Dragon Investigations

Activities for Reasoning about Genetics Using GenScope™ Dragons

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Name _____

From Genotypes to Phenotypes

Genetics defines inheritance patterns within a species. The genetic make up of an individual is its *genotype*. If you have information about dragon genetics, you can determine a dragon's *phenotype* (observable characteristics) from its genotype.

DRAGON GENETICS

Horns: Horns dominant to no horns.

Wings: Wings recessive to no wings.

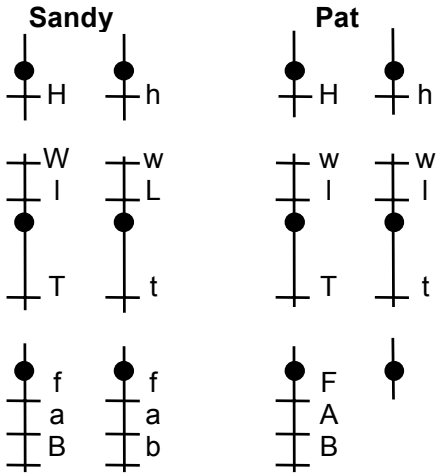
Legs: Four legs incompletely dominant to no legs; Two legs intermediate.

Tail: Fancy tail dominant to plain tail.

Fire: Breathing fire recessive to not breathing fire.

Sex: Females are XY. They have one X chromosome and one Y chromosome. Males are XX. They have two X chromosomes.

TWO DRAGON GENOTYPES



Sex Determination

1. Is Sandy a male or a female? _____ Is Pat a male or a female? _____

Genotype-Phenotype Mapping

For each mode of inheritance, figure out Sandy's and Pat's phenotypes. (The first one is done for you.)

Mode of Inheritance	Characteristic	Phenotype	
		Sandy	Pat
Autosomal, Simple Dominance	2. Does it have horns?	yes	_____
	3. Does it have wings?	_____	_____
	4. What kind of tail?	_____	_____
Autosomal, Incomplete Dominance	5. How many legs?	_____	_____
X-Linked, Simple Dominance	6. Does it breathe fire?	_____	_____

Name _____

From Phenotypes to Genotypes

We usually don't know the genotype of an individual. One way to figure out a genotype is using what is known about the genetics of the species to determine the possible genotypes for an individual's phenotype.

DRAGON GENETICS		TWO DRAGON PHENOTYPES	
		Ernest	**Jill**
Horns:	Horns dominant to no horns.	male	female
Wings:	Wings recessive to no wings.	no horns	horns
Legs:	Four legs incompletely dominant to no legs; Two legs intermediate.	wings	wings
Tail:	Fancy tail dominant to plain tail.	four legs	two legs
Fire:	Breathing fire recessive to not breathing fire.	fancy tail	plain tail
Sex:	Females are XY. They have one X chromosome and one Y chromosome. Males are XX. They have two X chromosomes.	no fire	fire

Phenotype-Genotype Mapping

For each characteristic, circle ALL of Ernest's and Jill's possible genotypes. The – (dash) , in H– for example, represents the Y chromosome. (The first one is done for you.)

Mode of Inheritance	Characteristic	Ernest				
Autosomal, Simple Dominance	1. Horns	HH	Hh	(hh)	H–	h–
	2. Wings	WW	Ww	ww	W–	w–
	3. Tail	TT	Tt	tt	T–	t–
Autosomal, Incomplete Dominance	4. Legs	LL	Ll	ll	L–	l–
X-Linked, Simple Dominance	5. Fire	FF	Ff	ff	F–	f–

Mode of Inheritance	Characteristic	Jill				
Autosomal, Simple Dominance	6. Horns	HH	Hh	hh	H–	h–
	7. Wings	WW	Ww	ww	W–	w–
	8. Tail	TT	Tt	tt	T–	t–
Autosomal, Incomplete Dominance	9. Legs	LL	Ll	ll	L–	l–
X-Linked, Simple Dominance	10. Fire	FF	Ff	ff	F–	f–

Name _____

From Parent to Offspring I

If you know the genotypes of two parents, you can determine the possible genotypes and phenotypes of their offspring. You can then use the possible phenotypes to determine the probability of seeing particular traits among the offspring.

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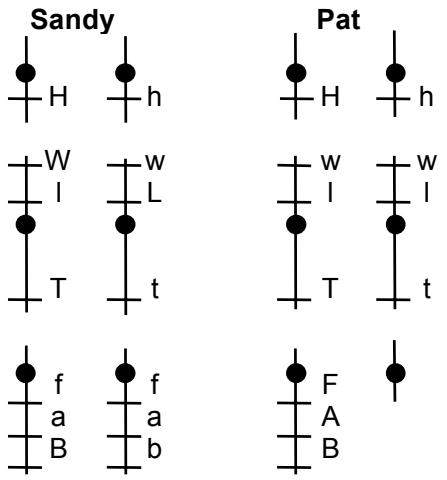
TWO DRAGON GENOTYPES

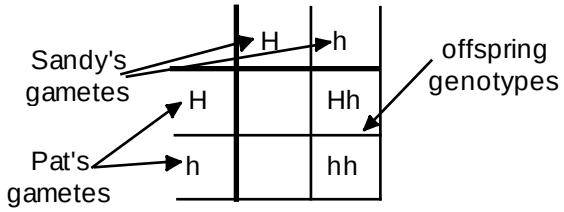


Monohybrid Inheritance I: Autosomal Simple Dominance

Fill in the Punnett square for each problem. Then use the information to answer the questions about the possible offspring. (The first one is started for you.)

1. **Horns.** Fill in the Punnett square to figure out the baby's possible genotypes (HH, Hh, or hh).

(Hh X Hh)



1a. Will the baby have **horns**?

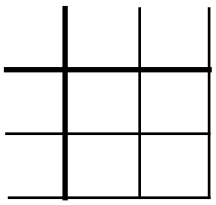
Definitely yes_____ Maybe____ Definitely no_____

1b. What are the chances the baby will have **no horns**?

0 ___ 1/4 ___ 1/2 ___ 3/4 ___ 1/1___

2. **Wings.** Fill in the Punnett square to figure out the baby's possible genotypes (WW, Ww, or ww).

(Ww X ww)



2a. Will the baby have **wings**?

Definitely yes_____ Maybe____ Definitely no_____

2b. What are the chances the baby will have **no wings**?

0 ___ 1/4 ___ 1/2 ___ 3/4 ___ 1/1___

Name _____

From Parent to Offspring II

If you know the genotypes of two parents, you can determine the possible genotypes and phenotypes of their offspring. You can then use the possible phenotypes to determine the probability of seeing particular traits among the offspring.

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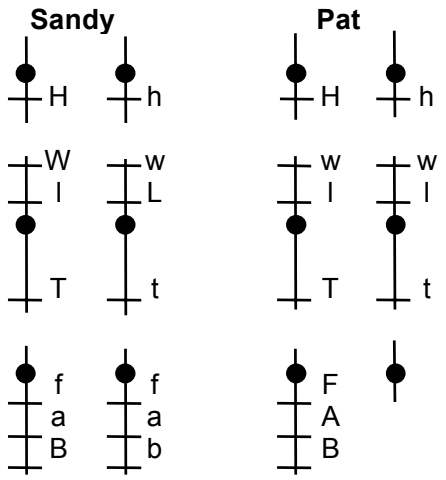
TWO DRAGON GENOTYPES



Monohybrid Inheritance II: Other Modes of Inheritance

Make and fill in a Punnett square for each problem. Then use the information to answer the questions about the offspring.

1. **Legs** (? X ?) (Autosomal, Incomplete Dominance)	1a. What are the chances the baby will have **no legs**? 0 ___ 1/4 ___ 1/2 ___ 3/4 ___ 1/1___ 1b. What are the chances the baby will have **two legs**? 0 ___ 1/4 ___ 1/2 ___ 3/4 ___ 1/1___ 1c. What are the chances the baby will have **four legs**? 0 __ 1/4 ___ 1/2 ___ 3/4 ___ 1/1___
2. **Fire** (? X F–) (X-linked, Simple Dominance)	2a. What are the chances the baby will **breathe fire**? 0 ___ 1/4 ___ 1/2 ___ 3/4 ___ 1/1___ 2b. What are the chances a baby will be female AND **breathe fire**? 0 ___ 1/4 ___ 1/2 ___ 3/4 ___ 1/1___ 2c. What are the chances a **male** baby will **breathe fire**? 0 ___ 1/4 ___ 1/2 ___ 3/4 ___ 1/1___

Name _____

Dihybrid Inheritance I

Sometimes it is useful to figure out inheritance for more than one characteristic at a time. Working with two characteristics at a time is called *dihybrid* inheritance.

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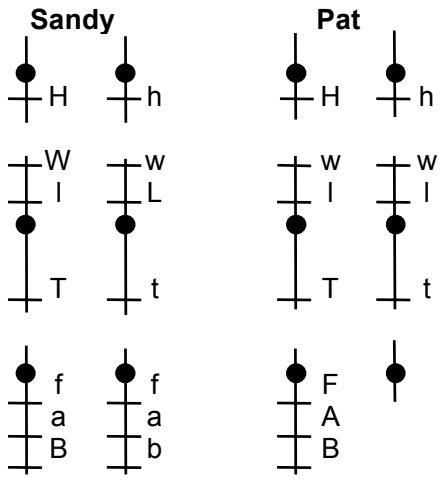
TWO DRAGON GENOTYPES



Use Sandy and Pat's genotypes to complete a Punnett square for each problem. Then use the information to answer the questions about the offspring. (The first one is started for you.)

1. Horns & Wings (HhWw X Hhww)

Sandy / Pat	HW	Hw	hW	hw
Hw	HHWw horns/ no wings	HHww	HhWw	
hw	HhWw horns/ no wings	Hhww	hhWw	

1a. Will the baby have **no horns** and **no wings**?

Definitely yes_____ Maybe_____ Definitely no_____

1b. What are the chances the baby will have **no horns** and **no wings**?

2. Horns & Legs (HhLl X Hhll)

Sandy / Pat				

2a. Will the baby have **two legs** and **no horns**?

Definitely yes_____ Maybe_____ Definitely no_____

2b. What are the chances the baby will have **two legs** and **horns?**

Name _____

Dihybrid Inheritance II

Sometimes it is useful to figure out inheritance for more than one characteristic at a time. Working with two characteristics at a time is called *dihybrid* inheritance.

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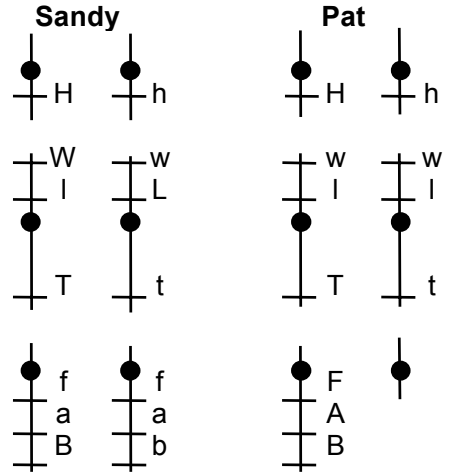
Horns:	Horns dominant to no horns.	
Wings:	Wings recessive to no wings.	
Legs:	Four legs incompletely dominant to no legs; Two legs intermediate.	
Tail:	Fancy tail dominant to plain tail.	
Fire:	Breathing fire recessive to not breathing fire.	
Sex:	Females are XY. They have one X chromosome and one Y chromosome. Males are XX. They have two X chromosomes.	

Use Sandy and Pat's genotypes to create Punnett squares for each problem. Then use the information to answer the questions about the offspring.

1. Horns & Tail (HhTt X ?)	1a. Will the baby have **horns** and a **fancy tail**? Definitely yes_____ Maybe_____ Definitely no_____ 1b. What are the chances the baby will have **no horns** and a **plain tail**? 1c. What are the chances the baby will have **horns** and a **fancy tail**?
2. Wings & Legs (? X ?)	2a. Will the baby have **no wings** and **two legs**? Definitely yes_____ Maybe_____ Definitely no_____ 2b. What are the chances the baby will have **wings** and **two legs**? (Hint: think about where these genes are located and events that occur during meiosis.)

Name _____

From Offspring to Mode of Inheritance

We often don't know the genotypes of individuals or the genetics of the species for a particular characteristic. One way to figure out the genetics of a particular characteristic is to carefully study of the patterns of inheritance of phenotypes.

Fangs

Another inherited characteristic in dragons is Fangs. Both Sandy and Pat have no fangs. But when you look at 100 of their offspring, you find the following:

- 29 (13 males and 16 females) have fangs
- 71 (37 males and 34 females) have no fangs

Monohybrid Inheritance III: Phenotypes to Genotypes

Use the information about the offspring to explain the mode of inheritance. Remember that in dragons, males are XX and females are XY.

1. The Fangs gene has two alleles–*fangs* and *no fangs*. The relationship between the two alleles is **simple dominance** (rather than incomplete dominance).

   What is it about the **offspring phenotypes** that indicates that the relationship is simple dominance?

2. The *no fang*s allele is **dominant** to the *fangs* allele (rather than the *no fangs* allele being recessive or incompletely dominant to the *fangs* allele).

   What is it about the **offspring data** that indicates that the *no fangs* allele is dominant to the *fangs* allele?

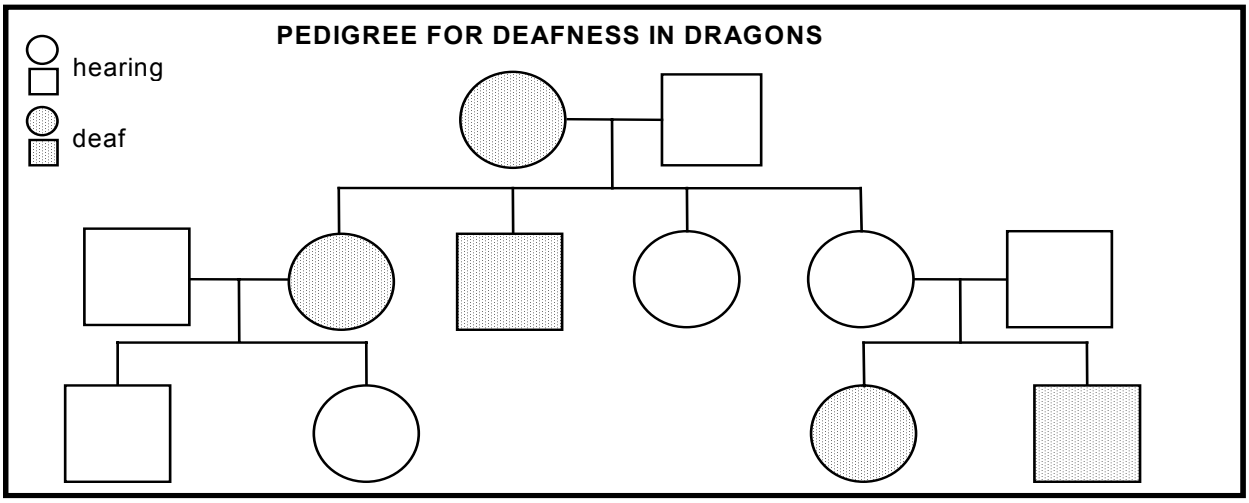
3. The gene for Fangs is **autosomal** (rather than X-linked).

   What is it about the **offspring data** that indicates that the Fangs gene is autosomal?

Name _____

From Pedigree to Mode of Inheritance I

When learning about new genes, sometimes it is useful to make a pedigree chart to track how the gene is inherited. If you know about the possible modes of inheritance, you can use the information in a pedigree chart to rule out all but one. In a pedigree chart, females are represented by circles and males are represented by squares.



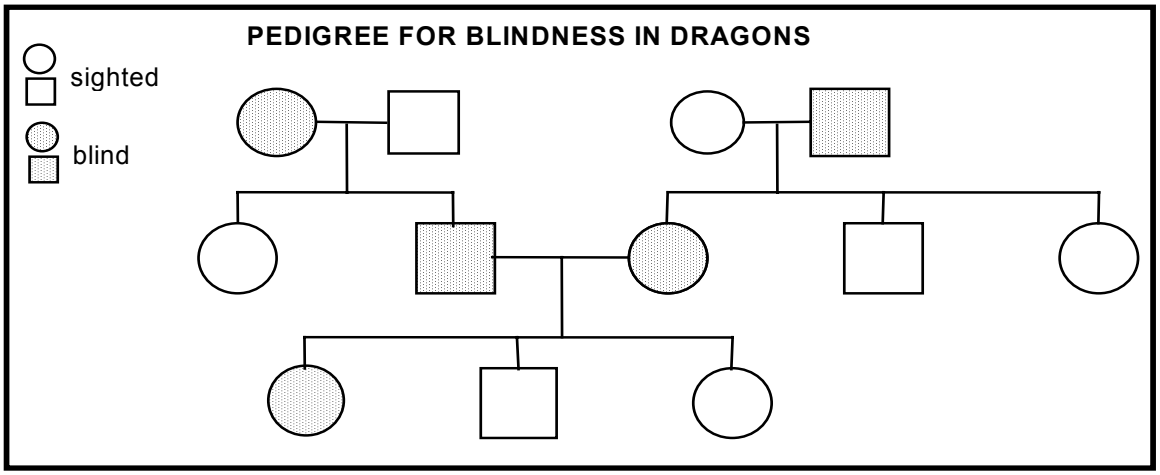
Consider another trait in dragons, deafness. In dragons, deafness is determined by a single gene.

1a. Is the allele for deafness dominant or recessive? Answer _____
1b. Draw a circle around <u>only</u> the individuals and relationships that told you whether deafness was dominant or recessive.
1c. How does the circled part of the pedigree tell you whether the allele for deafness is dominant or recessive?
1d. Is the gene for Deafness autosomal or X-linked? Remember that in dragons, males are XX and females are XY. Answer _____
1e. If you haven't already, write the genotype on each individual that proves whether the Deafness gene is autosomal or X-linked. Use **D** for dominant alleles and **d** for recessive alleles.

Name _____

From Pedigree to Mode of Inheritance II

When learning about new genes, sometimes it is useful to make a pedigree chart to track how the gene is inherited. If you know about the possible modes of inheritance, you can use the information in a pedigree chart to rule out all but one. In a pedigree chart, females are represented by circles and males are represented by squares.



Consider another dragon trait, blindness. In dragons, blindness is determined by a single gene.

1a. Is the allele for blindness dominant or recessive? Answer _____
1b. Draw a circle around <u>only</u> the individuals and relationships that told you whether the allele for blindness is dominant or recessive.
1c. How does the circled part of the pedigree tell you whether the allele for blindness is dominant or recessive?
1d. Is the gene for Blindness autosomal or X-linked? Remember that in dragons, males are XX and females are XY. Answer _____
1e. If you haven't already, write the genotype on each individual that proves whether the Blindness gene is autosomal or X-linked. Use **B** for dominant alleles and **b** for recessive alleles.

Name _____

Alignment vs. Crossover during Meiosis

You can learn about the complex processes that occur during meiosis by considering the genotypes of the gametes in light of the parental genotypes.

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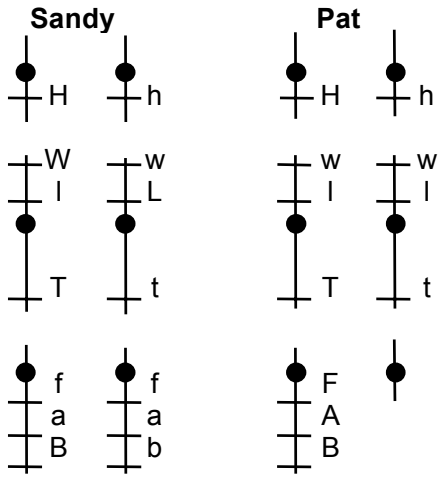
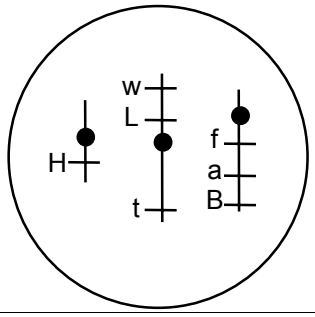
TWO DRAGON GENOTYPES



Gamete A

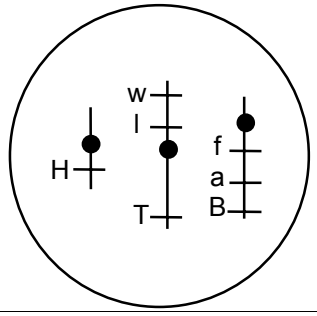


1. Was crossing over necessary for Sandy to produce Gamete A?

   Answer _____

1a. **If** crossing over was necessary, circle the chromosome(s) in Gamete A that resulted from crossing over.

Gamete B



2. Was crossing over necessary for Sandy to produce Gamete B?

   Answer _____

2a. **If** crossing over was necessary, circle the chromosome(s) in Gamete B that resulted from crossing over.

Name _____

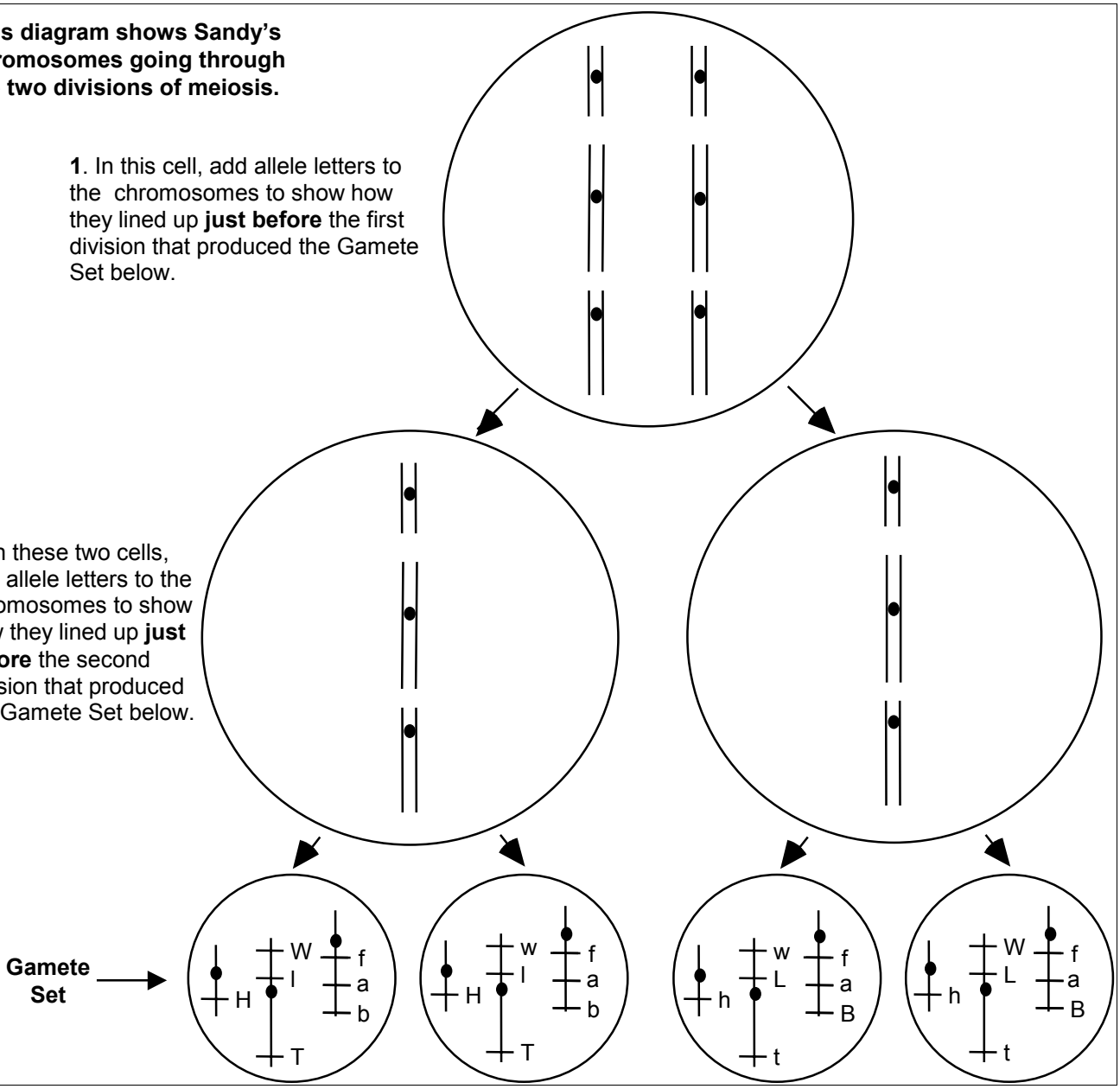
From Chromosomes to Gametes

Gametes are formed by the process of meiosis. It is useful to be able to figure out how the events that occur during meiosis result in particular gametes.

This diagram shows Sandy's chromosomes going through the two divisions of meiosis.

1. In this cell, add allele letters to the chromosomes to show how they lined up **just before** the first division that produced the Gamete Set below.

2. In these two cells, add allele letters to the chromosomes to show how they lined up **just before** the second division that produced the Gamete Set below.



This diagram shows Sandy's chromosomes at the beginning of meiosis.

3. Use arrows on this diagram to show the location of any crossovers needed to produce the Gamete Set above.