

Questions sent by the student:

Hi, could somebody please help me with these problems? I need the answers for tomorrow morning, before 10 am. Thank you so much!!

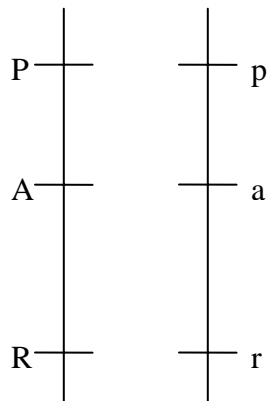
1- The father of Spock, first officer on the starship Enterprise is Vulcan.

Spock's mother came from earth. A Vulcan has pointed ears (allele P), adrenals absent (allele A), and heart on the right side (allele R). These 3 loci are linked on the same autosomal chromosome. All these alleles are dominant to earth alleles. The alleles appear as follows: P 15mu A 20mu R If Mr. Spock marries an earth woman what proportion of their children will have (assume no interference):

- Vulcan Phenotype for all three characters?
- Earth phenotype for all three characters?
- Vulcan ears and heart but earth adrenals?
- Vulcan ears but earth heart and adrenal?

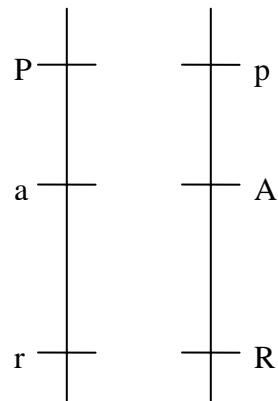
Explain the calculations that allow you to arrive at the answers.

Answers provided by a tutor from the University of Pennsylvania:



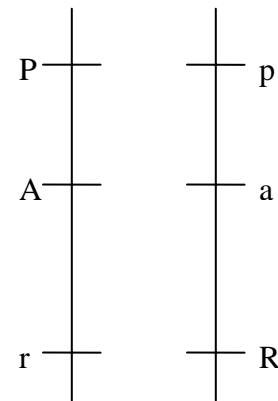
no crossing over
 $(100\% - 15\%) * (100\% - 20\%) = 68\%$

34% 34%



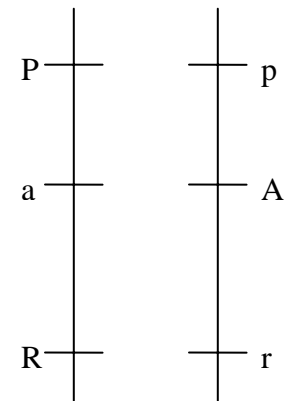
crossing over b/t P&A
 $15\% * (100\% - 20\%) = 12\%$

6% 6%



crossing over b/t A&R
 $(100\% - 15\%) * 20\% = 17\%$

8.5% 8.5%



crossing over b/t P&A, A&R
 $(15\%) * (20\%) = 3\%$

1.5% 1.5%

The earth woman will be homogenous recessive having all earth alleles and no Vulcan alleles. Therefore, the chromosome inherited from the mother will always have the 3 earth characters. Therefore, only the chromosome inherited from the father, Mr. Spock, will determine the characters of the offspring (i.e. if the offspring inherits a Vulcan allele from Mr. Spock, the child will have the Vulcan character; if not, then the child will have the earth character).

There are four different possibilities for a pair of chromosomes from Mr. Spock (think of this as after Meiosis I, but before each chromosome becomes its own gamete). The frequency that each crossing over event occurs is given by the distance between the alleles (in map units). Because the distance between the P and A alleles is 15 mu, the probability (or frequency) that it crosses over between these two alleles is 15%. The probability that no crossing over occurs is (100%-15%). Because of each pair of possible chromosomes, the offspring will only get one chromosome, the probability of getting any chromosome is half of getting the pair.

Finally, just look above to find the answers.

- a. Vulcan phenotype for all three characters? (1st chromosome) 34%
- b. Earth phenotype for all three characters? (2nd chromosome) 34%
- c. Vulcan ears and heart but earth adrenals? (7th chromosome) 1.5%
- d. Vulcan ears but earth heart and adrenal? (3rd chromosome) 6%

Also, if you don't want to list all of the possibilities, you can find the probability of each individually.

- a. Vulcan phenotype for all three characters?
 $(100\% - 15\%) * (100\% - 20\%) * 50\% = 34\%$
(probability of NO crossing over between P&A)*(probability of NO crossing over between A&R)*(PAR and not par)
- b. Earth phenotype for all three characters?
 $(100\% - 15\%) * (100\% - 20\%) * 50\% = 34\%$
(probability of NO crossing over between P&A)*(probability of NO crossing over between A&R)*(PAR and not par)
- c. Vulcan ears and heart but earth adrenals?
 $15\% * 20\% * 50\% = 1.5\%$
(probability of crossing over between P&A)*(probability of crossing over between A&R)*(PaR and not pAr)
- d. Vulcan ears but earth heart and adrenal?
 $15\% * (100\% - 20\%) * 50\% = 6\%$
(probability of crossing over between P&A)*(probability of NO crossing over between A&R)*(Par and not pAR)

Note: This answer assumes that we know what Mr. Spock looks like and that he has all three Vulcan characters.