Define the following terms (5 points each):

OMIM

twin spot

RefSeq

codominant alleles

template
Questions 1-4 are worth 5 points each. They concern two recessive mouse mutations, \textit{clubpaw1} (\textit{cp1}) and \textit{clubpaw2} (\textit{cp2}), that show the identical phenotype (fused digits on the paw). You first want to test whether these mutations are in the same gene. You cross \textit{cp1} homozygotes with \textit{cp2} homozygotes. For each of the four cases below, predict the frequency of mice with fused digits (assuming simple Mendelian ratios).

1) If \textit{cp1} and \textit{cp2} complement, you expect ______ % of the F1 mice to have fused digits.

2) If \textit{cp1} and \textit{cp2} do not complement, you expect ______ % of the F1 mice to have fused digits.

3) If \textit{cp1} and \textit{cp2} complement, you expect ______ % of the F2 mice to have fused digits.

4) If \textit{cp1} and \textit{cp2} do not complement, you expect ______ % of the F2 mice to have fused digits.

5. (5 points) Three \textbf{wild-type} alleles, 1, 2 and 3, are present in a population in Hardy-Weinberg equilibrium and no other alleles are present at appreciable frequencies. Homozygotes for allele 1 represent 16\% of the population, and homozygotes for allele 2 represent 9\% of the population. What fraction of the population is homozygous for allele 3?

6. (5 points) Allele 3 confers a semidominant increased risk of early-onset Alzheimer's disease. What fraction of the population shows the intermediate level of risk associated with \textbf{heterozygosity} for allele 3?
7. (5 points) Here is the sequence of the template strand of a DNA fragment:

\[ \text{GTCGCCGTGCAATGATGTAGGCGACTATGGTTGA} \]

Applying the standard **convention** for polarity (which end is 5' and which is 3'), which of the following would be the complementary, nontemplate, strand?

a) \[ \text{TCAACCATAGTCGCCTACATCATTGCACGGCGAC} \]

b) \[ \text{AGTTGGTATCAGCGGATCTAGTAACGTGCCGCTG} \]

c) \[ \text{GTCGCCGTGCAATGATGTAGGCGACTATGGTTGA} \]

d) \[ \text{CAGCGGCACGTTACTACATCCGCTGATACCAACT} \]

Problems 8-10 (4 points each). In each of the following there are two or more statements. One is true (generally, it is taken directly from your textbook) and the others have been modified so that to be untrue or misleading. Circle, check or otherwise designate the correct statement. Ambiguous marks (checking both, placing a mark between the two statements, etc.) will be considered wrong.

8. a The **primer** DNA provides a terminus with a free 5'-OH to which nucleotides are added during DNA synthesis.

b The **template** DNA provides a terminus with a free 5'-OH to which nucleotides are added during DNA synthesis.

c The **primer** DNA provides a terminus with a free 3'-OH to which nucleotides are added during DNA synthesis.

9. a A particular mutant allele is either dominant or recessive for all traits that it affects.

b The same mutant allele can be dominant with respect to some traits and recessive with respect to others.

10. a The probability of two independent events occurring together is the **product** of the probabilities that each event will occur by itself.

b The probability of two independent events occurring together is the **sum** of the probabilities that each event will occur by itself.
Consider two genes: $ABC1$ and $DEF2$.
When a wild-type ($ABC1$ and $DEF2$) strain is crossed to a doubly mutant strain ($abc1$ and $def2$) and sporulated, the following tetrads are observed:

- 83 tetrads with two $ABC1$ $DEF2$ spores and two $abc1$ $def2$ spores.
- 79 tetrads with two $ABC1$ $def2$ spores and two $abc1$ $DEF2$ spores.
- no tetrads of any other type.

11. (5 points) Are these two genes linked to each other (yes or no)?

12. (5 points) Are these genes linked to the centromere (i.e. is $ABC1$ centromere-linked? Is $DEF2$ centromere-linked?) Either or both can be true. Select one of the following:
   a) Neither is centromere-linked and they are not linked to each other.
   b) Both are centromere-linked, and they are on the same chromosomes (linked to each other).
   c) Both are centromere-linked, but they are on different chromosomes (not linked to each other).
   d) One is centromere-linked, which makes it impossible to determine whether the other (which is not linked to the first) is also centromere-linked.
   e) The two genes are linked to each other, and this makes it impossible to determine whether they are centromere-linked.

13. (10 points) Which of the following are true? None, all or any number can be true. (circle the letter corresponding to each that is true; this is really 5 true/false questions)?
   a) Experimental recombination frequencies between two genes are never greater than 50%
   b) The two terms centimorgan and map unit are interchangeable.
   c) When two genes are linked parental ditypes will outnumber nonparental ditypes.
   d) When two genes are unlinked the number of parental ditypes will be approximately the same as the number of nonparental ditypes.
   e) When two genes are linked but 60 cM. or farther apart the number of parental ditypes will be approximately the same as the number of nonparental ditypes.
14. (3 points) Consider the following two possible alignments. yfg (your favorite gene) differs from each of the other two sequences by three substitutions in the region of alignment shown. To which sequence (1 or 2) is yfg more likely to be related? Explain.

1

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>O</td>
<td>N</td>
<td>S</td>
<td>R</td>
</tr>
<tr>
<td>V</td>
<td>Q</td>
<td>Q</td>
<td>L</td>
<td>R</td>
</tr>
</tbody>
</table>

2

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Q</td>
<td>N</td>
<td>L</td>
<td>K</td>
</tr>
</tbody>
</table>

15. (5 points) The five amino acids E, F, G, N and W are pictured below. Which is which (put a number besides each of the five letters)?

E

F

G

N

W