



The snake problem (Chapter 7, Problem 26)



In corn snakes, the wild-type color is brown. One autosomal recessive mutation causes the snake to be orange, and another causes the snake to be black. An orange snake was crossed to a black one, and the F₁ offspring were all brown. Assume that all relevant genes are unlinked.

- Indicate what phenotypes and ratios you would expect in the F₂ generation of this cross if there is one pigment pathway, with orange and black being different intermediates on the way to brown.
- Indicate what phenotypes and ratios you would expect in the F₂ generation if orange pigment is a product of one pathway, black pigment is the product of another pathway, and brown is the effect of mixing the two pigments in the skin of the snake.

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Comments:

I picked this problem because it illustrates a very important concept: that the way that different genes interact in a biochemical pathway will lead to different predictions regarding the outcomes of crosses and epistasis analysis.

The main problem I had in going through this in class had to do with the poor choices I made in the notation I used to write out the different possibilities. This was embarrassing for me, but on the other hand it's a useful demonstration of why it's important to have a clear, logically consistent system for expressing genotypes and phenotypes. This is particularly challenging with phenotypes like color, which can result from the *absence* (rather than the presence) of pigments.

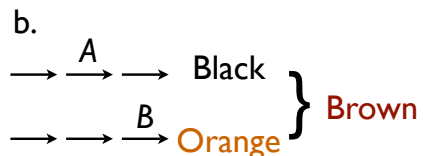
So, let's try it again...

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The two possible pathways described in parts a. and b. are diagrammed below:



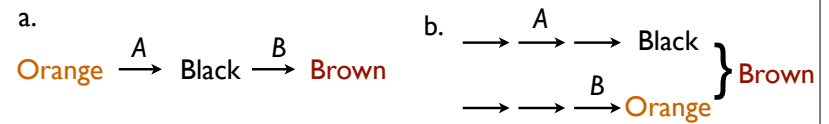
Here, genes A and B are in the same pathway. *aa* snakes are orange (because they can't turn substance Orange into substance Black, and *bb* snakes are black because they can't convert substance Black to substance Brown.



Here, gene A is a gene required in the pathway to make Black. *aa* snakes are thus orange because they don't make substance Black. Conversely, B is a gene required in the pathway to make Orange. *bb* snakes are thus black, because they don't make substance Orange.

I've changed the notation slightly to avoid making the error I made in class by failing to distinguish clearly between pigments and phenotypes. Here, pigments are capitalized and phenotypes are underlined. Note that in both cases, the phenotypes of *aaBB* and *AAbb* snakes are the same.

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In either case, the initial cross is *aaBB* X *AAbb*, the F₁ progeny are *AaBb*, and there are 4 genotypic classes of F₂ progeny expected in a 9 : 3 : 3 : 1 ratio (*A-B- : A-bb : aaB- : aabb*). The difference is in the phenotypes.

pathway:	a.	b.
9	<u>A-B-</u>	<u>brown</u> <u>brown</u>
3	<u>A-bb</u>	<u>black</u> <u>black</u>
3	<u>aaB-</u>	<u>orange</u> <u>orange</u>
1	<u>aabb</u>	<u>orange</u> <u>white*</u>

*or some color other than brown, black, or orange.
It's this case that differs in phenotype depending on the pathway.

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