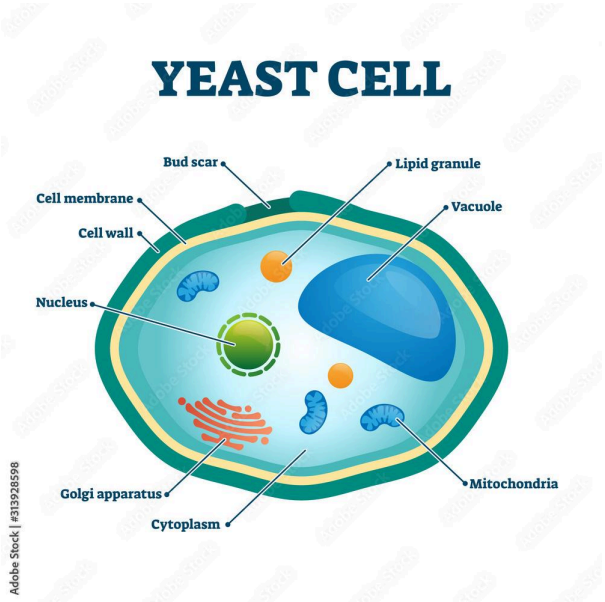
Simran Johal: Science Fair Lab Report 2023-2024

Testable Question:
When yeast colonies are grown and placed under the Sun while covered in different brands of mineral sunscreen (Blue Lizard, Sun Bum, Coppertone, Aveeno), which sunscreen will prevent the most damage to yeast cells? (which one is most effective against UV rays)

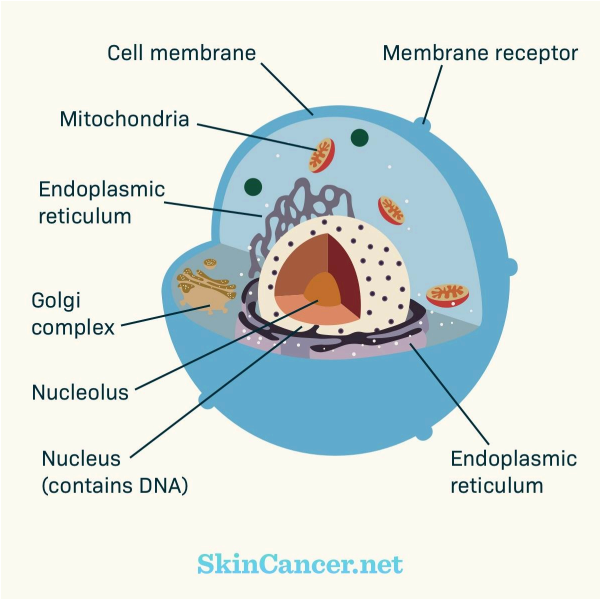
Background Research:

The focus of this experiment is to investigate which brand of mineral sunscreen is most protective against UV rays from the Sun. The brands I'll be using are: Blue Lizard Sensitive Mineral Sunscreen, Sun Bum Mineral Sunscreen Lotion, Coppertone Pure & Simple Sunscreen Lotion, and Aveeno Sensitive Skin Mineral Sunscreen. All of these sunscreens are SPF 50.

This project will not be conducted using human skin. Instead, I will be using yeast colonies to conduct this experiment. This is because yeast cells are able to quickly repair any damage in its DNA using its repair proteins. There are 3 different pathways that the DNA repair proteins function through: nucleotide excision, recombinational, and mismatch. These pathways are the paths that the yeast cells use to get rid of UV damaged DNA. When human and yeast DNA is compared, the pathways nucleotide excision and mismatch have a lot of functional conservation. This means that throughout evolution, yeast and human cells have been using unchanged pathways. Basically, yeast repair genes are similar to that of humans due to such high functional conservation levels. In fact, yeast is known as the best model to study human cells. This is because the way they turn nutrients into energy is practically the same. Their cells used for growing are similar (they grow in the same fashion) and they respond to certain situations using similar cellular systems. This makes yeast a great subject for testing human cells because yeast are very capable for experimentation. The strain of yeast that I will be using is called Saccharomyces cerevisiae. The Saccharomyces group is a strain of yeast commonly known for reproducing by budding. S. cerevisiae yeast is unicellular, meaning that it is only 1 cell. A yeast cell is a circular-oval cell that reproduces by using vegetative reproduction– either by budding or germinating. When the DNA is damaged, it can cause something called apoptosis. Apoptosis is a programmed cell death. When the DNA is damaged to such a rate that it becomes unfixable, it triggers the cell to die. However, if the damage isn't that severe, the cell will slowly and steadily repair itself using its repair proteins. The Sun, however, will end up triggering apoptosis since S. cerevisiae yeast is sensitive to UV rays.



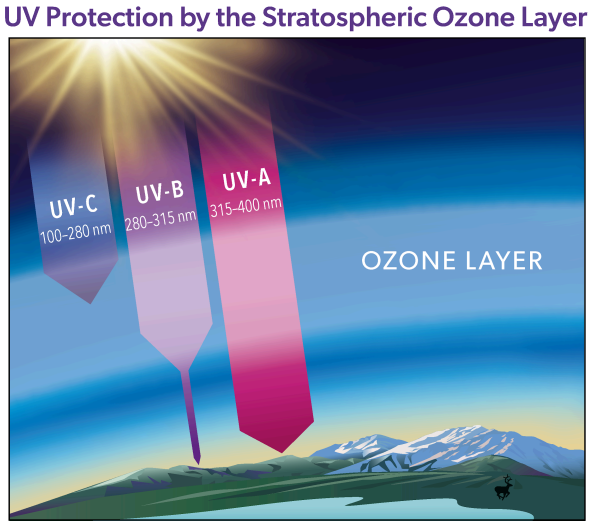
This is a diagram of a yeast cell.



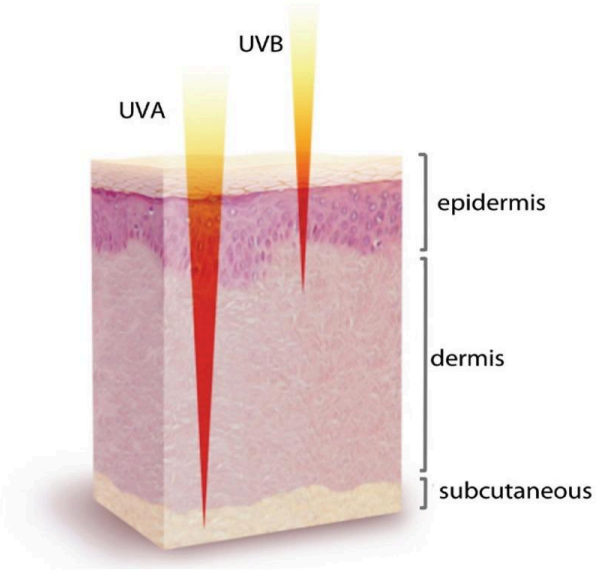
This is a diagram of a human skin cell.

You might be wondering, how do UV rays damage our skin? UV rays are natural and the main source of this energy is our Sun. On the electromagnetic spectrum, ultraviolet rays are past visible light, meaning that they cannot be seen or felt. There are 3 types of UV rays: UVA, UVB, AND UVC. UVA rays have a longer wavelength, UVB rays have a medium wavelength, and UVC rays have a shorter wavelength (in terms of UV rays). UVC rays aren't harmful, as these rays are fully absorbed by Earth's ozone layer. UVA and UVB rays, on the other hand, are harmful and proven to cause skin cancer. Some UVB rays are absorbed by Earth's ozone layer, however nearly no UVA rays are absorbed. The

difference between UVA rays and UVB rays is that UVA rays can dive deeper into your skin and the rays are more continuous throughout the year, whereas conditions such as weather, altitude, and location can affect the amount of UVB rays that reach your skin. UVA rays are not as intense as UVB rays. Human skin is composed of 3 layers: the epidermis, dermis, and the hypodermis (also known as subcutis/subcutaneous). The skin layers act as a natural (but not very effective) barrier against UV rays. The epidermis layer is the uppermost layer, the dermis layer is the middle layer, and the hypodermis is the innermost layer. Without sunscreen, UVA rays can penetrate all the way to the hypodermis layer, and UVB rays can reach the upper dermis layer. These UVA and UVB rays cause problems by damaging your skin cells. Small damage is usually repaired by your repair genes (located in your skin cell's nucleus), however, prolonged exposure to these rays can cause severe damage and issues such as skin cancer, sun burns, and eye damage such as snow blindness, where you are temporarily blind due to UV damage to the cells in your cornea.

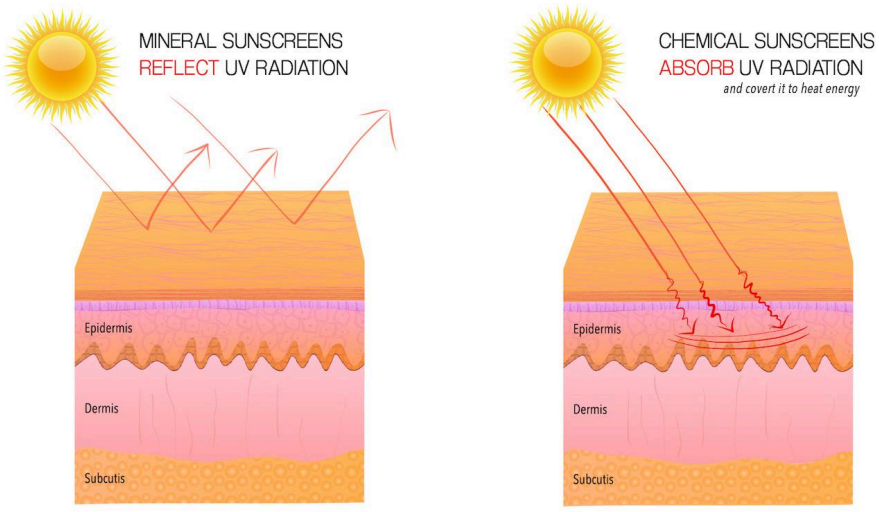


This diagram represents different types of UV rays passing through the ozone layer.



This diagram represents UVA and UVB rays penetrating the skin structure (without sunscreen).

Now this is where sunscreens come in. There are 2 main types of sunscreen: mineral and chemical. Mineral sunscreen forms a layer on top of your skin and acts as a mirror, reflecting UV rays. Mineral sunscreens create a physical barrier between the rays and your skin. Zinc oxide and titanium dioxide are the active ingredients in mineral sunscreens. Zinc oxide is more protective against UVA rays while titanium dioxide is more effective against UVB rays. Sunscreens that are formulated using only zinc oxide will offer protection against UVA rays, but not so much for UVB. However, sunscreen formulated using both chemicals will offer broad-spectrum protection (will protect against both UVA and UVB rays.) In addition, it can also protect against blue light (the fastest wave on the visible light spectrum– carries the highest amount of energy and can cause skin and eye problems.) Chemical sunscreens, on the other hand, absorb into your skin. They create a thin film that absorbs UV rays before they are able to go deep into your skin and do damage. These absorbed UV rays are transformed into heat energy. Avobenzone, octinoxate, and oxybenzone are the active ingredients in chemical sunscreens. Have you ever seen the word “SPF” on your sunscreen bottle? Well, SPF actually stands for sun protection factor. SPF is the amount of time it would take for the Sun to make your skin slightly red/tan with the sunscreen applied. If you have sensitive skin, SPF 50 roughly translates to 50 minutes of Sun exposure without your skin reddening. About 98% of UV rays are blocked out using SPF 50 sunscreen. Thi is why I am only using SPF 50 sunscreen. For this experiment, I will be placing the sunscreen on top of the petri dish glass cover. Since the glass cover is unable to absorb the chemical sunscreen, I will be sticking to using only mineral sunscreen.



This diagram represents the 2 types of sunscreens dealing with UV rays.

So what's the percentage of titanium dioxide and zinc oxide in each sunscreen I picked? In Blue Lizard Sensitive Mineral Sunscreen, the formula is 10% zinc oxide and 8% titanium dioxide. In Sun Bum Mineral Sunscreen Lotion, the formula is 20% zinc oxide. In Coppertone Pure & Simple Sunscreen Lotion, the formula is 24.08% zinc oxide. In Aveeno Sensitive Skin Mineral Sunscreen, the formula is 21.6% zinc oxide. I chose Blue Lizard Sensitive Mineral Sunscreen because it was chosen by the Allure Beauty Expert as the Best of Beauty and won the 2022 award from Allure. The Time Stamped voted Sun Bum Mineral Sunscreen Lotion as the best sunscreen for faces, and the Aveeno Sensitive Mineral Sunscreen as the best sunscreen for sensitive skin. The CNN Underscored ruled the Coppertone Pure & Simple Sunscreen Lotion as the best tested mineral sunscreen for your body.

Finally, how will I test this experiment? The experiment will be tested using yeast colonies grown in agar plates. In each trial, there will be one control plate. After exposing the plates, I will count the remaining colonies and divide it out of the whole, which will be the number of colonies in the controlled plate. Then I will multiply it by 100 to get a percent. I will compare these percentages to find out which sunscreen is most protective. Most protective=least colonies killed=higher percent.

Hypothesis

If different brands of mineral sunscreens are tested for which one is most effective against UV rays from the Sun, then Blue Lizard mineral sunscreen will be most protective. This is because although the formula is only 18% active ingredient (10% zinc oxide and 8% titanium dioxide), it is the only sunscreen out of the four I picked that is formulated using both titanium dioxide and zinc oxide. My research shows that when sunscreens are formulated using both titanium dioxide and zinc oxide, they have a broad-spectrum protection range. This means that they are effective against both UVA and UVB rays. I

hypothesize that this blend of compounds will be most effective against UV rays.

Variables

Controlled:

- The amount of time the yeast is allowed to grow for
- The amount of time the yeast is set out in the Sun
- The time of day the yeast is set out in the Sun
- The amount of agar poured in each plate
- The amount of yeast added in each plate
- The amount of mineral sunscreen applied to each plate
- The SPF for each sunscreen
- The temperature the yeast is grown in (I will keep the temperature in my house constant throughout the experiment).

Responding:

- The amount of yeast colonies that die when exposed to the Sun

Manipulated:

- The brand of mineral sunscreen

Uncontrolled:

- Airborne pollution (may hinder the sterility of sterile components of my experiment)
- Clouds (may hinder the amount of UV rays)
- Humidity (humidity effects activity in yeast and may cause varying results)
- Outdoor temperature (differences in temperature throughout the time the dishes are set outside may cause varying results)
- **Materials**
- 1 DNA Damage: Studying the Impact of UV Light Kit from Carolina Biological

This kit includes the following:

- ➢ 1 Wild-type yeast culture
- ➢ 1 tube of Saccharomyces cerevisiae yeast culture
- ➢ 1 box of sterile toothpicks
- ➢ 20 petri dishes
- ➢ 350mL of yeast-extract dextrose [Agar for growing yeast colonies] (YED) medium
- ➢ 3 sterile culture tubes
- ➢ 5 1mL transfer pipette
- ➢ 20mL of sterile distilled water
- ➢ 1 oz of glass beads
- 1 box of disposable gloves
- 1 microwave (mine is the Genius Prestige Plus by Panasonic)
- 1 Sharpie marker (any colour)
- 1 bottle of Clorox Disinfecting Concentrated Bleach
- 1 pair of Oven mitts
- 1 Stopwatch

- 1 Garbage can
- 1 spoon
- 1 bottle of Blue Lizard Sensitive Mineral Sunscreen
- 1 bottle of Sun Bum Mineral Sunscreen Lotion
- 1 bottle of Coppertone Pure and Simple Sunscreen Lotion
- 1 box of Alcan aluminum foil
- 1 roll of plastic wrap
- 1 ruler
- 1 plastic cup
- 1 roll of paper towel
- 1 calculator

Procedure

Step 1: First, take out your YED medium and unscrew the top.

Step 2: Microwave the bottle for thirty seconds.

➔ After 30 seconds, stir it with a spoon and continue with step 2 until the medium melts, being careful not to boil.

Step 3: Fill 5 petri dishes with the melted medium, being sure to fill the bottom completely.

➔ As soon as you pour the agar into the dishes, cover them to maintain sterility.

Step 4: Overnight, let the medium solidify.

Step 5: Get your Saccharomyces cerevisiae yeast culture tube, sterile toothpicks, and disposable gloves.

Step 6: Put on your disposable gloves and run the toothpick over the area of the tube where the yeast is growing.

Step 7: Apply the yeast on an agar plate by rubbing it in a zigzag motion.

Step 8: Press another zigzag pattern into the original zigzag pattern with a fresh toothpick.

Step 9: Close the petri dish cover and mark it “yeast” with a Sharpie.

Step 10: Use your aluminum foil to completely enclose the plate.

Step 11: Give the yeast two days to develop.

Step 12: After 2 days, take out your sterile culture tubes.

Step 13: Put this label on the four culture tubes you have:

1. 1
2. 1:10
3. 1:100
4. 1:1000

➔ This is making dilutions. The dilutions will spread out the yeast cells so that once they form the colonies are spread out enough to be counted.

Step 14: Put on your disposable gloves.

Step 15: Smear a 1 mm clump of yeast mass into the tube marked 1 after removing it from the main plate with your sterile toothpicks.

Step 16: Fill the tube with 5 mL of sterile water using your transfer pipet.
Step 17: Shake the tube.
Step 18: Fill each tube (apart from the tube marked 1) with 2.25 mL of sterile water using your transfer pipet.
Step 19: Transfer 0.25 mL of yeast from tube 1 to tube 1:10 using a new transfer pipet, and fully mix.
Step 20: Transfer 0.25 mL of yeast from tube 1:10 to tube 1:100 using a new transfer pipet, and fully mix.
Step 21: Transfer 0.25 mL of yeast from tube 1:100 to tube 1:1000 using a fresh transfer pipet.
Step 22: Write these labels on five petri dishes:

1. Blue Lizard
2. Sun Bum
3. Coppertone
4. Aveeno
5. Controlled

Step 23: Shake a few glass beads into each petri dish after turning the dish upside-down. When finished, turn them over again.
Step 24: Using a transfer pipet, transfer 0.25 mL of yeast from the 1:1000 tube to each plate with the sunscreen labels.
Step 25: Move the glass beads around the Petri dish by shaking it.
Step 26: Give the plates ten minutes to dry.

- ➔ During this time, you can label the bottoms of each plate to avoid mixing plates up when the lids are removed.

Step 27: To remove the beads, slightly open the lid and let the beads drop into the plastic cup.
Step 28: Remove the lids of each sunscreen plate and replace it with plastic wrap.
Step 29: Apply ⅛ a teaspoon of Blue Lizard sunscreen to the plastic wrap of the “Blue Lizard” labeled plate.
Step 30: Apply ⅛ a teaspoon of Sun Bum sunscreen to the plastic wrap of the “Sun Bum” labeled plate.
Step 31: Apply ⅛ a teaspoon of Coppertone sunscreen to the plastic wrap of the “Coppertone” labeled plate.
Step 32: Apply ⅛ a teaspoon of Aveeno sunscreen on the lid of the plastic wrap of the “Aveeno” labeled plate.
Step 33: Wrap aluminum foil around the dish that is marked "controlled."
Step 34: Let the dishes that are covered in sunscreen sit for fifteen minutes.
Step 35: For 50 minutes at noon, expose the plates covered in sunscreen to the Sun.

- ➔ Make sure the Sun’s rays are hitting the dishes from an overhead position.

Step 36: Replace the plastic wrap with the lids of the petri dishes.
Step 37: Place aluminum foil over the plates and let them sit for two days.

Step 38: Take off the coverings and count the colonies on the exposed plates as well as the control plate.
Step 39: Calculate and record the percentage of yeast colonies killed using the following equation: colonies on exposed plate ÷ colonies on control plate × 100 = percent alive.
Step 40: Soak the plates in bleach for 2 hours and then dispose of them in your garbage can.
Step 41: Repeat the procedure for 2 more trials.

Observations:
Trial 1:
Control Plate: The yeast colonies formed relatively close together, making it a little difficult to count each colony. There should be around 100 colonies in each control plate. After counting, recounting, and checking with someone else, I concluded that there are 93 colonies in this plate. The colonies in the center are larger than those around the sides.
Blue Lizard: The yeast colonies were more spread apart than the colonies on the control plate. There were 79 colonies on this plate. The colonies were more formed around the sides rather than at the middle. The colonies formed in an irregular pattern, sprouting randomly across the plate. The percent alive is 84.946%.
Sun Bum: The yeast colonies were basically spread out at the same rate as the Blue Lizard plate. On this plate, there were 81 colonies, barely any more than the Blue Lizard one. The percent alive is 87.097%.
Coppertone: The yeast colonies formed similarly to the other two plates. There were 68 colonies on this plate. The percentage is 73.118%.
Aveeno: Unlike the other plates, this one formed with more colonies in the center than the sides. The colonies were a lot smaller, with only a few large ones. There were 74 colonies on this plate. The corresponding percentage is 79.569%.
So, for trial 1, the Sun Bum sunscreen was most protective against UV rays.
Trial 2:
Control Plate: The colonies showed similar characteristics as trial 1, as they formed larger at the center than at the sides. On this plate, there are 94 colonies, barely any different than the first trial.
Blue Lizard: Similarly to trial 1, The colonies were spread apart and more accumulated towards the slides than at the middle. On this plate, there were 83 colonies. This can be expressed as a percentage of 88.297%.
Sun Bum: The results showed similarities between trials 1 and 2. There were 80 colonies on this plate. This is 85.106%.
Coppertone: As the other two plates, the results were relatively similar between trials 1 and 2. On this plate there were 72 colonies. This can be converted to percentage and expressed as 76.595%.
Aveeno: This plate showed relatively similar results to trial 1. In terms of colony formation, the colonies did form smaller around the center, however, the results were

pretty much the same in both trials. There were 72 colonies on this plate. This translates to 76.595%.

So, for trial 2, the Blue Lizard sunscreen was most protective against UV rays.

Trial 3:

Control Plate: As trials 1 and 2, the control plate for trial 3 had colonies that formed larger at the center than the sides. There were 91 colonies on this plate.

Blue Lizard: All 3 trials had relatively similar formations between the colonies: spread apart and accumulated towards the sides. The results were also similar, with 82 colonies on the plate. This is 90.109%.

Sun Bum: The colonies grew similarly in all 3 trials, spread out. There were 78 colonies on this plate. This is 85.714%.

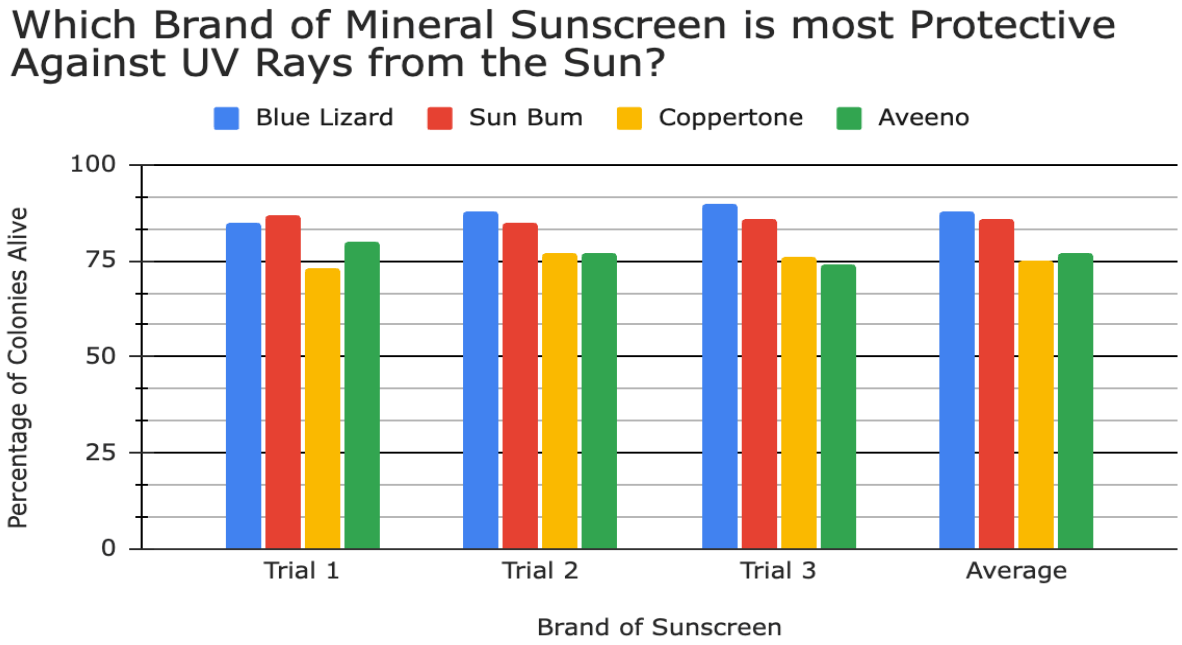
Coppertone: The growth remained uniform in all 3 trials. There were 69 colonies on this plate. This can be expressed as 75.824%.

Aveeno: In all 3 trials, the results for Aveeno stayed similar. The colonies formed as they did in the trials before, smaller and more concentrated in the center. The results for this trial were 67 colonies. This is 73.626%.

So, for trial 3, the Blue Lizard sunscreen was most protective against UV rays.

Results:

Sunscreen/ Trial	Trial 1	Trial 2	Trial 3	Average
Blue Lizard	84.946%	**88.297%**	**90.109%**	**87.784%**
Sun Bum	**87.097%**	85.106%	85.714%	85.972%
Coppertone	73.118%	76.595%	75.824%	75.179%
Aveeno	79.569%	76.595%	73.626%	76.597



Analysis:

Blue Lizard: The active ingredients in Blue Lizard Sensitive Mineral Sunscreen are zinc oxide and titanium dioxide. The formula is 10% zinc oxide and 8% titanium dioxide. Since the formula is formulated with both titanium dioxide and zinc oxide, it will offer broad spectrum protection against both UVA and UVB rays. UVC rays don't reach us here on Earth, so the sunscreen doesn't protect against UVC rays. Zinc oxide mainly protects more towards UVA rays whilst titanium dioxide has a better effect on UVB rays. Since the formula is 10% zinc oxide and 8% titanium dioxide, the sunscreen will protect against more UVA rays than UVB rays. This makes sense since there are less UVB rays than UVA rays in our atmosphere.

Sun Bum: The active ingredient in Sun Bum Mineral Sunscreen lotion is zinc oxide. The formula is 20% zinc oxide. Since the formula is formulated using only zinc oxide, the sunscreen will not offer broad spectrum protection. This is because zinc oxide is more protective against UVA rays rather than UVB rays. Protection against UVC rays isn't necessary since all UVC rays get absorbed by the ozone layer. Since the formula is 20% zinc oxide, it is very protective against UVA rays. UVB rays not so much. This is not a very big problem in winter since UV levels are lower. In summer, however, this can pose a big problem since UVB rays are stronger than UVA. If the sunscreen is not protective enough against UVB rays, it can be incapable of having adequate protection.

Coppertone: The active ingredient in Coppertone Pure & Simple Sunscreen Lotion is zinc oxide. The formula is 24.08% zinc oxide. Even though the formula has more percentage of active ingredient than the Sun Bum sunscreen, it performed worse than it. This is because the sunscreen is formulated with a certain inactive ingredient: butyloctyl salicylate. This chemical is supposed to enhance the effectiveness of sunscreen. However, this chemical can end up increasing sun sensitivity while acting as a chemical improvement. The S. cerevisiae strain of yeast is already sun sensitive. This chemical may have worsened the sun sensitivity of the yeast, which can answer the question as to why the coppertone sunscreen performed the worst.

Aveeno: The active ingredient in Aveeno Sensitive Skin Mineral Sunscreen is zinc oxide. The formula is 21.6% zinc oxide. Like the Coppertone sunscreen, the Aveeno sunscreen has more active ingredient than the Sun Bum and the Blue Lizard sunscreens. However, the Aveeno one performed worse than both. This is most likely due to a certain chemical in the sunscreen: phenoxyethanol. In sunscreen, it is commonly used as a preservative. However, phenoxyethanol has many harsh side effects including organ irritation and damage. These harsh side effects may have triggered apoptosis in some of the yeast cells due to excess damage.

Conclusion:
The purpose of this experiment was to investigate which mineral sunscreen (Blue Lizard, Sun Bum, Coppertone and Aveeno) is most protective against UV light from the Sun. It was hypothesized that the results of this experiment would show that Blue Lizard Australian Sunscreen will be the most protective. This hypothesis was proven correct after the yeast colonies covered in Blue Lizard sunscreen suffered the least damage when placed outside in the Sun. This happened because although Blue Lizard sunscreen had the least amount of active ingredient (18%) in the bottle, it was the only sunscreen that was formulated using both titanium dioxide and zinc oxide. This blend of compounds offers a broad spectrum protection range, meaning it is protective against both UVA rays and UVB rays. Zinc Oxide is more protective against UVA rays, so all the other sunscreens which were formulated using only zinc oxide were at a disadvantage due to their lack of titanium dioxide. This broad spectrum protection is what helped Blue Lizard sunscreen protect the best. This conclusion can be supported by the following information: *"Titanium dioxide (TiO_2) is a mineral filter which provides protection in the UVB and UVA range. While some organic filters cover only certain wavelengths, TiO2 acts as a broad spectrum filter, also protecting against blue light, which can be harmful for the skin."* (How titanium dioxide in sunscreens protects us from the sun - TDMA). *"Titanium dioxide (TiO2) and zinc oxide (ZnO) minerals are frequently employed in sunscreens as inorganic physical sun blockers. As TiO2 is more effective in UVB and ZnO in the UVA range, the combination of these particles assures a broad-band UV protection."* (Titanium dioxide and zinc oxide nanoparticles in sunscreens: focus on their safety and effectiveness - PMC Oct. 13, 2011). This research shows that titanium dioxide is an effective sun protection chemical and when paired with zinc oxide, it offers a great deal of protection from the Sun that zinc oxide alone would be unable to do. Thus, Blue Lizard Sensitive Mineral Sunscreen was most protective against UV rays.

Consumer Data:
In terms of consumer data, the cost of each sunscreen is as follows: Blue Lizard Sensitive Mineral Sunscreen- $19.99. Sun Bum Mineral SPF 50 Sunscreen Lotion- $17.49. Coppertone Pure and Simple Sunscreen Lotion- $8.85-$9.99. Aveeno Positively Mineral Sensitive Skin Sunscreen-$22.92. The Aveeno Sunscreen is the most costly one and 3rd best sunscreen, meaning that it is overpriced in terms of the quality of sun protection that you are receiving since they're are cheaper sunscreens like Blue Lizard or Sun Bum that work better for a lower price. So, the aveeno sunscreen is not worth your money. The Coppertone sunscreen is the cheapest, however, it is also the worst performing sunscreen out of the four I picked. This means that it is not protective enough for your skin and you are better off spending a little bit more money to buy the Sun Bum or Blue Lizard sunscreens rather than the Coppertone one. The Blue Lizard sunscreen is $2.50 more

expensive than the Sun Bum sunscreen. However, it is only 1.812% more protective against UV rays. The extra cost and extra protection aren't equal. This means that when buying the Blue Lizard sunscreen instead of the Sun Bum sunscreen, you are paying more for little extra protection. So, in terms of money, the Sun Bum Mineral SPF 50 Sunscreen Lotion is the best to buy. However, Blue Lizard Sensitive mineral Sunscreen is the most protective against UV rays from the Sun.

Sources of Error:
This project could've been improved in many ways. For example, I had started the experiment at around 3-4pm. Once I was ready to put the plates outside, the Sun began to set. I had realized that if I set the plates out, they wouldn't get sunlight from an overhead position since the Sun is setting. So, I decided to wrap the plates in aluminum foil and wait until noon the next day to set the plates out. This may have caused some of the colonies to start growing. This is a problem because the purpose of putting the plates outside before the colonies grew was that the cells that died wouldn't be able to grow. So, when I was counting the colonies, there was a small chance that some of them might be dead colonies that are only visible due to this mistake. This error could have been improved by starting step 12 in the morning so that by the time I had to set the plates out in the Sun, it would be around noon. Additionally, counting the colonies on each plate may have caused errors in the results. For the Aveeno plate in trial 2, I had initially counted 89 colonies. However, this seemed wrong to me so I put it through an online colony counter. The counter gave me my current result of 72 colonies. Turns out, I had just miscounted. This error could have been eliminated by putting every plate through the online counter to ensure that there is no place for counting errors. Variables like the time the plates were set out in the Sun could've been better controlled, as while I was setting each plate individually, the plates that were set out first got more time in the Sun than the last plates (I started the time when the last plate was set out). This could've been improved by using a tray to set out the plates rather than putting them out individually. Other errors that could be eliminated include having a larger sample size because there could be variations that were not shown in the experiment. Ex: experimenting with more brands of sunscreen or using different types of yeast to demonstrate different skin types that aren't as sensitive to the Sun as Saccharomyces cerevisiae yeast.

Applications:
This project is important for our daily lives, as it helps people know what sunscreen is the most effective against the harsh UV rays from the Sun. Wearing sunscreen daily can help prevent skin cancer, and this experiment informs people about which brand is the best to look towards. It also helps protect against certain skin problems such as acne scarring, hyperpigmentation, and sun spots caused due to Sun exposure. According to the Government of Canada, skin cancer is the most common cancer type. The main cause of skin cancer is prolonged UV radiation, and the main source of this radiation is our Sun. It is estimated that almost 9700 people will be diagnosed with this disease in Canada, and about 1250 people will die due to it. This experiment will also help promote sunscreen usage, as even with the Blue Lizard sunscreen, many colonies died. The results of this experiment will probably influence readers to apply sunscreen more often. It notifies people about what sunscreens are best when looking specifically for Sun protection measures.

Next Experiment:
To further study this experiment and gain additional insight on the topic, a good follow up experiment could be to test which type of sunscreen (baby, active, face, kids, sheer and sport) from the Blue Lizard brand is most protective against UV rays. In this experiment, the brand (Blue Lizard) would stay the same, however, the type of sunscreen would change. I would keep the brand Blue Lizard because in my current experiment, Blue Lizard sunscreen was most protective against UV rays from the Sun. Another topic could be to test how the effectiveness of sunscreen increases as you add more sunscreen. Doctors say you should apply at least 3 fingers worth of sunscreen to your face. I would test how much more protection additional fingers provide, and if the recommended amount is actually enough. In this experiment, the sunscreen will be Blue Lizard Sensitive Mineral sunscreen because in my current experiment, this one was most protective against UV rays.

References

Akgündüz, M. C. (2020, January 27). *The Potential Risk Assessment of Phenoxyethanol with a Versatile Model System*. NCBI. Retrieved January 22, 2024, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6985251/

Aveeno Zinc Oxide Mineral Sunscreen SPF 50, Active Naturals Body Sun Cream for Sensitive Skin, Oil Free, Hypoallergenic, Water resistant, 88ML. (n.d.). Amazon.ca. Retrieved January 21, 2024, from https://www.amazon.ca/Aveeno-Mineral-Sunscreen-Naturals-Sensitive/dp/B07CTMR22S?th=1

Bramlet, K. (2016, June). *How sunscreen works*. MD Anderson Cancer Center. Retrieved January 21, 2024, from https://www.mdanderson.org/publications/focused-on-health/how-sunscreen-works.h27Z1590624.html

Burhans, W. C., Weinburger, M., Marchetti, M. A., Ramachandran, L., D'Urso, G., & Huberman, J. A. (2003, November 27). *Apoptosis-like yeast cell death in response*

to DNA damage and replication defects. PubMed. Retrieved January 21, 2024, from https://pubmed.ncbi.nlm.nih.gov/14643439/

Chien, A., & Jacobe, H. (2021, August). *UV Radiation*. The Skin Cancer Foundation. Retrieved January 21, 2024, from https://www.skincancer.org/risk-factors/uv-radiation/

Edney, A. (2023, July 11). *Mineral Sunscreens BOS Chemical Booster Draws Safety Concerns*. Bloomberg.com. Retrieved January 22, 2024, from https://www.bloomberg.com/news/newsletters/2023-07-11/mineral-sunscreens-bos-chemical-booster-draws-safety-concerns

FOI 116-1516 Document 7. (2006, October 19). Therapeutic Goods Administration (TGA). Retrieved January 22, 2024, from https://www.tga.gov.au/sites/default/files/foi-116-1516-07.pdf

Harvey, D. (n.d.). *The difference between physical and chemical sunscreen*. Piedmont Healthcare. Retrieved January 21, 2024, from https://www.piedmont.org/living-real-change/the-difference-between-physical-and-chemical-sunscreen

Heid, M., & Haase, M. (2022, June 24). *SPF Meaning: What Is SPF Sunscreen, and Does High SPF Protect My Skin Better?* Prevention. Retrieved January 21, 2024, from https://www.prevention.com/health/g20448325/how-high-of-an-spf/

Humidity control for bakeries. (2023, June 19). IKEUCHI. Retrieved January 21, 2024, from https://www.ikeuchi.eu/news/humidity-control-for-bakeries/

Ishikawa, T. (2021, March). *Saccharomyces cerevisiae in neuroscience: how unicellular organism helps to better understand prion protein?* PubMed. Retrieved January 21, 2024, from https://pubmed.ncbi.nlm.nih.gov/32985470/

Masson, J. (1996, May 10). *Saccharomyces cerevisiae DNA repair processes: an update*. PubMed. Retrieved January 21, 2024, from https://pubmed.ncbi.nlm.nih.gov/8791286/

Melanoma skin cancer statistics. (2023, November). Canadian Cancer Society. Retrieved January 21, 2024, from https://cancer.ca/en/cancer-information/cancer-types/skin-melanoma/statistics

Mineral Sunscreen Lotion SPF 50. (n.d.). Sun Bum. Retrieved January 21, 2024, from https://www.sunbum.com/products/spf-50-mineral-lotion-3-0oz

Mineral vs. Chemical Sunscreen: Know The Difference! (n.d.). Mustela USA. Retrieved January 21, 2024, from https://www.mustelausa.com/blogs/mustela-mag/mineral-vs-chemical-sunscreen-know-the-difference

Pure & Simple SPF 50 Mineral Lotion. (n.d.). Coppertone. Retrieved January 21, 2024, from https://www.coppertone.com/products/coppertone-pure-simple-lotion-spf50-0002401.html

Saccharomyces | Yeasts, Brewing, Fermentation. (2023, December 9). Britannica. Retrieved January 21, 2024, from https://www.britannica.com/science/Saccharomyces

Schärer, O. D. (2013, October). *Nucleotide Excision Repair in Eukaryotes - PMC*. NCBI. Retrieved January 21, 2024, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3783044/

Sensitive SPF 50+ Mineral Sunscreen 5oz Bottle | Blue Lizard. (n.d.). Blue Lizard® Sunscreen. Retrieved January 21, 2024, from https://bluelizardsunscreen.com/products/sensitive-mineral-sunscreen-spf-50-5oz

Skin cancer. (2023, August 11). Canada.ca. Retrieved January 21, 2024, from https://www.canada.ca/en/public-health/services/sun-safety/skin-cancer.html

Ultraviolet (UV) Radiation and Sun Exposure | US EPA. (2023, July 6). Environmental Protection Agency (EPA). Retrieved January 21, 2024, from https://www.epa.gov/radtown/ultraviolet-uv-radiation-and-sun-exposure

UV Radiation | NCEH Environmental Health Features. (2023, July 3). CDC. Retrieved January 21, 2024, from https://www.cdc.gov/nceh/features/uv-radiation-safety/index.html

VanDerBill, B. (2023, October 26). *Best Mineral Sunscreens for Safer Fun in the Sun*. Time. Retrieved January 21, 2024, from https://time.com/shopping/article/best-mineral-sunscreens/

Webster, E. S. (2023, July 31). *The 27 best mineral sunscreens 2023 for healthy protected skin*. CNN. Retrieved January 21, 2024, from https://www.cnn.com/cnn-underscored/beauty/best-mineral-sunscreens

What's the difference between SPF30+ and SPF50+? (2021, April 7). Cancer Council WA. Retrieved January 21, 2024, from https://cancerwa.asn.au/news/whats-the-difference-between-spf30-and-spf50/

Yeast Molecular Genetics and Cell Biology. (n.d.). University of Colorado School of Medicine. Retrieved January 21, 2024, from https://medschool.cuanschutz.edu/biochemistry/research/yeast-molecular-genetics-and-cell-biology