Grade 9: Genetics Practice Problems

http://biology.clc.uc.edu/courses/bio105/geneprob.htm

Monohybrid Cross:

In humans, brown eyes (B) are dominant over blue (b)*. A brown-eyed man marries a blue-eyed woman and they have three children, two of whom are brown-eyed and one of whom is blue-eyed.

(* Actually, the situation is complicated by the fact that there is more than one gene involved in eye color, but for this example, we'll consider only this one gene.)

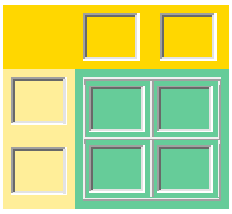
If blue is recessive, what must the woman's genotype be?
[ ]

If that's her genotype, what kind(s) of gametes (eggs) can she produce?
[ ] and/or [ ]

If the man has brown eyes, but has a blue-eyed child what must his genotype be?
(if you don't understand why, review the testcross problem)
[ ]

If that's his genotype, what kind(s) of gametes (sperm) can he produce?
[ ] and/or [ ]

If they have children:



Put the female gametes in the correct locations

Put the male gametes in the correct locations

Put the genotypes of the offspring in the correct locations

_____ of their children would be expected to be heterozygous brown and _____ homozygous blue.

Testcross:

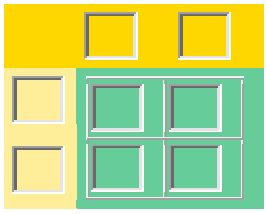
In dogs, there is an hereditary deafness caused by a recessive gene, "d." A kennel owner has a male dog that she wants to use for breeding purposes if possible. The dog can hear, so the owner knows his genotype is either DD or Dd. If the dog's genotype is Dd, the owner does not wish to use him for breeding so that the deafness gene will not be passed on. This can be tested by breeding the dog to a deaf female (dd).

A deaf female is genotype dd. What kind(s) of gametes (eggs) can she produce? ☐ and/or ☐

If the hearing male is DD, what kind(s) of gametes (sperm) can he produce? ☐ and/or ☐

If he is Dd, what kind(s) of gametes can he produce? ☐ and/or ☐

If he is DD:



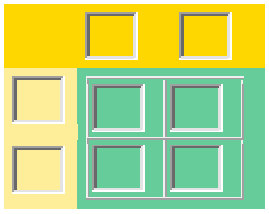
Put the female gametes in the correct locations

Put the male gametes in the correct locations

Put the genotypes of the offspring in the correct locations

_____% of offspring can hear

If he is Dd:



Put the female gametes in the correct locations

Put the male gametes in the correct locations

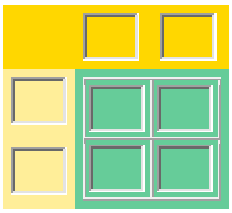
Put the genotypes of the offspring in the correct locations

_____ of offspring can hear
_____ of offspring are deaf

If any of the puppies are deaf, the male is Dd; but, assuming a litter of at least about 4 to 5 puppies or more, if they can all hear, he is most likely DD.

If two hearing dogs were both Dd, what kind(s) of gametes (eggs/sperm) could each produce? ☐ and/or ☐

If they are bred with each other:



Put the female gametes in the correct locations
Put the male gametes in the correct locations
Put the genotypes of the offspring in the correct locations

We would expect _____ of the puppies to be normal and _____ deaf.

Incomplete Dominance:

For many genes, such as the two mentioned above, the dominant allele codes for the presence of some characteristic (like, "B" codes for "make brown pigment" in someone's eyes), and the recessive allele codes for something along the lines of, "I don't know how to make that," (like "b" codes for the *absence* of brown pigment in someone's eyes, so by "default," the eyes turn out blue). If someone is a heterozygote (Bb), that person has one set of instructions for "make brown" and one set of instructions for, "I don't know how to make brown," with the result that the person ends up with brown eyes. There are, however, some genes where both alleles code for "something." One classic example is that in many flowering plants such as roses, snapdragons, and hybiscus, there is a gene for flower color with two alleles: red and white. However, in that case, white is not merely the absence of red, but that allele actually codes for, "make white pigment." Thus the flowers on a plant that is heterozygous have *two* sets of instructions: "make red," *and* "make white," with the result that the flowers turn out mid-way in between; they're pink.

In humans, there is a gene that controls formation of hemoglobin, the protein in the red blood cells which carries oxygen to the body tissue. The "normal" allele of this gene codes for "normal" hemoglobin. However, there is another allele for this gene that codes for a different amino acid in an important place in the hemoglobin molecule. A red blood cell (RBC) that contains this altered hemoglobin will, under stress, crinkle up into a shape that reminded someone of the shape of an old-fashioned sickle. While the letters "S" and"s" are often used to represent these alleles, since both of them code for "make hemoglobin", in reality, neither is dominant over the other. Someone who is SS makes all normal hemoglobin, someone who is ss makes all abnormal hemoglobin (and we say that person has sickle-cell anemia), and someone who is Ss essentially has two sets of instructions, and so, makes some of each kind of hemoglobin (often referred to as sickle-cell trait).

Because the RBCs of a person who is ss contain all abnormal hemoglobin, they will "sickle" very easily, with very little stress required to provoke that reaction. All those sickled cells tend to get stuck as they try to go through capillaries, and cause things like strokes, heart attacks, pulmonary embolisms, etc. that lead to death. Because only some of the RBCs of a person who is Ss contain abnormal hemoglobin, that person usually only has trouble with a lot of cells sickling if they're under a lot of stress trying to meet a higher-than-normal oxygen demand, and so the chances of a person dying from sickle-cell trait are much lower than for full-blown sickle-cell anemia.

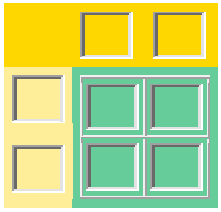
Malaria is a parasitic disease that's prevalent in tropical areas. When a mosquito that's carrying the parasites bites someone, the parasites enter the person's bloodstream, and invades and lives in the person's RBCs. However**,** if a person has sickle-cell anemia (ss), the presence of a parasite in a RBC is so stressful, it causes the RBC to sickle (crinkle up), and when that happens, that kills the parasite before it can multiply and spread to other RBCs. Thus, coincidentally, a person who is ss is also "immune" to malaria**.** If a person is Ss and a malaria parasite tries to invade a RBC with abnormal hemoglobin, again, the RBC will sickle, killing the parasite before it has a chance to reproduce. If a parasite invades a RBC with normal hemoglobin, it will be able to live and multiply, but if its offspring invade other RBCs with abnormal hemoglobin, they, too, will be killed. Thus, a person who is Ss is "resistant" (though not totally immune) to malaria. If a person is SS and has all normal hemoglobin, the malaria parasites do just fine, invading RBCs, growing and multiplying, and invading more RBCs. Thus, an SS person usually dies, eventually, from causes tied to the malaria.

A man and woman living in a tropical area where malaria is prevalent and health care is not accessible have seven children. The genotypes of these children are ss, Ss, SS, ss, Ss, Ss, and SS.

What must the genotype of both parents be? (Hint: what would be needed to have those kinds of children?) ☐

If that's their genotype, what kind(s) of gametes (eggs/sperm) can each produce? ☐ and/or ☐

To figure out what their children would be:



Put the female gametes in the correct locations
Put the male gametes in the correct locations
Put the genotypes of the offspring in the correct locations

_____ of their children would be expected to have normal hemoglobin,
_____ should have sickle-cell trait, and ____ should have sickle-cell anemia.

Which of their children would you expect to live to adulthood and reproduce?

ss	Ss	SS	ss	Ss	Ss	SS
☐	☐	☐	☐	☐	☐	☐

What is the most likely genotype of the children's future spouses? ☐

What is the most likely genotype of the *surviving* grandchildren? ☐

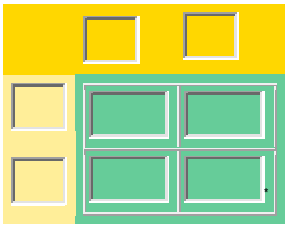
Sex-Linked Genes:

In humans, the genes for colorblindness and hemophilia are both located on the X chromosome with no corresponding gene on the Y. These are both recessive alleles. If a man and a woman, both with normal vision, marry and have a colorblind son, draw the Punnett square that illustrates this. If the man dies and the woman remarries to a colorblind man, draw a Punnett square showing the type(s) of children could be expected from her second marriage. How many/what percentage of each could be expected?

A man with normal vision is XY. What kind(s) of gametes (sperm) can he produce? ☐ and/or ☐

Any woman with normal vision could be XX or XX'.
Since *this* woman has a colorblind son (genotype X'Y), she has to be XX' (a **carrier**).
What kind(s) of gametes (eggs) can she produce? ☐ and/or ☐

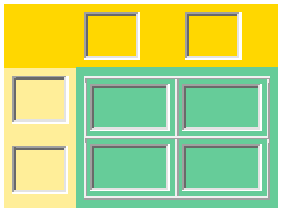
Her first marriage would look like:



Put the female gametes in the correct locations
Put the male gametes in the correct locations
Put the genotypes of the offspring in the correct locations
The child marked with an asterisk (*) is the son in the problem.

In order to be colorblind, her second husband must be X'Y (like her son).
What kind(s) of gametes (sperm) can he produce? ☐ and/or ☐

Her second marriage would look like:



Put the female gametes in the correct locations
Put the male gametes in the correct locations
Put the genotypes of the offspring in the correct locations

____of the *children* will be normal female carriers, ____colorblind females, ____normal males, and ____colorblind males;
_____of the *children* will be females and _____males;
_____of the *children* will have normal vision and _____will be colorblind;
_____of the *daughters* will be carriers and _____colorblind;
_____of the *sons* will be normal and _____colorblind.