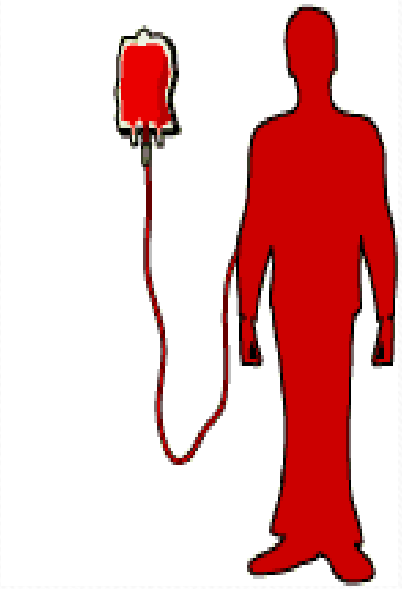
Zoo-352 Principles of genetics
Lecture 9

Genetic of the human blood group

Outlines:

- History of discoveries of the blood types.
- Types of blood group (ABO blood system).
- The Rhesus (Rh) system.
- Blood transfusions.
- Importance and inheritance of the ABO and Rh blood group systems.
- Practice exercises.

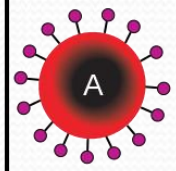
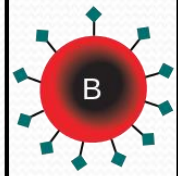
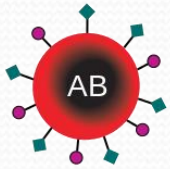
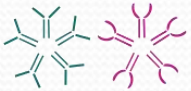
History of discoveries of the blood types



The ABO blood group system is discovered by the Austrian scientist **Karl Landsteiner** who identified the O, A, and B blood types in 1900.

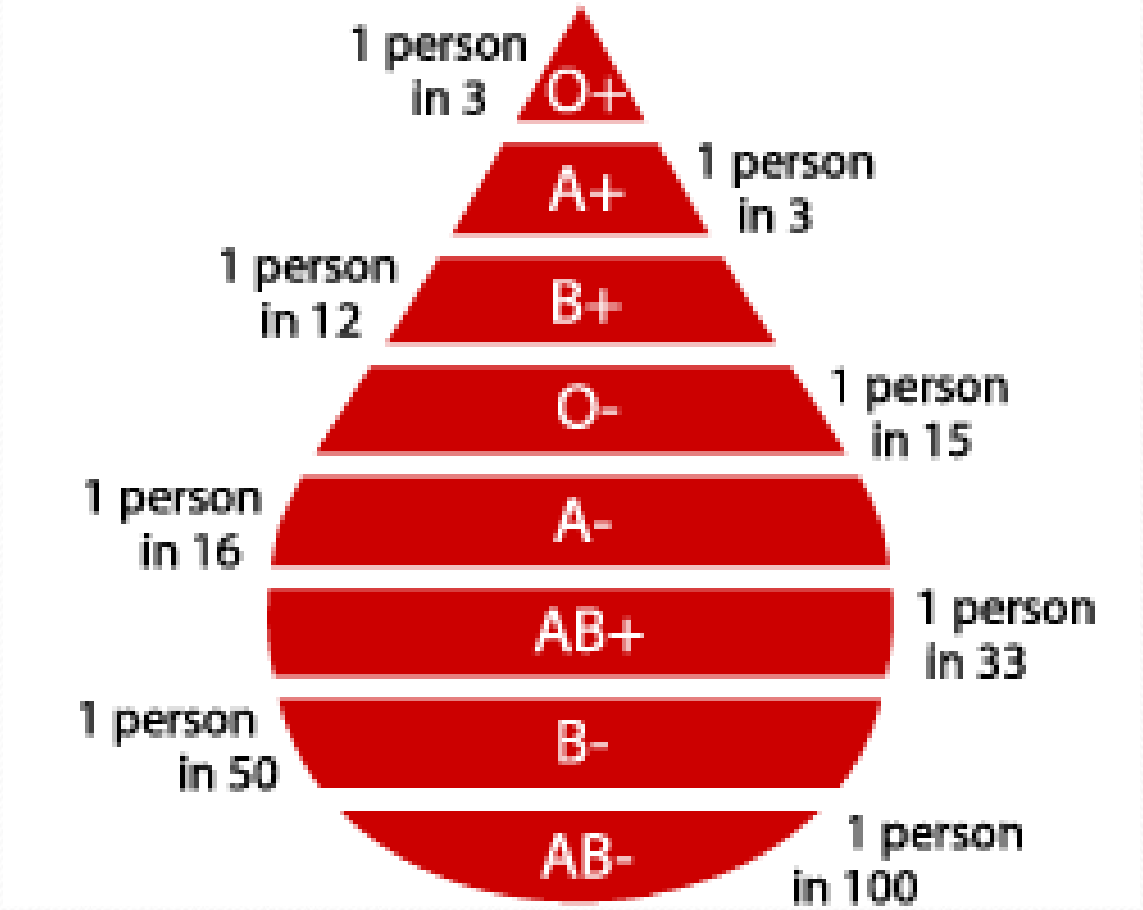
Types of blood group (ABO blood system)

- The differences in human blood are due to the presence or absence of certain protein molecules called antigens and antibodies.
- The antigens are located on the surface of the red blood cells
- The antibodies are in the blood plasma to attack foreign antigens, resulting in clumping (agglutination).
- The ABO blood system has four blood types: A, B, AB, and O.

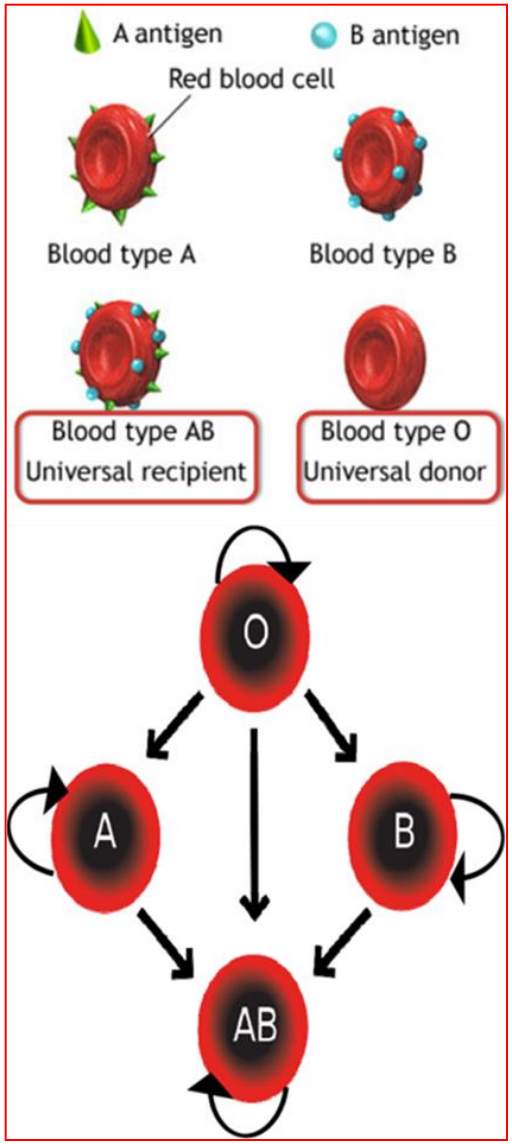
	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in Plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in Red Blood Cell	 A antigen	B antigen	 A and B antigens	None

The Rhesus (Rh) system

- They are named for the rhesus monkey in which they were first discovered.
- A person with Rh-negative (Rh-) blood does not have Rh antigen naturally in the surface of red blood cells.
- 85% of the population is Rh-positive (Rh+), the other 15% of the population is Rh negative blood.
- If it is present, the blood is Rh+, if not it's Rh-.
- Blood that is Rh- can be transfused into a person who is Rh+.
- The **Rh gene** locus is located on the **chromosome 1**.
- A person with Rh+ blood can receive blood from a person with Rh- blood without any problems.
- A person with Rh- blood can develop Rh antibodies in the blood plasma if he or she receives blood from a person with Rh+ blood, whose Rh antigens can trigger the production of Rh antibodies


1 person in 3
O+
A+
1 person in 3
1 person in 12
B+
O-
1 person in 15
1 person in 16
A-
AB+
1 person in 33
1 person in 50
B-
AB-
1 person in 100

Blood transfusions



Who can receive blood from whom?

		Donors							
		O+	A+	B+	AB+	O−	A−	B−	AB−
Receivers	O+	✓				✓			
	A+	✓	✓			✓	✓		
	B+	✓		✓		✓		✓	
	AB+	✓	✓	✓	✓	✓	✓	✓	✓
	O−					✓			
	A−					✓	✓		
	B−					✓		✓	
	AB−					✓	✓	✓	✓

- People with type **O** blood are called universal donors because they do not have any molecules on the surface of the red blood cells that can trigger an immune response.
- People with type **AB** blood are called universal receivers because they do not have any antibodies that will recognize type A or B surface molecules.

Importance and inheritance of the ABO and Rh blood group systems

- Blood group antigens must be determined to secure a safe practice of blood transfusion.
- They are also useful in determining familial relationships in forensic medicine.
- The **ABO gene is autosomal** (the gene is not on either sex chromosomes).
- The **ABO gene** locus is located on the **chromosome 9**.
- A and B blood groups are **dominant** over the O blood group.
- There are three different alleles: A, B, O.

Blood group	Genotype (alleles)
A (Homozygous)	AA
A (Heterozygous)	AO
B (Homozygous)	BB
B (Heterozygous)	BO
AB	AB
O	OO

Blood group	Genotype (alleles)
Rh positive (Rh+) (Homozygous)	RR
Rh positive (Rh+) (Heterozygous)	Rr
Rh negative (Rh-)	rr

Practice exercises

Question 1: Suppose that a mother has blood type A and genotype **AO** and the father has blood type B and genotype **BO**. Draw a Punnett square to show the possible genotypes of their children. What are the phenotypes of the kids?

P phenotype: ♂ heterozygous blood type B X ♀ heterozygous blood type A

P genotype: BO X AO

Gametes: B O and A O

Kids:

	B	**O**
A	**AB** AB blood group	**AO** A blood group
O	**BO** B blood group	**OO** O blood group

- The phenotypes of the kids are A, B, AB, and O

Question 2: Question 2: If one parent has blood type AB and the other has blood type O, what are the phenotypes of their kids?

♂ ♀

P phenotype: Blood type AB Blood type O

P genotype: AB X OO

Gametes: A B O

Kids:

	A	B
O	**AO** A blood group	**BO** B blood group

- The phenotypes of the kids are A and B

Question 3: If one parent has blood type AB+ and the other has blood type O-, what are the phenotypes of their kids?

♂ ♀

P phenotype: Blood type AB+ Blood type O-

P genotype: ABRR X OOrr

Gametes: AR BR Or

Kids:

	AR	BR
Or	**AORr** A+	**BORr** B+

- The phenotypes of the kids are A+ and B+

P genotype: ABRr X OOrr

Gametes: AR Ar BR Br Or

	AR	Ar	BR	Br
Or	AORr A+	Aorr A-	BORr B+	Borr B-

- The phenotypes of the kids are A+ , A-, B+ , B-

Question 4: A family of six includes four children, each of whom has a different blood type: A, B, AB and O. What are the genotypes of parents for this trait?

P genotype: AO X BO

Gametes: A O B O

Kids:

	A	**O**
B	**AB** AB blood group	**BO** B blood group
O	**AO** A blood group	**OO** O blood group

- The genotypes of parents are AO and BO

Question 5: It was suspected that two babies had been exchanged in a hospital. Mr. and Mrs. Jones received baby #1 and Mr. and Mrs. Simon received baby #2. Blood typing tests conducted on the parents and their respective babies yielded the following results: Were the babies switched? How can you determine whether they were or not?

Mr. Jones: Type A	Mr. Simon: Type AB
Mrs. Jones: Type O	Mrs. Simons: Type O
Baby #1: Type A	Baby #2 Type O

Jones

P genotype: AA X OO

Gametes: A O

Kids:

	A
O	AO A blood group

P genotype: AO X OO

Gametes: A O O

Kids:

	A	O
O	AO A blood group	OO O blood group

- Blood types of Jones children are A and O

Simon

P genotype: AB X OO

Gametes: A B O

Kids:

	A	B
O	AO A blood group	BO B blood group

- Blood types of Simon children are A and B

- ❑ Baby #1 for Mr. and Mrs. Simon
- ❑ Baby #2 for Mr. and Mrs. Jones

Quiz: Genetic of the human blood group

1. A man with blood type B, with one parent of blood type O, marries a woman with blood type AB. What will be the theoretical percentage of their children with blood type B?

- 25%
- 50%
- 75%
- 100%

2. In a particular family, one parent has type A blood, the other has type B. They have four children. One has type A, one has type B, one has type AB, and the last has type O. What are the genotypes of all six people in this family?

- Parents: AO and BB, Children: AB, AO, BO, and OO
- Parents: AA and BO, Children: AB, AO, BO, and OO
- Parents: AA and BB, Children: AB, AO, BO, and OO
- Parents: AO and BO, Children: AB, AO, BO, and OO