CHROMOSOMAL THEORY OF INHERITANCE

The Theory:

Evidence:

Cytologists:  

Geneticists:  

Sutton & Boveri:
<table>
<thead>
<tr>
<th>Phenotype</th>
<th>Expected if Unlinked</th>
<th>Expected if Linked</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
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<tr>
<td>Total</td>
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</table>
Recombination Frequency

<table>
<thead>
<tr>
<th>Loci</th>
<th>Recombination Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>b – vg</td>
<td>17%</td>
</tr>
<tr>
<td>cn – b</td>
<td>9%</td>
</tr>
<tr>
<td>cn – vg</td>
<td>9.5%</td>
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</table>
### Sex Linkage

<table>
<thead>
<tr>
<th>Males:</th>
<th>Females:</th>
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</table>

**Sry Gene:**

### Sex Linked Disorders
QUESTIONS:

1. A wild-type fruit fly (heterozygous for gray body color and normal wings) was mated with a black fly with vestigial wings. The offspring gave the following distribution: wild type, 778; black-vestigial, 785; black-normal, 158; gray-vestigial, 162.
   a. What are the phenotypes of the recombinants?
   __________________________________________________________
   b. What is the recombination frequency between the genes for body color and wing type? Show your work.

2. In guinea pigs, black (B) is dominant to brown (b), and solid color (S) is dominant to spotted (s). A heterozygous black, solid-colored pig is mated with a brown, spotted pig. The total offspring for several litters is:
   Black solid       16       Black spotted      5
   Brown solid      14       Brown spotted     14
   a. Calculate the recombination frequency for the cross. Show your work.
   b. Are these genes linked or nonlinked? _________________________________
   c. How do you know? ________________________________________________

3. The following recombination frequencies were found. Determine the order of these genes on the chromosome.
   a—c  10%   b—c  4%   c—d  20%
   a—d  30%   b—d  16%
   a—e  6%    b—e  20%
4. Spottedness, coloredness, antennae length, and fur type are traits found in tribbles. The key below represents the alleles for these traits:

\[
\begin{align*}
S &= \text{spotted} & s &= \text{solid color} \\
C &= \text{colored} & c &= \text{white} \\
L &= \text{long antennae} & l &= \text{short antennae} \\
F &= \text{fuzzy fur} & f &= \text{curly fur}
\end{align*}
\]

The chart below shows the results of crosses performed by a team of geneticists on the starship Enterprise C.

<table>
<thead>
<tr>
<th>Cross #</th>
<th>Parents</th>
<th>Offspring</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Heterozygous spotted long antennae X Solid short antennae</td>
<td>753 spotted long 748 solid short 151 spotted short 150 solid long</td>
</tr>
<tr>
<td>2</td>
<td>Heterozygous colored fuzzy fur X White curly fur</td>
<td>853 colored fuzzy 848 white curly 861 colored curly 840 white fuzzy</td>
</tr>
<tr>
<td>3</td>
<td>Heterozygous colored long antennae X White short antennae</td>
<td>500 colored long 503 white short 56 colored short 60 white long</td>
</tr>
<tr>
<td>4</td>
<td>Heterozygous colored spotted X White (solid colored)</td>
<td>1069 colored spotted 1074 white (solid colored) 85 colored solid 76 white spotted (spots appear as light gray patches)</td>
</tr>
</tbody>
</table>

a. Calculate the recombination frequency for each cross. Show your work.
Cross #3 Calculations | Cross #4 Calculations
<table>
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<tbody>
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</tbody>
</table>

b. Are all four genes found on the same chromosome? Explain.
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

c. For the genes that are found on the same chromosome, in what sequence are they found on the chromosome?
____________________________________________________________________

5. Why is the human male considered to be the heterogametic sex?
____________________________________________________________________
Why is the human female the homogametic sex?
____________________________________________________________________

6. What is the function of the *Sry* gene?
____________________________________________________________________
____________________________________________________________________
____________________________________________________________________
Where is it found?____________________________________________________________________
7. Define sex-linked disorders and give examples of those found in humans.
Definition: ______________________________________________________
________________________________________________________________________
Examples: _____________________________________________________________

8. From which parent do sons get their sex-linked alleles?_______________
From which parent do daughters get their sex-linked alleles?______________

9. Why do sex-linked disorders appear more often males than in females?
________________________________________________________________________

10. Two normal color-sighted individuals produce the following children and grandchildren. Determine the probable genotype for the indicated individuals. Remember colorblindness is a sex-linked trait. $X^N$ = normal allele; $X^o$ = colorblind allele; XX = female; XY = male.

```
1.___________  2.____________  3.____________
4.___________  5.____________  6.____________
7.___________
```
11. A woman is a carrier for a sex-linked lethal gene that causes spontaneous abortions. She has nine children. How many of these children do you expect to be boys?

____________________________________________________________

12. The normal daughter of a man with hemophilia marries a man who is normal for the trait.
   a. What is the probability that a daughter will be a hemophiliac?

____________________________________________________________

   b. What is the probability that a son will be a hemophiliac?

____________________________________________________________

d. If the couple has four sons, what is the probability that all four sons will be born with hemophilia?

____________________________________________________________

13. Red-green color blindness is caused by a sex-linked recessive allele. A color-blind man marries a woman with normal vision whose father was color-blind.
   a. What is the probability that they will have a color-blind daughter?

____________________________________________________________

   b. What is the probability that their first son will be color-blind. NOTE: This question is worded slightly different from the first.

____________________________________________________________

14. What are Barr bodies?

____________________________________________________________

____________________________________________________________

15. Explain what it means when females are referred to a mosaic of two cell types?

____________________________________________________________

____________________________________________________________

____________________________________________________________

Heredity Activity #5 page 9
What are two examples of this mosaicism in females?

____________________________________________________________


____________________________________________________________

17. Identify the type of chromosomal alteration being described in each of the following statements. Use the key below to indicate your answers.

A. Aneuploidy  B. Deletion  C. Duplication  D. Inversion  E. Polyploidy  F. Translocation

______ A piece of a chromosome breaks off and is lost
______ A piece of a chromosome breaks off and reattaches to the same chromosome, but in a reversed orientation.  
______ An extra chromosome
______ An extra complete set of chromosomes
______ A piece of chromosome 5 breaks off and attaches to chromosome 7
______ A piece of a chromosome breaks off and attaches to the end of its sister chromatid.
______ An individual with a 2n+1 chromosome number
______ An individual with a 4n chromosome number
______ The gene sequence on chromosome is ABCDEFG before the alteration and a sequence of ADCBEFG after.
______ The gene sequence on a chromosome is ABCDEFG before the alteration and ABCDABCDEFG after.
______ The gene sequence on a chromosome is ABCDEFG before the alteration and ABCDEF after.

18. What is the relationship between maternal age and the incidence of Down’s syndrome?

____________________________________________________________

____________________________________________________________
19. Complete the following chart comparing the types of human disorders or syndromes related to chromosomal abnormalities.

<table>
<thead>
<tr>
<th>Name of Disorder or Syndrome</th>
<th>Chromosomal Alternation Involved</th>
<th>Symptoms or Associated Traits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trisomy 21</td>
<td></td>
<td>Sterility, small testes, feminine body contours, normal intelligence or mental retardation</td>
</tr>
<tr>
<td>Turner Syndrome</td>
<td>Deletion in Chromosome 5</td>
<td></td>
</tr>
<tr>
<td>Metafemales</td>
<td>CML</td>
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</tbody>
</table>

20. Is the following statement true or false? “All the genes that are found in your cells are located in the nucleus on the chromosomes.” Provide evidence to support your answer.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________