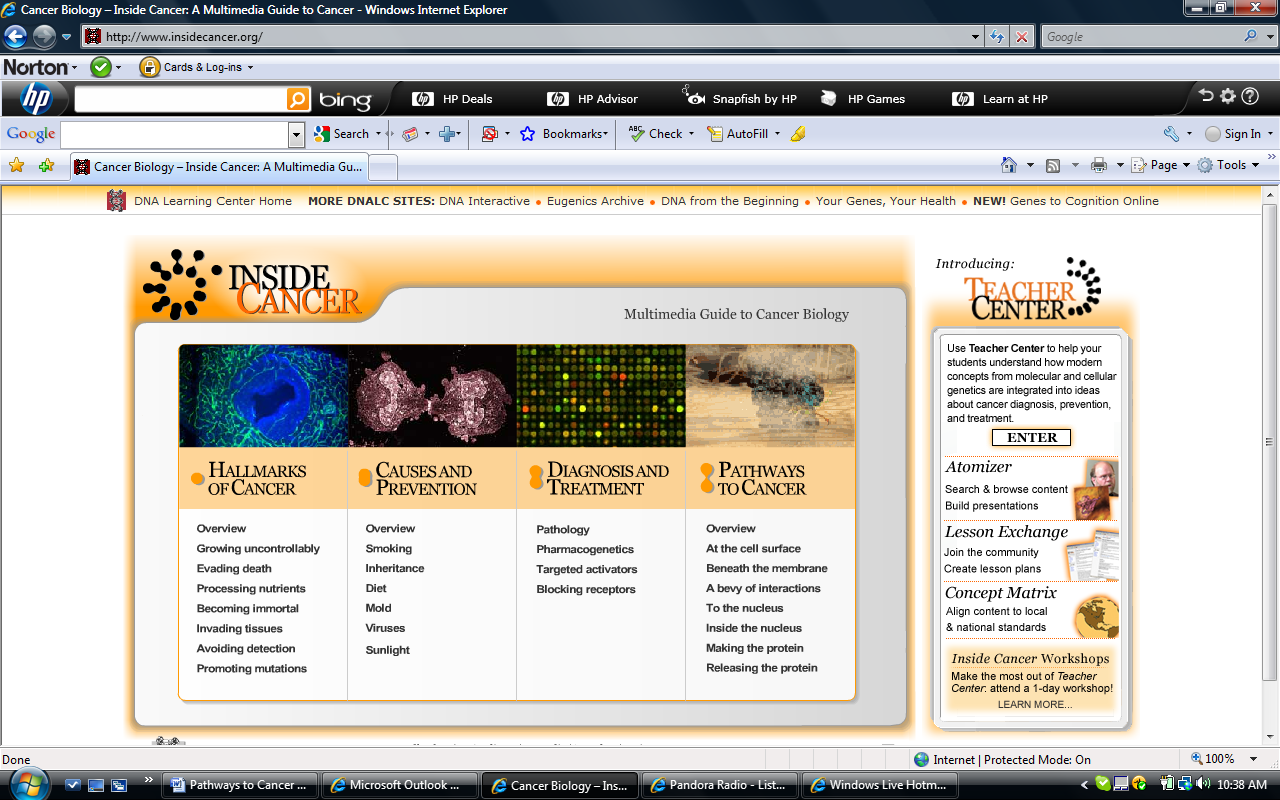
**INSIDE CANCER: Hallmarks of Cancer – Student Worksheet http://www.insidecancer.org/**



**Direction: Go to the website above and navigate through the Hallmarks of Cancer section to answer the following questions for each section.**

**OVERVIEW**

1. In a single cell, what do all cancers begin with? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   1. What are the two causes of these and which is more common?
2. DNA changes may result in a change in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ produced.
3. Demonstrate the three different types of mutations by writing an example of the resulting new DNA strand in the table below. (Circle the point where the mutation occurred.)

|  |  |  |
| --- | --- | --- |
| **Type of Mutation** | **Original DNA sequence** | **New DNA sequence** |
| Single Nucleotide Change  (aka Point Mutation) | CAGGCGCAT |  |
| Deletion | CAGGCGCAT |  |
| Duplication | CAGGCGCAT |  |

1. Explain why cancer incidence increases with age.

**GROWING UNCONTROLLABLY**

1. What normally regulates cell growth and division in typical cells?
2. What are two ways cancer cells are able to grow continuously?

**EVADING DEATH**

1. What is apoptosis?
2. What are the roles of proteases and enzymes in cell death?
3. What eventually happens to dead cells or cellular remains?
4. Why would a cell commit suicide?

**PROCESSING NUTRIENTS**

1. What does angiogenic mean?
2. Why do cancer cells need a blood supply?
3. What are some of the nutrients a cancer cell needs?
4. What are some of the waste products a cancer cell produces?
5. What types of cancers would be unlikely to undergo angiogenesis and why?
6. Extend your thinking: The outer layer of your skin (the epidermis) does not have a direct blood supply. How do you think this affects the growth rate of skin cancers compared to other cancers?

**BECOMING IMMORTAL**

1. What is a telomere?
2. What are two things that happen to telomeres as cells undergo cell divisions?
3. What is the role of telomer*ase*?
4. Where and/or when is telomer*ase* typically expressed?

**INVADING TISSUES**

1. What is usually the cause of people *dying* from cancer?
2. Cells normally stay in one site or one tissue type. Why can cancer spread to other tissues?
3. What happens to body tissues as a result of cancer that classifies cancer as a disease?

**AVOIDING DETECTION**

1. How does the appearance of a cancer cell compare to a normal cell?
2. What body system is responsible for detecting precancerous cells? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Describe the two adaptive immune responses (B cells and T cells) that respond to changes in cells in our body such as infections or cancer.
4. Describe what adjuvant therapy is.

**PROMOTING MUTATIONS**

1. One way mutations are acquired in cancer cells is during the process of \_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
2. WATCH THE DNA REPLICATION ANIMATION:
   1. What is the role of helicase?
   2. One strand of DNA is copied continuously. How is the other strand copied?
   3. Each DNA molecule formed has \_\_\_\_\_\_\_\_ original strand(s) and \_\_\_\_\_\_\_new strand(s).
3. What often happens once new daughter cells are formed and the copied DNA is separated?
4. What are cancer cells unable to do?
   1. What does this result in?
5. What is the estimated average number of mutations required to develop cancer?

**Part 2. MITOSIS PUZZLE**

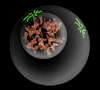
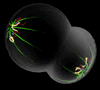
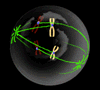
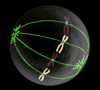
**Objective:** To identify the stages and events of mitosis (cell division) in a multicellular organism.

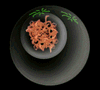
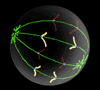
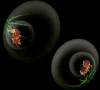
**Background:** Human embryos are similar in size to a rat embryo. Why then do they end up being such different sized organisms? The size of an organism is determined mostly by its number of cells and partially by the sizes of those cells. Certain cells in a human might be smaller than certain cells in a mouse and vice versa. In addition, most cells have a limit to the size they can grow. On the other hand fat cells can grow larger when we stores excess calories as fat droplets inside those cells. The more droplets, the larger the cell becomes until it reaches a point in which the control center (nucleus) can no longer manage a cell of that size. At that point the cell must undergo cell division.

In order for a cell to divide, it needs to make copies of the genetic code, cell organelles and other molecules necessary for each of the daughter cells to survive. After this point, the cell is ready to divide. The process of cell division occurs in a series of observable steps that scientists have termed “mitosis.” Below are some key players (organelles) in mitosis. Review their functions before going on.

* **Chromosomes**
* **Chromatin**
* **Centrioles**
* **Nuclear membrane**
* **Cell Membrane**

**Directions:** Trough observation of the following stages of mitosis, one can figure out the most logical sequence of events. You know you are starting with one cell and ending with two. Use the information depicted in the pictures to place them in the correct order. Once you have the correct order (check with your teacher), cut each picture out and tape or glue onto a clean page in your science notebook. Then use the vocabulary words of the key players to write a complete caption for each picture of what is going on in the cell at that time.

Pictures from: <http://www.biology.arizona.edu/Cell_Bio/tutorials/cell_cycle/cells3.html>

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period \_\_\_\_\_\_\_ Date\_\_\_\_\_\_\_\_\_\_\_\_

**Part 3: Cell Cycle and Cancer –Student Worksheet**

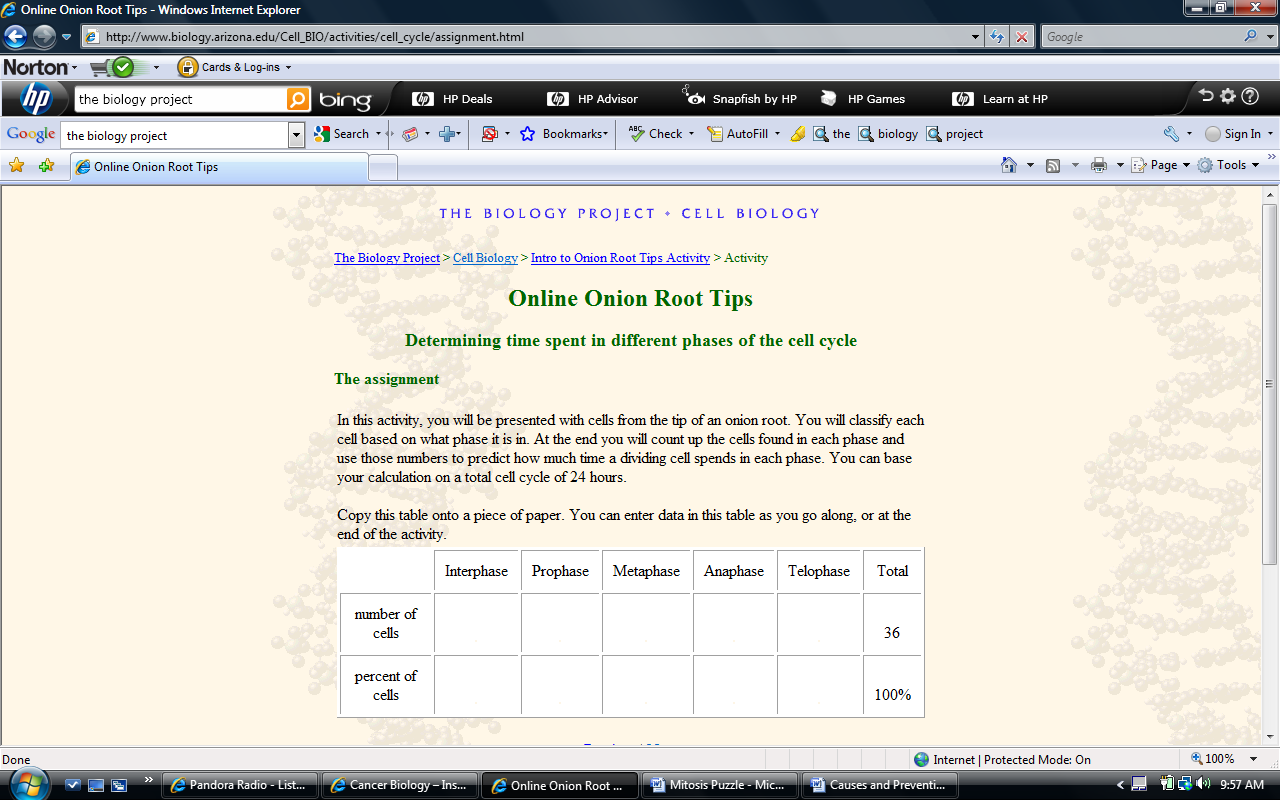
**Go to: http://www.biology.arizona.edu/Cell\_BIO/activities/cell\_cycle/activity\_description.html**

**Directions:**  For review on the stages of mitosis, go through the activity to identify the state of the cell cycle for each of the cells sampled from the onion root tip.



The picture of the cell that you are trying to identify is small and is located here.

1. Table: The Time Spent in Different Phases of the Cell Cycle.

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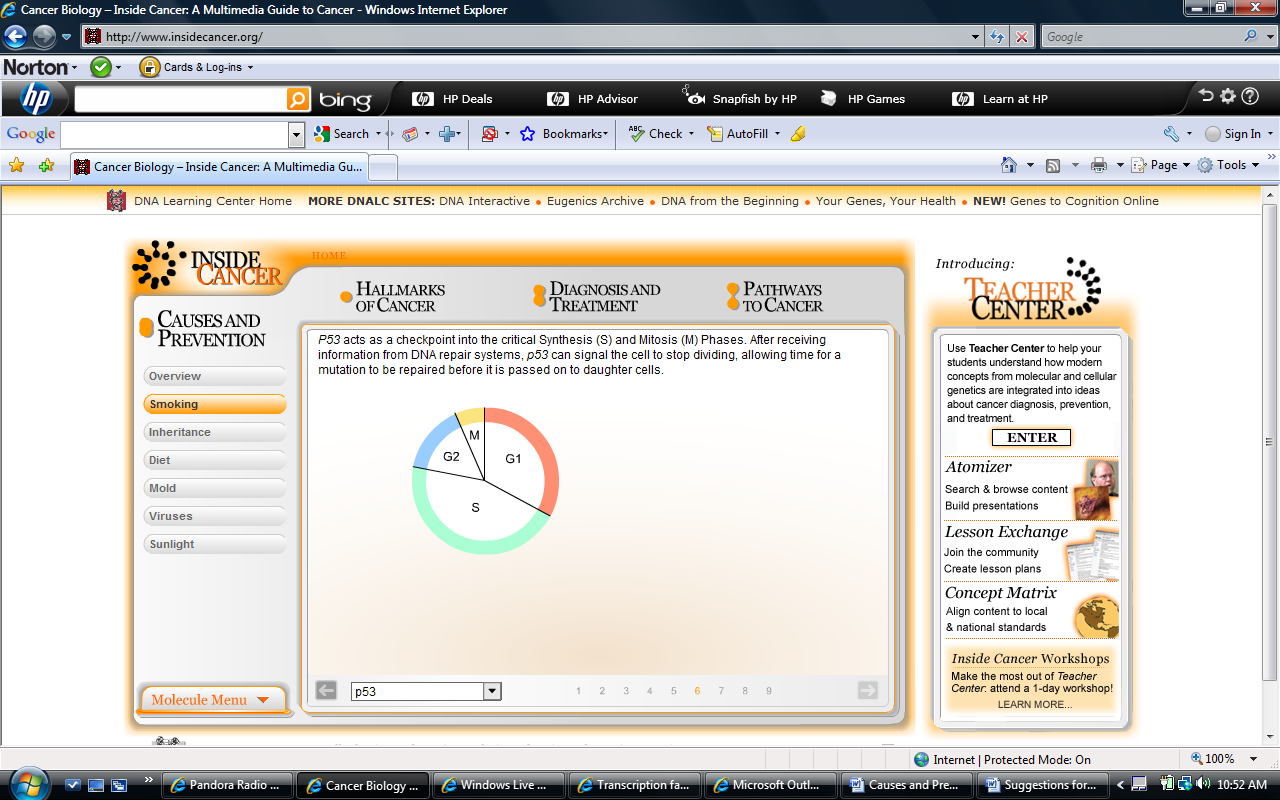
1. What stage is the cell in most of the time? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. The number of times you see a cell in a particular stage gives you an idea of how often the average cell spends in a particular stage. Use the blank pie chart below to draw in the approximate % of the stages you calculated. Make sure the numbers add up to 100%.
3. These numbers reflect the activity going on in cells in the root tip of an onion. What would you expect to see to the amount of time devoted to Interphase if you looked at cells further away from the tip? Why is this?

Remember that that the actual process of cell division does not begin until Prophase. So what exactly goes on during Interphase? The stages of Interphase can actually be broken down into three other stages: G1, S, and G2. To learn more about these stages and why they are important continue on to the *Inside Cancer* website.

**Directions:** Go to the *Inside Cancer* website (www.insidecancer.org). Navigate through the “Causes and Prevention” tab. Select “Smoking” and scroll to the “p53” link to answer the following questions:

1. Mutations in the p53 gene are found in what percentage of lung tumors? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. The p53 protein is a tumor \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ that is involved in detecting damage to \_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
3. Using the diagram below, write a caption highlighting the cellular events for each of the stages in the cell cycle:

CELL CYCLE



1. In the above diagram, identify the two checkpoints that p53 patrols with a \*.
2. If p53 is capable of stopping cell division to allow time for DNA repairs, at which checkpoint would this be appropriate? S or M (choose one)
3. If the DNA damage is not repairable what will p53 initiate? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. What happens to a cell’s DNA over time if p53 is mutated and nonfunctional?

COMPARE THIS INFO TO THE CELL CYCLE OF THE ONION ROOT TIP.

* + - 1. How does the Interphase stage from the onion root tip compare to the Interphase of the cell cycle diagram above?
      2. Some cells in the human body reach a point when they become so specialized that they usually lose their ability to divide, such as brain cells called neurons or even most skeletal muscle cells. If these cells are “suspended” in the cell cycle, at what stage would you expect to see them?
      3. Cancer can also result when a cell’s genome, or DNA, is unstable. This can happen from having too few or too many chromosomes. Can you think of a mutation involving one of the key players (organelles) in mitosis that could result in abnormal numbers of chromosomes in daughter cells?

*FOR MORE ON CANCER CONTINUE NAVIGATING THE “CAUSES AND PREVENTION” TAB & “SMOKING”*

*Nicotine Connection*

1. Nicotine and nitrosamines bind to what type of cell membrane proteins?
2. Akt is a protein kinase that activates other molecules (“substrates”) that then go on to influence cellular processes. What are the three different cellular processes mentioned that Akt can indirectly influence?
3. What effect does nicotine activation of Akt have on a cell?
4. When DNA damage is not repaired, Akt probably plays a role in deciding whether or not to undergo which cellular process?

*Prevention*

Use the information Dr. Glorian Sorenson presents as she discusses an anti-smoking campaign to answer the following questions.

1. Who is the audience public health researchers are targeting for their anti-smoking campaigns?
2. What was one reason these people gave for why they were not concerned about quitting tobacco use?
3. Define the following in the study:
   1. Manipulated (independent) variable: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. Responding (dependent) variable: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   3. Experimental Control: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. What do you suppose two controlled variables must have been? (describe/explain them)
   1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. What did researchers conclude from this study?