on Day 0, with the labelled seeds planted into each individual pellet.



**Figure 6.** Set up and materials for Yeast Experiment

## Methods

### Yeast Experiment

The agar was melted and poured into 12 labeled petri dishes (Figure 6). With the two master dishes → A UV Sensitive and Yeast strain were streaked on the agar.

0.1 ml of appropriate yeast solution was put onto 5 wild and 5 mutant petri dishes and then spread out. The petri dishes were left for 15 minutes to soak in.

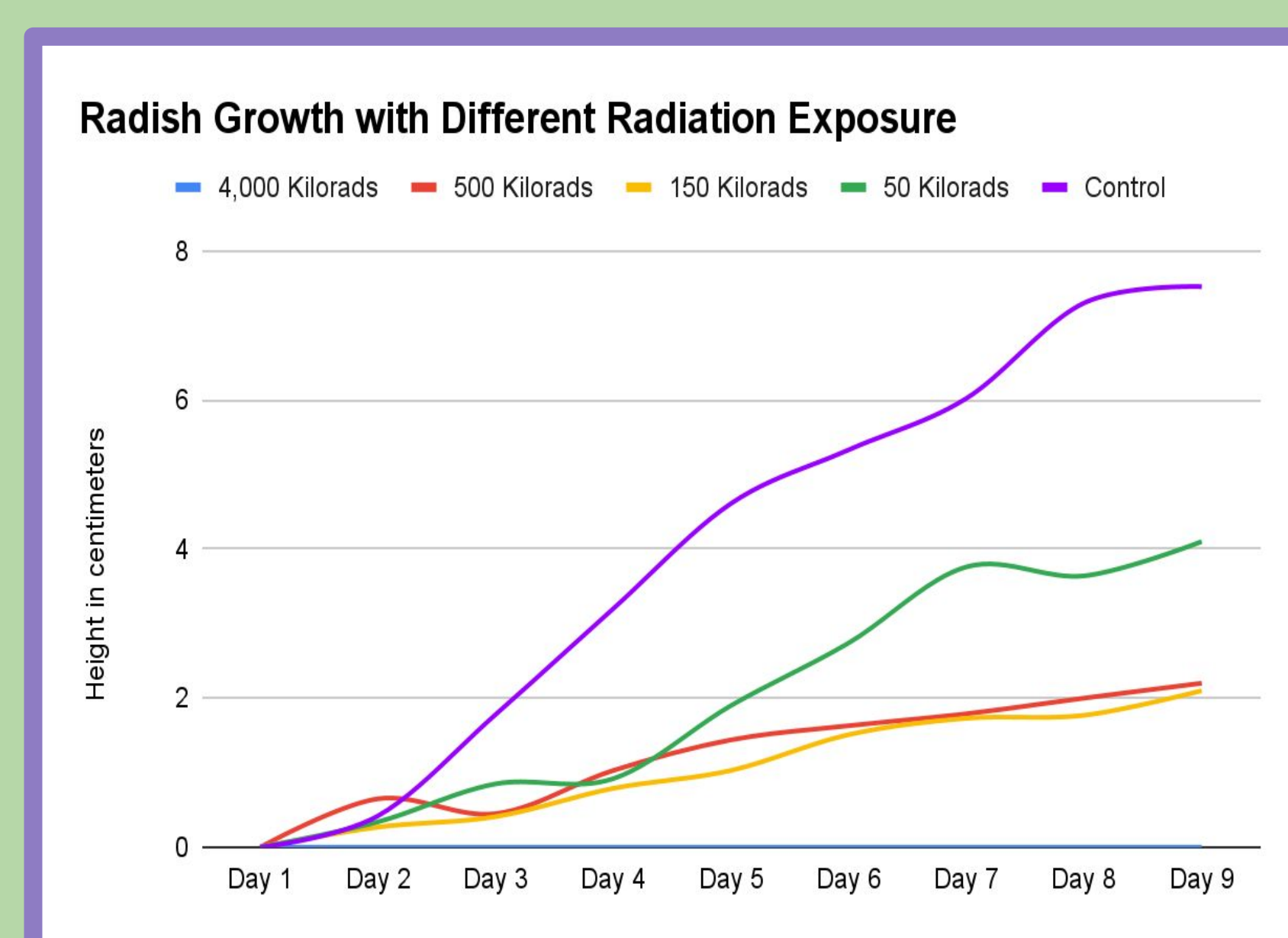
Petri dishes were then taken outside and placed under their shields (control, sunglasses, sunscreen, car windshield, white t-shirt) and left out for 1 hour.

The two masters were covered with aluminum and kept at room temperature while the remaining petri dishes were stored in the fridge.

After two days - the masters were uncovered. Using a pipette, 5 ml of sterile DI water was placed into each culture tube, labeled either wild or mutant. Yeast was taken from the master dishes and put into the respective culture tube.

Petri dishes were then stored inside covered with aluminum for two days. Petri dishes were uncovered and growth was observed and recorded using Image J.

## Results



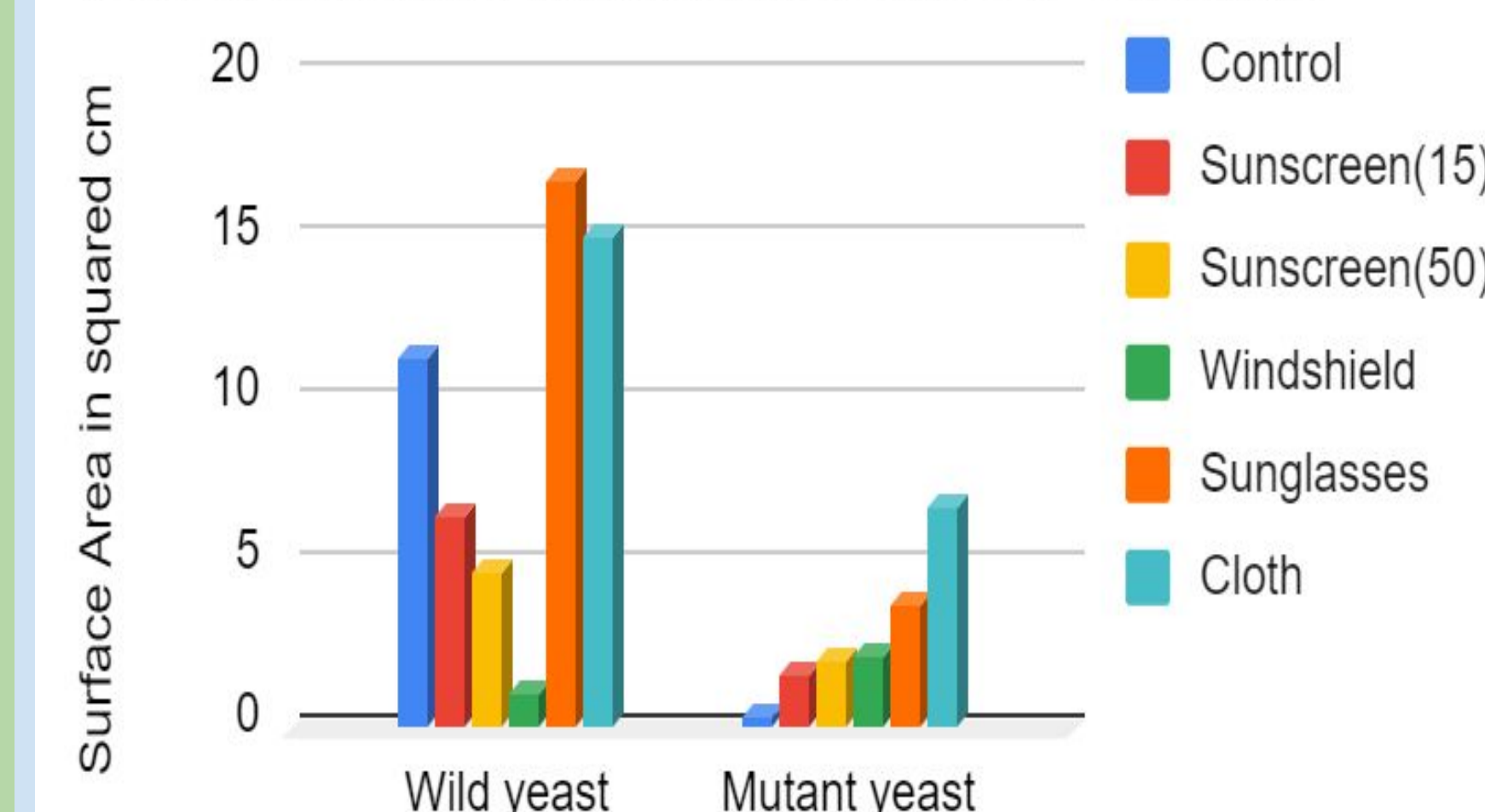
### Radish Experiment:

- The radish seeds that were exposed to less radiation grew better than the radish seeds that were exposed to more radiation.
- For example, the radishes that were not irradiated grew much more than the 4,000 kilorad seeds, which did not germinate.
- Although the seeds that were exposed to 4,000 kilorads did not grow, the other radish seeds like the 500 kilorad, 150 kilorad, and 50 kilorad still grew.
- These results were expected because radiation affects embryos in a seed at a greater magnitude than adult plants.



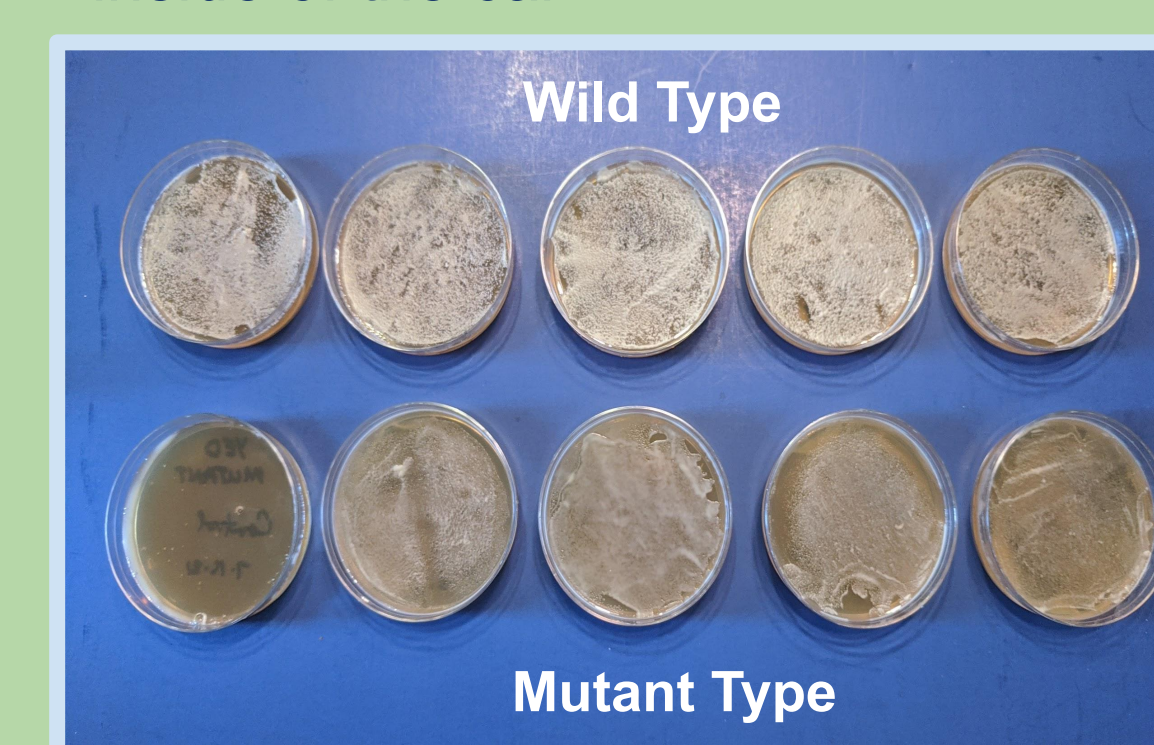
**Figure 7.** The picture to the left is a picture of the radishes' growth on Day 8. Top right of the picture purple tabs represent 4,000 kilorads, the peach color to the left represents 500 kilorads, followed by the top left two and the bottom right two yellow that represent 150 kilorads, the next four to the left represent 50 kilorads, and finally the last 4 bottom left are the control.

### Yeast Growth With Different UV Shields



### Yeast Experiment:

- The mutant yeast was shielded best by the cloth while the wild yeast grew more with the sunglasses as a protective shield.
- The cloth used was a white cotton t-shirt, this helped the yeast grow better because the UV rays were not absorbed but reflected.
- Sunglasses protected the wild yeast from UV rays very well.
- Windshields are designed to block UV so the lack of growth might have been caused by the high temperature inside of the car.



**Figure 8.** Picture to the left represents both the wild and mutant yeast growth with different shields. The shields used were (from left to right) the control petri dish, sunscreen, windshield, sunglasses, and cloth.

## Conclusions

These experiments demonstrated the effect of radiation on eukaryotic organisms and the best measures to take to prevent UV radiation exposure.

- The results supported the radish hypothesis: Total radish growth, for the most part, had an inverse relationship with the level of radiation exposure.
- The results did not support the yeast hypothesis: The car windshield did not facilitate the most yeast growth - it actually had the least amount. Additionally, the cloth-covered yeast had the most growth.

The results show:

- An understanding that high levels of radiation are most damaging, but that lower levels may be dangerous as well.
- Knowledge that clothing (white cotton cloth), and UV protected sunglasses are best for protection from damaging UV radiation.
- A better understanding of how radiation can be helpful, but must be treated with extreme caution.

The research collected is helpful for scientists to understand the limits of the human body in relation to radiation, as well as, to heal and protect humans from radioactive incidents. Radiation research will also support future space missions.

## Citations

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## Acknowledgements

Thank you to Ms. Bridget Kennedy who helped make our project and research experience possible. We appreciate the opportunity provided to us by Oak Ridge Institute for Science and Education, and the Defense Threat Reduction Agency's Joint Science and Technology Office for Chemical and Biological Defense. Thank you to Dr. Adayabalam Balajee, Dr. Elizabeth Ellis, Mr. Wayne Baxter who helped with research as well.