

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

Question 1

One could propose a genetic model to explain the inheritance of left- and right-handedness in humans. Their model is as follows:

Handedness is controlled by one gene with two alleles:

<u>allele</u>	<u>Contribution to phenotype</u>
R	right-handed (dominant)
r	undetermined handedness (recessive)

Therefore:

<u>genotype</u>	<u>phenotype</u>
RR, Rr	right-handed
rr	undetermined: half of these children develop into left-handed individuals and half develop into right-handed individuals.

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

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} .

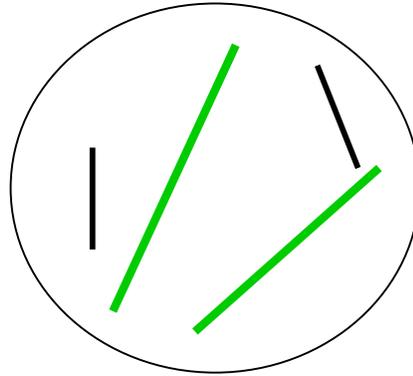
Experiment 1: You cross a chicken from a true-breeding strain with a crown comb to a chicken from a true-breeding strain with a V-shaped comb. All of the F1 progeny have V-shaped combs.

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.

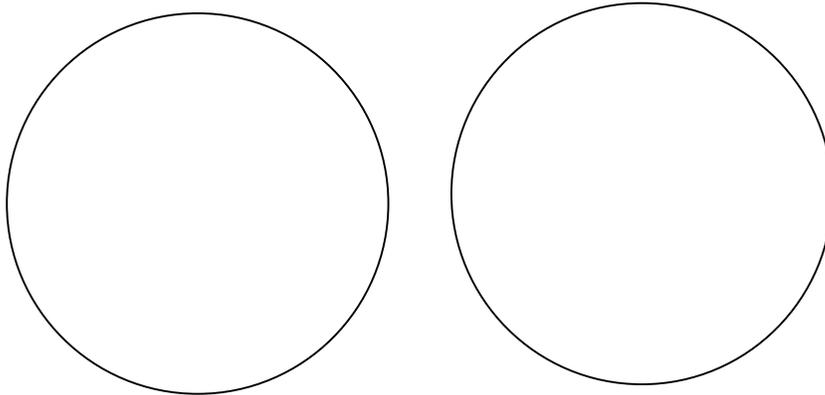
- Give the genotypes for the parents in Experiment 1.
- From these results, you could conclude that...
Crown-shaped is _____ to V-shaped (choose from dominant, recessive, can't tell)
V-shaped is _____ to Rose-shaped (choose from dominant, recessive, can't tell)
Rose-shaped is _____ to Crown-shaped (choose from dominant, recessive, can't tell)
- 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.
 - Describe what results you would see in the F1 progeny from your experiment.

Question 3

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



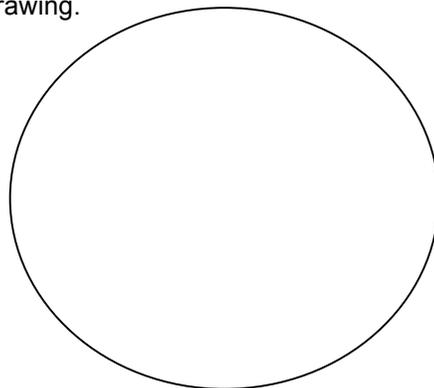
a) After mitosis, draw the chromosomes expected in each daughter cell nuclei.



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.

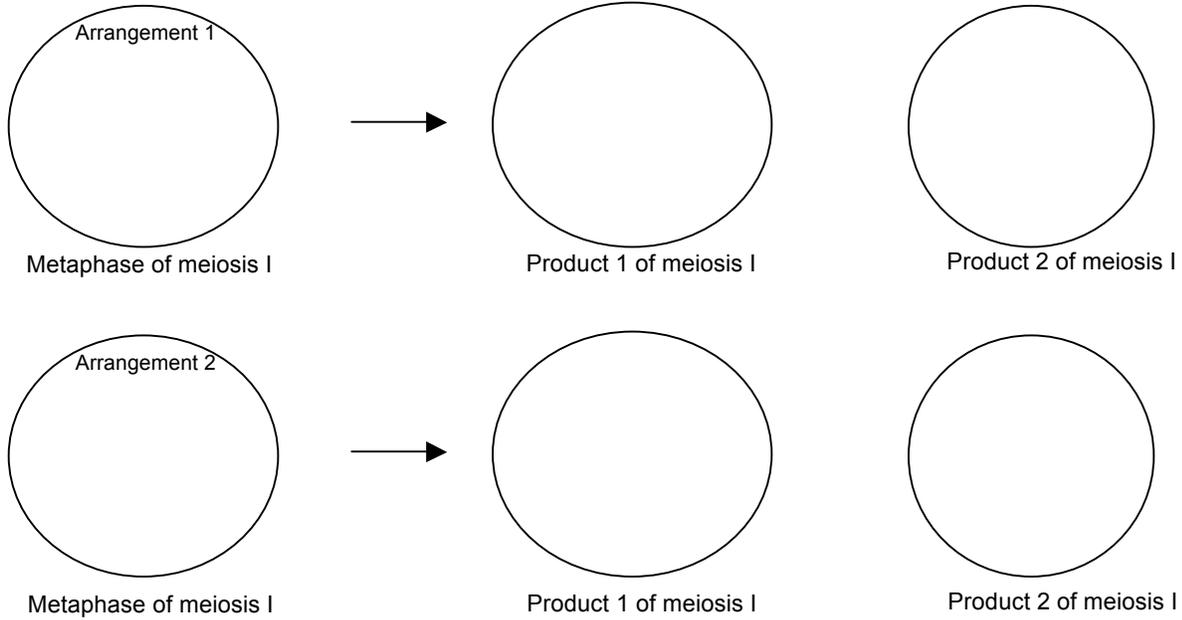


Question 2, continued

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?

iv) What would be the genotypes of the gametes produced from arrangement 2?

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

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:

_____ female and _____ male.

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

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

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

_____ # of winged brown flies (of the genotype _____)

_____ # of winged black flies (of the genotype _____)

_____ # of wingless brown flies (of the genotype _____)

_____ # of wingless black flies (of the genotype _____)

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:

_____ # of winged brown flies (of the genotype _____)

_____ # of winged black flies (of the genotype _____)

_____ # of wingless brown flies (of the genotype _____)

_____ # of wingless black flies (of the genotype _____)

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