Questions and problems:

1. Outline some of the ways in which genetics is important to each of us.
2. Briefly explain why genetics is crucial to modern biology.
3. List the three traditional subdisciplines of genetics and summarize what each covers.
4. Outline the notion of pangenesis and explain how it differs from the germ-plasm theory.
5. What does the concept of the inheritance of acquired characteristics propose and how is it related to the notion of pangenesis?
6. What is preformationism? What did it have to say about how traits are inherited?
7. Define blending inheritance and contrast it with preformationism.
8. Briefly define the following terms: **(a)** gene; **(b)** allele; **(c)** chromosome; **(d)** DNA; **(e)** RNA; **(f)** genetics; **(g)** genotype; **(h)** phenotype; **(i)** mutation; **(j)** evolution.
9. Outline the relations between genes, DNA, and chromosomes.
10. Genetics is said to be both a very old science and a very young science. Explain what is meant by this statement.
11. Match the theory or concept on the left with the correct description on the right.

Preformationism **(a)** Each reproductive cell contains a complete set of genetic information.
Pangenesis **(b)** All traits are inherited from one parent.
Germ-plasm theory **(c)** Genetic information may be altered by the use of a feature.
Inheritance of acquired characteristics **(d)** Cells of different tissues contain different genetic information.

12. For each of the following genetic topics, indicate whether it focuses on transmission genetics, molecular genetics, or population genetics.

a. Analysis of pedigrees to determine the probability of someone inheriting a trait.
b. Study of the genetic history of people on a small island to determine why a genetic form of asthma is so prevalent on the island.
c. The influence of nonrandom mating on the distribution of genotypes among a group of animals.
d. Examination of the nucleotide sequences found at the ends of chromosomes.
e. Mechanisms that ensure a high degree of accuracy during DNA replication.
f. Study of how the inheritance of traits encoded by genes on sex chromosomes (sex-linked traits) differs from the inheritance of traits encoded by genes on non sex chromosomes (autosomal traits).

13. The following concepts were widely believed at one time but are no longer accepted as valid genetic theories. What experimental evidence suggests that these concepts are incorrect and what theories have taken their place? **(a)** pangenesis; **(b)** the inheritance of acquired characteristics; **(c)** preformationism; **(d)** blending inheritance.
14. Consider the case in which testcrossing a black male produced black and white offspring in approximately equal numbers?
15. In the garden pea, Mendel found that yellow seed color was dominant to green (Y>y) and round seed shape was dominant to shrunken (S>s). (a) What phenotypic ratio would be expected in the F2 from a cross of a pure yellow, round X green, shrunken? (b) What is the F2 ratio of yellow: green and of round: shrunken?
16. Why was Mendel's approach to the study of heredity so successful?
17. What is the relation between the terms *allele, locus, gene,* and *genotype?*
18. What is the principle of segregation? Why is it important?

19. What is the concept of dominance? How does dominance differ from incomplete dominance?

20. Give the phenotypic ratios that may appear among the progeny of simple crosses and the genotypes of the parents that may give rise to each ratio.

21. Give the genotypic ratios that may appear among the progeny of simple crosses and the genotypes of the parents that may give rise to each ratio.

22. What is the chromosome theory of inheritance? Why was it important?

23. What is the principle of independent assortment? How is it related to the principle of segregation?

24. How is the principle of independent assortment related to meiosis?

25. In cucumbers, orange fruit color (*R*) is dominant over cream fruit color (*r*). A cucumber plant homozygous for orange fruits is crossed with a plant homozygous for cream fruits. The F1 are intercrossed to produce the F2.

a. Give the genotypes and phenotypes of the parents, the F1, and the F2.

b. Give the genotypes and phenotypes of the offspring of a backcross between the F1 and the orange parent.

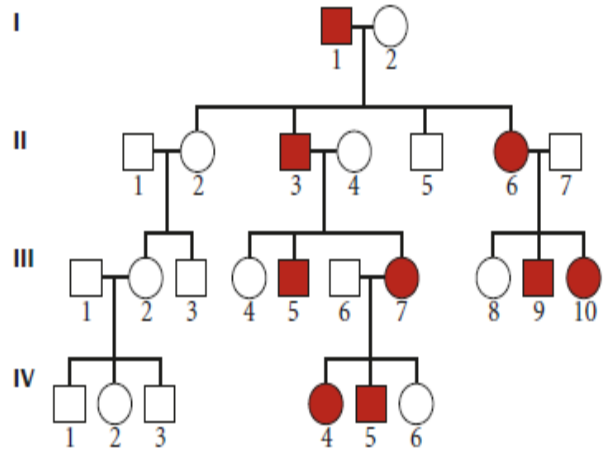
c. Give the genotypes and phenotypes of a backcross between the F1 and the cream parent.

26. What three factors complicate the task of studying the inheritance of human characteristics?

27.

For each of the following pedigrees, give the most likely mode of inheritance, assuming that the trait is rare. Carefully explain your reasoning.

a.



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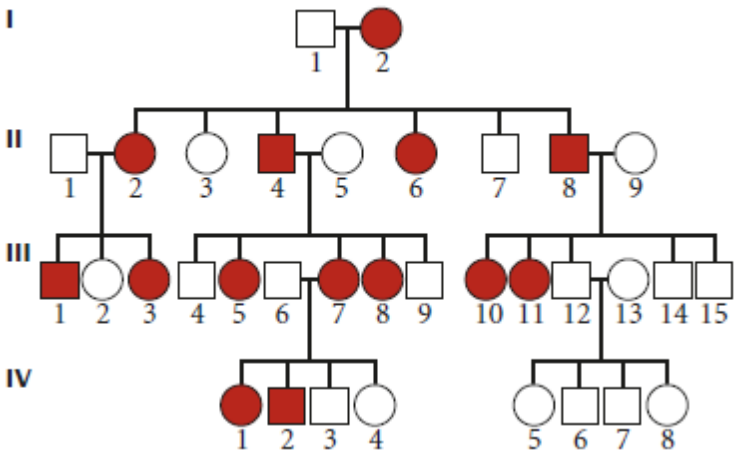


28. What are continuous characteristics and how do they arise?

29. Give the expected genotypic and phenotypic ratios for the following crosses for ABO blood types.

a. *I*A*i* X *I*B*i*

b. *I*A*I*B X *I*A*i*

c. *I*A*I*B X *I*A*I*B

d. *ii* X *I*A*i*

e. *I*A*I*B X *ii*

30. The type of plumage found in mallard ducks is determined by three alleles at a single locus: *M*R, which codes for restricted plumage; *M,* which codes for mallard plumage; and *m*d, which codes for dusky plumage. The restricted phenotype is dominant over mallard and dusky; mallard is dominant over dusky $(M^R > M > m^d)$. Give the expected phenotypes and proportions of offspring produced by the following crosses.

a. $M^RM \times m^dm^d$

b. $M^Rm^d \times Mm^d$

c. $M^Rm^d \times M^RM$

d. $M^RM \times Mm^d$

31. The L^M and L^N alleles at the MN blood group locus exhibit codominance. Give the expected genotypes and phenotypes and their ratios in progeny resulting from the following crosses.

a. $L^ML^M \times L^ML^N$

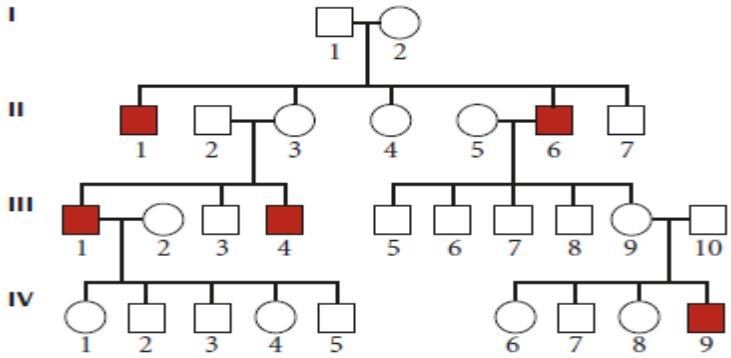
b. $L^NL^N \times L^NL^N$

c. $L^ML^N \times L^ML^N$

d. $L^ML^N \times L^NL^N$

e. $L^ML^M \times L^NL^N$

32. The following pedigree represents the inheritance of a rare disorder in an extended family. What is the most likely mode of inheritance for this disease?



33. A wheat variety with colored seeds is crossed to a colorless strain producing an all F1. In the F2, 1/64 of the progeny has colorless seeds.

(a) How many pairs of genes control seed color?

(b) What were the genotypes of the parents and the F1 (use your own symbols)?

Answer:

(a) 3 (b) P: AABBCC X aabbcc ; AaBbCc

34. Listed below are 7 two-factor interaction ratios observed in progeny from various dihybrid parents. Suppose that in each case one of the dihybrid parents is testcrossed (instead of being mated to another dihybrid individual). What phenotypic ratio is expected in the progeny of each testcross? (a) 9:6:1 (b) 9:3:4 (c) 9:7 (d) 15:1 (e) 12:3:1 (f) 9:3:3:1 (g) 13:3.

Answer:

(a) 1:2:1 (b) 1:1:2 (c) 1:3 (d) 3:1 (e) 2:1:1 (f) 1:1:1:1 (g) 3:1.

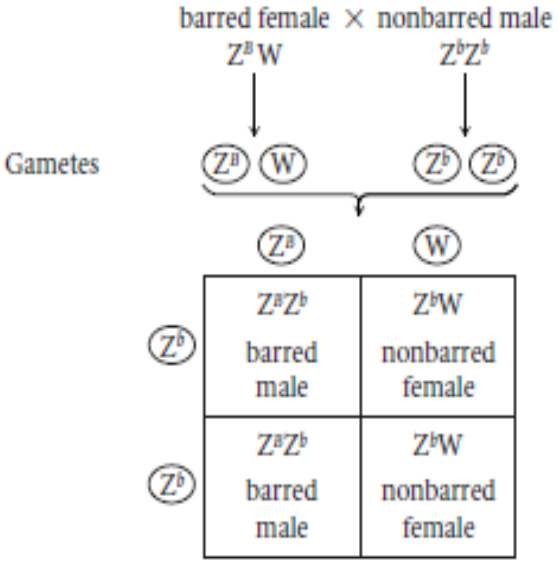
35. Two white flowered strains of the sweet pea were crossed, producing an F1 with only purple flowers. Random crossing among the F1 produced 96 progeny plants, 53 exhibiting purple flowers and 43 with white flowers. (a) What phenotypic ratio is approximated by the F2? (b) What type of interaction is involved? (c) What were the probable genotypes of parental strains?

36. Sex determination in the grasshopper is by the XO method. The somatic cells of a grasshopper are analyzed and found to contain 23 chromosomes. (a) What sex is this individual? (b) Determine the frequency with which different types of gametes number of autosomes and sex chromosomes) can be formed in this individual. (c) What is the diploid number of the opposite sex? Answer: (a) male (b) ½(11A+1X): ½(11A) (c) 24

37. Suppose that a female undergoes sex reversal to become a functional male and is then mated to a normal female. Determine the expected F1 sex ratios from such matings in species with (a) ZW method of sex determination, (b) XY method of sex determination. Answer: (a) 2 female : 1 male (b) all females

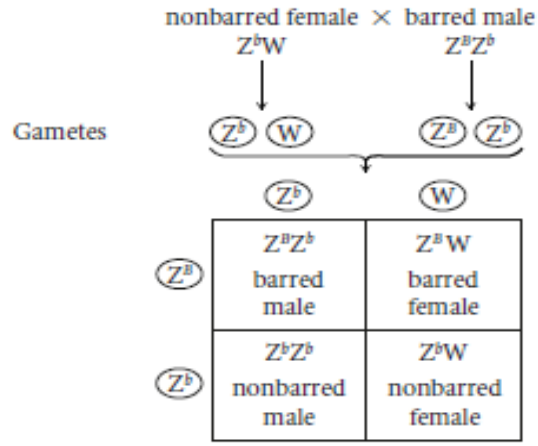
38. A fruit fly has XXXYY sex chromosomes; all the autosomal chromosomes are normal.What sexual phenotype will this fly have? **Answer:** Sex in fruit flies is determined by the X:A ratio—the ratio of the number of X chromosomes to the number of haploid autosomal sets. An X:A ratio of 1.0 produces a female fly; an X:A ratio of 0.5 produces a male. If the X:A ratio is greater than 1.0, the fly is a metafemale; if it is less than 0.5, the fly is a metamale; if the X:A ratio is between 1.0 and 0.5, the fly is an intersex. This fly has three X chromosomes and normal autosomes.Normal diploid flies have two autosomal sets of chromosomes; so the X:A ratio in this case is $3/2$, or 1.5. Thus, this fly is a metafemale.

39. Chickens, like all birds, have ZZ-ZW sex determination. The bar-feathered phenotype in chickens results from a Z-linked allele that is dominant over the allele for nonbar feathers. A barred female is crossed with a nonbarred male. The F1 from this cross are intercrossed to produce the F2.What will the phenotypes and their proportions be in the F1 and F2 progeny? **Answer:** With the ZZ-ZW system of sex determination, females are the heterogametic sex, possessing a Z chromosome and a W chromosome; males are the homogametic sex, with two Z chromosomes. In this problem, the barred female is hemizygous for the bar phenotype (Z*B*W). Because bar is dominant over nonbar, the nonbarred male must be homozygous for nonbar (Z*b*Z*b*). Crossing these two chickens, we obtain:



Thus, all the males in the F_1 will be barred (Z^BZ^b), and all the females will be nonbarred (Z^bW).

We now cross the F_1 to produce the F_2:



So, ¼ of the F_2 are barred males, ¼ are nonbarred males, ¼ are barred females, and ¼ are nonbarred females.

40. What is the pseudoautosomal region? How does the inheritance of genes in this region differ from the inheritance of other Y-linked characteristics?

41. How is sex determined in insects with haplodiploid sex determination?

42. What is meant by genic sex determination?

43. What is the sexual phenotype of fruit flies having the following chromosomes?

	Sex chromosomes	**Autosomal chromosomes**
a.	XX	all normal
b.	XY	all normal
c.	XO	all normal
d.	XXY	all normal
e.	XYY	all normal
f.	XXYY	all normal
g.	XXX	all normal
h.	XX	four haploid sets
i.	XXX	four haploid sets
j.	XXX	three haploid sets
k.	X	three haploid sets
l.	XY	three haploid sets
m.	XX	three haploid sets

(**a**) Female; (**b**) male; (**c**) male, sterile; (**d**) female; (**e**) male; (**f**) female; (**g**) metafemale; (**h**) male; (**i**) intersex; (**j**) female; (**k**) metamale, sterile; (**l**) metamale; (**m**) intersex.

44. What characteristics are exhibited by an X-linked trait?

45. What characteristics are exhibited by a Y-linked trait?

46. Chickens, like all birds, have ZZ-ZW sex determination. The bar-feathered phenotype in chickens results from a Z-linked allele that is dominant over the allele for nonbar feathers. A barred female is crossed with a nonbarred male. The F1 from this cross are intercrossed to produce the F2.What will the phenotypes and their proportions be in the F1 and F2 progeny?

47. Hemophilia results from a recessive X-linked gene. Jill has hemophilia. She marries Bill, who has normal blood clotting. What proportion of their children are expected to have hemophilia?