Rieder - Genetics
Worksheet 4
Due: 10/12/17 at the beginning of class

Name: ____

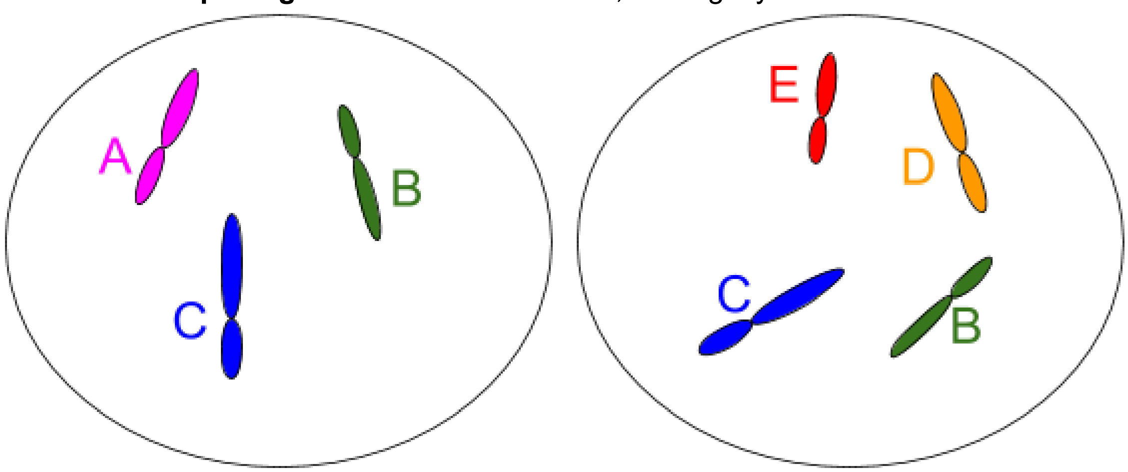
About how long did this homework take you? ____________________________________

I consulted/worked with: ____

<u>I will not accept late homework.</u> Special exceptions will be made **only** in the event of illness or if you contact me at least 24 hours ahead of when the assignment is due (at my discretion).

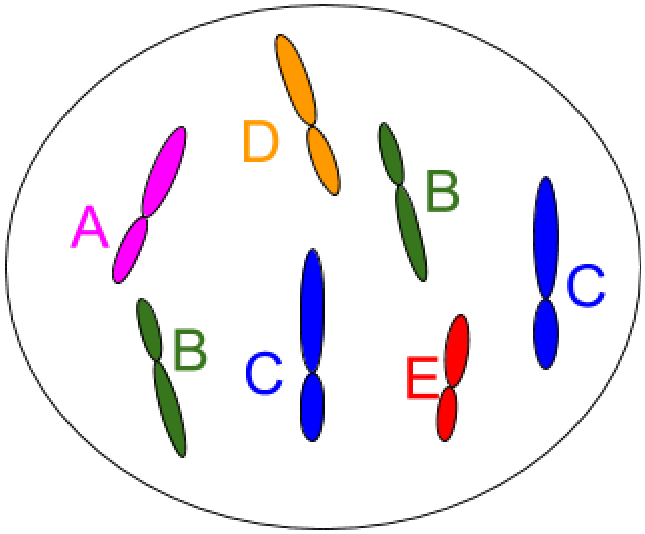
POINTS: / 50

1. Below are two **haploid gametes** from two related, but slightly different lizards:



Bryantus geneticus *Bryantus riederus*

You may notice the two species of lizards have different numbers of chromosomes in their genomes; <u>some of the chromosomes are **homologs**</u> and are colored the same. Other chromosomes are unique to each species and are colored differently. Imagine these gametes fuse during **fertilization** and produce the **hybrid** lizard species, *Bryantus bulldogus*:



Bryantus bulldogus

Mitosis proceeds just fine in this new species (or else there would be no *B. bulldogus* lizards!), but the adult animals are mostly sterile; they produce very few offspring by mating with *B. geneticus*, *B. riederus*, or even other *B. bulldogus*. This tells you that something is going wrong during *B. bulldogus* **meiosis**.

Please draw what the chromosomes of *B. bulldogus* would look like (how would they align) when preparing for **meiosis I** (4 pts). Remember that the cell above has undergone **DNA replication (S phase)**! You may use the chromosome names (A-F) rather than colors.

2. What are two possible <u>products</u> of *B. bulldogus* **meiosis I** (4 pts)? There is more than one correct answer here.

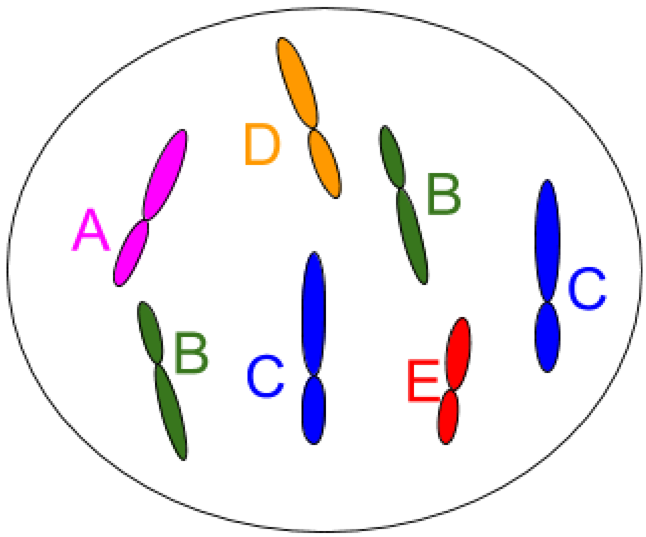
3. What are the possible **gamete** products of *B. bulldogus* **meiosis II**, based on your meiosis I above (4 pts)? There is more than one correct answer here.

4. *B. bulldogus* lizards are usually <u>infertile</u> with other *B. bulldogus* lizards. To explain why, draw out **fertilization** between <u>two</u> of the gametes you drew in question 22 above (4 pts).

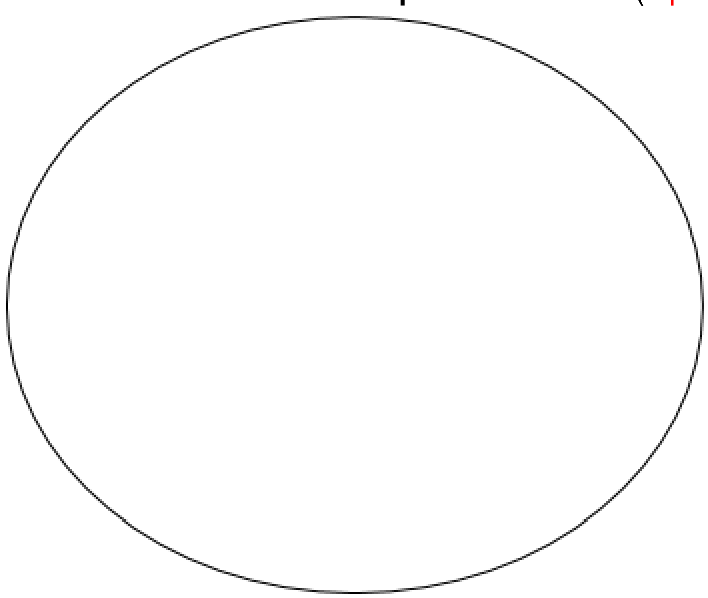
Note: When a horse (**diploid** = 64 chromosomes) and a donkey (**diploid** = 62 chromosomes) mate, they produce a mule (63 chromosomes). This is why mules are sterile!

5. Please read the article from [*Scientific American* **"**No sex needed: all female lizard species cross their chromosomes to make babies]." This super cool form of **asexual** (non sexual) reproduction, which occurs mostly in insects, lizards, snakes, and some sharks, is called **parthenogenesis**. This allows some species to exist that are *all female!!!* Development of embryos occurs without **fertilization**! This can occur when a female produces an egg via **mitosis** rather than **meiosis**.

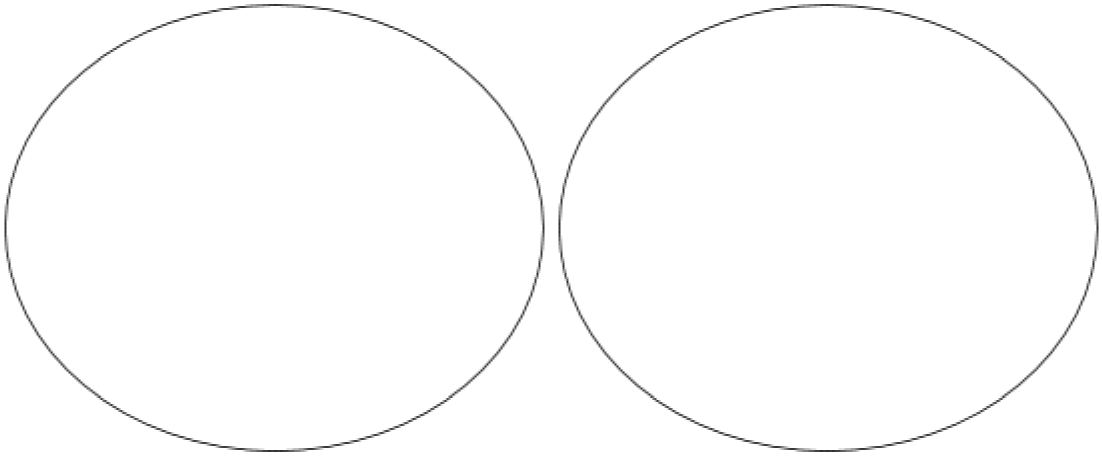
Let's imagine that *B. bulldogus* can't reproduce sexually, but females can undergo parthenogenesis to reproduce asexually.



What would the above **mother** cell look like after **S phase** of **mitosis** (2 pts)?



6. Which chromosomes--and how many of each--would end up in each **daughter** cell if this cell underwent normal **mitosis** (2 pts)?



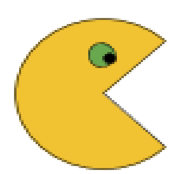
7. Are the **daughter** cells genetically different from the **mother** cell (1 pt)? Y/N______________

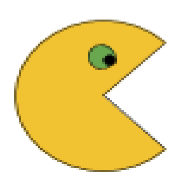
8. Last Thursday in class we discussed **Mendel's** "characters" (**genes**), each of which had two "variants" (**alleles**). Mendel got lucky; he chose simple traits, like plant height, flower color, and seed color that are only governed by a single **locus**-- that is, by one gene in one location on a chromosome. This is called a **monogenic** trait. This allowed Mendel to come up with his **Law of Segregation**: *"The two alleles of a gene <u>segregate</u> from each other as they are passed from parent to offspring."*

Today we discussed **dihybrid** crosses, which are governed by Mendel's **Law of Independent Assortment**: "*Alleles for two or more genes are <u>independently assorted</u> during gamete production (meiosis).*"

In class we discussed how the gene that governs one character would **independently assort** from a gene that governs another character <u>if the gene **loci** are on different chromosomes</u>. The Law of Independent Assortment means that you can get many possible phenotypes in the offspring, <u>including phenotypes that are not represented in the parents</u>.

Assuming the A/a and B/b **loci** are on different chromosomes, please fill out the punnett square for a **dihybrid** cross between (4 pts):

A pacman that is **heterozygous** at both the A and B **loci** with the phenotype: 

A pacman that is **heterozygous** at both the A and B **loci** with the phenotype: 

9. The A/a **locus** governs body color (A = yellow, a = blue), while the B/b **locus** governs eye color (B = green, b = white). The A **allele** is perfectly **dominant** to the a **allele**, while the B **allele** is perfectly **dominant** to the b **allele**. What is the ratio of **F1 phenotypes** that you expect from your cross above (4 pts)?

Yellow body, green eyes: _________________

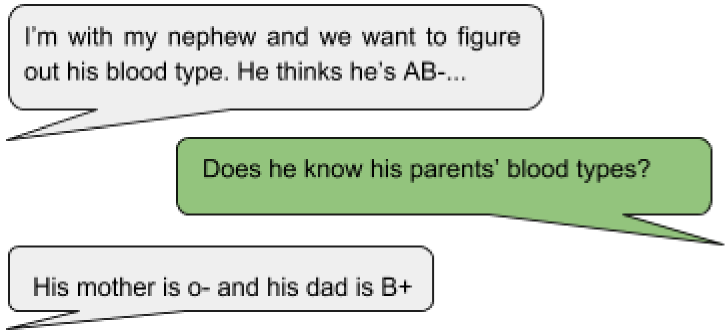
Yellow body, white eyes: __________________

Blue body, green eyes: ___________________

Blue body, white eyes: ____________________

10. What would change if the A/a locus displays **incomplete dominance**? What would be the phenotypes and their ratios from your cross above in question 8 (4 pts)?

11. Here is a *real live* text conversation I had with a relative two weeks ago:



How would *you* respond (4 pts)?

12. Now let's learn about **polygenic** characters. Human height is contiguous; people exist of all heights! There are not simply "short" and "tall" people, as with Mendel's pea plants. Human height is governed by the interaction of dozens of gene products from dozens of loci; it is a **polygenic** character! However, for simplicity, here let's say that human height is governed by two **loci:** genes on two different chromosomes.

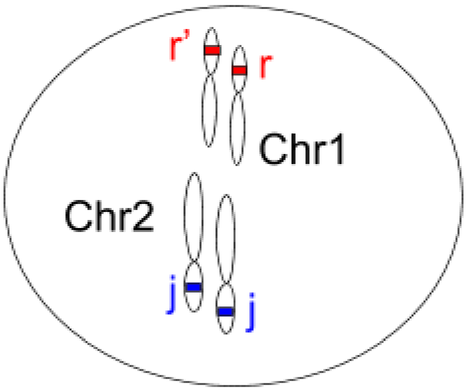
- The "R" **locus** has two alleles, **r** and **r'**. Note that neither is **dominant** or **recessive**.
- The "J" **locus** has two alleles, **j** and **j'**. Again, neither is **dominant** or **recessive**.

Because the R and J **loci** are on different chromosomes, they will <u>independently assort</u> during **meiosis**.

The effects that the R and J loci have on height follow the following formula:

5 feet + $(R_1 + R_2) - (J_1 + J_2)$

The value of the **r** allele is 4 inches
The value of the **r'** allele is 14 inches
The value of the **j** allele is 3 inches
The value of the **j'** allele is 1.5 inches



The above individual is **heterozygous** for the "R" locus and **homozygous** for the "J" locus. What is the individual's full genotype (1 pt)?

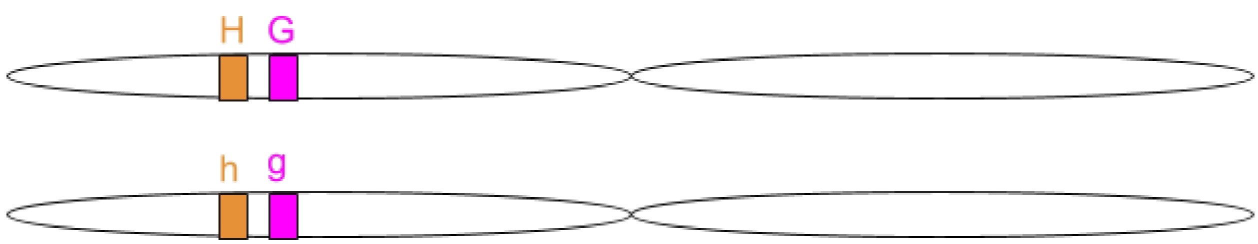
13. Based on the formula, what is the individual's height **phenotype** (1 pt)?

14. What are the **haploid genotypes** of all the possible gametes the above individual may make (4 pts)?

15. Now, let's say this individual mates with another individual whose full genotype is **rrj'j'**. This person's height phenotype is 5 feet, 5 inches. Because this person is homozygous at both the R and J loci, s/he produces gametes of only one haploid genotype: **rj'**. What are the possible **diploid genotypes** and height **phenotypes** of their offspring (**F1 generation**) (4 pts)?

Diploid Genotype	Height Phenotype

16. We are going to learn about **linkage** in class very soon. Let's say we want to study two **loci** that are located right next to each other on a chromosome:



This individual's full genotype is HhGg. Think about how **chromosomes** segregate and how **alleles** on different chromosomes **independently assort** during **meiosis**. What are the **genotypes** of the **haploid gametes** this individual will make? You may wish to draw out meiosis, but it is not necessary for your answer (3 pts).