Week 4
Genetics: BIO-2306

The concepts this resource covers are the topics typically covered during this week of the semester. If you do not see the topics your particular section of class is learning this week, please take a look at other weekly resources listed on our website for additional topics throughout the semester.

We also invite you to look at the group tutoring chart on our website to see if this course has a group tutoring session offered this semester.

If you have any questions about these study guides, group tutoring sessions, private 30 minute tutoring appointments, the Baylor Tutoring YouTube channel or any tutoring services we offer, please visit our website [www.baylor.edu/tutoring](http://www.baylor.edu/tutoring) or call our drop in center during open business hours. M-Th 9am-8pm on class days 254-710-4135.

**Keywords:** Pedigree, Testcross, Linked Genes, Recombination, Gene Map

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**Topic of the Week: Linked Genes and Recombination (7.1-7.2)**

**Linked Genes:** genes which do not follow mendel’s second law of inheritance (in that they do not segregate independently of one another) because the cross over together

**Genes** at different Loci May follow one of may patterns

**Completely Independent:** genes at two loci always assort independently

*note:* generally, these are genes on separate chromosomes

**Incompletely Linked:** genes at two loci that have a great deal of physical separation on the same chromosome; normally assort independently, but other times are linked

**Completely Linked:** genes at two loci on a single chromosome that will be linked at any crossover event

(a) **No crossing over**

1. Homologous chromosomes pair in prophase I.
2. If no crossing over takes place,...
3. ...all resulting chromosomes in gametes have original allele combinations and are nonrecombinants.

(b) **Crossing over**

1. A crossover may take place in prophase I.
2. In this case, half of the resulting gametes will have unchanged chromosomes (nonrecombinants)...
3. ...and half will have recombinant chromosomes.
Crossing Over: exchange of material between adjacent arms on homologous chromosomes in prophase I of gamete formation

Recombination: the formation of novel allelic combinations not present in the parents

Recombination Frequency ($f_R$): \[ \frac{\text{number of recombinant progeny}}{\text{total progeny}} \times 100\% \]

$f_R$ represents the likelihood that crossing over produces recombinant offspring at two incompletely linked loci.

The recombination frequency between two completely linked loci would be 50% if a crossover event happened in every meiosis. This is because at a single crossover, half of the gametes will be recombinant and the other half will be non-recombinant.

Frequency of recombinant gametes: the likelihood of the creation of each gamete, which will be $\frac{1}{2}$ the $f_R$.

Simplification: frequency of recombinant gametes = $\frac{1}{2} f_R$

Testcross: an individual with hetero- or homozygoys dominat expression of a gene is crossed with an individual who is recessive at both loci.

*Generally we use a double heterozygote crossed with a homozygous recessive

What is the expected genotypic ratio of a AaBb x aabb cross?

1:1:1:1

If genes are linked, the number will deviate from this.

Terminology:

Wild-Type: the allele most commonly seen in nature

Mutant-Type: a new allele created by natural or laboratory mechanisms which exists with a wild type allele at a locus (although many examples categorize these as recessive, they can be dominant or recessive, depending on the inheritance pattern of the wild type allele)

Gene Configuration: the conformation of homologous chromosomes with respect to where the how the dominant and recessive alleles are aligned at each locus

Coupling (cis): both dominant and both recessive alleles are present (at their respective locus) on each homolog $\frac{A}{a} \frac{B}{b}$

Repulsion (trans): 1 dominant and one recessive allele on each homolog $\frac{A}{a} \frac{b}{B}$

*Yes, this is the same as the conformations of vinyl H-atoms in double bond stereochemistry!
Highlight #1: Pedigree Analysis (6.2)

https://www.youtube.com/watch?v=Gd09V2AkZv4

Symbols used in pedigrees:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Male</th>
<th>Female</th>
<th>Sex unknown</th>
<th>Specified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unaffected person</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Person affected with trait</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obligate carrier (carries the gene but does not have the trait)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asymptomatic carrier (unaffected at this time but may later exhibit trait)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple persons</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deceased person</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proband (first affected family member coming to attention of geneticist)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Autosomal Recessive: Equal proportions in males and females; can skip generations/be ‘hidden’ by carriers (note: obligate carrier symbol will not always be shown in a pedigree)

Consanguinity: inbreeding/cross between cousins

Autosomal Dominant: Every affected individual must have an affected parent; Won’t skip generations

X-Linked Recessive: Unequal proportion of males and females affected (more in males); may skip generations

Rule of Thumb:
- When a daughter is affected, the father is affected
- An affected son’s mother has the trait, or is a carrier (heterozygote)

X-Linked Dominant: Every affected individual must have an affected parent; Won’t skip generations

Rule of Thumb:
- Every affected male’s daughter has the trait
- Sons: inherit from mom only
- Daughters: inherit from mother or father

Y-Linked trait: Passed from father to son; doesn’t skip generations (males only)

Note: see table 6.1 for more conditions for each of these general rules of thumb

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CHECK YOUR LEARNING

Concept Check: (Answers found on the last page)

1. What pattern of inheritance is displayed by the pedigree?
2. True/False Two alleles, \(A^o\) and \(A^p\) have a recombination frequency of 43 so they are in separate linkage groups.
3. Two loci, \(A(a)\) and \(B(b)\) are located near each other on a chromosome. A female in cis configuration is heterozygous at both loci and crosses with a recessive male. What is the recombination frequency of the following linked gene?

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\frac{AB}{a b})</td>
<td>82</td>
</tr>
<tr>
<td>(\frac{a b}{a b})</td>
<td>78</td>
</tr>
<tr>
<td>(\frac{A b}{a b})</td>
<td>8</td>
</tr>
<tr>
<td>(\frac{a B}{a b})</td>
<td>4</td>
</tr>
</tbody>
</table>
THINGS YOU MAY STRUGGLE WITH:
1. If you are stuck between multiple possible types of inheritance on a pedigree, try drawing out the crosses; sometimes, several inheritance patterns may seem identical, but they will have differences that can be visualized by a cross. When doing this, work from homozygous recessive individuals because you automatically know their genotype.
2. In a testcross evaluating recombination frequency, the recombinant progeny will be those which exist in the smallest numbers.
3. If the recombination frequency between two genes is $\geq 50$, the two are treated as two separate linkage groups, or on separate chromosomes, because they assort independently.

You Try: Click the link to try these practice problems on google forms!
Formative Practice: https://docs.google.com/forms/d/e/1FAIpQLSe7uszVJmMFnA4nSn_9eK7R7g7sNtuzOa24Br1irF7ENZN-eQ/viewform?usp=sf_link

CONGRATS: You made it to the end of the resource! Thanks for checking out these weekly resources! Don’t forget to check out our website for group tutoring times, video tutorials and lots of other resources: www.baylor.edu/tutoring!

Answers to check your learning questions are below!

Answers:
1. X-Linked Dominant
2. False
3. $f_r = 0.0698$

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