Blood Type and Sex Linked Inheritance
The Classic Example of Codominance in Humans is **BLOOD TYPE**

- Gene that controls ABO blood type codes for an enzyme that makes a glycolipid on blood cells
- Two alleles ($I^A$ and $I^B$) (call them “A” and “B”) are **codominant**
- Third allele ($I^O$) (call it “O”) is **recessive to A and B**
Possible Genotypes for Blood Types

- If the Phenotype: A
  - Genotype(s): AA, AO

- If the Phenotype: B
  - Genotype(s): BB, BO

- If the Phenotype: AB
  - Genotype(s): AB

- If the Phenotype: O
  - Genotype(s): OO
Your blood type is determined by A and/or B proteins on red blood cell surfaces.

<table>
<thead>
<tr>
<th>Blood Type (genotype)</th>
<th>Type A (AA, AO)</th>
<th>Type B (BB, BO)</th>
<th>Type AB (AB)</th>
<th>Type O (OO)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Red Blood Cell Surface Proteins (phenotype)</strong></td>
<td>A agglutinogens only</td>
<td>B agglutinogens only</td>
<td>A and B agglutinogens</td>
<td>No agglutinogens</td>
</tr>
<tr>
<td><strong>Plasma Antibodies (phenotype)</strong></td>
<td>b agglutinin only</td>
<td>a agglutinin only</td>
<td>No agglutinin</td>
<td>a and b agglutinin</td>
</tr>
</tbody>
</table>
Blood Tests are done by adding antibodies to the sample

- Which blood type clots with both anti-A and anti-B? **AB**
- Which blood type doesn’t clot with anti-A or anti-B? **O**

- Do you know what YOUR blood type is?
The **Rhesus Factor**
You are either R(+) or R(-) for the Rhesus Protein

**A problem for Rh (-) moms ...**

- What if baby is *Rh (+)*?
  - Doctor can give Mom a shot (Rhogam, at about 28 weeks) that removes or hides R(+) cells from Mom’s bloodstream
A Real Problem:
Mom is Type B, Dad is Type O ... Baby is Type AB. Is this possible?

• Cross: **BO** X **OO**

Remember, when in doubt, heterozygous is more likely

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<tr>
<th></th>
<th>B</th>
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<tr>
<td>O</td>
<td>BO</td>
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SORRY! NOT POSSIBLE!
Sex Chromosomes: the 23rd pair in humans

- All others (1-22) are called autosomes.

Boy    Girl
The Sex Chromosomes

- The “X” Chromosome
  - Has essential genes
  - *Can’t live without it!*
  - Female 23\(^{rd}\) pair = \(XX\) (one usually deactivated)

- The “Y” Chromosome
  - Few genes
  - Determines if testes develop
  - Male 23\(^{rd}\) pair = \(XY\)
What’s the probability of having a boy or girl?

50%

50%
Sex-Linked (X-Linked) Traits

- Sex-Linked traits are usually found on the X (not Y) chromosome (“X-linked”)
- Males are affected or not, no heterozygotes... WHY, do you think?
Some X-Linked Traits:

- Haemophilia (missing clotting enzymes)
- Colorblindness
- “Male-pattern” baldness
- Most are recessive
Haemophilia

- **Ability of blood to clot is impaired.**

- The main treatment for hemophilia is called replacement therapy—giving or replacing the clotting factor that’s too low or missing.
“The Royal Disease”
A haemophiliac man marries a healthy woman. What is the probability that they will have any haemophiliac children?

0%

- All sons healthy
- All daughters carriers
Colorblindness

- Red-green colorblindness - red and green are perceived as identical.

- Affects:
  - 1 in 10 males in the US
  - 1 in 100 females in the US

- Remember: Males have just one X chromosome. All X-linked alleles are expressed in males.
A man with normal vision marries a colorblind woman. What is the probability that they will have a colorblind SON?

- Cross: $X^cX^c \times XY$

Remember, Mom only shows if she is homozygous!

Focus only on SONS (not daughters)!

100% (2/2) SONS
What do you see?
A bald man marries a woman whose father was bald. What is the probability that they will have a **son** with male-pattern baldness?

### Cross:

- **MOM**: $X^b X$  
- **DAD**: $X^b Y$

**THE TRICK:** Focus only on **sons** (not daughters)!

- **50%** (1/2) **sons**

If Mom’s father was bald, then he must have passed that $X$ to her!