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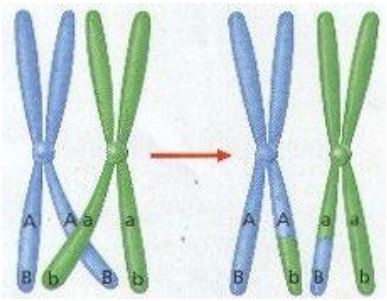
The Mating Game

Part 1: Reviewing Meiosis and Crossing Over

Introduction:

In prophase I of meiosis, the duplicated homologous pair of chromosomes comes together in a process called synapsis, and sections of homologous chromosomes are exchanged. In the image below, you will see that the inside sister chromatids first overlap. Then an enzyme cuts each chromosome at the location where they overlap in exactly the same place. Finally, another enzyme reattaches each section of a chromatid to the other homologous chromosome. Since genes on homologous chromosomes are always in the same place on a chromosome, this does not transfer one type of gene from one chromosome to another, but rather transfers a specific allele from one chromosome to another. Below you will see that after crossing over, the b allele from the right hand homologous chromosome is now on the left hand homologous chromosome.



Procedure:

1. Only remove the long homologous chromosomes from your bag, and leave the small and medium chromosomes in the bag.

2. Re-label the alleles for the eye color and ear lobe traits on your long pair of homologous chromosomes so that they match the chromosomes in the picture above.
    a. Eye color: A maternal, a paternal
    b. Ear lobe: B maternal, b paternal

3. Move your long chromosomes through Meiosis I and II first **without crossing over**. *Record the genotypes of the four resulting daughter cells in the second column of the Genotype Table on the next page.*

4. Re-form your long duplicated chromosomes. Place your long pair of chromosomes into prophase I of Meiosis I. This time, however, make the long chromosomes **cross over** between the two alleles on this chromosome. You will need to break and reattach a small segment of each inner sister chromatid to do this.

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5. Draw what your chromosomes look like after crossing over with gene labels in the space below. Label: **homologous chromosomes, sister chromatids,** and **alleles**

6. Move your chromosomes through the remaining stages of Meiosis I and Meiosis II.

7. Record the genotypes for each of the four resulting daughter cells made from meiosis in the third column of the Genotype Table below.

Genotype Table:

	Genotype	
	Without Crossing Over	**With Crossing Over**
Daughter cell 1		
Daughter cell 2		
Daughter cell 3		
Daughter cell 4		

Analysis Questions:

1. When meiosis occurred without crossing over, which daughter cells had the same genotypes? Explain why.

2. Were the genotypes of these daughter cells the same when crossing over occurred? Why or why not?

3. Explain how crossing over increases genetic variation of sex cells (egg or sperm) using the following terms: **homologous chromosomes, maternal chromosome, paternal chromosome, allele**

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Part 2: Meiosis and Fertilization

Introduction:

When fertilization takes place, gametes fuse and the genes from two individuals join. It is this new combination of genes that results in the formation of a unique individual. Fertilization in humans takes place in the Fallopian tube. Males release millions of sperm into the vaginal canal of the female. These sperm squirm and thrash their way through the uterus and enter the Fallopian tube. Here they encounter a mature egg that has been released from the ovary. Sperm compete to encounter a mature egg that has been released from the ovary. Sperm compete to donate DNA to the female egg. Millions of sperm surround the egg, which is approximately 75,000 times larger that a sperm cell. But only one sperm may bind, penetrate, and insert its DNA into the egg. The fertilized egg (or zygote) continues its journey through the Fallopian tube to the uterus; eventually, it attaches to the uterine wall. Here it continues to develop into a multicellular organism.

Procedure:

1. Take out the medium and small chromosomes from your bag and re-label both so that they each have heterozygous genotypes:
    a. Medium: Rr
    b. Small: Nn

2. Re-form your long chromosomes and place them with the other two pair of chromosomes into Prophase I.

3. Move your chromosomes through the remaining stages of Meiosis I and Meiosis II.
    - To model the 50/50 chance of whether paternal or maternal homologous chromosomes line up on the left or right during metaphase I, toss a coin for each pair.
    - Heads = paternal on left and tails = paternal on right.

    a. How many chromosomes did you have at the start of Meiosis I? Are they duplicated or unduplicated?

    b. How many cells do you have at the end of meiosis I?

    c. How many chromosomes do you have in each cell at the end of Meiosis I? Are they duplicated or unduplicated?

    d. What type of cell do you have at the end of meiosis?

4. Randomly take one set of chromosomes from one of your daughter cells (gametes) and record the genotype in the table on the next page (decide if your gamete is an egg or a sperm).

5. Find another group who is also at this stage and record the genotype of their gamete. If yours was an egg, theirs is a sperm or vice versa.

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6. Join the nuclei of these two gametes to model fertilization. Record the genotype of the gamete in the table on the next page.

Genotypes of Gametes and Fertilized Cell				
Genotype	**Eye Color (B/b)**	**Ear Lobe Shape (A/a)**	**Tongue Rolling (R/r)**	**Color Blind (N/n)**
Egg				
Sperm				
Offspring (Gamete)				

Analysis Questions:

1. What were the genotypes of both parents?
   a. Genotype of male making sperm:
   b. Genotype of female making egg:
2. What were the genotypes of the gametes?
   a. Egg:
   b. Sperm:
3. Explain how the egg and sperm had different genotypes even though they came from parents with the same genotypes.

4. What is the phenotype for the four traits of the offspring?

   Eye Color: Ear Lobe: Tongue Roll: Color Blind:

5. Explain why other groups' genotypes and phenotypes for their offspring might be different?

6. Explain how fertilization restores an organism's original chromosome number.

7. Explain how fertilization allows for variation among offspring from a single set of parents