

Instructions for the Punnett program

The organism and characters

This simulation is based on an animal known as the 'cowdog'. Each cowdog shows two characters: presence or absence of body colour, and presence or absence of spots. Body colour is determined by genes at the C locus, and spots are determined by the S locus. There is complete dominance at both loci, and the two loci are inherited independently. Cowdogs come in two sexes, but sexual differentiation is not shown in the simulation.

Drawing the Punnett square

When you start the program, you will see an outline on the screen of the boxes where all genes and animals go. You are instructed to press the **Show parents** button, which will reveal the initial genes and phenotypes.

Parents, F1 and F2

This simulation starts from two parents which are homozygous or 'pure-breeding'. These individuals are crossed to produce the F1, or first filial generation. Crossing two F1 individuals then produces the F2 generation, which is the main object of study. This structure of parents, F1 and F2 generations is common in the genetical study of many organisms.

Genes are inherited

All genes which you put in place in this program must be 'inherited'. This is simulated by clicking on a gene and dragging a copy to the desired location. Genes for the gametes come from the parents of the previous generation. The genotype of the next generation comes from combining the genes of the gametes.

The program imposes some constraints on where genes go in the pedigree. There are two loci involved, and you will not be allowed to copy a gene from one locus into the other locus. In dragging genes into diploid genotypes, however, either location may be chosen for the gene.

Phenotypes are chosen

Phenotypes are not directly inherited. In real life, the phenotype is determined by the genes of the organism, possibly modified by the environment. In this simulation, phenotypes are chosen from a 'template' of the four possible types. These phenotypes may be copied any number of times.

A character can only be assigned to an individual AFTER its genes have been assigned.

Changing genes and phenotypes

If you want to change a gene or phenotype, you must first remove the old one. Both genes and animals can be disposed of by dragging them out of their slot and depositing them over the garbage bin.

Listing all genotypes

The main purpose of this simulation is to list all possible genotypes and phenotypes in the F2 generation. This requires you to be careful in the choice of the gametes which give rise to this generation. There are four pairs of slots for genes, and all four pairs must be different. The program cannot stop you from putting any gene into any slot, but at the end it will mark you as incorrect if all genotypes have not been enumerated.

Automation in the F2

There are 64 gene slots which need to be filled in for the F2 generation. In order to simplify the process, the program will automatically fill gene slots based on the gametes. You will see that when you choose the gene for a gamete from the F1 generation, the four corresponding F2 row or column slots will be filled.

Phenotypes are not assigned automatically. However the program assists in counting up the number of each phenotype. When you copy a phenotype for the F2 generation, you will see that a number is incremented to indicate how often that phenotype has been used.

Checking answers

There are three stages in this exercise, Parents, F1 and F2. You can check each of these individually, or all together at the end. Perhaps the best way to do the exercise is to check each part as you go. Fill in the parents phenotypes, then check your answer. Then go on to the F1 and check again, before going on to the F2.

Wrong answers

The program will not give you much help if you have made a mistake, and will not let you go on until you have fixed it. However there are not many alternatives. Check particularly that all phenotypes are in agreement with their corresponding genotypes.

Help

This information is available at any time from the Help menu.

Part B. The probability method

The aim of this part of the program is to provide a simple derivation of the F2 expectations. This is done by concentrating on the adult characters and ignoring the gametic contributions.

Individual loci

In deriving the Punnett square, we use both loci together. The probability method goes back to look at the characters separately. All you have to do in the first part of this simulation is to keep clicking on the **Next** key, and take note of the ratios.

Problems

There are four problems which test that you have understood the method. The first two examples require you to drag probability values into a box. If you want to change a value, drag another value over the one you want to change. There is no trash can in this part of the exercise. The last two exercises just require a radio button to be clicked.

Press the **Done** button when you are satisfied with the answer. You will notice that this button is dimmed until you have made some answer. In the first two exercises, you will need to get the correct answer before going on. However the program will give you the correct answer after four unsuccessful tries.

Ending the exercise

You have the option at the end of checking up on the number of errors you have made and the time taken. To see this information, you need to click the appropriate button which will appear on the screen before you click the **Quit** button.

You also have the option at the end of going through the probability calculations again. These use the F2 array of animals you derive in the first part of the program, so it may be more efficient to run through this part of the program a second time rather than to through the whole program a second time.