Name: Per: Date:

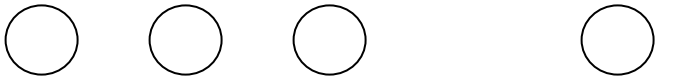
Genetics Notes: Multiple Alleles
Blood Typing

Inheriting Blood Type:
Many traits, other than blood, have more than two different alleles for the trait. This situation is referred to as _____ _____.
Geneticists probably know more about the inheritance of _____type than any inherited human trait. It is inherited from your parents.
In the ABO blood group, there are _____blood types.
These blood types are _____, _____, _____, _____.

Blood Antigens
These basic blood types are determined by the presence or absence of the _____(surface proteins) on the red blood cell membrane.
The gene for blood type is "_____".
There are 3 different alleles: _____ , _____ , **and** __ in the human population.
___ codes for the production of the **A** antigen on the RBC surface. _____ codes for the production of the **B** antigen on the RBC surface. **i** codes for neither antigen.

Blood Alleles
Both_____ and _____ are co-dominant and **i** is recessive.
This means that **both** A and B **antigens** will be _____ when they are together.
Both I^A and I^B are dominant to **i**.
Any individual only has 2 of these alleles, one from each _____, and they may be the same or they may be different.

Blood Types:
There are _____ types of blood due to the surface molecules present.
These surface molecules are called _____. (They are made of protein and indicated by "spikes" on the red blood cell diagrams below)
The four types are: **A,** **B,** **AB,** and **O**
Draw them here:



Red **Blue** **Red & Blue** **no spikes**

The Genotypes and Phenotypes of Blood Groups

Genotype(s)	Phenotype	Diagram of Red Blood Cell
_____(homozygous) or ____(heterozygous)	A	(red) 
_____(homozygous) or ____(heterozygous)	B	(blue) 
_____	AB	(red & blue) 
_____	O	(none) 

Importance: Why do we need to know our blood type?
-_____ / Organ transplants -Incompatible blood types could clump together and result in death.
-Cases of disputed **_____**

Blood Compatibility

Type	Can Give To	Can Receive From
_____	A, AB	_____, _____
_____	B, AB	_____, _____
_____	AB	_____, _____, _____, ___
_____	A, B, AB, O	_____

Universals:
Universal Donor: Type _____
Can donate blood to any blood type

Universal Recipient: Type _____
Can receive blood from any blood type

More about Blood Compatibility
As mentioned earlier, one type of protein, the antigens, are present on the surface of red blood cells. Another type of **protein** is present in the _____ or liquid component of the blood. These types are called _____.

The **two types of protein** will **react with each other** when they come into contact so the antibodies are called **anti-_____** and **anti-_____**.

If A antigen and anti- A come into contact, the blood will _____.
People with A antigen have anti- B in their plasma so clotting does not occur.
B antigen is compatible with anti- A.

Rh Factor: What does + and – mean?
The _____ **factor** is also a _____ that is inherited from our parents, but it is inherited independently of the ABO blood type alleles.
There are 2 different alleles for the Rh factor known as **Rh+** and **Rh-**.
Someone who is "Rh positive" has at least one Rh+ allele, but could have two.
The alleles for the Rh factor are "D" or "d".
Genotype for Rh Positive: _____ or _____
Genotype for Rh negative: _____

If someone is Rh positive, then they produce the protein and it is carried in the plasma (liquid portion) of blood. If someone is Rh negative, they do not produce the protein.
The importance of the Rh factor, aside from causing problems during transfusions, is during the _____ of human babies.

Pregnancy and the Rh factor:
If an **Rh _____ mother** is pregnant with an **Rh _____ baby**, the child could die.

This is due to _____ **created by** the **mother's blood** to stop the invasion of their system with the detrimental Rh positive blood of her unborn child.

Small amounts of fetal blood cross the placenta and come in contact with the mother's immune system usually late in pregnancy or during delivery, and this stimulates the production of antibodies to the Rh factor.

Although death of a child during the first pregnancy is rare, the possibility for death becomes greater with each succeeding pregnancy. A vaccination is administered to an Rh negative mother who is giving birth to an Rh positive child to prevent the problem in future pregnancies.

Blood Group Practice Problems:

Example 1: homozygous male Type B (_____) x heterozygous female Type A (_____)

	I^A	i
I^B		
I^B		

Genotypes: _____,_____
Genotypic Ratio: ___:____
Phenotypes: Type ___, Type __
Phenotypic ratio: :

Example 2: male Type O (_____) x female type AB (_____)

	I^A	I^B
i		
i		

Genotypes: _____, _____
Genotypic Ratio: _____:_____
Phenotypes: Type __, Type __
Phenotypic ratio: :

Example 3:

Mom is heterozygous for type B blood.
Dad is heterozygous for type A blood.
What are the possible blood types for their children?

P_1 generation: _____ x _____

Genotypes: ____, ____, ___,__
Genotypic Ratio: __:__:__:__
Phenotypes: Type __, Type __, Type __, Type __
Phenotypic ratio: __:__:__:__

Example 4:

If a boy has a blood type O and his sister has blood type AB, what are the genotypes and phenotypes of their parents?

boy: type O (_____) and girl: type AB (_____)

Parent genotypes:
_____ and _____
Parent phenotypes:__ and __

Example 5: Disputed Parentage
A lady has a baby but she is unsure who is the father. The **child** has **AB** blood and the **mother** has **type A**.
We know a man with Type _____ blood could not be the father.
The father would have to have type **___ or ____** blood.
Remember: Blood tests alone cannot prove a definite father, it only indicates that it is a possibility.

Example 6: Suppose that a woman with type O blood marries a man with Type AB blood. What are the expected genotypes and phenotypes of their children?
P_1 generation: _____ x _____

Genotypes:
Genotypic Ratio:
Phenotypes:
Phenotypic ratio:

Example 7: Two parents, both with type A blood, have a son with type O blood. What are the genotypes of the parents.

P_1 generation: _____ x _____

Example 8: A couple preparing for marriage have their blood typed. Both are AB. What are the possible blood types of their children and the percentage of each?
P_1 generation: _____ x _____

Genotypes: ____ ,_____, ____
Genotypic Ratio: ____: __: __
Phenotypes:Type ____,Type ____,
Type ____
Phenotypic ratio: __: __: __

Example 9: Mr. and Mrs. Fleming, both with type B blood, claimed that a certain JR Wilson, a billionaire technology tycoon, was the father of Mrs. Fleming's recent 4 month old baby. The Flemings took the issue to court, charging that Mr. Wilson was the father and that he should pay $300,000 per year to the Flemings for child support. Mr. Wilson's blood type is AB. The baby is type O.

Prove that the baby is not Mr. Wilson's.

b. Is it possible that the baby is Mr. Fleming's? Explain.

Example 10: Would it be possible for a child to have O type blood if one parent is type A and the other is type B?

P_1 generation: _____ **x** _____

Example 11: Cross I^BiDd x I^AI^BDd. Give the phenotypes in the offspring and the ratio.

	I^BD	I^Bd	iD	id
I^AD	I^AI^BDD			

Phenotypes: _____AB + , _____AB -
_____A + , _____A –
_____B + , _____B -