FAMILY TREE

Pick ONE trait in your family that shows a lot of variation: eye color, hair line, earlobes, dimples, cleft chin, tongue roller, etc. Fill in as much of the chart below as you can based on family history, photographs, etc. At the end of this unit you will diagram the POSSIBLE genotypes (in the space at the bottom of each box) for each of these members of the family.

Trait_____

GRANDPARENTS

Grandfather: _____

Trait: _____

Grandmother: _____

Trait: _____

Grandfather: _____

Trait: _____

Grandmother: _____

Trait: _____

PARENTS

Dad: _____

Trait: _____

Mom: _____

Trait: _____

CHILDREN

Name: _____

Trait: _____

ME!: _____

Trait: _____

Name: _____

Trait: _____

Name: _____

Trait: _____

Dominant: Widow's peak; Hair on mid-finger; Cleft chin; Tongue roller, Free earlobes; Dimples; Freckles; Bent pinky
Recessive: Hitchhiker's thumb; Blue eyes

Heredity Unit

Note: You may want to coordinate with students' math teacher about the concept of probability as it relates to Punnett squares.

Standards Addressed:

NYC Performance Standards:
The student produces evidence that demonstrates understanding of:

S2b. reproduction and heredity, such as sexual and asexual reproduction; and the role of genes and environment on trait expression.

MST Key Ideas:

Organisms inherit genetic information in a variety of ways that result in continuity of structure and function between parents and offspring.

Background

Students should be familiar with cell division, reproduction (sperm, egg, fertilization, offspring, etc.), chromosomes. Teacher will use direct instruction to familiarize students with genes, dominant/recessive genes, genotypes, and phenotypes: Use textbooks, articles, lecture/discussion, or other activities.

Instruction

This unit begins with students investigating their own family traits. The idea is to generate student interest in understanding how they get the characteristics that they have. The Family Tree serves as an opening and a closing activity. In the beginning, students will pick a trait (from a list of relatively simple recessive/dominant traits) within their family and fill in some information on the family tree. that some family members have and some don't.

<Cells and Reproduction> Direct instruction

<Classical Genetics> Direct Instruction

The "Alien Genetics" activity gives students the chance to construct a model "alien" with hereditary traits following classical or Mendelian genetics.

From those ideas students move into the use of Punnett squares as a means of determining the probability of getting a particular outcome from crossing parents with particular variations of a gene/trait.

As a concluding activity, students demonstrate their understanding by filling out the family tree with a possible family history for that single trait, including genotype and phenotype, going back 2 generations.

Classical or Mendelian Genetics

1. Genes are mechanisms for transmitting traits from parents to offspring.
2. For each trait the offspring inherit one gene from each parent.
3. Some genes are dominant, others are recessive. Dominant genes are expressed whenever they are present in any combination, recessive genes are only expressed when they occur in pairs.
4. In the real world, inheritance is more complex than the Mendelian model, but it is a good starting point for understanding more complex patterns such as codominance, multiple alleles, polygenic inheritance, sex-linked traits, etc.

Alien Genetics Activity

Materials needed for main activity:

Dominant traits — 1 sheet per person, one color
Recessive traits — 1 sheet per person, another color
Chromosomes — I male & 1 female pair per group
Scissors — 2 - 4 per group
Glue stick 2 - 4 per group
Blank paper as backdrop for models — 1 per person
Table of traits — 1 per group
Student worksheets — 1 per student or per group

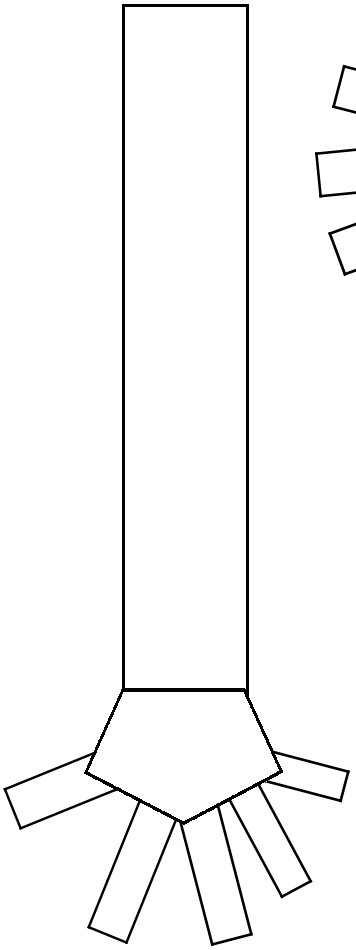
Instructions for Alien Heredity

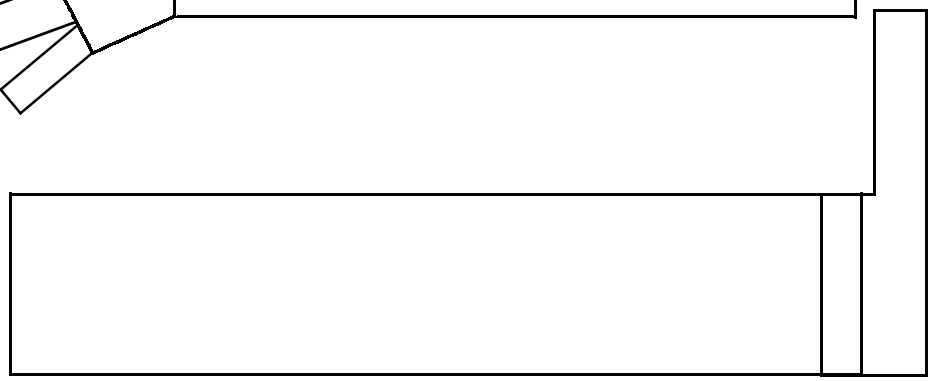
The imaginary aliens in this activity have only 10 identifiable external features, the genes for which are located on the same chromosome. These features or traits follow simple Mendelian laws of heredity (dominant/recessive). Students should work in groups of 4 (you will have to be creative in determining what to do with groups that have more than or fewer than 4 students).

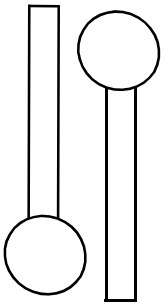
1. Two students from each group get a pair of "chromosomes." These chromosomes represent the genotype of the "parents." Students should record the genotype and phenotype of the parent on the sheet provided. These two students will then construct a model of the phenotype of the parent.

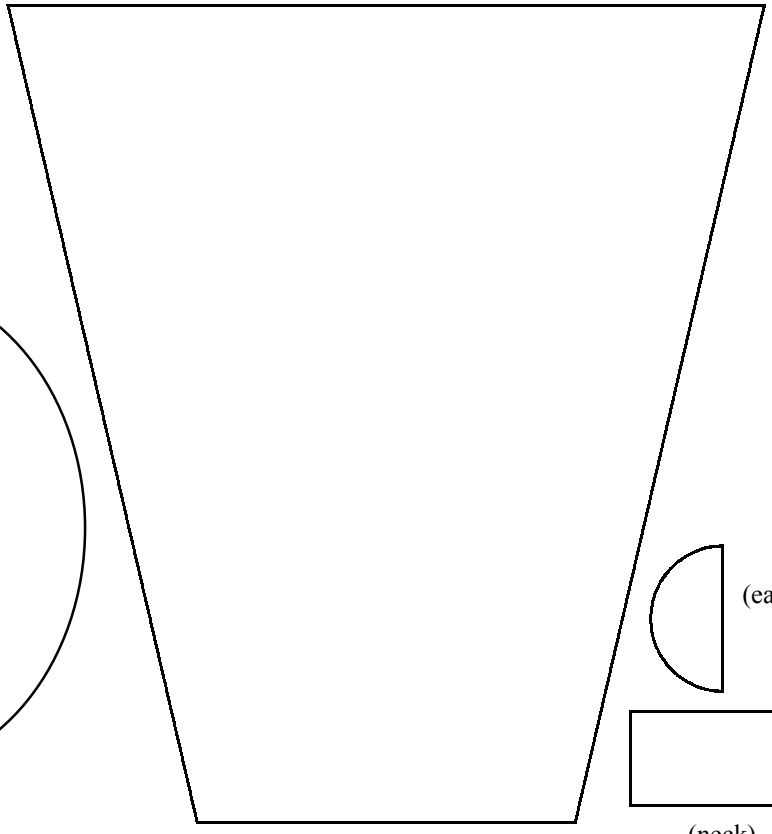
2. Split the parent chromosome pairs in half and mix — one male and one female half per offspring. The other two members of the group then record the genotype and phenotype of these offspring on the sheet provided and make models of their phenotypes. Compare genotype and phenotype, compare parents with offspring. Consult worksheets for full details.

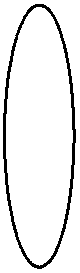
Recessive Traits





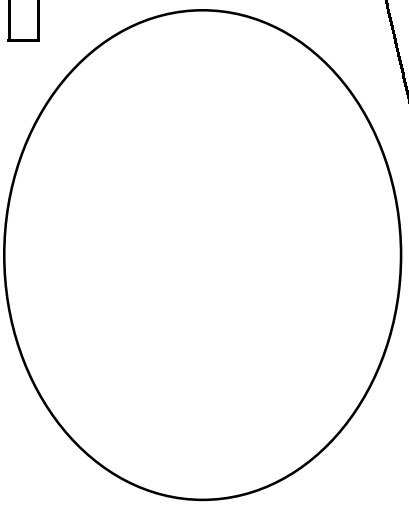


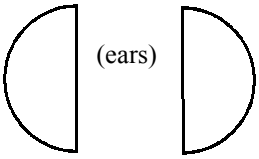




(mouth)

(head)



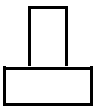


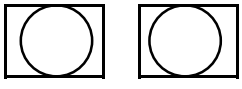
(ears)

(neck)

(trunk)

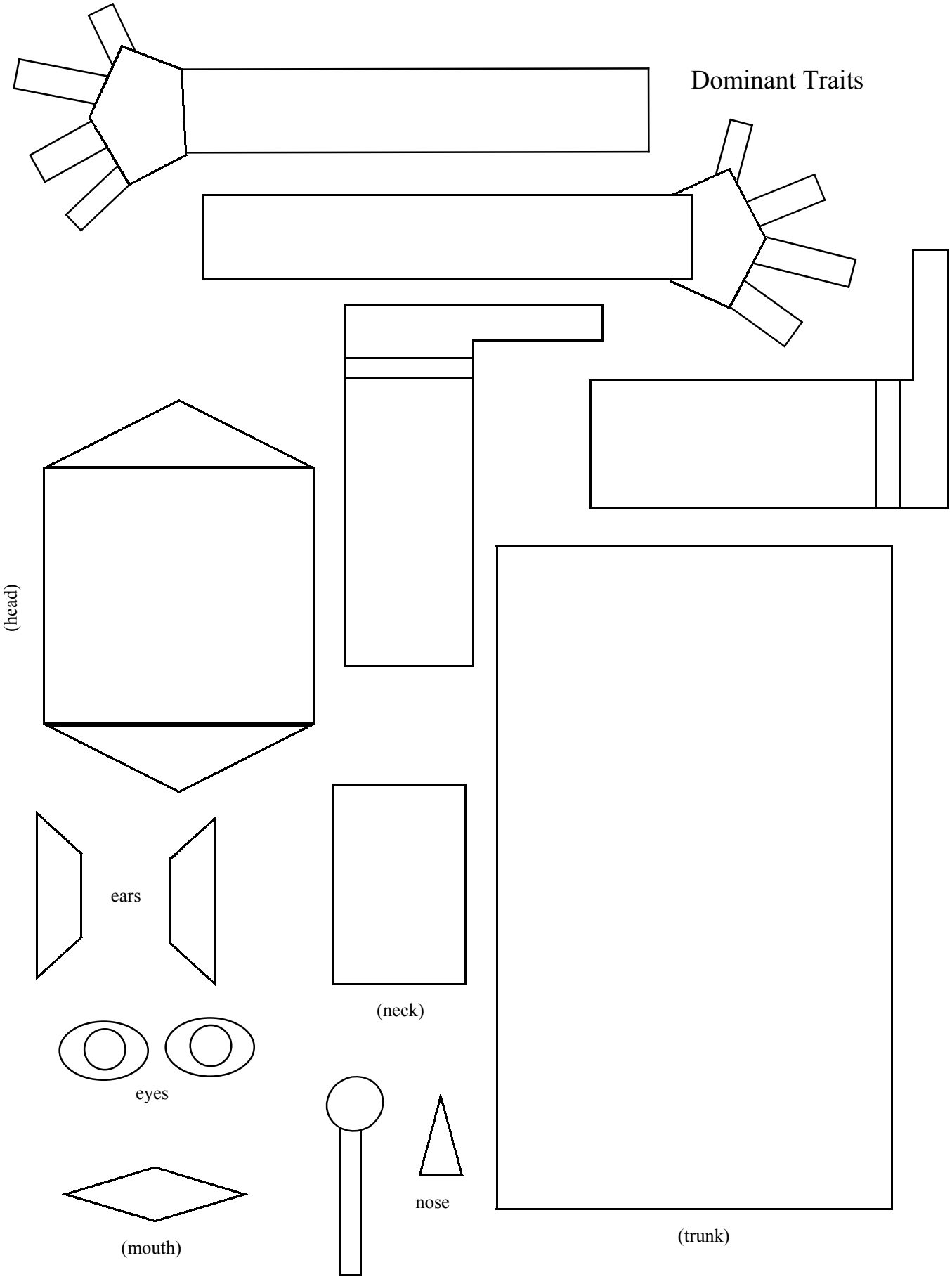
(nose)





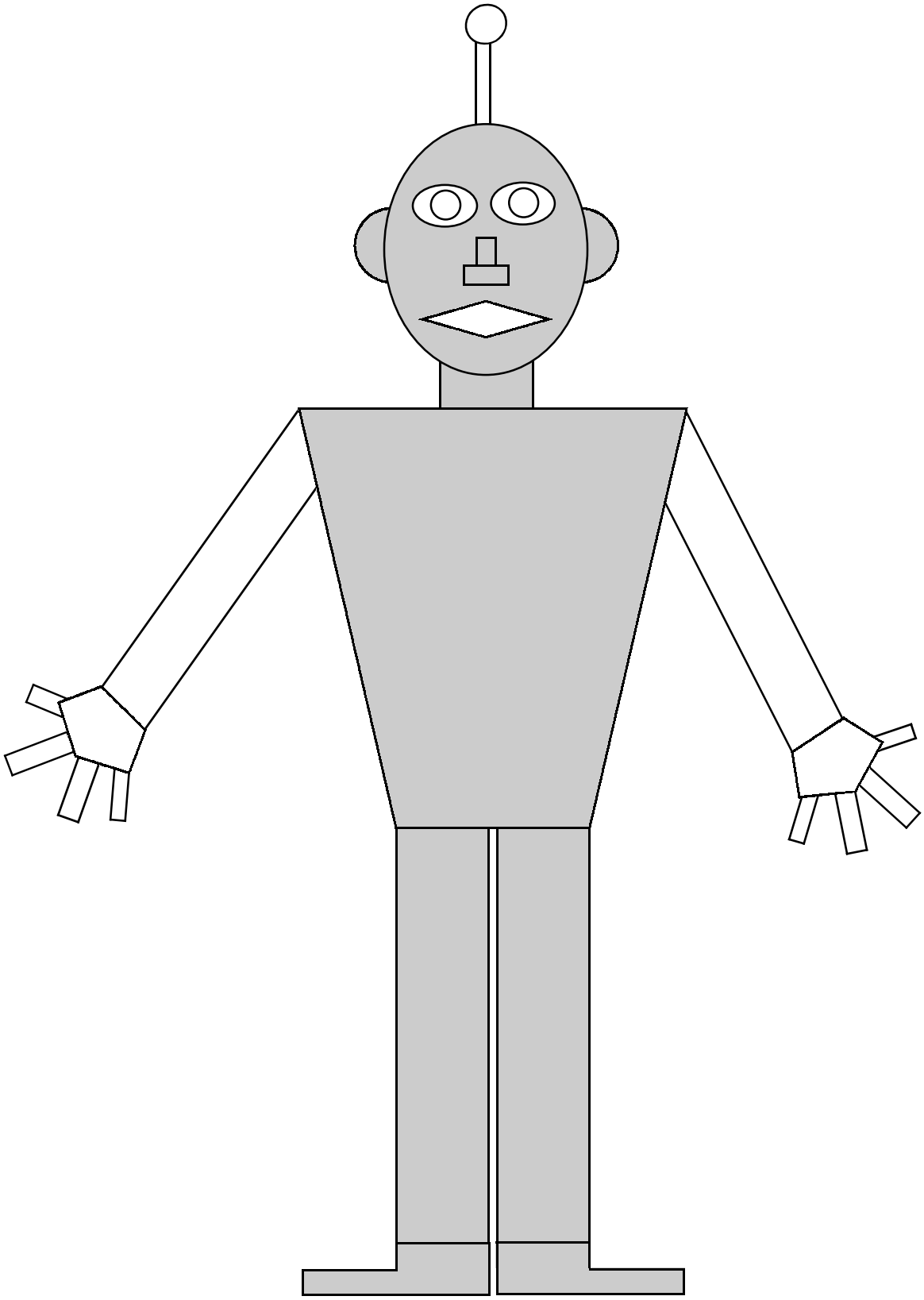
(eyes)

Dominant Traits



Sample Alien

Dominant
Recessive

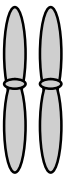


Alien Heredity

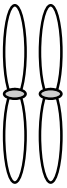
Table of Traits

Trait	Symbol	Dominant	Recessive
Eyes	R/r	Round	Square
Ears	P/p	Pointy	Round
Nose	T/t	Triangle	Rectangles
Head	A/a	Angular	Round
Antennae	U/u	Single (“Uni”)	Double
Neck	L/l	Long	Short
Trunk	B/b	Barrel	“V” shape
Fingers	F/f	Four	Five
Legs	S/s	Short	Long
Mouth	D/d	Diamond	Oval

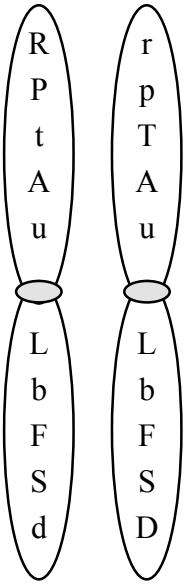
N.B. To keep it simple, chromosomes are depicted in unduplicated state.

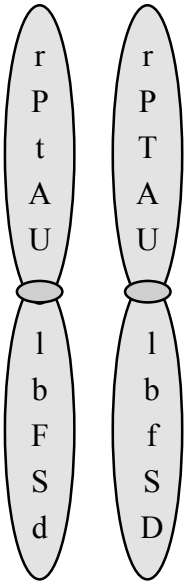


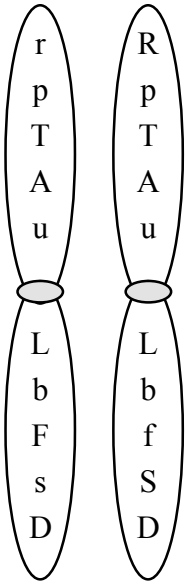
"Male" Chromosome

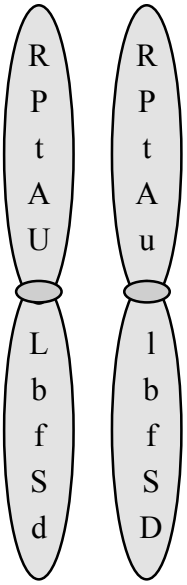


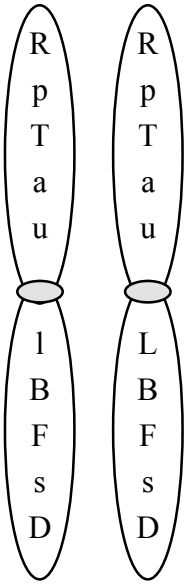
"Female" Chromosome

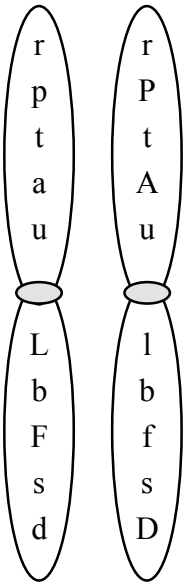


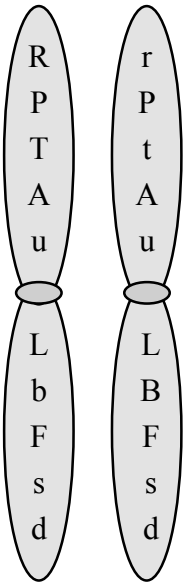


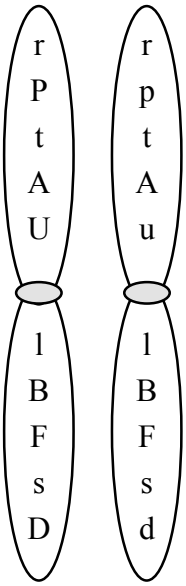


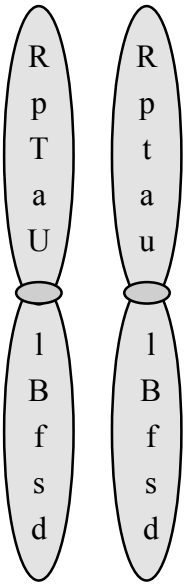


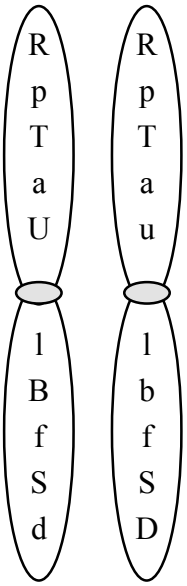


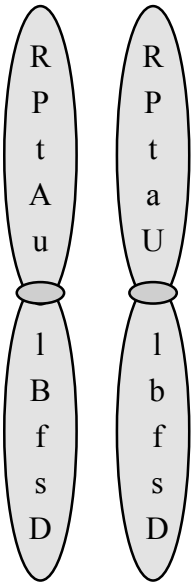


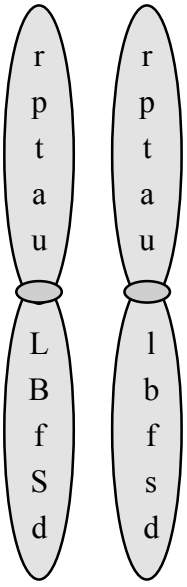


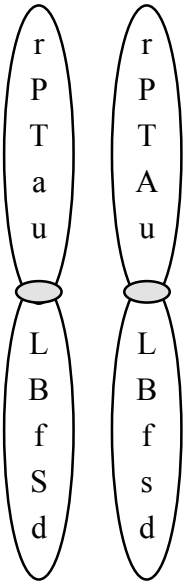


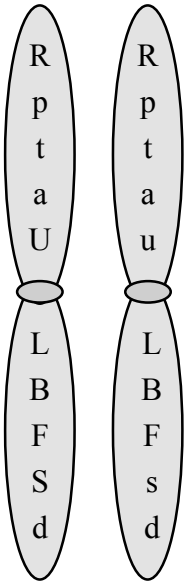


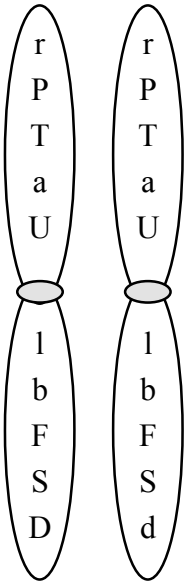


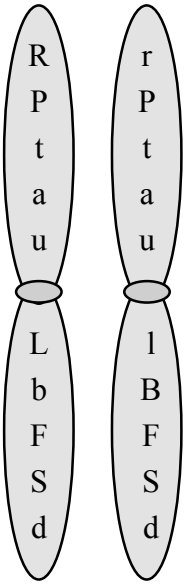


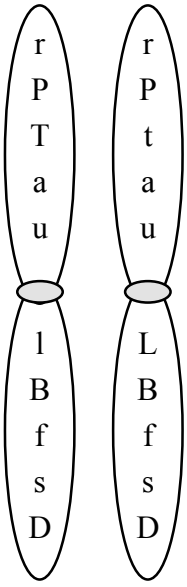












Name _____ Date _____ Assignment _____

Student Worksheet

Record the genotypes and phenotypes of your models in the chart below. Refer to the *Table of Traits* for help.

	Parent 1		Parent 2		Offspring 1		Offspring 2	
Trait	Genotype	Phenotype	Genotype	Phenotype	Genotype	Phenotype	Genotype	Phenotype
Example: Ears	*Pp*	*Pointy*	*Pp*	*Pointy*	*PP*	*Pointy*	*pp*	*Round*
Eyes								
Ears								
Nose								
Head								
Antennae								
Neck								
Trunk								
Fingers								
Legs								
Mouth								

Questions to consider and discuss. Refer to your charts and your models to answer these questions:

1. Are there traits (phenotypes) that both parents have but one offspring doesn't have? Explain.

_____

_____

2. Are there traits that both parents have but neither offspring has? Explain.

_____

_____

3. Are there traits that neither parent has but one offspring has? Explain.

_____

_____

4. Are there traits that neither parent has but both offspring have? Explain

_____

_____

5. What are some results that surprise you or confuse you?

_____

_____

6. Were the offspring that your group produced the only offspring possible from these parents? Explain.

_____

_____

7. What other genotypes/phenotypes were possible in the offspring? Fill in the chart to show these possibilities

	Possible 1		Possible 2	
Trait	Genotype	Phenotype	Genotype	Phenotype
Example: Ears	*Pp*	*Pointy*	*Pp*	*Pointy*
Eyes				
Ears				
Nose				
Head				
Antennae				
Neck				
Trunk				
Fingers				
Legs				
Mouth				

Group Members:

Parent 1 _____

Parent 2 _____

Offspring 1 _____

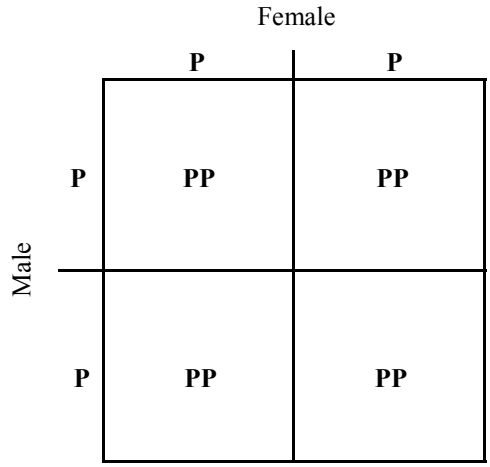
Offspring 2 _____

Name _____ Date _____ Assignment _____

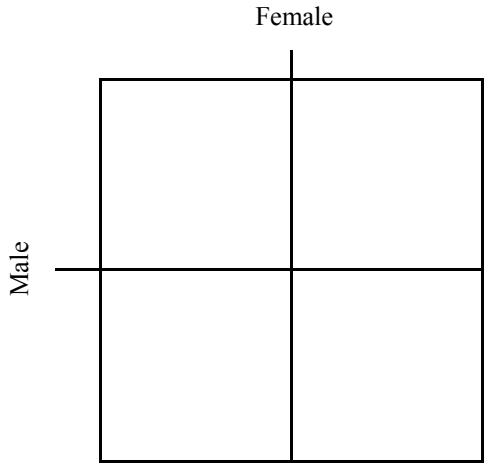
Punnett Squares

A Punnett square is a tool for determining the odds that a particular genotype or phenotype will result from 2 individuals reproducing sexually (remember, in *asexual* reproduction all the "offspring" are identical to the "parent").

As an example, look at what would happen if an alien male with the genotype PP (both dominant for pointy ears) mates with a female with the genotype PP. All sperm that the male produces will have the dominant "P" gene and all eggs produced by the female will have the dominant "P" gene. Inside the boxes are the possible combinations that might result when the male and female sex cells get together through fertilization:



Surprise! ALL the offspring, 4/4, will have a genotype PP and a phenotype of pointy ears. It is not possible for these two aliens to produce offspring with round ears. Ever. (Unless there is some sort of *mutation*, which we will discuss later).



Now pick one trait from your chart where each parent has a different genotype and use a Punnett square to determine the possible outcomes. Use the bottom to write the ratios (out of 4 possible outcomes) for each possible genotype and each possible phenotype.

Genotypes: (XX) (Xx) (xx)

$\frac{\quad}{4}$ $\frac{\quad}{4}$ $\frac{\quad}{4}$

_____ _____ _____

(Convert the ratios to decimals)

Phenotypes: Dominant Recessive

$\frac{\quad}{4}$ $\frac{\quad}{4}$

_____ _____

(Convert the ratios to decimals)

Instructions for Modeling Probability

Students will use some sort of game to model the act of fertilization and record the genotypes/phenotypes of the offspring that would result from that fertilization. This is to show that in the real world with small numbers, the results do not always match the (Punnett Square) predictions and leads to a better understanding of what "probability" means. Use the worksheet on the following page to record results.

Note: You may want to confer with the math teacher on how to go forward with the concept of probability. Technically speaking, probability is expressed as a fraction or a decimal (1/2 or 0.5, for example) but not as a percentage (50%)

Option 1:

Use coins but write the letters on the coins using labels. Do not require students, for example, to translate "heads = B, tails = b." Working in pairs, each student gets a coin, one represents the male, the other represents the female. Each flip of the coin represents the possible allele that the sex cell will have. Each time male and female coins are flipped represents a fertilization. Record the genotype/phenotype of the offspring.

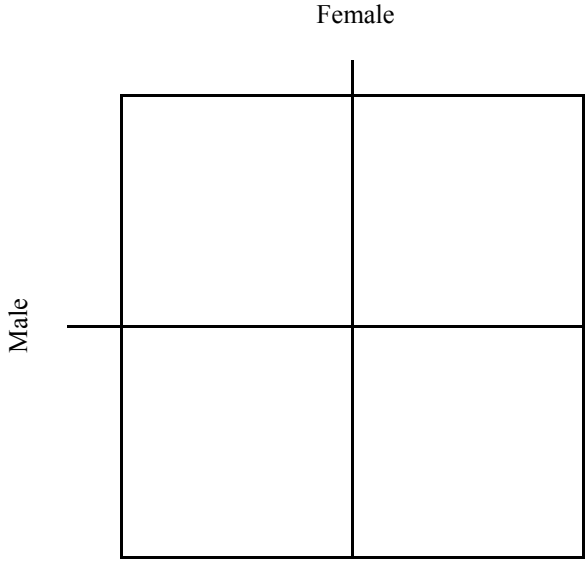
Option 2:

The meiotic division of a cell results in 4 possible sex cells (in the female only one sex cell actually results, but that's another story). To mirror this idea, use 4 beans (lima beans are best). Write the possible alleles on the lima beans with a marker (B or b, for example). Place 4 beans that represent all the possible alleles (2 with the "B" allele and 2 with "b" alleles for heterozygous parents) in a film canister. Again, each student gets a canister, one represents the male and the other the female. Shake the canisters, pull out one bean from each can. Each time male and female sex cells (beans) are selected represents a fertilization that will lead to an offspring. Record the genotype of the offspring.

Name_____ Date_____ Assignment _____

What are the Odds?

On the simplest level, the Punnett square allows us to state the odds that a particular genotype or phenotype will result from each fertilization. Fill in the Punnett square below to determine the odds that a particular outcome will occur if both parents have the genotype Bb for trunk shape.



Genotypes: (BB) (Bb) (bb)

$\frac{\quad}{4}$ $\frac{\quad}{4}$ $\frac{\quad}{4}$

_____ _____ _____

(Convert the ratios to decimals)

Phenotypes: Dominant Recessive

$\frac{\quad}{4}$ $\frac{\quad}{4}$

_____ _____

(Convert the ratios to decimals)

Based on the Punnett square, what do you expect will happen (genotype and phenotype) when these two aliens have their first child?

(It will probably…) _____

_____

What if they have 4 children?

_____

_____

What if they have 100 children?

_____

_____

Now let's see how well our predictions hold true if we "scale up."

The boxes that you receive hold the sex cells for a pair of aliens. Much like humans, the alien males produce sperm throughout most of their lives, while the female is born with a limited number of eggs (only about 400 are released during a female lifetime). Each box contains an equal number of maternal and paternal chromosomes, and we will only look at one gene on that chromosome, the gene for trunk shape (Bb).

You will randomly select a male sex cell and a female sex cell and record the genotype and phenotype for that particular "fertilization." Since both parents have a genotype of Bb, each time you pull out a sex cell, there is a 50/50 chance that you will get either of those possibilities. Place the sex cell back in the box after recording each attempt.

Attempt #	Genotype	Phenotype
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

Attempt #	Genotype	Phenotype
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		

In the box below, record the ratios at each of the intervals listed (4 tries, 10 tries, 25 tries)
How close is the prediction (Punnett square) to "reality" after 4 tries? After 10 tries? After 25 tries?

Ratios for each "type"

	Attempts	4	10	25	*Prediction*
Genotype	BB				
	Bb				
	bb				
Phenotype	Dominant				
	Recessive				