DNA STRUCTURE

THE CELL CYCLE

Important Dates:

Teks:

5A – Describe the stages of the cell cycle, including deoxyribonucleic acid (DNA) replication, and mitosis, and the importance of the cell cycle to the growth of organisms and as asexual reproduction

5D – Recognize the disruptions of the cell cycle lead to diseases such as cancer

6A – Identify the components of DNA, and describe how information for specifying the traits of an organism is carried in the DNA

6B – Recognize the components that make up the genetic code are common to all organisms
Big Themes for DNA and The Cell Cycle
Secret of Photo 51 Video Worksheet

Directions: Answer the following questions as you view the Nova video entitled “Secret of Photo 51”. Ask your instructor to pause the program if you get terribly behind, but not after each question you might miss.

1. Who were the two leading DNA scientists in this field? [introduction of the video]

2. What was Rosalind Franklin trying to do at the same time as Watson and Crick?

3. What year did Watson and Crick receive the Nobel Prize?

4. What is the title of James Watson’s book?

5. What year and where was Rosalind Franklin born?

6. What school (college) did Rosalind Franklin attend?

7. What is x-ray crystallography?

8. What were Rosalind’s first experiments concerned with and how did they contribute to the war effort?

9. Where did Rosalind work when she later moved to Paris and what did she perfect when she worked there?

10. What often forced Rosalind to suspend her work for weeks at a time?

11. Where in England was Rosalind offered a position?

12. What was her main assignment when Rosalind started there in 1951?

13. Who was in charge of Rosalind in the lab?

14. (BONUS): Where did the assistant (Mrs. Heller) graduate from in the letter Aaron Klug speaks of?
15. Who “enters the game” while setting up the lab at Kings?

16. Where does Watson end up getting a position?

17. Who was Watson’s office mate?

18. What nickname was Rosalind given that Watson later “popularizes”?

19. How many forms of DNA does Rosalind initially photograph?

20. How do Watson and Crick propose to demonstrate DNA structure?

21. Who do Watson and Crick “acquire” Franklin’s unpublished data?

22. What does Franklin finally name her best “B form” picture?

23. What new nickname does she acquire after this?

24. How many angstroms per “turn” is the DNA molecule?

25. What is the name of the pub that Watson and Crick declare that they have found the “secret of life” in?

26. What was the general theme of her work after leaving King’s?

27. What is she later diagnosed with and what is the probable cause?
Berry Full of DNA
Exploring properties of Strawberry DNA

Question: What properties of DNA can be observed in a test tube?

Lab Overview: In this investigation you will break open strawberry cells, prepare a filtered extract containing strawberry DNA and separate out molecules of DNA in a test tube.

Background: The native wild or wood strawberry, *Fragaria vesca*, has only two sets of chromosomes (diploid), but the grocery store strawberry, *Fragaria ananassa*, has eight sets of chromosomes (octoploid) and will supply an abundance of DNA. So, commercial strawberries make an excellent subject for collecting DNA.

Another reason strawberries work so well is that they are soft and easy to smash. Also, ripe strawberries produce enzymes (pectinases and cellulases) which help in breaking down the cell walls making it easier to extract the DNA.

First, you are going to break open the cells of a fresh strawberry by crushing it. Second, you will use a lysis buffer to break down the cellular and nuclear membranes to separate the DNA from the other cell parts. Third, you will filter the solid material out with a piece of cheesecloth and collect the liquid containing the DNA. Finally, you precipitate the DNA from the solution using cold ethanol.

After completing this lab, you will have a sample of pure strawberry DNA and you will never again look at a strawberry in the same way.

Materials: Plastic freezer bag
            Strawberry
            10 mL detergent solution
            Funnel
            Beaker
            Inoculating loop
            Test tube and test tube rack
            Ice-cold ethanol

Procedure:
1. Place one strawberry in a plastic freezer bag. Press the air out of the bag and seal the bag carefully. Gently mash the bagged strawberry with your fist for 2 minutes.

2. Measure 10 mL of detergent solution and add it to the bag of mashed strawberries. Press the air out carefully and seal the bag again.

3. Mash the bagged strawberry again for 1 minute.

4. Obtain a funnel and beaker to filter your bagged strawberry solution.

5. Pour the liquid strawberry solution into the filter/beaker set-up and let the extract drip into the beaker.

6. When most of the liquid has filtered through, remove the funnel. Discard any mashed strawberry pulp into the trash can. Rinse out the funnel and return it to the lab table.

7. Pour the liquid extract from the beaker into a test tube. Fill the test tube only about ¼ full.

8. Slowly drizzle cold ethanol along the side of the test tube, until the test tube is about half full of liquid. The ethanol should form a separate layer on top of the filtered extract.

9. Dip the inoculating loop into the tube where the strawberry extract and ethanol layers come into contact with each other and pull out some DNA.

10. **On your answer sheet,** draw your test tube and the contents in the space provided.

   **Label the following in your drawing:** Strawberry extract

   Ethanol

   DNA

   Nucleus

   Chromosome

   Chromatin

   Telomere

   Centromere

   Cell

   Histone

   Base Pair

   DNA (double helix)
Berry Full of DNA: Strawberry DNA Extraction

Draw and label the contents of your test tube:

Label the following:
- Strawberry extract
- Ethanol
- DNA

It is important that you understand the steps in the extraction procedure and why each step was necessary. Each step in the procedure aided in isolating the DNA from other cellular materials. Match the procedure with its function:

<table>
<thead>
<tr>
<th>PROCEDURE</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Filter the strawberry extract through the funnel.</td>
<td>___ Clumps DNA together</td>
</tr>
<tr>
<td>B. Add detergent solution and mush the strawberries again.</td>
<td>___ Separate components of the cell</td>
</tr>
<tr>
<td>C. Initial smashing and grinding of strawberries.</td>
<td>___ Break open the cells</td>
</tr>
<tr>
<td>D. Addition of ethanol to filtered extract.</td>
<td>___ Dissolves cell membrane of the cells</td>
</tr>
</tbody>
</table>

1. What is the function of DNA? _______________________________________________________
2. Where is DNA located in the cell? ___________________________________________________
3. What did the extracted strawberry DNA look like? ______________________________________
4. A person cannot see a single strand of cotton thread from 30 meters away, but if thousands of threads are wound together into a rope, the rope can be seen at some distance. How is this statement an analogy to the DNA extraction you did?
_____________________________  
_____________________________

5. DNA dissolves in water but not in ethanol. Explain what happened when the ethanol came in contact with the strawberry extract during the DNA extraction.
_____________________________  

6. In order to study our genes, scientists must extract the DNA from human tissue. Would you expect the method of DNA extraction we used for the strawberry to be the same for human DNA? ______ Explain? ________________________________  

7. Is the DNA in any cell in the human body the same? ______ Explain your answer.
_____________________________  

8. Why might the scientist want to study the DNA of strawberries?
_____________________________  

_____________________________  


NUCLEIC ACIDS (DNA and RNA) Notes

DNA – ________________________

- DNA controls all living processes including production of new cells – ______________
- DNA carries the genetic code – ______________ and ______________ genetic information from one ______________ to the next
- Chromosomes are made of __________
- DNA is located in the ______________ of the cell

Model of DNA:

- The model was developed by __________ and __________ in 1953.
- They received a __________ __________ in 1962 for their work.
- The model looks like a twisted ladder – ______________.

Untwisted it looks like this:

- The _______ of the ladder are P = ______________
  S = ______________ molecule

- The _______ of the ladder are C, G, T, A = ______________
  (Nitrogenous means containing the element __________.)
  
  A = ______________  \text{ (Apples are Tasty)}
  T = ______________
  A always pairs with T in DNA
  
  C = ______________  \text{ (Cookies are Good)}
  G = ______________
  C always pairs with G in DNA

- It is the order of these _______ _______ that determines ______________ __________

- One _______ + one ______ + one ______ = one ______

- Nucleotides are the ______________ ______ of DNA – thus, each strand of DNA is a string of ______________
DNA Replication

- Cell division involving ________ produces 2 ___________ cells that are genetically ____________ to each other and genetically identical to the ____________ cell

- Remember that for this to happen, DNA in the parent cell must be ________________ (copied) ____________ the cell divides – this process occurs during ________________ in the cell cycle

__________ _______ between base pairs are ________ by the enzyme ___________ and DNA molecule ________

![Diagram of DNA replication]

STEP 1

DNA molecule separates into ___________ __________

STEP 2

__________ __________ match up with complementary bases

STEP 3

Nucleotides are linked into 2 new strands of DNA by the enzyme, ___________—DNA polymerase also ____________ for copying errors

Free nucleotides abundant in ____________
Diagram Examples of DNA Replication: (You could see DNA replication represented different ways.)

Double helix unzips
New bases (A,T,G,C) are added

Two new strands are created, each contain half of the original strand.

___________ occur when copying _______ cause a _______ in the __________ of DNA nucleotide bases

Image adapted from: National Human Genome Research Institute.
RNA—____________________  _________

- RNA is a ______________ that allows the ______________ __ ______ to be delivered to the _______ __ ______

- RNA is different than DNA:
  1. The sugar in RNA is _______; the sugar in DNA is __________________
  2. RNA is a __________ _________ of nucleotides; DNA is a _________
     __________ of nucleotides
  3. RNA has __________ (U) instead of __________ (T) which is in DNA
  4. RNA is found __________ _____ ___________ of the __________;
     DNA is found ______ ______________ the nucleus

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<tr>
<th></th>
<th>DNA</th>
<th>RNA</th>
<th>Both</th>
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<tbody>
<tr>
<td>Deoxyribose</td>
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<tr>
<td>Ribose</td>
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<td>double stranded</td>
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<td>found in and out of nucleus</td>
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<td>Guanine</td>
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<td>Thymine</td>
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<td>replication</td>
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Build a DNA Ladder

**Purpose:** To better understand the way in which the DNA ladder is constructed.

**Materials:** DNA Pieces, Colors (map pencils, crayons, or markers), Scissors, and Glue

**Procedure:**
1. Using colors, quickly shade the DNA pieces according to the following key:
   - P = purple
   - T = blue
   - G = green
   - A = orange
   - C = yellow
   - S = red
2. Cut out all the DNA pieces. On the back of this paper, construct a DNA ladder from the pieces. Glue the pieces to the paper.
3. Using the following information, answer the analysis questions.

**Analysis:**
1. Cytosine is always joined to ____________ and a ____________.
2. Thymine is always joined to ____________ and a ____________.
3. Guanine is always joined to ____________ and a ____________.
4. Adenine is always joined to ____________ and a ____________.
5. Sugars are joined to ________________.
6. The rungs of the ladder are represented by which letters? (Circle all that apply.)
   - P  T  G  A  C  S
7. Which letters represent the sides of the ladder? (Circle all that apply.)
   - P  T  G  A  C  S
8. Explain what you have constructed. ________________________________________________
   ______________________________________________________________________________
   ______________________________________________________________________________
Pieces for DNA Ladder

Color the pieces according to the “Build a DNA Ladder” assignment instructions. Cut out all of the pieces and then piece them together to form a DNA ladder.

You can rotate any of the pieces so that they fit properly but all of the letters on each piece must be visible once glued down.

Glue the DNA ladder onto the back of the “Build a DNA Ladder” assignment.

NAME _______________________________   Pd ____
DNA & RNA Worksheet

1. Give the abbreviation for deoxyribonucleic acid: ______________

2. What chemical carries the genetic code? ______________

3. Chromosomes/genes are made of: ______________

4. Where in the cell is DNA located? ______________

5. What two men are responsible for developing the model of DNA? ___________ and ___________

6. What would a picture of DNA look like? _______________________________________________

7. Label the diagram below.

   a.

   b. ___________

   c. ___________

   d. ___________

   e. ___________

8. What does the above diagram represent? ______________

9. What two compounds make up the sides of DNA? ______________ and ______________

10. What are the 4 bases of DNA? _____________, _____________, _____________, & _____________

11. Adenine (A) pairs with: ________________ Cytosine (C) pairs with: ______________

12. A nucleotide is considered the basic unit of DNA. What are the 3 parts that make up this unit?
    ________________, ________________, and ________________

13. If one strand of DNA has the code:
    A  C  T  G  G  A  T  T  
    __________________________

    Write the complimentary code for the other side.

14. Why is it important for DNA to make exact copies of itself? ______________
    ______________
    ______________
15. When does DNA Replication take place? __________________________________________________
___________________________________________________________________________________

16. Place the below diagram in the correct order by writing the numbers 1-4 above each diagram.

Instructions: Using the pictures to the right, make strands of DNA and answer 17 -22

17. Write the complementary base sequence for DNA strand #1 below:

18. Write the complementary base sequence for DNA strand #2 below:

19. Write the complementary base sequence for RNA strand #3.

20. A always pairs with ______.

21. C always pairs with ______.

22. DNA is ________________ stranded.

Instructions: Using the pictures to the right, make strands of RNA and answer 23 -28

23. Write the complementary base sequence for DNA strand #1.

24. Write the complementary base sequence for RNA strand #3.

25. A always pairs with ______.

26. C always pairs with ______.

27. What replaces T in RNA? ______________________

28. RNA is ________________ stranded.
THE CELL CYCLE
Cell Division—Mitosis Notes

**Cell Division** — process by which a cell divides into ___ _____ ________

- Why do cells need to divide?
  1. Living things ________ by producing _______ ________, NOT because each cell increases in size
  2. ___________ of damaged tissue
  3. If cell gets too big, it _________ get enough _____________ into the cell and ___________ out of the cell

- The __________ cell is called the __________ cell; 2 _____cells are called ______________ cells
- Before cell division occurs, the cell _______________ (copies) all of its _______, so each daughter cell gets complete set of _______________ ________________ from parent cell
- Each daughter cell is ________ like the parent cell — ______ kind and number of ________________ as the original cell

Many organisms, especially ________________ organisms, reproduce by means of cell division – called _______________ ________________ — Ex: bacteria

**DNA**

- DNA is located in the ___________ and controls all cell _________________ including cell division
- Long and ______________ DNA in a _________________ cell is called ________________
- _______________, ______________, short DNA in a _________________ cell is called ________________

  Consists of 2 parts: ______________ and ______________

**CHROMOSOME STRUCTURE**

- 2 identical “sister” chromatids attached at an area in the middle called a ______________
- When cells divide, “sister” ________________ separate and 1 goes to each new cell
• Chromatin to chromosomes illustration:

Why does DNA need to change from chromatin to chromosome? More ____________ division

Chromosome number
• Every organism has its own ____________ ____________ of chromosomes
   Examples: Human = ____ chromosomes or ____ __________
   Dog = ____ chromosomes or ____ __________
   Goldfish = ____ chromosomes or ____ __________
   Lettuce = ____ chromosomes or ____ __________

• All ___________ (body) cells in an organism have the ________ kind and __________ of chromosomes
   Examples: Human = ____ chromosomes
   Human skin cell = ____ chromosomes
   Human heart cell = ____ chromosomes
   Human muscle cell = ____ chromosomes
   Fruit fly = 8 chromosomes
   Fruit fly skin cell = ____ chromosomes
   Fruit fly heart cell = ____ chromosomes
   Fruit fly muscle cell = ____ chromosomes

Cell Cycle -- series of events cells go through as they ________ and _________
• Cell ________, prepares for division, then __________ to form 2 ____________ cells – each of which then begins the cycle again
• Cell cycle has ____________ which “tell” the cells when it is time to __________. They are like __________ stoplights that tell the cell to “stop” or “go” on in the process of ______________.
**Interphase**—period of cell _______ and __________________
- DNA _______________ (copying) occurs during Interphase
- During Interphase the cell also ______, carries out normal _____ ______________, replicates all other ____________
- The cell spends most of its life cycle in __________________
- Divided into 3 phases:
  o G1 – cells _______ in size and __________________ new proteins and organelles
  o S – ______________ of DNA – DNA __________________
  o G2 – __________________ and molecules required for cell division are ______________

**Mitosis** – division of the ____________ into 2 nuclei, each with the same number of __________________
- Mitosis occurs in _____ the _____________ (body) cells

Why does mitosis occur? So __________ new ______________ cell has ____________ with a complete set of ____________________________.
- 4 phases of nuclear division (mitosis), directed by the cell’s DNA (PMAT)
Cytokinesis — the ___________ of the rest of the cell (___________ and organelles) after the nucleus divides

- In _________ cells the cytoplasm pinches in

- In _________ cells a cell plate forms

- After mitosis and cytokinesis, the cell returns to ________________ to continue to grow and perform regular cell activities

Summary: Cell Cycle

Interphase — Mitosis (PMAT) — Cytokinesis

- When cells become old or damaged, they _____ and are replaced with _______ cells

Cell Division Control

- _______ controls _____ cell activities including cell _____________
- Some cells _____ their ability to _________ their _____ __ ______ ___________ — the DNA of these cells has become _____________ or changed (___________)
- These __________________ cells form masses called _____________
- __________ tumors are ___ __________________ — these cells __ _____ ________ to other parts of the body
- ____________ tumors are __________________ — these cells break loose and can invade and ____________ ____________ in other parts of the body (called _____________)
- Cancer is not just one disease, but ________ — over ______ __________ types of cancers
Complete for review:

<table>
<thead>
<tr>
<th>Stage of Cell Cycle</th>
<th>Events of this stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interphase</td>
<td>G₁ - S - G₂ -</td>
</tr>
<tr>
<td>Mitosis</td>
<td>P – M – A – T -</td>
</tr>
<tr>
<td>Cytokinesis</td>
<td></td>
</tr>
</tbody>
</table>
The cell cycle is a repeating sequence of cellular growth and division during the life of a cell. Most of the time the cell is spent in interphase, a phase dedicated to growth and preparing for cell division. Interphase consists of three separate phases: G1 (the cell is growing), S (DNA is synthesizing or making copies of itself) and G2 (more growth and preparation for cell division). The rest of the cell cycle is called mitosis and cytokinesis. In these phases the cell divides.

Below is a list of the stages:

**Interphase**
- cell grows
- DNA is replicated, but still in chromatin (thin, stringy) form

**Mitosis**

**Prophase**
*DNA thickens to form visible chromosomes
*Nuclear membrane dissolves

**Metaphase**
*Chromosomes line up in the middle of the cell

**Anaphase**
*Chromosomes move apart

**Telophase**
*a new nuclear membrane forms around each set of chromosomes
*chromosomes uncoil and become chromatin again

**Cytokinesis**
*cytoplasm divides and you have two new cells!

**Instructions for making a cell cycle wheel:**

1. Trace a large circle on a manila folder.
2. Cut through two layers of the manila folder making 2 large circles.
3. In one of the circles, cut out a wedge (a triangle) approximately one fourth of the circle.
4. On this circle, write in large letters “Cell Cycle Wheel” and your name and period.
5. Fold the other circle into four equal parts (in half and then in half again)
6. Label 1 quarter of the circle “Cell Division”. Then explain the 5 stages of mitosis and draw a picture of each
7. Label the next quarter G1, explain what happens in this stage and draw a picture.
8. Label the next quarter S, explain what happens in this stage and draw a picture.
9. Label the final quarter G2, explain what happens in this phase and draw a picture
10. Now hold the two circles together putting the one with your name on top. About two centimeters from the inner point of the cut out wedge, take your metal fastener and pierce a whole through both layer. Fasten it!
The Cell Cycle & Mitosis Tutorial

DNA BASICS

To view the tutorial, type in the URL:
http://tinyurl.com/vyjp

1. Read, “What is DNA and Where is it Stored”
2. Answer the following questions.
   a. Which organelle contains DNA?
   b. What is DNA called, or in the form of, when in the nucleus?
   c. When cells divide, DNA is called what? It looks like the alphabet letter.
   d. A nucleosome is DNA wrapped around a , and they appear as “beads on a string.”
   e. The process of mitosis is designed to insure that are passed on to daughter cells.

3. Click “Next” at the bottom of the page.

THE CELL CYCLE

4. Read the introductory page, “Stages of the Cell Cycle.”
5. Answer the following questions:
   a. List the stages of the cell cycle beginning with G1.
   b. What occurs during the “S” phase?
   c. What occurs during the “M” phase?
   d. Complete the following sentence. “Cancer is a disease where .”
   e. What does p53 do for the cell?

6. Click “Next” at the bottom of the page.
MITOSIS

7. Read “What is (and is not) mitosis?”
8. Answer the following questions:

   a. Interphase encompasses which stages of the cell cycle?
   b. What is the purpose of mitosis?

   c. Mitosis has 4 main stages. Fill in the blank for each phase.

   **Prophase:** Chromatin condenses and begins visible as _________________.
   Centrioles begin moving to ______________________and fibers extend from the ________________. The _______________ disappears.

   **Metaphase:** Spindle fibers align the ______________________along the middle of the cell and this line is called the _________________.

   **Anaphase:** The paired chromosomes separate and move to _________________cell.

   **Telophase:** ______________________ arrive at opposites poles of the cell. The ___ ______________________ disperse. Cytokinesis may also _________________ during this phase.

   **Cytokinesis:** In animal cells, the center of the cell pinches into _________________.
   In plant cells, a ______________________ is synthesized between the two daughter cells.

9. **Cytokinesis:** In animal cells, the center of the cell pinches into _________________.

10. To view mitosis in action, click on “Mitosis Animation” at the bottom of the page.
Online Onion Root Tips – A Virtual Lab Exercise
Determining time spent in different phases of the cell cycle

The following activity is designed to test your ability in identifying the stages of mitosis in onion root cells. To access this activity, type in the URL below:

http://tinyurl.com/56669

1. Read the introduction on the first page then click “Next”.

2. Review the stages of mitosis on this page, paying particular attention to the pictures on the left side of the screen. When you are finished, click “Next”.

3. On the Activity page, you will be presented with cells from the tip of an onion root. You will classify each cell based on what phase of mitosis it is in. At the end, you will count up the cells found in each phase and use those numbers to predict how much time a dividing cell spends in each phase.

4. Before you begin the activity, make a prediction:
In what stage of the cell cycle will you find the majority of cells? Why?

5. Begin the activity by following the directions given to you on the screen. When you are finished classifying the phase of each cell, and complete the table below:

<table>
<thead>
<tr>
<th></th>
<th>INTERPHASE</th>
<th>PROPHASE</th>
<th>METAPHASE</th>
<th>ANAPHASE</th>
<th>TELOPHASE</th>
<th>TOTAL</th>
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</thead>
<tbody>
<tr>
<td># of cells</td>
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<td>36</td>
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<tr>
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<td>100%</td>
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</tbody>
</table>

6. Using your data, during which phase will the cell spend most of its time? Why?
CANCER PAMPHLET
Cell Growth & Reproduction Performance Task

Our unit of study about cell growth and reproduction includes knowledge about what happens when cells do not function correctly resulting in cancerous cells. This occurs when there is an interruption during the cell cycle. Many people are affected by cancer; you may even have some family members or friends that have had cancer.

The goal of this performance task is to research a cancer of your choice and create a pamphlet for the American Cancer Society.

Using the provided rubric, be sure to include the following sections. All sections should be clearly identifiable in your pamphlet with proper headings.

- Explanation of Type of Cancer and Its Effect on Cell Growth
- Possible Causes & Prevention
- Diagnosis and Symptoms
- Treatment and Prognosis
- Pamphlet Design and Research

The pamphlet can be created using technology, such as Microsoft Publisher, or it can be made by hand.

*My Cancer Topic is ________________________________*

*Due Date is ________________________________*

<table>
<thead>
<tr>
<th>Possible Cancer Topics</th>
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</thead>
<tbody>
<tr>
<td>Bladder</td>
</tr>
<tr>
<td>Endometrial (uterus)</td>
</tr>
<tr>
<td>Liver</td>
</tr>
<tr>
<td>Osteosarcoma (bone)</td>
</tr>
<tr>
<td>Cervix</td>
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<tr>
<td>Retinoblastoma (eye)</td>
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</tbody>
</table>
BIOLOGY WARM-UPS

Warm ups may be taken up after each test for a quiz grade.

<table>
<thead>
<tr>
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Unit Vocabulary and Prefixes: