SOLUTIONS TO THE STUDY GUIDE FOR MODULE #8

1. a. True breeding – If an organism has a certain characteristic that is always passed on to its offspring, we say that this organism bred true with respect to that characteristic.

b. Allele – One of a pair of genes that occupies the same position on homologous chromosomes

c. Genotype – Two-letter set that represents the alleles an organism possesses for a certain trait

d. Phenotype – The observable expression of an organism's genes

e. Homozygous genotype – A genotype in which both alleles are identical

f. Heterozygous genotype – A genotype with two different alleles

g. Dominant allele – An allele that will determine phenotype if just one is present in the genotype

h. Recessive allele – An allele that will not determine the phenotype unless the genotype is homozygous in that allele

i. Mendel's principles of genetics using updated terminology:

1. The traits of an organism are determined by its genes.
2. Each organism has two alleles that make up the genotype for a given trait.
3. In sexual reproduction, each parent contributes ONLY ONE of its alleles to the offspring.
4. In each genotype, there is a dominant allele. If it exists in an organism, the phenotype is determined by that allele.

j. Pedigree – A diagram that follows a particular phenotype through several generations

k. Monohybrid cross – A cross between two individuals, concentrating on only one definable trait

l. Dihybrid cross – A cross between two individuals, concentrating on two definable traits

m. Autosomes – Chromosomes that do not determine the sex of an individual

n. Sex chromosomes – Chromosomes that determine the sex of an individual

o. Antigen – A protein that, when introduced in the blood, triggers the production of an antibody

p. Autosomal inheritance – Inheritance of a genetic trait not on a sex chromosome

q. Genetic disease carrier – A person who is heterozygous in a recessive genetic disorder

r. Sex-linked inheritance – Inheritance of a genetic trait located on the sex chromosomes

s. Mutation – A radical chemical change in one or more alleles

t. Change in chromosome structure – A situation in which a chromosome loses or gains genes during meiosis

u. Change in chromosome number – A situation in which abnormal cellular events in meiosis lead to either none of a particular chromosome in the gamete or more than one chromosome in the gamete

2. a. This homozygous genotype is "YY," resulting in a phenotype of yellow peas.
   b. This heterozygous genotype is "Yy," resulting in a phenotype of yellow peas.
   c. This homozygous genotype is "yy," resulting in a phenotype of green peas.

3. Meiosis separates the two alleles.

4. One parent is homozygous dominant, so its genotype is "AA." The other is heterozygous, so its genotype is "Aa." The Punnett square looks like:

	A	A
A	AA	AA
a	Aa	Aa

Thus, 50% of the offspring have the "AA" genotype and 50% have the "Aa" genotype. Since each offspring has at least one of the dominant allele, however, 100% have the axial flower phenotype.

5. Since the woman is heterozygous, her genotype is "Rr." The man cannot roll his tongue. Since the inability to roll your tongue is recessive, his genotype must be "rr." The resulting Punnett square is:

	R	r
r	Rr	rr
r	Rr	rr

Since having even one dominant allele allows you to be able to roll your tongue, 50% of the children will be able to roll their tongues.

6. Since the square that represents the male parent is filled, it means that he has a black coat. This means he has at least one dominant allele. One of the offspring is white-coated. The only way that can happen is for each parent to have at least one recessive allele. Thus, the genotype is "Bb."

7. Individuals 1 and 2 can tell us which allele is dominant. After all, the offspring have both phenotypes. This means that at least one of them is homozygous recessive. Thus, each parent must

have the recessive allele. They both have no wings, but they must also carry the allele for wings, since one of their offspring has wings. This means no wings ("N") is the dominant allele. Since they each must also have the recessive allele, 1 and 2 must have the "Nn" genotype. Since some of the offspring between 3 and 4 also have recessive traits, they both must have the recessive allele. However, they do not express the recessive trait, so 3 and 4 must also have the "Nn" genotype.

8. Since the parent with smooth, yellow peas is homozygous, its genotype is "SSYY." Since the other expresses both recessive alleles, it must be homozygous in the recessive alleles. Thus, its genotype is "ssyy." Both of these parents can only produce one type of gamete each. The one parent can only produce a *SY* allele and the other can only produce a *sy*. This gives us a 1x1 Punnett square.

	SY
sy	*SsYy*

Since there is only one possible genotype, 100% of the offspring have the "SsYy" genotype and the smooth, yellow phenotype.

9. Since the parents are both heterozygous in each allele, their genotypes are "SsYy." There are 4 possible gametes: *SY, Sy, sY, sy*. The resulting Punnett square, then, is:

	SY	*Sy*	*sY*	sy
SY	*SSYY*	*SSYy*	*SsYY*	*SsYy*
Sy	*SSYy*	*SSyy*	*SsYy*	*Ssyy*
sY	*SsYY*	*SsYy*	*ssYY*	*ssYy*
sy	*SsYy*	*Ssyy*	*ssYy*	*ssyy*

smooth, yellow peas (genotypes SSYY, SsYy, SSYy, SsYY) 9 of 16 or 56.25 %
smooth, green peas (genotypes SSyy, Ssyy) 3 of 16 or 18.75 %
wrinkled, yellow peas (genotypes ssYY, ssYy) 3 of 16 or 18.75 %
wrinkled, green peas (genotype ssyy) 1 of 16 or 6.25 %

10. If the female is heterozygous, then her genotype is X^RX^r. Since the male is white-eyed, his genotype is X^rY. The resulting Punnett Square is:

	X^r	Y
X^R	X^RX^r	X^RY
X^r	X^rX^r	X^rY

Thus, 50% of the females (remember, only XX's are females) will be white-eyed and 50% of the males (only XY's are males) will be white-eyed.

11. If the male were white-eyed, then the Punnett square would look like the one above, resulting in 50% of the females having white eyes. If the male were red-eyed, however, the resulting Punnett square looks like this:

	X^R	Y
X^R	X^RX^R	X^RY
X^r	X^RX^r	X^rY

This Punnett square tells us that no white-eyed females (XX) are produced. Thus, the male's genotype is X^RY.

12. If a gamete has two alleles for the same trait, it must have two of the same chromosome. In the fertilization process, then, there will be three chromosomes. Thus, a genetic disorder from a change in chromosome number will result.

13. The genetic disorder must be recessive. Thus, the person can carry the trait but, as long as he has the dominant allele, the person will not have the disease.

14. Sex-linked disorders affect men more frequently than women. This is because men have only one allele in sex-linked traits.

15. Not all traits are determined completely by genetics. Most are also determined by environmental factors and (in the case of humans) spiritual factors. While the genetics are the same, the environmental and spiritual factors were probably different.

16. Since the woman is type O, her genotype must be OO, as that would be the only way the recessive allele could be expressed. The man is type AB, so his genotype is "AB." The Punnett square, then, is given below:

	A	B
O	AO	BO
O	AO	BO

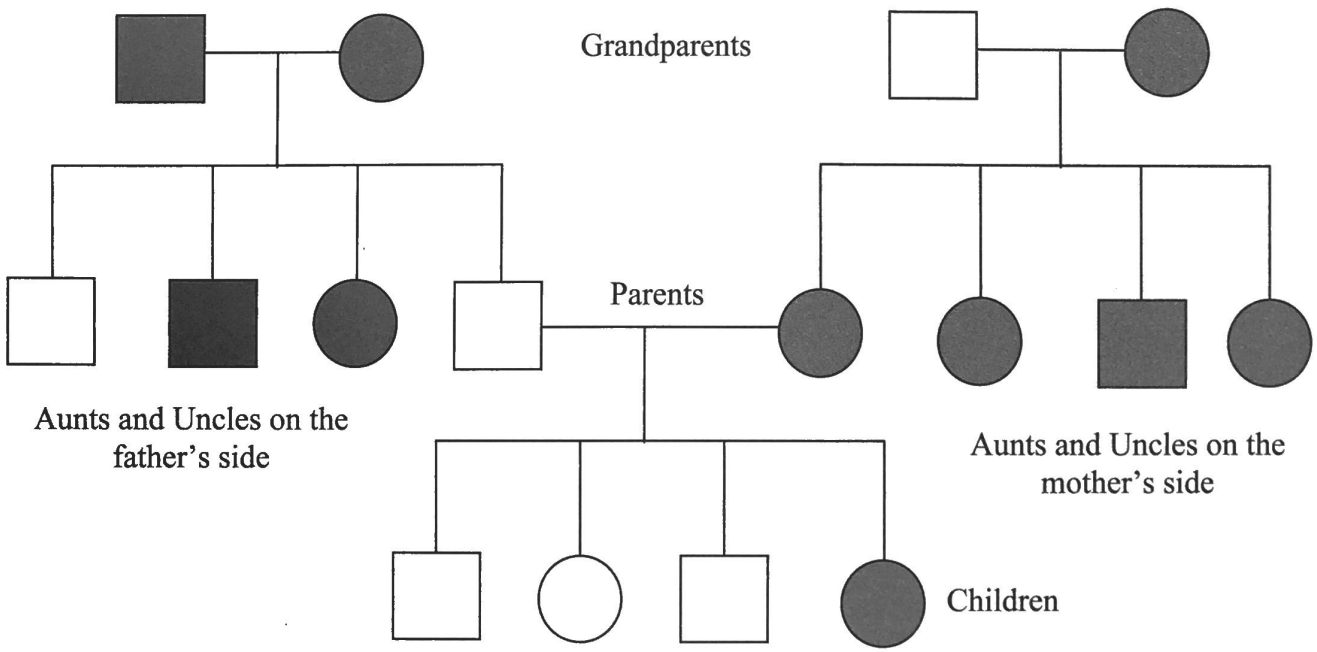
Since the O allele is recessive, the possible blood types for the children are A (50%) and B (50%).

17. Since the person is type B, the genotype must be either BB or BO. For the Rh-factor, the person expresses the recessive allele. Thus, her genotype must be homozygous in the recessive allele, which we called "pp" in "On Your Own" problem 8.10.

18. If a genetic trait is governed by many genes, we call it polygenetic inheritance.

ANSWERS TO EXPERIMENT 8.1

The free earlobe is dominant. If your pedigree can't determine this, that's fine. Now that you know the free earlobe is dominant, go back and review your pedigree to see if it makes sense. Here is an example of a family pedigree with respect to earlobe, using the filled circles and squares to represent free earlobes.



In this pedigree, you can see that the paternal grandparents have free earlobes, but they produce children with attached earlobes. Thus, they must each carry the recessive allele, so they are each heterozygous. The maternal grandfather has attached earlobes, and the maternal grandmother has free earlobes. Since all of their children have free earlobes, the maternal grandmother is probably homozygous in the free earlobe trait, because none of her children got an attached earlobe trait from her. The maternal grandfather must be homozygous in the attached earlobe trait, as that's the only way it could be expressed. In the same way, the father has attached earlobes and is therefore homozygous in that trait. The mother must be heterozygous, because she expresses the dominant trait, but since most of her children express the recessive trait, they had to get a recessive allele from her.

ANSWERS TO "EXPERIMENT" 8.2

1&2

	TR
tr	TtRr

3. The genotype is TtRr, making all children with the taster/roller phenotype.

4&5.

	TR	*Tr*	*tR*	tr
TR	*TTRR*	*TTRr*	*TtRR*	*TtRr*
Tr	*TTRr*	*TTrr*	*TtRr*	*Ttrr*
tR	*TtRR*	*TtRr*	*ttRR*	*ttRr*
tr	*TtRr*	*Ttrr*	*ttRr*	*ttrr*

6. roller / taster (genotypes TTRR, TtRr, TTRr, TtRR) 9 of 16 or 56.25 %
roller / nontaster (genotypes ttRR, ttRr) 3 of 16 or 18.75 %
nonroller / taster (genotypes TTrr, Ttrr) 3 of 16 or 18.75 %
nonroller / nontaster (genotype ttrr) 1 of 16 or 6.25 %

ANSWERS TO "EXPERIMENT" 8.3

3.

	X^H	Y
X^H	X^HX^H	X^HY
X^h	X^HX^h	X^hY

The girls (XX) will never be hemophiliacs, but half of the boys (XY) will be.

4. To have the disease, you must have only the recessive allele(s). For a son, that means X^hY

5. For a female to have the disease, she must have the recessive allele on both X chromosomes. Since one X always comes from the father, the father must have a recessive allele on his X chromosome. Also, the mother needs to have at least one, but she could have 2 recessive alleles. In the end, then, there are two possibilities, either of which is correct:

	X^h	Y
X^H	X^HX^h	X^HY
X^h	X^hX^h	X^hY

50% of the girls and 50% of the boys will have hemophilia.

OR

	X^h	Y
X^h	X^hX^h	X^hY
X^h	X^hX^h	X^hY

All children will have hemophilia.