

## Genetics: BIO-2306

Final Review For Genetics Covering Math Concepts  
(Cumulative practice problems may be found on the final page!)

**This week is the last week of class, and typically in this week (and the surrounding weeks of class) you are reviewing for the final exam. Please use the review below (as well as other resources from the semester) as a general overview of some of the key concepts taught in the course!** Please take a look at all 12 weekly resources listed on our website, as well as the biology content review, to help you review for the final exam!

If you have any questions about these study guides, the final schedule of 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. **The last day of tutoring in the drop in center will be the last day of class.** To learn about additional resources available during Finals Week, please visit CASE in the West Wing basement of Sid Rich! Good luck on your final exam!

### Section 1: Review of Mathematical Genetics

**Crosses:** do you best to memorize the **common patterns** in all Mendelian crosses

**Monohybrid Cross:** a cross at a single locus (*Law of Segregation*)

**Dihybrid Cross:** a cross at two loci (*Law of Independent Assortment*)

**Testcross:** a cross between a homozygous recessive and an unknown genotype

**Addition Rules:** rules for *adding* probabilities (Keyword “**OR**”)

**Multiplication Rules:** rules for *multiplying* probabilities (Keyword “**AND**”)

**Conditional Probability:** the probability of an event happening *depending* on another

**Binomial Expansion:** the **probability** (P) that an **event** (x) with a probability *p* **will occur s times** and the **alternate event** (y) with probability *q* **will happen t times:**  $P = \frac{n!}{s!t!} (p^s \times q^t)$

\**n* is the number of times an event occurs and “!” is the factorial, and is typed on the calculator as [value]!

**Chi Square (X<sup>2</sup>):** a statistical test which assess if difference between observed and expected values is significant

$$X^2 = \sum \frac{(\text{Observed} - \text{Expected})^2}{\text{Expected}}$$

\* **note:** degrees of freedom (DF) is *n*-1 (number of samples -1)

**Null Hypothesis (H<sub>0</sub>):** states that the difference between O and E is due to chance alone

**α-Value = 0.05:** states that you are 95% (1.0-0.05 = 0.95) confident in your significance

**Critical Value:** value on X<sup>2</sup> table that matches with the p value at a given DF

**Rule of thumb:** if X<sup>2</sup> > CV, *p* < 0.05 → significant difference; reject H<sub>0</sub>

if X<sup>2</sup> < CV, *p* > 0.05 → insignificant difference; *FAIL TO REJECT* H<sub>0</sub>

**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

**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, so frequency of recombinant gametes =  $\frac{1}{2}f_R$

**Testcross:** an individual with hetero- or homozygous dominant 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**

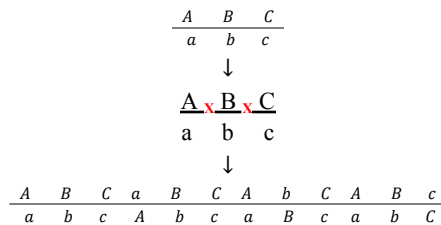
What is the expected genotypic ratio of a  $AaBb \times aabb$  cross? 1:1:1:1; If genes are **linked**, the number will deviate from this

**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)**

( $\frac{A}{a} \frac{B}{b}$  **same side**) or **repulsion (trans)** ( $\frac{A}{a} \frac{b}{B}$  **opposite sides**)

**Three-Point Testcross:** a single testcross used to show a double crossover

**Why:** use a gene in between 2 loci of crossovers



OR



**Gametes:** ^nonrecombinant      ^single crossover^      ^double crossover

**How:** follow the following steps to solve the position of genes and

1. Write out genotypes or phenotypes of offspring and categorize them by crossover (on *noncrossover*) pairs
  - a. The **double crossover** (DCO) will be the smallest number of progeny
  - b. The **non-recombinant** group will be the largest number of progeny
2. Locate find the middle gene by comparing the **DCO** with the nonrecombinant
  - a. **Where?** the middle gene is the place where the **DCO** is different than the non-recombinant
3. Rewrite the genotypes in proper order (ie with **middle gene** between the outside genes)
4. Calculate the recombination frequency ( $f_R$ ) for each crossover
5. Calculate **coefficient of coincidence** and **interference**

**Coefficient of Coincidence:** the frequency of DCO's relative to total crossovers

$$cc = \frac{\text{observed DCO}}{\text{expected DCO}} = \frac{DCO}{(A-dc) * (C=Dc) * \text{total progeny}}$$

**Interference:** the presence of one crossover event tends to inhibit the occurrence of another  
 \*larger values of **I** means greater interference between crossovers\*

$$I = 1.0 - cc = 0.228$$

**Heritability:** the proportion of *phenotypic variance* which can be explained by *genetic variance*

**Phenotypic Variance ( $V_P$ ):**  $V_P = V_G + V_E + V_{GE}$

**Genetic variance ( $V_G$ ):**  $V_G = V_D + V_A + V_I$

\*thus,  $V_P = (V_D + V_A + V_I) + V_E + V_{GE}$  \*

**Broad-Sense Heritability ( $H^2$ ):**  $H^2 = \frac{V_G}{V_P}$     **Narrow-Sense Heritability ( $h^2$ ):**  $h^2 = \frac{V_A}{V_P}$

**Response to Selection:** the extent of selected character change in a generation (**R**) → **R = h<sup>2</sup> x S**

**Selection Differential:** the difference between the selected populations' mean and that of the total population for the characteristic

**Population Genetics:** the study of **microevolution** (changes in the allelic frequencies within a population of individuals) that can lead to **speciation** (the creation of a new species)

**Gene Flow:** the transmission of genetic information between two groups of a species; cutoff of gene flow between populations considered **speciation**.

**Allelic Frequency** → **NOTE:** 2N is the total number of alleles present

**Dominant Allelic Frequency:** the frequency of a dominant allele (ex. A)

$$f(A)=p = \frac{2n(AA) + n(Aa)}{2N}$$

**Multiple Alleles:** when there is more than one allele (ex A1, A2, ...)

$$f(A^3)=p = \frac{2n(A3A3) + n(A3A1) + n(A3A2)}{2N}$$

**Recessive Allelic Frequency:** the frequency of a recessive allele (ex. a)

$$f(a)=q = \frac{2n(aa) + n(Aa)}{2N}$$

**Sex-Linked (X-Linked) Genes:** slight variation, were the number of males and females is considered as *m* and *f*, respectively

$$f(X) = \frac{2n(X1X1) + n(X1X2) + n(X1Y)}{2Nf + 2Nm}$$

**Hardy-Weinberg Equilibrium:** what about a *non-evolving* population? Hardy-Weinburg equilibrium describes when a population can be at “rest,” ie. not evolving:

**Large population, Random mating, No mutations, No natural selection, No migration**

**Hardy-Weinberg Equation:**

$$p^2 + 2pq + q^2 = 1$$

$$p + q = 1$$

**p:** dominant allelic frequency, **q:** recessive allelic frequency, **p<sup>2</sup>:** frequency of homozygous dominant, **q<sup>2</sup>:** frequency of homozygous recessive, **2pq:** frequency of heterozygotes

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**Practice Questions From the Whole Course:**

1. Click this [link](https://docs.google.com/document/d/13yQZ0q78hm8ORlilg22ZpWfVuq8dSWo6kEbq9aGfMCk/edit?usp=sharing) to view the practice problems:

<https://docs.google.com/document/d/13yQZ0q78hm8ORlilg22ZpWfVuq8dSWo6kEbq9aGfMCk/edit?usp=sharing>

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**THANK YOU** for using these resources this semester! Best wishes on your final exam!