1. A true-breeding black dog will have a *BBEE* genotype (black pigment that is deposited into the fur). A true-breeding brown dog will have a *bbEE* genotype (brown pigment that is deposited into the fur. For a true-breeding yellow dog, the genotype of the first gene is irrelevant, but the second gene will be *ee* (whatever pigment they have is not deposited in the fur).
2. No. brown pigment is a recessive trait, so the genotype for the one brown dog parent, and the two parents of the yellow dog would be *bb*. Without a *B* allele, it is not possible to breed puppies with black fur.
3. No. The *B* allele is dominant, so it is possible that both parents have a *Bb* genotype. In this situation, there is a 1 in 4 chance that these parents with the *Bb* genotype could produce a puppy with brown fur, who would have a *bb* genotype.
4. For the brown dog, we know that the genotype for the pigment color gene is *bb* as these alleles are recessive. For the black dog, we know that at least one of the pigment color alleles is a dominant *B* type. We also know for both of these dogs that at least one of the alleles on the second gene is of the dominant *E* variety.
   1. Possible genotypes, brown dog: *bbEe*, *bbEE*
   2. Possible genotypes, black dog: *BbEe*, *BBEe*, *BbEE, BBEE*
5. If any offspring from the parents in problem 4 have brown pigment, then we know that the black dog genotype for the first gene will be *Bb*. If any yellow fur offspring are produced, we know that both parents will have a recessive *e* allele and have the *Ee* genotype.
6. Yes. If the pairing of the brown dog and a yellow dog produced any yellow offspring, we can conclude that the brown dog’s genotype would be *bbEe*. If any offspring of the black and yellow dog pairing had brown pigment, we could conclude that the black dog has a *Bb* genotype in the first gene. And just like the brown dog, if any of the offspring of the black and yellow dog had yellow fur, we can conclude that the black dog’s genotype of the second gene was *Ee*. While this is roughly the same answer as questions five (if there is a brown puppy, the black dog has *Bb*, if there is a yellow puppy, both the black and brown dog have *Ee*), both of these outcomes would be rare, and more pairings and more puppies present more opportunities for these outcomes to be observed. The main benefit is in determining the genotype of the second gene. If the original black dog was *Bb*, offspring would have a 50% chance of being *bb*, but if both are *Ee*, there is only a 25% chance of a yellow *ee* dog. And if only one of the original parents has an *e* allele, then it would not be possible to determine the genotype for gene 2 in the original two black and brown parents without the additional pairings with the yellow dogs (as one would be homozygous dominant, and we wouldn’t be able to tell which one).