Blood Types and the Rh Factor

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MMHS
Anatomy & Physiology
I. Genetics

A. Blood type is a **genetically inherited trait** “codominance”

1. traits are made of two alleles (one from each parent)

2. Upon **fertilization** the two alleles join to determine **blood type**

3. Alleles can be **dominant** or **recessive**.
   a. A **dominant allele** is always shown “expressed” no matter what allele it is paired with
   b. A **recessive allele** is only expressed when it is paired with another **recessive allele**
Genetics of Blood

B. Genotype and Phenotype

1. How alleles appear on the chromosome is the genotype
   a. BB and Bb are both genotypes for brown eyes
   b. bb is the genotype for blue eyes

2. How the alleles appear physically is the phenotype
   a. different genotypes can have the same phenotype
ABO Blood Grouping

C. Genetics of A, B, O blood groups

1. Blood has **codominant** alleles
   a. A and B are dominant
   b. O is recessive
## Genotype vs. Phenotype

<table>
<thead>
<tr>
<th>Blood Genotype</th>
<th>Blood Phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I^A I^A$ (AA), $I^A i$ (A0)</td>
<td>Type A</td>
</tr>
<tr>
<td>$I^B I^B$ (BB), $I^B i$ (BO)</td>
<td>Type B</td>
</tr>
<tr>
<td>$I^A I^B$ (AB)</td>
<td>Type AB</td>
</tr>
<tr>
<td>ii (OO)</td>
<td>Type O</td>
</tr>
</tbody>
</table>
II. ABO blood groups

A. Antigens and Antibodies

1. Agglutination is the clumping of red blood cells following a transfusion reaction

2. Antigens (agglutinogens)
   a. surface molecules on RBC’s
   b. at least 50 different kinds (A, B, D most important)
   c. type A blood has only antigen A
   d. type B blood has only antigen B
   e. type AB blood has both antigen A and B
   f. type O blood has neither antigen
3. **Antibodies** (agglutinins)
   a. contained in **plasma**
   b. **attack** “foreign” **antigens** on others **RBC’s**

B. Type **AB** is considered to be the **universal recipient**

C. Type **O** is considered to be the **universal donor**
## Agglutinogens vs Agglutinins

<table>
<thead>
<tr>
<th>Blood Type</th>
<th>Agglutinogen</th>
<th>Agglutinin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Type B</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>Type AB</td>
<td>A, B</td>
<td>None</td>
</tr>
<tr>
<td>Type O</td>
<td>none</td>
<td>A, B</td>
</tr>
</tbody>
</table>
III. Rh Factor

A. Named after the rhesus monkey that was being studied

B. If antigen D is present the person is Rh+; if antigen D isn’t present then the person is Rh-

C. Rh antibodies (anti-Rh) are not inherited; they only appear when stimulated

1. Rh- person receives Rh+ blood: person will be safe the 1st time but the 2nd time anti-Rh will attack donor blood
RhoGam

2. Rh- mom pregnant with Rh+ baby: at birth, blood can mix causing mom to make anti-Rh that will attack future babies (erythroblastosis fetalis); prevention= (Rh-) mom is injected several times with RhoGAM which binds to fetal cells protecting them from mom’s antibodies.
### ABO Blood Types

<table>
<thead>
<tr>
<th>Erythrocytes</th>
<th>Plasma</th>
<th>Blood type</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Antigen A</strong></td>
<td>Anti-B antibodies</td>
<td><strong>Type A</strong> Erythrocytes with type A surface antigens and plasma with anti-B antibodies</td>
</tr>
<tr>
<td><strong>Antigen B</strong></td>
<td>Anti-A antibodies</td>
<td><strong>Type B</strong> Erythrocytes with type B surface antigens and plasma with anti-A antibodies</td>
</tr>
<tr>
<td><strong>Antigens A and B</strong></td>
<td>Neither anti-A nor anti-B antibodies</td>
<td><strong>Type AB</strong> Erythrocytes with both type A and type B surface antigens, and plasma with neither anti-A nor anti-B antibodies</td>
</tr>
<tr>
<td><strong>Neither antigen A nor B</strong></td>
<td>Both anti-A and anti-B antibodies</td>
<td><strong>Type O</strong> Erythrocytes with neither type A nor type B surface antigens, but plasma with both anti-A and anti-B antibodies</td>
</tr>
</tbody>
</table>
Blood Type Distribution

- O+ 40%
- O- 9%
- A+ 31%
- A- 7%
- B+ 8%
- B- 2%
- AB+ 2%
- AB- 1%
Antibody (specific)

A or B marker (antigen)

Agglutination

Normal blood

Agglutinated blood

Type AB

Type A

Type B

Type O
### Genetic Cross of Blood Types

<table>
<thead>
<tr>
<th>Father's Blood Type</th>
<th>A</th>
<th>B</th>
<th>AB</th>
<th>O</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A or O</td>
<td>A, B, AB,</td>
<td>A, B, or</td>
<td>A or O</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or O</td>
<td>AB</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>A, B, AB,</td>
<td>B or O</td>
<td>A, B, or</td>
<td>B or O</td>
</tr>
<tr>
<td></td>
<td>or O</td>
<td></td>
<td>AB</td>
<td></td>
</tr>
<tr>
<td>AB</td>
<td>A, B, or</td>
<td>A, B, or</td>
<td>A, B, or</td>
<td>A or B</td>
</tr>
<tr>
<td></td>
<td>AB</td>
<td>AB</td>
<td>AB</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>A or O</td>
<td>B or O</td>
<td>A or B</td>
<td>O</td>
</tr>
</tbody>
</table>