

Solutions to Practice Problems for Genetics, Session 1: Mendel's Laws

Question 1

a) Based on this model, two Rr parents (right-handed) have a 1/8 chance of having a left-handed child. Explain why this is so.

Rr X Rr gives 1/4 chance of rr child and rr children have a 1/2 chance of being left handed. Therefore, the chance is 1/4 x 1/2 or 1/8.

b) Based on this model, can a left-handed mother and a right-handed father have a left-handed child? Justify your answer.

The genotype of the left-handed mother is rr. The genotype of the right-handed father can either be Rr or rr. A left-handed mother (rr) and a right-handed father (Rr) have a 1/2 chance of having an rr child and this child has a half chance of being left handed. Therefore, the chance of this child being left-handed is 1/2x1/2 = 1/4. A left handed mother (rr) and a right handed father (rr) can only have a rr child who has a 1/2 chance of being left handed.

c) Based on this model, can two left-handed parents have a right-handed child? Justify your answer.

As stated above, a left handed mother (rr) and a right handed father (rr) can have a rr child who has a 1/2 chance of being right-handed.

d) One problem with this model is that it is consistent with virtually any combination of left-handed or right-handed parents and offspring. What data, if any, could you imagine finding that would not support this model?

This model allows for many possible individual families. However, on average, left-handed parents should be more likely to have left-handed children than right-handed parents. When looking at many families, if right-handed parents were just as likely as left-handed parents to have left-handed children, then the model is unlikely to be correct.

Question 2

The type of comb in chickens varies. Some combs resemble crowns, some have a deep V shape and some look like a rose. Assume that the comb shape is determined by three alleles of the C gene, C^{crown} , C^V , and C^{rose} .

Experiment 1: You cross a chicken from a true-breeding strain with a crown comb to a chicken from a true-breeding strain with a V-shaped comb. All of the F1 progeny have V-shaped combs.

Experiment 2: You cross a chicken from a true-breeding strain with a V-shaped comb to a chicken from a true-breeding strain with a rose comb. All of the F1 progeny have V-shaped combs.

a) Give the genotypes for the parents in Experiment 1. $C^{crown} C^{crown} \times C^V C^V$

b) From these results, you could conclude that...

Crown-shaped is recessive to V-shaped (choose from dominant, recessive, can't tell)

V-shaped is dominant to Rose-shaped (choose from dominant, recessive, can't tell)

Rose-shaped is Can't tell to Crown-shaped (choose from dominant, recessive, can't tell)

c) If you chose "can't tell" for any statement above...

- Outline an experiment that would allow you to modify the statement such that inserting "dominant" in the blank makes the statement correct.

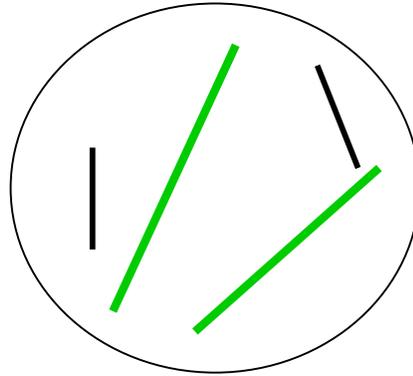
You would cross a chicken from a true breeding strain with a rose-shaped combs to a chicken from a true breeding strain with a v-shaped combs. Examine the offspring.

$C^{rose} C^{rose} \times C^V C^V$

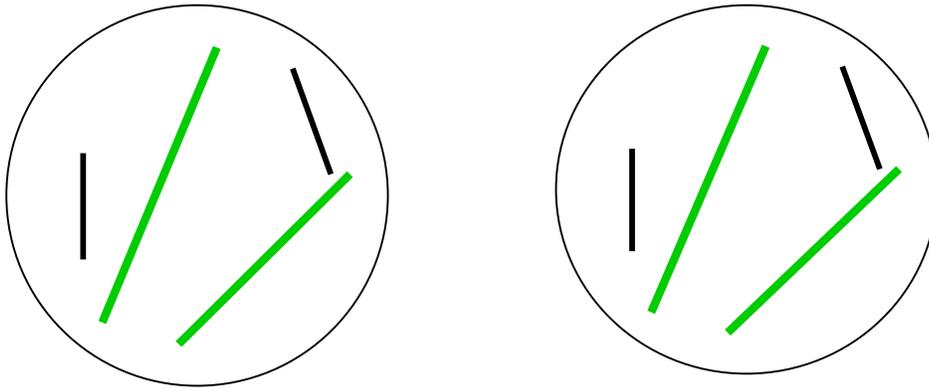
- Describe what results you would see in the F1 progeny from your experiment.
All F1 chickens should have Rose-shaped combs.

Question 3

A schematic of a diploid nucleus prior to DNA replication is drawn below. It contains two pairs of chromosomes ($2n = 4$).



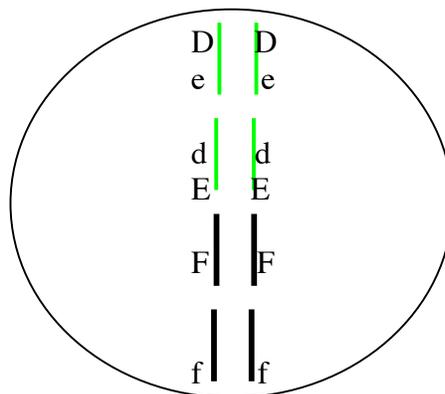
a) After mitosis, draw the chromosomes expected in each daughter cell nuclei.



The genotype of the cell above is $DdEeFf$, where the D and E loci are on the large chromosome and the F locus is on the small chromosome. This cell was taken from an F_1 organism that resulted from the cross of two true-breeding parents of the following genotypes.

Parent 1: $DDeeFF$ and Parent 2: $ddEEff$

b) Draw and align the chromosomes as they would appear in metaphase of **mitosis** in an F_1 cell. Include the D , d , E , e , F , and f alleles on the drawing.

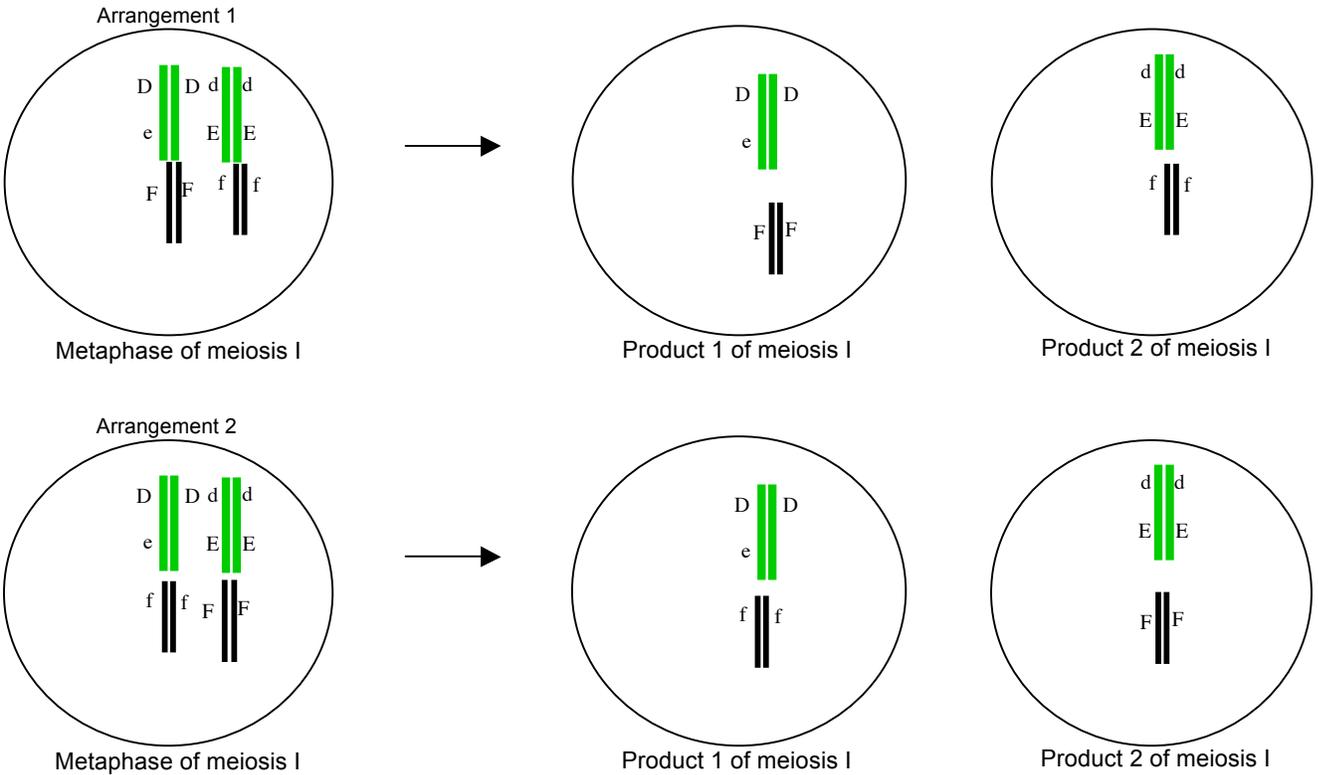


Question 2, continued

c) Now consider **meiosis**.

i) Draw the two possible arrangements of chromosomes as they could appear in metaphase of meiosis I. Include the D, d, E, e, F, and f alleles on the drawing and assume no recombination.

ii) Given your drawings for part (i), draw the chromosomes in each of the two products resulting from meiosis I. Include the D, d, E, e, F, and f alleles on the drawing.

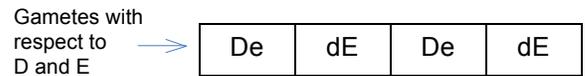


iii) What would be the genotypes of the gametes produced from arrangement 1? *DeF, DeF, dEf, dEf*

iv) What would be the genotypes of the gametes produced from arrangement 2? *Def, Def, dEF, dEF*

d) Which of the loci, (D and F) or (D and E) are following Mendel's law of independent assortment?

Only the D and the F loci are following Mendel's laws of independent assortment. In arrangement 1, the chromosome carrying the D allele and the chromosome carrying the F allele are found on the same side of the metaphase plate. However, this was a random alignment, and arrangement 2 is equally likely. If you were to make a Punnett square to show the gametes expected from this individual with respect to the D and F loci it would represent both arrangements, as each is equally likely. Because the D and E loci are on the same chromosome, (and we are assuming no recombination) when you make a Punnett square to show the gametes expected from this individual with respect to the D and E loci you would only see two types of gametes.



Question 3

You are doing a genetics experiment with the fruit fly. In the "P" generation, you cross two true-breeding flies. The female parent is brown and wingless and the male parent is black with normal wings. All of the flies in the F1 generation are brown and have normal wings.

Indicate the alleles associated with dominant phenotypes by capital letters and alleles associated with recessive phenotypes by lowercase letters. Assume the genes for the two traits you are following are found on autosomes. Indicate the wing alleles by the letters "N" and "n" and indicate the color alleles as "B" and "b."

a) The genotypes of the flies in the P generation are:

BBnn female and *bbNN* male.

b) The genotype of the flies in the F1 generation is: *BbNn*

c) You now take an F1 generation female and cross her to a true-breeding wingless black male. This male's genotype is: *bbnn*.

d) You count 1600 offspring in the F2 generation you would expect to count:

400 winged brown flies (of the genotype *BbNn*)

400 winged black flies (of the genotype *bbNn*)

400 wingless brown flies (of the genotype *Bbnn*)

400 wingless black flies (of the genotype *bbnn*)

c) You now take two F1 generation flies and cross them together. You count 1600 offspring in the F2 generation you would expect to count:

900 winged brown flies (of the genotype *BBNN, BBNn, BbNN, BbNn*)

300 winged black flies (of the genotype *bbNN, bbNn*)

300 wingless brown flies (of the genotype *BBnn, Bbnn*)

100 wingless black flies (of the genotype *bbnn*)

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