C1. Dominance occurs when one allele completely exerts its phenotypic effects over another allele. Incomplete dominance is a situation in which two alleles in the heterozygote have an intermediate phenotype. Codominance is when both alleles exert their effects independently in the heterozygote. And overdominance is a case in which the heterozygote has a phenotype that is superior to either homozygote.

C2. Sex-influenced traits are influenced by the sex of the individual even though the gene that governs the trait may be autosomally inherited. Pattern baldness in people is an example. Sex-limited traits are an extreme example of sex influence. The expression of a sex-limited trait is limited to one sex. For example, colorful plumage in certain species of birds is limited to the male sex. Sex-linked traits involve traits whose genes are found on the sex chromosomes. Examples in humans include hemophilia and color blindness.

C3. The term *gene interaction* refers to the phenomenon that two or more different genes can have an impact on the same trait. This can occur, for example, if two genes encode enzymes in the same metabolic pathway. If the pathway is disrupted by a mutation in either of these two genes, the same net result may occur.

C4. If the normal allele is dominant, it tells you that one copy of the gene produces a saturating amount of the protein encoded by the gene. Having twice as much of this protein, as in the normal homozygote, does not alter the phenotype. If the allele is incompletely dominant, this means that one copy of the normal allele is not saturating.

C5. Recessive alleles are often loss-of-function alleles. It would generally be more likely for a recessive allele to eliminate a trait or function rather than create one. Therefore, the peach carries the dominant allele while the nectarine has a loss-of-function allele that prevents fuzz formation. The recessive allele is in a gene that is necessary for fuzz formation.

C6. There would be a ratio of 1 normal : 2 star-eyed individuals.

C7. The red and white seed packs should be from true-breeding (homozygous) strains. The pink pack should be seeds from a cross between white- and red-flowered plants.

C8. The amount of protein produced from a single gene is not a saturating amount. Therefore, additional copies produce more of the protein, whose functional consequences can be increased.

C9. If individual 1 is *ii*, individual 2 could be I^Ai, I^AI^A, I^Bi, I^BI^B, or I^AI^B.
If individual 1 is I^Ai or I^AI^A, individual 2 could be I^Bi, I^BI^B, or I^AI^B.
If individual 1 is I^Bi or I^BI^B, individual 2 could be I^Ai, I^AI^A, or I^AI^B.

Assuming individual 1 is the parent of individual 2:

If individual 1 is *ii*, individual 2 could be I^Ai or I^Bi.
If individual 1 is I^Ai, individual 2 could be I^Bi or I^AI^B.
If individual 1 is I^AI^A, individual 2 could be I^AI^B.
If individual 1 is I^Bi, individual 2 could be I^Ai or I^AI^B.
If individual 1 is I^BI^B, individual 2 could be I^AI^B.

C10. Types O and AB provide an unambiguous genotype. Type O can only be *ii*, and type AB can only be I^AI^B. It is possible for a couple to produce children with all four blood types. The couple would have to be I^Ai and I^Bi. If you construct a Punnett square, you will see that they can produce children with AB, A, B, and O blood types.

C11. The father could not be I^AI^B, I^BI^B, or I^AI^A. He is contributing the O allele to his offspring. Genotypically, he could be I^Ai, I^Bi, or *ii* and have type A, B, or O blood, respectively.

C12. A. 1/4

B. 0

C. (1/4)(1/4)(1/4) = 1/64

D. Use the binomial expansion:

$$P = \frac{n!}{x!(n-x)!} p^x q^{(n-x)}$$

$$n = 3,\ p = 1/4,\ q = 1/4,\ x = 2$$

$$P = 3/64 = 0.047,\ \text{or } 4.7\%$$

C13. Perhaps it should be called codominant at the “hair level” because one or the other allele is dominant with regard to a single hair. However, this is not the same as codominance in blood types in which every cell can express both alleles.

C14. Let's begin with the assumption that the recessive alleles encode enzymes that are completely defective. If so, we could explain solved problem S1 in the following manner. Gene *A* might encode an enzyme that converts a colorless pigment precursor into a (black) pigmented molecule. If an animal is *aa*, no pigment is made and it becomes white. Gene *C* could encode an enzyme that converts some of this black pigment into a brown pigment to produce the agouti phenotype. If an animal is *cc*, no brown pigment is made, so the animal stays black.

C15. All the F_1 generation will be white because they have inherited the dominant white allele from their Leghorn parent. Construct a Punnett square. Let *W* and *w* represent one gene, where *W* is dominant and causes a white phenotype. Let *A* and *a* represent the second gene, where the recessive allele causes a white phenotype in the homozygous condition. The genotype of the F_1 birds is *WwAa*. The phenotypic ratio of the F_2 generation will be 13 white : 3 brown. The only brown birds will be 2 *wwAa*, 1 *wwAA*.

C16. We know that the parents must be heterozygotes for both genes.

The genotypic ratio of their children is 1 *BB* : 2 *Bb* : 1 *Bb*

The phenotypic ratio depends on sex.

1 *BB* bald male : 1 *BB* bald female : 2 *Bb* bald males : 2 *Bb* nonbald females : 1 *bb* nonbald male : 1 *bb* nonbald female

A. 50%

B. 1/8

C. (3/8)(3/8)(3/8)= 27/512 = 0.05, or 5%

C17. On a standard vegetarian diet, the results would be 50% white and 50% yellow.

On a xanthophyll-free diet, the results would be 100% white.

C18. A. The male offspring would be hemizygous for apricot and have 3% pigment. The female offspring would be heterozygous for apricot and white and also have 3% pigment.

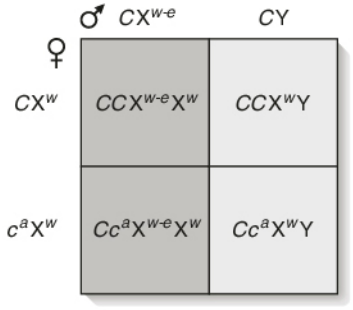
B. Half of the male offspring would be hemizygous for coral and have 4% pigment, and the other half of the male offspring would be hemizygous for apricot and have 3% pigment. All of the female offspring would be heterozygous and have one copy of the dominant red allele. Therefore, all of the female offspring would have 100% pigment.

C. Half of the males would have red eyes with 100% pigment and the other half of the males would be hemizygous for the apricot allele and have 3% pigment. Half of the females would be heterozygous for the red allele and white allele and would have red eyes with 100% pigment (red is dominant). The other half of the females would be heterozygous for the white allele and apricot allele and have about 3% pigment.

D. All of the males would be hemizygous for the coral allele and have about 4% pigment. All of the females would be heterozygous for the coral and apricot alleles and have about 7% pigment.

C19. It probably occurred in the summer. Dark fur occurs in cooler regions of the body. If the fur grows during the summer, these regions are likely to be somewhat warmer, and therefore the fur will be lighter.

C20. Set up a Punnett square, but keep in mind that the eosin gene is X linked.



Because *C* is dominant, the phenotypic ratios are two light-eosin females and two white males.

C21. First, you would cross heterozygous birds to each other. This would yield an F_1 generation consisting of a ratio of 1 *HH* : 2 *Hh* : 1 *hh.* The male offspring that are *hh* would have cock-feathering. All the female offspring would have hen-feathering. You would then take cock-feathered males and cross them to F_1 females. If all the males within a brood were cock-feathered, it is likely that the mother was *hh.* If so, all the offspring would be *hh.* The offspring from such a brood could be crossed to each other. If they are truly *hh,* the males of the F_3 generation should all be cock-feathered.

C22. A. Could be.

B. No, because an unaffected father has an affected daughter.

C. No, because two unaffected parents have affected children.

D. No, because an unaffected father has an affected daughter.

E. No, because both sexes exhibit the trait.

F. Could be.

C23. A. Could be.

B. No, because an affected female has an unaffected son.

C. Could be.

D. No, because an affected male has an unaffected daughter.

E. No, because it affects both sexes.

C24. You would look at the pattern within families over the course of many generations. For a recessive trait, 25% of the offspring within a family are expected to be affected if both parents are unaffected carriers, and 50% of the offspring would be affected if one parent was affected. You could look at many families and see if these 25% and 50% values are approximately true. Incomplete penetrance would not necessarily predict such numbers. Also, for very rare alleles, incomplete penetrance would probably have a much higher frequency of affected parents producing affected offspring. For rare recessive disorders, it is most likely that both parents are heterozygous carriers. Finally, the most informative pedigrees would be situations in which two affected parents produce children. If they can produce an unaffected offspring, this would indicate incomplete penetrance. If all of their offspring were affected, this would be consistent with recessive inheritance.

C25. Molecular: The ß-globin gene for Hb^A homozygotes encodes a ß-globin polypeptide with a normal amino acid sequence compared to the Hb^S homozygotes whose ß-globin genes encode a polypeptide that has an abnormal structure. The abnormal structure affects the ability of hemoglobin to carry oxygen.

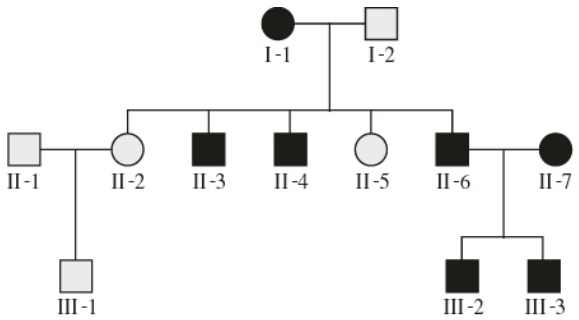
Cellular: Under conditions of low oxygen, Hb^SHb^S cells form a sickle shape compared to the normal biconcave disk shape of Hb^AHb^A cells.

Organismal: In Hb^SHb^S individuals, the sickle shape decreases the life span of the red blood cell, which causes anemia. Also, the clogging of red blood cells in the capillaries causes tissue damage and painful crises. This does not occur in Hb^AHb^A people.

C26. Since this is a rare trait, we assume the other parent is homozygous for the normal allele. The probability of a heterozygote passing the allele to his/her offspring is 50%. The probability of an affected offspring expressing the trait is 80%. We use the product rule to determine the likelihood of these two independent events.

(0.5)(0.8) = 0.4, or 40% of the time

C27.



C28. This is an example of incomplete dominance. The heterozygous horses are palominos. For example, if *C* represents chestnut and *c* represents cremello, the chestnut horses are *CC*, the cremello horses are *cc*, and the palominos are *Cc*.