

KEY

GENETICS PRACTICE PROBLEMS

Simple Genetics Practice Problems

1. For each genotype, indicate whether it is heterozygous (HE) or homozygous (HO)

AA <u>HO</u>	Ee <u>HE</u>	li <u>HE</u>	Mm <u>HE</u>
Bb <u>HE</u>	ff <u>HO</u>	Jj <u>HE</u>	nn <u>HO</u>
Cc <u>HE</u>	GG <u>HO</u>	kk <u>HO</u>	OO <u>HO</u>
Dd <u>HE</u>	HH <u>HO</u>	Ll <u>HE</u>	Pp <u>HE</u>

2. For each of the genotypes below, determine the phenotype.

Purple flowers are dominant to white flowers

PP Purple
Pp Purple
pp white

Brown eyes are dominant to blue eyes

BB Brown
Bb Brown
bb blue

Round seeds are dominant to wrinkled

RR Round
Rr Round
rr Wrinkled

Bobtails are recessive (long tails dominant)

TT Long
Tt Long
tt Short

3. For each phenotype, list the genotypes. (Remember to use the letter of the dominant trait)

Straight hair is dominant to curly.

SS, Ss straight
Ss, Ss straight
ss curly

Pointed heads are dominant to round heads.

PP pointed
Pp pointed
pp round

4. Set up the square for each of the crosses listed below. The trait being studied is round seeds (dominant) and wrinkled seeds (recessive)

Rr x rr

	R	r
r	Rr	rr
r	Rr	rr

What percentage of the offspring will be round? 50%

Rr x Rr

	R	r
R	RR	Rr
r	Rr	rr

What percentage of the offspring will be round? ~~100%~~ 75%

RR x Rr

	R	R
R	RR	RR
r	Rr	Rr

What percentage of the offspring will be round? 100%

Practice with Crosses. Show all work!

5. A TT (tall) plant is crossed with a tt (short plant).
What percentage of the offspring will be tall? 100%

	T	T
t	Tt	Tt
t	Tt	Tt

6. A Tt plant is crossed with a Tt plant. What percentage of the offspring will be short? 25%

	T	t
T	TT	Tt
t	Tt	tt

7. A heterozygous round seeded plant (Rr) is crossed with a homozygous round seeded plant (RR). What percentage of the offspring will be homozygous (RR)? 50%

	R	r
R	RR	Rr
R	RR	Rr

8. A homozygous round seeded plant is crossed with a homozygous wrinkled seeded plant. What are the genotypes of the parents?

RR x rr

	R	R
r		
r		

What percentage of the offspring will also be homozygous? 0%

9. In pea plants purple flowers are dominant to white flowers. If two white flowered plants are cross, what percentage of their offspring will be white flowered? 100%

	P	p
P	PP	Pp
p	Pp	pp

10. A white flowered plant is crossed with a plant that is heterozygous for the trait. What percentage of the offspring will have purple flowers? 50%

	P	p
P	Pp	Pp
p	pp	pp

11. Two plants, both heterozygous for the gene that controls flower color are crossed. What percentage of their offspring will have purple flowers? 75%
What percentage will have white flowers? 25%

	P	p
P	Pp	Pp
p	Pp	pp

12. In guinea pigs, the allele for short hair is dominant.

What genotype would a heterozygous short haired guinea pig have? Ss
What genotype would a purebreeding short haired guinea pig have? SS
What genotype would a long haired guinea pig have? ss

13. Show the cross for a pure breeding short haired guinea pig and a long haired guinea pig.

What percentage of the offspring will have short hair? 100% or 50%

	S	s
S	SS	Ss
s	Ss	ss

or

	S	S
S	SS	SS
s	Ss	Ss

14. Show the cross for two heterozygous guinea pigs.

What percentage of the offspring will have short hair? 75%
What percentage of the offspring will have long hair? 25%

	S	s
S	SS	Ss
s	Ss	ss

15. Two short haired guinea pigs are mated several times. Out of 100 offspring, 25 of them have long hair. What are the probable genotypes of the parents? Ss x Ss Show the cross to prove it!

Monohybrid Crosses

1. Mendel knew that some pea plants made green pea pods, and some yellow pea pods. He crossed a true-breeding green pod plant with a true-breeding yellow pod plant, and all the "offspring" plants had green pods. He then let the offspring self-cross, and tabulated the results: 428 plants with green pods, 152 with yellow pods. What are the genotypes of all the plants mentioned in this problem? GG, Gg, gg

2. Mendel crossed red flowered pea plants with white flowered pea plants. (Red flowers are dominant to white.) Both stocks of plants were true breeding.

- What color flowers will the offspring plants have? Red ~ Rr
- If Mendel crosses one of these offspring (hybrid) plants with its white flowered parent, what color flowers will *their* offspring have? Red, white

	r	r
R	Rr	Rr
r	rr	rr

3. About seven out of every ten humans has the ability to taste a harmless chemical called PTC (phenylthiocarbamide) as a salty, sweet, sour, or bitter substance. To the others, PTC is tasteless. A taster and a nontaster (both with long family histories of tasting or nontasting, respectively) have a child who can taste PTC. Which form of the trait is dominant – tasting or nontasting?

Tasting

4. In fruit flies, long wings are dominant to short wings. A long winged fly crossed to a short winged fly produces 27 long winged offspring and 25 short winged offspring. What are the genotypes of the parents?

Ll, ll

5. Nearsightedness is dominant to normal vision in people. A man with normal vision marries a nearsighted woman with a long family history of nearsightedness. What fraction of the time would you expect them to have a nearsighted child?



6. Assume that, in people, curly hair is dominant to straight hair. A man with curly hair marries a straight haired woman. They have a straight haired baby. What is the man's genotype? What is the baby's genotype?

Cc

7. A spotted bull and a solid colored cow have four calves. Two of these calves are solid colored and two are spotted. If P = allele for spotted and p = allele for solid colored, and if spotted is known to be dominant to solid colored, give the genotype of the bull.

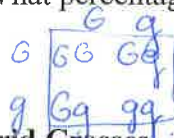
Pp

8. Although they are perfectly healthy, Mary and John are told by their geneticist that they each carry a recessive allele for a debilitating disease. What are the "odds" for having a healthy baby?

25%

9. Suppose that the ability to be a gourmet cook is heritable. Gourmet cooking ability (G) is dominant to lousy cooking ability (g). A woman who is a gourmet cook (but whose father was a lousy cook!) marries a man who is a gourmet cook (but whose mother was such a lousy cook, she burned boiling water!). What percentage of their children will be gourmet cooks?

Gg x Gg
1/2 x 1/2 =



75%

Dihybrid Crosses

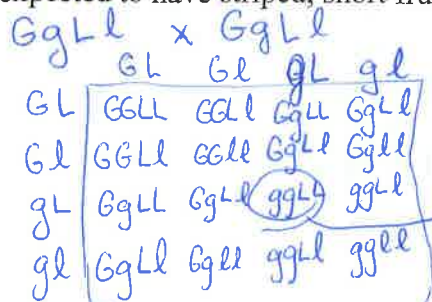
10. What kinds of gametes can a person with the genotype HhEe make?

HE, He, hE, he

11. Write out all the possible gametes for an individual which is ffGgHhIijj. (If we did a genetics problem with this person it would be a 5 factor cross!)

fGHIj
fghij
FGhIj
fgHIj
FgHIj
fghij

12. In watermelons, the allele for solid green color (G) is dominant to the allele for striped green color (g); the allele for short watermelons (L) is dominant to the allele for long watermelons (l). In a cross between two GgLl watermelon plants, what fraction of the offspring would be expected to have striped, short fruit?



ggLL
1/4 x 1/4 = 1/16

	BT	BT	BT	Bt
bT	BbTt			
bT	BbTt			
bT				
bT				

13. In horses, black coat B and trotting gait T are dominant alleles, while the corresponding alleles (white coat, b, and pacing gait, t) are inherited as recessives.
- When a black trotter (BBTT) is mated with a white pacer (bbtt), what will the phenotypes and genotypes of the first generation offspring be? *BbTt = 100%; black coat, trotting*
 - If a breeder decided to mate two of the first generation offspring, what are the types and expected proportions of the offspring horses?

BbTt x BbTt

	BT	Bt	bT	bt
BT	BBTT	BbTt	BbTt	BbTt
Bt	BbTt	Bbtt	BbTt	Bbtt
bT	BbTt	BbTt	bbTT	bbTt
bt	BbTt	Bbtt	bbTt	bbtt

Soap Opera Genetics -- Genetics to Resolve Family Arguments¹

I. How could our baby be an albino?

Tiffany and Joe have just had a baby and are very surprised to learn that their baby is albino with very pale skin and hair color. Tiffany's sister comes in to visit Tiffany and the new baby, and Joe goes out to talk with his sister Vicky.

How does their baby have albinism?

Joe is very upset. He tells Vicky, "I just don't understand how the baby could be an albino when Tiffany and I are not."

Luckily, Vicky is a biology teacher, so she explains how two parents with normal skin color could have an albino baby. She draws a Punnett Square to illustrate her explanation.

- Draw a Punnett Square to show how two parents with normal skin color could have an albino baby. Use **a** for the recessive allele that can result in very pale skin and hair color and **A** for the dominant allele that results in normal skin and hair color.

	A	a
A	AA	Aa
a	Aa	aa

albinism

¹ by Ingrid Waldron, Department of Biology, University of Pennsylvania, 2012. Teachers are encouraged to copy this Student Handout for classroom use. A Word file (which can be used to prepare a modified version if desired), Teacher Notes, comments, and additional activities are available at <http://serendip.brynmawr.edu/exchange/bioactivities>.

Why aren't more babies albino?

By now, Joe has calmed down and he is getting interested. He asks Vicky "If that's how it works, it seems as though a quarter of all babies should be albino. How come there are hardly any albino babies?"

3. What explanation should Vicky give to answer this question?

Need to be a carrier for the allele.
This 25% applies to the particular cross
of Vicky and Joe

Will Tiffany and Joe's next baby be albino?

Two years later, Tiffany is pregnant again, and she and Joe are discussing whether their second baby will be albino. Tiffany thinks the baby probably will be albino, but Joe remembers Vicky's explanation, and he tells Tiffany, "No, our second baby can't be albino because only one out of every four of our babies should be albino. We already have one albino baby, so our next three babies should not be albino."

4. What is the probability that Tiffany and Joe's second baby will be albino like their first baby?

How do you know?

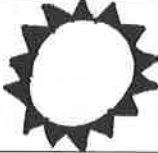
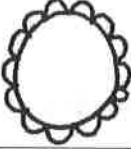


25% , probability is the same.
Discrete events

II. Were the babies switched?

Two couples had babies in the same hospital at the same time. Michael and Danielle had twins, a boy, Michael, Jr., and a girl, Michelle. Denise and Earnest had a girl, Tonja. Danielle was convinced that there had been a mix-up and she had the wrong girl, since Michael Jr. and Tonja were both light-skinned, while Michelle was dark skinned. Danielle insisted on blood type tests for both families to check whether there had been a mix-up. In order to interpret the results of the blood type tests, you will need to understand the basic biology of blood types.

Blood Types

The ABO blood types are the major blood type classification system which determines which type of blood can safely be used for a transfusion. The four blood types in the ABO system are Type A, Type B, Type AB, and Type O. These blood types refer to different versions of carbohydrate molecules (complex sugars) which are present on the surface of red blood cells.

People with:	Have:
Type A blood	Type A carbohydrate molecules on their red blood cells 
Type B blood	Type B carbohydrate molecules on their red blood cells 
Type AB blood	Type A and B carbohydrate molecules on their red blood cells 
Type O blood	Neither A nor B carbohydrate molecules on their red blood cells 

Genetics of Blood Types

Your blood type was established before you were born, by genes inherited from your mother and father. This blood type gene has three different versions or alleles that code for different versions of a protein enzyme as follows:

The I^A allele codes for a version of the enzyme that puts Type A carbohydrate molecules on the red blood cells.

The I^B allele codes for a version of the enzyme that puts Type B carbohydrate molecules on the red blood cells.

The i allele codes for an inactive version of the enzyme, so red blood cells have neither type of carbohydrate molecule on their surface.

Everyone has two copies of these genes, so there are six possible combinations of alleles (called genotypes) which result in the four possible blood types (phenotypes):

- $I^A I^A$ and $I^A i$ - both resulting in Type A blood,
- $I^B I^B$ and $I^B i$ - both resulting in Type B blood,
- $I^A I^B$ - resulting in Type AB blood,
- ii - resulting in Type O blood.

1. In a heterozygous $I^A i$ person, which allele is dominant, I^A or i ? Explain your reasoning.

I^A , they will have carbohydrates on the red blood cells

Codominance refers to inheritance in which two alleles of a gene each have a different observable effect on the phenotype of a heterozygous individual. Thus, in codominance, neither allele is recessive—both alleles are dominant.

2. Which one of the genotypes results in a phenotype that provides clear evidence of codominance? (Hint: Look at the information on the top of this page and the drawings on page 3.)

$I^A I^B$

3. Each biological parent gives one of their two blood type alleles to their child. For example, a father who has blood type AB has the genotype $I^A I^B$, so he will produce sperm with either an I^A or an I^B allele and he can give either an I^A or an I^B allele to a child of his. If the mother has blood type O, her genotype must be ii , and she can only give an i allele to a child of hers.

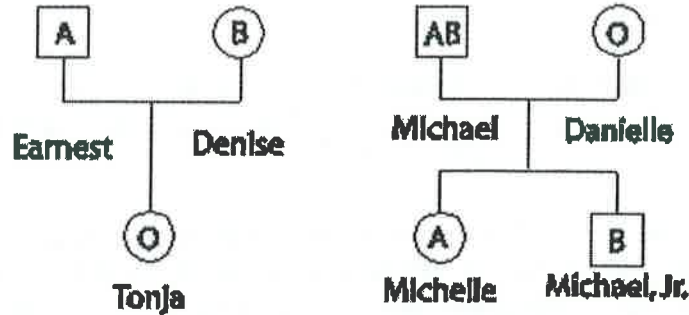
4. The Punnett Square below shows the possible genotypes for the children of these parents. Write in the blood type for each genotype to show the possible blood types for the children of these parents.

Father (Type AB) Sperm	Mother (Type O) Eggs	
	i	i
	I^A	$I^A i$
I^B	$I^B i$	$I^B i$

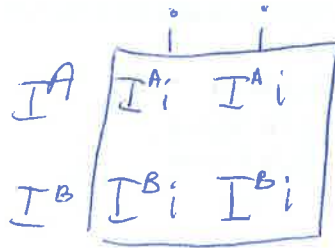
Type A
or
Type B

Were the babies switched?

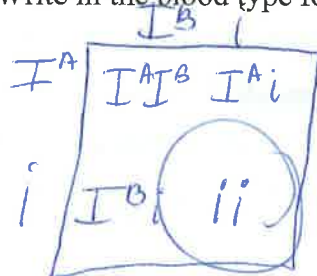
Now you are ready to evaluate whether Earnest and Denise's baby girl was switched with Michael and Danielle's baby girl. The following family trees show the blood types for each person in both families.



5. Is it possible for Michael and Danielle to have a child who has type O blood? How do you know this? (Hint: Use the Punnett square on the previous page to help you to answer these questions.) *No*



6. To check whether Earnest and Denise could have a baby with Type O blood, draw a Punnett square for a father who has blood Type A and genotype $I^A i$ and a mother who has blood Type B and genotype $I^B i$. Write in the blood type for each child's genotype.



7. Was a switch made at the hospital? Explain your reasoning.

No, Michael and Danielle cannot have a baby with O blood because of their blood types.

Why do the twins look so different?

Now, Danielle wants to know how her twins could look so different with one having light skin and the other having dark skin. First, she needs to understand that there are two types of twins. Identical twins come from the same zygote when a developing embryo splits in two, so identical twins have exactly the same genes.

8. How do you know that Michelle and Michael Jr. are not identical twins?

Different blood types, different genders

Michelle and Michael Jr. are fraternal twins, the result of two separate eggs, each fertilized by a different sperm. Michelle and Michael Jr. inherited different alleles of the genes for skin color because the egg and sperm that formed the zygote that developed into Michelle carried different alleles of the genes for skin color than the egg and sperm that formed the zygote that developed into Michael Jr.

To understand how one of the twins could have light skin and the other dark skin, we will consider two alleles of one of the genes for skin color.

Genotype	Phenotype (skin color)
BB	dark brown
Bb	light brown
bb	tan

Notice that a heterozygous individual has an intermediate phenotype, halfway between the two homozygous individuals. This is called **incomplete dominance**. For example, if a red flower and white flower had offspring, you might have a pink flower.

9. Explain how incomplete dominance differs from a dominant-recessive pair of alleles.

~~Both alleles are expressed~~
Dominant allele would normally be expressed, but instead, halfway phenotype

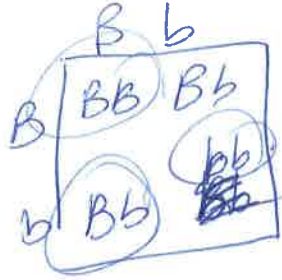
10. Explain how incomplete dominance differs from co-dominance.

*Co-dominance = both alleles are expressed.
Incomplete is a half-way phenotype*

11. The parents, Michael and Danielle, both have light brown skin. What is their genetic makeup (genotype)?

Bb x Bb

12. Draw a Punnett square to show how these parents could have two babies with very different color skin -- one dark brown and the other tan.



Obviously, people have many different skin colors, not just dark brown, light brown, or tan. The reasons for all these different skin colors include:

- multiple genes influence skin color
- for at least one of these genes, multiple different alleles have differing effects on skin color
- skin color is also influenced by the amount of exposure to the sun.

