

**Project 3.2.2 Skin Cancer Prevention**

Introduction

All life on Earth depends on the energy from the Sun. It is this energy that allows plants to produce glucose, but it is also this energy, in the form of ultraviolet (UV) photons, that can damage the DNA in your cells and cause skin cancer. Did you know that skin cancer is the most common type of cancer in the United States? It is estimated that there are more than one million new cases of skin cancer in the United States each year. The incidence of skin cancer has been on the rise for the last few decades, even in young adults. Long-term exposure to ultraviolet rays increases the risk for developing skin cancer. In fact, a woman or man who uses a tanning bed more than once a month is 55% more likely to develop melanoma, the deadliest form of skin cancer. The good news is that skin cancer can be prevented and is highly treatable when caught early.

There are precautions you can take to protect yourself from skin cancer. In this activity, you will investigate your risk factors for skin cancer, learn how to do a self-examination for suspicious moles, as well as design and conduct an experiment to test the effectiveness of sunscreen to prevent harmful damage to DNA.

Equipment

* Computer with Internet access
* Laboratory journal
* PLTW Biomedical Sciences Experimental Design handout
* How to Write a Scientific Laboratory Research Report handout
* Science Laboratory Report rubric
* Safety goggles
* Latex or nitrile exam gloves
* Carolina’s *Sunscreen for Yeast and People, Too* lab kit:
* YED plates
* Bottle of sterile water
* Sterile, capped, plastic test tubes
* 1-mL individually-wrapped sterile bulb pipets
* 5-mL individually-wrapped sterile bulb pipets
* Small jar of glass beads
* Box of sterile toothpicks
* Starter plate with UV light-sensitive yeast strain (mutant yeast strain)
* Starter plate with wild-type yeast strain
* Aluminum foil squares (approximately 12 cm x 12 cm)
* Stop watch
* 30 ˚C Incubator
* Various types of sunscreens or tanning oils
* Common clothing fabric

Note: The list of equipment is meant to be a guide for ideas. If your design requires something not listed, check with the teacher to see if it is available.

Procedure

Part I: Prevention and Early Detection

1. Access the American Cancer Society’s “Skin Cancer Prevention and Early Detection” website and take notes in your laboratory journal. Include information on the different types of skin cancers, where they develop, and the likelihood that they will spread. This website is found at: <http://www.cancer.org/docroot/PED/content/ped_7_1_Skin_Cancer_Detection_What_You_Can_Do.asp>
2. Read the story of Dan, a 24 year old engineer who was diagnosed with melanoma, the deadliest form of skin cancer, found at Melanoma Education Foundation’s “Dan’s Story: If Only He Had Known”: <http://www.skincheck.org/Page7.php>
3. Reflect on lessons that can be learned from Dan’s story by answering Conclusion questions 1 - 2.
4. Take the skin cancer risk questionnaire below by checking “Yes” or “No” in the columns to the right. Knowing your risk is important so you can take preventative measures to reduce your risk and be on the look out for early signs of skin cancer.

|  |  |  |
| --- | --- | --- |
|  | YES | NO |
| Do you frequently spend time in the sun between 10:00 am and 4:00 pm without sunscreen with a Sun Protection Factor (SPF) of 15 or more? |  |  |
| Do you frequently spend time in the sun between the hours of 10:00 am and 4:00 pm without wearing protective clothing? |  |  |
| Do you frequently spend time in the sun between the hours of 10:00 am and 4:00 pm without wearing sunglasses? |  |  |
| Do you frequently spend time in the sun between the hours of 10:00 am and 4:00 pm without wearing a hat? |  |  |
| Do you have fair skin that freckles or burns easily? |  |  |
| Do you live in a region that gets high levels of UV radiation? |  |  |
| Do you have red, blonde, or light brown hair? |  |  |
| Do you have blue, green, or hazel eyes? |  |  |
| Have you ever experienced severe, blistering sunburns? |  |  |
| Do you have any family members who have had skin cancer? |  |  |
| Do you have a lot of moles? |  |  |
| Have you used tanning lamps or booths? |  |  |
| Have you ever been exposed to large amounts of arsenic, industrial tar, coal, or paraffin? |  |  |
| Have you ever been treated for psoriasis with psoraleen and ultraviolet light treatments? |  |  |
| Are you a smoker? |  |  |

1. Tally the total number of check marks in the “yes” column. Every “yes” answer corresponds with a potential risk for developing skin cancer in the future. The more times you answered yes, the higher your risk. Remember, just because you have a higher risk for developing skin cancer does NOT mean that you will definitely get skin cancer. Some risks for skin cancer deal with factors that we may not have control over, such as heredity or family history; whereas, some risks can be controlled by personal healthy behaviors.
2. Create a data table in your laboratory journal with the following headings: My Uncontrollable Risk Factors, Positive Actions I Already Take, and Positive Actions I Need To Take To Reduce My Risk.
3. Look at your answers and decide which risks are out of your control and which are in your control.
4. Fill-out the data table using information you learned from taking the skin cancer risk questionnaire in your laboratory journal.

Melanoma is a very serious form of skin cancer that starts in melanocytes of normal skin or moles and metastasizes rapidly and widely. Melanoma can usually be cured if caught early. Self-examinations of unusual moles or suspicious spots on your skin can be the key to detecting melanoma early.

1. Go through The American Academy of Dermatology’s “A-B-C-D-E Guide” for skin cancer self-exams to learn how to perform a self-examination for melanoma found at:
* The Mayo Clinic’s “Slide Show: Melanoma pictures to help identify skin cancer”: <http://www.mayoclinic.com/health/melanoma/DS00575>
1. Answer Conclusion questions 3 - 4.

Part II: Mutant Yeast

Ultraviolet light causes mutations in our DNA which can cause a cell to become cancerous or to die. Luckily, our cells have special enzymes that repair the DNA damage caused by ultraviolet light. However, occasionally the repair enzymes make a mistake which results in a mutation. The more exposure to UV light that one has, the more times the enzymes have to repair the DNA, which increases the chances that a DNA mutation will occur. One of the simplest ways to reduce your risk for developing skin cancer is to protect your skin from harmful UV rays with sunscreen. Sunscreen works by filtering or blocking dangerous UV rays from the sun which prevents the UV rays from damaging the DNA found in the skin cells. Yeast cells can be used as a “model system” to study the effects of UV exposure. Yeast cells are a good model system because they are single-celled organisms that are easy to grow. Since they are eukaryotes, their DNA is organized and replicated in much the same way as mammalian DNA. The enzymes yeast cells use to repair their DNA are similar to the enzymes used in mammalian cells. Scientists have been able to develop a UV-sensitive yeast strain whose DNA has been altered so that it is not able to repair its DNA. Observing how sensitive these mutated yeast cells are to UV exposure, we can learn more about the damage our cells must repair in response to our exposure to the sun. With a lab partner, you will determine how the two strains of yeast respond to exposure to the sun.

1. Put on safety gloves and goggles.
2. Working with your partner(s), obtain a *WT Yeast Strain* starter plate and a *Mutant Yeast Strain* starter plate from your teacher. You will have to share these starter plates with another group.
3. Obtain two sterile, capped, plastic test tubes from your teacher. Label one of the tubes *WT Yeast Strain* (wild type yeast). Label the other tube *Mutant Yeast Strain*.
4. Pick up a toothpick from the box. Be careful not to touch one end of the toothpick.
5. Using the clean end of the toothpick, collect a mass of yeast from the starter plate labeled *WT yeast strain*. The mass of yeast on your toothpick should be about 1 mm in diameter.
6. Smear the mass of yeast as far down as you can possibly reach in the test tube labeled *WT Yeast Strain*.
7. Obtain a clean toothpick and repeat steps 14-16 using the *Mutant Yeast Strain*.
8. Obtain a sterile 5 mL pipet from your teacher. Pull out the pipet from the packet from the bulb end (the side away from the end used to take up liquid). This will ensure that the pipet remains sterile.
9. Pipet 5 mL of sterile water into each test tube. Make sure to not touch the walls of the tube with the pipet. You do not want to cross-contaminate your tubes. If you do accidentally touch the wall of the tube with the pipet, obtain a new pipet from your teacher before adding water to the second test tube.
10. Shake or vortex the tubes until the yeast cells are completely resuspended in the water (the water should look slightly cloudy).
11. Obtain two YED plates from your teacher. YED stands for Yeast Extract-Dextrose agar, a growth medium for yeast.
12. Label one plate *WT Yeast Strain* and one plate *Mutant Yeast Strain*. Also label both plates with your and your partner’s names. In addition, label the lids of each plate with this information.
13. Obtain a small jar of glass beads from your teacher.
14. Open each of the plates with the lid-side down. Shake 4 – 5 glass beads onto the lid of the plates and immediately close and flip the plates back over.
15. Use the 1 mL pipet and pipet 250 μL of each yeast suspension onto the appropriately labeled plate. Use the diagram below to help you determine the 250 μL mark. Use a different pipet for each yeast strain. Close the plates as soon as the yeast suspension has been added.



1. Spread the yeast cells onto the plates by shaking the glass beads back and forth across the entire surface of the plate. Do not use a swirling motion, as this will only run the beads along the edge of the plate.
2. Let the plates sit until the excess liquid has soaked into the agar.
3. Hold each plate vertically over a disposal container and open the plates slightly to allow the beads to drop into the container. Immediately close the plate.
4. Remove the lid from one of the plates and quickly cover the plate with plastic wrap. Make sure the plastic wrap is pulled taut and does not touch the surface of the plate.
* Note: The plastic wrap is used instead of the petri dish cover because the petri dish cover might contain a pigment that absorbs some components of sunlight and will interfere with this experiment.
1. Repeat step 29 with the other plate.
2. Obtain two squares of aluminum foil from your teacher.
3. Place the squares of aluminum foil so that they cover half of the yeast plates. The aluminum foil will shield half of the yeast plates from sun exposure. Use a permanent marker to label which half is shielded from the sun.
4. Expose the plates to the sun according to your teacher’s directions. If it is a cloudy day out, your teacher might instruct you to use UV lamps.
5. After the plates have been exposed, remove the plastic wrap and aluminum foil and quickly replace the corresponding lids.
6. Incubate the plates overnight at 30˚ C. Replace aluminum foil to prevent additional UV exposure.
7. Properly discard of waste, clean all equipment, and return supplies to the designated area.

Part III: Experimental Design

1. Gather your plates from the incubator and observe the growth of yeast on both plates.
2. In your laboratory journal, draw what you see on both plates.
3. Calculate what percent of the exposed and unexposed WT yeast strain plates have growth on them as well as the mutant yeast strain plates. Record this information in your laboratory journal.
4. Answer Conclusion questions 5 – 7.

Now that you have seen the effect sun exposure has on both yeast strains, you will work with a lab partner to design an experiment to test the effectiveness of various sunscreens or types of cloth against UV light using UV sensitive yeast cells.

1. Work with your partner(s) to brainstorm what variable you would like to test. Identify your independent and dependent variables.
* The independent variable is the variable that is varied or manipulated by the researcher. The dependent variable is the measurable effect, outcome, or response in which the researcher is interested. In other words, the independent variable is the presumed cause, whereas the dependent variable is the presumed effect. In an experiment, the independent variable is the variable that is controlled and manipulated by the experimenter; the dependent variable is not manipulated but instead is observed or measured for variations as a presumed result of the variation in the independent variable.
1. Obtain the PLTW Biomedical Sciences Experimental Design handout from your teacher.
2. Discuss how you will set-up your experimental procedure with your partner.
3. Follow the steps outlined in the PLTW Biomedical Sciences Experimental Design handout.
4. Keep in mind all aspects of valid experimental design, including control(s) when creating your procedure.
5. Write a draft of your experimental procedure on loose leaf paper. Make sure to include all safety precautions that must be taken when carrying out the procedure. Note that the various sunscreens and/or types of cloth should be put on top of plastic wrap instead of applied directly on the agar. Applying these materials directly on the agar will kill all of the yeast.
6. When the draft is complete, meet with your teacher for approval.
7. Make any changes suggested by your teacher and write a formal, detailed experimental procedure in your laboratory journal.
8. Devise a way to score the extent to which the yeast cells are killed in the presence or absence of the various UV light-blocking agents tested.
9. Create any data tables and/or graphs that will be used to summarize your data.
10. Proceed with the actual experiment when given approval. Incubate the covered plates overnight at 30˚ C.
11. When finished, properly discard of waste, clean all equipment, and return supplies to the designated area.
12. Observe and write down results in your laboratory journal.
13. Share your findings with the class.
14. Show your laboratory journal with the completed project to the teacher before proceeding to Step 56.
15. Obtain the *How to Write a Science Lab Report* handout and the Science Laboratory rubric from your teacher.
16. Using the handout, create a written report which will be submitted to the teacher for evaluation. This report should follow the structure outlined on the document and will be scored according to the Science Laboratory Report rubric.
17. Answer the remaining Conclusion questions 8 - 9.

Exposure to UV light can cause Acidic Keratosis (AK) lesions to form on the skin. AK lesions are small, scaly patches of precancerous skin cells on the epidermis (the top layer of the skin). When left untreated, AK lesions can turn into a form of skin cancer called squamous cell carcinoma. The good news AK lesions are easily identifiable and can be easily treated before they become cancerous. One treatment for AK lesions is a topical medication called 5-fluorouracil (also known as 5-FU). 5-FU belongs to a group of medications called pyrimidine antagonists.

1. Use appropriate Internet search techniques to investigate 5-fluorouracil. Research the following questions:
* How do pyrimidine antagonists work?
* How was 5-FU discovered?
* What is 5-FU’s mechanism of action?
* What should patients using 5-FU expect with treatment?
1. Summarize the information in your laboratory journal.
2. Answer Conclusion question 10.

Conclusion Questions

1. What warning signs were there that Dan had skin cancer?
2. How do you think Dan’s death could have been prevented?
3. When doing a self-examination for suspicious mole or spots on your skin, what should you look for?
4. Mr. Smith is a professional landscaper and spends a majority of his day working outside in the sun. What advice would you give him so that he can lower his risk for developing skin cancer?
5. Given what you know about these two strains of yeast, what role does a cell’s ability to repair DNA play in how well it tolerates exposure to sunlight?
6. Why is it important for a cell to be able to efficiently repair its DNA?
7. What conclusions can you draw from the experiment you designed and ran?
8. If you were to perform this experiment again, what would you do differently? Why?
9. If yeast cells repair damage to their DNA in a similar manner to humans, what do these results tell you about the degree of DNA repair that occurs in our cells each time we expose ourselves to sunlight?
10. You have been contracted to design a new medical intervention to help prevent skin cancer. What type of medical intervention would you design? Describe your medical intervention and explain how it works to prevent skin cancer.

**Web Portfolio**

1. A short description of what you are learning with this activity.
2. A picture of the yeast plates with description