Sex-linked traits

Background Information:

Sex-linked traits are those whose genes are found on the X chromosome but not on the Y chromosome. In humans the X chromosomes are much larger than the Y chromosome and contain thousands of more genes than the Y chromosome. For each of the genes that are exclusively on the X chromosomes, females, who are XX, would obviously have two alleles. Males, who are XY, would have only one allele. Thus females with one recessive allele and one dominant allele, for a gene that is unique to the X chromosome, will always display the dominant phenotype. However, a male with a recessive allele for a gene unique to the X chromosome will always exhibit that recessive trait because there is no other corresponding allele on the Y chromosome.

In humans, each of two different sex-linked genes has a defective recessive allele that causes a disease. The diseases are hemophilia and colorblindness. In hemophilia, the defective allele prevents the synthesis of a factor needed for blood clotting. In colorblindness, the defective allele prevents a person from seeing certain colors.

Use the information below to answer the following questions.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td>X&lt;sup&gt;H&lt;/sup&gt;</td>
<td>X chromosome with normal dominant allele (no hemophilia)</td>
</tr>
<tr>
<td>X&lt;sup&gt;h&lt;/sup&gt;</td>
<td>X chromosome with recessive hemophilia allele</td>
</tr>
<tr>
<td>Y</td>
<td>Y chromosome (does not contain comparable gene)</td>
</tr>
<tr>
<td>X&lt;sup&gt;B&lt;/sup&gt;</td>
<td>X chromosome with normal dominant allele (not colorblind)</td>
</tr>
<tr>
<td>X&lt;sup&gt;b&lt;/sup&gt;</td>
<td>X chromosome with recessive colorblind allele</td>
</tr>
<tr>
<td>Y</td>
<td>Y chromosome (does not contain comparable gene)</td>
</tr>
</tbody>
</table>

1. Write the genotypes for the following phenotypes of red-green color blindness.

a. normal male _____________

b. normal female carrying no colorblind alleles (Homozygous) _____________

c. colorblind male _____________

d. normal female carrying the colorblind allele (Heterozygous) _____________

e. colorblind female _____________
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2. $X^B X^b \times X^b Y$
   a. What proportion/percent of the male children are colorblind? _____________
   
   b. What proportion/percent of the female children are colorblind? _____________

3. $X^B X^b \times X^B Y$
   a. What proportion of the male children are colorblind? _____________
   
   b. What proportion of the female children are colorblind? _____________

4. What is the probability that a colorblind woman who marries a man with normal vision will have a colorblind child? _____________

   ______ X _________

5. A normal-sighted woman (whose father was colorblind) marries a colorblind man. _________ X _________

   a. What is the probability that they will have a son who is colorblind? _____________
   
   b. What is the probability that they will have a colorblind daughter? _____________
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For the following sex-linked punnett squares:

H= normal blood clotting  
h=hemophilia

6. \( X^H_X^h \times X^h_Y \)
   a. What is the probability that any of their offspring will have hemophilia? 

   

7. A woman who is a carrier for hemophilia marries a hemophiliac man.
   a. What proportion of the male children are hemophiliacs? 
   b. What proportion of the female children are hemophiliacs? 

8. A phenotypically normal man marries a homozygous normal woman.
   
   a. What is the probability that any of their children will be hemophiliacs? 

9. A phenotypically normal woman has phenotypically normal parents. However, she has a hemophiliac brother. (Mom is carrier) (Dad) Brother

__________   __________    __________

   a. What are her chances of being a carrier for hemophilia? ____________

ANSWER THE FOLLOWING QUESTIONS USING YOUR KNOWLEDGE OF SEX-LINKED TRAITS, THE BACKGROUND INFORMATION AND YOUR NOTES.

10. What is a sex-linked trait?

11. Why must males inherit colorblindness or hemophilia from their mothers?

12. Why is colorblindness or hemophilia more common in males than in females?