Genetics Practice Problems

Work out these genetic problems.
The answers are provided but the most important aspect is the practice of working out the problems.

Use this information for the two questions below:

G and g are dominant and recessive alleles, respectively, of the same gene.

1) Which genotype(s) would result in an individual with the dominant phenotype?
A) GG and gg B) GG and Gg C) Gg and gg D) only GG E) only Gg

Answer: B

2) Which genotype(s) would result in an individual with the recessive phenotype?
A) gg only B) Gg only C) Gg or gg D) GG only E) GG or gg

Answer: A

Use this information for the four questions below.
Cystic fibrosis (CF) is caused by a recessive allele. A child has CF, even though neither of his parents has CF.
Use this information for questions 3 – 10 below.

3) What can you conclude about the parents?
A) They are both homozygous dominant for the CF gene.
B) They are both homozygous recessive for the CF gene.
C) One is homozygous dominant for the CF gene, the other is heterozygous.
D) One is homozygous recessive for the CF gene, the other is heterozygous.
E) They are both heterozygous for the CF gene.

Answer: E

4) This couple has another child who does not have CF. What is the probability he or she is heterozygous?
A) 1/4
B) 2/4
C) ¾
D) 1/3
E) 2/3

Answer: E

5) If this couple has another child, what is the probability he or she will NOT have CF?
A) 1/4
B) 2/4
C) 3/4
D) 1/3
E) 2/3

Answer: C

6) If this couple has another child, what is the probability it will be a boy, with CF?

A) 1/32
B) 1/20
C) 1/16
D) 1/10
E) 1/8

Answer: E

7) Widows peak hairline in humans is dominant to non-widows peak hairline. If a person has a widows peak hairline, what is his or her genotype?

A) It must be homozygous dominant.
B) It must be homozygous recessive.
C) It is either homozygous dominant or homozygous recessive.
D) It must be heterozygous.
E) It is either heterozygous or homozygous dominant.

Answer: E

Use this information for the four questions below.
In humans, "unattached" earlobes are dominant over "attached" earlobes. "Widows peak" hairline is dominant over "non-widows peak" hairline. Use E and e for the earlobe phenotype alleles, and W and w for the hairline phenotype alleles.

8) A female and a male, both with unattached earlobes, have a child with attached earlobes. What is the probability their next child will have attached earlobes?

A) 4/4
B) 3/4
C) 2/4
D) 1/4
E) 0

Answer: D

9) A female and a male, both with genotype EeWw have a child. What is the probability it will have attached earlobes and a widows peak hairline?

A) 9/16
B) 3/16
C) 1/16
D) 1/3
E) 3/4

Answer: B

10) A female and a male, both with genotype EeWw have a child. What is the probability it will be a boy, and have attached earlobes and a widows peak hairline?

A) 1/6
B) 3/16
C) 1/16
D) 1/32
E) 3/32

Answer: E

11) A female with unattached earlobes and a widows peak hairline and a male with attached earlobes and a widows peak hairline have a child. The child has attached earlobes and a non-widows peak hairline. What are the genotypes of the parents?

A) EeWw and eeww
B) EeWw and eeWw
C) EEWW and eeww
D) EEWW and eeWw
E) EeWw and EeWW

Answer: B

12) In a dihybrid cross, if heterozygotes are crossed, what fraction of the offspring are expected to have both the dominant ***phenotypes***?

A) 1/3
B) 2/3
C) 1/16
D) 3/16
E) 9/16

Answer: E

13) In the individual with genotype AaBB, what percent of gametes will contain the A allele?

A) 100%
B) 75%
C) 50%
D) 25%
E) 10%

Answer: C

14) How many different types of gametes can be generated by an individual with genotype AaBB?

A) 1
B) 2
C) 3
D) 4
E) 8

Answer: B

Use this information for the next six questions below.
In Mendel's pea plants, yellow seeds are dominant to green seeds. Purple flowers are dominant to white flowers. Use Y and y for the seed color alleles and P and p for the flower color alleles. Flower color and seed color assort independently.

15) If a homozygous green seed-producing plant is crossed to a heterozygous yellow seed-producing plant, what percent of offspring produce green seeds?

A) 10
B) 25
C) 33
D) 50
E) 100

Answer: D

16) If a YyPp plant is crossed to a Yypp plant, what is the probability that the resulting plant will have the genotype Yypp? (Hint: Determine two separate probabilities and use the rule of multiplication.)

A) 1/2
B) 1/4
C) 1/8
D) 1/16
E) 1/32

Answer: B

17) A plant of unknown genotype with yellow seeds and purple flowers is crossed to a plant with green seeds and white flowers. The offspring all have yellow seeds, but some have purple flowers and some have white flowers. What is the genotype of the yellow-seeded, purple-flowered plant?

A) YyPp
B) YyPP
C) YYPP
D) YYPp
E) Yypp

Answer: D

18) A true-breeding plant with green seeds and white flowers is crossed to a plant that is heterozygous for the genes for both phenotypes. What is the probability that the cross will yield a plant with green seeds and white flowers?

A) 1/16
B) 3/16
C) 1/4
D) 1/32
E) 3/32

Answer: C

19) If a plant that is heterozygous for both flower color and seed color genes is self-fertilized, what proportion of the offspring will have one of the dominant phenotypes, either the seed color or flower color, but NOT both?

A) 9/16
B) 6/16
C) 9/32
D) 6/32
E) 6/64

Answer: B

20) What is the relationship between the Y and P?

A) They are two different chromosomes in the pea plant.
B) They are incompletely dominant alleles of the same gene.
C) They are two different genes on the same chromosome.
D) They are the pleiotropic effects of a single gene.
E) They are two different genes on two different chromosomes.

Answer: E

Use this information for the three questions below.

A, B, and O blood type in humans is controlled by a single gene with three alleles:

I^A and I^B and i.

21) Imagine a fourth allele for blood type, I^C. If it is also codominant with $I^A$and I^B, and dominant to i, how many possible blood type phenotypes are there?

A) 3 B) 6 C) 7 D) 8 E) 9

Answer: C

22) Type O is the recessive trait. The i allele is recessive to both I to power of (A) and I to power of (B). Which of the following could be possible genotypes of the parents of a person with type O blood?

A) I to power of (A) I to power of (B) and ii
B) I to power of (A)i and I to power of (B)i
C) I to power of (A)i and I to power of (A) I to power of (A)
D) I to power of (A) I to power of (B) and I to power of (A) I to power of (B)
E) both parents must be ii

Answer: B

23) A person with the genotype I to power of (A) I to power of (B) has type AB blood. This is an example of

A) dihybridness.
B) the effect of the environment on phenotype.
C) codominance.
D) pleiotropy.
E) incomplete dominance.

Answer: C

24) If a female who is a carrier for the hemophilia gene has a child with a male who does not have hemophilia, which prediction is correct?

A) All of the sons and none of the daughters will have hemophilia.
B) All of the daughters and none of the sons will have hemophilia.
C) Half of the sons and half of the daughters will have hemophilia.
D) Half of the sons and none of the daughters will have hemophilia.
E) Half of the daughters and none of the sons will have hemophilia.

Answer: D

25) A female who does not carry the color blindness allele has children with a male who is color blind. What proportion of their children will be color blind?

A) all B) 1/4 C) 1/2 D) 3/4 E) none

Answer: E

26) A female is not color blind, but half her sons are. Her daughters are not color blind. Which conclusion is correct?

A) The father is color blind.
B) The father is not color blind, but is heterozygous for the color blindness gene.
C) The woman is heterozygous for the color blindness gene.
D) Color blindness is dominant.
E) Color blindness is autosomal.

Answer: C

Use this information for the question(s) below.
A man and a woman are both carriers of sickle cell anemia. The man is color blind.
The woman is not color blind, nor is she a carrier of color blindness.

27) How would the genotype of the man be written?
A) Hb to power of (S), XY
B) Hb to power of (A) Hb to power of (A), Y to power of (C)Y
C) Hb to power of (S) Hb to power of (A), Y to power of (C)Y
D) Hb to power of (S) Hb to power of (S), X to power of (C)Y
E) Hb to power of (S) Hb to power of (A), X to power of (C)Y

Answer: E

28) The proportion of all their children who will be carriers of color blindness who also have sickle cell anemia is
A) 1/2. B) 1/6. C) 1/8. D) 1/16. E) 1/32.

Answer: C

29) The percentage of all their children who will be color blind males with sickle cell anemia (meeting all three conditions) is
A) 0. B) 10. C) 25. D) 33. E) 50.

Answer: A

30) What proportion of their children will not have sickle cell anemia, yet will have malaria resistance?
A) 1/2 B) 1/4 C) 3/4 D) none E) all

Answer: A

31) A person who is heterozygous for the Huntington disease allele has offspring with someone who does not have HD. What proportion of their children will have HD?
A) 1/16 B) 1/10 C) 1/8 D) 1/4 E) 1/2
Answer: E

32) What is a karyotype?
A) a fetal cell
B) a technique that obtains fetal cells for testing
C) a test that determines if a cell is cancerous
D) a test for the activity of amino acid synthesizing enzymes in a cell
E) a picture of the set of chromosomes from a cell

Answer: E

33) Which condition is caused by a chromosomal deletion?
A) Down Syndrome
B) Huntington disease
C) Turner Syndrome
D) cri-du-chat
E) sickle cell anemia

Answer: D

34) Why might a chromosomal duplication be harmful?
A) It involves the loss of some genes.
B) It changes the orientation of a chromosomal segment.
C) It might result in production of too much of a protein.
D) It adds so many chromosomes that they might not fit in the cell.
E) It results in polyploidy, which is not tolerated by humans.

Answer: C

35) People with Down Syndrome have
A) a diploid set of chromosomes, plus one extra of number 21.
B) a haploid set of chromosomes, plus one extra of number 21.
C) a diploid set of autosomes, but only one sex chromosome.
D) three of all the chromosomes, including X and Y.
E) a diploid set of chromosomes, except only one of number 21.

Answer: A

36) A person with the genotype XO is mainly female, phenotypically. A person with the genotype XXY is mainly male. What can you conclude about the Y chromosome?
A) It has the same genes as X, just different alleles.
B) It has the same genes as X, in different orientation.
C) A Y chromosome confers maleness, regardless of the number of X chromosomes.
D) The only genes it carries are for male development.
E) A human cannot survive without a Y chromosome.

Answer: C

37) Gametes with too many or too few chromosomes can result from non-disjunction in
A) either mitosis I or mitosis II.
B) mitosis I only.
C) mitosis II only.
D) either meiosis I or meiosis II.
E) meiosis I only.

Answer: D

38) If a disease is autosomal recessive, it is caused by
A) failure to inherit one of the sex chromosomes.
B) failure to inherit one of the autosomes.
C) inheritance of an extra autosome.
D) a gene on a chromosome other than X or Y.
E) a gene on a chromosome other than an autosome.

Answer: D

39) What is the connection between sickle cell anemia and malaria?
A) Both are X-linked.
B) Both are autosomal recessive.
C) Both are dominant.
D) Heterozygotes for malaria have some resistance to sickle cell anemia.
E) Heterozygotes for sickle cell anemia have some resistance to malaria.

Answer: E

40) A person is heterozygous for an autosomal dominant condition. If they have children with someone who is homozygous recessive, which statement is correct?

A) All of their children will be carriers.
B) Half of their children will be carriers.
C) All their children will have the condition.
D) Half of their children will have the condition.
E) None of their children will have the condition.

Answer: D

Review Part 2: Written Practice Problems

Important Note: Get in the habit right from the first of writing down the work necessary to solve the problems you do. You will be required to show work on your .

I. Problems Involving One Gene (Monohybrid Crosses)

1. In cats, long hair is recessive to short hair. A true-breeding (homozygous) short-haired male is mated to a long-haired female. What will their kittens look like?

2. Two cats are mated. One of the parent cats is long-haired (recessive allele). The litter which results contains two short-haired and three long-haired kittens. What does the second parent look like, and what is its genotype?

3. Mrs. And Mr. Smith both have widow's peaks (dominant). Their first child also has a widow's peak, but their second child doesn't. Mr. Smith accuses Mrs. Smith of being unfaithful to him. Is he necessarily justified? Why or why not? Work the genetics problem predicting the frequencies of the versions of this trait among their prospective children.

4. Mr. and Mrs. Jones have six children. Three of them have attached earlobes (recessive) like their father, and the other three have free earlobes like their mother. What are the genotypes of Mr. and Mrs. Jones and of their numerous offspring?

5. Mr. and Mrs. Anderson both have tightly curled hair. (The hair form gene shows incomplete dominance. There are two alleles, curly and straight. The heterozygote has wavy hair.) The Andersons have a child with wavy hair. Mr. Anderson accuses Mrs. Anderson of being unfaithful to him. Is he necessarily justified? Why or why not?

6. Two wavy haired people (one male and one female) marry and have eight children. Of these eight, how many would you expect to be curly haired, how many wavy haired and how many straight haired, assuming that the family follows the expected predicted inheritance pattern?

7. Basic body color for horses is influenced by several genes. For one of the genes, the two alleles—the chestnut (dark brown) allele and a diluting (pale cream) allele—display incomplete dominance. A horse heterozygous for these two alleles is a palomino (golden body color with flaxen mane and tail). Is it possible to produce a herd of pure-breeding palomino horses? Why or why not?

8. In certain portions of the Jewish population, there is a genetic disease called Tay Sachs disease, which is fatal to infants within the first five years of life. This disease is caused by a recessive allele of a single gene. Why does this disease persist, even though it is **invariably** fatal long before the afflicted individual reaches reproductive age? (In other words, why doesn't the allele for Tay Sachs disease simply disappear?)

II. Problems Involving Two Genes (Dihybrid Crosses)

1. A man with dark (dominant), curly (see problem I.5.) hair marries a woman with light, straight hair. Their daughter, who happens to have dark hair, marries a man with light, wavy hair. Answer the following questions about this dark-haired daughter and her family.
   a. Draw a Punnett's square for the daughter's marriage, and predict the phenotypic ratio among the offspring of the daughter and her husband.
   b. What is the chance that they will have a child with hair just like their father's (light and wavy)?

2. In cats, again, black color is dominant to a special, temperature-sensitive albino gene which produces cats with dark legs, faces and tails (Siamese cats, in case you don't recognize it). A short haired (dominant) Siamese female is bred to a long-haired black male (check question I.1 for hair length genes). They have eight kittens: 2 black, short-haired; 2 black, long-haired; 2 Siamese, short-haired; and 2 Siamese, long-haired. What were the genotypes of the two parents?

3. If a pure-breeding (homozygous) black (dominant), long-haired (recessive) cat is mated to a pure-breeding Siamese, short-haired cat, and one of their male offspring is mated to one of their female offspring, what is the chance of producing a Siamese colored, short-haired kitten?

4. In garden peas, long stems are dominant to short stems, and yellow seeds are dominant to green seeds. 100 long/yellow pea plants, all of which had one short/green parent, are interbred (bred to each other). 1600 progeny result. Please answer the following questions about these progeny.
   a. Assuming that these two genes are unlinked, about how many long/green pea plants would you expect to find among the offspring?
   b. What ratio of yellow to green seed color would you expect among the offspring?
   c. What would you expect the overall phenotypic ratio among the 1600 offspring to be (taking BOTH traits – colour and stem length – into consideration)?

III. Problems Involving Sex Linkage (X-linked Genes)

1. Earl has normal color vision, while his wife Erma is colorblind. Colorblindness is an X-linked trait, and the normal allele is dominant to the colorblindness allele. If they have a large family, in what percentages of the sons would be colour blind? Daughters?

2. Ethan is colorblind. His wife, Edna, is homozygous for the normal color vision allele. If they have eight children, how man of them would you expect to be colorblind? Using Punnett squares, derive and compare the genotypic and phenotypic ratios expected for the offspring of this marriage and those expected for the offspring of the marriage described in the previous question.

3. Marian's father is colorblind, as is her maternal grandfather (her mother's father). Marian herself has normal color vision. Marian and her husband, Martin, who is also colorblind, have just had their first child, a son they have named Mickey. Please answer the following questions about this small family.
   a. What is the probability that this child will be colorblind?
   b. Three sources of the colorblindness allele are mentioned in this family. If Mickey is colorblind, from which of these three men (Marian's grandfather, Marian's father, or Martin) did he inherit the allele?
   c. If Martin were not colorblind, how would this affect the prediction about Mickey?

4. In cats, there is a coat color gene located on the X chromosome. This gene has two alleles—orange and black. A heterozygous cat has tortoiseshell color (a splotchy mixture of orange and black). Predict the genotypic and phenotypic frequencies among the offspring of the following crosses. Pay careful attention to the **genders** of the offspring.
   a. Black female X Orange male
   b. Orange female X Black male
   c. Tortoiseshell female X Black male
   d. Tortoiseshell female X Orange male

IV. Problems Involving Codominant Genes (…ie: blood type problems)

1. In a particular family, one parent has Type A blood, the other has Type B. They have four children. One has Type A, one has Type B, one has Type AB, and the last has Type O. What are the genotypes of all six people in this family?

   NOTE: The ABO blood type gene has three alleles. $\mathbf{I^A}$ and $\mathbf{I^B}$ are codominant; **i** (for Type O) is recessive to both.

2. Refer to problem I.3. Mrs. Smith has blood type A. Mr. Smith has blood type B. Their first child has blood type AB. Their second child has blood type O. **Now** is Mr. Smith justified? What are Mr. and Mrs. Smith's genotypes for these two genes?

3. In a recent case in Spokane, Washington, a young woman accused a soldier of being the father of her child. The soldier, of course, denied it. The soldier's lawyer demanded that blood types be taken to prove the innocence of his client. The following results were obtained: Alleged father, Type O. Mother, Type A. Child, Type AB. The court found the soldier guilty on the basis of the woman's remarkable memory for dates and details that apparently eliminated all other possible fathers.
   a. What are the possible genotypes for these three people?
   b. Do you agree with the court's decision? Why or why not?

4. It was suspected that two babies had been exchanged in a hospital. Mr. and Mrs. Jones received baby #1 and Mr. and Mrs. Simon received baby #2. Blood typing tests on the parents and the babies showed the following:

Mr. Jones: Type A Mrs. Jones: Type O	Mr. Simon: Type AB Mrs. Simons: Type O
Baby #1: Type A	Baby #2 Type O

   Were the babies switched? How do you know whether they were or they weren't?

5. A man with type O blood marries a woman with Type AB blood. Among their children, what proportion would you expect to have blood types like one or the other of these parents? What proportion would be expected to have blood types different from both parents?

6. A woman has a daughter. There are three men whom she claims might have been the father of the child. The judge in the paternity court orders that all three men, the child, and the mother have blood tests. The results are: mother, Type A; Daughter, Type O; Man #1, Type AB; Man #2, Type B; Man #3, Type O. The mother claims that this proves that Man #3 must be the little girl's father.
   a. Is the mother correct? Why or why not?
   b. The judge isn't satisfied, so he asks for the medical records of the people involved. He discovers that the little girl is colorblind. Men #'s 1 and 2 are also colorblind; Man #3 has normal color vision, as does the mother. (NOTE: Colorblindness is X-linked and recessive.) Assuming that one of these three men **must** be the father, can you now determine which of the three it is?

7. Another woman has the same problem. Her blood type is A, her child's is B. She again has three candidates for fatherhood. Their blood types are: Man #1, B; Man #2, AB; Man #3, O. Based on blood types, the mother says it must have been #1.
   a. Do you agree? Why or why not?
   b. This child, a son this time, is also colorblind. The only one of the men in question to share this characteristic is #2. The mother is not colorblind. Can you now determine who the father of the little boy is, assuming it must be one of these men? Explain your answer.

Sex-linked Inheritance Practice Problems

1. In fruit flies, the gene for white eyes is sex-linked recessive. (R) is red and (r) is white. Cross a white-eyed female with a normal red-eyed male.

a. What percent of the males will have red eyes? White eyes?

b. What percent of the females will have red eyes? White eyes?

c. What **total percent** of the offspring will be white-eyed?

d. What **percent** of the offspring will be carriers of the white eye trait?

2. Using the same information as for question #1, cross a heterozygous red-eyed female with a red-eyed male.

a. What are the genotypes of each parent?

b. What **fraction** of the children will have red eyes?

c. What **fraction** of the children will have white eyes?

d. What **fraction** of the female children will carry the white eyed trait?

3. In humans, hemophilia is a sex-linked recessive trait. If a female who is a carrier for hemophilia marries a male with normal blood clotting, answer the following questions.

a. What fraction of the female children will have hemophilia?

b. What fraction of the female children will be carriers?

c. What fraction of the male children will have normal blood clotting?

d. What fraction of the male children will be carriers?

e. What fraction of the male children will have hemophilia?

4. Two parents with normal vision have a color-blind son. Give the genotype of both parents and the son.

5. A woman (whose father was red-green colour-blind) and a man with no history of colour-blindness in his family choose to have children. What is the chance that they will have children (of either gender) that are colour-blind?

6. In cats, the allele (B) produces black color but (b) produces a yellow color. These alleles are incompletely dominant to each other. A heterozygote produces a tortoise shell color. The alleles (B) and (b) are sex-linked as well. Cross a tortoise shell female with a yellow male.

a. What percent of their offspring will be yellow?

b. What percent of their offspring will be black?

c. What percent of their offspring will be tortoise shell?

d. Why is it impossible to have a tortoise shell male offspring?

7. A couple has four children, all of whom are boys. What is the chance that their next child will be another boy?

8. Duchenne muscular dystrophy (DMD) is a recessive, sex-linked disorder. A man and a woman who are both free of the disorder have two children – both boys. Their elder son develops DMD, while their younger son is free of the disorder.
    a. Determine the genotypes of the parents.

    b. Determine the genotypes of the children.