NAME ______________________________

DATE ______________________________

Meiosis and Genetics

Sexually reproducing organisms incorporate meiosis in some stage of their life cycles. In animals, meiosis results in the formation of sperm and egg. In plants, meiosis produces spores. Since genes are located on chromosomes, an understanding of what happens to chromosomes in meiosis is essential to understanding patterns of inheritance (genetics).

The body cells of the fruit fly (*Drosophila*) each have four pairs of chromosomes, which are numbered 1 through 4 for ease of reference. We will focus on chromosome pair 2. One chromosome of this pair, the maternal chromosome, came from the female parent and the other, the paternal chromosome, came from the male parent. These matched pairs of chromosomes, one from each parent, are homologous chromosomes, which means that they are highly similar to each other. Each chromosome 2 has a gene locus for brown eye color. Different forms or alleles of the gene may be present at the brown locus. There can be a wild-type allele for normal red eyes or a mutant allele for brown eyes. What happens if a pure-breeding fly with wild-type red eyes is crossed with a pure-breeding mutant fly having brown eyes?

Using the symbol *B* as the allele for red eyes and *b* as the allele for brown eyes, we can represent the genotypes of the parent flies as follows:

B/*B* = homozygous red eyes, the genotype of the wild-type parent fly, and

b/*b* = homozygous brown eyes, the genotype of the brown-eyed parent fly.

(The / between the allele symbols indicates that the alleles are on homologous chromosomes.)

We can now represent the cross:

Parents— $B/B \times b/b$

Offspring (F_1)— B/b

Notice that the wild-type parent can donate only allele *B* to its offspring, and the mutant fly can contribute only allele *b*. All the offspring of this cross will be heterozygous in genotype: *B*/*b*. In this pairing of alleles, *B* is dominant and *b* is recessive; that is, in the heterozygous condition, the trait associated with allele *B* is expressed and that of *b* is not. Consequently, all the F_1 flies have red eyes. Since the heterozygous flies carry allele *b*, it can be inherited by their offspring. In the following simulation, you will investigate what happens to these alleles in meiosis and how they recombine in the next generation of flies.

Mark *B* on two small pieces of masking tape (or adhesive dots) and *b* on two others.

Assemble two homologous chromosomes. Count three beads down from the tip of one arm of the red chromosome and fasten one of the *B* pieces of masking tape. This represents the gene locus for brown. Do the same for the other arm of the red chromosome. Repeat for the yellow chromosome, but use tape with a lowercase *b*. The red chromosome now represents the chromosome received from the parent fly with red eyes, and the yellow chromosome represents the chromosome received from the parent with brown eyes.

What Happens to Allele Pairs in Meiosis?

Now work through the simulation of meiosis. The four cells produced by meiosis are gametes.

What fraction of the gametes carry allele *B*? ______________________

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At what stage of meiosis were alleles *B* separated from alleles *b*?____

How Do Alleles Recombine in Offspring?

In sexual reproduction, the gametes of two individuals fuse. Simulate this process by selecting one of your chromosomes and pairing it with a chromosome from another group. (Remember that at this point each single-stranded chromosome represents a gamete.) Record here the allele pairing that you produced.

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This offspring would be an F_2 fly, the second generation after the parents.

How many different combinations of the alleles can you produce by pairings with the other group?_______________

Show the combinations here. ____

These combinations are the possible genotypes of the F_2 flies.

A Punnet square is one way of determining the pattern of allele combinations that can occur. Consider the following cross.

A/*a* × *A*/*a*

Each parent can contribute alleles *A* and *a* to its offspring in approximately equal numbers.

Write the alleles contributed by one parent across the top of the Punnett square and the alleles contributed by the other, down the side.

	A	*a*
A		
a		

Fill in the squares with the alleles contributed by both parents.

	A	*a*
A	*A*/*A*	*A*/*a*
a	*A*/*a*	*a*/*a*

Using the above as a model, fill in the following Punnett square for the cross of your F_1 flies: *B*/*b* × *B*/*b*.

From your completed Punnett square, give the following:

The number of combinations that give a homozygous red-eyed fly__________

The number of combinations that give a homozygous brown-eyed fly_______

The number of combinations that give a heterozygous red-eyed fly_________

The number of combinations that give a red-eyed fly______________________

The number of combinations that give a brown-eyed fly ___________________

What is the probability of getting a red-eyed fly from this cross?___________

What is the probability of getting a brown-eyed fly from this cross?_________

What is the expected ratio of red eyes to brown eyes in the F_2?_____________

A student makes this cross and obtains 120 offspring.
Of these, approximately how many would you expect to have red eyes?__________ brown eyes?__________

Carolina Biological Supply Company

2700 York Road, Burlington, North Carolina 27215
Phone: 800.334.5551 • Fax: 800.222.7112
Technical Support: 800.227.1150 • www.carolina.com
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