Lab 6: Mitosis and Meiosis

Objectives:
Become familiar with mitosis and meiosis and differentiate between the two processes

Pre-Lab Questions
Make a list of the differences between mitosis and meiosis

Related Textbook Chapter:
Chapter 12

Lab instructions

Each group will be provided with 3 colors of playdoh. Use different colors to represent the maternal and paternal chromosomes. Use the third color to designate certain genes on your chromosomes.

Chromosomes

Take some of the first color of playdoh and roll it into a somewhat cylindrical object. Repeat for the second color. Let's pretend these are both chromosome #4 in humans, which includes everyone's favorite gene, *alcohol dehydrogenase (ADH2)*.

1. What term from genetics best describes the relationship between these chromosomes?

Take some of your third color and make a narrow band to indicate the location of the *ADH2* locus (note that genes are relatively small compared to the chromosome, so this should be a rather small strip of playdoh). On only the paternal chromosome use a pencil to poke a hole (that is, mutate) the *ADH2* gene. We will consider the hole copy of *ADH2* as recessive to a non-hole copy.

2. Are these copies of *AHD2* considered alleles of one another? How are alleles different than genes?

3. Would this individual be considered homozygous or heterozygous at the *ADH2* allele?

Chromosome replication

Chromosomes are made up of more than just DNA. There are other components involved that must also be replicated. Make a new chromosome (a single cylinder) using your first playdoh color. We will model chromosomal replication so these two copies should be identical (that is, don't forget to include your *ADH2* bands). Attach these together at their centromere. What you have just made is also called a chromosome (it's a little confusing but true) with the original and newly duplicated chromosome each being called sister chromatids. Repeat this replication for the second color.

4. Why does DNA replicate itself?

Mitosis

Make another, but smaller, chromosome from each parent (4 total). Let's consider this second pair of chromosomes as chromosome 5 in humans. Add a band for each copy of *5-methyltetrahydrofolate-homocysteine methyltransferase reductase (MTRR*) on your chromosomes (try and put the band in a different spot than *ADH2* so you can keep track of chromosomes 4 and 5). During mitosis the chromosomes will line up with their homolog and will be pulled into opposite corners of the cell by microtubules that attach to the centromere.

5. Why is mitosis important? What does it do?

Line the chromosomes up as you think they should be for mitosis.

6. For mitosis, should the maternal and paternal chromosomes be lined up next to each other (2 by 2) or should all 4 be lined up into a column? Think about the goal of mitosis.

Pull your chromosomes apart from one another. In cells after this happen, the nuclear membrane reforms and you will have 2 different cells with exactly the same genetic information.

7. Would each of these cells be haploid or diploid?

Meiosis (part I)

Similar to mitosis, to undergo meiosis a cell must replicate its chromosomes **(**to do this with your playdoh simply reattach your sister chromatids). In contrast to mitosis, during meiosis the chromosomes will line up and separate on two separate occasions. Now line up the chromosomes for the first round of meiosis.

8. What are the products of meiosis? Are these different in plants and animals?

9. For the first round of cell division in meiosis, should the maternal and paternal chromosomes be lined up next to each other (2 by 2) or should all 4 be lined up in a column? Remember, the end products of mitosis and meiosis are different. If you lined them up 2 by 2 then put the maternal chromosomes on the left and the paternal ones on the right; if they're in a column then don't worry about this yet.

Recombination

During the first round of meiosis when the chromosomes are lined up, genes can be exchanged between homologous chromosomes. This process is called crossing over or recombination.

Exchange a maternal and paternal copy of the *AHD2* allele along with some of the surrounding chromosome (please try not to smash or blend too much so we can reuse the playdough ☺).

10. Does recombination mean that you can chromosomally be more like one of your parents than the other? Explain why or why not (think about who mom and dad are during meiosis).

11. If we had a plant that mated with itself or a genetically related individual (inbreeding) would the goals of recombination be successful? (Think homozygosity versus heterozygosity).

Pull your chromosomes apart from one another.

12. Were the chromosomes you pulled apart homologous or the sister chromatids?

***Meiosis (part II*)**

Once again line your chromosomes up for the second round of meiosis.

13. Are there 1 or 2 cells at this point in meiosis in which the chromosomes line up?

Mendel's Law of Segregation

Pull these chromosomes apart from one another (if you can't pull them apart without breaking, then the line up in meiosis Part I is off!).

14. How many copies of *ADH2* are there? How many from mom and dad in each cell?

15. Did each copy of *ADH2* segregate dependently or independently? What proportion segregated into each cell?

Mendel's Law of Independent Assortment

Write down the 4 combinations of chromosome 4 and 5 you now have here denoting whether each copy in each cell came from mom or dad's copy (consider the majority of the chromosome and not the recombined portion here).

1

2

3

4

16. Did you end up with only the maternally or paternally derived chromosomes in your cells or both?

Remember, in meiosis part I if you had your chromosomes 2 by 2 then mom's was on the left and dad's on the right? Switch the location of chromosome 5 (so now dad's chromosome 5 is on the left). Now go through the rest of meiosis.

Write the 4 combinations of chromosome 4 and 5 and denote whether each copy in each cell came from the maternal or paternal parent (again consider the majority of the chromosome and not the recombined portion here).

1

2

3

4

17. Now did you end up with only the maternally or paternally derived chromosomes in your cells or both?

18. Does this mean that different chromosomes sort independently or dependently? Is the line-up random? What would random line-ups provide potential offspring?

19. If this individual mated with another individual that is heterozygous at the ADH2 locus what percentage of the offspring will be

a. homozygous dominant _____

b. heterozygous _____

c. homozygous recessive_____

Post-lab Assignment

- Turn in your answers to the above questions