

Virtual Genetics Lab (VGL) II

Exercise 1¹

Objective

To use your knowledge of genetics to design and interpret crosses to figure out

- 1) which allele of a gene has a dominant phenotype and which has a recessive phenotype;
- 2) whether a gene exhibits simple dominance or incomplete dominance;
- 3) whether a gene is autosomal or sex-linked.

You will first be given the opportunity to practice crosses involving each of these modes of inheritance. Then, you will conduct a cross that exhibits simple dominance, but there will be no way to see if you've got the answer right. This simulates a real lab in which you will have to convince yourselves when you've done enough experiments to be sure.

Description

VGL II is a computer simulation of the genetics of an imaginary insect. The computer randomly picks a character with two traits. It then randomly chooses which form of the character will be dominant and which will be recessive. That way, each time you start the program, you get a different problem (also, every group will get a different problem). Finally, it creates a population of insects with random genotypes called the Field Population.

As in a real genetics lab, the insects are kept in cages; Cage 1 contains the Field Population. You can select any two insects (one must be male and the other female) and cross them; the computer automatically puts their offspring in a new cage.

Warm-up

As a warm-up to this lab, work through the following genetics problems.

Monohybrid Genetic Problems

¹ This lab exercise is a modification of the Introductory Lab Exercise provided by Brian White of the University of Massachusetts, Boston, as part of the online documentation for VGL. VGL is freely-available, open-source, and subject to the GNU Public License ([GPL](#)).



1. In many organisms, including humans, normal pigmentation (A) is dominant to albinism (a), which is a lack of pigmentation. Set up a Punnett Square to determine the phenotype and genotype of the offspring for each of the following:

(a) AA × aa:

Phenotype:

Genotype:

(b) Aa × aa:

Phenotypic ratio:

Genotypic ratio:

(c) Aa × Aa:



Phenotypic ratio:

Genotypic ratio:

(d) $aaxaa$:

Phenotype:

Genotype:

2. A male tiger with normal pigmentation, whose father was albino, is mated with a female albino tiger. What chance is there that their first cub will be albino?

3. A male tiger with normal pigmentation is mated with a female with normal pigmentation. They have an albino cub. What are the genotypes of all three tigers?



Male:

Female:

Cub:

4. Andalusian chickens may be black, white, or gray. The gene for black is not dominant over the gene for white, nor is the gene for white dominant over the gene for black. When a black rooster is mated to a white hen, all gray chicks are produced.

(a) What term is used to describe a condition when neither gene shows dominance over its homologous allele?

(b) Using a Punnett Square, demonstrate the inheritance of feather color in Andalusian chickens by crossing a black rooster with a white hen. Give the color(s) of the chicks:



(c) Why would it be impossible to establish a true breeding flock of gray Andalusian chickens?

6. In human, the determination of sex depends upon whether the male sperm carries an X chromosome (resulting in a daughter) or a Y chromosome (resulting in a son). In other words, body cells of females carry two X chromosomes, and those of the males carry one X and one Y. During meiotic division, the egg of the female must of necessity carry one X, whereas segregation of the X and Y in spermatogenesis results in half of the sperm that are Y bearing, and half that are X bearing.

One human condition, called red-green color blindness, is the result of a recessive gene carried on the X chromosome. It has no allele on the Y. Consequently, the genotypes $X^C X^C$, $X^C X^c$ and $X^c X^c$ are possible in females, but a male must be either $X^C Y$ or $X^c Y$. Answer the following questions:

(a) Is it possible for a female to be color-blind?



(b) Can two persons with normal vision produce a color-blind daughter? a color-blind son? Demonstrate using a Punnett Square.

Daughter:

Son:

(c) Can two color-blind parents produce a child with normal vision? Demonstrate using a Punnett Square.



(d) Suppose that a woman with normal vision, whose father was color-blind, marries a colorblind man. Using a Punnett Square, determine the following:

What proportion of their sons may be expected to be color-blind?



What proportion of their daughters may be expected to be color-blind?

If one of their sons whose vision is normal marries a woman of the genotype $X^C X^C$, can they have any color-blind children? Demonstrate with a Punnett Square.

The task:

To solve several different problems generated by VGLII. A solution is a genetic model that accounts for all your data. This exercise will involve hypothesis testing. Here, the hypotheses are your genetic models, the experiments are the crosses you do, the results are the offspring the crosses generate, and the conclusions are the model you finally choose as the correct one.

Starting up VGLII:

1) You will work in groups of two people per computer. You may want to take turns using the computer. It is easy to fill the screen with cages of creatures and get totally confused so you should work slowly and deliberately and keep careful notes about the experiments you do and the contents of each cage. If you get very confused, you can quit the program and start fresh with a new problem.



2) The program runs all of the computers in the lab. You can run the program on your home computer (Mac or PC). It can be found on the Internet at <http://intro.bio.umb.edu/VGL/index.htm>. Click the “DOWNLOAD” link on the left hand side of the page.

3) To run the VGLII program: double-click the VGLII icon.

4) If you want to read the manual, click on the “Help” bookmark at the top of the Welcome page. Note that the manual describes some features present in VGLII that you will not be using for this week’s lab exercise.

5) Click on "New Problem" to begin. Each time you start a new problem, the computer will choose a new set of traits and characters as well as the underlying genetic model. Note that a character with the same name may have different properties in a different problem.



Once you click "New Problem", a window will appear for you to select the problem you will work on. Double-click on the “OneGene” folder and select “OneGene01p.pr2”.

6) A cage will appear holding the “Field Population”. It will look something like this, with minor changes in the updated version of the software:



Click on individual creatures to select them for crossing.

These are the numbers of each type of creature.

These pictures illustrate the particular phenotype; click on them to see a bigger picture.

Individual Animals	Number	Bodycolor Phenotype
♂♂♂♂♂ ♀♀♀♀♀	Five green body males Five green body females	green
♂♂♂♂♂♂♂♂♂ ♀♀	Nine blue body males Two blue body females	blue

In your case, the phenotypes involved will likely be different. Your task is to figure out which is dominant and which is recessive. You will determine this by designing crosses and analyzing the resulting offspring.

7) Begin your experiments. Select a male and a female fly to be the parents: click on one parent then click on the other parent. One parent must be male and the other female but they may come from different cages. Note that you can cross a given fly more than once.

To cross (also known as “mate”) the selected flies, click the "Cross" button at the top of the VGLII window. A cage will appear with the resulting offspring. A typical result is shown below:



Individual Animals	Number	Bodycolor Phenotype
♂♂♂♂♂♂♂♂♂♂ ♀♀♀♀♀♀♀	10 ♂ 7 ♀	green
♂♂ ♀	2 ♂ 1 ♀	blue

Parent ♂ (2) green ♀ (2) green

The information in this vial could also be presented in words:



“A male with a green body from Cage 2 (this is a translation of: “♂ (Cage 2 Green)”

was crossed with

a female with a green body from Cage 2 (this is a translation of: “♀ (Cage 2 Green)”

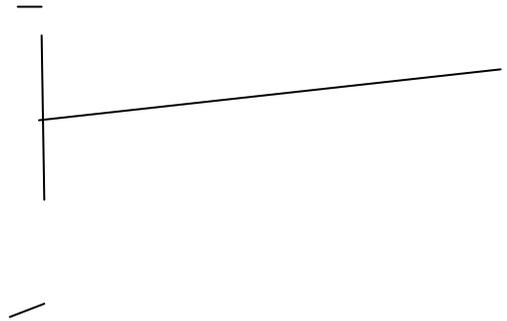
This cross resulted in 20 (= 10+ 7 + 2 + 1) offspring:

10 males with green body

7 females with green body

2 males with blue body

1 female with blue body”



8) Continue crossing as needed; the objective is to make a genetic model to explain the inheritance of the traits you are studying. You decide whether you're convinced or not; if not, keep crossing until you are convinced. An example of a complete model is shown below:

The color of the body is controlled by one gene with two alleles:

allele contribution to phenotype

G green body (dominant)

g blue body (recessive)

9) Once you and your partner are convinced of your model, you can check to see if you are right. Click on Cage 1 to bring it to the front of the screen. Click on the button marked “Show Genetic Model”. The window will expand to show the genetic model underlying the trait you are studying.

10) When you are done with this problem, click the “Close Work” button at the top of the VGLII window. When it asks if you want to save your work, click “Don't save”.



11) Click the “New Problem” button and choose “OneGene02p.pr2”. You should solve this problem with your partner as you did before.

12) After completing the second problem and checking your answer, close your work and start a new problem as you did before. This time choose “OneGene03p.pr2” and solve this problem with your partner as you did before, closing your work when you are finished.

13) After completing the first three practice problems, start a new problem and, this time, choose “OneGene01.pr2” (note: there is no ‘p’ following the 1 in this problem). For this problem you will not be able to see the correct answer; you must decide for yourselves when you have it right. When you reach the point that you think you are right, formally write out your model similar to the following example:

Model: “Green is dominant”

allele contribution to phenotype

G Green (dominant)

g Blue (recessive)

You will then present it to another pair of lab partners, called the **reviewers**. The reviewers will then perform a cross with your creatures to test your model. The final step is to have your instructor check off that the reviewers’ cross results agree with the prediction.

Write your model in the space provided below:



