Mitosis, Meiosis, and Cancer

Learner objectives:

1. What is cancer?
2. Compare and contrast mutations that occur in **gametes** versus **somatic** cells
3. Compare and contrast mutations that occur in genes that are involved in cell cycle regulation versus genes that are not in cell cycle regulation
4. Describe how cancer can sometimes be related to meiosis, but is always related to mitosis.

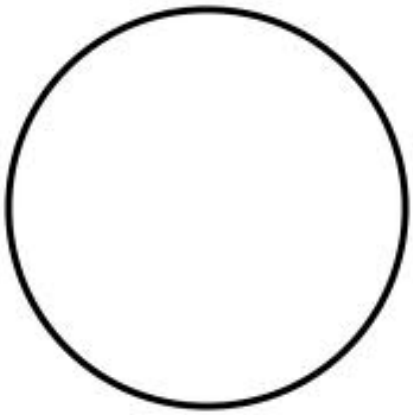
Define a **homologous** chromosome. How is a homologous chromosome different from a sister chromatid?

What is the definition of a gene?

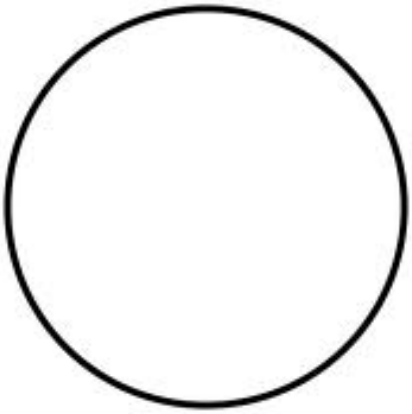
What is the definition of a mutation?

1. Draw the resulting daughter cells that are produced when **1 pair of homologous** chromosomes go through **MITOSIS.** Start with the chromosomes **before they have replicated**. You should use different colors or shading to keep track of which chromosome is which.

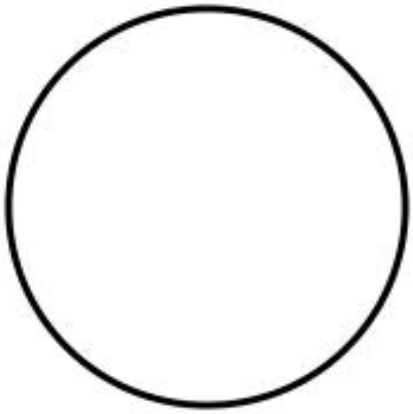
Parent Cell:
Draw chromosomes before replication has occurred. Include all alleles

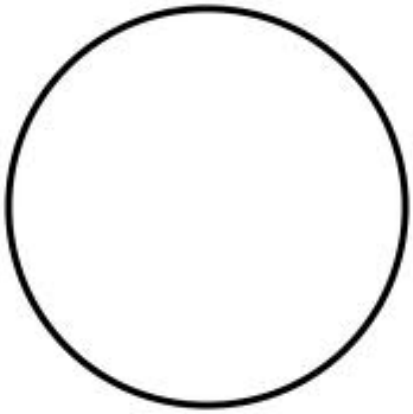


Parent Cell:
Draw replicated chromosomes just before they split apart



Resulting Daughter Cells





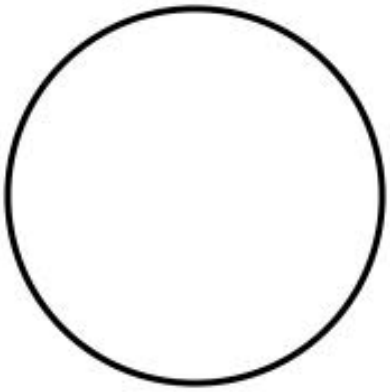
2. How does a daughter cell compare to the parent cell after going through **MITOSIS**? Is the parent cell haploid or diploid? Is the daughter cell haploid or diploid?

3. What types of cells in the human body undergo mitosis? List at least 3.

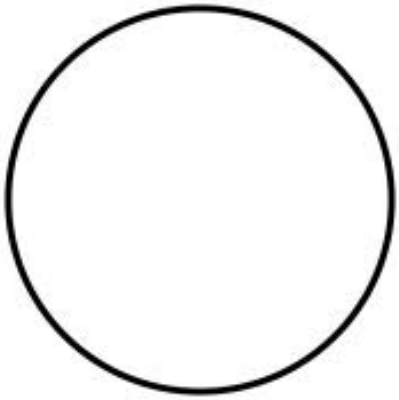
4. Understanding what types of cells undergo mitosis, why might it be important to have the parent cell and daughter cell have identical genetics?

5. Using the same starting homologous chromosomes as your first picture, draw the resulting daughter cells when the parent cell undergoes **MEIOSIS**.

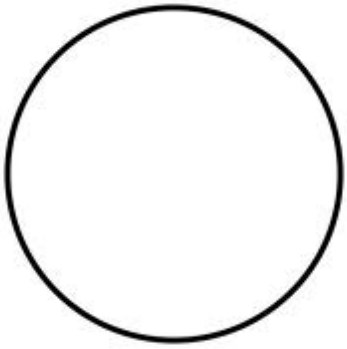
Parent Cell:
Unreplicated chromosomes

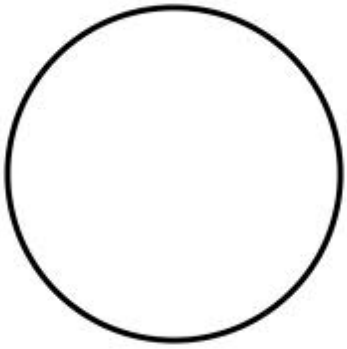


Parent Cell:
Replicated Chromosomes (lined up at center ready to split)

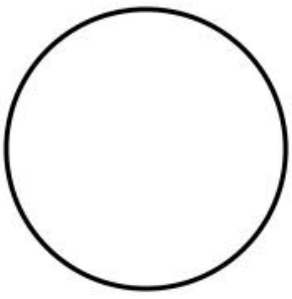


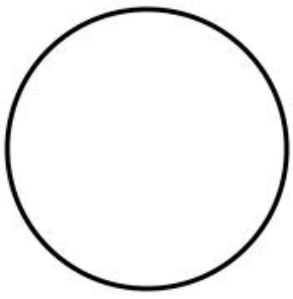
Result of Meiosis I

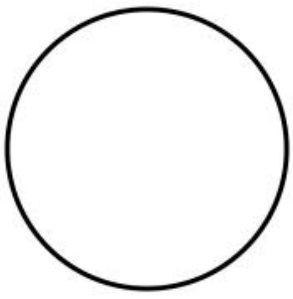


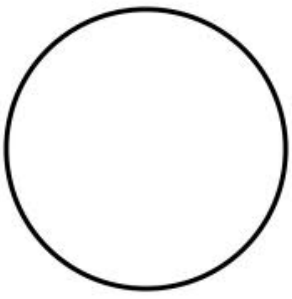


Result of Meiosis II









6. How does a single daughter cell compare to the original parent cell after going through **MEIOSIS?** Is the parent cell haploid or diploid? Is the daughter cell haploid or diploid?

7. What types of cells in the human body undergo **MEIOSIS**? List at least 2.

8. Understanding what types of cells undergo **MEIOSIS**, **why** is it important for them to undergo MEIOSIS instead of MITOSIS?

9. Imagine a mutation occurs during DNA replication in a cell about to undergo MITOSIS. Where in your body could this occur? List 2 possible effects on the daughter cell.

10. Imagine a mutation occurs during DNA replication in a cell about to undergo MEIOSIS. Where in your body could this occur? List 2 possible effects on the daughter cell.

What is Cancer?

Cancer is a variety of diseases caused by an **uncontrolled division of abnormal cells** in a part of the body. There about 200 different types of cancer, and each is classified by the type of cell that is initially affected.

11. From your knowledge of the cell cycle, list several possible causes of cancer.

12. Looking at the definition of cancer, pick either MITOSIS or MEIOSIS as the **primary** culprit in cancer cases. **Justify** your choice based on your knowledge of mitosis and meiosis and where they occur in the body.

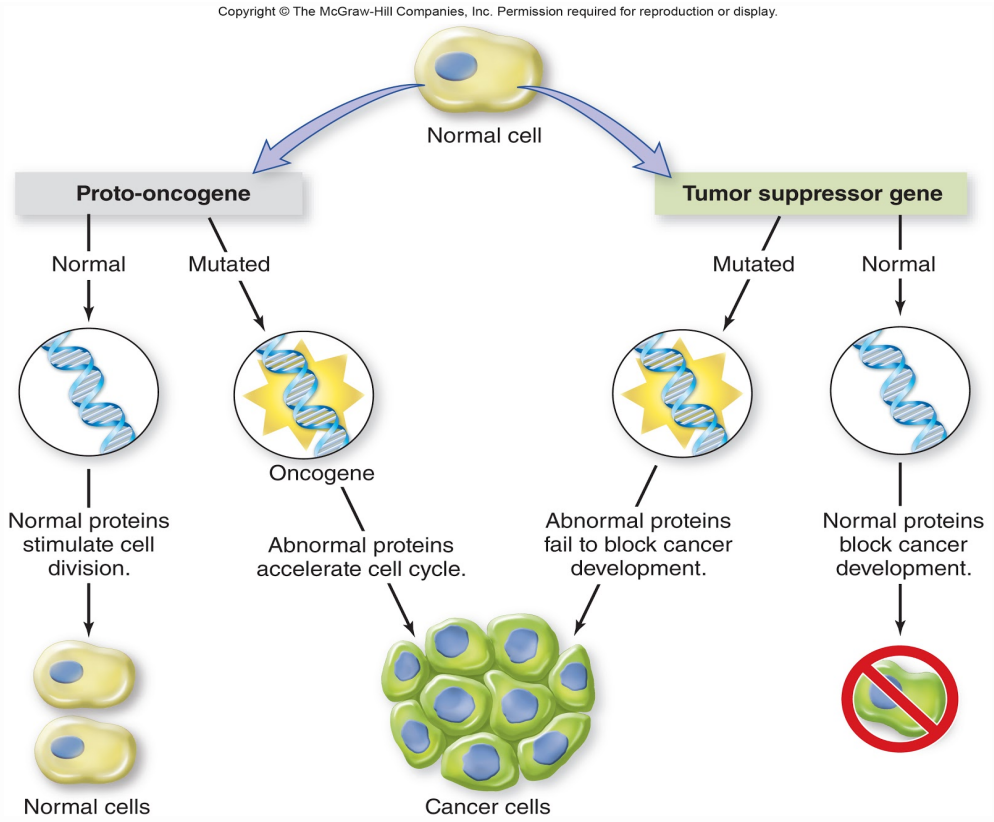
Some genes code for proteins. If the gene is mutated, it can cause the protein to be made incorrectly.

13. Using the table and diagram below, describe what would happen if there was a mutation (causing a nonfunctional protein) in:

A proto-oncogene -

A tumor-suppressor gene -

Gene Type	Normal Gene Function
Proto-oncogene	Signals cells to grow and replicate in response to a specific signal. Code for a growth factor protein.
Tumor-Suppressor Gene	Promote apoptosis Tell a cell when to stop replicating



14. Describe why mutations in these 2 types of genes lead to cancer more often than any other random mutation in the genome.

15. Describe what would happen if a cell has a **mutated proto-oncogene**, but still has a **functional tumor-suppressor gene**.

So in fact, cells often need to have **several mutations** (in both tumor suppressor genes and proto-oncogenes) **in order for a cancer to develop.** This is called the **mutation accumulation hypothesis**. Although in rare cases one mutation is enough, it is usually an accumulation of mutations that irreversibly transforms a normal cell into a cancerous one.

16. If a person **inherits** a mutation in a tumor-suppressor gene, did the mutation occur during MITOSIS or MEIOSIS? Is the person GUARANTEED to develop cancer?

17. About 163,000 Americans die each year from lung cancer. This is greater than deaths caused by the next four cancers combined. Smoking can cause mutations in lung cells. Are lung cancer cells undergoing MEIOSIS or MITOSIS when they replicate?

18. If your parent develops lung cancer after you are born, would this increase your chances of getting lung cancer? **Justify** your choice with your knowledge of mitosis and meiosis.

19. Gene p53 is a tumor suppressor-gene found in humans. This gene is mutated in around **50%** of all human cancer cases. If your parent has this **mutated gene from birth**, but **does not** develop cancer, are you more or less likely to develop cancer? **Explain** your reasoning.

20. **An inherited, mutated gene is a major factor in only about 5% to 10% of all cancer cases.** While some mutations which lead to cancer are caused by environmental or behavioral factors (smoking, UV exposure, food additives, mold, viruses) most cases of cancer are caused by the **natural accumulation of mutations**. Using this knowledge, and the **mutation accumulation hypothesis**, explain why cancer rates increase as people age.

21. Explain how meiosis and mitosis could be involved in someone getting cancer.

22. 23andme (https://www.23andme.com/health/) is website that sequences your DNA. In the past they have given health-related reports based on your genome. After the FDA passed a new directive (effective November 22, 2013) they are no longer allowed to interpret the data, but can still give you the raw genetic data. This means that you could still get your genome sequenced and look up individual genes (like the p53 gene) to figure out your predisposition to develop cancer. Would you want to get this done? Discuss with your group.

23. Based on your knowledge of how cancer develops, how do you think anti-cancer therapies work to disrupt the **uncontrolled division of abnormal cells**?