Instructor's Manual

Lab 3 Inheritance

Answers to Lab 3 Concept Review Questions

1. Two pea plant traits studied by Mendel include these: **flower position, flower color, stem/plant height, pea shape, pea color, pod shape, and pod color.**

2. **Genotype is defined as the alleles (genetic material) carried by an individual.**

3. **Phenotype is the physical expression of the alleles carried by an individual.**

4. A pea plant heterozygous for tallness is tall because the **dominant allele masks the effect of the recessive allele.**

5. **B. *tt*** is the genotype for a pea plant with recessive phenotype for tallness (not *TT*, *Tt*, or *TT* or *Tt*).

6. **D. *TT* or *Tt*** is the genotype for a pea plant with the dominant phenotype for tallness (not *TT*, *tt*, or *Tt*; note that D is the best choice among correct answers).

7. Difference: **Mendelian traits are determined by alleles at one genetic locus, whereas polygenic traits are determined by alleles at more than one genetic locus.**

8. **C. Skin color** is a polygenic trait in humans (not hitchhiker's thumb, earlobe attachment, or freckles).

9. ***AA* and *AO*** are the possible genotypes for a person who has the A blood type.

10. ***OO*** is the possible genotype for a person who has the O blood type.

Answers to Lab 3 Exercises

Exercise 1: Creating Punnett Squares (10 to 15 minutes)

Students are asked to complete the blank Punnett squares given genotypes for six people:

Timmy is homozygous dominant for freckle trait (*FF*)

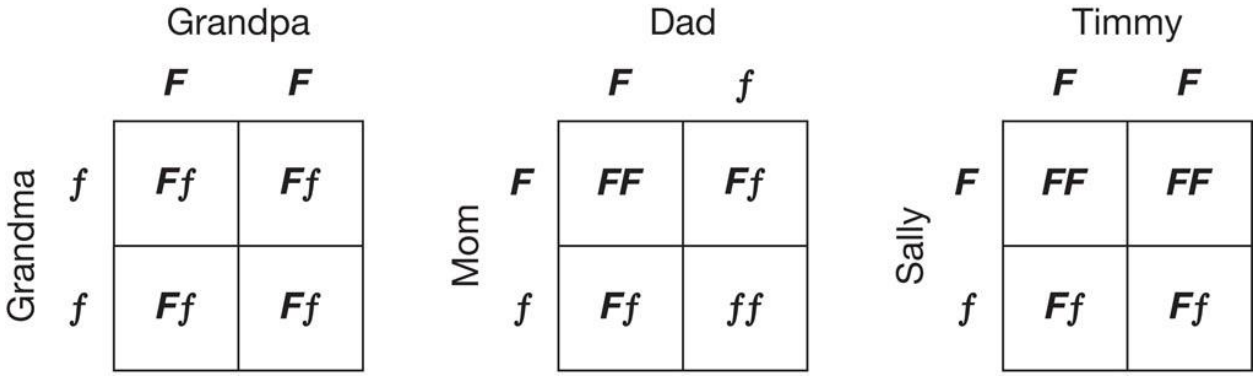
Sally is heterozygous (*Ff*)

Mom is heterozygous (*Ff*)

Dad is heterozygous (*Ff*)

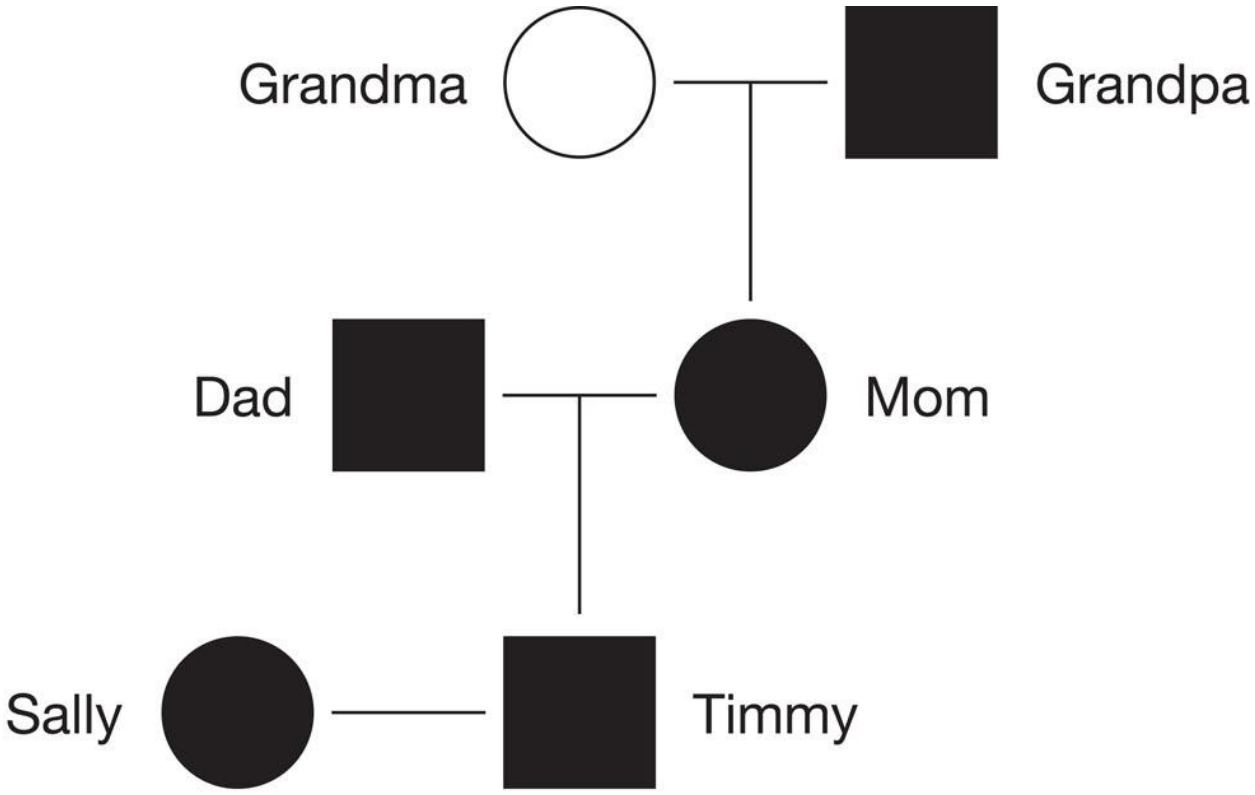
Grandma is homozygous recessive (*ff*)

Grandpa is homozygous dominant (*FF*)



Exercise 2: Creating Pedigree Diagrams (10 to 15 minutes)

Students use the family from Exercise 1 to make a pedigree diagram, with males denoted as squares, females as circles, matings as horizontal lines, and offspring as vertical lines. Expression of the trait in question is indicated by filled symbols, here indicating freckles being dominant over no freckles (Mendelian inheritance at the F *locus). Note that mating partners can be reversed. For example, in the pedigree shown Grandma is on the left and Grandpa on the right. This could be written with Grandma on the right and Grandpa on the left.*



Exercise 3: Interpreting Punnett Squares (10 to 15 minutes)

Students interpret the Punnett square showing the mating of Dad and Mom (both Rr for *tongue rolling).*

1. What is the mother's genotype? ***Rr*** **(heterozygous)**

2. What is the mother's phenotype? **Dominant (ability to roll tongue)**

3. What is the father's genotype? ***Rr*** **(heterozygous)**

4. What is the father's phenotype? **Dominant (ability to roll tongue)**

5. What is the probability of their daughter Maria having each of the possible genotypes and phenotypes?

Genotypes: 25% *RR*; 25% *rr*; 50% *Rr*

Phenotypes: 75% dominant (ability to roll tongue); 25% recessive (inability to roll tongue)

6. Are you 100% sure of the parents' phenotypes? Are you 100% sure of Maria's phenotype? If not, which are problematic? Why?

For the parents, yes, we know they have the ability to roll the tongue (phenotype) because they possess a dominant *R* allele that masks the effect of the recessive allele. For Maria, no, we can't be 100% confident in her phenotype because the Punnett square only shows us the *possible* outcomes of her parents' mating.

7. Are you 100% sure of the parents' genotypes? Are you 100% sure of Maria's genotype? If not, which are problematic? Why?

Yes, we are sure of the parents' genotypes because they were given in the Punnett square. No, we can't be 100% confident in Maria's genotype because the Punnett square only shows us the *possible* outcomes of her parents' mating.

Exercise 4: Interpreting Pedigree Diagrams (10 to 15 minutes)

The completed chart is based on the pedigree diagram for the tongue rolling trait given in the lab manual.

Person	Genotype	Phenotype
A	*rr*	Recessive
B	*rr*	Recessive
C	*Rr*	Dominant
D	*RR* or *Rr*	Dominant
E	*Rr*	Dominant
F	*rr*	Recessive
G	*RR* or *Rr*	Dominant

1. Are you 100% sure of the phenotypes? If not, which are problematic? Why?

Yes, we are100% sure of all phenotypes because that is what the pedigree diagram shows (solid symbols = dominant phenotype, outline symbols = recessive phenotype).

2. Are you 100% sure of the genotypes? If not, which are problematic? Why?

We are 100% sure of genotypes for individuals A, B, and F because they are recessive and only one genotype is possible. We are sure of individuals C and E because based on their close relationship with someone (parent or offspring) who is recessive, they must be heterozygous. We're not sure of individuals D and G because we don't have enough information to distinguish if they are heterozygous or homozygous dominant.

Exercise 5: Mendelian Traits in Humans 1 (10 to 15 minutes)

For this exercise, we encourage you to have your students use letters that are appropriate for each of the five traits, such as C *for cleft chin (dominant),* F *for freckles (dominant),* E *for earlobes (recessive),* H *or* T *for hitchhiker's thumb (recessive), and* W *for widow's peak (dominant).*

Answers will vary, but entries in the chart for phenotype and genotype should correspond appropriately.

Exercise 6: Mendelian Traits in Humans 2 (10 to 15 minutes)

For this exercise, which like all exercises is optional for the instructor, you will need to purchase phenylthiocarbamide (PTC) taste strips, which are widely available from scientific supply companies. Be sure to order and provide students with an equal number of PTC strips and control strips.

Note: If your class is small enough, you may want to have students report their results to the class. You can track their answers on the board and then ask students to see how they compare to the class as a whole. In order to facilitate comparisons in a larger class, you may want to have students work in groups. Each student will conduct their own test, and they will compare their results within their group.

1. Are you a PTC taster? Do you have the dominant phenotype or the recessive phenotype?

   Answers will vary, but "taster" = dominant phenotype, "nontaster" = recessive phenotype.

2. What is your possible genotype(s)?

   Answers will vary, but should match answer above. Dominant phenotype = *TT* or *Tt*, recessive phenotype = *tt*.

3. Discuss your results with several of your classmates. How do you compare to other people?

   Answers will vary (especially by population and ancestry), but generally 25% of people are nontasters, and 75% of people are tasters.

Exercise 7: The ABO Blood System (5 to 10 minutes)

Students are to answer the questions about the ABO blood system and blood type compatibility.

1. Can a person with type A blood successfully receive a transfusion from a person who has type O? Why or why not?

Yes, because the type O blood does not introduce any foreign antigens.

2. Can a person with type A blood successfully receive a transfusion from a person who has type B? Why or why not?

No, because the type B blood introduces foreign B antigens.

3. Can a person with type O blood successfully donate their blood to a person who has type AB? Why or why not?

Yes, because the type O blood does not introduce any foreign antigens.

4. Can a person with type B blood successfully donate their blood to a person who has type O? Why or why not?

No, because the type B blood introduces foreign B antigens.

5. Can a person with type AB blood successfully donate their blood to a person who has type A? Why or why not?

No, because although the A antigens in the AB blood are not foreign, the B antigens are foreign.

Exercise 8: Dihybrid Cross (10 to 15 minutes)

In this exercise, students read through Scenario A to learn how to use Punnett squares for diagramming inheritance of two traits simultaneously (pea plant height and flower color). Scenario B involves estimating the inheritance of the two Mendelian traits freckles (dominant) and widow's peak (recessive) in humans. Suzy is heterozygous for both traits, and Jose is homozygous recessive for both. Students should complete the Punnett square for Scenario B.

Suzy: *FfWw*

Jose *ffww*	***FW***	***Fw***	***fW***	***fw***
fw	*FfWw*	*Ffww*	*ffWw*	*ffww*
fw	*FfWw*	*Ffww*	*ffWw*	*ffww*
fw	*FfWw*	*Ffww*	*ffWw*	*ffww*
fw	*FfWw*	*Ffww*	*ffWw*	*ffww*

1. What is the likelihood that Suzy and Jose's child will have freckles but will not have a widow's peak? **25%**
2. What is the likelihood that Suzy and Jose's child will not have freckles but will have a widow's peak? **25%**
3. What is the likelihood that Suzy and Jose's child will have freckles and a widow's peak? **25%**
4. What is the likelihood that Suzy and Jose's child will not have freckles or a widow's peak? **25%**

Answers to Lab 3 Critical Thinking Questions

1. Law of segregation: Mendel recognized that traits are controlled by distinct units. Our modern understanding of sexual reproduction and meiosis confirms that genes appear separately in the sex cells of the parents and are brought together in the offspring.

   Law of independent assortment: Mendel noticed that the pea plant traits were often inherited separately from one another. Our modern understanding of meiosis confirms that genes on nonhomologous chromosomes are sorted independently in gametes.

2. Timmy was homozygous dominant for trait *F*. Looking at the Punnett square for his parents' mating (Mom and Dad both *Ff*), what was the probability of Timmy having a different genotype? What was the probability of Timmy having a different phenotype?

   Different genotype = 75% chance (50% chance of *Ff*; 25% chance of *ff*)

   Different phenotype = 25% chance (25% chance of recessive phenotype)

   Timmy's mother was heterozygous for trait *F*. Looking at the Punnett square for the grandparents' mating (Grandpa *FF* and Grandma *ff*), what was the probability of Timmy's mother having a different genotype? What was the probability of Timmy's mother having a different phenotype?

   Different genotype = 0% chance; different phenotype = 0% chance

3. The complete chart is as follows:

	Punnett Square	**Pedigree Diagram**
Shows One Mating at a Time	X	
Shows Multiple Generations at a Time		X
Shows Phenotypes		X
Requires You to Infer Phenotypes	X	
Shows Genotypes	X	
Requires You to Infer Genotypes		X
Shows Real Individuals	X (parents)	X (all people)
Shows Potential Individuals	X (an offspring)	

4. Answers will vary, depending on students' analysis of themselves for the five Mendelian traits in Exercise 5 (cleft chin, freckles, attached earlobes, hitch-hiker's thumb, and widow's peak). For unclear genotypes, students are to collect phenotypes of parents and siblings to help elucidiate them. *Note*: This question could be modified to ask students to actually create the appropriate pedigree diagram for each of the traits in question.
5. No, in the the dihybrid cross in Exercise 8 inheriting one trait did not necessarily impact the inheritance of the other. There was a 50% chance that Suzy and Jose's child would have freckles. Of that, there was an equal likelihood of the child having or not having a widow's peak. This demonstrates that Mendel's law of independent assortment was correct. The two traits are inherited separately, and one trait does not necessarily impact the inheritance of the other. *Note*: This question could be completed as part of Exercise 8.
6. Yes, it is possible that Max is the father of this litter of puppies. Based on the pedigree information (see diagram), it is possible that both Max and Stella are heterozygous (*Nn*) for

this trait. If this is the case, then there is a 25% chance that each puppy will have agouti fur (*nn*). *Note*: In the pedigree diagram shown, normal puppies are also included in Stella and Max's litter, and sexes of puppies may vary.