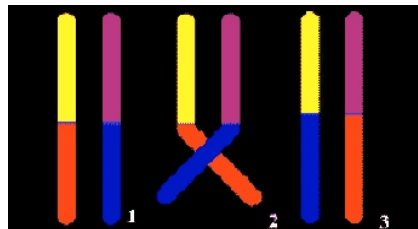


## V. Genetics

### A. Terminology

1. **Genes** may be said to be the units of inheritance. They contain the necessary information to determine specific biologic structures and processes.
2. In humans there are 46 **chromosomes**, 23 pairs of homologous. The chromosomal pairs, XX in females and XY in males, are the **sex chromosomes** and the other 22 pairs are the **autosomes**.
3. The place of a gene on chromosome that carries it is called its **locus**.
4. A locus may be occupied by one of several alternative forms of the gene and these alternatives are called **alleles**.
5. If both alleles are the same the owner is said to be **homozygous** in respect of this locus; if different he is said to be **heterozygous**.
6. Loci present on the same chromosome are **syntenic** with one another, regardless of the distance between the loci on the chromosome.
7. Terms are used to describe the location of genes on the chromosome.
  - a. When the alleles that occupy adjacent loci are on the same chromosome, they are in **cis** position.
  - b. When they are on opposite chromosomes they are in **trans** position.
  - c. These terms are particularly useful in the Rh groups and can be demonstrated by the following example: in the heterozygote CDe/cDE, C and e are in **cis** and so are c and E, but C and E, and c and e, are in **trans**.
8. When two loci are known to be carried on the same chromosome and to be within measurable distance of each other they are said to be **linked**. The nearer their loci are together the closer the linkage. Two alleles whose loci are closely linked may travel together through many generations without being separated.
9. Alleles at loci linked but sited at some distance from each other will often be separated by **crossing over**. Crossing over happens at the first meiotic division of gametogenesis.



10. Alleles at loci which are carried on different chromosomes or at loci far apart on the same chromosome, and whose entry together into a sex cell is a matter of chance, are said to **segregate independently**.

11. A **phenotype** is the assortment of antigens actually detectable on an individual's red cell. **Genotypes** cannot be determined with certainty and can only be accomplished through family studies.

B. Dominant and Recessive Traits

1. **Traits** are the observed expressions of genes.
2. A trait that is manifested when the determining allele is present in a single dose is called **dominant**; the person may be heterozygous at that locus and still reveal the trait (i.e., a brown eyed person may also have a blue eye gene and can transmit that to offspring).
3. A **recessive** trait is revealed only when the allele is present in the homozygous state (must have 2 blue eye genes to express blue eye color).
4. Blood group antigens, as a rule, are **codominant** traits; heterozygotes manifest the products of both alleles present (if a person has inherited an A blood group gene and a B blood group gene both are expressed and the individual is AB).
5. To determine potential blood groups inherited by offspring the parents genotype must be known.

Genotypes	A	O
O	AO	OO
O	AO	OO

- a. This represents one parent being group A and the other group O.
- b. In this example 50% of the children will be group A and 50% will be group O.
6. At times the genotype can be determined by the phenotypes inherited by the children.
  - a. Child is group O, one parent is group A, one parent is group B.

Genotypes	A	O
B	AB	BO
O	AO	OO

- b. In this example the couple has a 25% chance of having group O, A, B or AB.

C. Parentage testing

1. Many of the blood group antigens are expressions of codominant traits with a straightforward mode of inheritance and are useful in determining exclusion of paternity and probability of paternity.
2. If one assumes that the mother is truly the mother and that the testing was done properly, there are two types of exclusions.

- a. **Direct exclusion** is established when a *genetic marker is present in the child, but is absent from the mother and the alleged father*. Example:

Child	Mother	Father
A	O	O

Provided that neither the mother nor the father are of the rare Oh phenotype, the child has inherited the A gene, which could not come from either the mother or the alleged father.

- b. In an **indirect exclusion**, *genetic markers are absent from the child that should be transmitted by the alleged father*, given his observed phenotype. Example:

Child	Mother	Father
Fy(a+b-)	Fy(a+b-)	Fy(a-b+)

In this case the alleged father is presumably homozygous for the Fy<sup>b</sup> and should have transmitted Fy<sup>b</sup> to the child. Since the child is Fy(b-), there is an indirect exclusion.

- Direct exclusions provide more convincing evidence that the alleged father is not the biologic father than indirect exclusions because only rarely can the test results be explained by established mechanisms (eg, suppressor genes).
- Apparent indirect exclusions, however, can sometimes result from the presence of a silent allele (Fy<sup>b</sup>/Fy).
- In addition to blood group antigens DNA testing, enzyme testing and typing for HLA antigens (tissue antigens) are also utilized in determining the paternity of a child.

#### D. Population Genetics

- Basic understanding of population genetics is important not only in parentage testing but also in such clinical situations as predicting the likelihood of finding compatible blood for a patient with multiple antibodies.
- Phenotype frequencies are determined by testing red cells from a large number of random people of the same race, then calculating the percentage of positive or negative reactions with a given antiserum.
- Phenotype frequencies for a given blood group system should equal 100%. Example: 77% Jk(a+) and 23% Jk(a-). If blood is needed for a patient with anti-Jk<sup>a</sup>, 23 units out of 100 (or approximately 1 out of four) should be compatible.
- If the patient has multiple blood group antibodies it is possible to calculate the frequency of the combined phenotype by multiplying the individual frequencies. **\*Must be able to calculate for exam.***

	Phenotype Frequency %
Little c-	20
K-	91
Jk(a-)	23

$$0.2 \times 0.91 \times 0.23 = 0.04$$

Four units out of 100 would possibly be negative for all 3 antigens listed above. In some cases, due to the high frequency of some of the antigens involved, it may be necessary to contact the rate donor supplier.

### **EXAM 2 ONLINE**