Name: _____ Class: _____ Date: _____

Chromosomes of a Frimpanzee
An Imaginary Animal

Learner Outcomes:

- Describe, in general terms, the role and relationship of chromosomes, genes and DNA
- Distinguish between cell division that leads to identical daughter cells, such as binary fission and mitosis, and cell division that leads to the formation of the sex cells, as in meiosis; and describe in general terms, the synthesis of genetic materials that takes place during fertilization.

Key Terms:

Chromosome	Meiosis	Genotype
DNA	Mitosis	Phenotype
Gene	Gametes	Allele

Background Information:

You know that chromosomes contain genetic information in the form of DNA and that humans have 23 pairs of chromosomes containing exactly the same genetic information in every cell in his/her body (except the sex cells). But have you ever seen a chromosome? Have you ever seen mitosis or meiosis as it was happening? Almost certainly not! Chromosomes are too small to see with the naked eye. One way that scientists try to understand processes that are too small (or too big) to see is to build simple models and to use them to try to understand how things work.

Research Problem: Let's build a model of chromosomes! We will use colored paper to model the chromosomes of a make-believe animal called a Frimpanzee that has a total of 6 chromosomes per cell.

Materials:

Blue paper chromosomes	Pink paper chromosomes	Scissors
		Tape

Procedure:

Pre-lab: Making your chromosome models

1. Fold the blue sheet in half lengthwise (along the solid line).
2. Keeping the sheet folded, cut on the dotted lines - Keep the four folded pieces of paper that have a shape that looks like this <.

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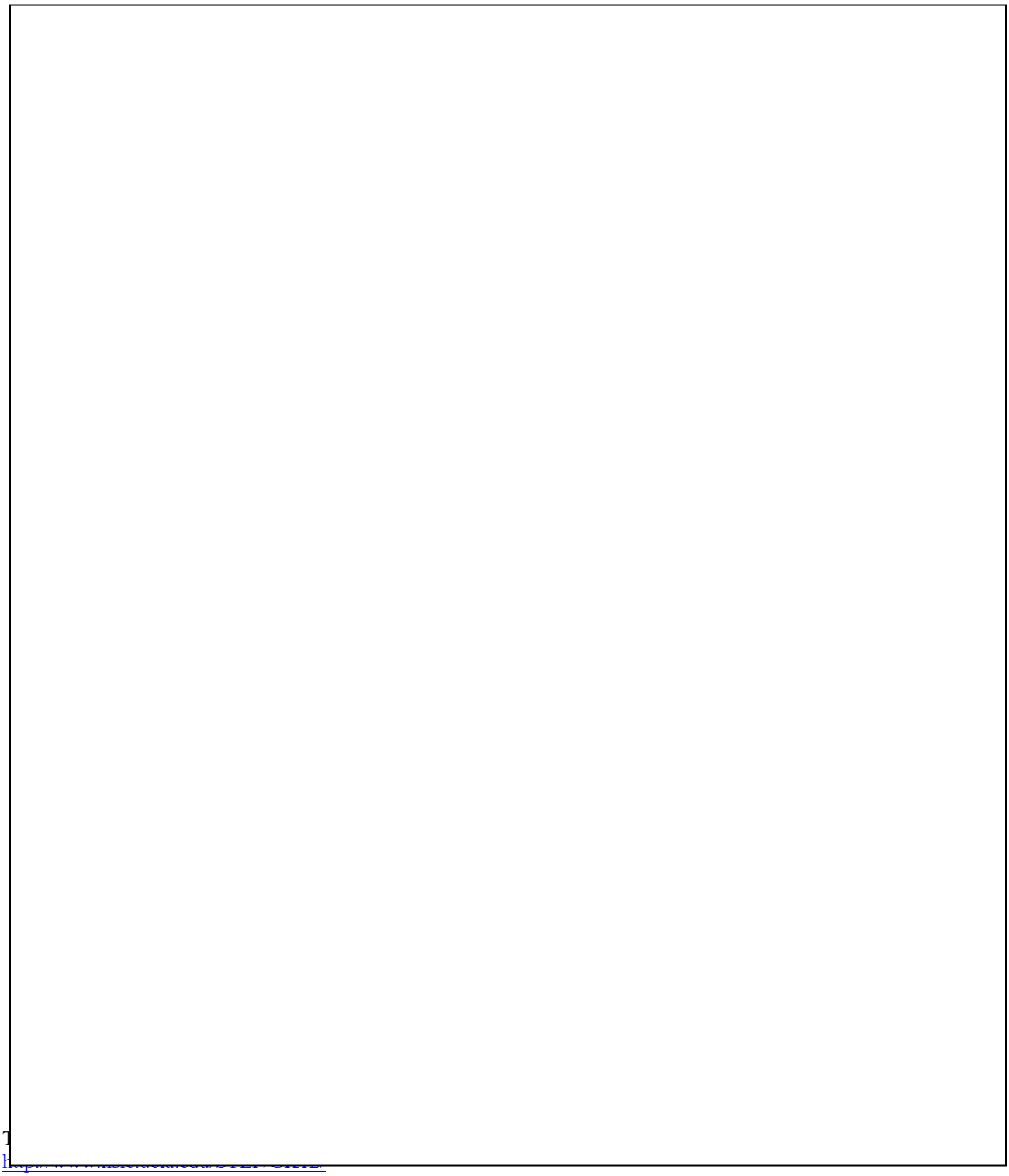
http://www.nslc.ucla.edu/STEP/GK12/

3. Repeat steps 1 and 2 with the pink sheet of paper.
4. Label your chromosomes by size and color (PL – Pink Large, BL, PM, BM, PS, BS).

You should end up with 6 pieces of paper that have the < shape. ***For now, keep them folded!*** These are the chromosomes in a normal Frimpanzee cell. Trace the outline of your set of chromosomes in the space below. Label your chromosomes.



Pre-lab: DNA Replication:

Before mitosis or meiosis can occur, the DNA making up the chromosomes must be copied.

1. Unfold all of your chromosomes so that the model looks like an X. The unfolding represents the copying of the DNA. Notice that the two sides of the X are identical.
2. Draw a circle in the center of each chromosome to represent the centromere (where the two copied chromosomes are connected).

PART I. Modeling Mitosis

1. Let's try to model the phases of mitosis with our new chromosome models. Move the chromosomes around on the table to represent their movement during mitosis:

Prophase - this is the way your chromosome models already look. Congratulations! - you have already finished prophase...

Metaphase - Chromosomes line up on the equator (an imaginary line in the middle of the cell).

Anaphase - Chromosomes split at the centromere (use your scissors to cut the chromosome in half) and the individual chromosomes move to opposite ends of the cell, forming two groups.

Telophase – The cell begins to divide... with one of the groups of chromosomes in each new cell.

PART I: MITOSIS QUESTIONS

1. Compare the two groups:

   a. What is the total number of chromosomes in each group? _____

   b. How many pink chromosomes are in each group? _____

   c. How many large chromosomes are in each group? _____

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d. Are the two groups identical? _____

2. Now compare the two groups of chromosomes with your observations and drawings of the chromosomes on the first page. How do they compare?

3. **Use a small piece of tape to rejoin the identical chromosomes at the centromere.**

PART II: Modeling Meiosis

Frimpanzees are animals and each frimpanzee has a mother and a father. When frimpanzee males mate with frimpanzee females, a sperm cell from the father joins an egg cell from the mother. The sperm cell from the father and the egg cell from the mother both contain DNA in the form of chromosomes. They join together and their chromosomes mix in an embryo cell which will eventually become a baby frimpanzee. In our model, the chromosomes that are blue have come from the father frimpanzee, while the chromosomes that are pink have come from the mother frimpanzee.

1. Now let's model the steps of meiosis...

MEIOSIS I

Prophase I – Unfold your chromosomes to represent DNA replication.

Metaphase I - Chromosomes line up on the equator (an imaginary line in the middle of the cell).

Anaphase I – Large chromosomes move to opposite ends of the cell (color doesn't matter), then the medium, then the small; forming two equal groups.

Telophase I – The cell begins to divide... with one of the groups of chromosomes in each new cell.

MEIOSIS II - This will be a ***separate*** process in each of the two new cells.

Prophase II - Chromosomes become visible (under a microscope).

Metaphase II - Chromosomes line up at the equator.

Anaphase II - Chromosomes split at the centromere (use your scissors to cut the chromosome in half) and the individual chromosomes move to opposite ends of the cell, forming two groups.

Telophase II - The cells split and a total of four new cells are formed. These cells are called **gametes** - they are the sex cells that will be either frimpanzee sperm or egg cells.

PART II: MEIOSIS QUESTIONS

1. How many chromosomes are in each of the new cells? _____

2. Each of the chromosomes is either large, medium or small, and either blue or pink. Describe each of the chromosomes in each of the new cells:

Cell 1: _____ _____ _____

Cell 2: _____ _____ _____

Cell 3: _____ _____ _____

Cell 4: _____ _____ _____

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3. Is the combination of chromosomes the same in all four of the cells? _____

4. Compare the combination on the table with your picture on page 1. How do the chromosomes after meiosis compare with the chromosomes in the original frimpanzee cell?

5. Compare your results with those of another group - did they get the same combinations? _____

   Did they start with the same original combinations as you? (compare your pictures on page 1). _____

6. Cells resulting from mitosis all have the same chromosomes as the original cell, but cells resulting from **meiosis** have different combinations of chromosomes. During which phase of meiosis does this difference start to occur?_____ _____

PART III: Meiosis, Genes, and Frimpanzee hair

Let's look at just one aspect of a Frimpanzees' looks - hair color. Frimpanzees have either yellow or blue hair and it can be either curly or straight. The gene for hair color is on the big chromosome and the gene for hair type is on the small chromosome. There are two **alleles** for each. Yellow hair (Y) is dominant over blue (y) and curly hair (C) is dominant over straight (c). We are going to locate these alleles on our chromosome models to see what happens to them during meiosis.

1. **Use tape to put your chromosomes back together** just as they were when you drew them on page 1. Make sure to fold the chromosomes.

2. The frimpanzee hair color gene is on the large chromosome. Our frimpanzee got an allele for yellow hair color (Y) from its mother and an allele for blue hair color (y) from its father. ***Write these alleles on the same location on the large chromosomes.***

3. The frimpanzee hair type gene is on the small chromosome. Our frimpanzee got an allele for straight hair (c) from its mother and an allele for curly hair (C) from its father. ***Write these alleles on the same location on the small chromosomes.*** Be sure your C's can be distinguished from your c's.

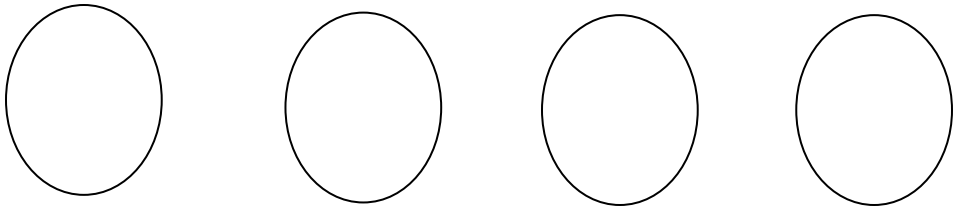
4. Remember that before any cell division can take place the DNA making up the chromosome must be copied. **Unfold your chromosomes.** Since the two chromosomes are exact copies, **write the same letters on the new copies**.

5. Now go through the steps of meiosis.

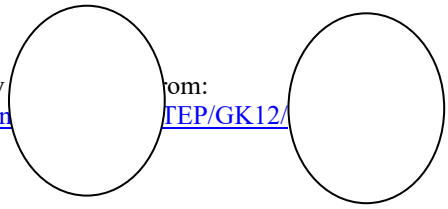
PART III: MEIOSIS, GENES & ALLELES QUESTIONS

1. Our frimpanzee has a genotype YyCc. What does its hair look like (what is its phenotype?).

2. What combinations of alleles did you have in your four frimpanzee gametes after meiosis was finished?

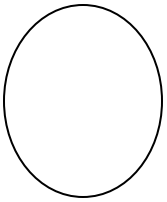


3. What other combinations are possible? All these combinations of alleles are the possible combinations that could wind up in the sperm or egg of a frimpanzee.



4. Now your frimpanzee is ready to mate! Pick one of your gametes to use to mate with the frimpanzee of another group. Put the chromosomes together - what combination of alleles did you create for your new baby frimpanzee?

   Genotype of baby frimpanzee:

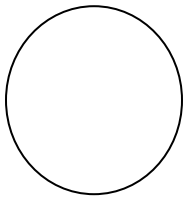


   Phenotype of baby frimpanzee:

5. Select 2 more of your gametes and mate with two other groups. Record the allele combinations for each of your new offspring.

   Offspring 1

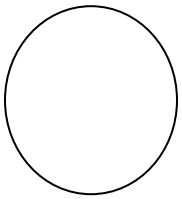
   Genotype:



   Phenotype:

   Offspring 2

   Genotype:



   Phenotype:

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A Punnett square helps to show geneticists the possible combinations of alleles that are possible from the mating. The possible combinations of alleles from one parent are listed across the top, and the possible combinations of alleles from the other parent are listed across the bottom. Since in your mating of frimpanzees, both parents are YyCc, complete the following Punnett Square for (YyCc x YyCc)

Mom / Dad	YC	Yc	yC	yc
YC				
Yc				
yC				
yc				

Frequency of Phenotypes

Yellow & Curly Hair: _____

Yellow & Straight Hair: _____

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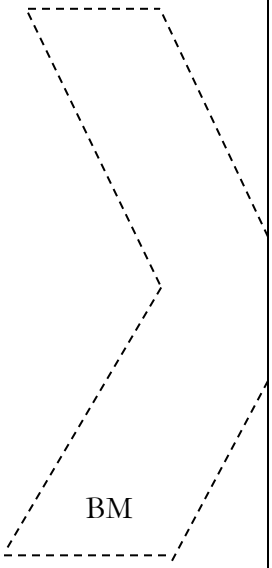
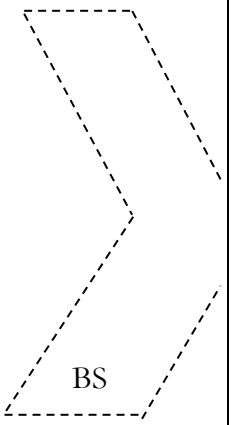
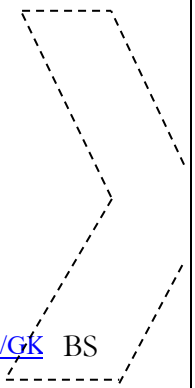
Yellow & Curly Hair: _____

Yellow & Straight Hair: _____

Photocopy on BLUE Paper







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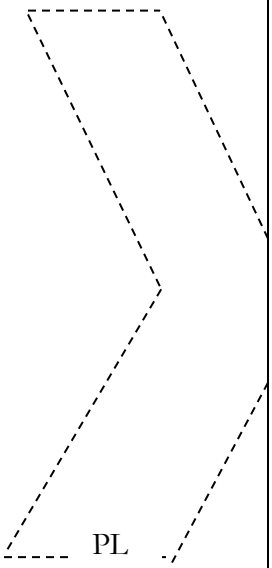
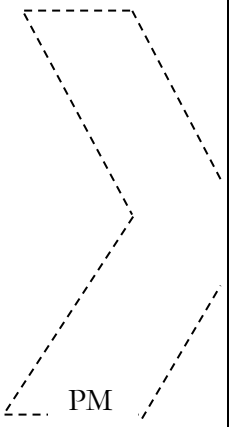
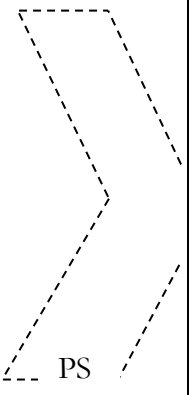
Photocopy on PINK Paper







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