K. HEREDITY AND THE ENVIRONMENT. Most of an organism's characteristics come from the organism's genes. The development of an organism is usually controlled by its genetic makeup but sometimes the genetic makeup is also influenced by the environment. For example, in plants genes control the production of chlorophyll but light must be present for the plant to produce chlorophyll. In this way the environment (light) influenced how the genes were expressed.

Another example of the effect of environment on gene expression is shown in fur color in Himalayan rabbits. In Himalayan rabbits fur color is affected by temperature. The gene for black fur is active at low temperatures. However, when white fur on the rabbit’s back is shaved and the area is covered with an ice pack the fur grows in black. In addition, Himalayan rabbits normally have black fur on the tips of their ears. When the ears are kept warm the fur grows in white (Figure 25-6).

![Figure 25-6. Environment influences heredity.]

Studies using human identical twins have been done to learn about the relative effects of environment and heredity. Such studies involved identical twins who were raised together in the same environment and identical twins who were separated at birth. The separated twins did not eat the same kinds and amounts of food. After studying large numbers of twins scientists found that in separated identical twins, the twin who ate more food was usually larger than the twin who ate less food.

QUESTION PACKET
Some studies of identical twins show that their height and weights may be different. The best explanation for these differences is that (c) 75% are combined and 25% are single-combined.

In chickens, rose comb (R) is dominant over single comb (r). When a heterozygous rose-combined rooster is mated with several single-combined hens, what is the expected phenotypic ratio of the offspring?

(a) 0% rose-combined and 0% single-combined
(b) 50% rose-combined and 50% single-combined
(c) 100% rose-combined
(d) 75% rose-combined and 25% single-combined

In peas, yellow (Y) is dominant over green (y). Two pea plants with yellow flowers were crossed and produced offspring with yellow flowers. If all the offspring are yellow, then the parents must have been (a) homozygous for yellow flowers or (b) heterozygous for yellow flowers.

In regards to the breeding of plants, what is the expected phenotype of a heterozygous parent?

(a) Aa x Aa
(b) Aa x aa
(c) aa x aa
(d) Aa x Aa

In pea breeding, if the green flowers are dominant to the yellow flowers, and a cross is made between a pea with green flowers and a pea with yellow flowers, the offspring will be (a) a mutation or (b) a hybrid.
1. Although identical twins inherit exact copies of the same genes, the twins may look and act differently from each other because
   A) a mutation took place in the gametes that produced the twins
   B) the expression of genes may be modified by environmental factors
   C) the expression of genes may be different in males and females
   D) a mutation took place in the zygote that produced the twins

2. Which statement best explains the change shown in the diagram below?

   ![Diagram: Before and After with ice pack and black fur]  

   A) Gene expression in an organism can be modified by interactions with the environment.  
   B) Certain rabbits produce mutations that affect genes in specific areas of the body.  
   C) Sorting and recombination of genes can be influenced by very cold temperatures.  
   D) Molecular arrangement in existing proteins can be altered by environmental factors.

3. In certain rats, black fur is dominant over white fur. If two rats, both heterozygous for fur color, are mated, their offspring would be expected to have
   A) four different genotypes and two different colors  
   B) two different genotypes and three different colors  
   C) three different genotypes and two different colors  
   D) three different genotypes and three different colors

4. Only red tulips result from a cross between homozygous red and homozygous white tulips. This illustrates the principle of
   A) independent assortment  
   B) dominance  
   C) segregation  
   D) incomplete dominance

5. Which statements best describe the relationship between the terms chromosomes, genes, and nuclei?
   A) Chromosomes are found on genes. Genes are found in nuclei.  
   B) Chromosomes are found in nuclei. Nuclei are found in genes.  
   C) Genes are found on chromosomes. Chromosomes are found in nuclei.  
   D) Genes are found in nuclei. Nuclei are found in chromosomes.

6. In screech owls, red feathers are dominant over gray feathers. If two heterozygous red-feathered owls are mated, what percentage of their offspring would be expected to have red feathers?
   A) 25%  B) 50%  C) 75%  D) 100%

7. Gregor Mendel developed heredity principles from his
   A) mathematical analysis of the results of pea plant crosses  
   B) working model of the structure of DNA  
   C) mapping of the locations of human genes on chromosomes  
   D) extensive study of breeding Drosophila

8. In dogs, wire hair (D) is dominant over smooth hair (d). If two wire-haired dogs produce a smooth-haired pup, the genotypes of the parent dogs are most likely
   A) DD and Dd  
   B) Dd and Dd  
   C) DD and DD  
   D) Dd and dd

9. Which sequence correctly represents the arrangement of structures containing genetic material, from the largest to the smallest size?
   A) chromosome → gene → nucleus  
   B) nucleus → chromosome → gene  
   C) gene → chromosome → nucleus  
   D) gene → nucleus → chromosome

10. Which statement best describes a chromosome?
    A) It is a gene that has thousands of different forms.  
    B) It has genetic information contained in DNA.  
    C) It is a reproductive cell that influences more than one trait.  
    D) It contains hundreds of genetically identical DNA molecules.
11. In a certain species of plant, the allele for tallness is dominant over the allele for shortness. To determine whether a tall plant is heterozygous or homozygous, it should be crossed with a

A) short plant  
B) tall plant  
C) medium-sized plant  
D) different species of plant

12. F represents the gene for brown coat color and f represents the gene for white coat color. In the cross FF x ff all the offspring have a brown coat. Which genetic principle is illustrated by this cross?

A) crossing-over  
B) multiple alleles  
C) codominance  
D) dominance

13. In a certain species of mouse, gray fur (G) is dominant over cream-colored fur (g). If a homozygous gray mouse is crossed with a cream-colored mouse, the genotype of the F1 generation will most likely be

A) 100% Gg  
B) 50% GG and 50% gg  
C) 25% GG, 50% Gg, and 25% gg  
D) 75% Gg and 25% gg

14. In canaries, the gene for singing (S) is dominant over the gene for non-singing (s). When hybrid singing canaries are mated with non-singing canaries, what percentage of the offspring is likely to possess the singing trait?

A) 0%  
B) 25%  
C) 50%  
D) 100%

15. In a population of dogs, curly hair is dominant over straight hair. If two parents are heterozygous for this trait, what is the probability that any of their offspring will have straight hair?

A) 0%  
B) 25%  
C) 75%  
D) 100%

16. In humans, the gene for polydactyly (having extra fingers or toes) is dominant over the gene for the normal number of digits. If parents who are both homozygous dominant for polydactyly have four children, how many of these children would most likely have extra fingers or toes?

A) 0  
B) 2  
C) 3  
D) 4

17. In a particular variety of corn, the kernels turn red when exposed to sunlight. In the absence of sunlight, the kernels remain yellow. Based on this information, it can be concluded that the color of these corn kernels is due to

A) a different type of DNA that is produced when sunlight is present  
B) a different species of corn that is produced in sunlight  
C) the effect of sunlight on the number of chromosomes inherited  
D) the effect of environment on gene expression

18. The diagram below represents a microscopic structure observed during mitosis.

```
A
```

The region indicated by letter A is known as

A) an enzyme  
B) a gamete  
C) a gene  
D) an amino acid

19. After observing the offspring of many generations of pea plant crosses, Gregor Mendel formulated the principle of

A) dominance  
B) polyploidy  
C) crossing-over  
D) mutation

20. The transfer of genes from parents to their offspring is known as

A) differentiation  
B) heredity  
C) immunity  
D) evolution
PUNNETT SQUARES—CROSSES INVOLVING ONE TRAIT

In a certain species of animal, black fur (B) is dominant over brown fur (b). Using the following Punnett square, predict the genotypes and phenotypes of the offspring whose parents are both Bb or have heterozygous black fur.

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Genotypes: 
- \( \frac{25}{50} \) % homozygous black fur (BB) 
- \( \frac{25}{50} \) % homozygous brown fur (bb)
- \( \frac{50}{50} \) % heterozygous black fur (Bb)

Phenotypes:
- \( \frac{15}{25} \) % black fur
- \( \frac{25}{25} \) % brown fur

Now do the same when one parent is homozygous black and the other is homozygous brown.

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Genotypes:
- \( \frac{100}{100} \) % homozygous black fur (BB)
- \( \frac{0}{100} \) % heterozygous black fur (Bb)
- \( \frac{0}{100} \) % homozygous brown fur (bb)

Phenotypes:
- \( \frac{100}{100} \) % black fur
- \( \frac{0}{100} \) % brown fur

Repeat this process again when one parent is heterozygous black and the other is homozygous brown.

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Genotypes:
- \( \frac{50}{50} \) % homozygous black fur (BB)
- \( \frac{50}{50} \) % homozygous brown fur (bb)
- \( \frac{50}{50} \) % heterozygous black fur (Bb)

Phenotypes:
- \( \frac{50}{50} \) % black fur
- \( \frac{50}{50} \) % brown fur
Punnett Squares A
Answer the Following Questions and show your work.

1) In pea plants, yellow peas are dominant over green peas. Use a Punnett square to predict the phenotypic and genotypic outcome (offspring) of a cross between a plant heterozygous/hybrid for yellow (Yy) peas and a plant homozygous/purebred for green (yy) peas.

   |   |   |
---|---|---|
   | y | y |
---|---|---|
   | y | y |

   **Pheno:** 50% yellow

   **Gene:** 50% heterozygous

   **Gene:** 50% homo.

2) Use a Punnett square to predict the genotypic and phenotypic outcome (offspring) of a cross between two heterozygous/hybrid tall (Tt) pea plants.

   |   |   |
---|---|---|
   | T | T |
---|---|---|
   | t | t |

   **Pheno:** 25% tall

   **Gene:** a50% homo. dominant (TT)

   **Gene:** 25% homo. recessive (tt)

3) In guinea pigs, black coat color is dominant over white. If a heterozygous black-coated guinea pig is mated with a white-coated guinea pig, how many different phenotypes with respect to coat color could be expected in the offspring?

   |   |   |
---|---|---|
   | b | b |
---|---|---|
   | b | b |

   **Phenotypes:**

   **50% black**

   **50% white**

4) In mice, black is dominant over tan and short tails are dominant over long. Use B for black and b for tan. Use S for short and s for long. Write the genotype for a heterozygous black, short-tailed mouse. Cross two of these individuals. Describe the phenotypes of the offspring.
Multiple Alleles Problems

1. In a certain case a woman's blood type was tested to be AB. She married and her husband's blood type was type A. Their children have blood types A, AB, and B. What are the genotypes of the parents? What are the genotypic ratios of the children?

Ans ________

Ans ________

2. Ellie G. Teemate was testing her and her parents' blood types. She found that her blood type was type O. Her mother's blood type was also type O. Her father had blood type A. What are the implications of her tests? Show your Punnett square.

Ans ________

3. A certain woman's blood type is type A. Her husband's blood is type B. If they have 8 kids and some of the kids have type AB, some have type A, some B, and some O. What are the genotypes of the parents? How many kids would you expect to have each blood type?

Ans ________

Ans ________

4. In a certain breed of cow the gene for red fur, R, is codominant with that of white fur, W. In the heterozygous condition the cow has a light red look since the cow has both white and red fur at the same time. These cows are called roans. What would be the phenotypic ratios of the offspring if you breed two roan cows? What (are the ratios) if you breed a red cow with a white one?

Ans ________

Ans ________

25% red
25% white
50% roan
BLOOD TYPE AND INHERITANCE

In blood typing, the gene for type A and the gene for type B are codominant. The gene for type O is recessive. Using Punnett squares, determine the possible blood types of the offspring when:

1. Father is type O, Mother is type O

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   100% O
   0% A
   0% B
   0% AB

2. Father is type A, homozygous; Mother is type B, homozygous

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   0% O
   100% A
   100% B
   0% AB

3. Father is type A, heterozygous; Mother is type B, heterozygous

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   25% O
   25% A
   25% B
   25% AB

4. Father is type O, Mother is type AB

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   50% O
   50% A
   50% B
   0% AB

5. Father and Mother are both type AB

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   25% O
   25% A
   25% B
   25% AB