

Bio 102 Practice Problems

Mendel: Principles of Inheritance

Multiple choice: Unless otherwise directed, circle the one best answer (2 points each)

1. The first person to apply experimental techniques and mathematical analysis to the study of inheritance was:
 - A. Darwin
 - B. Aristotle
 - C. Tschermak
 - D. Mendel
 - E. Hippocrates
2. Mendel succeeded where others had failed in part because of:
 - A. his knowledge of chromosomes
 - B. his understanding of DNA structure
 - C. his use of mathematics and statistics
 - D. his acceptance of Darwin's evolutionary theory
 - E. his use of fruit flies as experimental organisms

Short answer (show your work or thinking to get partial credit):

1. If the allele for tall is represented by T and the allele for dwarf by t , give the gametes produced by the parents and the phenotypes of the offspring for each of the following crosses:
 - a. $Tt \times tt$

Gametes:
Tt parent: $\frac{1}{2} T$ and $\frac{1}{2} t$
tt parent: all t

Offspring:
 $\frac{1}{2} Tt$, tall
 $\frac{1}{2} tt$, dwarf
 - b. $TT \times Tt$

Gametes:
TT parent: all T
Tt: $\frac{1}{2} T$ and $\frac{1}{2} t$

Offspring:
all tall ($\frac{1}{2} Tt$, and $\frac{1}{2} TT$)
 - c. $Tt \times Tt$

Gametes: $\frac{1}{2} T$ and $\frac{1}{2} t$ from each parent

Offspring:
 $\frac{3}{4}$ tall ($\frac{1}{4} TT$ and $\frac{1}{2} Tt$)
 $\frac{1}{4}$ dwarf (tt)

2. A pure-breeding, tall pea plant is crossed with a pure-breeding, short pea plant. All of the offspring of this cross are tall.

a. Which allele is dominant, and how do you know?

Because the parents are pure-breeding, the offspring must be heterozygous. The dominant allele is defined as the one that produces the phenotype of the heterozygous individuals, so tall is dominant.

b. What are the genotypes of these offspring?

If T =tall and t =short, all are Tt .

c. Suppose two of these offspring are crossed and produce 1000 offspring. How many tall and how many short plants will you expect?

We expect $\frac{3}{4}$ of the offspring to be either TT or Tt , so 750 tall; $\frac{1}{4}$ should be short, or 250.

d. How many of each genotype would you expect among the 1000 offspring?

The 250 short plants are all tt . The 750 tall are actually TT and Tt , and $\frac{1}{4}$ of the total is expected to be TT with $\frac{1}{2}$ Tt , so 250 TT and 500 Tt .

3. While tromping through the woods, you come across a very unusual animal: an odorless skunk. Of course, you immediately want to study the inheritance of this trait! Since you don't have any pure-breeding skunks around, you cross your odorless skunk with an ordinary, stinky skunk chosen at random. Half of the 18 offspring are odorless, and half are smelly.

a. There are two different ways you could've gotten this result. Diagram both possible crosses below, showing genotypes and phenotypes of parents and offspring. Be sure to define your symbols!

Possibility #1

If stinky is dominant, S = stinky, s = odorless

Stinky parent must be heterozygous (to get $\frac{1}{2}$ odorless offspring), so the cross is $ss \times Ss$

Offspring are: $\frac{1}{2} Ss$, stinky
 $\frac{1}{2} ss$, odorless

Possibility #2

If odorless is dominant, O = odorless, o = stinky

Stinky parent must be homozygous, so odorless skunk must be heterozygous (to get $\frac{1}{2}$ odorless offspring), so the cross is $Oo \times oo$

Offspring are: $\frac{1}{2} Oo$, odorless
 $\frac{1}{2} oo$, stinky

b. Now, what one further cross could you do in order to decide which possibility is the correct one?

An easy way would be to cross two odorless skunks. If possibility #1 is correct, then this cross will be $ss \times ss$, and all the offspring will be odorless. If possibility #2 is correct, then the cross is $Oo \times Oo$, and the offspring will be about $\frac{3}{4}$ odorless, $\frac{1}{4}$ stinky.

4. A male's genotype is $AaBBCCddEeFF$. What fraction of the sperm cells produced by this individual will carry the dominant A allele, the dominant C allele and the recessive e allele?

All the gametes will get the dominant C allele. Half will get the dominant A allele (the other half get a). And, half will get the recessive e allele (the other half get E). If these genes assort independently, $\frac{1}{4}$ ($\frac{1}{2} \times \frac{1}{2}$) will get the combination of A , C and e .

True or False? Read carefully: a question is false unless it is completely true!

- T** **F** 1. The importance of Mendel's work was recognized by many of his contemporaries, including Darwin.
- T** **F** 2. Genes control simple traits like hair color and blood type, but more complex characteristics such as development and behavior of higher organisms are usually not genetic.
- T** **F** 3. The effect of a recessive allele is seen phenotypically only in a homozygous individual.
- T** **F** 4. We can tell which allele is dominant because it produces a larger size, darker color or some other kind of stronger characteristic.
- T** **F** 5. We can predict the overall outcome of a genetic cross, given a large number of offspring, but not the specific outcome of one fertilization event.
- T** **F** 6. Any gene can come in one of two forms, called alleles.
- T** **F** 7. Mendel's work helped Darwin better understand the genetic basis of natural selection.
- T** **F** 8. Darwin was the first to publish a scientific theory that effectively explained how traits are inherited
- T** **F** 9. Darwin was the first to base a theory of genetics on experiments and evidence.
- T** **F** 10. Mendel's Law of Segregation says each gamete gets one allele of each gene.
- T** **F** 11. Pure-breeding individuals could be either homozygous dominant or heterozygous.
- T** **F** 12. There could be hundreds of alleles of a particular gene in the population as a whole, but one individual can only have one or two different alleles for that gene.
- T** **F** 13. Each cell in your body has the same set of genes, and each cell has two alleles for each gene.
- T** **F** 14. Every person has the same set of genes, though they may not have the same alleles.
- T** **F** 15. If the genotypes of the two parents are known (for a particular gene), Mendelian genetics can be used to accurately predict the genotype of their child.
- T** **F** 16. A haploid gamete (sperm or egg cell) has the same genes as a diploid body cell.

Fill in the blank:

1. Most of your body cells are **diploid**, meaning they have two alleles of each gene. However, **gamete** cells are haploid, meaning they have only one allele of each gene.
2. A gene is typically responsible for one inherited **character**, while a(n) **allele** is a form of a gene that produces one inheritable trait.
3. An individual's genetic makeup is referred to as his/her **genotype**, while the visible or measurable effects of that genetic makeup is called the **phenotype**.
4. In a cross between two true-breeding parents, the allele that produces the phenotype seen in the **F₁** generation is considered to be the **dominant** allele.
5. If an individual is true-breeding, we can say that he/she is **homozygous** for the gene we are looking at.