Ultra Violet Radiation and Yeast: Radiation Biology

Presented by: Alissa Keil

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Ultra Violet Radiation and Yeast: Radiation Biology

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Subject Areas

Grade Level
9-12

Subject Area
Biology
National Standards

• Life Science
  – Matter, energy and organization in living systems

Science in personal and social perspectives

Natural and Induced hazards
What do students need to know?

• Understand that DNA contains the instructions for proper cell function
• DNA can be changed
• Skin cancer and other adverse health effects can be caused by exposure to ultraviolet (UV) radiation
• Sun protection factor (SPF) ratings on sunscreens
Learning Objectives

Students will be able to:

- Discuss the counter measures for UV radiation
- Describe phenotypic changes in yeast as a result of radiation damage.
Biological Effects of Radiation Damage in Yeast

- Radiation Biology Educator Guide
  http://er.jsc.nasa.gov/seh/RB_Module_2_11.pdf
- Space radiation’s importance to NASA.
- Most effective method for preventing UV damage in yeast.
- Discussion questions for lab.
NASA eClips
Our World: The Sun, A Real Star
Our World: Radiation

NASA eClips™
Innovative Real World Learning
Why is NASA studying biological effects of radiation?

- Keep astronauts safe
- Identify health risks
- Work to understand damage
- Develop countermeasures
Why does NASA study yeast in space?

- NASA uses yeast as a model system to explore the effects of radiation on cells. Just like human cells, most yeast cells effectively repair DNA damage caused by radiation.
How do scientists study biological change during spaceflight?

- Scientists develop space biology experiments
  - in flight experiment
  - ground control
- Analyze both to understand biological changes
Using Non-Human Organisms to Understand Radiation Damage

- Study model organisms
- Small in size, large numbers studied in smaller volume
- Fruit flies – many things in common with humans
Risks and Symptoms

- The biological effects of exposure vary with the dose.
What is radiation?

- Form of energy that is transmitted in the form of rays, electromagnetic waves and or particles
- Daily life - cell phones, microwaves, X-rays, light bulbs, heaters
- Natural – Sun, radioactive elements in the Earth’s Crust
Radioactive radon gas produced from the breakdown of uranium in the Earth’s crust accounts for over half of the radiation exposure to the general public.
Radiation Types

Non-ionizing

Ionizing
What is DNA?
What is DNA’s role in protein production?

DNA is the storage unit for the information used to make proteins.
What kinds of damage occurs due to radiation?

- Single strand break, or SSB
- Double strand break, or DSB
• Not immediately observable
• Some damage may not show up until much later
How does radiation affect us?
Harm to DNA
Earth’s Protection

- Magnetic fields
- Atmosphere
Questions?
Long Term Space Travel

- Monitoring and collecting radiation doses received by Astronauts for years
- Effects poorly understood
NASA Research

• Materials on International Space Station Experiment-8
NASA Radiation Lab

http://www.nasa.gov/centers/johnson/slsd/about/divisions/hacd/laboratories/radiation.html
Radiation Factors

- Altitude
- Solar Cycle
- Astronaut’s susceptibility
How is radiation measured?

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Radioactivity</th>
<th>Absorbed Dose</th>
<th>Dose Equivalent*</th>
<th>Exposure (for x-rays and gamma rays only)</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>Rate of radiation emission (transformation or disintegration) from a radioactive substance</td>
<td>Energy imparted by radiation per unit mass onto an absorbing material</td>
<td>Expression of dose in terms of its biological effect</td>
<td>Quantity that expresses the ability of radiation to ionize air and thereby create electric charges that can be collected and measured</td>
<td>The capacity to do work</td>
</tr>
<tr>
<td>Common Units Measurement Label</td>
<td>Curie (Ci)</td>
<td>rad</td>
<td>rem</td>
<td>Roentgen (R)</td>
<td>Joule (J)</td>
</tr>
<tr>
<td>1 Ci = 37 GigaBq (this is a large amount)</td>
<td>1 rad = 100 ergs/g</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>International System of Units (SI) Measurement Label</td>
<td>Becquerel (Bq)</td>
<td>Gray (Gy)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Bq = 1 event of radiation emission per second (this is a very small amount)</td>
<td>1 Gy = 100 rad</td>
<td></td>
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</tr>
</tbody>
</table>

*DE = Absorbed Dose × Quality Factor (Q), where Q depends on the type of radiation

Q = 1 for gamma, x-ray, or beta radiation; Q = 20 for alpha radiation

1 R = 2.58 × 10⁻⁶ C/kg air
Radiation Biology?
Lesson in Detail

Radiation Biology
Materials for lesson

1. Yeast-Extract Dextrose media plates (from kit, can also be made)
2. UV-sensitive yeast suspension in liquid media and wild type yeast suspension in liquid media
3. A source of UV radiation such as direct sunlight.
4. Several kinds of sunscreen (each with different SPF), black paper, cloth, metal foil, or other types of materials that can be used to experiment with UU shielding.
5. Sterile water, sterile pipettes, and sterile toothpicks
6. Plastic wrap (to cover plates)
Procedures

1. Ensure that your hands and the work area are clean.
2. Plate the yeast suspension.
3. Label the dish by drawing lines on the top and bottom of the dish to divide it into 4 parts.
4. Spread sunscreen on the lid of the Petri dish (or on the plastic wrap) in the places you marked; use an equal amount in each section and spread the sunscreen evenly. You can also use plastic, foil, etc. instead of sunscreen.
Procedures continued

5. Expose Petri dish to sun or to UV light.
6. After the exposure, wipe the sunscreen off the lid of the Petri dish. Place the Petri dish upside down in an incubator or in a dark place and let it grow for 1-2 days in an incubator at 30°C or 3-4 days at room temperature.
7. If desired, repeat these steps with a wild type strain as a control for comparison.
8. Compare the amount of yeast that has grown in different areas of the Petri dish and draw conclusions.
Engagement

- Introduce video to students
- Generate discussion
- Why radiation biology?
- UV Radiation: How it affects life on Earth?
- Stimulate interest with the NASA connection.
Discussion Questions

• What are the effects of different types of sunscreen on yeast?
• How can health be affected by exposure to ultraviolet radiation?
• Why use yeast to study the effects of UV radiation?
• Does yeast grow less in some areas? More in others? Why?
Discussion Questions

• Did some sunscreen protect the yeast better than others?
• Does the UV pass through plastic wrap or petri dish covers?
• What can you conclude from the results of your experiment?
Questions?
Extensions and Resources
Radiation Biology
Extensions

• Make several plates with diluted yeast cultures and expose the yeast to sunlight at various times of day - every 2 hours. You can use the same period of exposure.
• Expose the yeast for different durations at the same time of day, for example 0, 0.5, 1, 2, 4, and 8 minutes at a certain time.
Extensions

• Compare the different types of yeast strains for UV sensitivity. Obtain wild-type *S. cerevisiae* and culture this strain then plate out dilutions. Compare the sensitivity of the two to ultraviolet light from the sun.
More advanced experiment

• Using Yeast to Measure the Intensity of Solar Ultraviolet Radiation

• http://www.phys.ksu.edu/gene/d3.html
Questions?
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