Blood Typing and Blood Genetics

Make up of Blood

- Whole blood contains red blood cells, white blood cells, and platelets (~45% of volume) suspended in plasma (~55% of volume)

Make up of Blood

- Plasma
  - A fluid composed of 92% water, 7% vital proteins such as albumin, gamma globulin, anti-hemophilic factor, and other clotting factors, and 1% mineral salts, sugars, fats, hormones, and vitamins

Make up of Blood

- Red Blood Cells (RBC)
- Also known as erythrocytes
- Carry oxygen from the lungs to your body's tissue and take carbon dioxide back to your lungs to be exhaled
- Hemoglobin– protein found in red blood cell
- Do not have nuclei

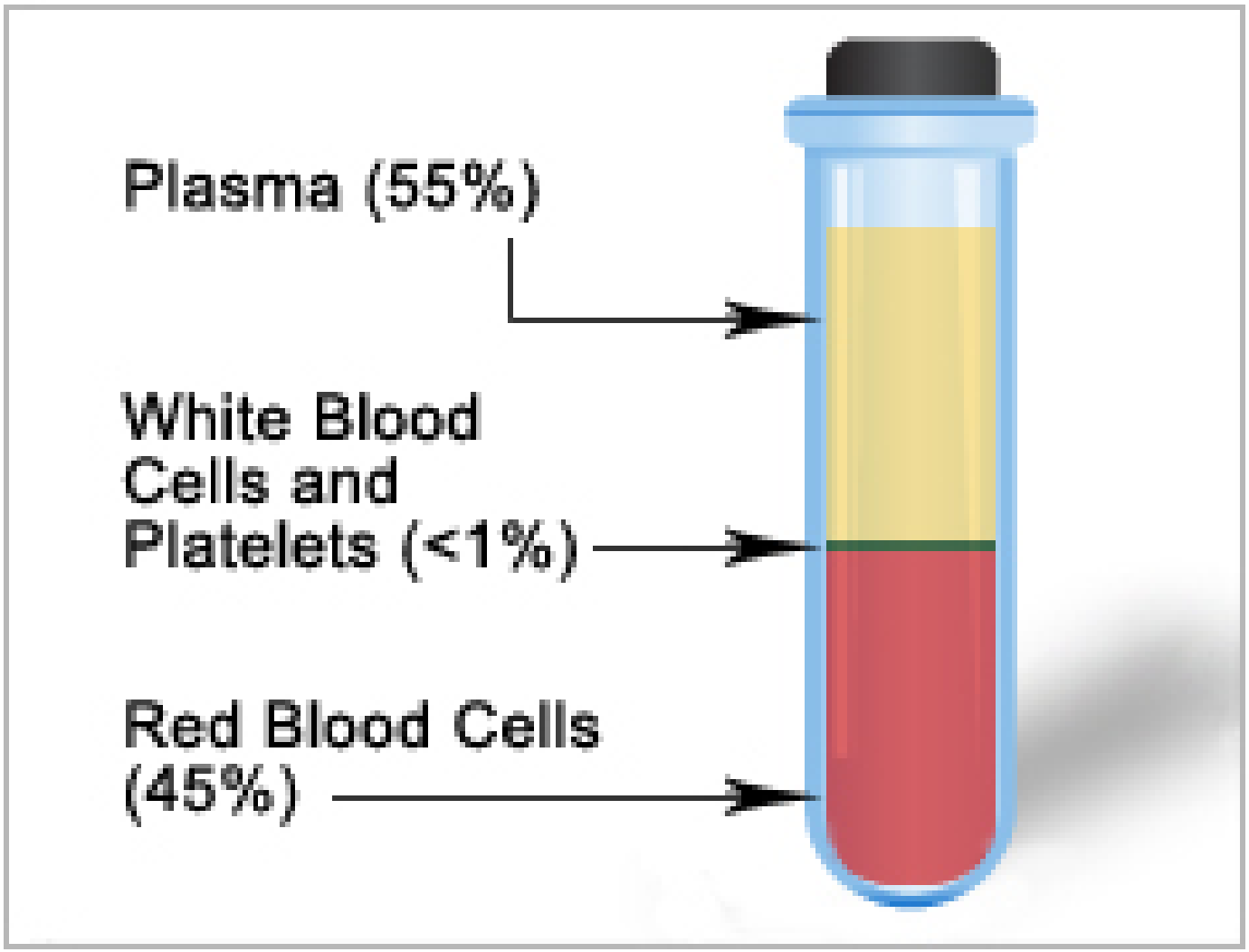
Make up of Blood

- White blood cells (WBC)
- Also known as leukocytes
- Cells of the immune system that are involved in protecting the body against infectious disease and foreign invaders
- Have nuclei which distinguishes WBC from other blood cells

Make up of Blood

- Platelets
- Also known as thrombocytes
- Small, colorless cell fragments in the blood whose main function is to interact with clotting proteins to stop or prevent bleeding

Separated blood



Blood Genetics

- The human *ABO* gene is on chromosome 9.
- Everyone has two copies of chromosome 9 so you have two *ABO* genes.
- One copy is inherited from your mother, the other from your father.

Alleles

- There are three versions (called “alleles”) of this blood type gene: A, B, and O.
- A person’s blood type is determined by which allele he/she inherits from each parent.

Pheno vs. Geno

- The genetic makeup of an organism is called the “genotype”.
- The “phenotype” is the visible properties of an organism.
- In this case, the A, B, and O allele combination a person has is their genotype
- Their blood type is their phenotype.

Dominant vs. Recessive Genes

- The “A” allele is dominant and so is the “B” allele.
- Together though, the “A” and “B” alleles are co-dominant.
- The “O” allele is recessive.

Determining the Genotype

The blood type gene has three different alleles:

- **AA** is Type A
- **AB is Type** AB
- **BB** results in Type B
- **oo *is Type O***

Determining the Genotype

- Scenario:
  - Mom has the alleles I^AI^A for blood type and Dad has the alleles I^BI^B blood type.
  - What will be the blood type for their child?

Punnett Sqaures

	A	A
B		
B		

Practice

Suppose that a mother has blood Type A and genotype $I^A i$ and the father has blood Type B and genotype $I^B i$. Draw a Punnett square to show the possible genotypes of their children.

What are the phenotypes of the kids?

Practice

	B	o
A		
o		

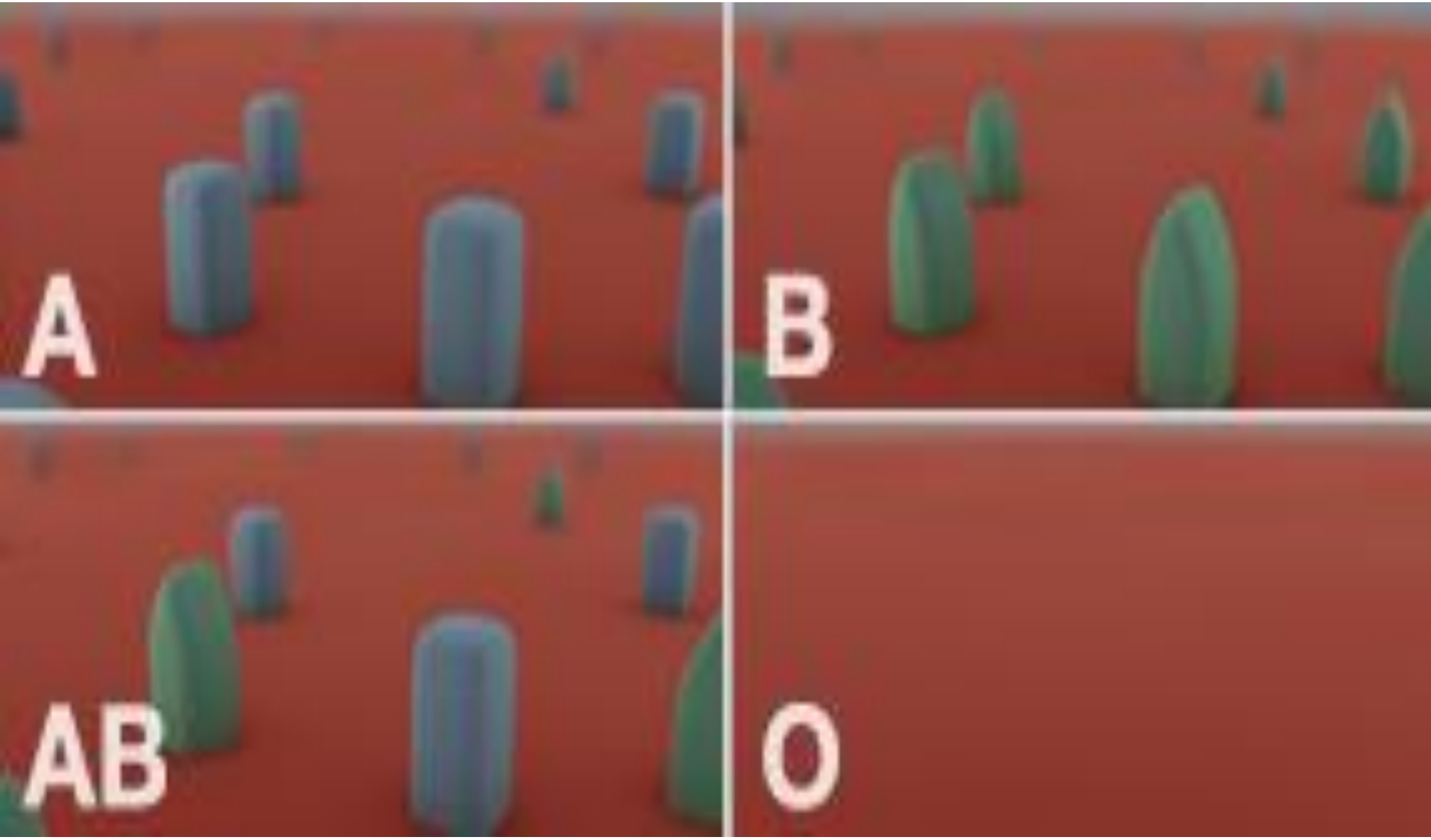
Blood Types

- The alleles we discussed “code” for blood type.
- What they REALLY “code” for is a specific enzyme.
- That enzyme creates specific antigens on your RBC (red blood cells)

Antigens

- An antigen is a protein (encoded from the right enzyme) that “sits” on the surface of your RBC.
- There are 2 different blood antigens, A and B.
- If you have the A antigen, you have type A blood.
- If you have the B antigen, you have type B blood.

Antigens of the Surface of the RBC



Antibodies

- Blood plasma is packed with proteins called antibodies.
- The body produces a wide variety of antibodies that will recognize and attack foreign molecules.
- A person’s plasma does not contain any antibodies that will bind to molecules that are part of his or her own body.

blood type	red blood cell surface molecules	plasma antibodies
type A	A only	B only
type B	B only	A only
type AB	A & B	neither
type O	neither	both

Blood Transfusions

- It is important to carefully match the donor and recipient blood types.
- If the donor's blood cells have antigen that are different from those of the recipient, antibodies in the recipient's blood recognize the donor blood as foreign.
- This triggers an immune response resulting in blood clotting.

Blood Transfusions

Antigen	Antibody	Can donate to…	Can receive from…
A			
B			
AB			
O			

Relative Abundance of Blood Types

A	B	AB	O
40-42%	10-12%	3-5%	43-45%

Rhesus Factor (Rh)

- If a person has a positive Rh factor, this means that their blood contains another type of protein
- Most people (about 85%) have a positive Rh factor
- Rh is expressed as either positive or negative.
- The Rh factor, like other antigens, is found on the surface of the red blood cells.

Stats

O^+	1 in 3 persons
O^-	1 in 15 persons
A^+	1 in 3 persons
A^-	1 in 16 persons
B^+	1 in 12 persons
B^-	1 in 67 persons
AB^+	1 in 29 persons
AB^-	1 in 167 persons

Can Blood Be Individualized?

- Individualizing a blood sample is based on the typing of proteins and enzymes. Blood proteins have subtypes.
- You can also extract DNA from your white blood cells.
- So, yes.