MCDB 1041/2152 Activity 1 answers

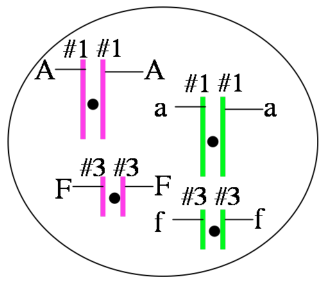
Chris and Emma are each carriers for hemochromatosis and cystic fibrosis. Another way of saying this is that they are heterozygous.

1. Write the genotype of Chris and Emma, with respect to these two genes.
   AaFf

2. What is their phenotype? Do these individuals have symptoms of either disease? No, they are carriers, and thus, because both diseases are recessive, they do not have symptoms.

Before a cell enters into either mitosis or meiosis, it makes an identical copy of its DNA. Replicate each chromosome by selecting matching color and size paper pieces from the general supply in the paper cup.

1. Draw the cell after replication (note chromosome # and letters on your drawing):



Concepts: Questions about your observations

Look at one replicated chromosome. It is comprised of two sister chromosomes known as sister chromatids.

2. Are the sister chromatids different from each other? no
3. Do the sister chromatids have the same set of genes? yes
4. Do they have the same alleles? yes

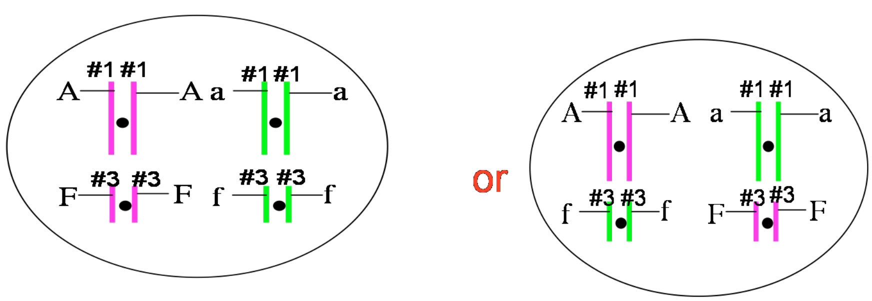
The term "homologous chromosome" describes the relationship between the pink and green #1 chromosomes.

5. Are the homologous chromosome #1s different from each other? yes
6. Do the homologous chromosomes have the same set of genes? yes
7. Do they have the same alleles? no

Part 2: Drawing Meiosis 1 and 2

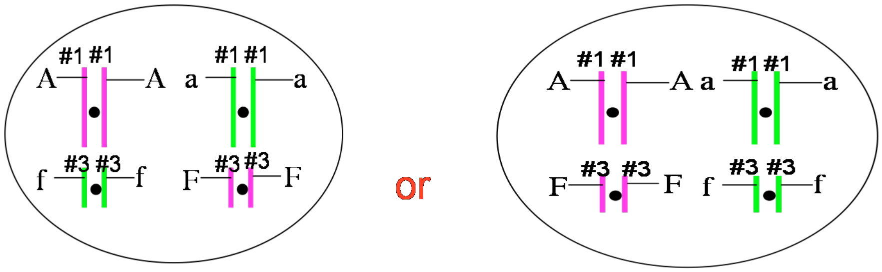
During meiosis the homologous chromosomes align themselves so half of them are on one side of a center line though the cell (illustrated as a dotted line below, and known as the metaphase plate) and half of them are on the other side of the metaphase plate. Align the chromosomes as if they were in metaphase of meiosis I.

1. Draw what that looks like here (note chromosome # and letters on your drawing):



For this example, there are two ways to line up the chromosomes on the metaphase plate.

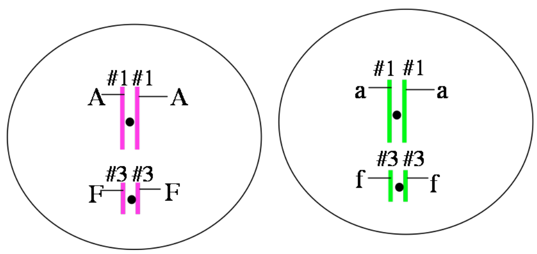
2. Look at your drawing above and draw the other way that the chromosomes could align:



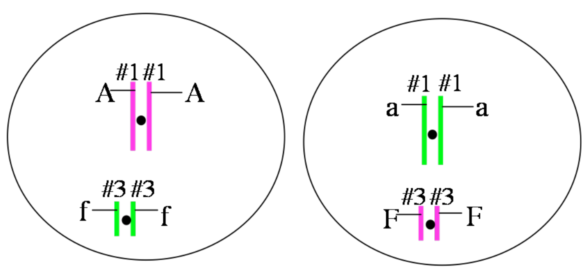
The principle you have just illustrated in the two drawings above is called **Independent Assortment**. Aside from crossing over (recombination), which we will discuss later, it is the main reason why there are so many different possibilities in the genotypes of germ cells.

At the end of meiosis I, the cell splits into two new cells.

3. Draw the chromosomes that are in each of these cells below (note chromosome # and letters on your drawing).

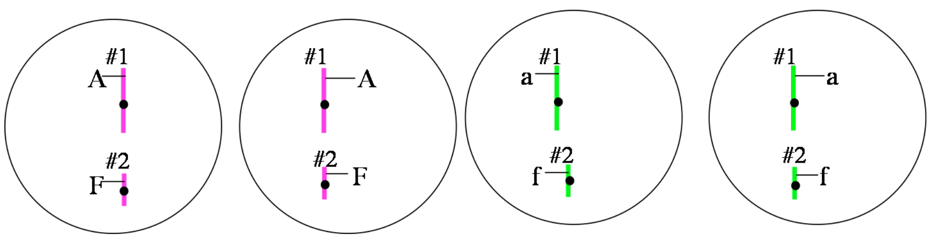


Note each cell should have sister chromatid pairs of the #1 and #3 chromosomes. However, the color and allele type can be switched. For example, this would also be a correct answer depending on how the cell looks in metaphase of meiosis I:

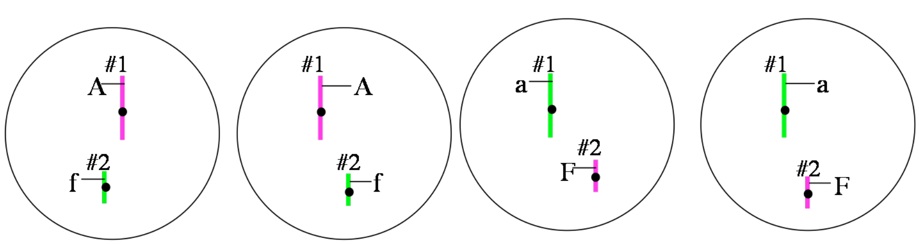


At the end of meiosis II, four cells have been generated from the two above. The end products of meiosis are mature sperm.

4. Draw the sperm cells with their chromosomes here (note chromosome # and letters on your drawing):



Depending on how the chromosomes were aligned in metaphase I, this could also be a correct answer:



Concepts: What can you deduce from your meiosis drawings?

5. How many chromosomes are in each sperm cell at the end of meiosis for this activity? 2
6. In real life, how many chromosomes are there in each sperm cell in humans after meiosis? 23
7. Is the process of generating an egg similar or different than that of generating a sperm? Explain.

The process of cell division is the same in both males and females. In both cases the starting material is a diploid cell (two non identical copies of each chromosome) and the ending material is a haploid cell (one copy of each chromosome). We will learn about some differences in the products of meiosis later in the course. For example females produce only one egg at the end of meiosis and males produce 4 sperm.

Part 3: Generating the next generation

You have completed the meiosis process for Chris. Now, go through meiosis for Emma, represented by the "cell" with orange and yellow chromosomes. Once both sets of meiosis are complete for both parents, **randomly** pick a germ cell from Parent 1 (pink and green) and a germ cell from Parent 2 (orange and yellow) and put them together: this is **Child 1**.

1. Record its "genotype" (chromosome color and alleles; see example child) and phenotype in the table below. **The answers will depend for this question**

Decision time!

2. When you made each child above, you probably just picked from the gametes you made from one round of meiosis I and II. Is that the most realistic way? Should you return all the pieces of paper to their original containers and begin meiosis over again to produce each new child? Why or why not?
   No, this is not the most realistic way. You should start meiosis over to produce a new child in order to maintain the random assortment of chromosomes. Also, women only produce one egg at the end of meiosis, so using multiple gametes from Emma's one meiotic event is unrealistic.

Concepts: What can you deduce from the mating activity?

What results do you get if you align the chromosomes differently at metaphase of meiosis I? If meiosis is normal, could Chris and Emma end up with a **child** that has

3. 2 orange and 2 yellow chromosomes? Why or why not? No, all the genetic information would be coming from Emma
4. 2 pink and 2 yellow chromosomes? Why or why not? Yes, the 2 pink chromosomes can come from Chris and the 2 yellow chromosomes can come from Emma
5. One orange, 1 green, 1 pink and 1 yellow chromosome? Why or why not? Yes, the pink and green chromosomes come from Chris and the yellow and orange chromosomes come from Emma
6. All 4 chromosomes of one color? Why or why not? No, this would mean that all genetic information came from one parent and the chromosomes did not separate properly

Practice connecting meiosis to inheritance probabilities

1. Say Bob is heterozygous for sickle cell anemia, Ss. Bob's wife Sarah is also Ss. Draw a Punnett Square if you would like.
   What's the chance that Bob and Sarah's offspring will have sickle cell anemia? 1/4
   What's the chance than Bob and Sarah's will be normal phenotypically? 3/4
2. Say Bob is ALSO heterozygous for cystic fibrosis, so his genotype is SsFf.

What gametes can Bob produce? SF, Sf, sf, sF

What's the chance of producing each gamete? 25%

If Sarah is SsFF, draw out the Punnett Square for their possible children. Circle all who will be normal phenotypically with respect to cystic fibrosis, but will have sickle cell anemia.

	SF	sf (sarah's gametes)
SF	SSFF	SsFf
Sf	SsFf	Ssff
sf	SsFf	ssff
sF	SsFF	ssFf

Challenge question: What's the probability of this phenotype? 1/8