CHAPTER 14
MENDEL AND THE GENE IDEA

Learning objectives

Gregor Mendel's Discoveries

1. Explain how Mendel's particulate mechanism differed from the blending theory of inheritance.
2. Define the following terms: true breeding, hybridization, monohybrid cross, P generation, F_1 generation, F_2 generation.
3. List and explain the four components of Mendel's hypothesis that led him to deduce the law of segregation.
4. Use a Punnett square to predict the results of a monohybrid cross, stating the phenotypic and genotypic ratios of the F_2 generation.
5. Distinguish between the following pairs of terms: dominant and recessive; heterozygous and homozygous; genotype and phenotype.
6. Explain how a testcross can be used to determine if an individual with the dominant phenotype is homozygous or heterozygous.
7. Use a Punnett square to predict the results of a dihybrid cross and state the phenotypic and genotypic ratios of the F_2 generation.
8. State Mendel's law of independent assortment and describe how this law can be explained by the behavior of chromosomes during meiosis.
9. Use the rule of multiplication to calculate the probability that a particular F_2 individual will be homozygous recessive or dominant.
10. Given a Mendelian cross, use the rule of addition to calculate the probability that a particular F_2 individual will be heterozygous.
11. Use the laws of probability to predict, from a trihybrid cross between two individuals that are heterozygous for all three traits, the expected proportion of the offspring that would be:
    a. homozygous dominant for the three traits
    b. heterozygous for all three traits
    c. homozygous recessive for two specific traits and heterozygous for the third
12. Explain why it was important that Mendel used large sample sizes in his studies.

Extending Mendelian Genetics

13. Give an example of incomplete dominance and explain why it does not support the blending theory of inheritance.
14. Explain how phenotypic expression in the heterozygote differs with complete dominance, incomplete dominance, and co-dominance.
15. Explain why Tay-Sachs is considered recessive at the organismal level and co-dominant at the molecular level.
16. Explain why genetic dominance does not mean that the dominant allele subdues a recessive allele. Illustrate your explanation with the example of round versus wrinkled pea seed shape.
17. Explain why dominant alleles are not necessarily more common in a population. Illustrate your explanation with an example.
18. Describe the inheritance of the ABO blood system and explain why the I^A and I^B alleles are said to be *co-dominant.*

19. Define and give examples of pleiotropy and epistasis.
20. Describe a simple model for polygenic inheritance and explain why most polygenic characters are described in quantitative terms.
21. Describe how environmental conditions can influence the phenotypic expression of a character. Explain what is meant by "a norm of reaction."
22. Distinguish between the specific and broad interpretations of the terms "phenotype" and "genotype."

Mendelian Inheritance in Humans

23. Explain why studies of human inheritance are not as easily conducted as Mendel's work with peas.
24. Given a simple family pedigree, deduce the genotypes for specific family members.
25. Explain how a lethal recessive allele can be maintained in a population.
26. Describe the inheritance and expression of cystic fibrosis and sickle-cell disease.
27. Explain why lethal dominant genes are much rarer than lethal recessive genes.
28. Give an example of a late-acting lethal dominant in humans and explain how it may escape elimination by natural selection.
29. Define and give examples of multifactorial disorders in humans.
30. Explain how carrier recognition, fetal testing, and newborn screening can be used in genetic screening and counseling.