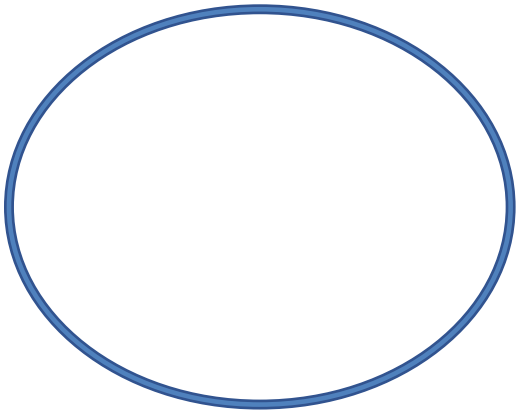
110 Meiosis Lab

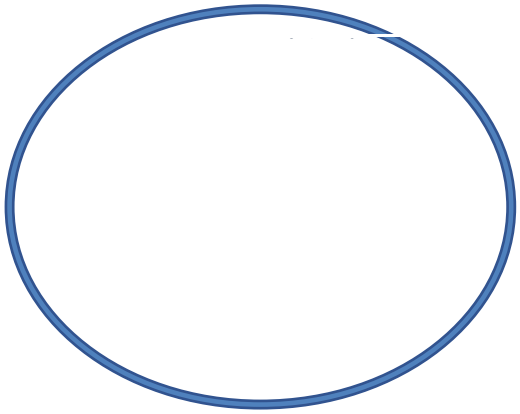
Meiosis I

In this activity, you will model the process of meiosis, and compare the number of chromosomes in the resulting daughter cells to that of mitosis, as well as the way meiosis can result in genetic variation in offspring.

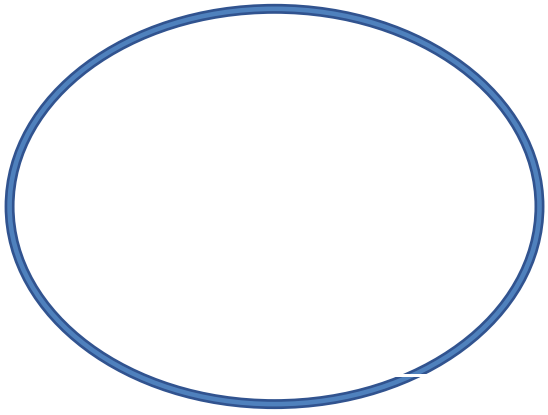
Find the pages of chromosomes at the end of this worksheet, and cut out the pairs of homologous chromosomes (you should end up with 6 slips of paper). These chromosomes represent homologous chromosomes for a relatively simple genome (just three sets of chromosomes). Red strands were inherited from the organism's mother; blue strands were inherited from the organism's father. The "beads" on each strand represent individual genes that are present on the chromosome. You can manipulate these paper chromosomes to model the process of meiosis.

1. In the ovals below, draw what the cell looks like while in Interphase, before and after chromosome duplication:



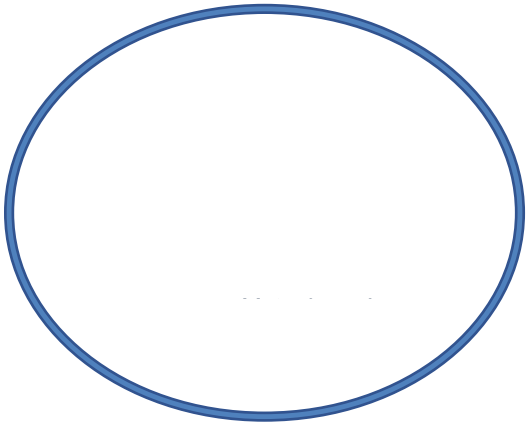


2. Manipulate the paper chromosomes to simulate the pcoess of crossing over. Draw what the cell looks like in Prophase I.



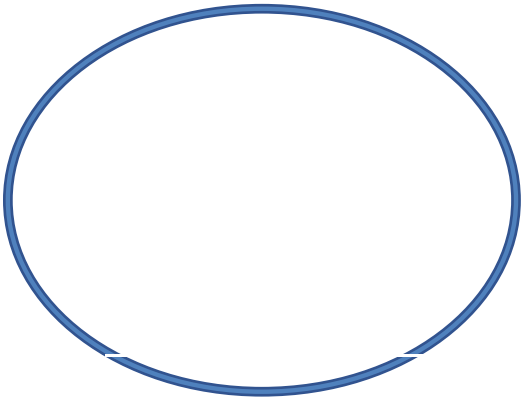
Simulate Metaphase I by lining the chromosomes up along the metaphase plate, You can also cut off the crossed over parts of overlapping chromosomes, to "swap" those genes to the other strand. including the movement of the spindle fibers, and ***crossing over*** *between homologous chromosomes (move beads from one strand to another to represent the swapping of genes between mom's chromosomes and dad's).*

3. Draw what the cell looks like in Metaphase I. Include the spindle fibers and crossed over homologous chromosomes.



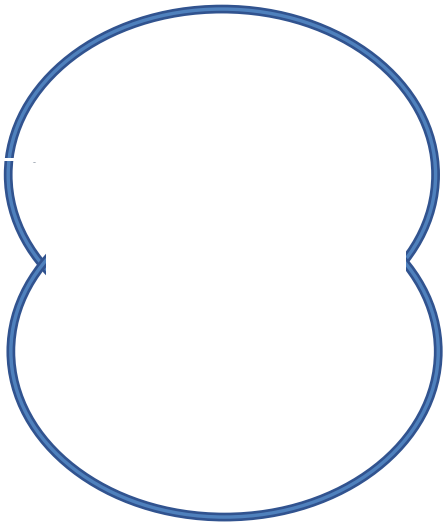
Simulate Anaphase I by separating the homolgous chromosomes and moving them to opposite poles.

4. Draw what the cell looks like in Anaphase I.



Simulate Telophase I and Cytokinesis.

5. Draw what the cells look like in Telophase I.



6. How many copies of each chromosome were present in the cell prior to S phase?

7. How many copies of each chromosome are present in the new daughter cells?

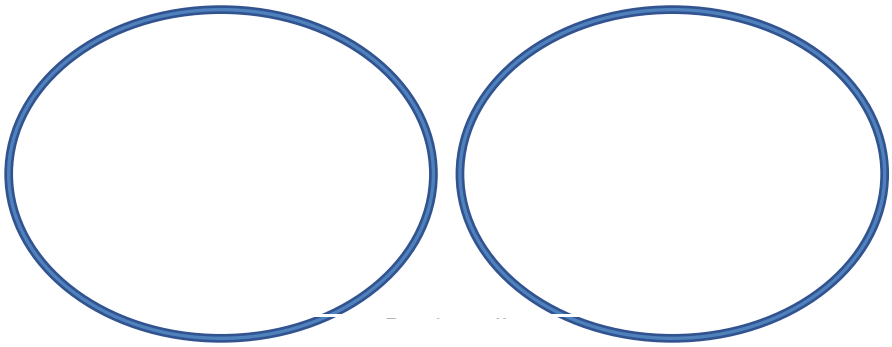
8. What do we call the structures that were pulled apart during Anaphase I?

Meiosis II

Continue to manipulate the paper chromosomes on your desk.

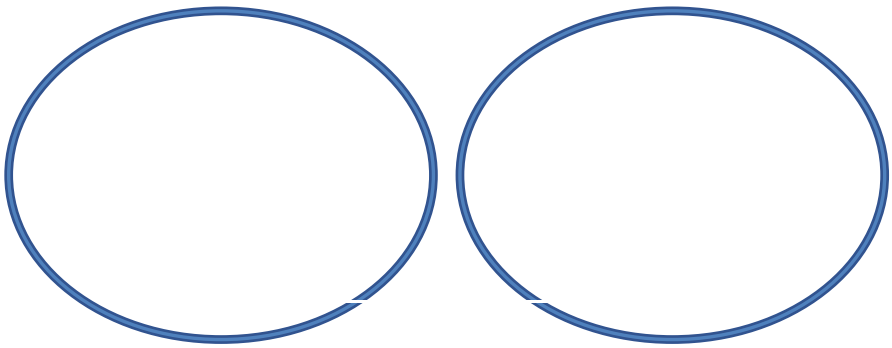
Simulate Prophase II.

9. Draw what the cells look like in Prophase II.



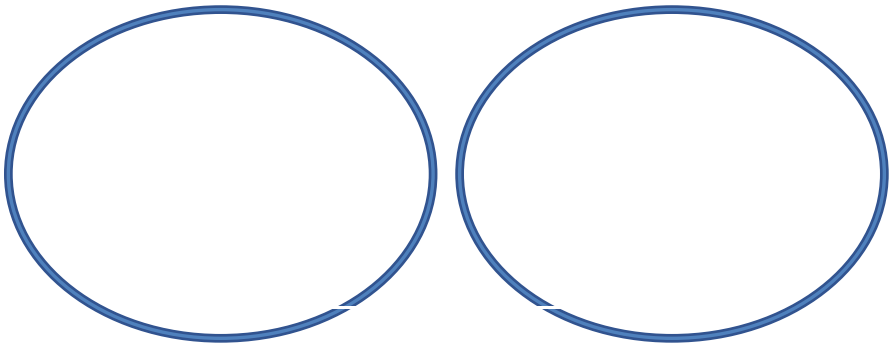
Simulate Metaphase II.

10. Draw what the cells look like in Metaphase II.



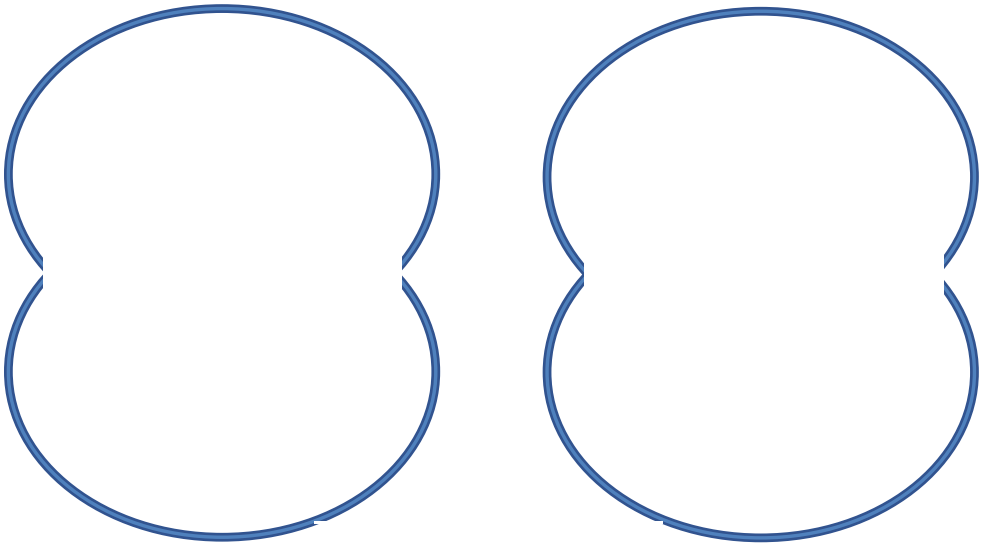
Simulate Anaphase II.

11. Draw what the cells look like in Anaphase II.



Simulate Telophase II and Cytokinesis.

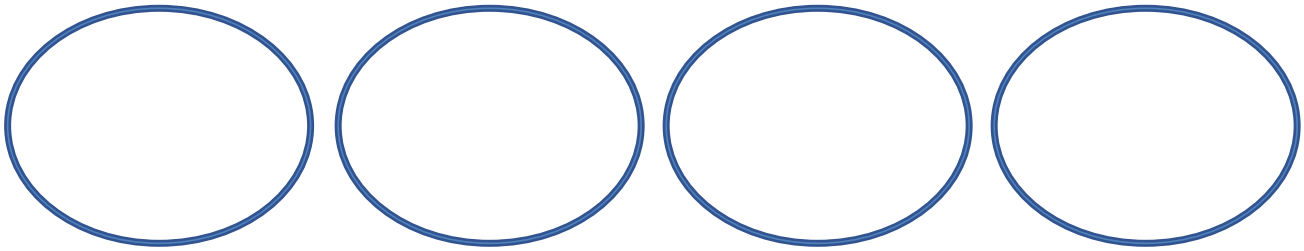
12. Draw what the cells look like in Telophase II and Cytokinesis.



13. How many copies of each chromosome were present in the cell during prophase II?

14. Which structures were pulled apart during anaphase II?

15. Draw each of the daughter cells below:



16. How many copies of each chromosome are present in the new daughter cells?

17. Describe the genetic relationship of each of the new daughter cells to one another, and also to the parent cells. (Hint: look at the colors of the beads on the chromosomes).

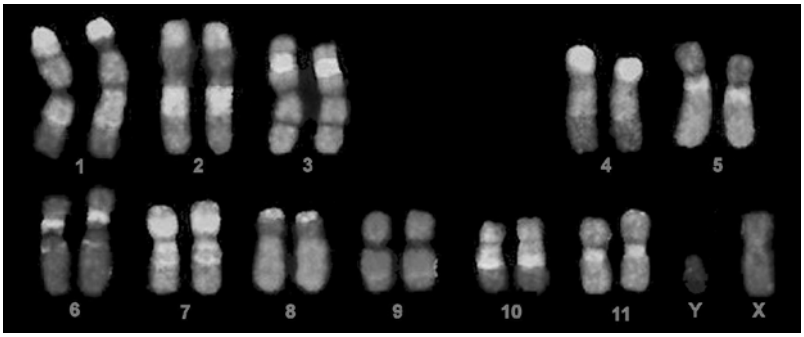
18. What is the significance of chromosome number, given the role the cells produced in meiosis have in reproduction?

19. Explain the benefit of this diversity between daughter cells for sexually reproducing species.

Dragon Genetics

In this activity, imagine that you have recently embarked on a career as a **dragon** breeder. You will explore various aspects of inheritance and pedigree, and at the end, you will produce a baby. Before you begin your breeding project, read through this information about your dragons, as well as a review of the basic concepts of inheritance.

Dragon Genetics: *Draconis siirexus* is a species of dragon that has twelve sets of homologous chromosomes: eleven sets of autosomal chromosomes, and a pair of sex chromosomes (X & Y).



This species has several characters that are inherited according to the laws of inheritance we studied in class, including:

● Body color	● Horns
● Stripes	● Wings
● Spots	● External ear flaps
● Beard	

Activity: Punnett Squares

Albinism: Tyrosinase is an enzyme involved in pigment production (in both dragons and humans). Dragons have a single gene that codes for the production of this enzyme, which in turn produces the pigments that give dragons their skin color.

- The dominant allele (A) codes for a normal enzyme
- The recessive allele (a) codes for a defective protein that will not produce the necessary enzyme

AA or Aa

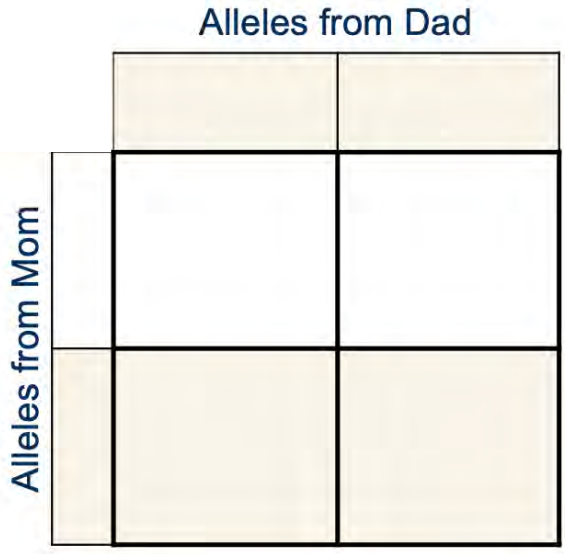
aa

A dragon with the recessive condition (aa) will be albino with completely white skin.

The two dragons pictured below are both heterozygous at this gene locus.

We can use a Punnett square to determine the probability that this pair of dragons will have an albinistic offspring.

1. Complete the Punnett square to determine the probability that these two heterozygous dragons will produce an offspring with albinism.



Leather or Feather?

In dragons, the allele that causes dragons to have feathered wings is recessive. This means that the leathery-winged allele is dominant.

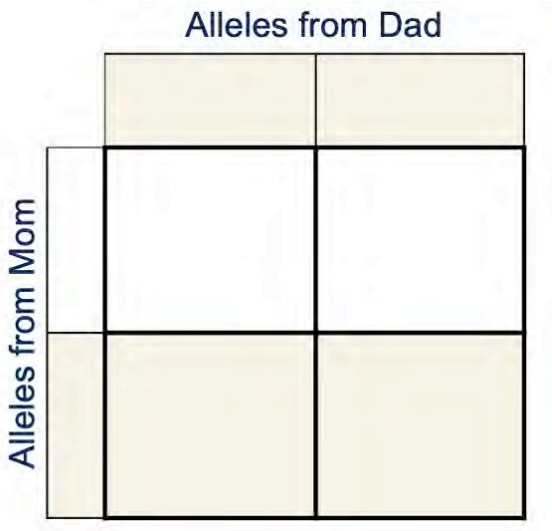
- W denotes a leathery-winged allele
- w denotes the allele for feathers

If a feathered male mates with a leather-winged female that is heterozygous for the W allele, what is the probability that these two parents will produce an offspring with feathers?

2. What are the genotypes of the parents?

Father	

Mother	



3. What is the probability of these dragons having an offspring with feathers?

____ in ____ chance, or _____%

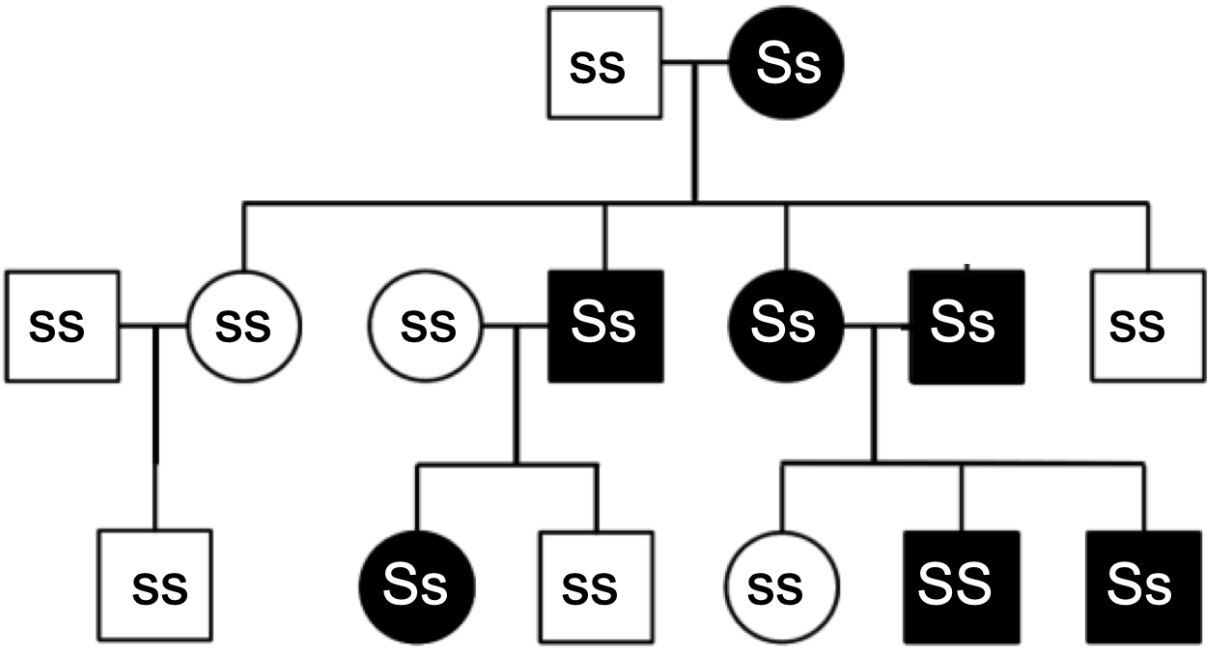
Activity: Pedigree Charts

Stripes: Dominant or Recessive?

Some dragons have stripes, while others do not. As a new breeder, you aren't sure which is the dominant condition.

Rules of pedigree charts:

- Males are squares; females are circles
- Filled in has trait; empty does not
- Matings joined with horizontal line
- Offspring joined with vertical lines



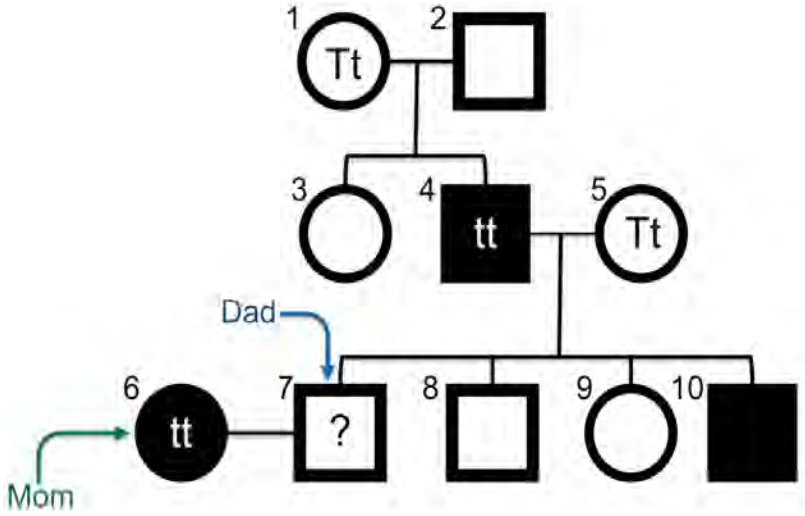
1. Based on the pedigree chart above, are stripes (represented by the S allele) a dominant trait or a recessive one? (Hint: look to see if heterozygotes have the trait).

Spots or Not?

Having spots is an autosomal recessive trait, represented by the T allele. Can you determine whether two dragon parents are likely to have a spotted offspring?

The mother has spots and the father doesn't, but you don't know if he has one of the recessive alleles or not.

At right is a pedigree chart. **Could dragons 6 and 7 produce a baby dragon with spots?** You have been given the genotypes of a few of the dragons, but will have to deduce the others by their relationships with family members. Use this information to determine the father's genotype, and whether or not he could produce a spotted offspring. (Hint: there is one individual on this chart whose genotype cannot be determined. Make sure to identify which one that is).



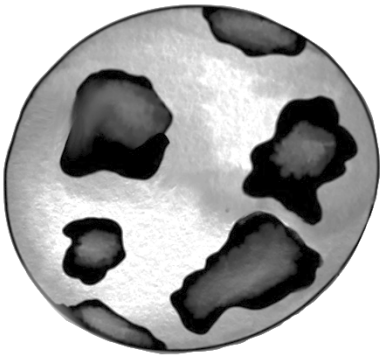
2. Fill in the missing genotypes:

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Genotype:	Tt			tt	Tt	tt				

3. What is the genotype of the potential father (dragon #7)? Is he capable of siring (fathering) a baby dragon with spots. Why or why not?

Activity: Breed a Baby Dragon!

Dragon breeders have been keeping track of dragon genetics for several generations, and we understand how many characters are inherited. Now, it's time to put your genetics skills to use! Follow the steps on the following pages to fill the chart below and breed your baby dragon!



Sex Determination	**Chromosome from Mom**	**Chromosome from Dad**	**Genotype of Offspring**	**Phenotype of Offspring**
Sex	X or X	X or Y		
Character	**Allele from Mom**	**Allele from Dad**	**Genotype of Offspring**	**Phenotype of Offspring**
Albinism	A or a	A or a		
Beard (Only if male)	N/A	Y^B		
Ear Flaps	E or e	E or e		
Grounded (Wingless)	X^G or X^g	X^G or X^g or Y		
Horns	H or h	H or h		
Stripes	S or s	S or s		
Spots	T or t	T or t		
Wings	W or w	W or w		

Genotype

To randomly determine the alleles and sex of your offspring:

- Familiarize yourself with the inherited characters on the chart below
- Assume that both parents are heterozygous for all autosomal characters
- Your dragon will inherit two alleles for every character: one from mom and one from dad.
- To ensure that fertilization is random, flip a coin to see which allele is inherited at each locus.
    - If the flip lands on HEADS, select the allele on the left
    - If the flip lands on TAILS, select the allele on the right
- Keep track of the alleles in the chart in the worksheet.

Sex Determination	Chromosome from Mom	Chromosome from Dad	Genotype of Offspring	Phenotype of Offspring
Sex	X or (X)	(X) or Y	XX	

Allele	Character	Possible Genotypes and Phenotypes		Sex-linked
A	Albinism	AA: Pigmentation present aa: no pigmentation (albinism)	Aa: Pigmentation present	No
Y^B	Beard	XX: no beard	XY^B Beard present	Yes
E	Ear Flaps	EE: Long external ear flaps. ee: External ear flaps absent	Ee: Short external ear flaps	No
X^G	Grounded (Wingless)	X^GX^G: Normal wings. X^GY: Normal wings X^gY: Wings absent	X^GX^g:Normal wings X^gX^g: Wings absent	Yes
H	Horns	HH: Rear horns hh: Nose horn	Hh: Rear and nose horns	No
S	Stripes	SS: Stripes present ss: Stripes absent	Ss: Stripes present	No
T	Spots	TT: Spots absent tt: Spots present	Tt: Spots absent	No
W	Wings	WW: Leathery wings ww: Feathered wings	Ww: Leathery wings	No

Please note: for Grounded trait, flip twice to determine the allele from dad. 1) does dad pass on an X or a Y chromosome? If that flip is heads, 2) does dad pass on the X^G or X^g allele?

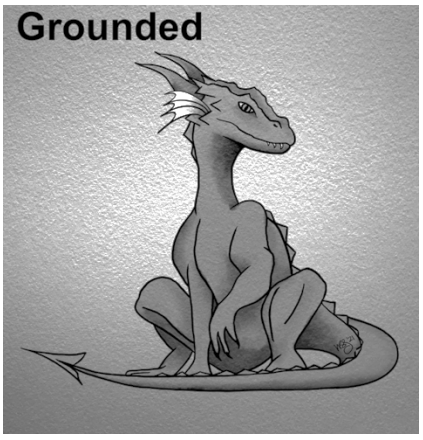
Phenotype

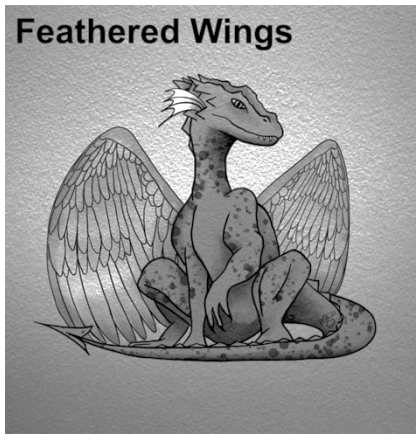
Once you know the genotype, consult the character chart to determine the phenotype your baby dragon will express for each character.

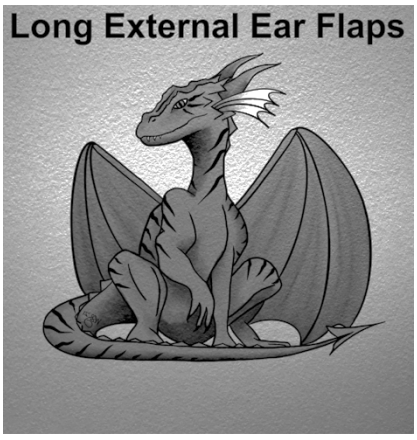
Now that you've determined the baby's alleles, it's time to see how your dragon will look!

- Consult the character chart to determine the phenotype your baby dragon will express for each character
- Remember that there are a few special cases where the genotype for one character will be superseded by a gene at a different locus.
  - If **albinism** is present, no pigment is produced, therefore neither stripes nor spots will be present, regardless of genotype.
  - If **grounded** condition is present, no wings or dorsal spines are produced, regardless of genotype.

Character	Allele from Mom	Allele from Dad	Genotype of Offspring	Phenotype of Offspring
Albinism	(A) or a	A or (a)	Aa	pigmentation
Beard (Only if male)	N/A	Y^B	—	none
Ear Flaps	E or (e)	E or (e)	ee	absent







Congratulations! You've just successfully bred a baby dragon!

Visualize Your Dragon

Now, you will create an image of your new dragon that illustrates the **correct phenotype** for every character we tracked. When creating an image, feel free to use your imagination, as long as the dragon has the correct phenotypic traits. The easiest way to do this is to use Professor St. John's online dragon generator: https://meiker.io/play/13361/online.html

To use the generator, just click "Play" at the link above, and then customize your dragon with the options available.

- In some categories, you may choose more than one option (Markings and Head Accessories).
- You may use any combination of **colors** for the body, wings, and ear flaps that the dragon may have inherited, unless your dragon is albino.
    - Albino dragons will be pure white with no stripes or spots even, if they inherited those traits from a parent.
- Dragons who have the grounded trait should not have wings.
- Only male dragons have beards.

Alternately, you may create your dragon in a variety of other ways. You can color, cut and paste the necessary traits on the "blank" dragon on the last page of this worksheet. You are also welcome to draw your dragon by hand.

Follow-up Questions:

1. What type of dominance is exhibited by the traits for Wings (W)?

2. What type of dominance is exhibited by the traits for Ear Flaps (E)? Can two dragons with Long Ear Flaps have the different genotypes?

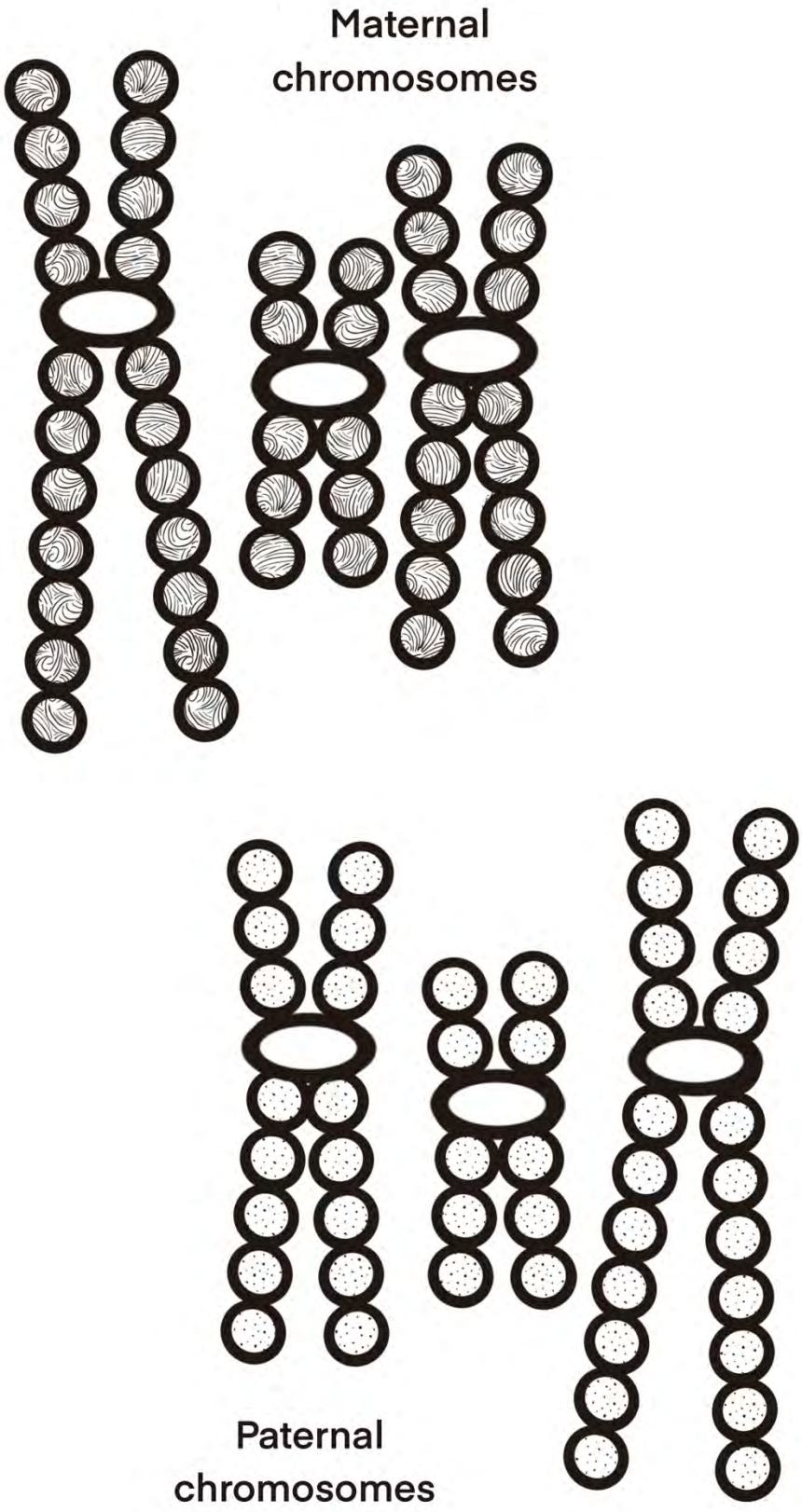
3. Why can only male dragons inherit a Beard?

4. Do you think the Grounded condition happens more often in male dragons, more often in female dragons, or in about equal numbers for both sexes? Please explain your answer.

5. Can two dragons with Leathery Wings have different genotypes? If so, list them.

6. Can two dragons with Spots have different genotypes? If so, list them.

7. Phenotypic traits are often influenced by environmental factors, as well as genetics. Propose a way that one of the traits we explored in this assignment might be influenced by some factor in the environment (for example, perhaps their skin pigmentation will darken with sun exposure, the way it does in humans). Name the trait and environmental influence, as well as a brief description of what you propose might happen.


Maternal
chromosomes
Paternal
chromosomes