Lesson 6.6 — Dragon Genetics, pt. IV: Codominance

Name

Date

Period

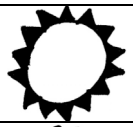
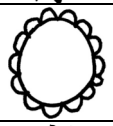
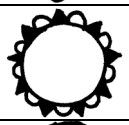
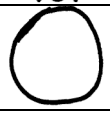
Key Terms		
Antigen	Antibody	codominance

Explore I Were the babies switched?

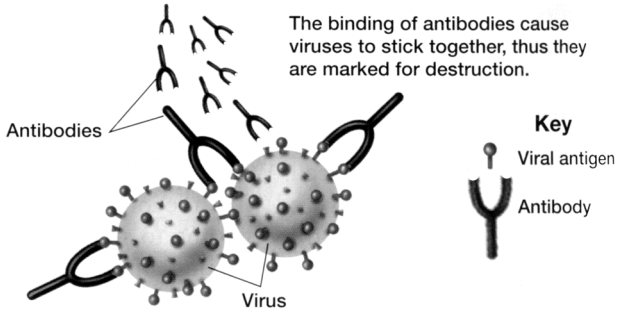
Many times in dragon society, eggs are communally laid in one large dragon nest – similar to a human maternity ward. Two expectant dragon couples had eggs hatch at the same time. Elizardbeth and Davik had twin boys, Jonzo and Sunno and Flamo and Wiza had Barney. After being home a few days, Elizardbeth was convinced that she had the wrong dragon. There must have been a mix-up at the hospital. After all, her dragons were twins, and even though they were fraternal, you would think they would look a lot more alike than they do – Jonzo was darker than Sunno. At Elizardbeth's insistence, blood types were taken for her family and for Flamo, Wiza and Barney. In order to interpret the results of the blood type tests, you will need to understand the basic biology of blood types.

Blood Types

There are many different ways to classify blood types, but the most common blood type classification system is the ABO (said "A-B-O") system in people and dragons. There are four blood types in the ABO system: 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 

The Type A and Type B carbohydrate molecules are called **antigens** because they can stimulate the body to produce an immune response, including antibodies. **Antibodies** are special proteins that travel in the blood and help our bodies to destroy viruses or bacteria that may have infected our bodies (see figure on next page).



Normally, our bodies do <u>not</u> make antibodies against any molecules that are part of our own bodies. Thus, antibodies help to defend against invading viruses and bacteria, but normally antibodies do not attack our own body cells.

For example, people with Type A blood do not make antibodies against the Type A antigen, which is present on their red blood cells, but they do make antibodies against the Type B antigen.

Answer all questions ***in complete sentences unless*** it is fill in the blank.

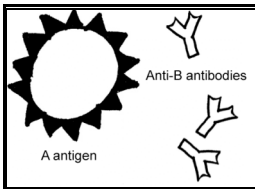
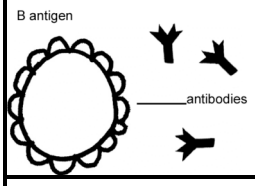
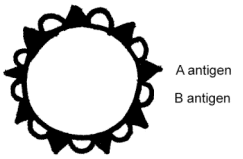
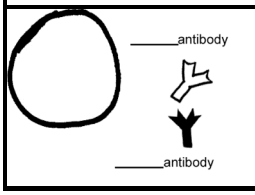
1. Where are the identifying carbohydrate molecules located on red blood cells?

2. These carbohydrate molecules are called _____ because they can _____

_____.

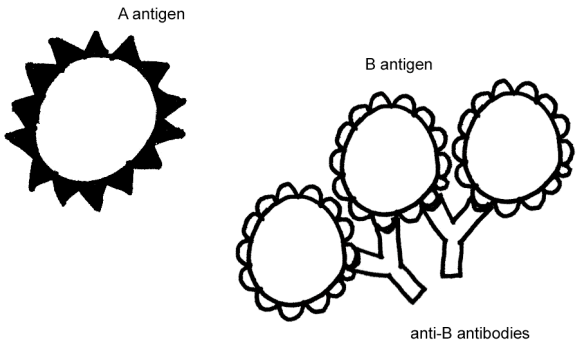
3. What are antibodies?

4. Fill in the blanks in the table below.

	**Blood group A** If you belong to the blood group A, you have A antigens on the surface of your red blood cells and _____ antibodies in your blood.
	**Blood group B** If you belong to the blood group B, you have B antigens on the surface of your red blood cells and _____ antibodies in your blood.
	**Blood group AB** If you belong to the blood group AB, you have both __and __ antigens on the surface of your red blood cells and no anti-A or anti-B antibodies in your blood.
	**Blood group O** If you belong to the blood group O, you have neither A nor B antigens on the surface of your red blood cells, but you have both _____ and _____ antibodies in your blood.

Blood transfusions — who can receive blood from whom?

If you are given a blood transfusion that does not match your blood type, antibodies present in your blood can react with the antigens present on the donated red blood cells. For example, if a person who has Type A blood is given a Type B blood transfusion, then this person's anti-B antibodies will react with the Type B antigens on the donated red blood cells and cause a harmful reaction. This reaction can cause the donated red blood cells to burst and/or clump together and block blood vessels. This type of transfusion reaction is illustrated in the following drawing.



Transfusion reactions can be fatal. To prevent this from happening, doctors test whether a person's blood is compatible with the donated blood before they give a transfusion. A person can only be given donated blood with red blood cells that do not have any antigen that can react with the antibodies in the person's blood.

5. Test your understanding of blood groups by completing the table below.

Blood Group	Antigens on red blood cells	Antibodies in plasma	Can receive blood from	Can give blood to
A				
B				
AB				
O				

6. Which blood type would be considered a universal donor (someone who can give blood to anyone)?

Genetics of Blood Types

Like people, dragon blood types are established before they are born, by specific genes inherited from both parents. Dragonets receive one blood type gene from their mother and one from their father. These two genes determine their blood type by causing the presence or absence of the Type A and Type B antigen molecules on the red blood cells.

The blood type gene has three different versions or alleles:

- $\mathbf{I^A}$ results in A antigen on the red blood cells,
- $\mathbf{I^B}$ results in B antigen on the red blood cells, and
- $\boldsymbol{i}$ does not result in either antigen.

Everyone has two copies of these genes, so there are six possible combinations of alleles (called genotypes):

- $\mathbf{I^A\ I^A}$ and $\mathbf{I^A}\ \boldsymbol{i}$ - both resulting in Type A blood,
- $\mathbf{I^B\ I^B}$ and $\mathbf{I^B}\ \boldsymbol{i}$ - both resulting in Type B blood,
- $\mathbf{I^A\ I^B}$ - resulting in Type AB blood,
- $\boldsymbol{i\ i}$ - resulting in Type O blood.

7. In a heterozygous $\mathbf{I^A}\ \boldsymbol{i}$ dragon, which allele is dominant, $\mathbf{I^A}$ or $\boldsymbol{i}$? Explain your reasoning.

Codominance refers to inheritance in which both alleles of a gene affect the phenotypic traits of an individual. Thus, in codominance, neither allele is recessive – both alleles are dominant.

8. Which one of the genotypes shown above results in a phenotype that provides clear evidence of codominance?

9. Draw a picture of a red blood cell for the genotype in the previous question to illustrate how both alleles influence blood type in this case.

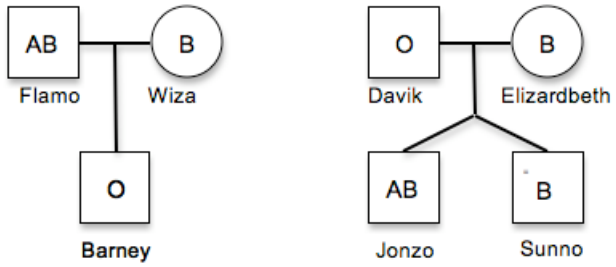
Each biological parent gives one of their two ABO alleles to their child. For example, a mother who is blood type O has genotype $\boldsymbol{ii}$ and can only give an $\boldsymbol{i}$ allele to her son or daughter. A father who is blood type AB could give either an $\mathbf{I^A}$ or a $\mathbf{I^B}$ allele to his son or daughter. This couple could have children of either blood type A ($\boldsymbol{i}$ from mother and $\mathbf{I^A}$ from father) or blood type B ($\boldsymbol{i}$ from mother and $\mathbf{I^B}$ from father). This is illustrated in the Punnett square below.

Father (Type AB) Sperm	**Mother (Type O)** Eggs		
		$\boldsymbol{i}$	$\boldsymbol{i}$
	$\mathbf{I^A}$	$\mathbf{I^A}\ \boldsymbol{i}$	$\mathbf{I^A}\ \boldsymbol{i}$
	$\mathbf{I^B}$	$\mathbf{I^B}\ \boldsymbol{i}$	$\mathbf{I^B}\ \boldsymbol{i}$

10. Now, suppose that a mother has blood Type A and genotype $\mathbf{I^A}\ \boldsymbol{i}$ and the father has blood Type B and genotype $\mathbf{I^B}\ \boldsymbol{i}$. Draw a Punnett square to identify the possible genotypes. Then state the predicted phenotypic percentages of blood types for their children.

Explain I - Were the babies switched?

Now you are ready to evaluate whether Flamo and Wiza's baby boy was switched with one of Davik's and Elizardbeth's boys. The following family tree shows the blood types for both families.



11. Is it possible for Flamo and Wiza to have a child who is type O? Explain.

12. Is it possible for Davik and Elizardbeth to have a child who is type O? Explain.

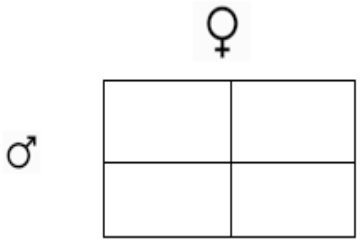
13. Based on the blood type results, which statement provides the best explanation about whether the dragons were switched?
    a. There was no switch
    b. Barney was switched with Jonzo
    c. Barney was switched with Sunno
    d. Jonzo was switched with Sunno

Prove your choice using Punnett squares. Be sure to include names on the Punnett Squares to clarify which family each Punnett Square represents.

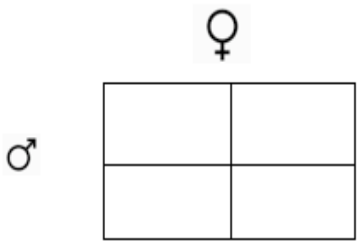
Explore II More Dragon blood types and other examples of codominance

Using Punnett squares for all problems, determine the possible blood types of offspring:

14. If a dragonette with type AB blood has offspring with a drake with type O blood, then what are the possible blood types of the offspring?



15. If a drake homozygous for type A blood is crossed with a dragonette heterozygous for type B blood, then what are the possible blood types of their offspring?



In addition to blood typing, dragons show codominance in other traits as well.
Use lesson 6.12 to complete the problems ***(SHOW ALL WORK)***

16. If Fango has rounded tail spikes and Dragona has rounded and pointed tail spikes, then what are the possible phenotypes of their offspring?
    - **A. Assign Symbols (alleles): __ = _____ and __ = _____**
    - **B. What phenotype will a heterozygote exhibit? _____**
    - **C. Show the cross __ __ x __ __**
    - **D. Complete the Punnett square**
    - **E. List genotypic percentages**
    - **F. List phenotypic percentages**

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17. Two of Fango and Dragona's children are round eye at the front and the other two are oval eyed. If Dragona has oval eyes, demonstrate what genotype Fango must be.
    - **G. Assign Symbols (alleles): __ = _____ and __ = _____**
    - **H. What phenotype will a heterozygote exhibit? _____**
    - **I. Show the cross __ __ x __ __**
    - **J. Complete the Punnett square**
    - **K. List genotypic ratios**
    - **L. List phenotypic ratios**

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18. One of the daughters, Elizardbeth who shared Fango's genotype married another dragon, Davik, that had round eye in the front only. If they had dragonets, then what are the possible genotypes and phenotypes of their offspring?
    - **A. Assign Symbols (alleles): __ = _____ and __ = _____**
    - **B. What phenotype will a heterozygote exhibit? _____**
    - **C. Show the cross __ __ x __ __**
    - **D. Complete the Punnett square**
    - **E. List genotypic percentages**
    - **F. List phenotypic percentages**

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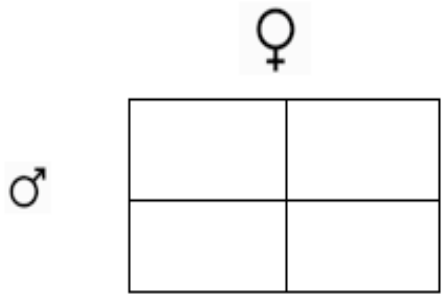
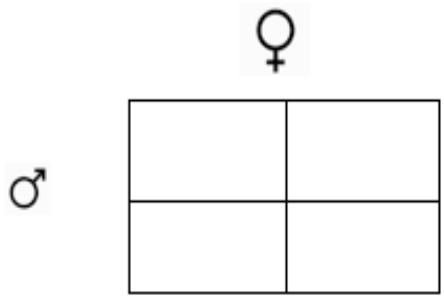
MAKE UP ASSIGNMENT- 6.6 Day 2

In addition to blood typing, dragons show codominance in other traits as well.
Use lesson 6.12 to complete the problems ***(SHOW ALL WORK)***

16. A male drake with rounded and pointed tail spikes and a a dragonette with pointed tail spikes are considering having children. What are the possible phenotypes of their offspring?
    - **A. Assign Symbols (alleles): __ = _____ and __ = _____**
    - **B. What phenotype will a heterozygote exhibit? _____**
    - **C. Show the cross __ __ x __ __**
    - **D. Complete the Punnett square**
    - **E. List genotypic percentages**
    - **F. List phenotypic percentages**



17. An male with eyes that are round at the front marries a female that also has eyes that are round at the front. Determine the possible genotypes and phenotypes of their future offspring.
    - **A. Assign Symbols (alleles): __ = _____ and __ = _____**
    - **B. What phenotype will a heterozygote exhibit? _____**
    - **C. Show the cross __ __ x __ __**
    - **D. Complete the Punnett square**
    - **E. List genotypic ratios**
    - **F. List phenotypic ratios**



18. One of the daughters with pointed eyes marries another dragon that had oval eyes. If they have offspring, what are the possible genotypes and phenotypes of their offspring?
    - **G. Assign Symbols (alleles): __ = _____ and __ = _____**
    - **A. What phenotype will a heterozygote exhibit? _____**
    - **B. Show the cross __ __ x __ __**
    - **C. Complete the Punnett square**
    - **D. List genotypic percentages**
    - **E. List phenotypic percentages**