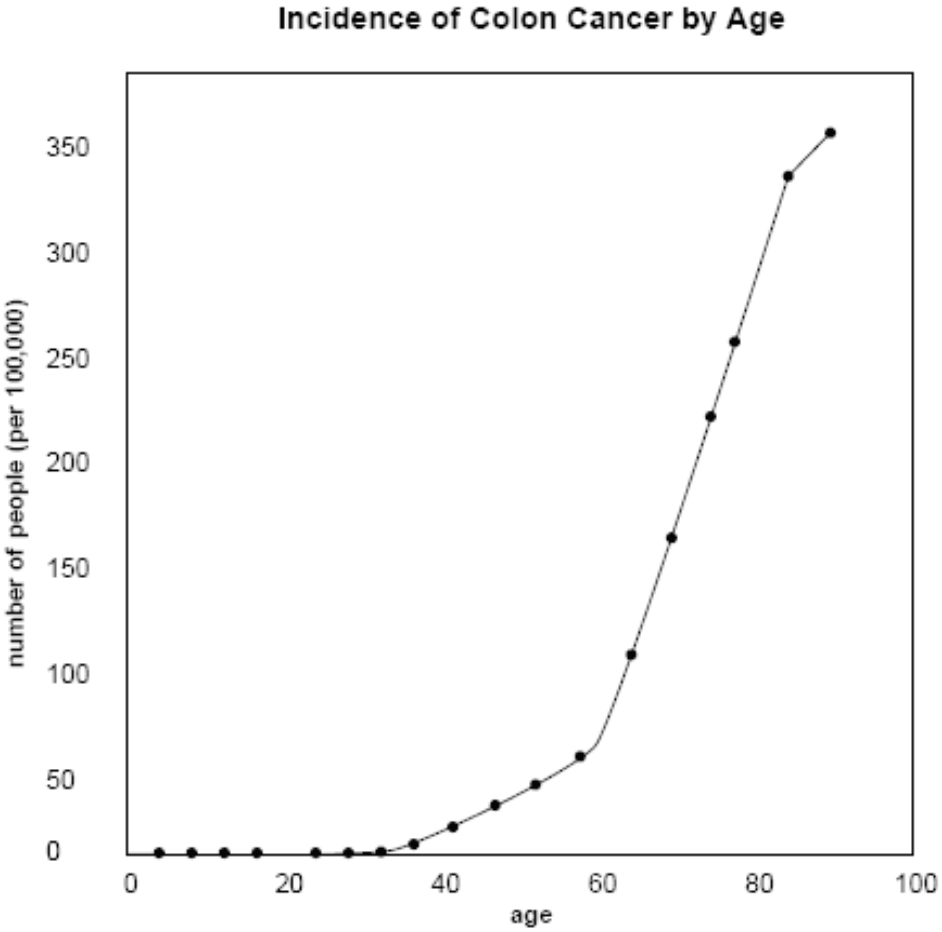
Cancer and the Cell Cycle

I. Building an Explanation for the Cause of Cancer
View the animations under "Cell Cycle Animations" on the CD-ROM or at
http://science.education.nih.gov/supplements/nih1/cancer/activities/activity2_animations.htm
Answer the questions in your lab report.

II. Colon Cancer Incidence by Age
View the graph below and answer the questions in your lab report.



Note: To calculate percent of people from this graph, you would take the value on the Y-axis (# of People/100,000) and move the decimal 2 places to the right. (Alternatively, calculate: # of people/100,000 * 100)

III. Using the Hit Simulator
Does having *one mutation* make a cell cancerous???

Use the hit simulator at:
http://science.education.nih.gov/supplements/nih1/cancer/activities/activity3.htm to test

hypotheses about how cancer develops (a "Hit" is a mutation). Your goal is to try to estimate the mutation rate and number of mutations required in proto-oncogenes and tumor suppressor genes for a cell to be cancerous.

Earlier you calculated rates of cancer based on actual colon cancer data. You will now create graphs to try to estimate the mutation rate and number of mutations required in proto-oncogenes and tumor suppressor genes to get this frequency of cancer.

Conduct Your First Run

To familiarize yourself with the Hit Simulator, conduct a trial run as follows:

- Enter a "1" in the window labeled "number of hits required for cancer." This value means that you are testing the hypothesis that only one mutation is required for cancer to develop.
- Enter a "0.5" in the window labeled "mutation rate per age interval." This value means that you are testing the hypothesis that there is a 50% probability of experiencing a cancer-causing mutation at each age interval.
- Click the button labeled "Calculate Next 5 Years." The bar on the graph on the right side of the screen indicates the percentage of people in a population who would be expected to develop cancer by the age of 5 if the mutation rate were 50% and it required only one hit for a cell to become cancerous.
- Continue clicking the button labeled "Calculate Next 5 Years" until you reach age 25, age 50 and age 80.

Investigate the Effect of Changing the Number of Hits Required

Use the Hit Simulator to investigate how the incidence of cancer in a population would be expected to change if different numbers of hits were required for a cell to become cancerous. For this investigation, keep the mutation rate set at 0.5 (50%). Conduct the runs indicated in the table, then conduct three of your choice. Record your results in the table.

Investigate the Effect of Changing Both the Number of Hits Required and the Mutation Rate

Now use the Hit Simulator to investigate how the incidence of cancer in a population would be expected to change with different combinations of the number of hits required and mutation rates. Conduct the runs indicated in the table, then conduct three of your choice. Record your results in the table.

IV. Using a Model System to Test Claims About UV Light

You and your teammates will use yeast as a model system for testing a claim your media item made about a particular product and UV light. Follow the steps below to design and conduct a controlled experiment that tests such a claim. You will need to write your proposal as a group onto separate paper to submit to your instructor for approval before running your experiment.

Learn About UV Light and Yeast

1. Read the following paragraphs to learn about ultraviolet (UV) light and the yeast you will use to test claims about UV light.

What is UV light?

UV light is one of the forms of radiation that is produced by the sun and by a variety of other sources (for example, certain types of artificial lights). UV light is not visible to us, but it is all around us. It is the part of sunlight that causes sunburns and tans. It also is the part of sunlight that can cause skin cancer.

Why is UV light dangerous?
UV light can damage the DNA inside cells. Cells repair most of this damage, but occasionally a cell makes a mistake during this repair process. This mistake causes a mutation in one of the cell's genes. The accumulation of mutations inside skin cells can lead to skin cancer.

What are yeast?
Yeast—in this case, baker's yeast (scientific name, *Saccharomyces cerevisiae*)—are a simple, single-celled form of fungus. Yeast reproduce both sexually and asexually and have simple nutritional needs. You need a microscope to see a single yeast cell. But that cell can grow into a whole colony of cells (that you can just barely see) in one day if it is provided with the right conditions.

Why are yeast a good organism for testing claims about UV light?
Yeast are easy to grow in the laboratory. The type of yeast that you will use is especially sensitive to UV light. It cannot repair the damage that UV light causes to its DNA. Thus, these yeast are killed by sunlight. As you will see, you can use these UV-sensitive yeast to measure the killing effect of sunlight under different conditions.

Human skin cells (as well as normal yeast cells and most other normal cells) have enzymes that repair damage to DNA that is caused by UV light. But when too much damage occurs (as might occur, for example, when a person spends a great deal of time outdoors), the repair enzymes may not be able to keep up. Across time, mutations may accumulate inside skin cells, leading to cancer. UV-sensitive yeast are a good **model** for testing products claimed to protect a person from skin cancer because the yeast's sensitivity allows the damaging effects of UV light to be observed very quickly.

Write a Hypothesis

2. Write the claim you would like to test about UV light.

Note: Be sure that your claim is related in some way to your media item. An example of a claim about UV light is that the higher the altitude on the earth's surface, the greater the amount of UV light present.

3. Now write the claim that you want to test in the form of a question.

Note: If you wanted to test the claim that more UV light reaches the earth's surface at higher altitudes than at lower altitudes, you might ask, "Does more UV light reach the earth's surface at higher altitudes than at lower altitudes?"

4. Write a tentative answer to your question.

Scientists call such tentative answers "hypotheses." Your hypothesis about UV light and altitude might read, "Yes, more UV light reaches the earth's surface at higher altitudes than at lower altitudes."

5. Use your hypothesis to write a prediction.

A prediction is a sentence that describes something that would happen if your hypothesis is correct. For example, your prediction about UV light and altitude might read, "If the amount of UV light that reaches the earth's surface increases with increasing altitude, then the maximum at altitude X will be greater than the maximum at altitude Y."

Design an Experiment

6. Describe the major parts of your experiment.
   - What are your variables? That is, what will you change? What else might change?

In the UV light and altitude experiment, you would need to change the altitude at which you measure the UV light coming from the sun. The amount of UV light might also change as a result of the difference in altitude.

   - What will you measure?

In the UV light and altitude experiment, you would measure the altitude and the maximum amount of UV light received in a certain size area during a certain length of time.

   - How will you measure this?

In the UV light and altitude experiment, you might use published values for altitude, and you might measure the ability of UV light to kill UV-sensitive yeast as an indication of the amount of UV light received during a certain period of time.

   - What is your control?

A control is a group of individuals in an experiment that do not receive the treatment given to the test subjects. In the UV light and altitude experiment, you might prepare a set of identical plates and expose half to UV light at the two altitudes, but leave the other half unexposed. The unexposed plates are your controls.

7. Write a description of your experiment and check it with your instructor before proceeding.

Conduct the Experiment

Follow the instructions below for spreading your plates of yeast and conducting your experiment.

Collect the following materials:

- culture of G948-IC/U yeast (1 per team)
- sealed tube containing 10 to 15 ml of sterile water (1 per team)
- packet of sterile toothpicks (1 per team)
- 1-ml sterile calibrated bulbed transfer pipet (1 per team member)
- petri plate containing YED agar medium (1 per team member)

Your instructor will indicate other materials that you may need to test your claim.

Record the Results

Collect your plates from the previous day and describe in writing and/or sketch the results on each plate. Attach a table to organize your results.

Be sure to check your instructor's website for extra credit questions and announcements.

Name _____

Cancer and the Cell Cycle

I. Building an Explanation for the Cause of Cancer
Think about the information each animation presents, and write a sentence to complete each statement below.

Animation 1:
Cancer involves . . .

Animation 2:
The G1 phase of the cell cycle involves . . .

The S phase of the cell cycle involves . . .

Mitosis involves . . .

Animation 3:
Proto-oncogenes regulate the cell cycle by . . .

Tumor suppressor genes regulate the cell cycle by . . .

Animation 4:
Cancer-causing agents often . . .

Animation 5:
When damage occurs to proto-oncogenes . . .

When damage occurs to tumor suppressor genes . . .

Given what you've learned in the animations, work as a team to brainstorm *how you think each of the following things could play a role in giving a person mutations that lead to cancer*.

Family History	Chemical Poisons	UV Light

II. Colon Cancer Incidence by Age

Calculate:

Percentage of People Expected to Develop Colon Cancer		
By Age 25	By Age 60	By Age 80

What **percent** of people your age are expected to develop colon cancer this year?

III. Using the Hit Simulator

The Effect of Changing the Number of Hits Required

		Percentage of People Expected to Develop Cancer		
Number of Hits	Mutation Rate	By Age 25	By Age 50	By Age 80
1	0.5			
2	0.5			
5	0.5			
	0.5			
	0.5			
	0.5			

Did the numbers you recorded in the chart on the previous page look close to the actual rates of cancer you calculated on the colon cancer graph? How do they differ?

The Effect of Changing Both the Number of Hits Required and the Mutation Rate

Number of Hits	Mutation Rate	Percentage of People Expected to Develop Cancer		
		By Age 25	By Age 50	By Age 80
1	0.1			
5	0.1			
7	0.1			
1	0.04			
5	0.04			
7	0.04			

Did the numbers for any of the trials you recorded in the chart above look close to the actual rates of cancer you calculated on the colon cancer graph?

What was the **number of mutations (hits)** and the **mutation rate** required to develop cancer in the trial that came closest to matching actual colon cancer rates?

IV. Using a Model System to Test Claims About UV Light
Yeast Experiment

1. Collect the following materials:
   - culture of G948-IC/U yeast (1 per team)
   - sealed tube containing 10 to 15 ml of sterile water (1 per team)
   - packet of sterile toothpicks (1 per team)
   - 1-ml sterile calibrated bulbed transfer pipet (1 per team member)
   - petri plate containing YED agar medium (1 per team member)
2. Open one end of your packet of toothpicks and carefully remove just one toothpick. (**Do not touch the other end of the toothpick.**)
3. Make a visibly turbid yeast suspension by using the toothpick to scrape some yeast from your culture plate and wiping them off on the inside of your tube of sterile water. Replace the lid and swirl to mix. If the suspension is not visibly cloudy, add more yeast cells, using a new toothpick.
4. Swirl the tube to resuspend the cells before removing each sample. Remove the sterile pipet from its wrapping just before you use it and carefully remove 0.5 ml of the yeast suspension. (**Do not touch the end of the pipet.**)
5. Lift the lid of a YED agar plate at an angle just enough to deposit the 1 ml of the suspension directly onto the surface of the plate. Replace the lid of the plate.

6. Tilt and rotate the plate to spread the cells over the surface of the agar. If the liquid does not cover, use the blunt end of a toothpick to spread the suspension.
7. Let the agar absorb the liquid until it disappears (about 15 minutes).
8. Secure the lid to the bottom of the petri dish using a small piece of tape on the side of the dish. (The plastic lid of the petri dish does not absorb a significant amount of the UV light found in sunlight, but the tape will.)
9. Treat your plates according to the experimental plan you devised. Then, if appropriate, expose the plates under a medium-range UV lamp for 2-3 minutes.
10. Incubate your plates **in the dark**, overnight at 30°C, or two days at room temperature. Incubate with the agar side up to prevent condensation from dropping on the colonies.

Results
Answer the questions below and attach a table to organize your data.

a. State the claim or hypothesis you tested.

b. Explain how you tested the claim. (For example, what did you change? What did you measure?)

c. Describe your results. (Be sure to also attach a table of your data.)

d. State your conclusion(s).

V. Cancer: Putting the Pieces Together
Write this on a separate piece of paper or type as instructed.
A friend of yours recently had genetic testing done to see if she is carrying the "breast cancer gene." The doctor told her that she "**has inherited one mutation in a tumor suppressor gene that is associated with breast cancer**." Your friend is confused about that statement and is worried that it means she will definitely get breast cancer later in life.

Using words and diagrams explain the doctor's statement to your friend; including why she will or will not definitely get cancer later in life. You should have all this information in your notes from watching the animations (http://science.education.nih.gov/supplements/nih1/cancer/activities/activity2/animations.htm) and using the "Hit Simulator" in class. Be sure to discuss the roles of the following things in cancer:

- Mitosis
- Mutations
- Proto-Oncogenes and Oncogenes
- Tumor Suppressor Genes
- Family History
- Chemical Toxins
- Radiation