1 Unit Overview: DNA and Heredity

Name: _____

Teacher: _____

1.4 DNA and Heredity

1.4.1 DNA Fingerprinting: Study
1.4.2 DNA Fingerprinting: Lesson QUIZ Scoring: 20 points

1.5 Wrap-Up

1.5.2 DNA and Heredity: Unit Test Scoring: 50 points

Directions: Read each question and answer choice carefully. Choose the ONE best answer and record your answers using CAPITAL letters only.

Lesson Quiz 1.4.1

1. _____
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10. _____

(Score: _____ out of 20)

UNIT TEST 1.5.2

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(Score: _____ out of 50)

Instructions:
Students please *annotate, by highlighting or underlining*, words or sentences in the Study sections to show that you have read and studied the study sections prior to taking the quizzes.

Lesson 1.4 DNA and Heredity
Doing Science: DNA and Heredity

Can you actually see a person's DNA without a microscope? You can, using a method called DNA fingerprinting. In this lesson, you will learn how DNA fingerprinting can be used to identify a person, solve crimes, and even trace your family history.

You'll get a chance to examine some DNA fingerprints and draw your own conclusions about who committed a crime and which two people are identical twins. You'll also learn how to identify the sex of a person by looking at his or her chromosomes.

Objectives:

- Describe the level of similarity among all human DNA.
- Differentiate between technologies and methods used in DNA fingerprinting.
- Read DNA fingerprints.
- Use a karyotype to determine sex.

1.4.1 Study: DNA and Fingerprinting

DNA Fingerprinting **How similar are you and your friends?**

You and your friends may like the same music, have the same hobbies, and share opinions on a variety of topics, but how similar are your DNA?

Human DNA Similarity

Every human's DNA is 99.9% the same as every other human's DNA.

A DNA molecule

You and your friends are incredibly similar, genetically speaking. 99.9% of your DNA, or your genome, is the same as theirs! But wait a second . . . If your DNA is so similar, how is it that your friends don't look almost exactly like you? The 0.1% difference in DNA may seem small, but it represents 3 billion pairs of nucleotide bases that are different. Those 3 billion base pairs can explain all the differences in people's traits, such as height, skin color, and hair texture. The DNA differences among people are useful to scientists studying the human genome. The differences can also be useful to society.

DNA Fingerprinting

DNA fingerprinting is useful at crime scenes, in tracing family history, and in medicine.

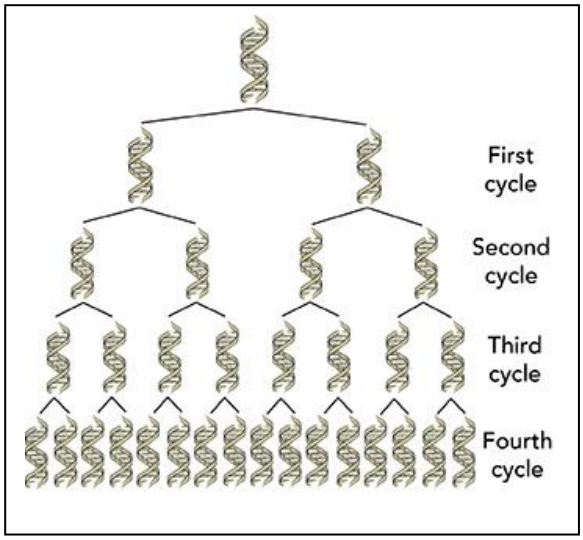
DNA fingerprinting can be used to help you learn more about your ethnicity and family history.
A technology called DNA fingerprinting is used to look at unique patterns in a person's DNA. In forensic science, DNA fingerprinting can help identify the victim at a crime scene, identify a person who has committed a crime, or clear the name of an innocent person who was accused of a crime.
DNA fingerprinting can also help determine individuals' family heritage, including who their parents are, as well as their ethnicity, or where their ancestors are from.
In medicine, DNA fingerprinting is used more and more commonly to help provide medical treatment that is as specific as possible to a patient's needs. One important use of DNA fingerprinting in medicine is to identify a good match for organ donation.

DNA Samples

DNA samples can come from a variety of sources.
The first step in DNA fingerprinting is getting a DNA sample. What do you think can be used as a DNA sample?

PCR

Polymerase chain reaction (PCR) is used to make a small DNA sample much bigger.



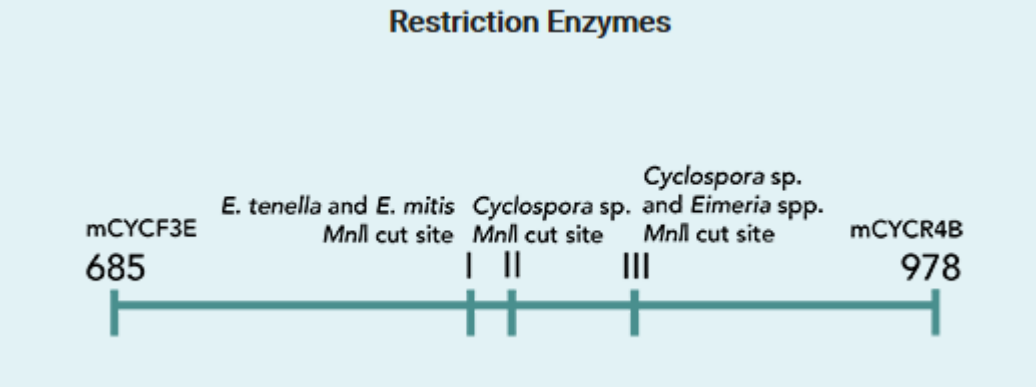
PCR is done many times, doubling the number of copies of a DNA sample in each cycle.

Once you have a DNA sample, it must be purified to remove matter other than DNA. Because the amount of DNA is often very small, scientists want to replicate the sample many, many times so they have enough DNA to study. The process they use to replicate DNA is called polymerase chain reaction (PCR). PCR makes the DNA sample much larger without changing or harming it.

Restriction Enzymes

Restriction enzymes cut DNA.

After the DNA sample is made larger using PCR, scientists use restriction enzymes to cut the DNA into fragments, or bands, of varying size. The fragments of each person's DNA are unique, allowing scientists to make a DNA "fingerprint" that can identify an individual. Each restriction enzyme recognizes a specific region of DNA and cuts the DNA at that point. Answer the questions to learn more about restriction enzymes

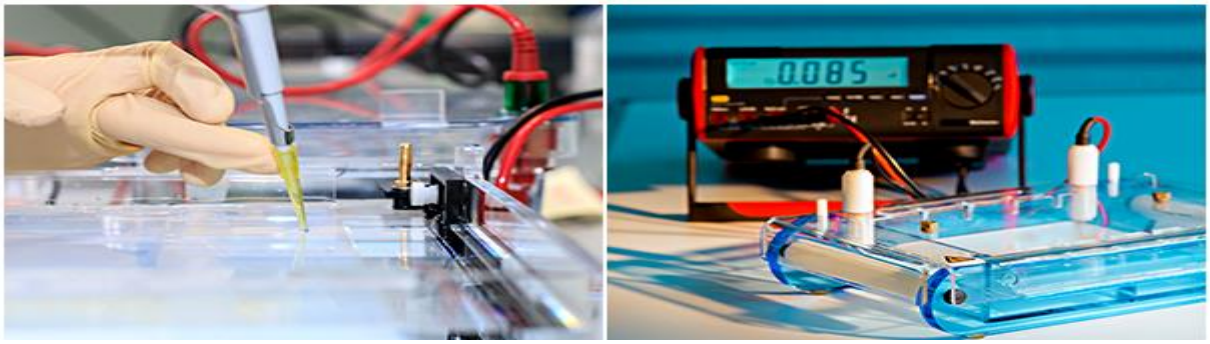


Gel Electrophoresis

Gel electrophoresis is used to examine DNA from a sample.

Once DNA has been cut by restriction enzymes, samples can be analyzed using gel electrophoresis. Samples are loaded into little wells in a gelatin-like material. Then electricity is used to pull the DNA samples through the gel. Electricity can move the DNA because DNA molecules naturally have a negative charge.

On the left, you can see a scientist putting a DNA sample into a gel. On the right, you can see the gel hooked up to a source of electricity. Each portion of DNA in the sample will travel a certain distance through the gel, and that distance depends on its mass.



Looking at DNA Fingerprints

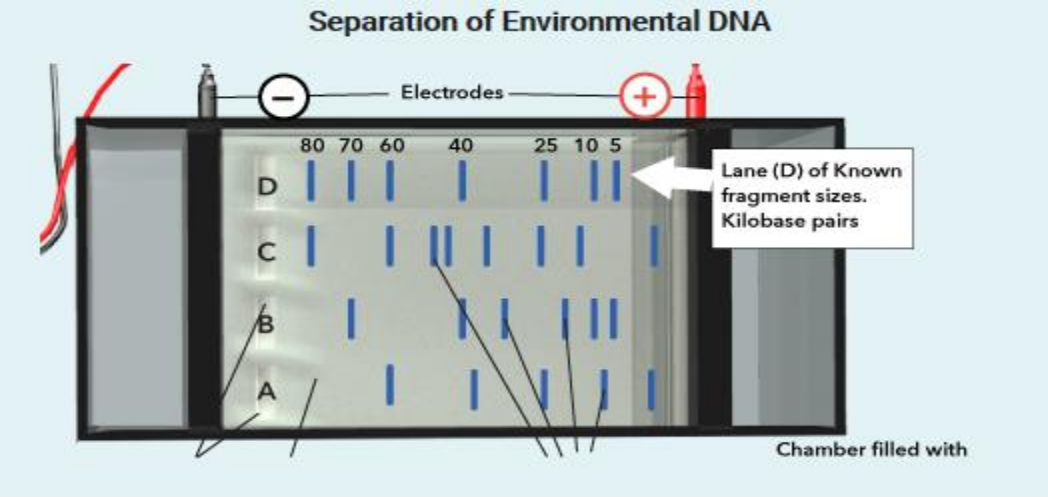
A DNA fingerprint is an image of a gel electrophoresis result.

After gel electrophoresis, imaging techniques are used to preserve a picture of all the DNA fragments. The images allow fragments from different samples to be compared.

Karyotypes

A karyotype is a picture of all a person's chromosomes.

DNA fingerprinting is not the only DNA-based technology. Scientists sometimes look at all a person's chromosomes in an image called a karyotype. A karyotype shows some types of diseases or disorders, as well as a person's biological sex.



During the process of gel electrophoresis, fragments of negatively charged DNA are placed in wells at the negative end of the gel bed. The fragments of DNA are then pulled toward the positive end of the bed. Why do some DNA fragments travel farther than others?

Karyotypes

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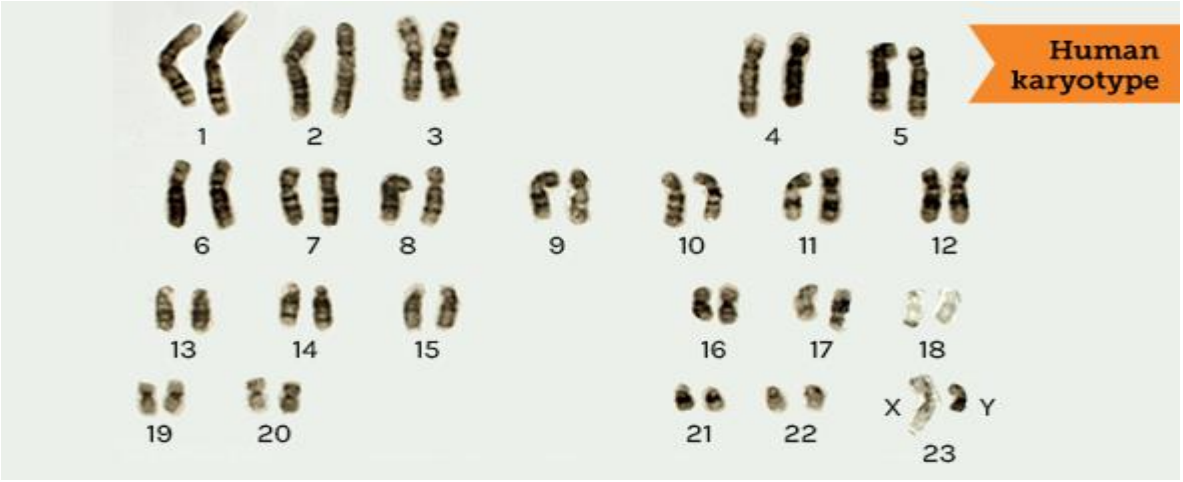
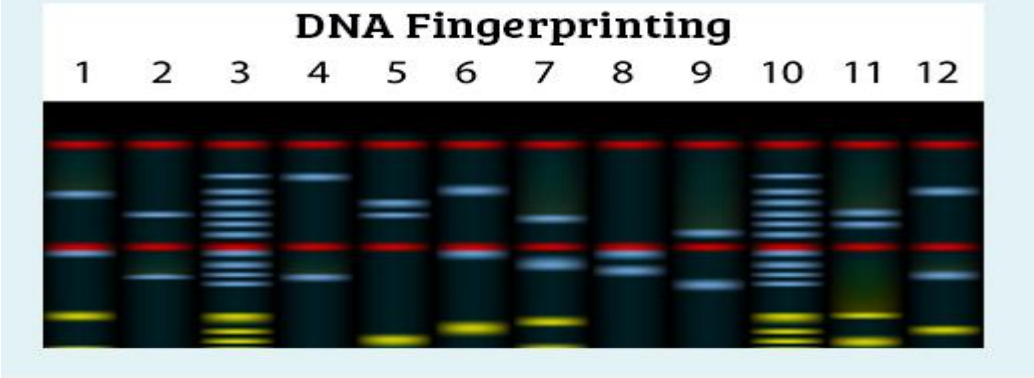


Karyotypes and Sex

A karyotype shows X and Y chromosomes.

The X and Y chromosomes
The X chromosome and Y chromosome can be seen on a karyotype. The X chromosome is noticeably larger than the Y chromosome.
The combination of sex chromosomes determines a person's biological sex.



How can DNA fingerprinting be used in forensic science?

DNA Fingerprinting

You've learned that DNA fingerprinting can be used to identify someone who has committed a crime or free someone who hasn't, to determine someone's family heritage, or to help give patients more precise medical treatments. In the DNA Fingerprinting Lab, you will get a chance to examine DNA fingerprints and look for matches. A match of two DNA fingerprints means that the two samples came from either the same person or identical twins.

Main Idea 1: All human DNA is very similar.

Similarity of Human DNA

How similar is the DNA of any two humans? (pg. 2)	How similar are the DNA fingerprints of identical twins? (pg. 14)
99.9% similar	100% similar

Main Idea 2: DNA fingerprinting technology is useful in many fields.

Uses of DNA fingerprinting

How is DNA fingerprinting used in forensics? (pg. 3)

It can be used to identify a victim, identify a suspect, or clear the name of an innocent person who is accused of a crime.

How is DNA fingerprinting used in medicine? (pg. 3)

It can be used to provide more individualized care and treatments.

How is DNA fingerprinting used to help people learn more about their families? (pg. 3)

It can be used to learn more about someone's ethnicity or to identify the parents of a child.

Main Idea 3: DNA fingerprinting involves several lab techniques.

Steps in DNA fingerprinting

STEP 1: Get a DNA sample.

Where can a DNA sample come from? (pg. 4)

Anything containing cells: blood, body fluids, hair, or even nails.

STEP 2: Perform polymerase chain reaction (PCR).

Explain what PCR does. (pg. 6)

PCR makes many copies of a sample of DNA.

STEP 3: Use restriction enzymes.

Explain what restriction enzymes do. (pg. 7)

Restriction enzymes cut DNA at specific sites, resulting in DNA fragments.

STEP 4: Perform gel electrophoresis.

Explain what gel electrophoresis does. (pg. 8)

Gel electrophoresis separates DNA fragments based on mass so they can be visualized.

Main Idea 4: DNA fingerprints can show whether two samples come from the same individual. A karyotype can be used to identify biological sex.

Using DNA Technology

How can you tell whether two DNA fingerprints come from the same individual? (pg. 10, 14)

If the pattern of lines on a DNA fingerprint is exactly the same for two samples, then they most likely come from the same individual.

What is a karyotype? (pg. 11)

An image showing all of a person's chromosomes. It can be used to determine biological sex.

Which sex would each of the following combinations of sex chromosomes indicate? (pg. 11–12)

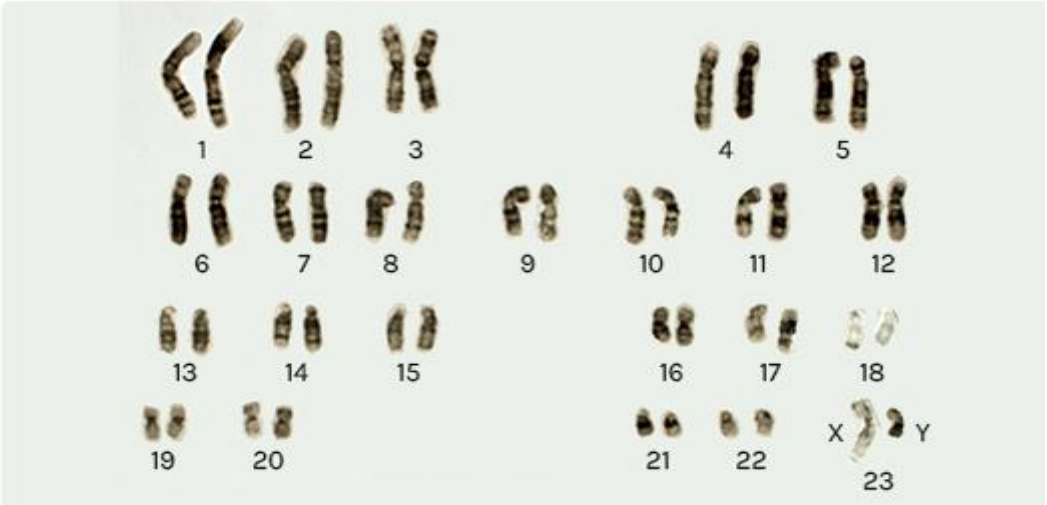
XX: Female
XY: Male

1.4.2 Lesson QUIZ: DNA and Fingerprinting (20 POINTS)

To receive credit, you must record your answers on the first page using CAPITAL LETTERS.

1.

What process is shown *most* directly in the diagram below?



- ○ **A.** Polymerase chain reaction (PCR)
- ○ **B.** Use of restriction enzymes
- ○ **C.** Karyotyping
- ○ **D.** Gel electrophoresis

2.

A scientist uses materials in her lab to separate DNA fragments by size. What process is she using?

- **A.** Karyotyping
- **B.** Use of restriction enzymes
- **C.** Polymerase chain reaction (PCR)
- **D.** Gel electrophoresis

3.

Imagine you are a detective examining a crime scene. You are trying to identify the person who committed the crime, so you collect many samples at the crime scene. Which sample would be *most* useful in identifying the person who committed the crime?

- **A.** Drops of blood found at the crime scene
- **B.** Plants growing at the crime scene
- **C.** A watch and keys found at the crime scene
- **D.** Pieces of flooring from the crime scene

4.

What do restriction enzymes do?

- **A.** They separate DNA fragments so they can be seen.
- **B.** They make one DNA sample into many copies.
- **C.** They cut strands of DNA at specific sites.
- **D.** They illustrate which chromosomes are present.

5.

A scientist wants to make a DNA fingerprint, and she has used polymerase chain reaction (PCR) and restriction enzymes. What should her next step be?

- **A.** Obtain a sample.
- **B.** Use imaging techniques.
- **C.** Run gel electrophoresis.
- **D.** Make a karyotype.

6.

Mark has a friend named Chloe. How different are Mark's and Chloe's DNA?

- **A.** 0.1% different
- **B.** 1% different
- **C.** 100% different
- **D.** 99.9% different

7.

A scientist uses materials in her lab to turn one piece of DNA into 100 copies of the same piece. What process is the scientist using?

- **A.** Use of restriction enzymes
- **B.** Polymerase chain reaction (PCR)
- **C.** Gel electrophoresis
- **D.** Karyotyping

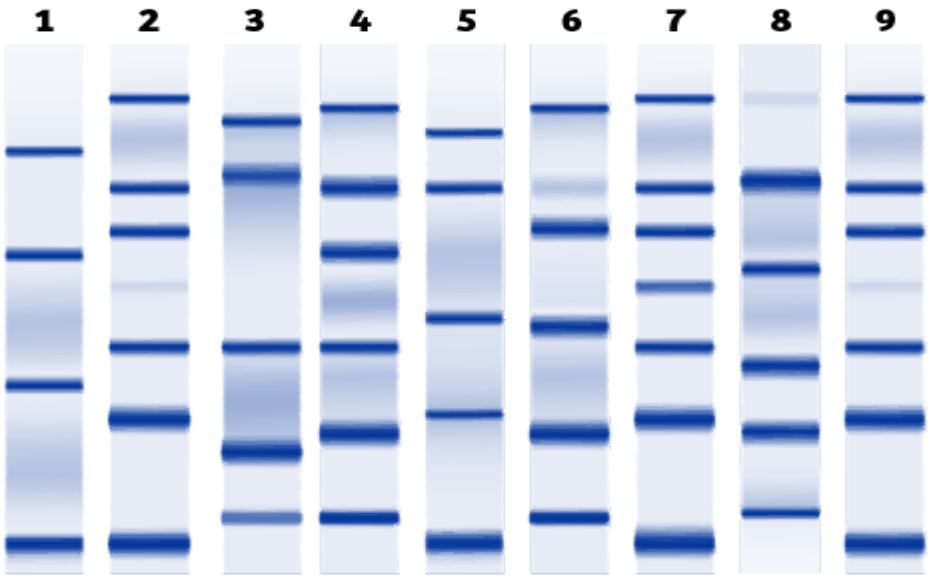
8.

What combination of sex chromosomes is shown in the image?

- **A.** XXY
- **B.** XY
- **C.** YY
- **D.** XX

9.

Imagine you do DNA fingerprinting in a forensics lab. You obtain nine samples from a crime scene and use them to make the DNA fingerprints shown below. Which two samples are *most* likely to have come from the same person?



- **A.** 2 and 7
- **B.** 7 and 9
- **C.** No two samples came from the same person.
- **D.** 2 and 9

10.

Why can gel electrophoresis separate DNA fragments?

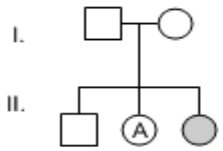
- **A.** DNA fragments are magnetic.
- **B.** DNA fragments are negatively charged.
- **C.** DNA fragments are all the same size.
- **D.** DNA fragments are positively charged.

1.5.2 UNIT TEST: DNA and Fingerprinting (50 POINTS)

To receive credit, you must record your answers on the first page (Use Capital Letters).

1.

In the family tree below, people with the recessive trait of attached earlobes are shaded gray.



What must be true about the person labeled "A"?

- **A.** It is a male with two dominant alleles.
- **B.** It is a female with two dominant alleles.
- **C.** It is a female with at least one dominant allele.
- **D.** It is a male with at least one dominant allele.

2.

Which best describes the daughter cells produced by mitosis?

- **A.** They are identical to the cell they formed from.
- **B.** They are haploid cells.
- **C.** They have no organelles.
- **D.** They cannot function with the help of the parent cell.

3.

Why does sexual reproduction result in more genetic variation in a species than asexual reproduction?

- **A.** In sexual reproduction, offspring are haploid organisms.
- **B.** In sexual reproduction, offspring are not identical to either parent.
- **C.** In sexual reproduction, offspring have more chromosomes than either parent.
- **D.** In sexual reproduction, offspring have fewer genes.

4.

Scientists compare two different plant species. In species A, the leaf color is controlled by two alleles. In species B, leaf color is controlled by five alleles. How will these two plants be different?

- **A.** Species B will have a wider range of leaf colors.
- **B.** Species A will have a wider range of genotypes
- **C.** Species B will have more offspring.
- **D.** Species A will have a wider range of phenotypes.

5.

What happens during interphase?

- **A.** The cell prepares for mitosis.
- **B.** The sister chromatids separate.
- **C.** The gametes form.
- **D.** The cell splits apart.

6.

One trait a plant can have is either red leaves (*R*) or brown leaves (*r*). Another trait is tall stems (*T*) or short stems (*t*). A plant used in a dihybrid cross has the genotype *RRTt*. What is the phenotype of this plant?

- **A.** Brown leaves, tall stems
- **B.** Red leaves, short stems
- **C.** Red leaves, tall stems
- **D.** Brown leaves, short stems

7.

A plant can have either brown (*B*) or red (*b*) leaves. Brown is the dominant trait. If a plant has genotype *BB*, which best describes the plant?

- **A.** Heterozygous with brown leaves
- **B.** Heterozygous with red leaves
- **C.** Homozygous with brown leaves
- **D.** Homozygous with red leaves

8.

Which best describes the sex chromosomes in humans?

- **A.** Males have two X chromosomes.
- **B.** Males have two Y chromosomes.
- **C.** Males have one X and one Y chromosome.
- **D.** Females have two Y chromosomes

9.

Which is a non-Mendelian trait?

- **A.** A trait controlled by many genes
- **B.** A trait controlled by one gene
- **C.** A trait with two alleles
- **D.** A trait with a clearly dominant form

10.

What is the term for a female reproductive cell?

- **A.** Chromatid
- **B.** Egg
- **C.** Fertilization
- **D.** Allele

11.

How are tumor cells different from normal cells?

- **A.** Tumor cells multiply too quickly.
- **B.** Tumor cells are prokaryotes.
- **C.** Tumor cells have no nucleus.
- **D.** Tumor cells are smaller.

12.

What evidence did Mendel find that supported his law of independent assortment?

- **A.** One trait does not affect whether another trait will be passed on.
- **B.** Most traits have a dominant form and a recessive form.
- **C.** Some traits are controlled by a combination of several genes.
- **D.** Recessive traits only appear when the offspring has two recessive alleles.

13.

In a certain cat, long whiskers (*W*) are dominant and short whiskers (*w*) are recessive. Two cats have genotypes *Ww* and *ww*. If they have an offspring with short whiskers, what is the genotype of their offspring?

- **A.** *Ww*
- **B.** *WW*
- **C.** *wW*
- **D.** *ww*

14.

An organism that reproduces sexually has a diploid number of 30. How many chromosomes will a gamete of this organism have?

- **A.** 30
- **B.** 45
- **C.** 10
- **D.** 15

15.

A cactus can either have long needles (*L*) or short needles (*l*). A cactus grower crosses two cacti. The cross is shown in the Punnett square below.

	L	l
L	LL	Ll
l	Ll	ll

What is the phenotype ratio for this cross?

- **A.** One long, three short
- **B.** Three long, one short
- **C.** Four long, zero short
- **D.** Two long, two short

16.

How are mitosis and meiosis similar?

- **A.** They both produce new cells.
- **B.** They both make new cell walls.
- **C.** They both reduce the chromosome number.
- **D.** They both produce reproductive cells.

17.

The table below shows the number of chromosome pairs for various organisms.

Organism	Number of Chromosome Pairs
Elephant	28
Ferret	20
Giraffe	31
Gorilla	24

Which organism can produce the highest number of genetically different gametes?

- **A.** Giraffe
- **B.** Gorilla
- **C.** Ferret
- **D.** Elephant

18.

What was the purpose of Mendel's experiments with dihybrid crosses?

- **A.** To find out if pea plants had traits with more than two alleles
- **B.** To find out if traits could affect the inheritance of other traits
- **C.** To find out if animals produced haploid cells or diploid cells
- **D.** To find out if recessive traits could be passed to offspring

19.

Albinism is a recessive trait in humans that is controlled by a single gene. How many recessive alleles must a person have to have albinism?

- **A.** 1
- **B.** 2
- **C.** 3
- **D.** 0

20.

What happens directly after prophase?

- **A.** Telophase
- **B.** Interphase
- **C.** Metaphase
- **D.** Anaphase

21.

A plant can have either broad leaves (*B*) or narrow leaves (*b*). A plant with genotype *BB* is crossed with a plant with genotype *Bb*. Which Punnett square correctly represents this cross?

A.

	B	b
B	Bb	Bb
b	Bb	Bb

B.

	B	b
B	BB	Bb
B	BB	Bb

C.

	b	b
B	Bb	Bb
b	bb	bb

D.

	B	b
B	Bb	Bb
B	Bb	Bb

22.
What is produced by meiosis?

- **A.** Chromatids
- **B.** Centromeres
- **C.** Gametes
- **D.** Spindles

23.
Which best summarizes the findings of Hershey and Chase?

- **A.** DNA carries genetic material.
- **B.** All alleles are heterozygous.
- **C.** Humans reproduce sexually.
- **D.** Traits cannot be inherited.

24.
Which best describes a gene?

- **A.** A sister chromatid
- **B.** A tetrad
- **C.** A chromosome
- **D.** A piece of a chromosome

25.
Why did Mendel use pea plants in his experiments?

- **A.** They produce many offspring.
- **B.** They are all male.
- **C.** They are haploid organisms.
- **D.** They have no dominant traits.

Next Week
February 1-5:
Lesson 2.1
Lesson 2.2

-END-