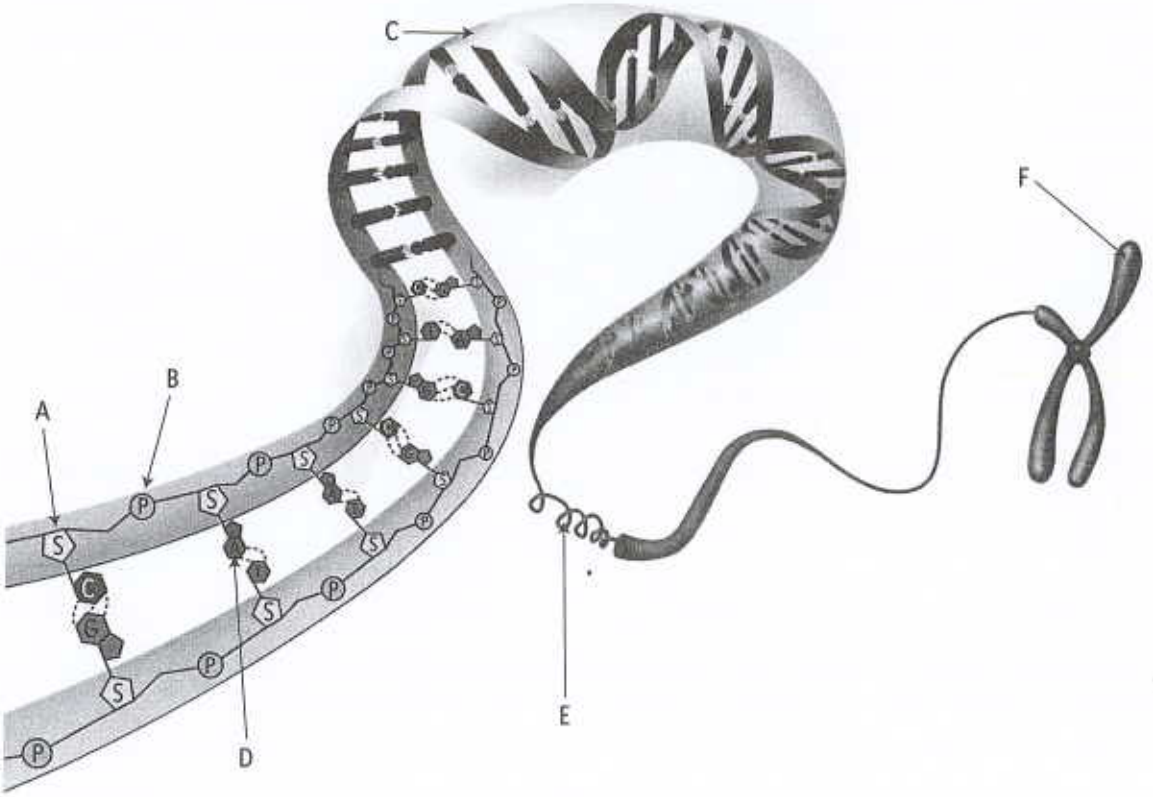
The Structure and Function of DNA

Use with textbook pages 10–15.

1. The diagram below shows the relationships among DNA, chromatin, and chromosomes. Label the diagram with the following terms:

chromatin	**nitrogenous base**
chromosome	**phosphate group**
DNA double helix	**sugar**

You might find it helpful to refer to Figure 1.2 and Figure 1.3 in your textbook.



A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

2. Describe how the following are related to each other.

a) DNA and RNA

b) adenine and thymine

c) complementary base pairing and hydrogen bonds

d) nucleotide and nucleic acid

e) gene and allele

f) sequence of nucleotide and protein

DNA Replication

Use with textbook page 16.

1. Consider the following biological structures: cell, gene, DNA, nucleotide, chromosome, nucleus. Rank them from smallest to biggest.

2. Where does DNA replication take place?

3. When does DNA replication take place?

4. Assume that the sequence of bases in one strand of a DNA molecule is G-A-C-T-T-A-C-G-T-A-C-C. What is the sequence of complementary bases in the other strand of DNA during DNA replication?

5. What is the result of DNA replication? How does each strand in the new molecule compare to the other?

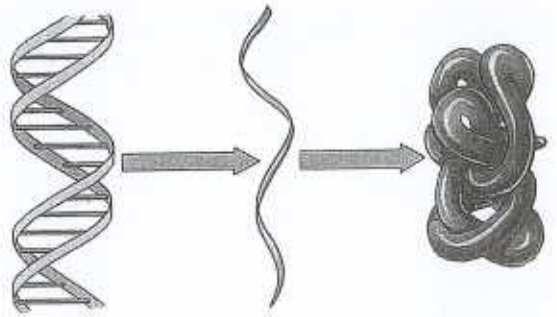
6. Consider the following analogy: The genetic code—the set of instructions that determines all the traits of an organism—may be compared to a book. Still using this analogy, what could the following be compared to?

   a) chapters in the book

   b) sentences in the book

   c) letters in the book

7. Identify Molecules X, Y, and Z. Describe how each molecule contributes to the development of an organism.



Molecule X Molecule Y Molecule Z

a) Name of Molecule X _____

b) Name of Molecule Y _____

c) Name of Molecule Z _____

d) Function of Molecule X

_____

e) Function of Molecule Y

_____

f) Function of Molecule Z

_____

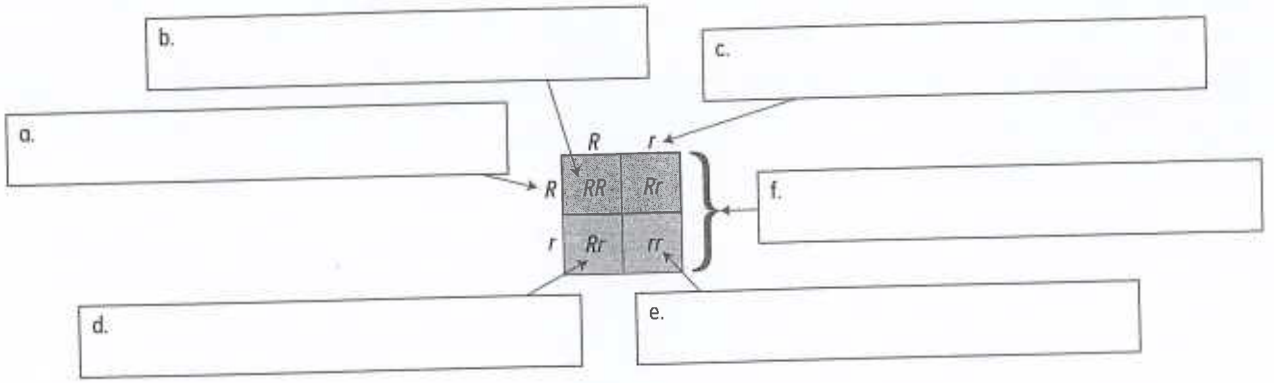
8. How are genes involved in the production of proteins?

_____

_____

_____

Use the following Punnett square to answer questions 3 to 5.



3. Use the terms in the box to label the Punnett square.

dominant allele	**homozygous recessive**
heterozygous	**recessive allele**
homozygous dominant	**offspring**

4. What type of cross is shown in the Punnett square?

_____

5. The Punnett square shows the alleles for seed shape in pea plants. The allele for round seeds (*R*) is dominant and the allele for wrinkled seeds (*r*) is recessive.

a) What are the genotypes of the parent pea plants?

_____

b) What are the phenotypes of the parent pea plants?

_____

c) What percentage of the offspring will have round seeds?

_____

d) What percentage of the offspring will have wrinkled seeds?

_____

e) Determine the genotypic ratio of the F_1 generation.

_____

f) Determine the phenotypic ratio of the F_1 generation.

_____

Dominant and Recessive

Use with textbook pages 31–32.

1. When is a recessive trait expressed?

_____

2. When is a dominant trait expressed?

_____

3. In humans, the allele for freckles (*F*) is dominant and the allele for no freckles (*f*) is recessive.

a) What is the genotype of a person who is homozygous dominant?

_____

b) What is the genotype of a person who is heterozygous?

_____

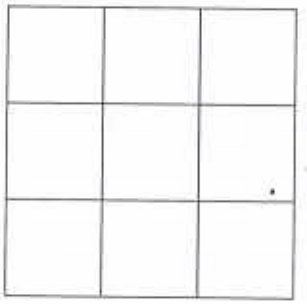
c) What is the genotype of a person who is homozygous recessive?

_____

4. Complete the Punnett squares below for each of the following crosses in pea plants. The dominant and recessive alleles are given for each trait.

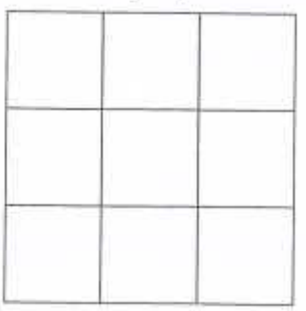
a) Trait: Stem Length
Tall Stem (*T*); **Short Stem** (*t*)
TT* × *TT
_____% *TT*
_____% *Tt*
_____% *tt*
_____% tall stem
_____% short stem

TT × *TT*



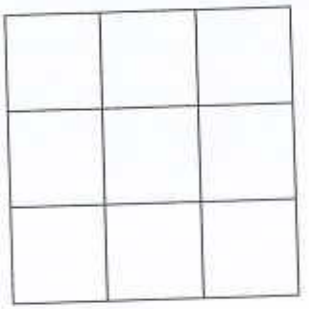
b) Trait: Seed Colour
Yellow Seed (*Y*); **Green Seed** (*y*)
Yy* × *Yy
_____% *YY*
_____% *Yy*
_____% *yy*
_____% yellow seed
_____% green seed

Yy × *Yy*



c) Trait: Flower Colour
Purple (*P*); White (*p*)
PP* × *Pp

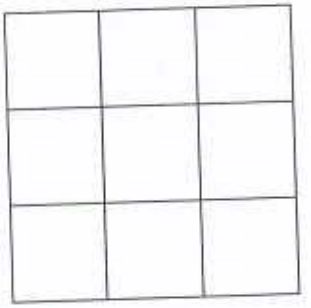
PP × Pp



_____% *PP*
_____% *Pp*
_____% *pp*
_____% purple flower
_____% white flower

d) Trait: Seed Shape
Round (*R*); Wrinkled (*r*)
rr* × *rr

rr × rr



_____% *RR*
_____% *Rr*
_____% *rr*
_____% round seed
_____% wrinkled seed

5. In humans, the allele for long eyelashes (*E*) is dominant and the allele for short eyelashes (*e*) is recessive. The mother is heterozygous and the father is homozygous recessive for the eyelash gene. Draw a Punnett square and use it to determine the possible genotypes and phenotypes of the children.

a) Genotypes:
_____% homozygous dominant (*EE*)
_____% heterozygous (*Ee*)
_____% homozygous recessive (*ee*)

b) Phenotypes:
_____% long eyelashes
_____% short eyelashes

6. Imagine that three pairs of trolls and their offspring are discovered on a remote island. Phenotypes of the parents and their offspring are shown in the table below.

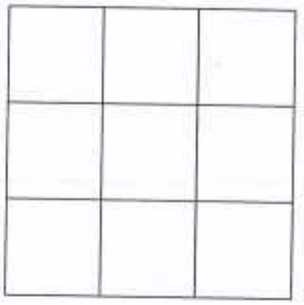
Pair	Male Troll Parent	Female Troll Parent	Troll Offspring
1	hairy toes	hairy toes	75% hairy toes 25% hairless toes
2	hairless toes	hairy toes	50% hairy toes 50% hairless toes
3	hairy toes	hairy toes	100% hairy toes

a) What is the dominant form of the gene?

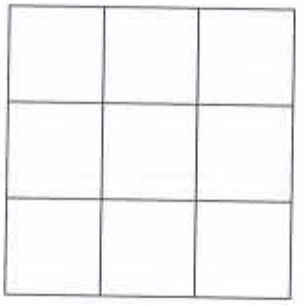
_____

b) Use the information from the table to draw a Punnett square for each of the troll pairs. Determine the genotypes of the troll parents.

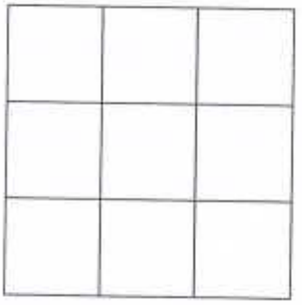
Pair 1



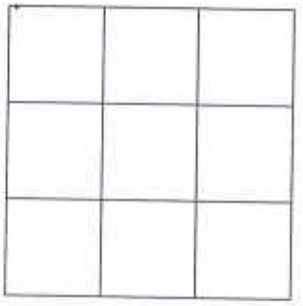
Pair 2



Pair 3



Pair 3



Genotypes of Pair 1: _____

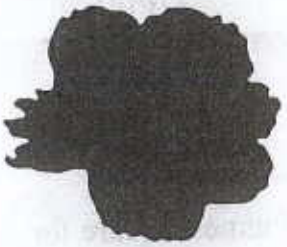
Genotypes of Pair 2: _____

Genotypes of Pair 3: _____

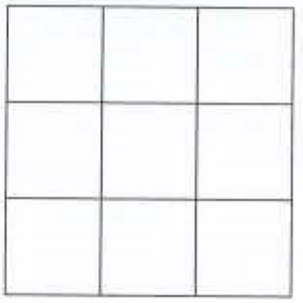
Codominance and Incomplete Dominance

Use with textbook pages 31–34.

1. Consider petal colour as the trait for flowers. The genotypes and phenotypes of the homozygotes are given. If both parents are true-breeding, predict the phenotype and genotype of the heterozygote for each of the following genetic conditions: complete dominance, incomplete dominance, and codominance.

Complete Dominance	 Genotype: *RR* Phenotype: red	 Genotype: _____ Phenotype: _____	 Genotype: *rr* Phenotype: white
Incomplete Dominance	 Genotype: F^RF^R Phenotype: red	 Genotype: _____ Phenotype: _____	 Genotype: F^WF^W Phenotype: white
Codominance	 Genotype: F^RF^R Phenotype: red	 Genotype: _____ Phenotype: _____	 Genotype: F^WF^W Phenotype: white

2. In cattle, roan coloration is the result of a mixture of red hair (H^R) and white hair (H^W). The codominant roan is produced by the presence of both red and white hairs in the coat of the cattle. If a roan bull mates with a roan cow, what are the probable genotypes and phenotypes of their offspring? It may be useful to complete a Punnett square.



a) Genotypes:

_____% H^RH^R

_____% H^RH^W

_____% H^WH^W

b) Phenotypes:

_____% red

_____% roan

_____% white

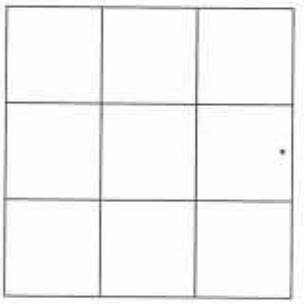
c) Genotypic Ratio: _____

d) Phenotypic Ratio: _____

e) If the roan cow and roan bull produce 12 offspring, how many of the offspring will be red, roan, and white in colour?

_____

3. Checkered feathers in chickens are a mixture of black feathers (F^B) and white feathers (F^W). If a rooster with black feathers mates with a hen with white feathers, what are the probable genotypes and phenotypes of their offspring? It may be useful to complete a Punnett square.



a) Genotypes:

_____% F^BF^B

_____% F^BF^W

_____% F^WF^W

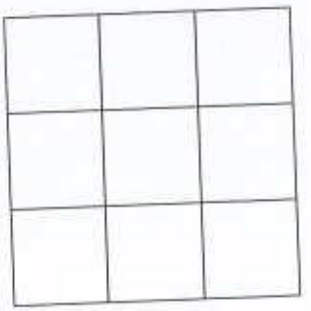
b) Phenotypes:

_____% black

_____% checkered

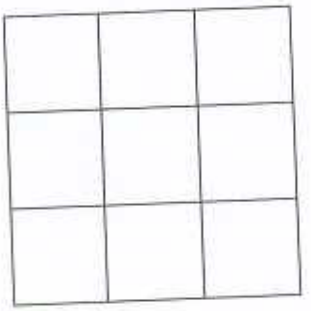
_____% white

4. What are the possible phenotypes of the children of a genetic female with Type AB blood and a genetic male with Type O blood? Give the probability of their children inheriting certain blood types. It may be useful to complete a Punnett square.



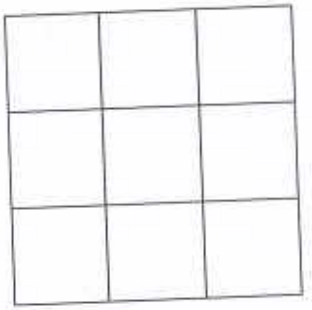
Phenotypes of children: _____

5. A genetic male who is a homozygote for Type A blood and a genetic female with Type O blood have a child. What is the probability that the child will have Type O blood? It may be useful to complete a Punnett square.



Probability of Type O blood: _____

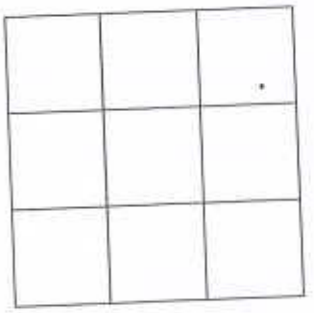
6. A genetic female with Type A blood and a genetic male with Type B blood have a daughter with Type O blood. What are the genotypes of the parents? It may be useful to complete a Punnett square.



Genotypes of the parents: _____

7. In four o'clock flowers, the alleles for flower colour express incomplete dominance.

   a) A red flower (F^R) is crossed with a white flower (F^W) and an intermediate pink flower results. What are the genotypes of the parents? It may be useful to complete a Punnett square.

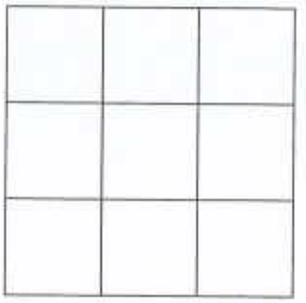


Genotypes of the parents: _____

b) What is the genotype of the pink flowers in the F_1 generation?

_____

c) Two pink flowers are then crossed. What are the possible genotypes and phenotypes of the offspring of the F_2 generation?



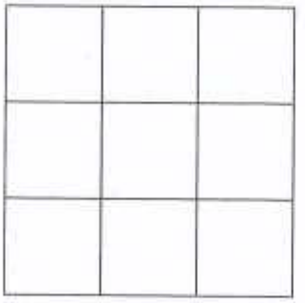
Genotypes of offspring in F_2 generation:

_____

Phenotypes of offspring in F_2 generation:

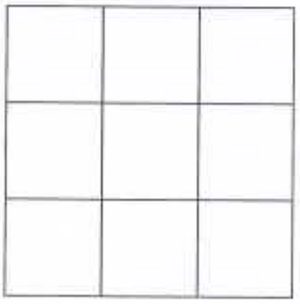
_____

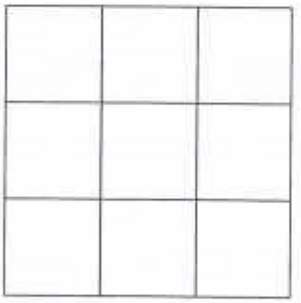
8. The alleles for hair colour in rabbits express incomplete dominance. If a black rabbit (H^B) mates with a white rabbit (H^W), an intermediate grey rabbit will result. What are possible genotypes of the offspring when a grey rabbit mates with a white rabbit? It may be useful to complete a Punnett square.



Possible genotypes: _____

9. Flower colour is determined by incomplete dominance in one species of flowers. A true-breeding red flower (F^R) is crossed with a true-breeding blue flower (F^B) to produce purple flowers. What two flowers could be crossed to result in a 50% chance of producing purple flowers? It may be useful to complete a Punnett square.





Cross 1: _____

Cross 2: _____

Sex-Linked Traits

Use with textbook page 36.

1. Define *sex-linked trait.*

_____

_____

2. Consider the X-linked trait hemophilia. What is the genotype for each of the following individuals?

a) a man with hemophilia _____

b) a woman with hemophilia _____

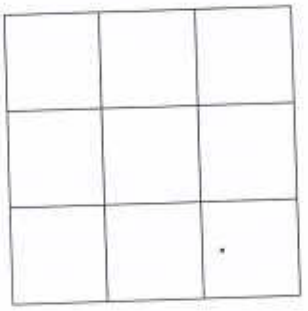
c) a man with normal blood clotting ability _____

d) a woman who is a carrier for hemophilia _____

e) a woman with normal blood clotting ability and who is not a carrier

_____

3. A woman who is a carrier for hemophilia marries a man with normal blood clotting ability. What are the possible genotypes and phenotypes of their children? It may be useful to complete a Punnett square.



a) Genotypes:

_____% X^HX^H

_____% X^HX^h

_____% X^hX^h

_____% X^HY

_____% X^hY

b) Phenotypes:

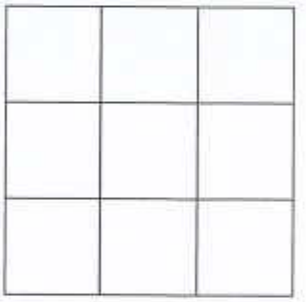
_____% hemophiliac

_____% normal blood clotting ability

4. Colour vision deficiency is a recessive X-linked trait. A woman who has normal vision and is not a carrier for vision deficiency marries a man who has colour vision deficiency. What is the probability that they will have a child who has colour vision deficiency? It may be useful to complete a Punnett square.

Probability of child with vision deficiency:

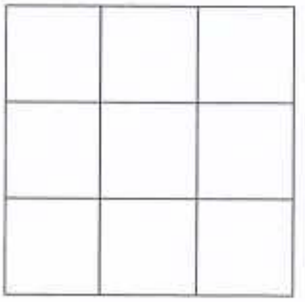
_____



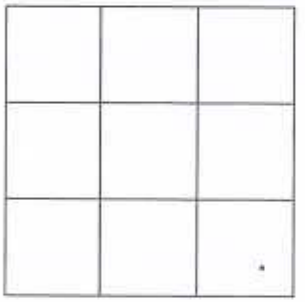
5. A woman with normal vision has a father who has colour vision deficiency. She marries a man with normal vision. What is the probability that they will have a child with colour vision deficiency? It may be useful to complete a Punnett square.

Probability of child with vision deficiency:

_____



6. Duchenne muscular dystrophy is a recessive X-linked condition. A mother and a father, neither of whom have the condition, have a daughter who is a carrier. It may be useful to complete a Punnett square.



a) What are the genotypes of the parents?

_____

b) What is the probability that their next child will have Duchenne muscular dystrophy?

_____