NTI

Non-Traditional Instruction

Science

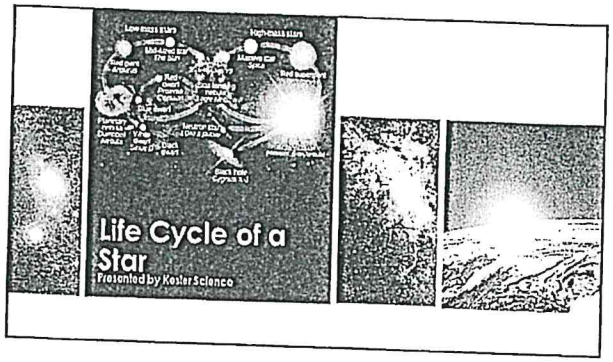
Days 11-20

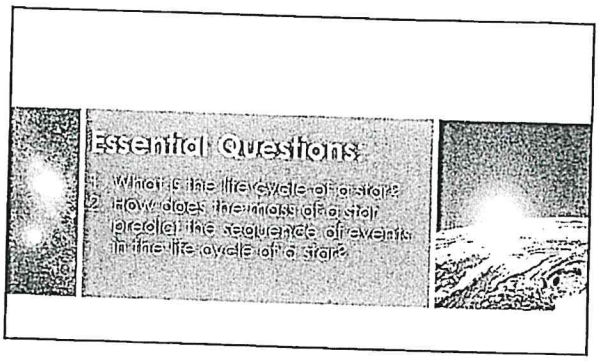
**Work will be modified according to each student's IEP or 504 plan

11

Day 1: Take all notes from PowerPoint using any strategy you like

Slusher 3/17/20

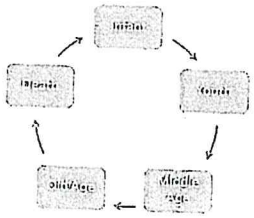


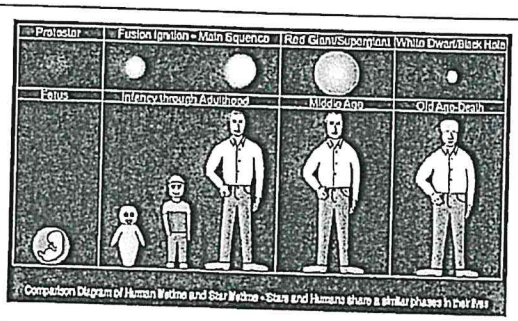


Life Cycle of a Star Vocabulary

Life cycle of a star

The sequence of changes that occur in a star as it ages.

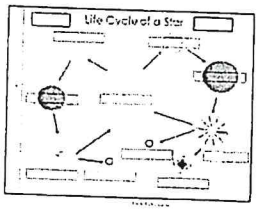




Quick Action – INB Templates

Life Cycle of a Star

1. Cut out the Life Cycle of a Star template.
2. Glue it into your journal.

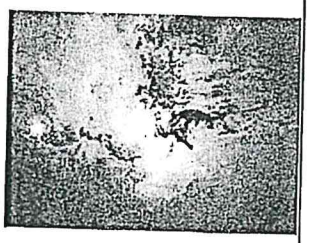


Life Cycle of a Star Vocabulary

Where do stars come from?

Interstellar medium

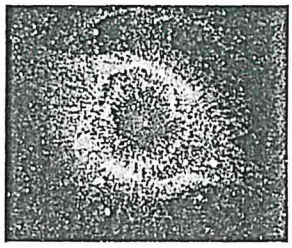
- A thinly spread area of gas and dust
- The gas is mostly hydrogen (H_2)
- The dust is mostly carbon (C) and silicon (Si)



Life Cycle of a Star Vocabulary

Nebula

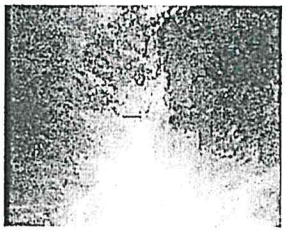
- Interstellar medium begins to collect into big clouds.
- The birthplace of stars, as stars are made up of gas and dust.
- "Star Nursery"



Life Cycle of a Star Vocabulary

Protostar

- Inside the nebula are regions of greater and less gravity causing the gas and dust to pull together.
- As more atoms gather, their gravitational attraction increases.
- Not a very stable phase because many reactions are occurring within the protostar.



Life Cycle of a Star Vocabulary

Equilibrium

- A battle between gravity and gas pressure
- Reactions within life cycle phases where gravity and gas pressure are constantly changing.
- Equilibrium is reached when both are equal.

Life Cycle of a Star Vocabulary

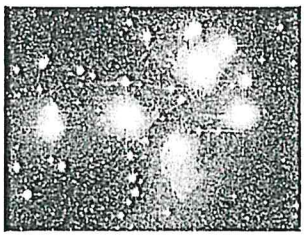
A Star is Born –

- when a critical temperature in the core of the protostar is reached and nuclear fusion begins.
- Hydrogen (H_2) begins fusing into helium (He).

Life Cycle of a Star Vocabulary

Star

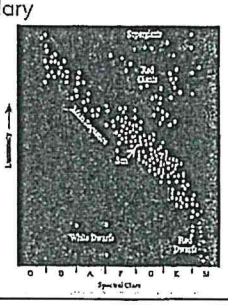
- An extremely hot ball of gas, with hydrogen (H_2) fusing into helium(He)at its core.
- Spend most of their lives fusing hydrogen
- When the hydrogen is used up, stars fuse helium to carbon
- They are always trying to achieve equilibrium



Life Cycle of a Star Vocabulary

Main Sequence

- Stars live out most of their lives in this phase.
- Stars have achieved nuclear fusion.
- Stars stays at equilibrium.
- Stars radiate (shine) energy into space.



Life Cycle of a Star Vocabulary

Low Mass Stars in Main Sequence

The mass of a star determines what happens to it after living most of its life in Main Sequence.

Life Cycle of a Star Vocabulary

Low mass stars –

- Very low mass stars such as red dwarfs, are half as massive as the Sun
- Can live 80 to 100 **billion** years in Main Sequence.

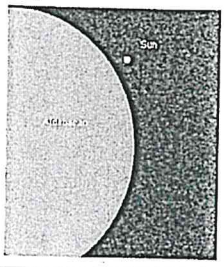
Our Sun –

- A medium sized, low mass star
- Spends about 10 billion years in Main Sequence.
- A Main Sequence star for about 4.57 billion years.

Life Cycle of a Star Vocabulary

Red Giant

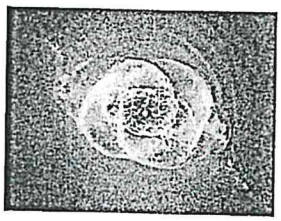
- Phase after Main Sequence
- Low and high mass Main Sequence stars progress to Red Giants.
- Outer gas layers of the star expand
- As the star uses all its fuel its core shrinks.
- Red in color
- High luminosity



Life Cycle of a Star Vocabulary

Planetary nebula

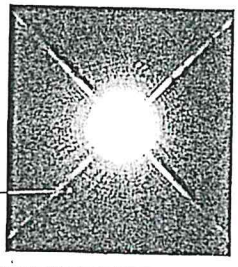
- Occurs at the end of a low mass Red Giant's life.
- The outer layers of the star are expelled.
- The core is very hot and luminous.
- The outer shell appears as bright colored gas clouds.



Life Cycle of a Star Vocabulary

White Dwarf

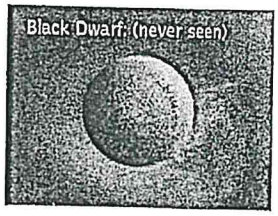
- Forms when a low mass star runs out of fuel.
- The core of a planetary nebula
- Final stage in the cycle for low mass stars
- Incredibly dense
- Gravity is 350,000 times that of gravity on Earth.
- Will change colors as it cools



Life Cycle of a Star Vocabulary

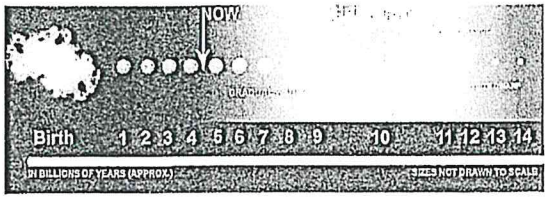
Black Dwarf

- End product of a White Dwarf
- The last stage of stellar evolution for low mass stars
- No longer emits heat or light
- No longer a star

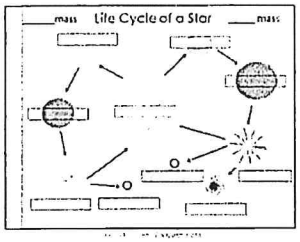


Life Cycle of a Star Vocabulary

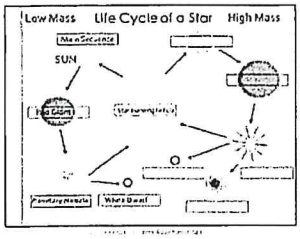
LIFE CYCLE OF THE SUN



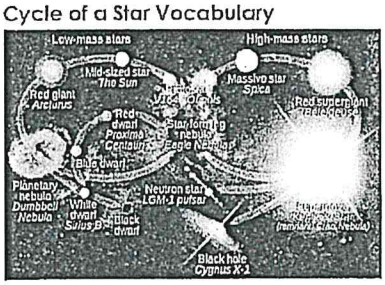
Quick Action – Life Cycle of a Star



Quick Action – Life Cycle of a Star



Life Cycle of a Star Vocabulary



Life Cycle of a Star Vocabulary

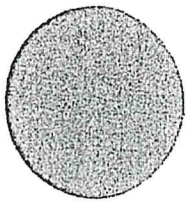
High Mass Main Sequence

The mass of a star determines what happens to it after living most of its life in Main Sequence.

Life Cycle of a Star Vocabulary

High Mass stars -

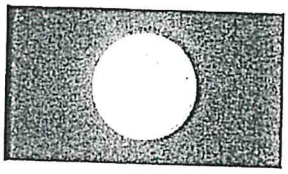
- 10 times as massive as our Sun
- Remains in Main Sequence for about 20 **million** years.



Life Cycle of a Star Vocabulary

Red Super Giants

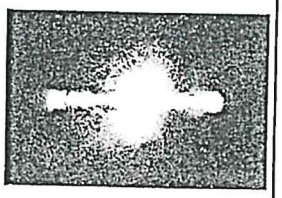
- The same thing as a giant star only much bigger.
- As a star gets older it begins to run out of fuel and expand.



Life Cycle of a Star Vocabulary

Supernova

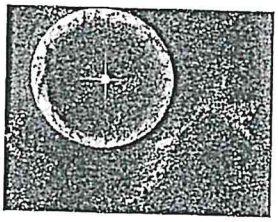
- Last stage of a massive star's life
- Occurs as the star runs out of nuclear fuel, some of its mass flows into its core.
- Core becomes so heavy that it cannot withstand its own gravitational force.
- The core collapses and results in a giant explosion.



Life Cycle of a Star Vocabulary

Neutron Star

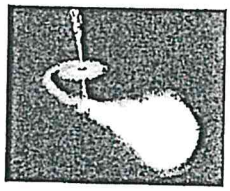
- The core left behind in a supernova
- Very dense - 1Tsp. = 1billion tons
- Gravity is 2 billion times that of the gravity on Earth.
- Gravity presses the material in on itself so tightly that protons and electrons combine to make neutrons, yielding the name "neutron star".



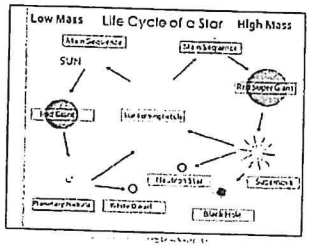
Life Cycle of a Star Vocabulary

Black Hole

- Forms when very massive stars collapse at the end of their life cycle
- A large area in space with a very strong gravitational pull
- Nothing can escape, even light.



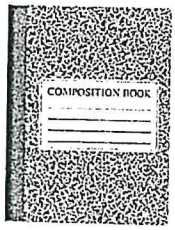
Quick Action – Life Cycle of a Star



Quick Action – Life Cycle of a Star

Journal Activity

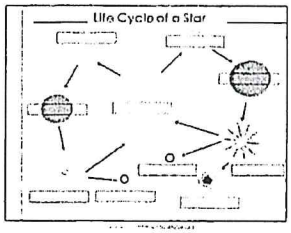
- In your INB write a passage that compares the human life cycle to the life cycle of a star.
- Provide as much detail as possible.



Check for Understanding

Can you...

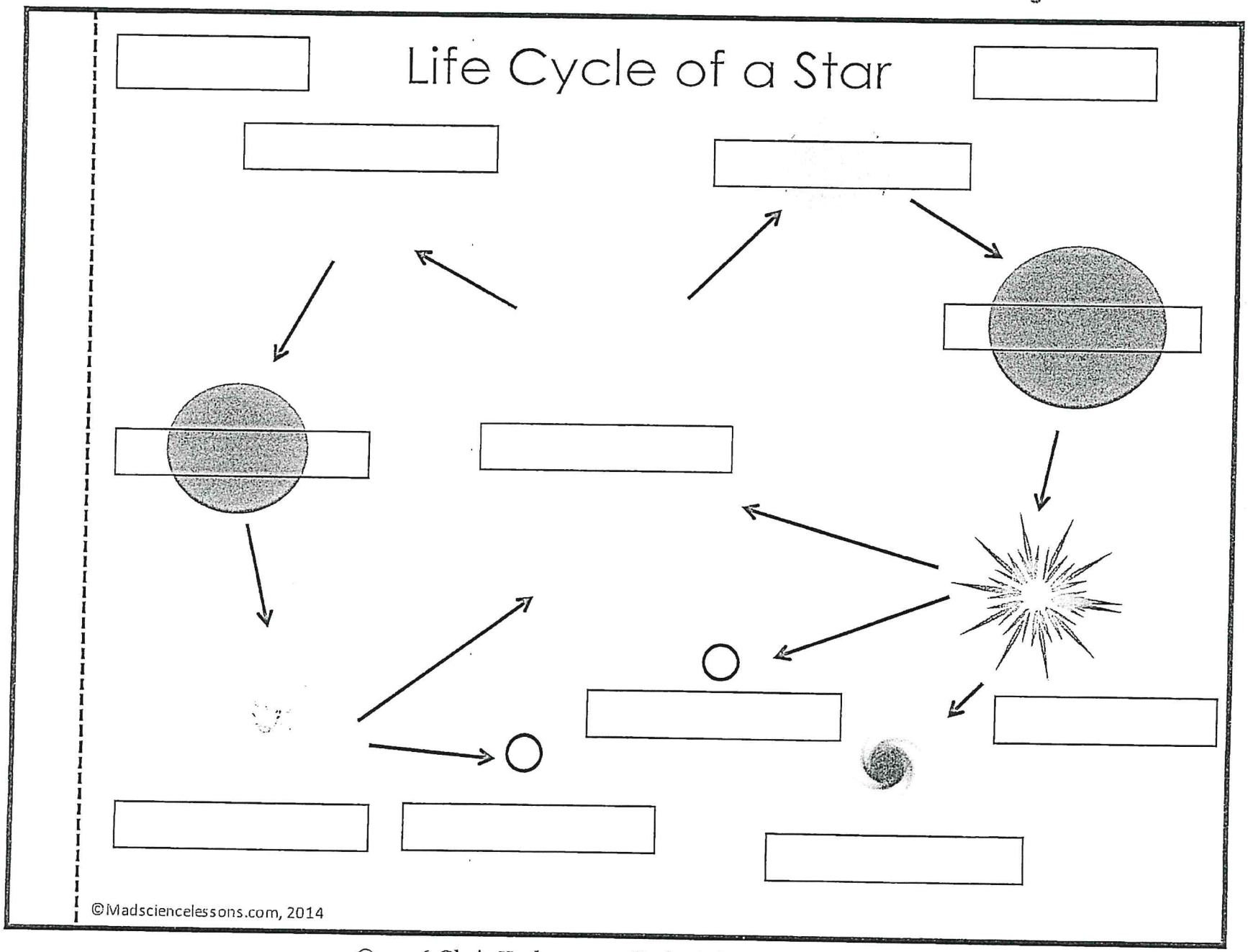
1. Describe why a star goes through a cycle?
2. Predict what stages a low mass star will pass through in its lifetime?
3. Label a blank Life Cycle of a Star diagram?



12

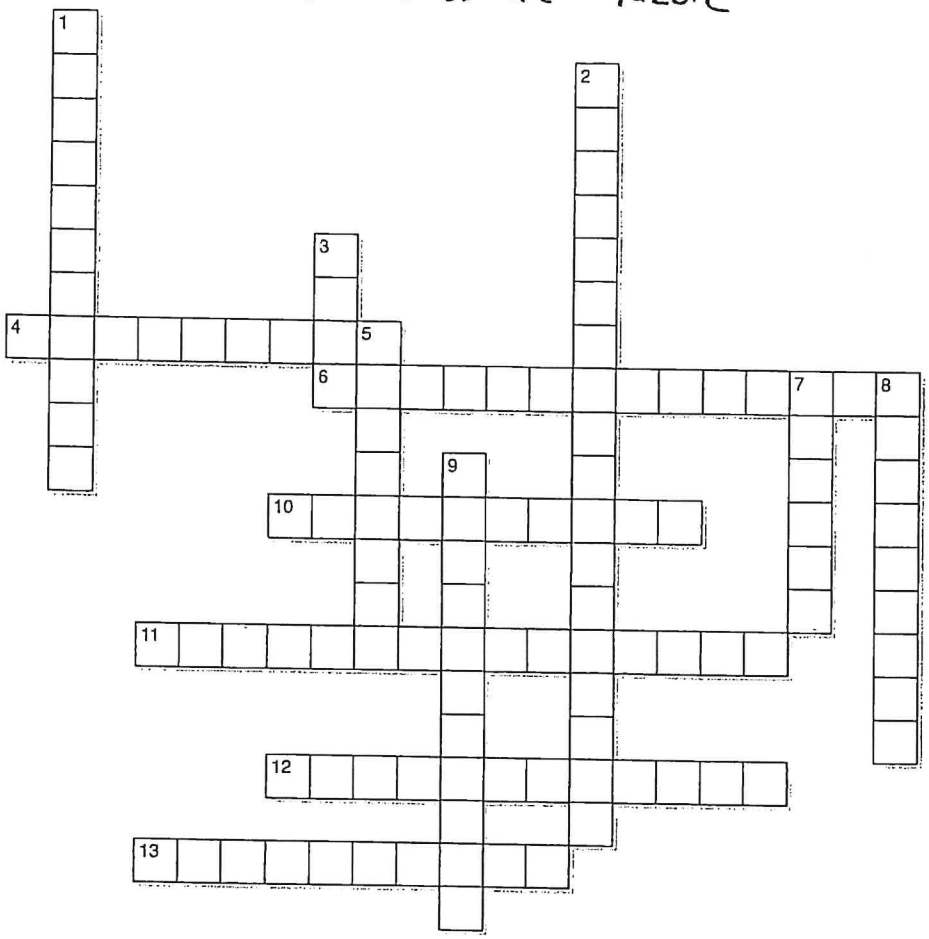
Day 8: using the notes & pics Complete star life cycle

Life Cycle of a Star



Life Cycle of a Star Day #13 Name _____

finish Crossword Puzzle



Across

4. a contracting of gas that represents an early stage in the formation of a star
6. a high mass, giant star that has consumed its core's supply of hydrogen fuel
10. when a low-mass star has exhausted all its central nuclear fuel and lost its outer layers
11. a ring-shaped nebula formed by expanding shell of gas around an aging star. Planets are formed here.
12. Most stars in the universe are this type of star
13. a theoretical star remnant; a cooled white dwarf that no longer emits significant light or heat

Down

1. a state of physical balance
2. the matter that exists in the space between the star systems in the galaxy
3. a fixed luminous point in the night sky that is a large, remote incandescent body
5. a very large high luminosity star and low surface temperature
7. where stars are born. "star nursery"
8. a star that suddenly increases greatly in brightness because of a catastrophic explosion that ejects most of its mass
9. Highly dense star predominantly of closely packed neutrons

Day 14 #1 Finish using Notes. Front for grade, back for extra credit

Life Cycle of a Star Assessment Name _____

1. How does the life cycle of humans compare to the life cycle of a star?

_____

_____

_____

_____

_____

2. _____ _____is thinly spread hydrogen gas and carbon and silicon dust.
3. _____ are known as the birthplace of stars.
4. A protostar develops in a nebula as _____ causes the gas and dust to pull together.
5. A star is born when nuclear fusion begins. In this process _____ fuses into _____.
6. What is a star?

_____

_____

_____

_____

7. Stars live most of their lifetime in this phase. _____
8. The _____ of a star determines what happens to it after living out most of its life.
9. The _____ is a medium sized star and will live about 10 billion years in Main Sequence.
10. Explain why low mass stars will live longer than high mass stars.

_____

_____

_____

_____

Life Cycle of a Star Assessment Name _____

11. Our Sun's next phase will be _____ _____.

12. During the Sun's next phase its outer layers will _____ and cool changing from a yellow star to a _____ star.

13. A _____ _____ forms as a Red Giant's life ends.

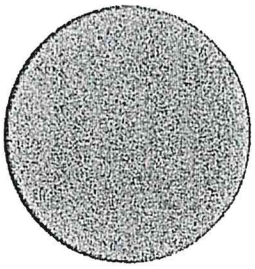
14. This phase of a stars life forms when the star has run out of fuel and is the final stage in the cycle for a low mass star. _____ _____

15. High mass stars end their life in a huge explosion called a _____.

16. The core or _____ _____ left behind in this explosion is very dense with gravity 2 billion times that of Earth.

17. The last stage of stellar evolution in high mass stars is a _____ _____.

In the diagram below label the phases in the life cycle of a low mass star.



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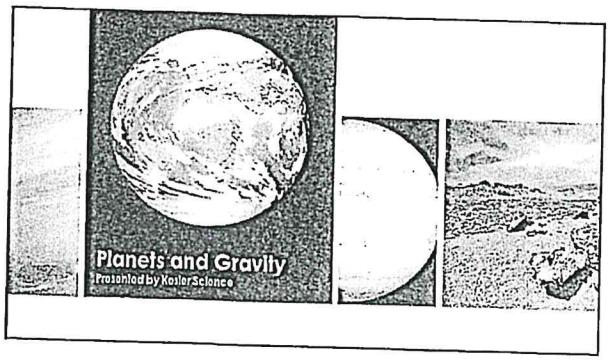
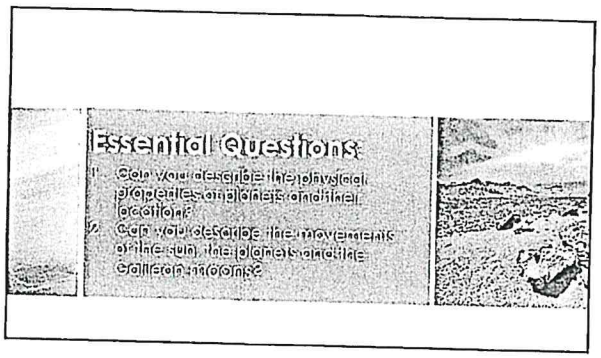
Day [redacted]: Copy all Notes on Paper

3/17/20





Planets

Planet definition

A celestial body moving in an elliptical orbit around a star.

Planets

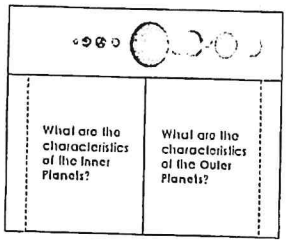
Some Characteristics Include:

- Color
- Proximity to Sun
- Size
- Speed
- Density
- Physical/Chemical make up

Quick Action – Inner and Outer Planets INB Template

INB Template

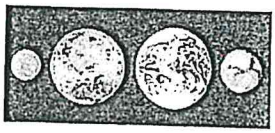
1. Cut out the planets template.
2. Glue it to your journal along the 2 skinny tabs.



Planets

Inner Planets compared to Outer Planets

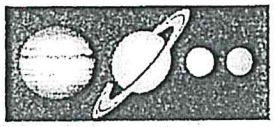
- Mercury, Venus, Earth, Mars
- Closer together
- Terrestrial, rocky
- More dense
- Smaller
- Shorter revolution



Planets

Outer Planets compared to Inner Planets

- Jupiter, Saturn, Neptune, Uranus
- Farther apart
- Made up mostly of gas
- Less dense
- Larger
- Longer revolution
- Less known about them



Quick Action – Gravity INB Template

INB Template

1. Cut out the gravity template.
2. Glue it to your journal along the 2 skinny tabs.

What is Gravity?	How does the mass of an object affect gravity?
What is the force that governs all planetary movement in the solar system?	How does the distance between two objects affect the force of gravity?

Planets

Gravity – *What is it?*

A natural <u>force</u> of attraction exerted by a celestial body on objects that are on or near its surface.

Planets

Gravity – *How does the mass on an object affect gravity?*

The <u>greater the mass</u> of an object, the <u>more gravitational force</u> is exerted on other objects around it.

Planets

Gravity – *What is the force that governs all planetary movement in the solar system?*

The <u>Sun's gravity</u> is what causes the planets to orbit in our solar system.

Planets

Gravity – *How does the distance between two objects affect the force of gravity?*

The closer the two objects are the more gravitational force they have.

Ex: The Moon has as much larger impact on our tides than the Sun does.

Check for Understanding

Write a short essay to answer the following question.

Give two reasons why the Galilean moons stay in orbit around Jupiter rather than pulled toward Saturn or the Sun?

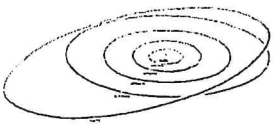
Quick Action – Planet INB Template

Sun (star)	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune

Planets

How do planets move?

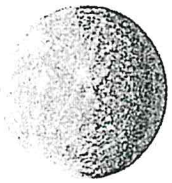
- Planets orbit (revolve) clockwise around the sun (Except for Venus and Uranus, which rotate counter-clockwise.)
- The Sun's gravity keeps them in their orbits.
- The planets orbits are elliptical shaped.



Planets

Mercury

- Closest planet to the sun
- Smallest planet in solar system
- 2nd hottest planet
- No atmosphere
- Revolution 88 Earth days
- Craters



Planets

Venus

- 2nd closest planet to the Sun
- "Sister" to Earth in size
- Thick atmosphere
- Hottest planet because of Greenhouse Effect
- Revolution 243 Earth days

Planets

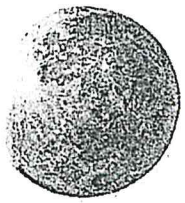
Earth

- Our home
- Made of 2/3 water
- Only planet known to support life
- Has a magnetosphere which deflects harmful electromagnetic rays from the Sun
- Revolution 365 Earth days

Planets

Mars

- The "red planet"
- Grand Canyon of Mars dwarfs Earth's Grand Canyon
- Largest dust storms
- Unmanned rovers currently exploring Mars
- Revolution 687 Earth days



Planets

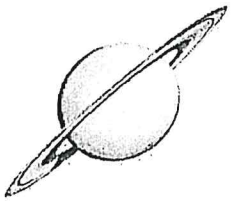
Jupiter

- Largest planet
- Great Red Spot can fit 2 Earth's inside it.
- Galileo discovered many of Jupiter's moon's.
- Ganymede is the largest moon in the solar system.
- Revolution 12 Earth years

Planets

Saturn

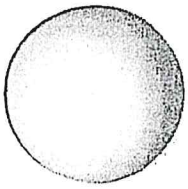
- Many rings made of dust and ice
- Low density – could float in a bathtub if one were big enough
- Revolution 29 Earth years



Planets

Uranus

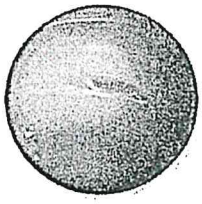
- Axis is sideways and rotates north and south
- Thirteen sets of rings, some partial
- Voyager 2 passed by
- Revolution 84 Earth years



Planets

Neptune

- Smaller than Uranus but greater mass
- Has a Great Dark Spot similar to Jupiter's Great Red Spot
- Voyager 2 passed by
- Revolution 165 Earth years

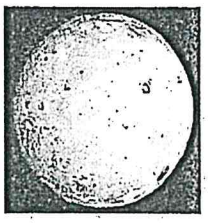


Planets

Galilean Moons

<u>Io</u>

- Innermost moon to Jupiter
- Highest Density
- Driest and most geologically active object in the solar system

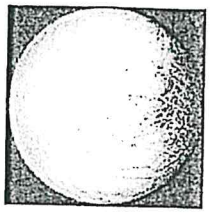


Planets

Galilean Moons

Europa

- Smallest of Galilean Moons
- Smoothest surface of any known solid object in the solar system

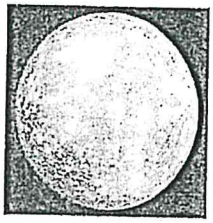


Planets

Galilean Moons

Callisto

- Almost as big as Mercury
- Same hemisphere always faces Jupiter
- Heavily cratered



Planets

Galilean Moons

Ganymede

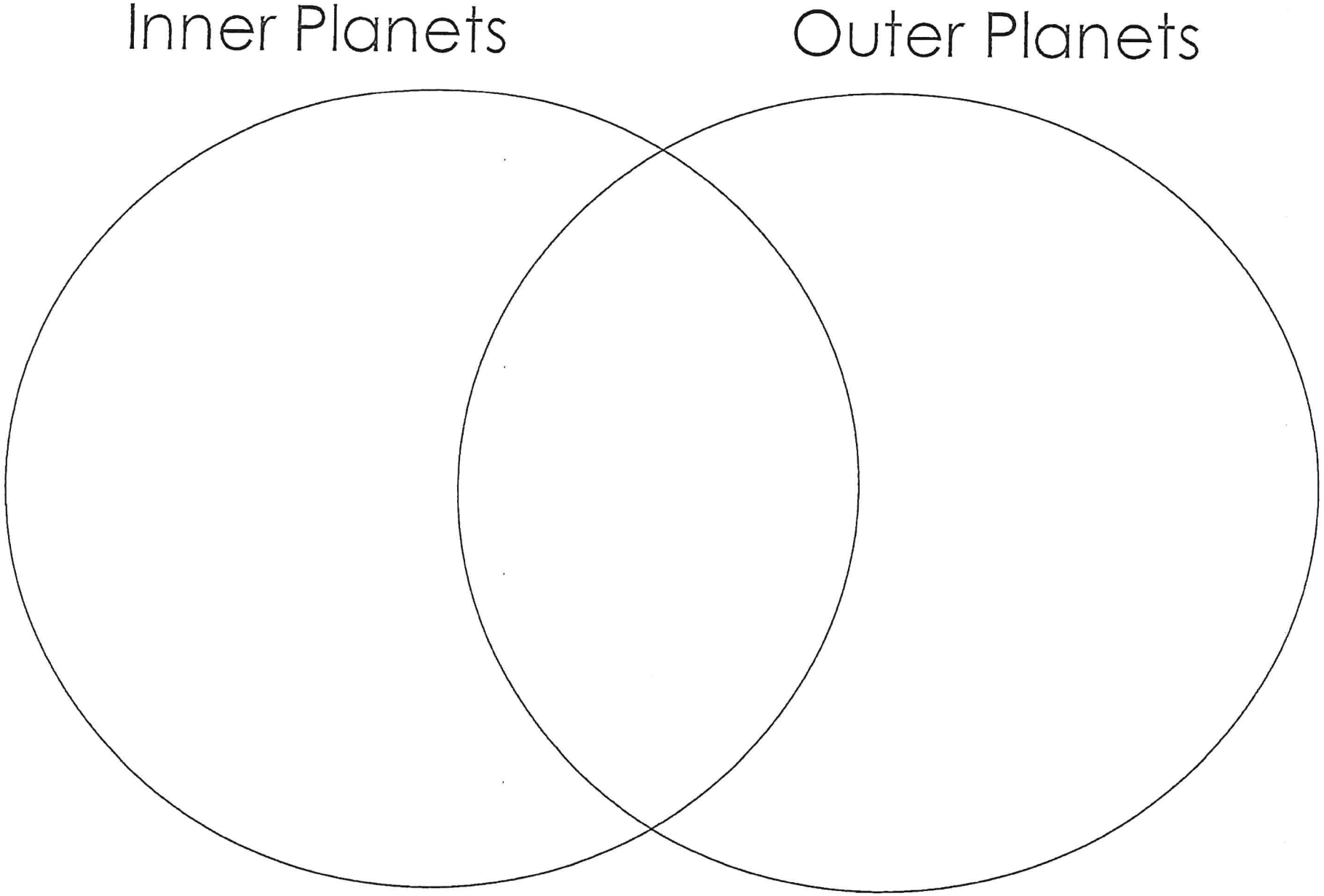
- Largest moon in the solar system (8% larger than Mercury)
- Underground ocean and magnetic field
- First observed by Galileo in 1610

Check for Understanding

Can I describe the physical properties of the planets and their location

Can I describe the movements of the sun, the planets, and the Galilean moons.

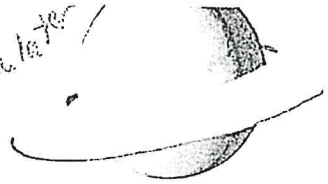
Day 16: Compare & Contrast using Notes



Day 17

Complete. Use formula & calculator

How Much Do You Weigh on Other Planets?



The formula to find out your weight on other planets is **Weight on Earth x Gravity**

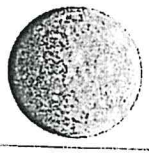
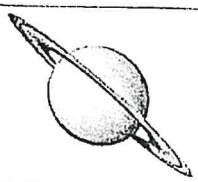
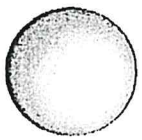
Planetary Object	Weight on Earth	Gravity	Weight
Earth	100 lbs	x 1	= 100
Moon		.166	
Outer Space		0	
Mercury		.38	
Venus		.91	
Mars		.38	
Jupiter		2.14	
Saturn		.91	
Uranus		.86	
Neptune		1.1	
Pluto		.08	
The Sun		28	

Day 18 & 19 This Should Take Two Days

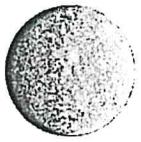
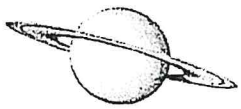
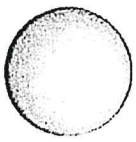
Planets Choice Project

Name _____

It seems impossible but in the year 2060 space travel to other planets is now available to the general public. All you need is some "dough". How much would you be willing to spend to visit the planet of your dreams? **Your goal is to raise $100,000**, so you can visit one or more of your favorite planets.

Planets	Project Type	Dollars
	Chart	$25,000
	Story	$25,000
	Mural	$75,000
	Travelogue	$75,000
	Picture Story Book	$100,000
	Game	$100,000
	Original Song	$50,000
	Newspaper Article	$50,000

Planet Choice Project Name _____

Planets	Project Title	Dollars
	Chart - Make a chart to show the specific characteristics of each of the eight planets. List at least six characteristics for each planet.	$25,000
	Story – Write a creative story about visiting one of the eight planets. What would you see?	$25,000
	Mural – Illustrate a mural of the planets. Research their size and colors and make the planets somewhat representative of their sizes.	$75,000
	Travelogue – Design a travelogue that a travel agent might use to sell a trip to the planets. Include facts about each planet and reasons for visiting there.	$75,000
	Picture Story Book – Write a non-fiction book about the planets with facts and illustrations.	$100,000
	Game - Make a board game for the planets. Have at least 40 questions included in the game.	$100,000
	Song – Create an original song about the planets. Include information about gravity as well.	$50,000
	Newspaper Article – Write a "creative" newspaper article about someone who has returned from visiting a planet. Include pictures.	$50.000

Day 20

Planets Assessment

Name _____

1. Explain the effects that distance and mass have on the gravitational pull of the planets.

_____

_____

_____

_____

2. List the characteristics of the inner and outer planets.

Inner Planets

Outer Planets

3. These are the four Galilean Moons: Io, Europa, Callisto, and Ganymede. Match the moon to its characteristic.

a. The largest in our solar system _____

b. The smoothest surface _____

c. Has an underground ocean _____

d. Is the most geologically active _____

e. Same hemisphere always faces Jupiter _____

Planets Assessment

Name _____

4. Write the names of the planets starting from the Sun.

1. _____ 2. _____ 3. _____

4. _____ 5. _____ 6. _____

7. _____ 8. _____

5. Match the name of the planet to its characteristic.

a. Hottest planet because of the Greenhouse Effect _____

b. Planet with the "Great Dark Spot" _____

c. Fastest orbiting planet _____

d. Planet with a sideways axis _____

e. The "red planet" _____

f. The largest planet _____

g. Planet with the most rings _____

h. Planet made of 2/3 water _____

i. Planet with the Great Red Spot _____

j. Planet with a canyon larger than the Grand Canyon _____

Zoology NTI Instruction Sheet

Brock

NTI Day 6: Ecology- Quizizz
NTI Day 7: Abiotic v Biotic worksheet
NTI Day 8: Abiotic v Biotic worksheet
NTI Day 9: Interactions Among Species Notes

NTI Day 10: Abiotic v Biotic- Quizizz
NTI Day 11: Interactions Among Species- Quizizz
NTI Day 12: Porifera- Quizizz
NTI Day 13: Cnidaria- Quizizz

NTI Day 14: Platyhelminthes- Quizizz
NTI Day 15: Echinodermata Quizizz
NTI Day 16: Annelida- Quizizz
NTI Day 17: Mollusca- Quizizz

NTI Day 18: Nematoda- Quizizz
NTI Day 19: Arthropoda- Quizizz
NTI Day 20: Vertebrate v Invertebrate- Quizizz

Zoology

QUIZIZZ

NAME : Day 11

CLASS : _____

DATE : _____

1.3 Interactions Among Living Things

10 Questions

1. The behaviors and physical characteristics of species that allow them to live successfully in their environment are called

☐ a) habitats. ☐ b) biotic factors.

☐ c) limiting factors. ☐ d) adaptations.

2. The struggle between organisms to survive in a habitat with limited resources is called

☐ a) symbiosis. ☐ b) competition.

☐ c) predation. ☐ d) parasitism.

3. When a jellyfish paralyzes a tiny fish with its poisonous tentacles, the fish is the

☐ a) parasite. ☐ b) prey.

☐ c) predator. ☐ d) host.

4. A close relationship between two species that benefits at least one of the species is called

☐ a) competition. ☐ b) symbiosis.

☐ c) adaptation. ☐ d) natural selection.

5. When a flea is living on a dog, the dog is the

☐ a) host. ☐ b) parasite.

☐ c) predator. ☐ d) prey.

6. Mutualism, commensalism, and parasitism are the three types of

☐ a) competition. ☐ b) symbiotic relationships.

☐ c) prey adaptations. ☐ d) predation.

7. A hawk building its nest on an arm of a saguaro cactus is an example of

- ☐ a) commensalism.
- ☐ b) mutualism.
- ☐ c) parasitism.
- ☐ d) predation.

8. A tapeworm living inside a wolf's body is a

- ☐ a) predator.
- ☐ b) host.
- ☐ c) parasite.
- ☐ d) prey.

9. Both species benefit in the type of symbiosis called

- ☐ a) mutualism.
- ☐ b) commensalism.
- ☐ c) parasitism.
- ☐ d) competition.

10. An organism's particular role in its habitat, or how it makes its living, is called its

- ☐ a) carrying capacity.
- ☐ b) competition.
- ☐ c) ecosystem.
- ☐ d) niche.

Zoology

QUIZIZZ

NAME : Day 12

CLASS : _____

DATE : _____

Phylum Porifera

10 Questions

1. Which Kingdom are sponges classified?

☐ a) Fungi ☐ b) Animalia

☐ c) Plantae ☐ d) Monera

2. Which phylum are sponges classified?

☐ a) Cnidaria ☐ b) Animalia

☐ c) Porifera ☐ d) Protista

3. What does the term Porifera mean?

☐ a) pore-bearing ☐ b) sponge-bearing

☐ c) cell-bearing ☐ d) bud-bearing

4. Water enters the sponge through which structure?

☐ a) Incurrent pores ☐ b) Osculum

☐ c) Epidermal Cells ☐ d) Gemmules

5. Water exits the sponge through which structure?

☐ a) Incurrent pores ☐ b) Osculum

☐ c) Epidermal cells ☐ d) Gemmules

6. Which of the following describes the shape of a sponge?

☐ a) Symmetrical ☐ b) Asymmetrical

☐ c) Fragmentation ☐ d) Sessile

7. This term describes the condition of non-movement.

☐ a) Fragmentation ☐ b) Regeneration

☐ c) Sessile ☐ d) Spicule

8. Which of the following terms defines how sponges can regrow lost body parts?

- ☐ a) Budding
- ☐ b) Symmetry
- ☐ c) Choanocytes
- ☐ d) Regeneration

9. Which of the following terms describes organisms that produce both egg and sperm?

- ☐ a) Autotrophs
- ☐ b) Heterotrophs
- ☐ c) Fragmentation
- ☐ d) Hermaphrodites

10. Which term defines how water enters through the sponge's pores bringing in food and oxygen.

- ☐ a) Filter feeders
- ☐ b) pore-bearing
- ☐ c) sexual reproduction
- ☐ d) Collar cells

Zoology

QUIZIZZ

NAME : Day 13

CLASS :

DATE :

Phylum Cnidaria

10 Questions

1. Animals in the phylum Cnidaria are found in

☐ a) desert habitats ☐ b) forest habitats

☐ c) aquatic habitats ☐ d) all habitats

2. Jellyfish differ from sea anemones in that

☐ a) only one has stinging cells ☐ b) only one has tentacles

☐ c) only one uses the same opening for food and waste ☐ d) only one has a mouth that faces downward

3. The bell-shaped Cnidaria include (adult)

☐ a) jellyfish ☐ b) sea anemones

☐ c) coral ☐ d) hydras

4. Which body form of cnidarians are free swimming?

☐ a) Polyp ☐ b) Medusa

☐ c) Endoderm ☐ d) Ectoderm

5. Which body form of cnidarians are sessile?

☐ a) Polyp ☐ b) Medusa

☐ c) Endoderm ☐ d) Ectoderm

6. Which of the following is not a layer in cnidarians?

☐ a) Ectoderm ☐ b) Mesoglea

☐ c) Endoderm ☐ d) Ganglion

7. The free-floating cnidaria (not attached to the sea floor) is the

☐ a) jellyfish ☐ b) sea anemones

☐ c) coral reefs ☐ d) hydra

8. Classify the following as a polyp form or medusa form: uses sexual reproduction.

☐ a) polyp ☐ b) medusa

9. Classify the following as a polyp form or medusa form: uses asexual reproduction.

☐ a) polyp ☐ b) medusa

10. Which phylum are jellyfish and sea anemones classified?

☐ a) Porifera ☐ b) Cnidaria

☐ c) Annelida ☐ d) Platyhelminthes

Zoology Day 14

QUIZIZZ

NAME : _____

CLASS : _____

DATE : _____

Phylum Platyhelminthes

10 Questions

1. Flatworms are classified into which phylum?

☐ a) Porifera ☐ b) Platyhelminthes

☐ c) Cnidaria ☐ d) Nematoda

2. Which of the following is an evolutionary advance of flatworms?

☐ a) Bilateral Symmetry ☐ b) Radial Symmetry

☐ c) Gastrovascular Cavity ☐ d) Epidermis

3. Which of the following divides the organism into equal left and right sides?

☐ a) Radial Symmetry ☐ b) Bilateral Symmetry

☐ c) Biradial Symmetry ☐ d) Lateral Symmetry

4. Which of the following is an evolutionary advance of flatworms?

☐ a) Radial Symmetry ☐ b) Fission

☐ c) Sexual Reproduction ☐ d) Cephalization

5. Which term refers to the head region on a flatworm?

☐ a) Fertilization ☐ b) Fission

☐ c) Cephalization ☐ d) Coelom

6. True/False: Flatworms are coelomates.

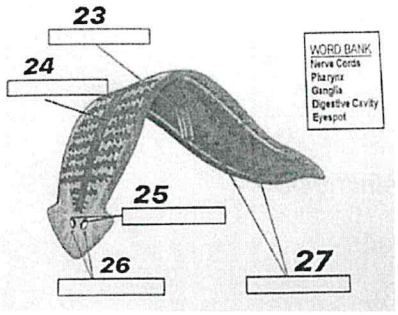
☐ a) True ☐ b) False

7. True/False: Flatworms have 2 openings.

☐ a) True ☐ b) False

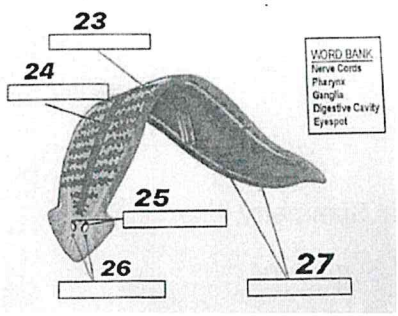
8. Which of the following is NOT a form of stimuli that flatworms respond to?

- ☐ a) Light
- ☐ b) Touch
- ☐ c) Chemical
- ☐ d) Sound

9. 

label 25

- ☐ a) Eyespot
- ☐ b) Ganglia
- ☐ c) Pharynx
- ☐ d) Nerve Cords

10. 

Label 26

- ☐ a) Ganglia
- ☐ b) Eyespot
- ☐ c) Nerve Cords
- ☐ d) Digestive Cavity

Zoology

QUIZIZZ

NAME : Day 15

CLASS :

DATE :

Echinoderm

10 Questions

1. There are 6 different classes for Echinoderms.

☐ a) True ☐ b) False

2. What are the 5 class names for Echinoderms?

☐ a) Star brittle, sea urchins, sea horse, sea cucumber, starfish

☐ b) Starfish, sea urchin, star brittle, sea cucumber, feather star

☐ c) Fish, sea brittle, sea urchin, sea horse, sea cucumber, starfish

☐ d) None of the above

3. A characteristic of an echinoderm would be..

☐ a) It's a vertabrate

☐ b) Only one cell layer

☐ c) Vascular system

☐ d) Slow regeneration

4. Where would you find starfish?

☐ a) Deep ocean floor

☐ b) Tropical coral reefs

☐ c) Ocean surface

☐ d) Ocean trenches

5. Which is not an Echinoderm?

☐ a) Sea urchin

☐ b) Sea horse

☐ c) Crab

☐ d) starfish

6. How many eyes does an echinoderm have?

☐ a) 4

☐ b) 0

☐ c) 2

☐ d) 1

7. Echinoderms can go on land

☐ a) True ☐ b) False

8. Forms of echinoderms from the past and now are the exact same.

☐ a) True ☐ b) False

9. How many starfish pictures were in this presentation total?

- ☐ a) 4
- ☐ b) 5
- ☐ c) 7
- ☐ d) 6

10. How many slides were there total?

- ☐ a) 11
- ☐ b) 9
- ☐ c) 10
- ☐ d) 12

Zoology

QUIZIZZ

NAME : Day 11a

CLASS : _____

DATE : _____

Phylum Annelida

10 Questions

1. Segmented worms are known as

☐ a) Nematodes ☐ b) Annelids

☐ c) Planarians ☐ d) Cnidarians

2. Which of the following is not a class in Annelida?

☐ a) Hirudinea ☐ b) Oligochaeta

☐ c) Hydrozoa ☐ d) Polychaeta

3. Which type of symmetry do Annelids possess?

☐ a) Radial ☐ b) Biradial

☐ c) Lateral ☐ d) Bilateral

4. Which term refers to the hard bristle-like, chitinous structures?

☐ a) Nephridia ☐ b) Spongin

☐ c) Setae ☐ d) Cilia

5. Which type of circulatory system do Annelids have?

☐ a) Open ☐ b) Closed

☐ c) Full ☐ d) None of the above

6. In a triploblastic organism, which of the following is not one of the three tissue layers?

☐ a) Ectoderm ☐ b) Endoderm

☐ c) Entoderm ☐ d) Mesoderm

7. Annelids reproduce by what type of reproduction?

☐ a) Asexual ☐ b) Sexual

☐ c) Fragmentation ☐ d) Both asexual and sexual

8. Which of the following habitats are Annelids found?

☐ a) Marine ☐ b) Freshwater

☐ c) Moist environments ☐ d) All of the above

9. Leeches have been used for medicinal purposes.

☐ a) True ☐ b) False

10. Annelids are hermaphrodites. Define this term.

☐ a) They have three tissue layers. ☐ b) They have a body cavity.

☐ c) They produce both egg and sperm. ☐ d) They can regenerate lost body parts.

Zoology

QUIZIZZ

NAME : Day 17

CLASS : _____

DATE : _____

Phlym Mollusca

10 Questions

1. Which of the following class is not classified in the phylum Mollusca?

☐ a) Polyplacophora ☐ b) Hydrozoa

☐ c) Gastropoda ☐ d) Cephalopoda

2. Which of the following organisms are not classified as Mollusks?

☐ a) Snails ☐ b) Sponges

☐ c) Squids ☐ d) Scallops

3. Which of the following does the muscular foot aid in?

☐ a) Movement ☐ b) Capture prey

☐ c) Sight ☐ d) Camouflage

4. Which of the following habitats are mollusks found?

☐ a) Marine ☐ b) Freshwater

☐ c) Terrestrail ☐ d) All of the above

5. True/False: Cephalopods have the largest invertebrate brain.

☐ a) True ☐ b) False

6. True/False: Squids release inky substance in the water for protection.

☐ a) True ☐ b) False

7. True/False: Many snails can withdraw into the shell and close it off.

☐ a) True ☐ b) False

8. Which of the following terms describes an organism with a backbone?

☐ a) Vertebrate ☐ b) Invertebrate

9. Which of the following describes an organism that lacks a backbone

☐ a) Vertebrate ☐ b) Invertebrate

10. How does changing colors help a cephalopod?

☐ a) Allows it to blend into the background ☐ b) Allows it to move

☐ c) Allows it to see ☐ d) Allows it to attack

Zoology Day 18

QUIZIZZ

NAME : _____

CLASS : _____

DATE : _____

Nematoda and Annelida

10 Questions

1. Which phylum do roundworms belong to?

☐ a) Turbellaria ☐ b) Cestoda

☐ c) Nematoda ☐ d) Porifera

2. Earthworms have setae, which are like bristles that help them ___.

☐ a) move ☐ b) eat

☐ c) reproduce

3. Which of the following phyla contains mostly parasitic roundworms?

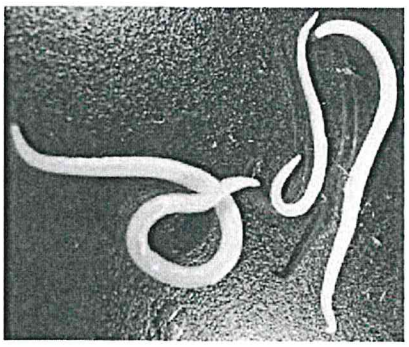
☐ a) Annelida ☐ b) Cnidara

☐ c) Nematoda ☐ d) Platyhelminthes

4. What is an Acoelmate?

☐ a) Animal with false body cavity ☐ b) Animal lacking body cavity

☐ c) Animal with true body cavity ☐ d) Animal with cavities in its teeth

5.  What phylum?

☐ a) Platyhelminthes ☐ b) Nematoda

☐ c) Annelida ☐ d) Echinodermata

6. Animals that live and feed off other animals are called _____

- ☐ a) planarians
- ☐ b) parasites
- ☐ c) proglottids
- ☐ d) teguments

7. True or false: Some marine worms can withstand boiling water.

- ☐ a) True
- ☐ b) False

8. True or false: Earthworms have gills.

- ☐ a) True
- ☐ b) False

9. True or False: Marine worms have gills.

- ☐ a) True
- ☐ b) False

10. true/false: nematodes do not have a digestive system.

- ☐ a) true
- ☐ b) false

Zoology

QUIZIZZ

NAME : Day 19

CLASS : _____

DATE : _____

Phylum Arthropoda

10 Questions

1. True/False: Arthropods inhabit all ecosystems.

☐ a) True ☐ b) False

2. True/False: Arthropods have a closed circulatory system.

☐ a) True ☐ b) False

3. What does metamorphosis mean?

☐ a) Change ☐ b) Regrow

☐ c) Camoflauge ☐ d) Transform

4. Class Arachnida includes which of the following organisms?

☐ a) Spiders, scorpions, ticks ☐ b) centipedes

☐ c) millipedes ☐ d) sea spiders

5. Class Insecta includes which of the following insects?

☐ a) Insects ☐ b) Spiders, Scorpions, Ticks

☐ c) Millipedes ☐ d) Centipedes

6. Class Diplopoda includes which of the following organisms?

☐ a) Insects ☐ b) Centipedes

☐ c) Millipedes ☐ d) Spiders, Scorpions, Ticks

7. Subphylum Crustacea includes which of the following organisms?

☐ a) Insects ☐ b) Millipedes

☐ c) Scorpions, Spiders, Ticks ☐ d) Crabs, Lobsters, Crayfish, Shrimp, Barnacles

8. True/False: Arthropods have an ectoskeleton.

☐ a) True ☐ b) False

9. True/False: Arthropods have developed sensory organs (true eyes and antennae)

☐ a) True

☐ b) False

10. Which of the following is the correct order of classification?

☐ a) Kingdom, Phylum, Class, Order, Family, Genus, Species

☐ b) Species, Genus, Family, Order, Class, Phylum, Kingdom

☐ c) Kingdom, Family, Order, Genus, Class, Species, Phylum

☐ d) Phylum, Kingdom, Order, Class, Family, Genus, Species

Zoology
Day 20

QUIZIZZ

NAME : _____

CLASS : _____

DATE : _____

Vertebrates and Invertebrates Test

10 Questions

1. This vertebrate breathes through gills, lives in water, and has scales and fins.

☐ a) bird
☐ b) fish
☐ c) reptile
☐ d) mammal

2. This invertebrate has many pores through which water flow.

☐ a) sponge
☐ b) echinoderm
☐ c) mollusk
☐ d) segmented worm
☐ e) arthropod

3. This vertebrate is endothermic, breathes with lungs, has babies that are born live, has fur or hair, and produces milk to feed its young.

☐ a) bird
☐ b) fish
☐ c) amphibian
☐ d) reptile
☐ e) mammal

4. Arthropods have this outer covering that protects them.

☐ a) vertebrae
☐ b) scales
☐ c) exoskeleton
☐ d) feathers
☐ e) tube-like spine

5. These are the simplest organisms that have a true nervous system.

☐ a) sponges
☐ b) ants
☐ c) starfish
☐ d) worms
☐ e) snails

6. Which of the following are NOT vertebrates?

- ☐ a) amphibians
- ☐ b) arthropods
- ☐ c) mammals
- ☐ d) reptiles
- ☐ e) fish

7. Which of the following are NOT invertebrates?

- ☐ a) sponges
- ☐ b) reptiles
- ☐ c) echinoderms
- ☐ d) arthropods
- ☐ e) mollusks

8. Animals are heterotrophs. What does that mean?

- ☐ a) They make their own food.
- ☐ b) They cannot make their own food.

9. Arthropods have this characteristic on their limbs. This helps them to move around.

- ☐ a) an embarassing rash
- ☐ b) joints
- ☐ c) Lee press-on nails
- ☐ d) vampire fangs

10. This is an identifying characteristic of a bird.

- ☐ a) lay jelly-like eggs
- ☐ b) have shells
- ☐ c) 2 wings and 2 feet
- ☐ d) gills

Biology NTI Instruction Sheet

Brock & McClelland

NTI Day 6: Protein Synthesis- Quizizz
NTI Day 7: Protein Synthesis Unit Exam (10 questions)
NTI Day 8: Mutations Notes (slides 1-12)
NTI Day 9: Mutations Notes (slides 13-24)

NTI Day 10: Evolution Pretest- Quizizz
NTI Day 11: Evolution Vocabulary Notes (must be handwritten)
NTI Day 12: Darwin's Theory of Evolution Notes (must be handwritten)
NTI Day 13: Evolution Vocabulary Notes (must be handwritten)

NTI Day 14: Evidence of Evolution Notes (must be handwritten)
NTI Day 15: Phylogeny Notes (must be handwritten)
NTI Day 16: Evolution Review- Quizizz
NTI Day 17: Evolution Unit Test- Quizizz

NTI Day 18: Ecology Pretest- Quizizz
NTI Day 19: Ecology Notes (slides 1-11)
NTI Day 20: Ecology Notes (slides 12-23)

Biology
NTI Day #11: Evolution Vocabulary
Take Notes and send it to me (handwritten).

Term	Meaning
Evolution	The process by which modern organisms have descended from ancient organisms over time
Common ancestor	An ancestor shared by two or more descendant species
Natural selection	Evolutionary mechanism in which individuals that are better suited to their environment survive and reproduce most successfully
Variation	Difference between traits in individuals of the same species
Adaptation	A trait that improves an organism's ability to survive and reproduce in an environment
Fitness	The ability of an organism to survive and reproduce
Artificial selection	Selective breeding of organisms to promote the appearance of desirable traits in offspring
Genetic drift	A mechanism of evolution in which allele frequencies of a population change over generations due to chance

Biology
NTI Day 12: Take notes and send it to me (handwritten).

Darwin's theory of evolution

Charles Darwin developed a theory of **evolution** to explain the unity and diversity of life, based on the idea of shared **common ancestors**.

Natural selection

Darwin's theory was based on the mechanism of **natural selection**, which explains how populations can evolve in such a way that they become better suited to their environments over time.

Individuals have **variations** within their heritable traits. Some variations make an individual better suited to survive and reproduce in their environment.

If this continues over generations, these favorable **adaptations** (the heritable features that aid survival and reproduction) will become more and more common in the population.

The population will not only evolve (change in its genetic makeup and inherited traits), but will evolve in such a way that it becomes adapted, or better-suited, to its environment.

Artificial selection

There are other types of selection, in addition to natural selection, that are out there in the world.

Artificial selection, also called "selective breeding", is where humans select for desirable traits in agricultural products or animals, rather than leaving the species to evolve and change gradually without human interference, like in natural selection.

Dog breeding is a perfect example of how humans select for desirable or fashionable traits. Breeders deliberately mate parents with the hope of producing offspring with specific traits (such as color, size, ear shape, snout length, and so on).

Common mistakes and misconceptions

- **Evolution is not the same as adaptation or natural selection.** Natural selection is a mechanism, or cause, of evolution. Adaptations are physical or behavioral traits that make an organism better suited to its environment.
- **Heritable variation comes from random mutations.** Random mutations are the initial cause of new heritable traits. For example, a rabbit can't choose to have a different fur color. Rather, a genetic mutation causes a difference in fur color, which may help that rabbit hide better in its environment.
- **Natural selection acts on existing heritable variation.** Natural selection needs some starting material, and that starting material is heritable variation. For natural selection to act on a feature, there must already be variation, and that variation must be able to be passed on to offspring.
- **Natural selection depends on the environment.** Natural selection doesn't favor traits that are somehow inherently superior. Instead, it favors traits that are beneficial in a specific environment. Traits that are helpful in one environment might actually be harmful in another.

Biology
NTI Day #13:
Take Notes and send it to me (handwritten).

Term	Meaning
Evolution	The process by which modern organisms have descended from ancient organisms over time
Common ancestor	An ancestor shared by two or more descendant species
Fossil	Preserved remains of ancient organisms
Homologous structure	Structure that are similar in different species due to common ancestry
Vestigial structure	Structure that is non-functional, or reduced in function
Analogous structure	Structure that evolved independently in different organisms because the organisms lived in similar environments or experienced similar selective pressures
Embryology	The study of embryos and their development
Biogeography	The study of where organisms live currently, and where their ancestors lived in the past

Biology
NTI Day 14: Take notes and send it to me (handwritten).

Evidence of evolution

Scientists who study **evolution** may want to know whether two present-day species are closely related. Evidence for evolution can be structural, genetic, or biogeographical.

Structural evidence for evolution

Observing anatomical features shared between organisms (including ones that are visible only during development) can indicate that they share a **common ancestor**.

Structural evidence can be compared between extant (currently living) organisms and the **fossils** of extinct organisms.

Homologous structures

If two or more species share a unique physical trait they may all have inherited this trait from a common ancestor. Traits that are shared due to common ancestry are **homologous structures**.

For example, the forelimbs of whales, humans, and birds look different on the outside because they're adapted to function in different environments. However, if you look at the bone structure of the forelimbs, the organization of the bones is similar across species.
Embryology is important to understanding a species' evolution, since some homologous structures can be seen only in embryo development. For example, all vertebrate embryos, from humans to chickens to fish, have a tail during early development, even if that tail does not appear in the fully developed organism.

Vestigial structures

Vestigial structuresserve little or no present purpose for an organism. The human tail, which is reduced to the tailbone during development, is one example. Vestigial structures can provide insights an organism's ancestry. For instance, the tiny vestigial leg bones found in some snakes reflect that snakes had a four-legged ancestor.

Analogous structures

While similar structure can indicate relatedness, not all structures that look alike are due to common ancestry.

Analogous structures evolved independently in different organisms because the organisms lived in similar environments or experienced similar selective pressure.

For example, the leg of a cat and the leg of a praying mantis are analogous. Both legs are used for walking, but they have separate evolutionary origins. On the outside, they appear similar because they have both experienced similar selection pressures that optimized them for walking. However, the actual structures that make up the leg are quite different, suggesting that the limbs are not due to a common ancestor.

DNA evidence for evolution

At the most basic level, all living organisms share the same genetic material (DNA), similar genetic codes, and the same basic process of gene expression (transcription and translation).

In order to determine which organisms in a group are most closely related, we need to use different types of molecular features, such as the nucleotide sequences of genes.

Biologists often compare the sequences of related (or homologous) genes. If two species have the "same" gene, it is because they inherited it from a common ancestor.

In general, the more DNA differences in homologous genes between two species, the more distantly the species are related.

Biogeographical evidence for evolution

The notion of **biogeography** is what first indicated to Charles Darwin that species evolve from common ancestors. Patterns of distribution of fossils and living species may tell us how modern organisms evolved.

For example, broad groupings of organisms that had already evolved before the breakup of the supercontinent Pangaea (about 200 million years ago) tend to be distributed worldwide. In contrast, broad groupings that evolved after the breakup tend to appear uniquely in smaller regions of Earth.

Environment cannot always account for either similarity or dissimilarity. Closely related species can evolve different traits under different environmental pressures. Likewise, very distantly related species can evolve similar traits if they have similar environmental pressures.

Common mistakes and misconceptions

- **Evolution is not "just" a theory.** In science, a "theory" addresses a broader question and is supported by a large amount of data from multiple sources. Evolution is a well-supported and accepted scientific theory that is supported by the evidence listed above.
- **Biologists do not draw conclusions about how species are related on the basis of structure or biogeographical evidence alone.** Instead, they study both both physical features and DNA sequences, and draw conclusions about relatedness based on these features as a group.
- **Not all species left fossils behind.** Some people believe that all living organisms leave behind fossil evidence. Unfortunately, fossilization is fairly rare, because it requires many different conditions to occur over time in a specific order. Because these conditions do not occur all the time, we do not have fossils for all of the extinct organisms.
  Because many species that existed on earth were not fossilized, this has left gaps in our fossil record. However, that doesn't mean these organisms didn't exist, and the fossil record we do have contains many transitional fossils, all of which support evolution!

Biology
NTI Day 15: Take notes and send it to me (handwritten).

Phylogeny	The study of evolutionary lineages of a species, or group of species
Common ancestor	An ancestor shared by two or more descendant species.
Phylogenetic tree (cladogram)	A diagram that represents evolutionary relationships among organisms

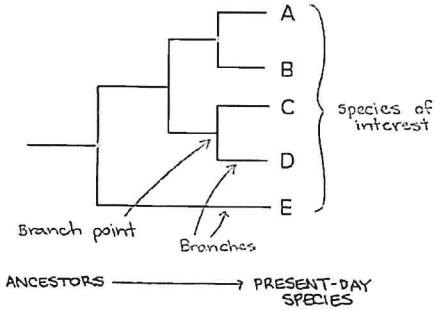
Phylogeny

Phylogeny helps scientists organize species or other groups in ways that represent our understanding of how they evolved from **common ancestors**.

Phylogenetic trees

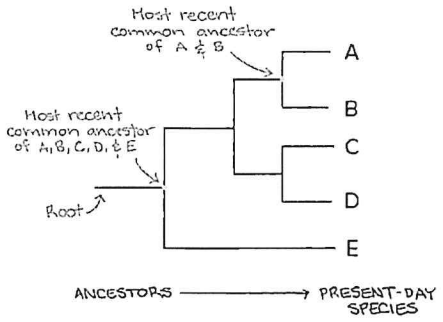
In a **phylogenetic tree**, or cladogram, the species or groups of interest are found at the tips of lines referred to as the tree's *branches*.

For example, the phylogenetic tree below represents relationships between five species, A, B, C, D, and E, which are positioned at the ends of the branches:



How the branches connect represents our understanding of how the species in the tree evolved from a series of common ancestors. At each branch point lies the *most recent common ancestor* of all the groups descended from that branch point. For instance, at the branch point giving rise to species A and B, we would find the most recent common ancestor

of those two species. At the furthest left branch point, we would find the most recent common ancestor of all the species in the tree.



Not all phylogenetic trees look the same. Some are blocky, like the tree at left below. Others use diagonal lines, like the tree at right below. You may also see trees of either kind oriented vertically or flipped on their sides, as shown for the blocky tree. The orientation of the phylogenetic tree does not change the information in the tree.

Relatedness

In a phylogenetic tree, two species are more related if they have a more recent common ancestor, and less related if they have a less recent common ancestor.

To find the most recent common ancestor of any pair or group of species, start at the branch ends carrying the two species of interest and "walk backwards" in the tree until you find the point where the species' lines meet.

For example, to determine whether species A and B are more related than species B and C, we would follow the lines of both pairs of species backward in the tree. A and B meet first, indicating they have a more recent common ancestor and are more related than B and C.

Common mistakes and misconceptions

- **Phylogenetic trees are hypotheses of relatedness.** Although we know that modern organisms evolved from ancient organisms, the pathway of this evolution is sometimes a best guess based on the amount of evidence available at the time. The more we uncover about the lineage of a set of organisms, the more accurate the phylogenetic trees become.
- **Phylogenetic trees are not just based on physical traits.** To create a phylogenetic tree, scientists often compare and analyze many characteristics of the species or other groups involved. Although this may include internal and external physical traits, it can also include other factors like behavior or DNA sequences.

QUIZIZZ

Evolution

10 Questions

Day 16

NAME : _____

CLASS : _____

DATE : _____

1. 

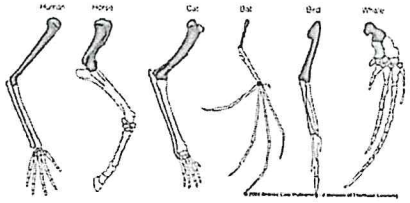
What is the term for a feature that allows an organism to survive in its environment?

- ☐ a) adaptation
- ☐ b) variation
- ☐ c) homologous structure
- ☐ d) vestigial structure

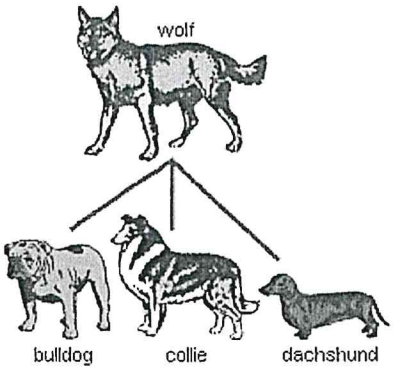
2. 

Who hypothesized that human populations are kept in check by war, famine, and disease?

- ☐ a) Darwin
- ☐ b) Hutton
- ☐ c) Malthus
- ☐ d) Lamarck

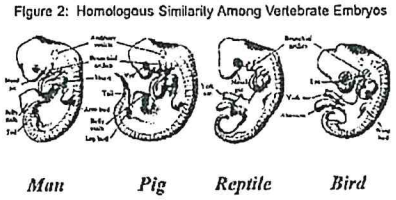
3. 

- ☐ a) analogous structures
- ☐ b) homologous structures
- ☐ c) vestigial structures
- ☐ d) none of the above

4. 

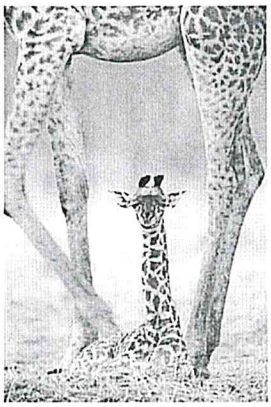
What is the process of which humans breed organisms for certain traits?

- ☐ a) artificial selection
- ☐ b) descent without modification
- ☐ c) inheritance of acquired characteristics
- ☐ d) natural selection

5. 

Vertebrate embryos pass through similar stages of development is evidence for

- ☐ a) use and disuse
- ☐ b) homologous structures
- ☐ c) common ancestry
- ☐ d) acquired characteristics

6. 

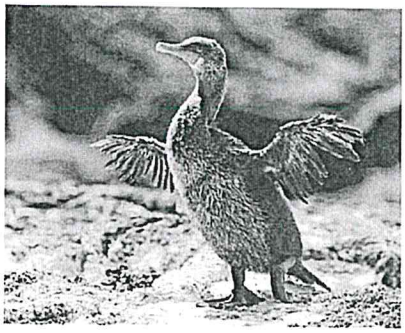
Individuals that are well adapted to their environment will survive and produce

- ☐ a) better traits
- ☐ b) stronger genes
- ☐ c) more offspring
- ☐ d) fewer mutations

7. 

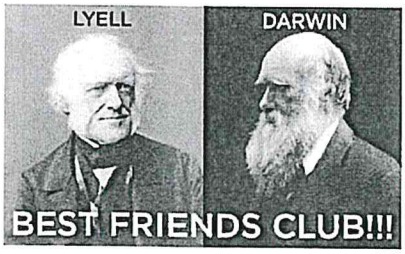
All the individuals of a species that live in a particular area are called a

- ☐ a) group
- ☐ b) population
- ☐ c) variation
- ☐ d) fossil

8. 

The remnant of an organ that had a function in an early ancestor is known as a(n)

- ☐ a) vestigial structure
- ☐ b) analogous structure
- ☐ c) homologous structure
- ☐ d) fossil structure

9. 

Who said that geological forces acting today are the same ones that have been acting in the past?

- ☐ a) Lamarck
- ☐ b) Darwin
- ☐ c) Hutton
- ☐ d) Lyell

10. 

What is the study of the distribution of organisms around the world?

- ☐ a) geology
- ☐ b) biogeography
- ☐ c) paleontology
- ☐ d) geography

QUIZIZZ Day 17

NAME : _____

CLASS : _____

DATE : _____

Evolution (pretest/posttest)

12 Questions

1. Who was the first naturalist to study evolution?

☐ a) Charles Darwin
☐ b) Gregor Mendal
☐ c) Carolus Linneaus
☐ d) Thomas Edison

2. This is a process by which organisms inherited advantageous traits that tend to reproduce more successfully than the other organisms do.

☐ a) Artificial selection
☐ b) Natural selection
☐ c) Populations
☐ d) Environment

3. This is a process in which organisms gradually change over time.

☐ a) Environment
☐ b) Competition
☐ c) Evolution
☐ d) Fossils

4. This is a group of organisms of the same species that live in a specific geographical area.

☐ a) Environment
☐ b) Evolution
☐ c) Biological diversity
☐ d) Populations

5. The surroundings and conditions in which an organism lives and operates.

☐ a) Evolution
☐ b) Population
☐ c) Environment
☐ d) Biological diversity

6. These are natural differences within a species.

☐ a) Evolution
☐ b) Genetic variation
☐ c) Biological diversity
☐ d) Populations

7. This is the variation of living organisms.

☐ a) Biological diversity ☐ b) Evolution

☐ c) Environment ☐ d) Natural selection

8. This is an inherited trait that helps an organism survive and reproduce in its environment.

☐ a) Evolution ☐ b) Population

☐ c) Environment ☐ d) Adaptation

9. This is an ecological relationship in which two or more organisms depend on the same limited resource.

☐ a) Adaptation ☐ b) Competition

☐ c) Evolution ☐ d) Natural selection

10. The death of every member of a species.

☐ a) Competition ☐ b) Population

☐ c) Extinction ☐ d) Evidence

11. The availability of facts indicating whether a hypothesis is valid (true).

☐ a) Fossil ☐ b) Evidence

☐ c) Extinction ☐ d) Competition

12. This is the trace or remains of an organism that lived long ago, most commonly preserved in sedimentary rock.

☐ a) Competiton ☐ b) Extinction

☐ c) Evidence ☐ d) Fossil

QUIZIZZ

Day 18

Ecology

10 Questions

NAME : _____

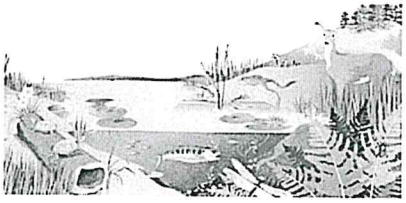
CLASS : _____

DATE : _____

1. 

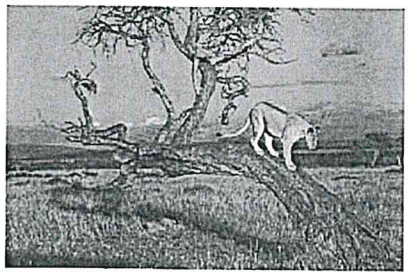
An individual belonging to a specific species

- ☐ a) Biotic
- ☐ b) Community
- ☐ c) Organism
- ☐ d) Reptile

2. 

All of the living and nonliving things in an area that interact with each other are called a/an _____.

- ☐ a) community
- ☐ b) habitat
- ☐ c) population
- ☐ d) ecosystem

3. 

An area where an organism finds food, shelter and water in a specific arrangement

- ☐ a) niche
- ☐ b) biosphere
- ☐ c) biome
- ☐ d) habitat

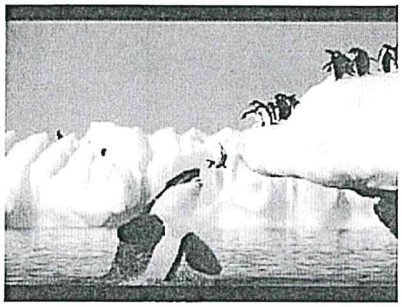
4. The living part of an ecosystem

- ☐ a) Biotic
- ☐ b) Abiotic
- ☐ c) Mother Earth
- ☐ d) Flowers

5. 

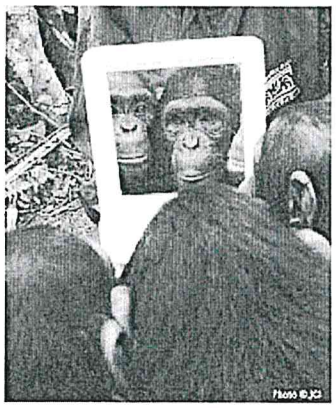
The non-living part of an ecosystem

- ☐ a) Ocean
- ☐ b) Lava Flow
- ☐ c) Birds
- ☐ d) Abiotic

6. 

The study of how living things interact with one another and with their environment.

- ☐ a) Biology
- ☐ b) Lithology
- ☐ c) Ecology
- ☐ d) Farmacology

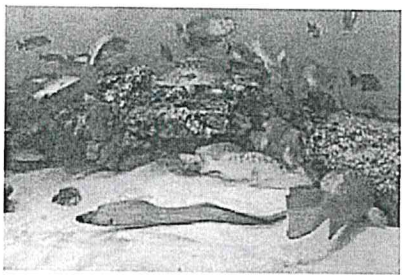
7. 

Organisms that look similar and can produce fertile offspring

- ☐ a) Species
- ☐ b) Fish
- ☐ c) Community
- ☐ d) Trees

8. Two or more members of a particular species living and interacting in the same area

- ☐ a) Community
- ☐ b) Population
- ☐ c) Organisms
- ☐ d) Biosphere

9. 

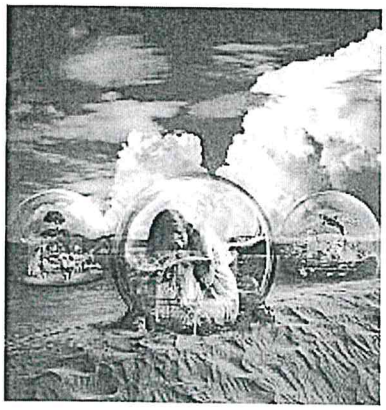
Different populations living and interacting with each other in the same area

☐ a) Biome

☐ b) Ecosystem

☐ c) Community

☐ d) Niche

10. 

The area between the highest mountain and the deepest ocean where life can be found

☐ a) Biosphere

☐ b) Biome

☐ c) Farm

☐ d) Ecosystem

Day 19: Slides 1-11
Day 20: Slides 12-23

Ecosystem

Includes all of the living things and the environment in which they live

includes all abiotic and biotic factors

Biotic Factors

the living parts of an ecosystem

Abiotic Factors

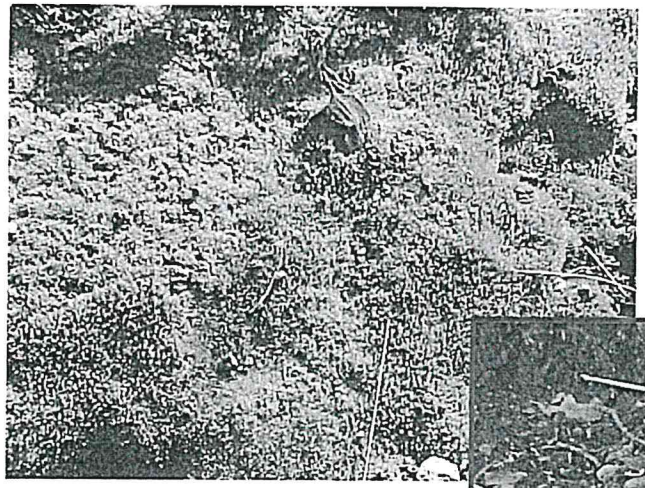
the nonliving parts of an ecosystem

Biotic Factors

include plants, animals, fungi, microorganisms

bio(s), bio(t) (G) root life

Examples of Biotic Factors

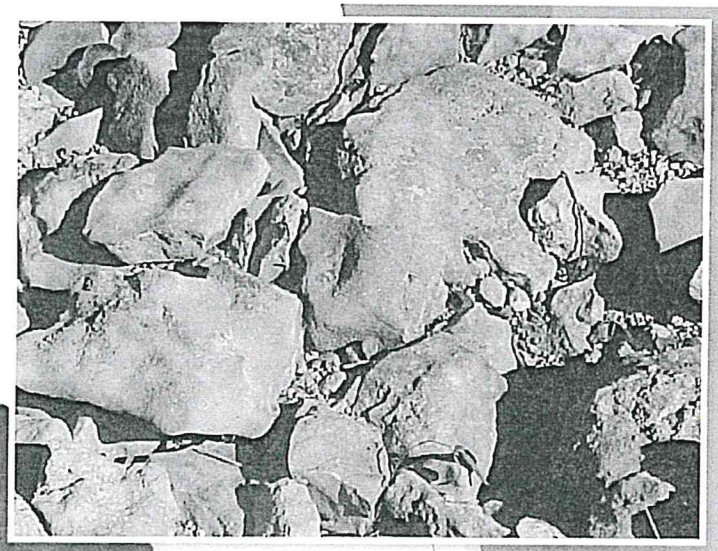


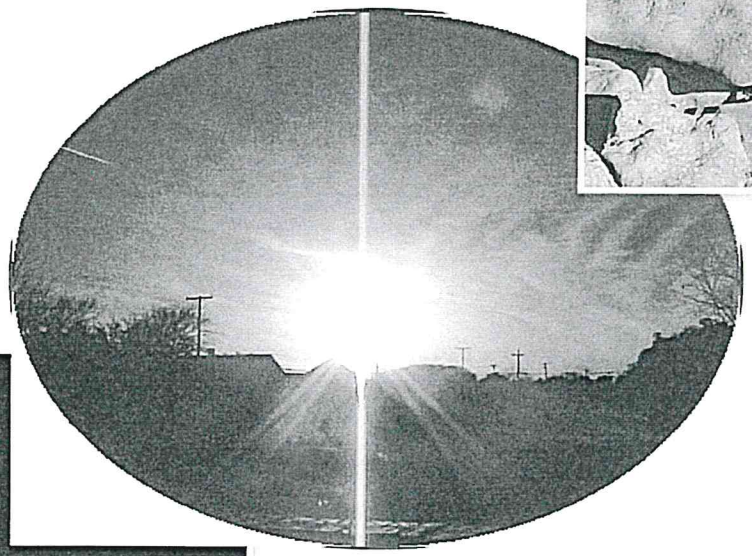
Abiotic Factors

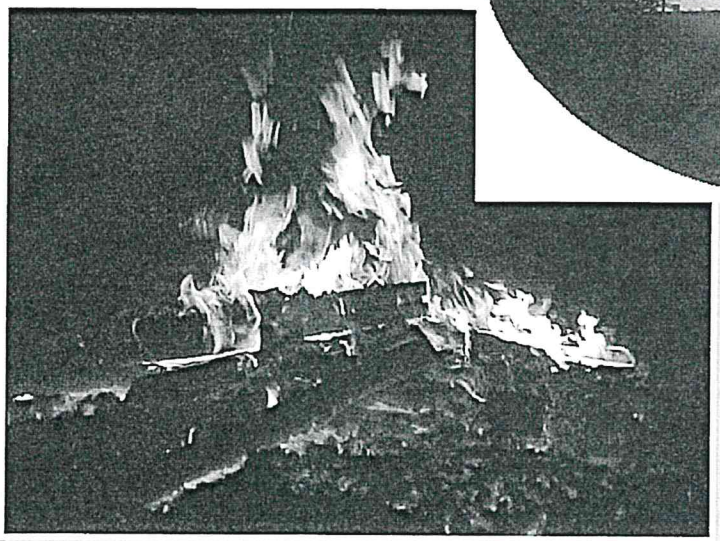
include air, water, soil, temperature, wind, source of energy (usually sun)

a, an (G) prefix not, without

Examples of Abiotic Factors

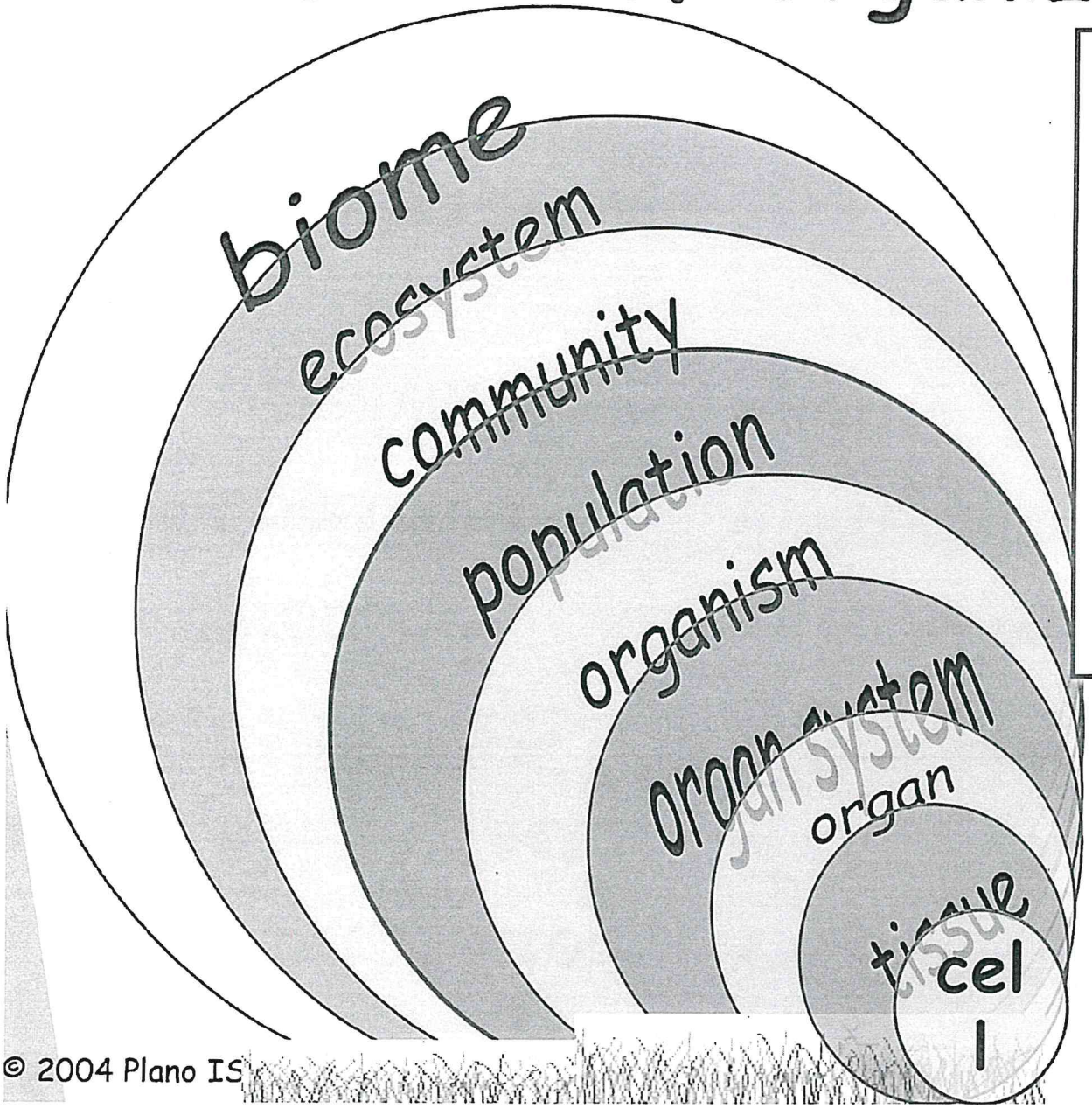






Biotic Factors	Abiotic Factors
predators	water
parasites	weather
plants	climate
trees	air
prey	sand
algae	temperature
carnivores	rainfall
fungi	frost
	sunlight
	soil
	rocks

Levels of Organization

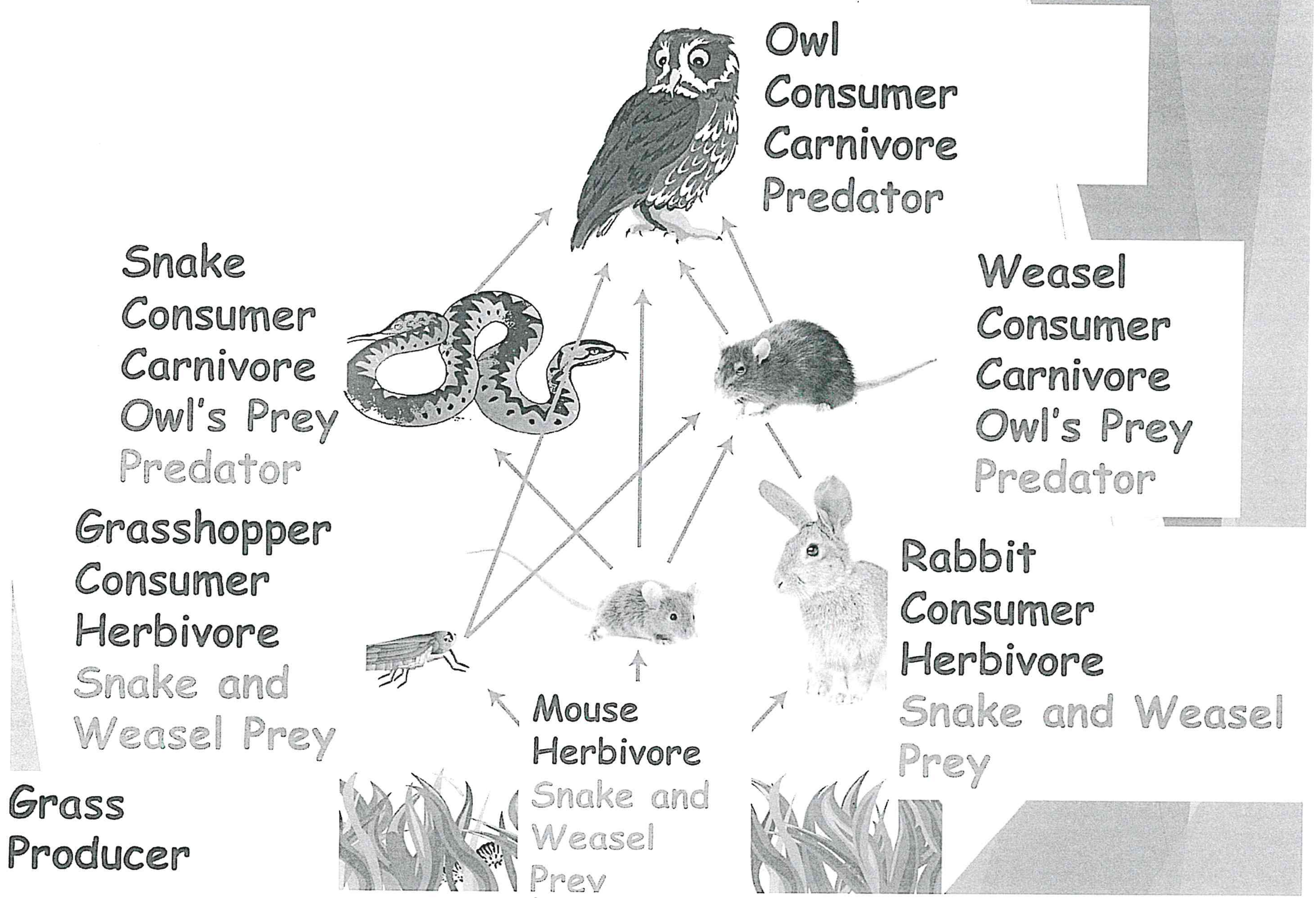


large region with typical plants and animals that includes several ecosystems

Ecosystem Vocabulary

- Biotic factor
- Abiotic factor
- Food chain
- Producer
- Consumer
- Herbivore
- Carnivore
- Omnivore
- Scavenger
- Food web
- Predator
- Prey

Food Web


Owl
Consumer
Carnivore
Predator
Snake
Consumer
Carnivore
Owl's Prey
Predator
Weasel
Consumer
Carnivore
Owl's Prey
Predator
Grasshopper
Consumer
Herbivore
Snake and
Weasel Prey
Rabbit
Consumer
Herbivore
Snake and Weasel
Prey
Mouse
Herbivore
Snake and
Weasel
Prey
Grass
Producer

What is "adapted"?

- It means that the plants and animals have developed (over time) special characteristics that allow them to survive and be successful in their environment.

Ecosystems

do not necessarily have clear boundaries due to biotic and abiotic changes

can change daily as things move from one ecosystem to another

Biotic	Abiotic
migration, seed dispersal	flood, erosion, drought

Biotic Factors

interact with each other in complex ways

such as

Symbiotic relationships:

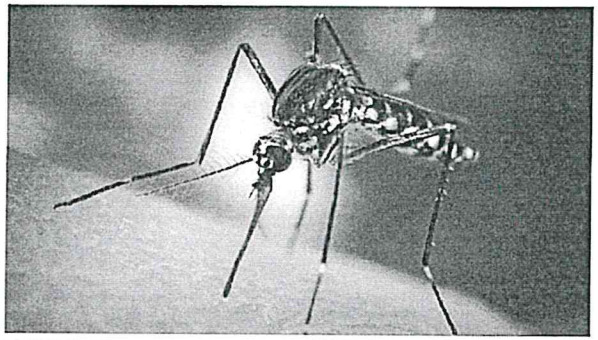
- Parasitism
- Mutualism
- Competition

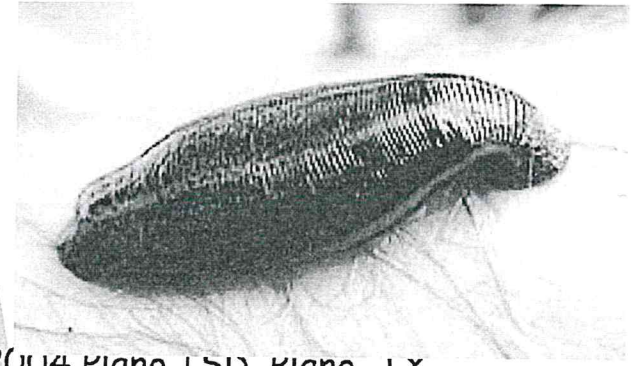
also interact with abiotic factors in the ecosystem

dependent upon water, minerals, temperature, light

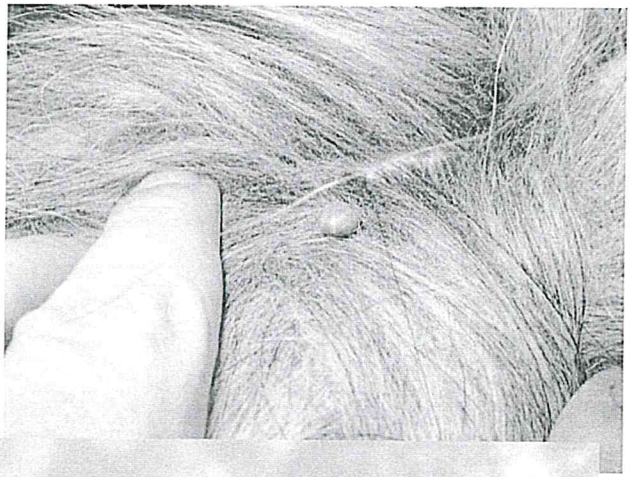
Biotic Factor Interactions: Symbiotic Relationships

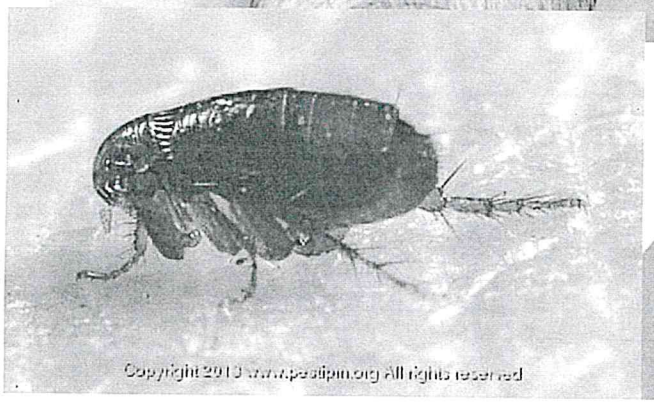
- Parasitism: one organism benefits (the parasite), while the other is harmed (host)





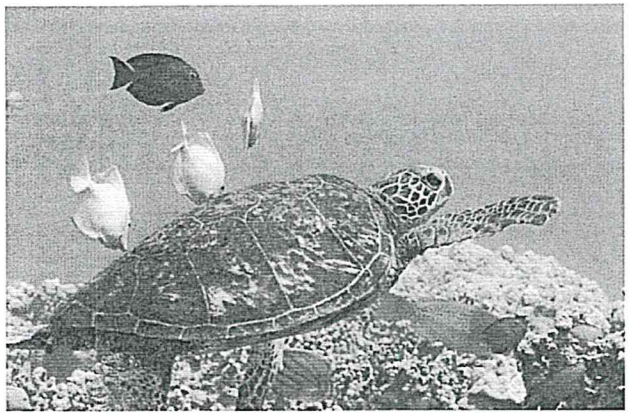
2004 Plano ISD, Plano, TX





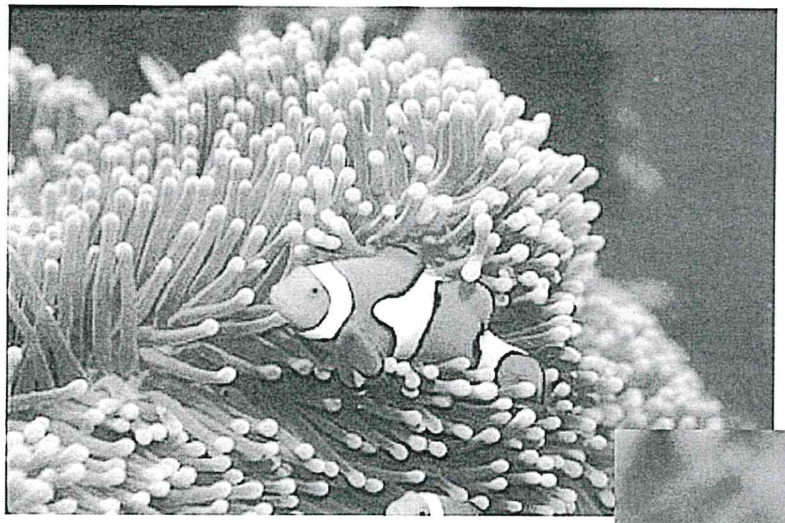
Biotic Factor Interactions: Symbiotic Relationships

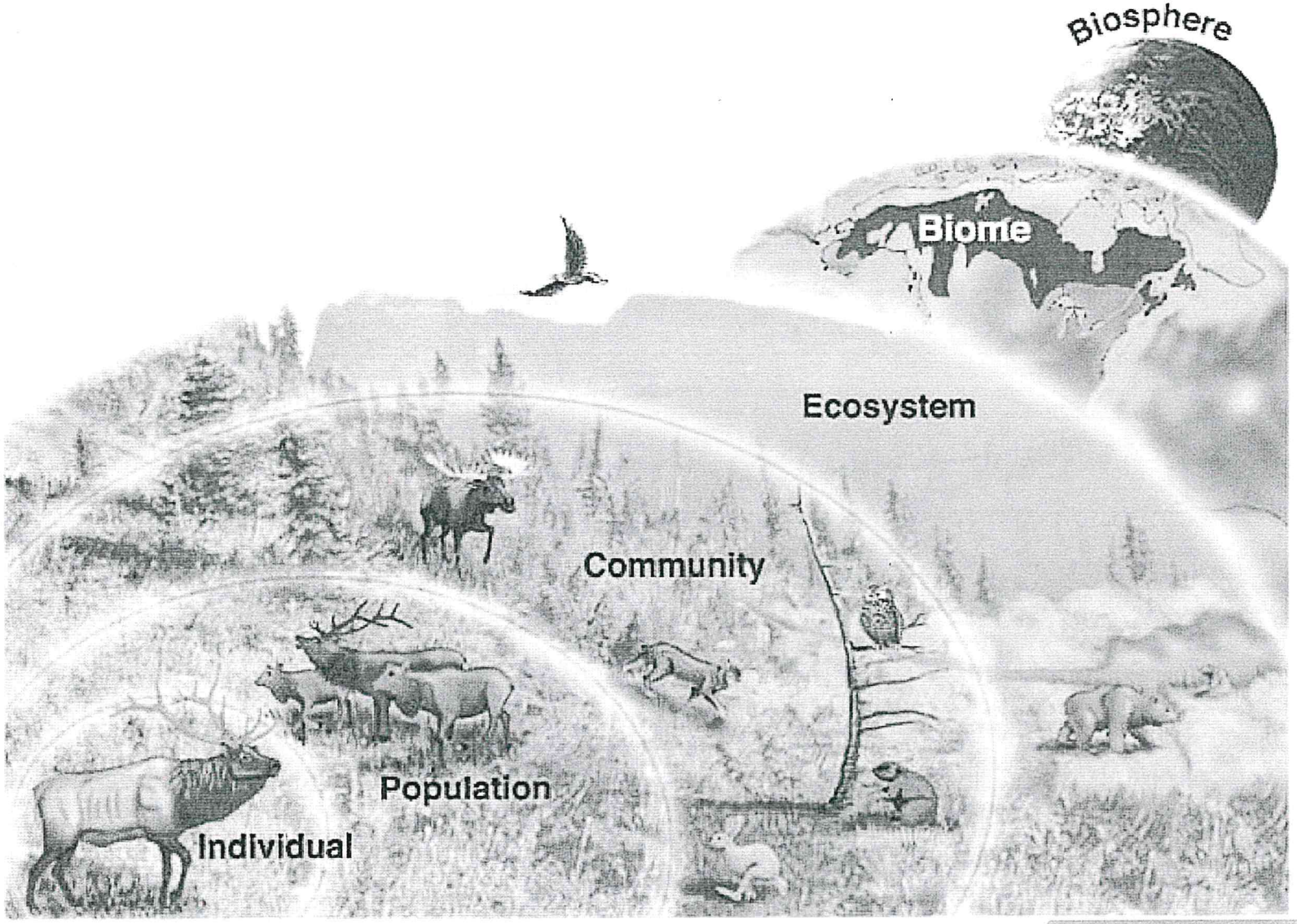
- Commensalism: one organism is benefits while the other is not affected



Biotic Factor Interactions: Symbiotic Relationships

- Mutualism: both organisms in the relationship benefit





Major Biomes of the World

desert

grassland

tropical rain forest

deciduous forest

coniferous forest

tundra

ocean

Biome

a major regional or global biotic community, a super ecosystem, defined chiefly by the dominant forms of plant life and the prevailing climate

Habitats and Niches

- Within an ecosystem, organisms occupy habitats and niches.
- What are these and what is the difference between these?

Habitat

- A **location** in the environment where an organism can grow and survive
- Includes all of the physical and biological resources available to a species

Niche

- Refers to the way an organism fits into and survives in its ecosystem
- Includes not only where it lives but what it does in its environment
- No two species occupy exactly the same niche
- Niche is determined by physical characteristics of organism, its behavior, how it reproduces, etc.

AP Biology NTI Instruction Sheet

Brock

NTI Day 6: Non Mendelian Genetics Notes (must be handwritten)
NTI Day 7: Chromosome Theory of Inheritance Notes (must be handwritten)
NTI Day 8: Sex-Linked Traits Notes (must be handwritten)
NTI Day 9: Sex-Linked Traits Practice Worksheet

NTI Day 10: Pedigree Notes (must be handwritten)
NTI Day 11: Pedigree Notes (must be handwritten)
NTI Day 12: Phenotypic Plasticity Notes (must be handwritten)
NTI Day 13: Genetics Review- Quizizz

NTI Day 14: College Board Progress Check
NTI Day 15: College Board Progress Check
NTI Day 16: Nucleic Acids Notes (must be handwritten)
NTI Day 17: DNA Replication Notes (must be handwritten)

NTI Day 18: DNA Replication Worksheet (front side)
NTI Day 19: DNA Replication Worksheet (back side)
NTI Day 20: Transcription Notes (must be handwritten)

Day 11: Take Notes and send them to me! ☺

* You may split this up into 2 days!

PEDIGREE NOTES

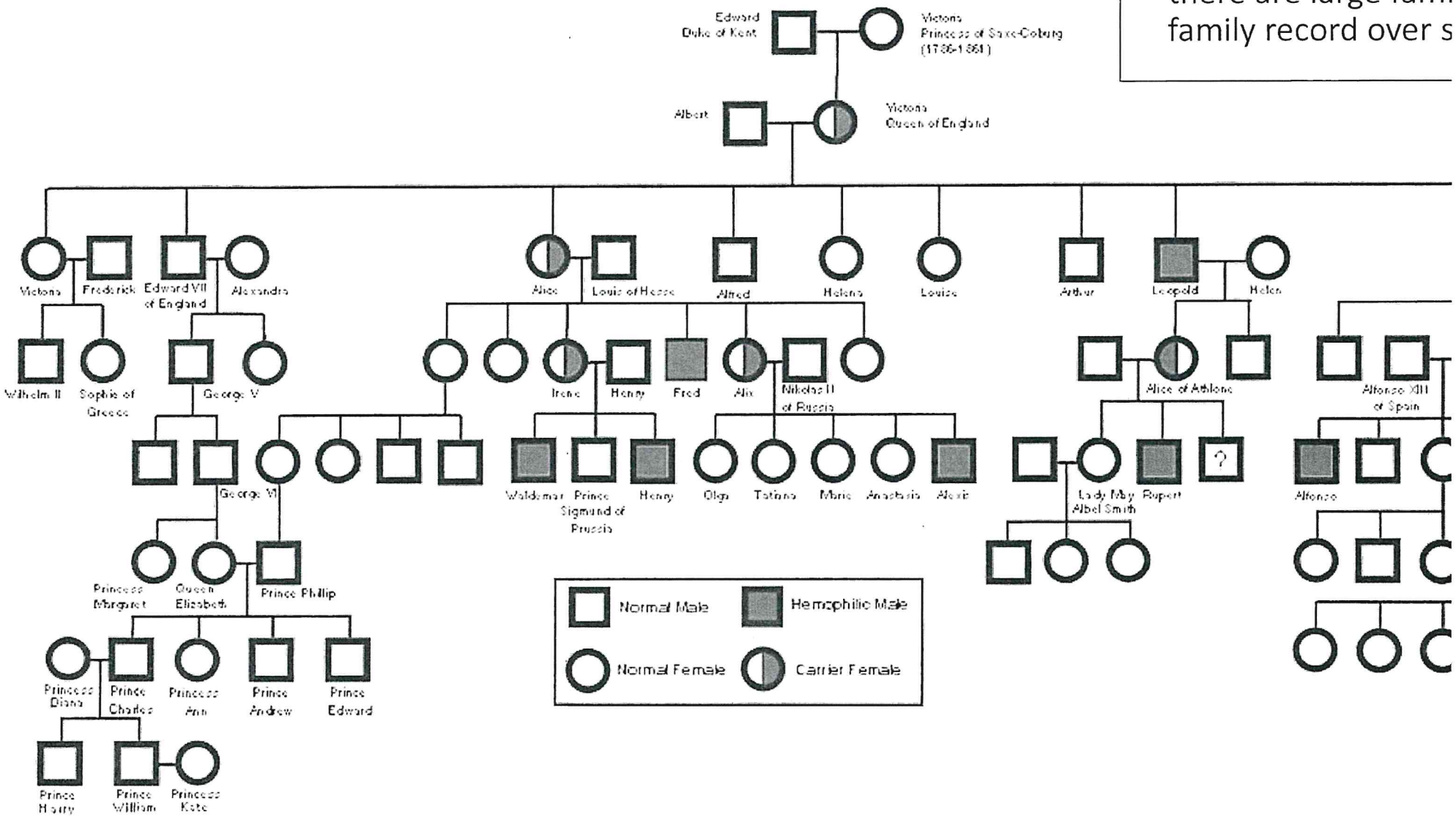
PP B-C

Pedigrees

- Pedigrees can be used to study the transmission of a hereditary condit

- Pedigree charts show a record of the family of an individual

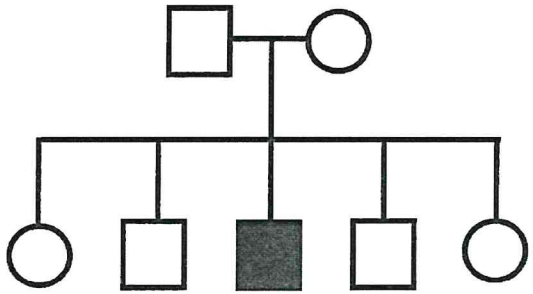
- Pedigrees are partic
  there are large fami
  family record over s



THE BASICS

- Normal male
- Affected male
- Normal female
- Affected female
- Marriage

A marriage with five children, two daughters and three sons. The eldest son is affected by the condition.

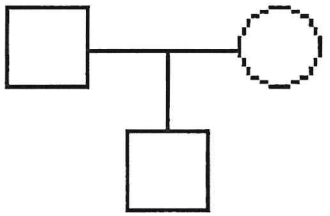


Eldest child ↔ Youngest child

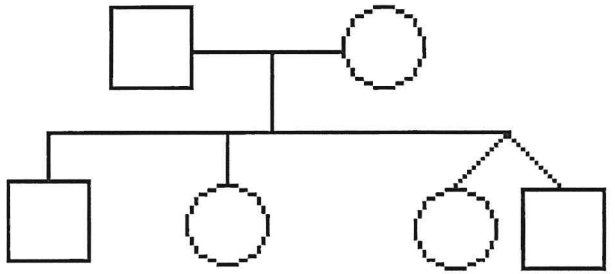
- A circle represents
- A square represent
- A horizontal line co male and female re marriage
- A vertical line and a connect the parent children
- A circle/square tha means the person
- A circle/square tha means the person the trait.
- Children are placed youngest.
- A key is given to ex trait is.

Symbols

- One offspring



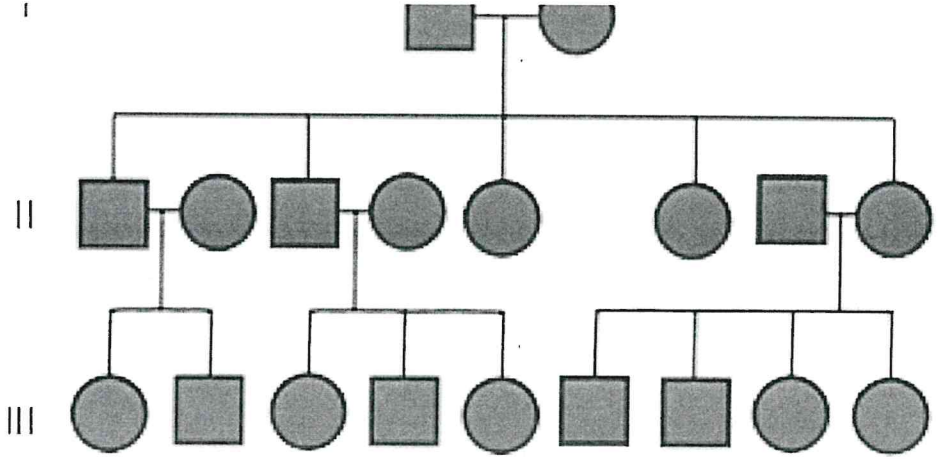
How do you differentiate between a brother and sister **and** a husband and wife on a pedigree?

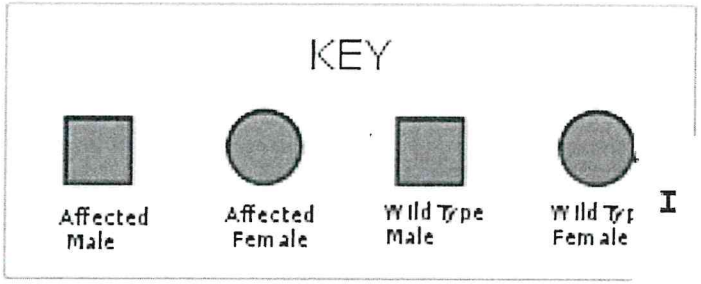


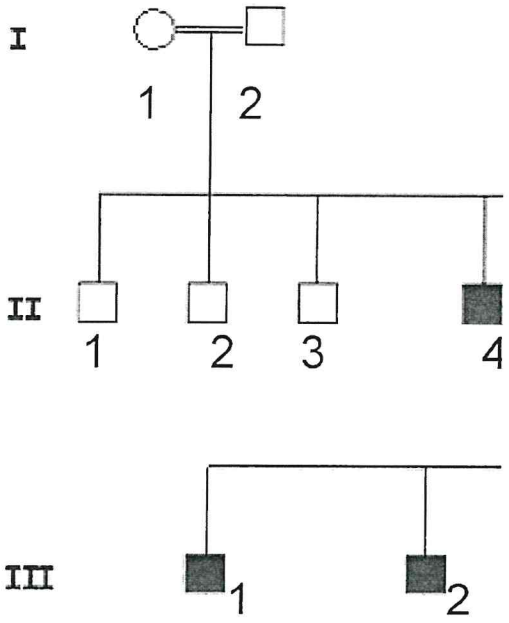
- Multiple Offspring

Generations

- Each generation is (often) labeled with a Roman numeral.
- Oldest generation at top of pedigree
- Current generation at bottom

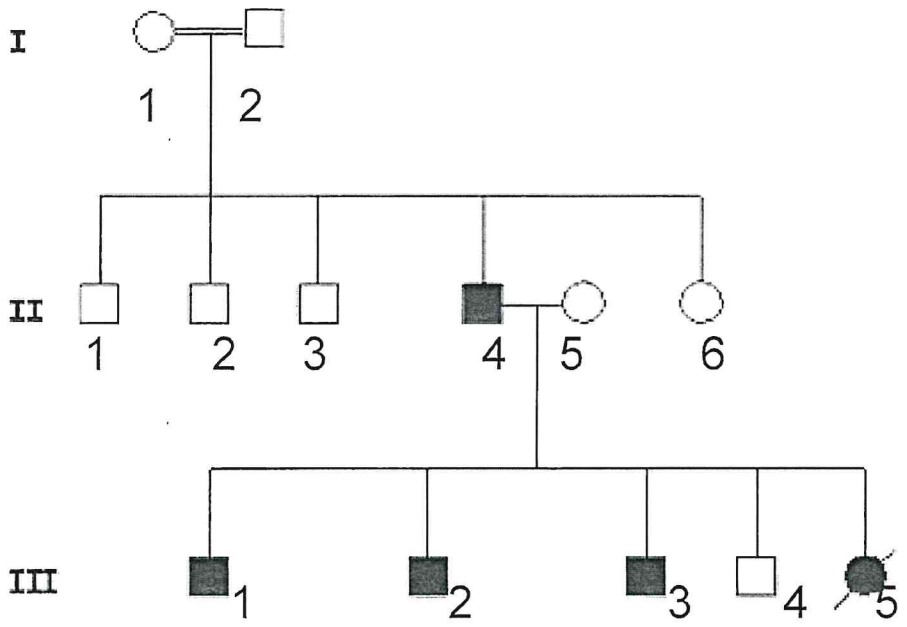






Analysis

- How many offspring were produced by generation 1?
- Number of boys? Girls?
- How many of generation II were married with children?
- Deaths are shown with a slash.



Steps:

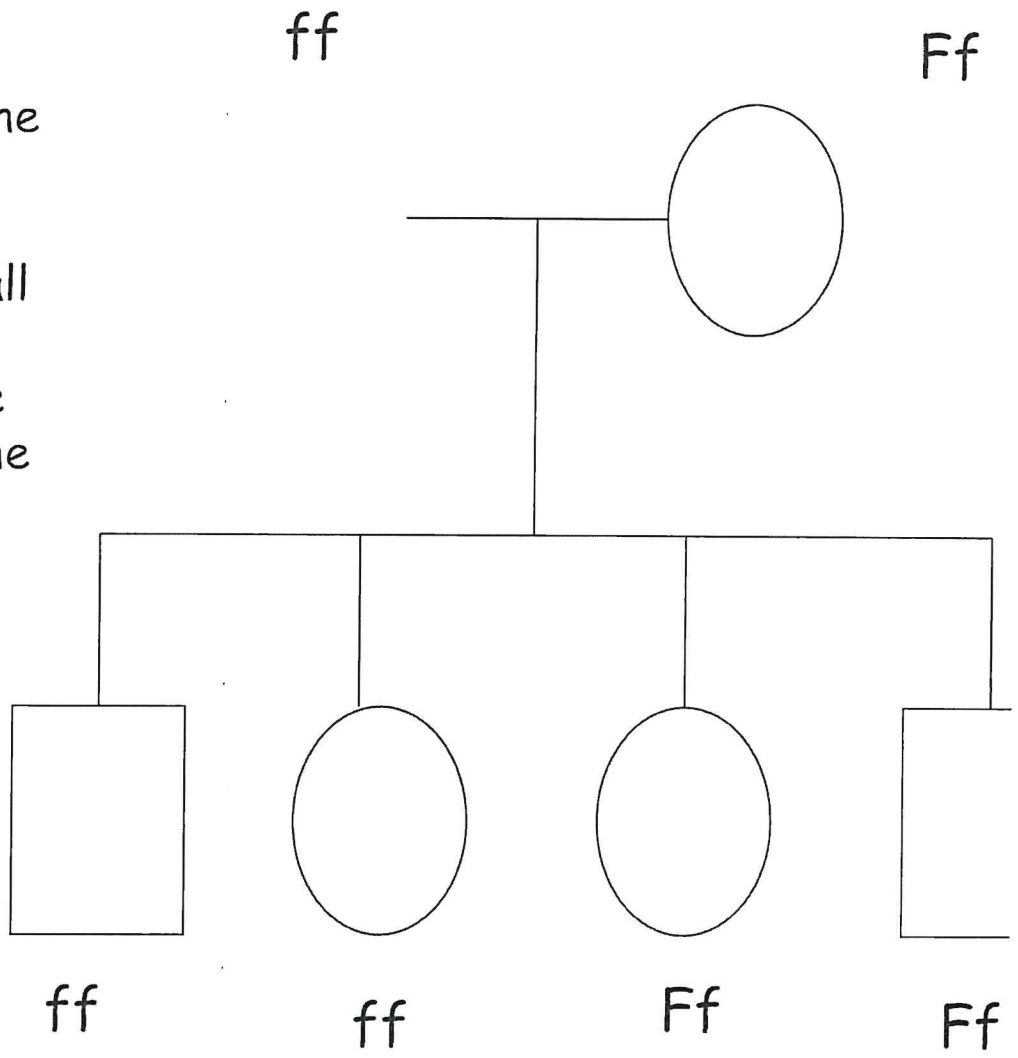
•Identify all people who have the trait.

•For the purpose of this class all traits will be given to you. In other instances, you would have to determine whether or not the trait is autosomal dominant, autosomal recessive, or sex-linked.

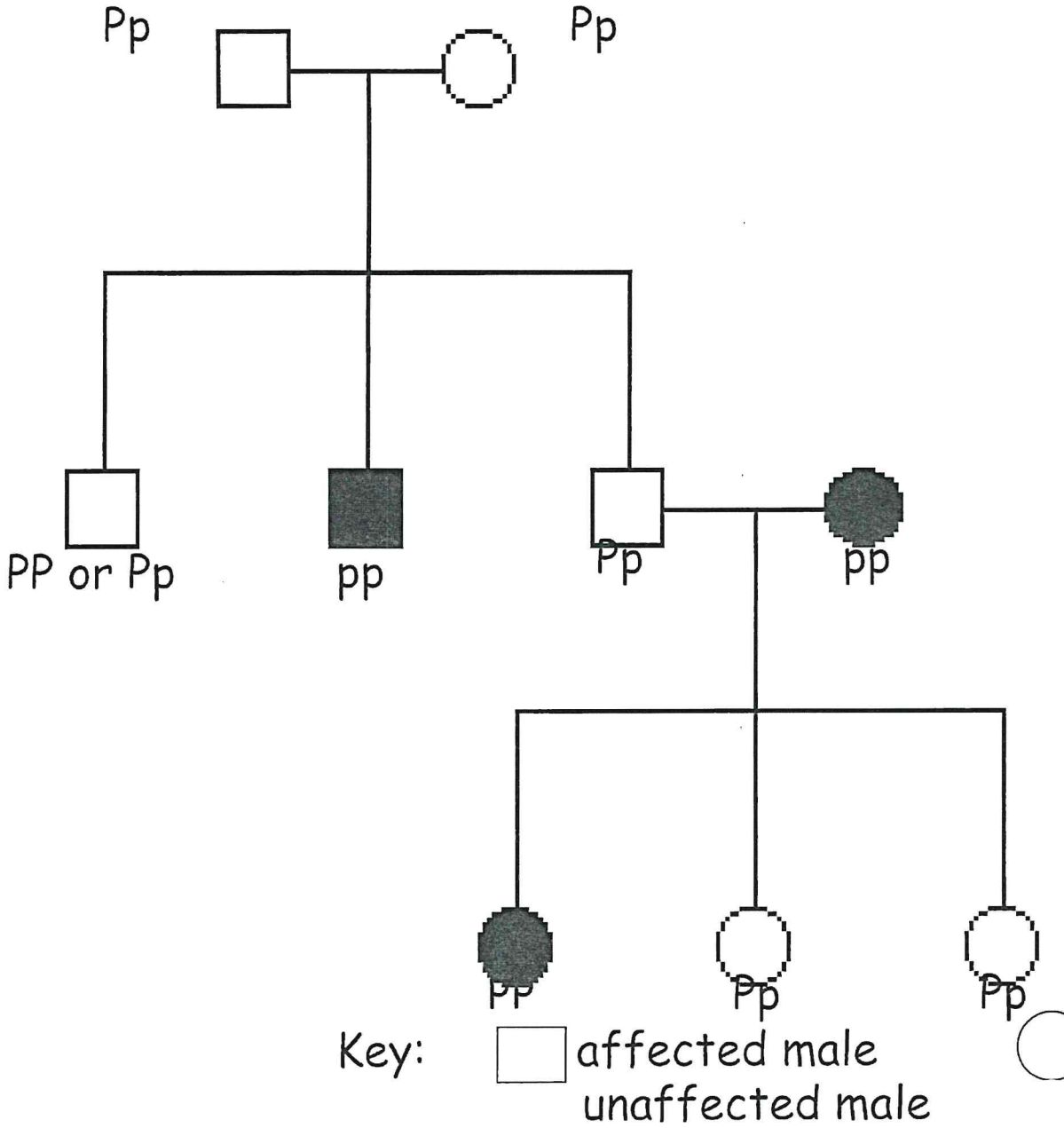
•In this example, all those who have the trait are homozygous recessive.

•Can you correctly identify all genotypes of this family?

- •F- Normal
- •f- cystic fibrosis



Key: affected male unaffected male affected femal unaffected fen



- Phenylke
  cannot b
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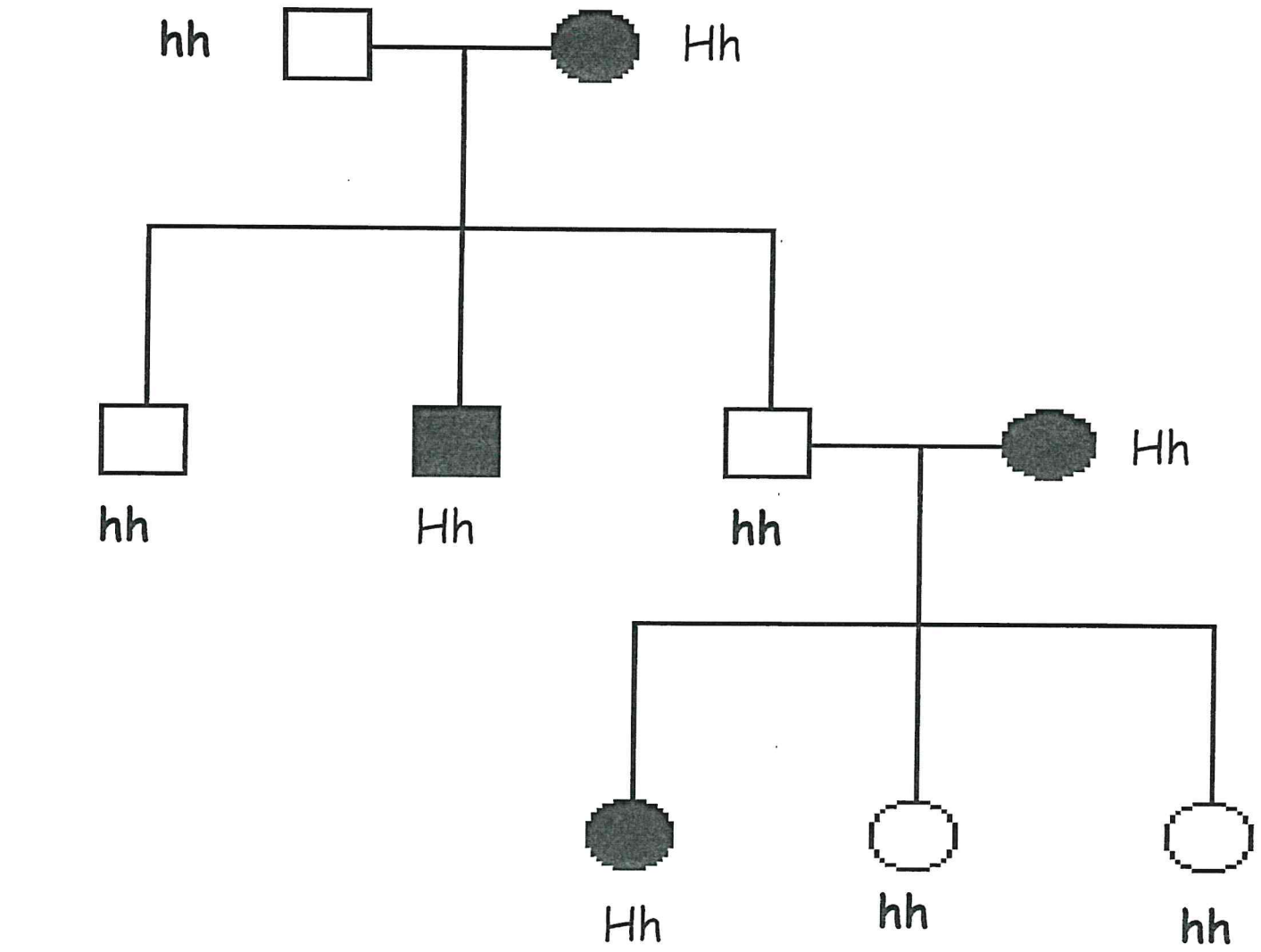
- PKU
  - P- Una
  - p- phe


hh
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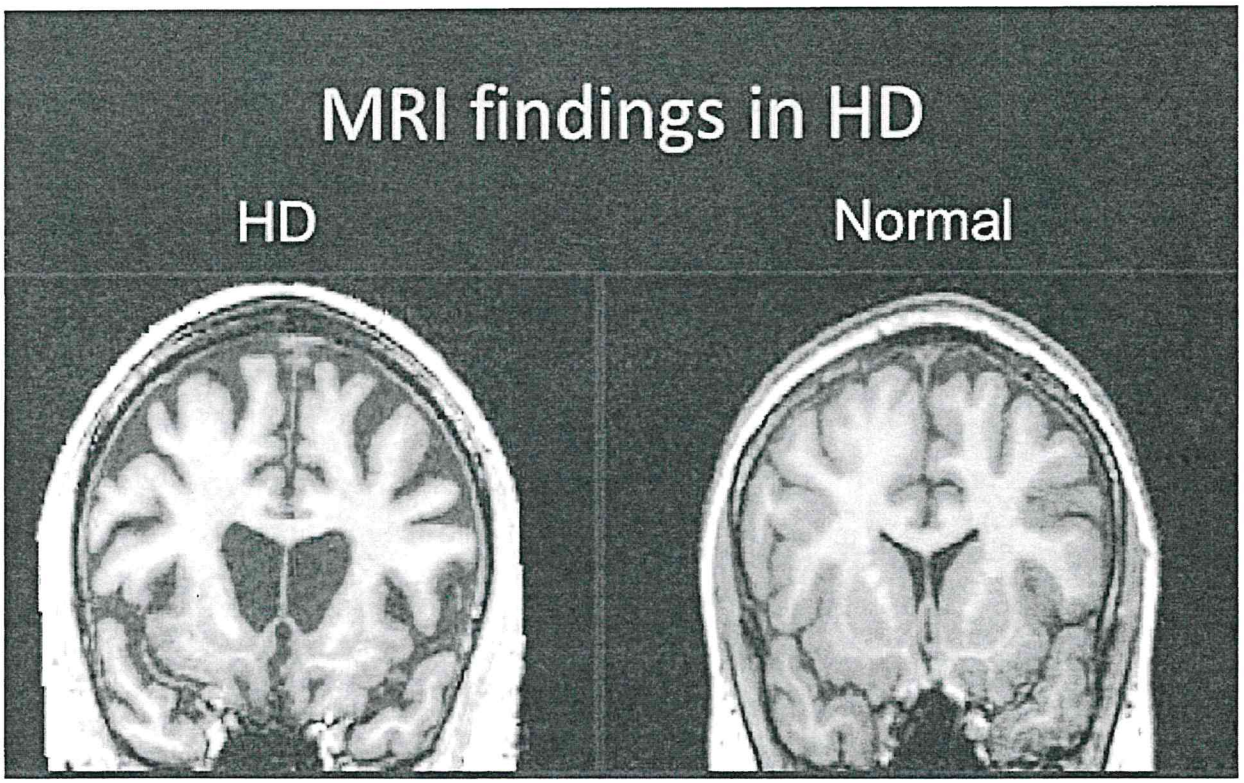
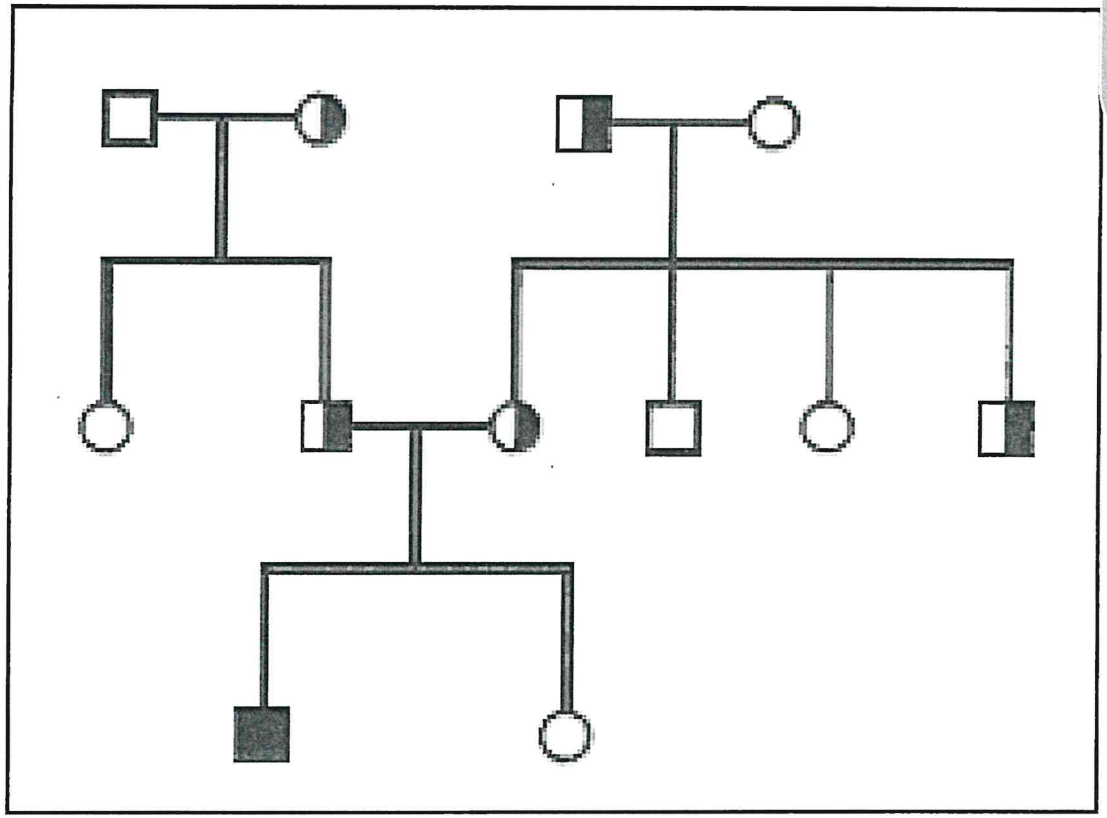
Key:
affected male
unaffected male
affected female
unaffected female

Huntington's Disease is Autosomal Domi



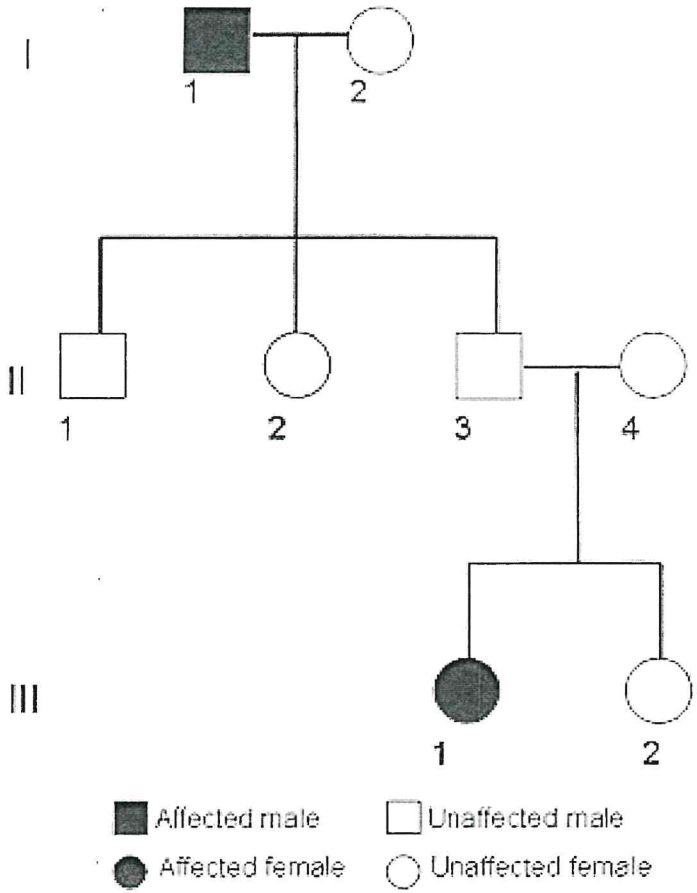
Analysis of a Recessive Trait

- How many individuals on this pedigree **have** the trait?
- How many are carriers?

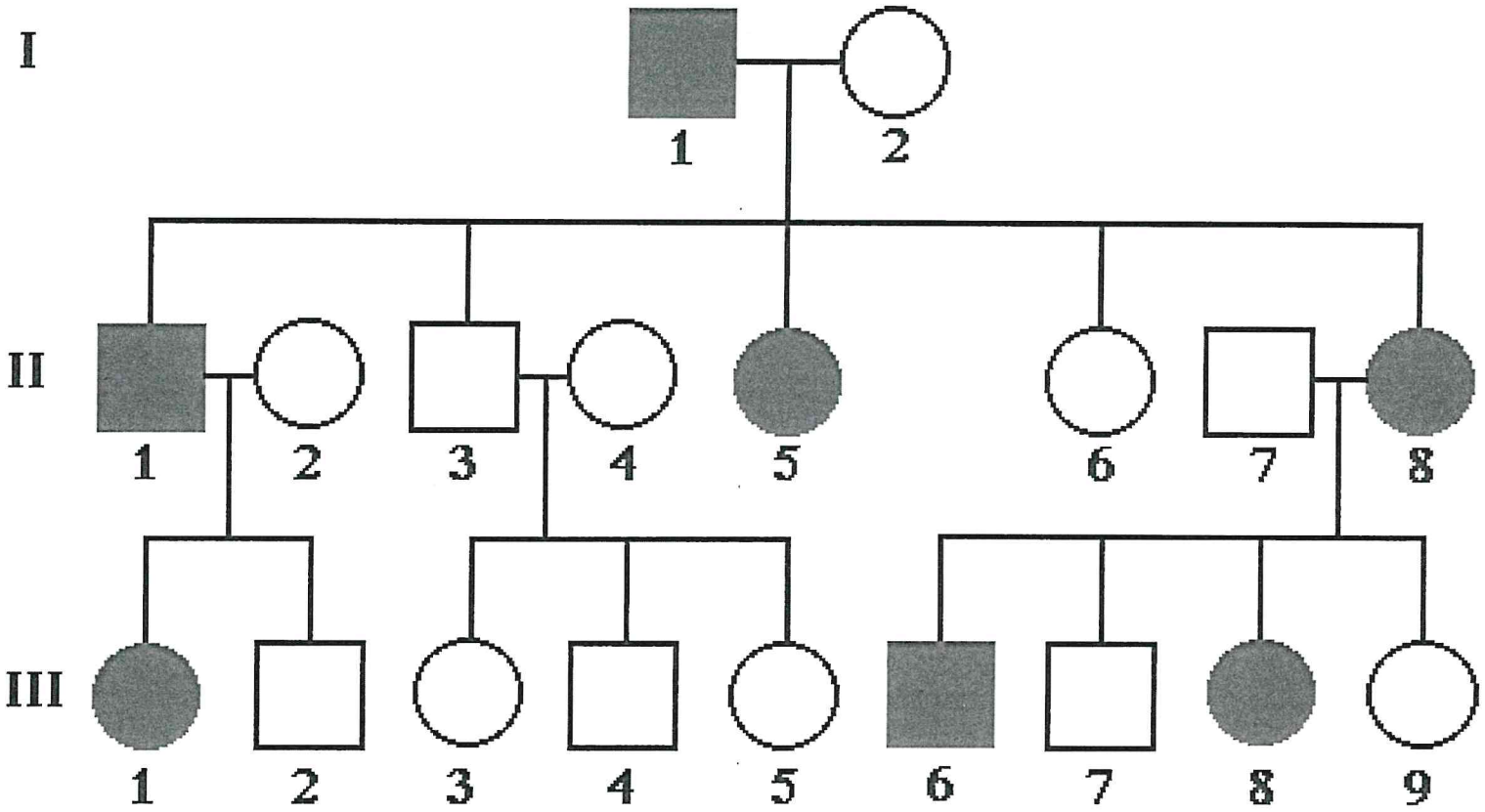


HINT
Traits
ge

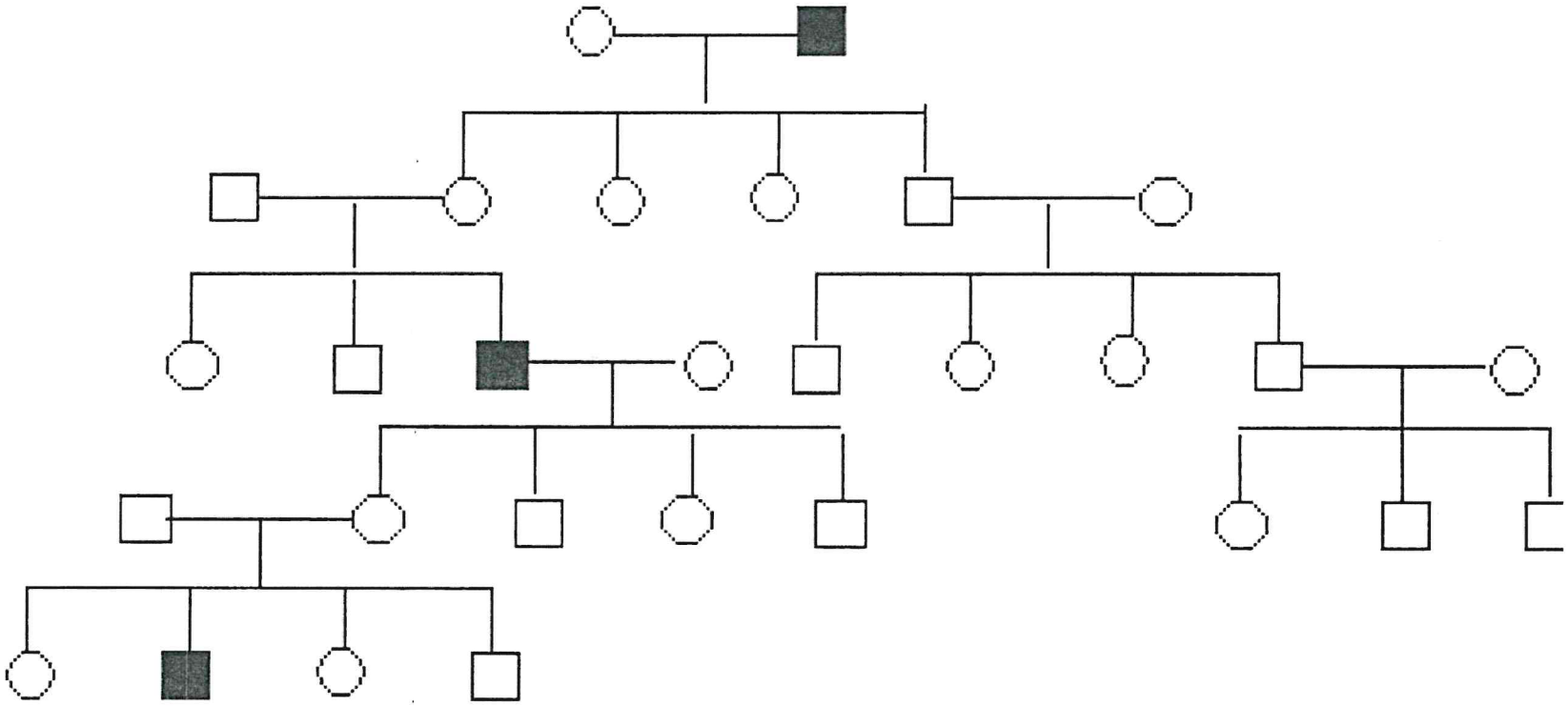
- Sometimes a pedigree is drawn without the carriers shown.
- Can you tell if the trait is recessive or dominant?
- Explain.



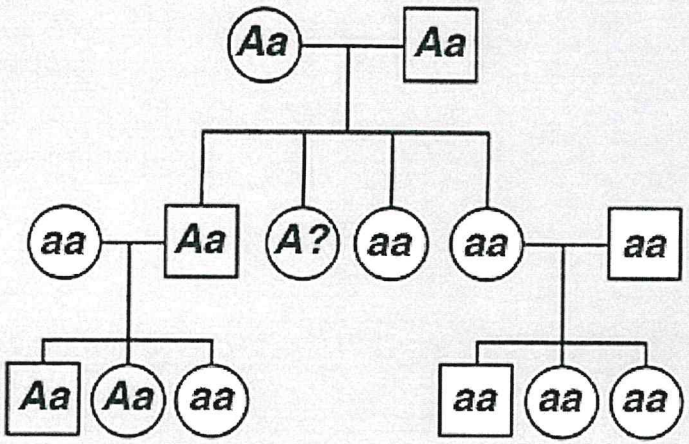
Dominant or Recessive Trait?



Dominant or Recessive Trait?



Autosomal dominant pedigree chart

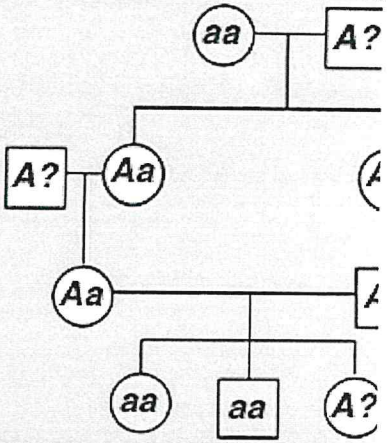


Autosomal dominant disorders

- Affected children usually have an affected parent.
- Heterozygotes (*Aa*) are affected.
- Two affected parents can produce an unaffected child.
- Two unaffected parents will not have affected children.
- Both males and females are affected with equal frequency.

Key:
AA = affected
Aa = affected
aa = normal

Autosomal recessive p



Autosomal recessive disorders

- Most affected children have normal parents.
- Heterozygotes (*Aa*) have a normal phenotype
- Two affected parents will always have affecte
- Affected individuals with homozygous norma normal children.
- Close relatives who reproduce are more likel affected children.
- Both males and females are affected with equ

The difference between Autosomal Dominant & Autosomal Re

Khan Academy

Assign to 19-20 AP Biology- 3rd Period All students due by Mar 18th, 11:59 PM Save Assign

Assign Day 12: Take notes and send them to me! ☺

Polygenic inheritance and environmental effects

AP Bio: IST-1.J (LO), IST-1.J.3 (EK), SYI-3 (EU), SYI-3.B (LO), SYI-3.B.1 (EK)

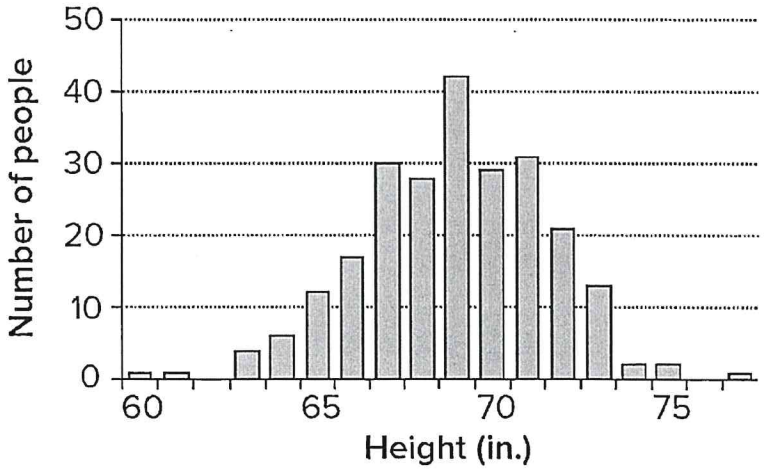
Traits that are controlled by multiple genes and/or influenced by the environment. Penetrance and expressivity.

How is height inherited?

If what you're really interested in is human genetics, learning about Mendelian genetics can sometimes be frustrating. You'll often hear a teacher use a human trait as an example in a genetics problem, but then say, "that's an oversimplification" or "it's much more complicated than that." So, what's actually going on with those interesting human traits, such as eye color, hair and skin color, height, and disease risk?

As an example, let's consider human height. Unlike a simple Mendelian characteristic, human height displays:

- **Continuous variation.** Unlike Mendel's pea plants, humans don't come in two clear-cut "tall" and "short" varieties. In fact, they don't even come in four heights, or eight, or sixteen. Instead, it's possible to get humans of many different heights, and height can vary in increments of inches or fractions of inches[1].



The heights of a group of male high school seniors. Image modified from "Continuous variation: Quantitative traits," by J. W. Kimball (CC BY 3.0)

- **A complex inheritance pattern.** You may have noticed that tall parents can have a short child, short parents can have a tall child, and two parents of different heights may or may not have a child in the middle. Also, siblings with the same two parents may have a range of

heights, ones that don't fall into distinct categories.

Simple models involving one or two genes can't accurately predict all of these inheritance patterns. How, then, is height inherited?

Height and other similar features are controlled not just by one gene, but rather, by multiple (often many) genes that each make a small contribution to the overall outcome. This inheritance pattern is sometimes called **polygenic inheritance** (*poly-* = many). For instance, a recent study found over 400 genes linked to variation in height[2].

When there are large numbers of genes involved, it becomes hard to distinguish the effect of each individual gene, and even harder to see that gene variants (alleles) are inherited according to Mendelian rules. In an additional complication, height doesn't just depend on genetics: it also depends on environmental factors, such as a child's overall health and the type of nutrition he or she gets while growing up.

In this article, we'll examine how complex traits such as height are inherited. We'll also see how factors like genetic background and environment can affect the **phenotype** (observable features) produced by a particular **genotype** (set of gene variants, or alleles).

Polygenic inheritance

Human features like height, eye color, and hair color come in lots of slightly different forms because they are controlled by many genes, each of which contributes some amount to the overall phenotype. For example, there are two major eye color genes, but at least 14 other genes that play roles in determining a person's exact eye color[3].

Looking at a real example of a human polygenic trait would get complicated, largely because we'd have to keep track of tens, or even hundreds, of different allele pairs (like the 400 involved in height!). However, we can use an example involving wheat kernels to see how several genes whose alleles "add up" to influence the same trait can produce a spectrum of phenotypes[1,4].

In this example, there are three genes that make reddish pigment in wheat kernels, which we'll call *A*, *B*, and *C*. Each comes in two alleles, one of which makes pigment (the capital-letter allele) and one of which does not (the lowercase allele). These alleles have additive effects: the *aa* genotype would contribute no pigment, the *Aa* genotype would contribute some amount of pigment, and the *AA* genotype would contribute more pigment (twice as much as *Aa*). The same would hold true for the *B* and *C* genes[1,4].

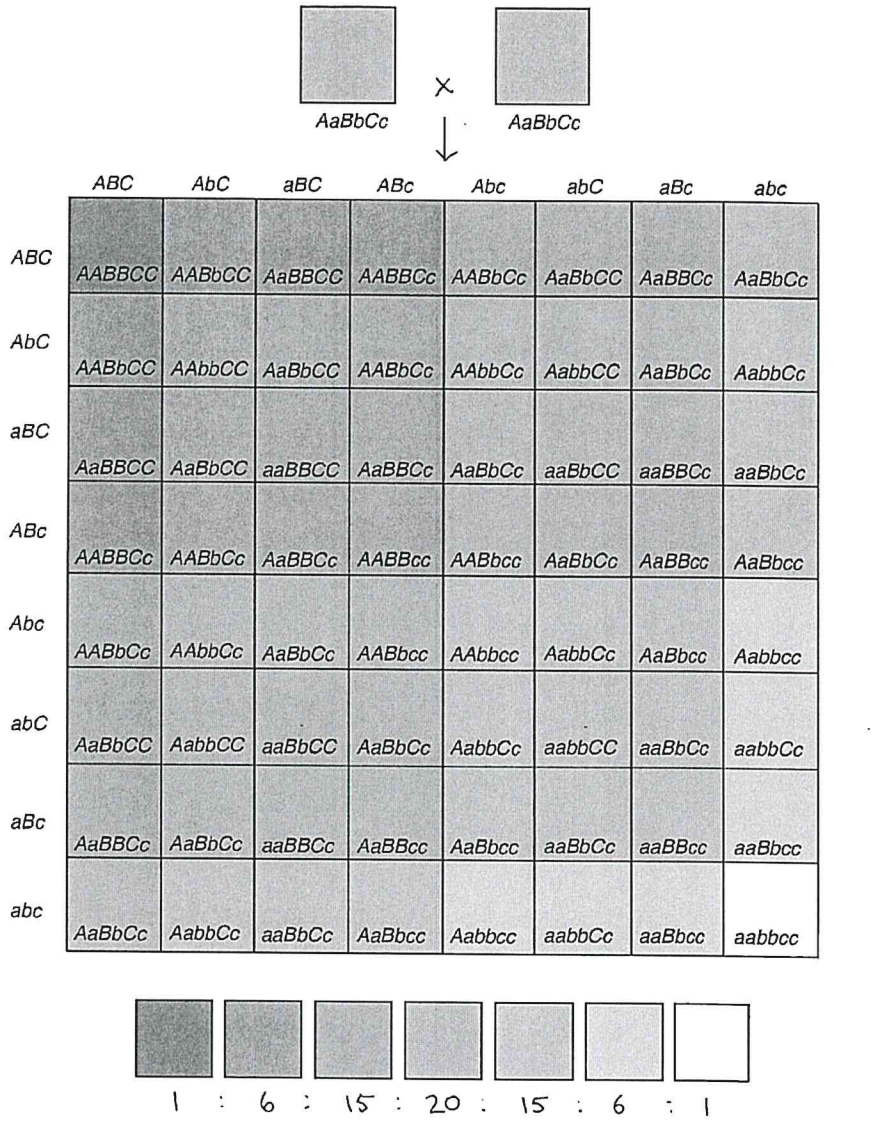


Diagram based on similar diagram by W. P. Armstrong[5].

Now, let's imagine that two plants heterozygous for all three genes (*AaBbCc*) were crossed to one another. Each of the parent plants would have three alleles that made pigment, leading to pinkish kernels. Their offspring, however, would fall into seven color groups, ranging from no pigment whatsoever (*aabbcc*) and white kernels to lots of pigment (*AABBCC*) and dark red kernels. This is in

fact what researchers have seen when crossing certain varieties of wheat[1,4].

This example shows how we can get a spectrum of slightly different phenotypes (something close to continuous variation) with just three genes. It's not hard to imagine that, as we increased the number of genes involved, we'd be able to get even finer variations in color, or in another trait such as height.

Environmental effects

Human phenotypes—and phenotypes of other organisms—also vary because they are affected by the environment. For instance, a person may have a genetic tendency to be underweight or obese, but his or her actual weight will depend on diet and exercise (with these factors often playing a greater role than genes). In another example, your hair color may depend on your genes—until you dye your hair purple!

One striking example of how environment can affect phenotype comes from the hereditary disorder **phenylketonuria (PKU)**[6]. People who are homozygous for disease alleles of the PKU gene lack activity of an enzyme that breaks down the amino acid phenylalanine. Because people with this disorder cannot get rid of excess phenylalanine, it rapidly builds up to toxic levels in their bodies[7].

If PKU is not treated, the extra phenylalanine can keep the brain from developing normally, leading to intellectual disability, seizures, and mood disorders. However, because PKU is caused by the buildup of too much phenylalanine, it can also be treated in a very simple way: by giving affected babies and children a diet low in phenylalanine[8].

If people with phenylketonuria follow this diet strictly from a very young age, they can have few, or even no, symptoms of the disorder. In many countries, all newborns are screened for PKU and similar genetic diseases shortly after birth through a simple blood test, as shown in the image above.

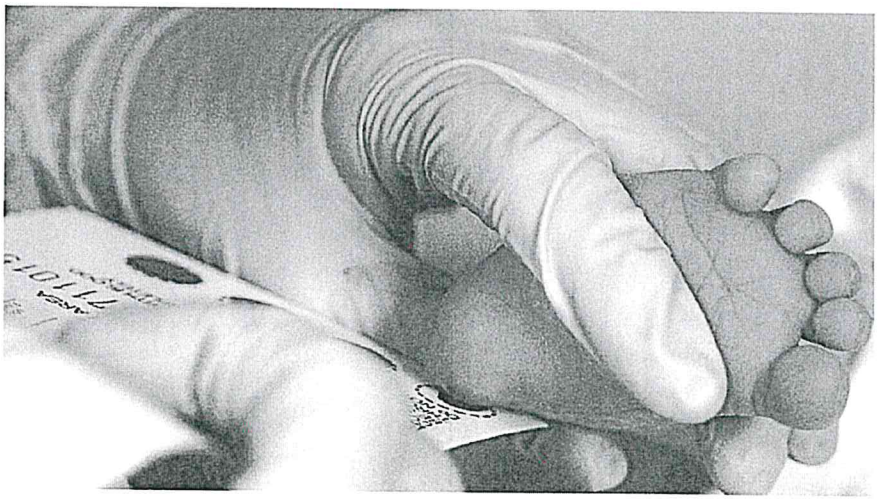


Image credit: "Phenylketonuria testing," by Eric T. Sheler, USAF Photographic Archives (public domain).

Variable expressivity, incomplete penetrance

Even for characteristics that are controlled by a single gene, it's possible for individuals with the same genotype to have different phenotypes. For example, in the case of a genetic disorder, people with the same disease genotype may have stronger or weaker forms of the disorder, and some may never develop the disorder at all.

In **variable expressivity**, a phenotype may be stronger or weaker in different people with the same genotype. For instance, in a group of people with a disease-causing genotype, some might develop a severe form of the disorder, while others might have a milder form. The idea of expressivity is illustrated in the diagram below, with the shade of green representing the strength of the phenotype. *[Example]*

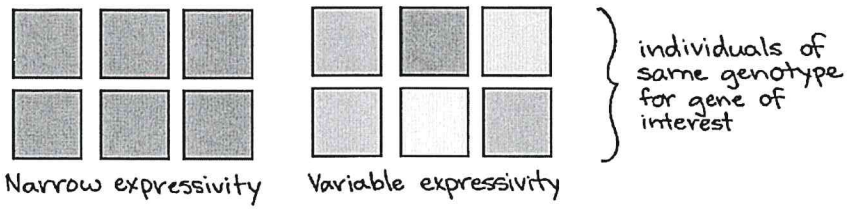


Illustration modeled after similar image by Steven M. Carr[10].

In **incomplete penetrance**, individuals with a certain genotype may or may not develop a phenotype associated with the genotype. For example, among people with the same disease-causing genotype for a hereditary disorder, some might never actually develop the disorder. The idea of penetrance is illustrated in the diagram below, with green or

white color representing the presence or absence of a phenotype. *[Example]*

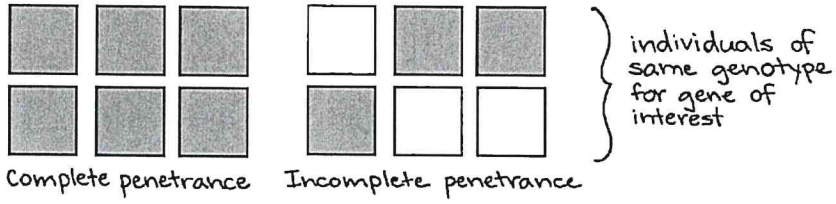


Illustration modeled after similar image by Steven M. Carr[10].

What causes variable expressivity and incomplete penetrance? Other genes and environmental effects are often part of the explanation. For example, disease-causing alleles of one gene may be suppressed by alleles of another gene elsewhere in the genome, or a person's overall health may influence the strength of a disease phenotype[11].

[Attribution and references]

Sort by: Top Voted

Questions Tips & Thanks

Want to join the conversation?

You need at least 5000 energy points to get started.

QUIZIZZ Day 13 Complete Quizizz

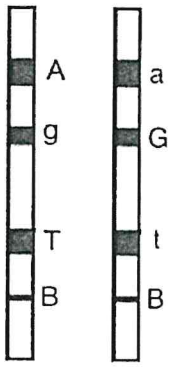
NAME : _____

CLASS : _____

DATE : _____

AP Bio Mendelian Genetics

10 Questions

1. 

Which of the following crossover events would be most difficult to detect in offspring?

☐ a) A crossover occurring in the region between gene A and G

☐ b) A crossover occurring in the region between gene G and T

☐ c) A crossover occurring in the region between gene T and B

☐ d) A crossover occurring in the region between gene A and T

2. A wide range of phenotypic variations occur in the trait for human height. Which of the following accounts for these variations?

☐ a) Polygenic Inheritance

☐ b) Codominance

☐ c) Incomplete dominance

☐ d) Multiple Alleles

3.

Genes	Frequency of crossover
5%	*B* and *D*
15%	*C* and *A*
30%	*A* and *B*
45%	*C* and *B*
50%	*C* and *D*

Map relative position of the four genes on a chromosome from the data on crossover frequencies.

☐ a) ABCD

☐ b) ADCB

☐ c) CABD

☐ d) CBAD

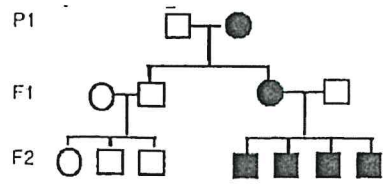
4.

Species	Cheek cell chromosome count
Humans	46
Bonobos	48
Elephant	50
Dog	78

Examine the image. Which of the following would be the respective autosomal chromosome count for each organism?

- ☐ a) 46, 48, 50, 78
- ☐ b) 44, 46, 48, 76
- ☐ c) 23, 24, 25, 39
- ☐ d) 92, 96, 100, 156

5.



The pedigree shown indicates the expression pattern of VHL in a specific family. Genetic counselors told the affected female that she and her non-carrier husband had a 50% chance of producing children with VHL. Based on this information, which of the following best describes the inheritance pattern for this disorder?

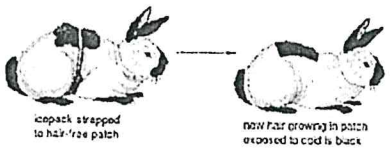
- ☐ a) X-linked recessive
- ☐ b) Incomplete dominance
- ☐ c) Autosomal dominance
- ☐ d) Autosomal recessive

6. Australian Shepherds are a breed of dogs whose coat color is directly impacted by two different genes. The gene that determines basic coat color exhibits a dominant allele (B) for black coat color and a recessive allele (b) for red coat color. Additionally, these dogs can have a solid coat color (mm) or a mixed pattern coat color called merle (Mm). The homozygous dominant coat color is called a lethal white (MM) which produces pups that are deaf and blind. What is the probability that two red Australian shepherds will produce a black pup?

- ☐ a) 0
- ☐ b) 1/4
- ☐ c) 1/2
- ☐ d) 3/4

7. The Australian Shepherds of America Club discourages from mating two merles. Which of the following best explains why merle to merle matings are undesirable?

- ☐ a) The cross has the probability of producing litters with 50% solid coat color pups.
- ☐ b) The cross produces all homozygous recessive pups
- ☐ c) The cross has the probability of producing litters with 25% merle coat pups.
- ☐ d) The cross has a 25% chance of producing homozygous dominant pups.

8. 

The diagram depicts an experiment in which ice packs were strapped to a hair-free patch on a species of rabbits. The new hair that grew in the patch exposed to cold was black.Which of the following statements is supported by the results of this experiment?

- ☐ a) The rabbits' genomes have a flexible response to environmental stimuli.
- ☐ b) The rabbits change their phenotypes to attract mates.
- ☐ c) Rabbits whose coat color does not change represent a more evolved species
- ☐ d) Increased ultraviolet light can alter the genome of these rabbits.

9. In horses, the grey coat color (G) is dominant to non-grey coat color (g). Additionally, some horses have a genetic disorder called hyperkalemic periodic paralysis or HYPP. HYPP is an inherited autosomal dominant disorder that affects the sodium channels in muscle cells. HYPP (H) is dominant to the normal condition (h). If a non-grey, normal stallion sires a foal that is not grey and does not have HYPP, which of the following genotypes are possible genotypes for the mother?

- ☐ a) GGhh and ggHH
- ☐ b) ggHH and GgHh
- ☐ c) GGHH and GGHh
- ☐ d) GgHh and gghh

10. Many plant species are capable of producing offspring through self-pollination. In self-pollination, gametes formed by meiosis and are used to fertilize egg cells from the same plant. Which of the following statements describes why offspring produced through self-pollination can exhibit genetic diversity?

- ☐ a) The genes found in each gamete will be genetically identical to one another.
- ☐ b) The self-pollination gametes are produced through meiosis and have undergone DNA replication.
- ☐ c) Homologous chromosomes were sorted into different gamete cells causing separation of allele pairs.
- ☐ d) Gametes involved in self-pollination only travel a short distance prior to becoming involved in fertilization.

Day 14 } Complete progress
Day 15 } Check on AP Central.

Khan Academy

Assign to 19-20 AP Biology- 3rd Period All students due by Mar 18th, 11:59 PM Save Assign

Assign Day 16 Take notes and send to me! :)

Nucleic acids

AP Bio: IST-1 (EU), IST-1.A (LO), IST-1.A.1 (EK), IST-1.L (LO), IST-1.L.1 (EK), IST-1.N (LO), IST-1.N.1 (EK), IST-1.N.2 (EK)

DNA and RNA structure and function. Nucleotides and polynucleotides. mRNA, rRNA, tRNA, miRNA, and siRNA.

Introduction

Nucleic acids, and DNA in particular, are key macromolecules for the continuity of life. DNA bears the hereditary information that's passed on from parents to children, providing instructions for how (and when) to make the many proteins needed to build and maintain functioning cells, tissues, and organisms.

How DNA carries this information, and how it is put into action by cells and organisms, is complex, fascinating, and fairly mind-blowing, and we'll explore it in more detail in the section on molecular

biology. Here, we'll just take a quick look at nucleic acids from the macromolecule perspective.

Roles of DNA and RNA in cells

Nucleic acids, macromolecules made out of units called nucleotides, come in two naturally occurring varieties: **deoxyribonucleic acid** (**DNA**) and **ribonucleic acid** (**RNA**). DNA is the genetic material found in living organisms, all the way from single-celled bacteria to multicellular mammals like you and me. Some viruses use RNA, not DNA, as their genetic material, but aren't technically considered to be alive (since they cannot reproduce without help from a host).

DNA in cells

In eukaryotes, such as plants and animals, DNA is found in the **nucleus**, a specialized, membrane-bound vault in the cell, as well as in certain other types of organelles (such as mitochondria and the chloroplasts of plants). In prokaryotes, such as bacteria, the DNA is not enclosed in a membranous envelope, although it's located in a specialized cell region called the **nucleoid**.

In eukaryotes, DNA is typically broken up into a number of very long, linear pieces called **chromosomes**, while in prokaryotes such as bacteria, chromosomes are much smaller and often

circular (ring-shaped). A chromosome may contain tens of thousands of **genes**, each providing instructions on how to make a particular product needed by the cell.

From DNA to RNA to proteins

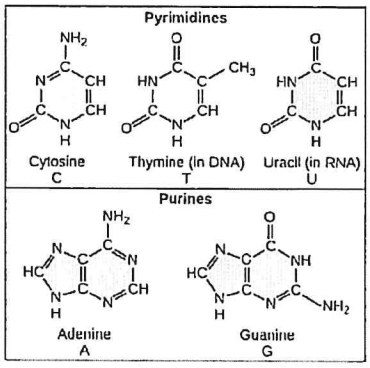
Many genes encode protein products, meaning that they specify the sequence of amino acids used to build a particular protein. Before this information can be used for protein synthesis, however, an RNA copy (transcript) of the gene must first be made. This type of RNA is called a **messenger RNA (mRNA)**, as it serves as a messenger between DNA and the ribosomes, molecular machines that read mRNA sequences and use them to build proteins. This progression from DNA to RNA to protein is called the "central dogma" of molecular biology.

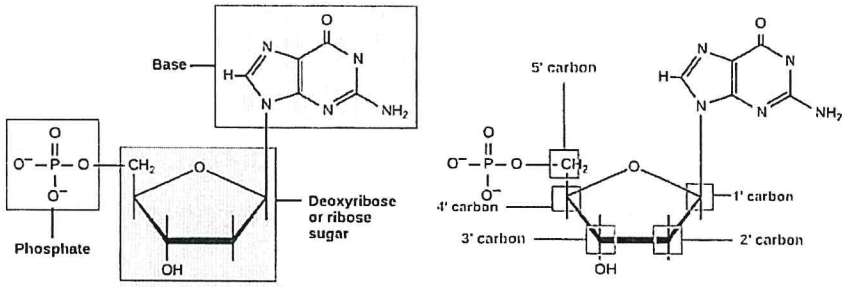
Importantly, not all genes encode protein products. For instance, some genes specify **ribosomal RNAs (rRNAs)**, which serve as structural components of ribosomes, or **transfer RNAs (tRNAs)**, cloverleaf-shaped RNA molecules that bring amino acids to the ribosome for protein synthesis. Still other RNA molecules, such as tiny **microRNAs (miRNAs)**, act as regulators of other genes, and new types of non-protein-coding RNAs are being discovered all the time.

Nucleotides

DNA and RNA are polymers (in the case of DNA, often very long polymers), and are made up of monomers known as **nucleotides**. When these monomers combine, the resulting chain is called a **polynucleotide** (*poly-* = "many").

Each nucleotide is made up of three parts: a nitrogen-containing ring structure called a nitrogenous base, a five-carbon sugar, and at least one phosphate group. The sugar molecule has a central position in the nucleotide, with the base attached to one of its carbons and the phosphate group (or groups) attached to another. Let's look at each part of a nucleotide in turn.





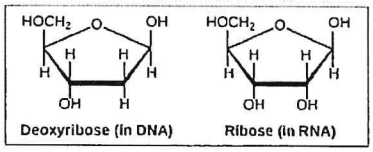


Image modified from "Nucleic acids: Figure 1," by OpenStax College, Biology (CC BY 3.0).

Nitrogenous bases

The nitrogenous bases of nucleotides are organic (carbon-based) molecules made up of nitrogen-containing ring structures. *[Why is it called a base?]*

Each nucleotide in DNA contains one of four possible nitrogenous bases: adenine (A), guanine (G) cytosine (C), and thymine (T). Adenine and guanine are **purines**, meaning that their structures contain two fused carbon-nitrogen rings. Cytosine and thymine, in contrast, are **pyrimidines** and have a single carbon-nitrogen ring. RNA nucleotides may also bear adenine, guanine and cytosine bases, but instead of thymine they have another pyrimidine base called uracil (U). As shown in the figure above, each base has a unique structure, with its own set of functional groups attached to the ring structure.

In molecular biology shorthand, the nitrogenous bases are often just referred to by their one-letter symbols, A, T, G, C, and U. DNA contains A, T, G, and C, while RNA contains A, U, G, and C (that is, U is swapped in for T).

Sugars

In addition to having slightly different sets of bases, DNA and RNA nucleotides also have slightly different sugars. The five-carbon sugar in DNA is

called **deoxyribose**, while in RNA, the sugar is **ribose**. These two are very similar in structure, with just one difference: the second carbon of ribose bears a hydroxyl group, while the equivalent carbon of deoxyribose has a hydrogen instead. The carbon atoms of a nucleotide's sugar molecule are numbered as 1′, 2′, 3′, 4′, and 5′ (1′ is read as "one prime"), as shown in the figure above. In a nucleotide, the sugar occupies a central position, with the base attached to its 1′ carbon and the phosphate group (or groups) attached to its 5′ carbon.

Phosphate

Nucleotides may have a single phosphate group, or a chain of up to three phosphate groups, attached to the 5' carbon of the sugar. Some chemistry sources use the term "nucleotide" only for the single-phosphate case, but in molecular biology, the broader definition is generally accepted[1]

In a cell, a nucleotide about to be added to the end of a polynucleotide chain will bear a series of three phosphate groups. When the nucleotide joins the growing DNA or RNA chain, it loses two phosphate groups. So, in a chain of DNA or RNA, each nucleotide has just one phosphate group.

Polynucleotide chains

A consequence of the structure of nucleotides is that a polynucleotide chain has **directionality** – that is, it has two ends that are different from each other. At the **5' end**, or beginning, of the chain, the 5' phosphate group of the first nucleotide in the chain sticks out. At the other end, called the **3' end**, the 3' hydroxyl of the last nucleotide added to the chain is exposed. DNA sequences are usually written in the 5' to 3' direction, meaning that the nucleotide at the 5' end comes first and the nucleotide at the 3' end comes last.

As new nucleotides are added to a strand of DNA or RNA, the strand grows at its 3' end, with the 5′ phosphate of an incoming nucleotide attaching to the hydroxyl group at the 3' end of the chain. This makes a chain with each sugar joined to its neighbors by a set of bonds called a **phosphodiester linkage**.

Properties of DNA

Deoxyribonucleic acid, or DNA, chains are typically found in a **double helix**, a structure in which two matching (complementary) chains are stuck together, as shown in the diagram at left. The sugars and phosphates lie on the outside of the helix, forming the backbone of the DNA; this portion of the molecule is sometimes called the **sugar-phosphate** backbone. The nitrogenous bases

extend into the interior, like the steps of a staircase, in pairs; the bases of a pair are bound to each other by hydrogen bonds.

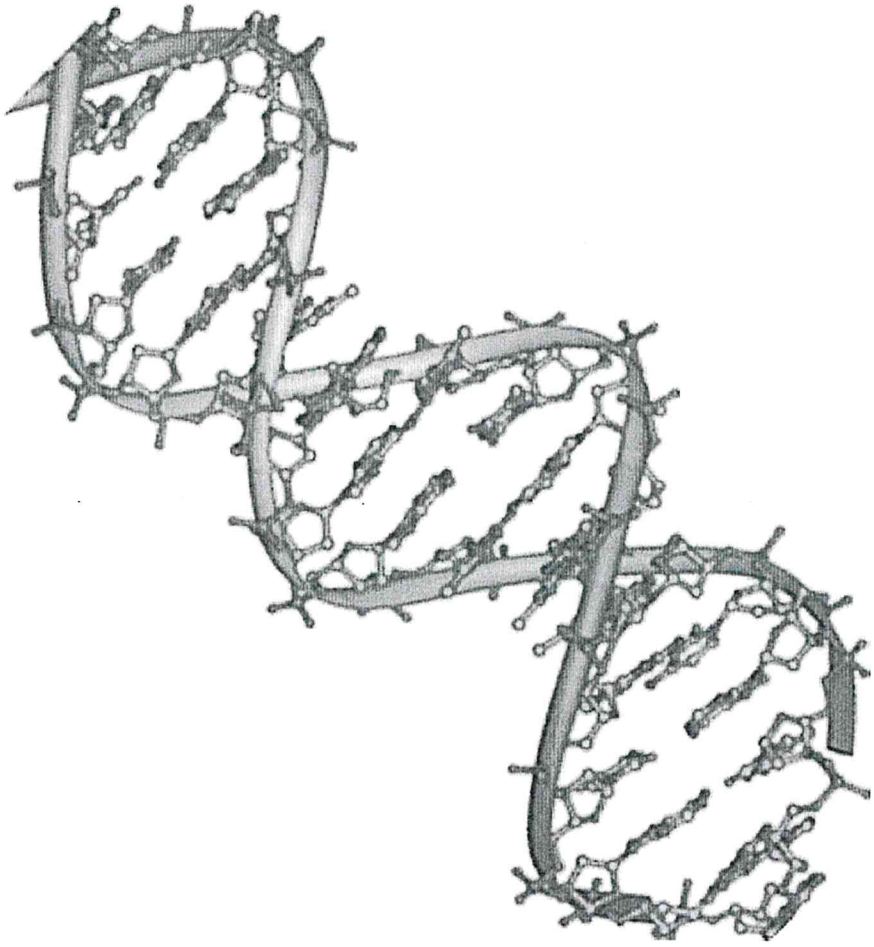


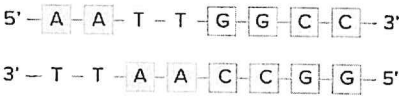
Image credit: Jerome Walker/Dennis Myts.

The two strands of the helix run in opposite directions, meaning that the 5′ end of one strand is paired up with the 3′ end of its matching strand. (This is referred to as **antiparallel** orientation and is important for the copying of DNA.)

So, can any two bases decide to get together and form a pair in the double helix? The answer is a definite no. Because of the sizes and functional

groups of the bases, base pairing is highly specific: A can only pair with T, and G can only pair with C, as shown below. This means that the two strands of a DNA double helix have a very predictable relationship to each other.

For instance, if you know that the sequence of one strand is 5'-AATTGGCC-3', the complementary strand must have the sequence 3'-TTAACCGG-5'. This allows each base to match up with its partner:



When two DNA sequences match in this way, such that they can stick to each other in an antiparallel fashion and form a helix, they are said to be **complementary**.

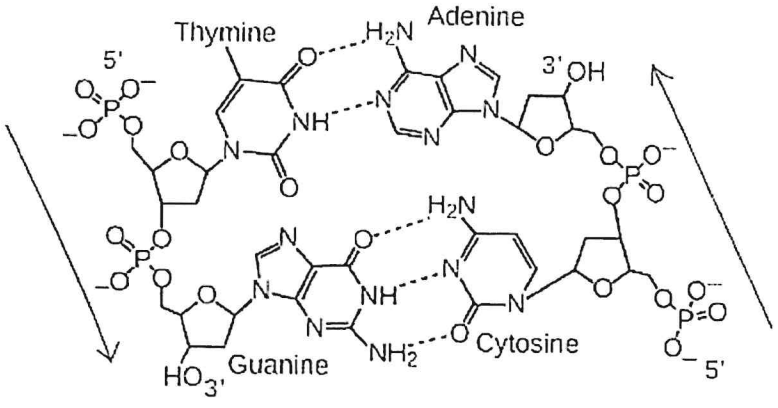


Image modified from OpenStax Biology.

Properties of RNA

Ribonucleic acid (RNA), unlike DNA, is usually single-stranded. A nucleotide in an RNA chain will contain ribose (the five-carbon sugar), one of the four nitrogenous bases (A, U, G, or C), and a phosphate group. Here, we'll take a look at four major types of RNA: messenger RNA (mRNA), ribosomal RNA (rRNA), transfer RNA (tRNA), and regulatory RNAs.

Messenger RNA (mRNA)

Messenger RNA (mRNA) is an intermediate between a protein-coding gene and its protein product. If a cell needs to make a particular protein, the gene encoding the protein will be turned "on," meaning an RNA-polymerizing enzyme will come and make an RNA copy, or transcript, of the gene's DNA sequence. The transcript carries the same information as the DNA sequence of its gene. However, in the RNA molecule, the base T is replaced with U. For instance, if a DNA coding strand has the sequence 5'-AATTGCGC-3', the sequence of the corresponding RNA will be 5'-AAUUGCGC-3'.

Once an mRNA has been produced, it will associate with a ribosome, a molecular machine that specializes in assembling proteins out of amino acids. The ribosome uses the information in the mRNA to make a protein of a specific sequence,

"reading out" the mRNA's nucleotides in groups of three (called **codons**) and adding a particular amino acid for each codon.

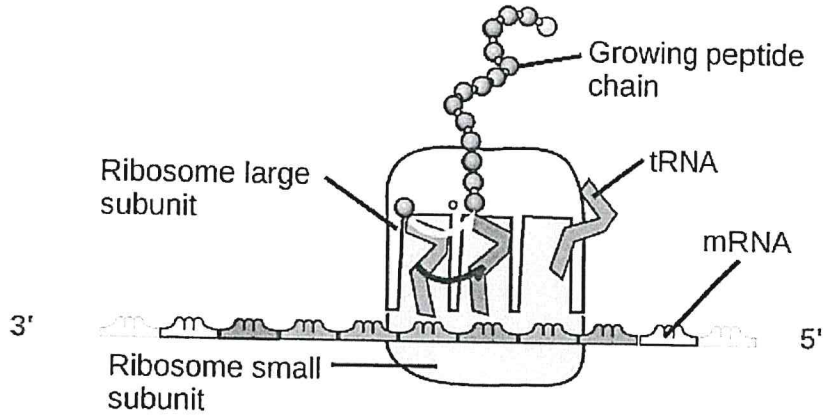


Image credit: OpenStax Biology.

Ribosomal RNA (rRNA) and transfer RNA (tRNA)

Ribosomal RNA (**rRNA**) is a major component of ribosomes, where it helps mRNA bind in the right spot so its sequence information can be read out. Some rRNAs also act as enzymes, meaning that they help accelerate (catalyze) chemical reactions – in this case, the formation of bonds that link amino acids to form a protein. RNAs that act as enzymes are known as **ribozymes**.

Transfer RNAs (**tRNAs**) are also involved in protein synthesis, but their job is to act as carriers – to bring amino acids to the ribosome, ensuring that the amino acid added to the chain is the one specified by the mRNA. Transfer RNAs consist of a single strand of RNA, but this strand has

complementary segments that stick together to make double-stranded regions. This base-pairing creates a complex 3D structure important to the function of the molecule.

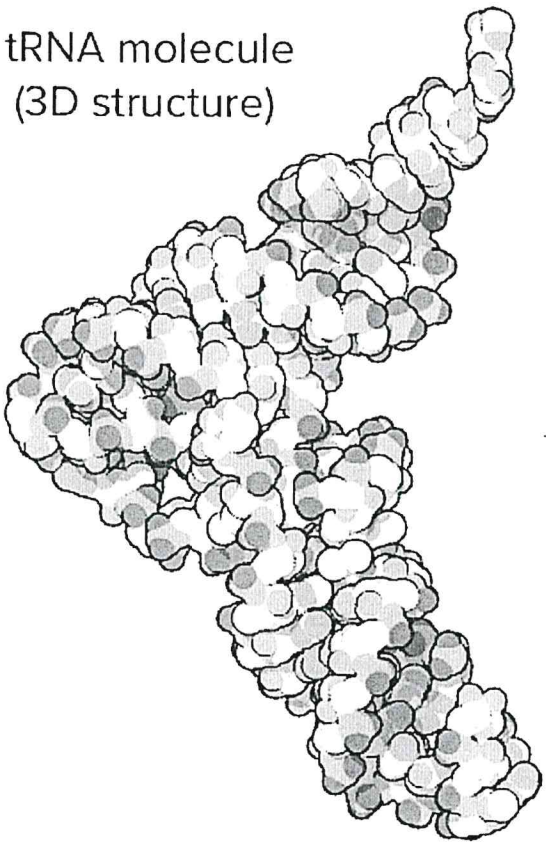


Image modified from Protein Data Bank (work of the U.S. government).

Regulatory RNA (miRNAs and siRNAs)

Some types of non-coding RNAs (RNAs that do not encode proteins) help regulate the expression of other genes. Such RNAs may be called regulatory RNAs. For example, **microRNAs** (**miRNAs**) and **small interfering RNAs siRNAs** are small regulatory RNA molecules about 22 nucleotides long. They bind to specific mRNA molecules (with partly or

fully complementary sequences) and reduce their stability or interfere with their translation, providing a way for the cell to decrease or fine-tune levels of these mRNAs.

These are just some examples out of many types of noncoding and regulatory RNAs. Scientists are still discovering new varieties of noncoding RNA.

[More about regulatory RNAs]

Summary: Features of DNA and RNA

	DNA	RNA
Function	Repository of genetic information	Involved in protein synthesis and gene regulation; carrier of genetic information in some viruses
Sugar	Deoxyribose	Ribose
Structure	Double helix	Usually single-stranded
Bases	C, T, A, G	C, U, A, G

Table modified from OpenStax Biology.

Khan Academy

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Assign Day 17: Take notes and send to me! ☺

Replication

- DNA strands
- Leading and lagging strands in DNA replication
- Speed and precision of DNA replication
- Semi conservative replication
- Molecular mechanism of DNA replication

DNA structure and replication review

AP Bio: IST-1 (EU), IST-1.M (LO), IST-1.M.1 (EK)

Key terms

Term	Meaning
DNA (deoxyribonucleic acid)	Nucleic acid that transmits genetic information from parent to offspring and codes for the production of proteins
Nucleotide	Building block of nucleic acids
Double helix	Structure of two strands, intertwining around an axis like a twisted ladder

Term	Meaning
DNA replication	Process during which a double-stranded DNA molecule is copied to produce two identical DNA molecules
Base pairing	Principle in which the nitrogenous bases of the DNA molecules bond with one another

DNA structure

DNA is a nucleic acid, one of the four major groups of biological macromolecules.

Nucleotides

All nucleic acids are made up of **nucleotides**. In DNA, each nucleotide is made up of three parts: a 5-carbon sugar called deoxyribose, a phosphate group, and a nitrogenous base.

DNA uses four kinds of nitrogenous bases: adenine (A), guanine (G) cytosine (C), and thymine (T).

RNA nucleotides may also contain adenine, guanine and cytosine bases, but instead of thymine they have another base called uracil (U).

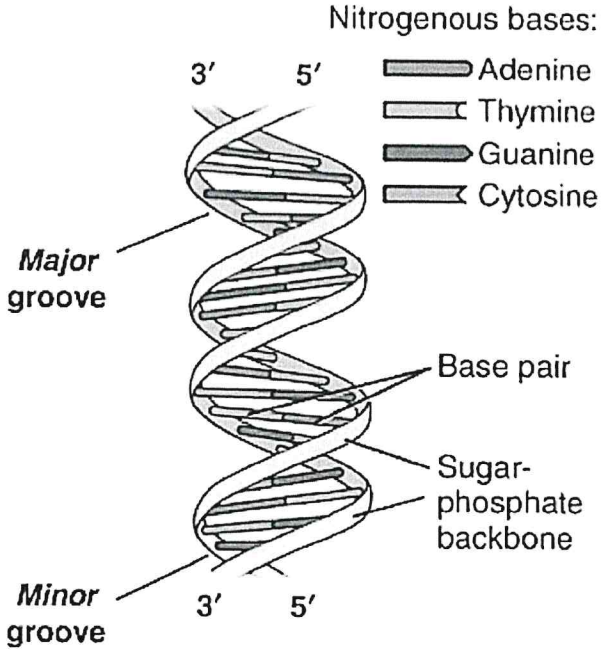
Chargaff's rules

In the 1950s, a biochemist named Erwin Chargaff discovered that the amounts of the nitrogenous bases (A, T, C, and G) were not found in equal quantities. However, the amount of A always equalled the amount of T, and the amount of C always equalled the amount of G.

These findings turned out to be crucial to uncovering the model of the DNA double helix.

Double helix

The discovery of the **double helix** structure of DNA was made thanks to a number of scientists in the 1950s.



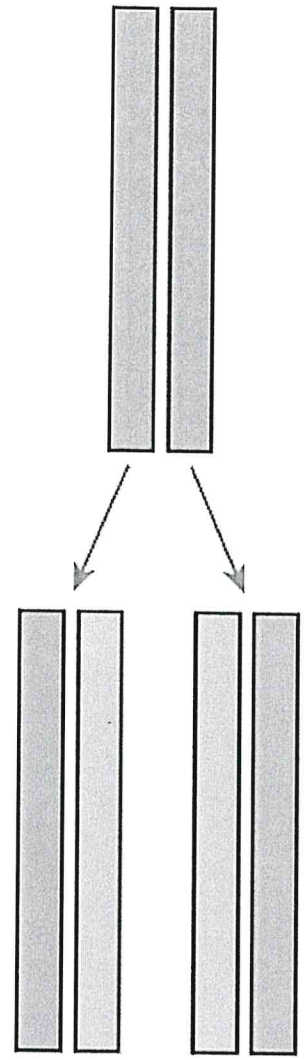
DNA double helix. Image modified from OpenStax, CC BY 3.0.

DNA molecules have an *antiparallel* structure - that is, the two strands of the helix run in opposite directions of one another. Each strand has a 5' end and a 3' end.

Solving the structure of DNA was one of the great scientific achievements of the century.

Knowing the structure of DNA unlocked the door to understanding many aspects of DNA's function, such as how it is copied and how the information it carries can be used to produce proteins.

DNA replication

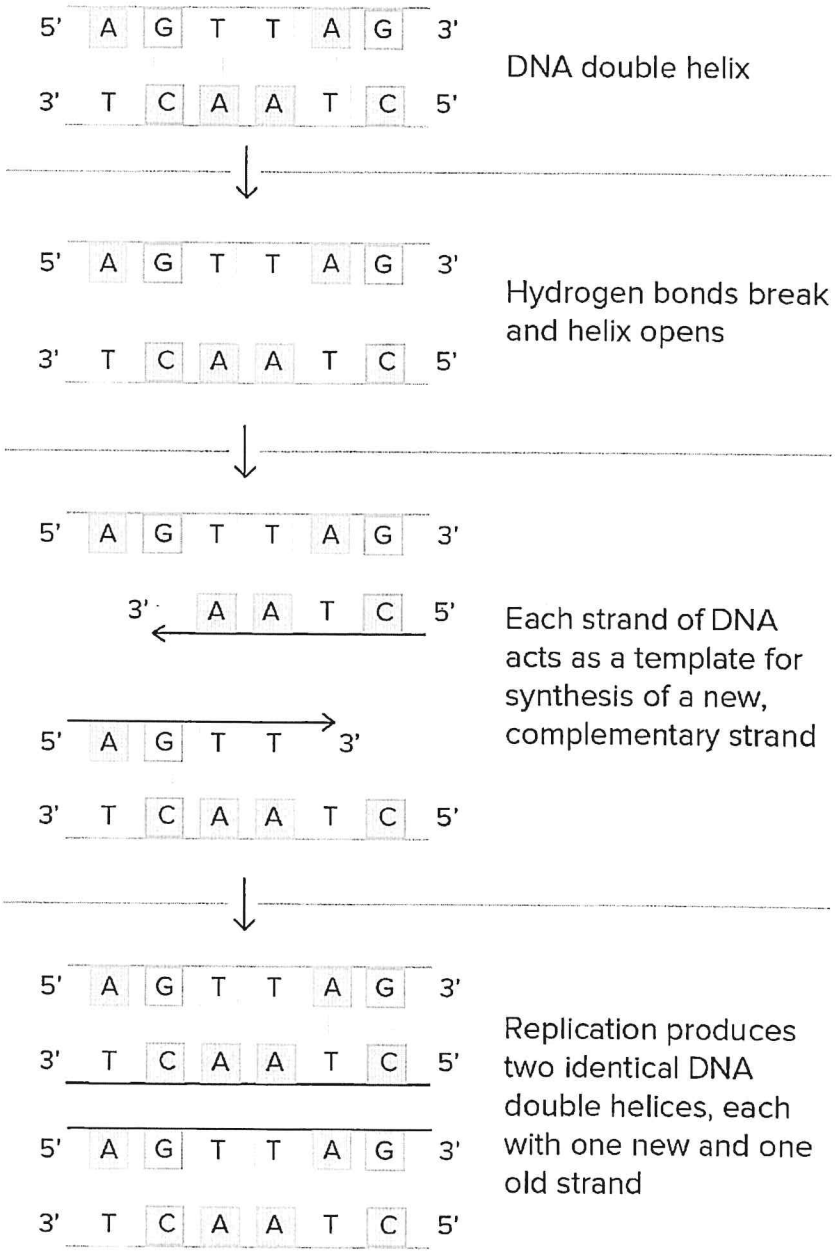


Semi-conservative replication. Image modified from OpenStax, CC BY 3.0.

DNA replication is semi-conservative. This means that each of the two strands in double-stranded DNA acts as a template to produce two new strands.

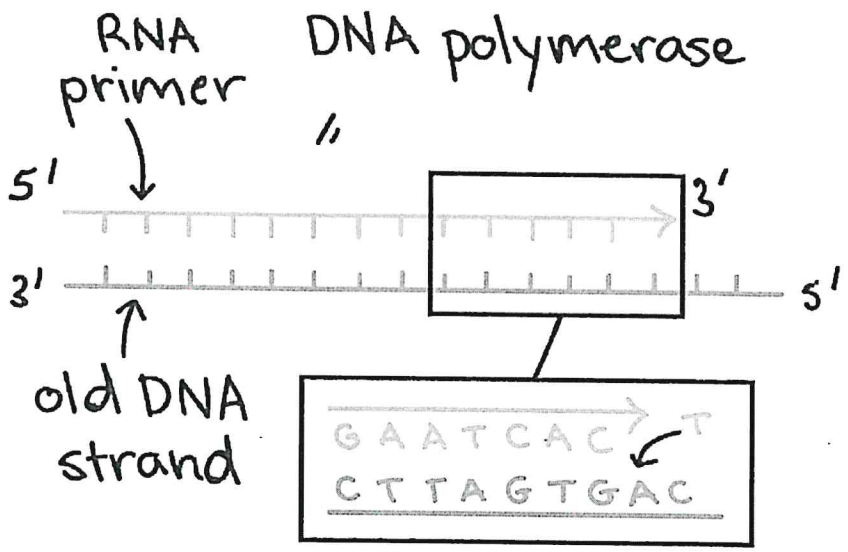
Replication relies on complementary **base pairing**, that is the principle explained by Chargaff's rules: adenine (A) always bonds with thymine (T) and cytosine (C) always bonds with guanine (G).

The replication process



DNA replication occurs through the help of several enzymes. These enzymes "unzip" DNA molecules by breaking the hydrogen bonds that hold the two strands together.

Each strand then serves as a template for a new *complementary strand* to be created. Complementary bases attach to one another (A-T and C-G).



The primary enzyme involved in this is *DNA polymerase* which joins nucleotides to synthesize the new complementary strand. DNA polymerase also proofreads each new DNA strand to make sure that there are no errors.

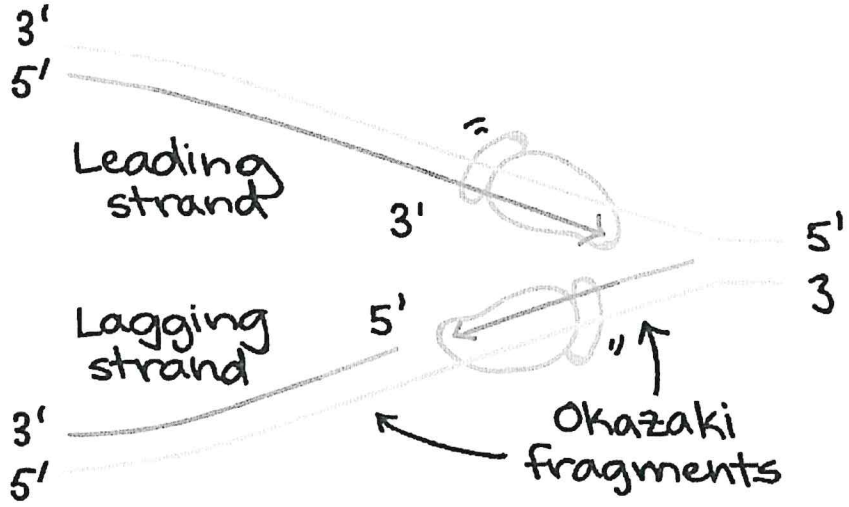
Leading and lagging strands

DNA is made differently on the two strands at a replication fork.

One new strand, the *leading strand*, runs 5' to 3' towards the fork and is made continuously.

The other, the *lagging strand*, runs 5' to 3' away from the fork and is made in small pieces called

Okazaki fragments.



Example: Determining a complementary strand

DNA is only synthesized in the 5' to 3' direction. You can determine the sequence of a complementary strand if you are given the sequence of the template strand.

For instance, if you know that the sequence of one strand is 5'-AATTGGCC-3', the complementary strand must have the sequence 3'-TTAACCGG-5'. This allows each base to match up with its partner:

5' — A — A — T — T — G — G — C — C — 3'

3' — T — T — A — A — C — C — G — G — 5'

Common mistakes and misconceptions

- **DNA replication is not the same as cell division.** Replication occurs before cell division, during the S phase of the cell cycle. However, replication only concerns the production of new DNA strands, not of new cells.

- **Some people think that in the leading strand, DNA is synthesized in the 5' to 3' direction, while in lagging strand, DNA is synthesized in the 3' to 5' direction.** This is not the case. DNA polymerase only synthesizes DNA in the 5' to 3' direction only. The difference between the leading and lagging strands is that the leading strand is formed towards replication fork, while the lagging strand is formed away from replication fork.

Sort by: Top Voted

Questions Tips & Thanks

Want to join the conversation?

You need at least 5000 energy points to get started.

Samuel Rex 4 years ago

more

What does the "prime" mean when he is

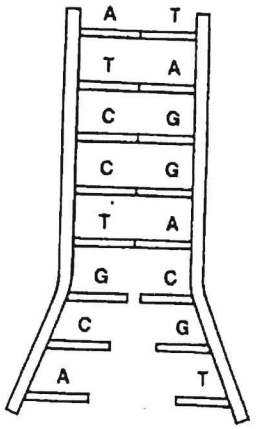
Name: Day 18: Complete Worksheet **Period:**_____

DNA Replication Practice

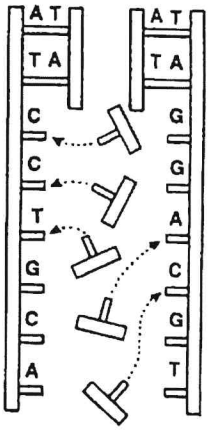
Note: Day 19 on back

Directions: Below are the 3 steps in DNA replication. Follow the directions for each step and then answer the questions below.

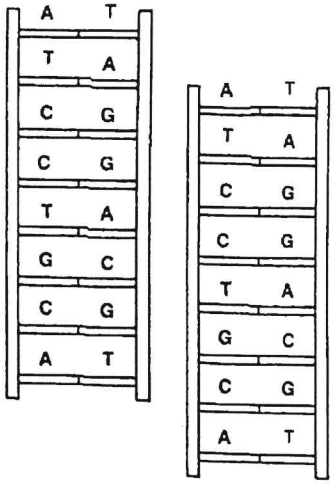
1. -What is happening to the DNA molecule in the figure? (Explain the first step in DNA replication)



2. -What happens to the DNA molecule during the second step of DNA replication?



3. -What happens during the third step of DNA replication?



Day 19: Finish Worksheet.

How DNA Is Copied

4. What does it mean that the two strands of DNA are complementary? _____
   _____

5. What is **DNA replication?**_____

6. Using your notes, book, and this assignment, place the steps of DNA replication in the correct order.
   ____ a. The enzyme DNA polymerase moves along the exposed strands and adds complementary nucleotides to each nucleotide in each existing strand.
   ____ b. The DNA double helix breaks or unzips down the middle between the base pairs.
   ____ c. A complementary strand is created for each of the two strands of the original double helix.
   ____ d. Two new identical DNA molecules have been produced.

7. (True or False) The process of DNA replication results in a copy of the original DNA molecule.

8. (True or False) DNA does not have to break apart to be copied.

9. (True or False) After DNA replication is complete, there are two new DNA molecules; one molecule has both of the original strands and one molecule has two new strands of DNA.

10. Where does DNA replication happen?_____
    _____.

11. When does DNA replication happen?_____

12. Below are DNA strands. Make the complementary DNA strand:

Original Strand: A T G C A A A T T G C T C A C C G G G G A T C A G C A C C G G

Complementary Strand: _____

Original Strand: A G G G G A T C A G C A C C G G A T T T C A T G A G C C C T A

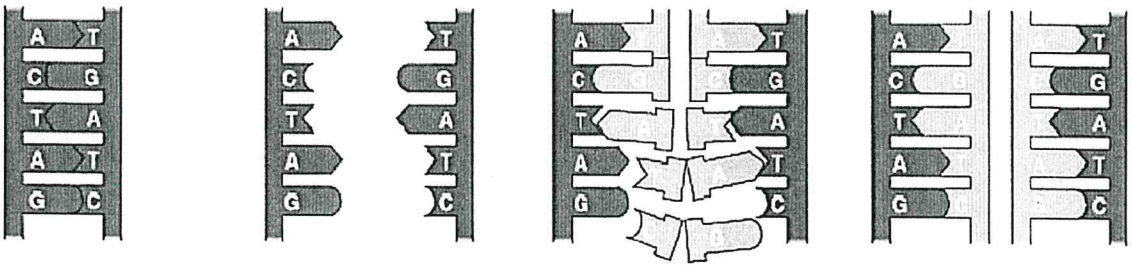
Complementary Strand: _____

Original Strand: A A G T A C G A T C G A T G C A C A T G C A T G G C T A C G C

Complementary Strand: _____

When a cell copies a DNA molecule:

1. DNA is unzipped. by helicase
2. The complementary bases are added to each template strand. by DNA polymerase
3. The 2 new strands are proofread for errors. by DNA polymerase and then DNA winds up.



Khan Academy

Assign to 19-20 AP Biology- 3rd Period All students due by Mar 18th, 11:59 PM Save Assign

Assign Day 20: Take Notes and Email (send) them to me! ☺

Overview of transcription

AP Bio: IST-1 (EU), IST-1.N (LO), IST-1.N.2 (EK), IST-1.N.3 (EK), IST-1.N.4 (EK), IST-1.N.5 (EK), IST-1.N.6 (EK)

In transcription, the DNA sequence of a gene is transcribed (copied out) to make an RNA molecule.

Key points:

- **Transcription** is the first step in gene expression. It involves copying a gene's DNA sequence to make an RNA molecule.
- Transcription is performed by enzymes called **RNA polymerases**, which link nucleotides to form an RNA strand (using a DNA strand as a template).
- Transcription has three stages: initiation, elongation, and termination.

- In eukaryotes, RNA molecules must be processed after transcription: they are **spliced** and have a **5' cap** and **poly-A tail** put on their ends.

- Transcription is controlled separately for each gene in your genome.

Introduction

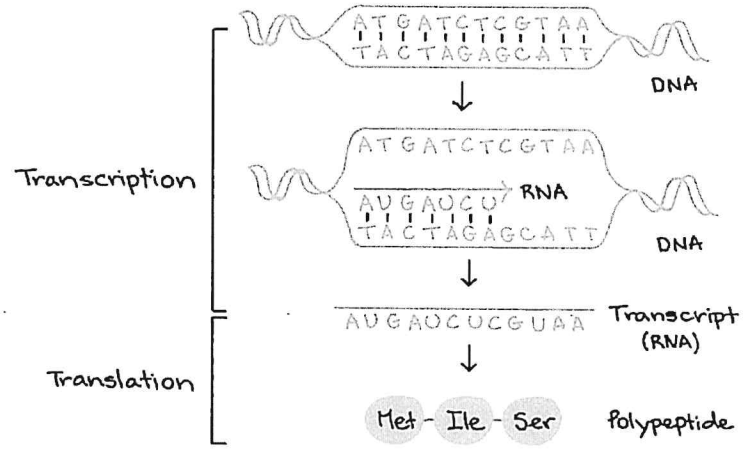
Have you ever had to transcribe something? Maybe someone left a message on your voicemail, and you had to write it down on paper. Or maybe you took notes in class, then rewrote them neatly to help you review.

As these examples show, *transcription* is a process in which information is rewritten. Transcription is something we do in our everyday lives, and it's also something our cells must do, in a more specialized and narrowly defined way. In biology, **transcription** is the process of copying out the DNA sequence of a gene in the similar alphabet of RNA.

Overview of transcription

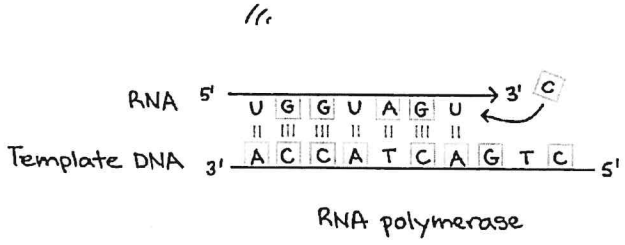
Transcription is the first step in gene expression, in which information from a gene is used to construct a functional product such as a protein. The goal of

transcription is to make a RNA copy of a gene's DNA sequence. For a protein-coding gene, the RNA copy, or **transcript**, carries the information needed to build a polypeptide (protein or protein subunit). Eukaryotic transcripts need to go through some processing steps before translation into proteins.



RNA polymerase

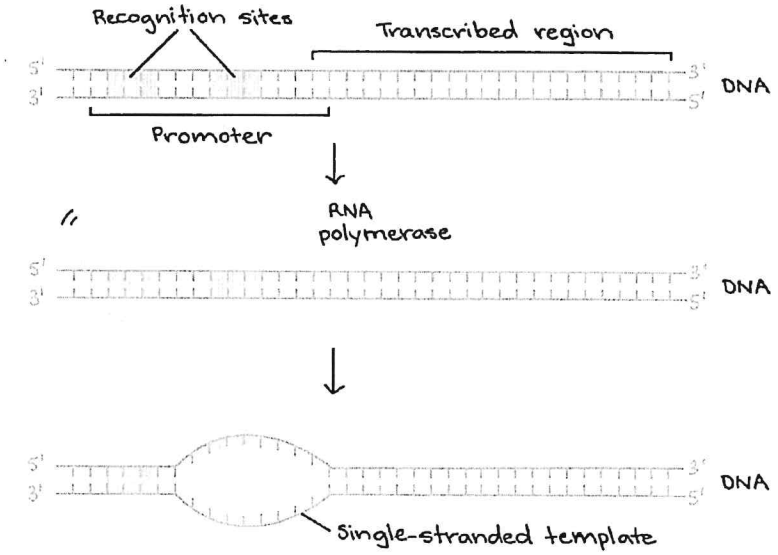
The main enzyme involved in transcription is **RNA polymerase**, which uses a single-stranded DNA template to synthesize a complementary strand of RNA. Specifically, RNA polymerase builds an RNA strand in the 5' to 3' direction, adding each new nucleotide to the 3' end of the strand.



Stages of transcription

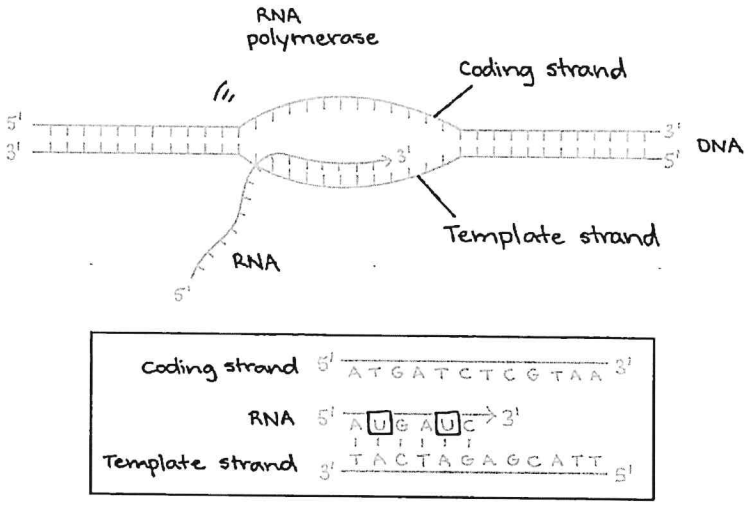
Transcription of a gene takes place in three stages: initiation, elongation, and termination. Here, we will briefly see how these steps happen in bacteria. You can learn more about the details of each stage (and about how eukaryotic transcription is different) in the stages of transcription article.

1. **Initiation.** RNA polymerase binds to a sequence of DNA called the **promoter**, found near the beginning of a gene. Each gene (or group of co-transcribed genes, in bacteria) has its own promoter. Once bound, RNA polymerase separates the DNA strands, providing the single-stranded template needed for transcription.

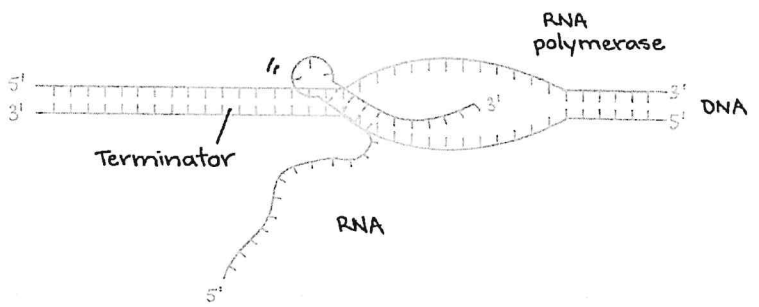


2. **Elongation.** One strand of DNA, the **template strand**, acts as a template for RNA polymerase. As it "reads" this template one base at a time,

the polymerase builds an RNA molecule out of complementary nucleotides, making a chain that grows from 5' to 3'. The RNA transcript carries the same information as the non-template (**coding**) strand of DNA, but it contains the base uracil (U) instead of thymine (T). *[What do 5' and 3' mean?]*



3. **Termination.** Sequences called **terminators** signal that the RNA transcript is complete. Once they are transcribed, they cause the transcript to be released from the RNA polymerase. An example of a termination mechanism involving formation of a hairpin in the RNA is shown below.

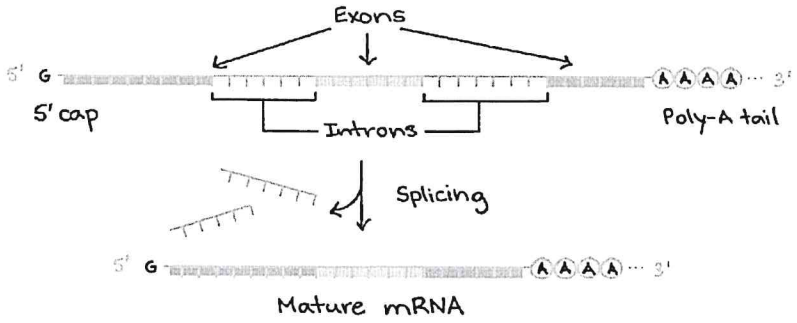


Eukaryotic RNA modifications

In bacteria, RNA transcripts can act as **messenger RNAs (mRNAs)** right away. In eukaryotes, the transcript of a protein-coding gene is called a **pre-mRNA** and must go through extra processing before it can direct translation.

- Eukaryotic pre-mRNAs must have their ends modified, by addition of a **5' cap** (at the beginning) and **3' poly-A tail** (at the end).

- Many eukaryotic pre-mRNAs undergo **splicing**. In this process, parts of the pre-mRNA (called **introns**) are chopped out, and the remaining pieces (called **exons**) are stuck back together.



End modifications increase the stability of the mRNA, while splicing gives the mRNA its correct sequence. (If the introns are not removed, they'll be translated along with the exons, producing a "gibberish" polypeptide.)

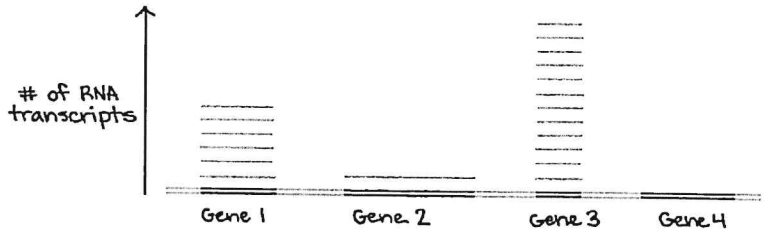
To learn more about pre-mRNA modifications in eukaryotes, check out the article on pre-mRNA

processing.

Transcription happens for individual genes

Not all genes are transcribed all the time. Instead, transcription is controlled individually for each gene (or, in bacteria, for small groups of genes that are transcribed together). Cells carefully regulate transcription, transcribing just the genes whose products are needed at a particular moment.

For example, the diagram below shows a "snapshot" of an imaginary cell's RNAs at a given moment in time. In this cell, genes 1, 2 and 3, are transcribed, while gene 4 is not. Also, genes 1, 2, and 3 are transcribed at different levels, meaning that different numbers of RNA molecules are made for each.



In the following articles, we'll take a more in-depth look at RNA polymerase, the stages of transcription, and the process of RNA modification in eukaryotes. We'll also consider some important

differences between bacterial and eukaryotic transcription.

[References]

Sort by: Top Voted

Questions Tips & Thanks

Want to join the conversation?

You need at least 5000 energy points to get started.

Anson Chan 4 years ago more

The hairpin somewhat appears to look like a tRNA molecule. Am I wrong in saying that tRNA is formed from these hairpin structures?

(14 votes) Flag more

emilyabrash 4 years ago more

No, you're not wrong. A tRNA contains hairpins as well, though the hairpins play different roles in the two cases. In transcription termination, the hairpin causes the RNA polymerase to stall and the transcript to separate from the DNA. In a tRNA, multiple hairpins form and give the tRNA molecule the 3D

Chemistry
Days 10, 11, 12, 13

Writing the Formulas of Covalent Compounds

1) Write the symbol/formula of the first element in the compound's name, then the symbol/formula of the second element in the compound's name.
2) Indicate how many atoms of each element the molecule contains using subscripts after the atomic symbol.
    - The numbers of atoms are given in the molecule's name in Greek prefixes
    - NOTE: If there is no Greek prefix in front of the first element in the name, that means the number is 1.

Example: Write the formula of **dinitrogen tetrafluoride.**

1) Write the symbol/formula of the first element in the compound's name, then the symbol/formula of the second element in the compound's name.

N F

2) Indicate how many atoms of each element the molecule contains using subscripts after the atomic symbol.

$N_{\square}F_{\square}$

- The numbers of atoms are given in the molecule's name in Greek prefixes.
    - **di**nitrogen **tetra**fluoride
    - see your chapter 3 notes for a list of the Greek prefixes

N_2F_4

- **NOTE:** If there is no Greek prefix in front of the first element in the name, then the number is 1.
    - Example carbon tetrachloride = CCl_4

Example: Write the formula of **carbon disulfide.**

1) Write the symbol/formula of the first element in the compound's name, then the symbol/formula of the second element in the compound's name.

C S

2) Indicate how many atoms of each element the molecule contains using subscripts after the atomic symbol.

$C_{\square}S_{\square}$

- The numbers of atoms are given in the molecule's name in Greek prefixes.
    - carbon **di**sulfide
    - see your chapter 3 notes for a list of the Greek prefixes

$C_1S_2 \quad = CS_2$

- **NOTE:** If there is no Greek prefix in front of the first element in the name, then the number is 1.

Write the formulas for the following covalent compounds:

See next page for KEY

a. disulfur tetrafluoride _____

b. carbon trioxide _____

c. nitrogen pentoxide _____

d. nitrogen tribromide _____

e. dinitrogen heptachloride _____

f. carbon tetrachloride_____

g. hydrogen monochloride_____

h. trihydrogen monophosphide _____

i. dihydrogen monoxide _____

KEY

a. disulfur tetrafluoride S_2F_4

b. carbon trioxide CO_3

c. nitrogen pentoxide NO_5

d. nitrogen tribromide NBr_3

e. dinitrogen heptachloride N_2Cl_7

f. carbon tetrachloride CCl_4

g. hydrogen monochloride HCl

h. trihydrogen monophosphide H_3P

i. dihydrogen monoxide H_2O

Given the Formulas for Compounds, Write the Name

Determine if the Compound is **Binary Covalent (Molecular)** or **Ionic**:

Does the compound contain **only** *two types of nonmetal elements*?

Yes

No

Binary Covalent (Molecular) Compound:

1) List the name of the first element in the formula.
2) List the second element and add the "ide" suffix.
3) Use Greek prefixes to indicate the number of each atom in the formula.
   - Exception: **Do not use** mono- for the first element in the name.
   - The ***o*** or ***a*** at the end of the Greek prefix is dropped when the element name begins with a vowel.

Ionic Compound:

1) Write the cation name first, then name the anion.
   - Monoatomic anions use the "ide" suffix
2) If the cation is one of the metals with various charges, write the charge using parenthesis and Roman numerals after the metal name.

Writing the Names of Ionic Compounds

Example: Write the name for $CaBr_2$

1) Write the cation name first, then name the anion.
   - monoatomic anions use the "ide" suffix

calcium bromide

2) If the cation is one of the transition metals with various charges, write the charge using parenthesis and Roman numerals after the metal name.
   - Not necessary here, there is not a transition metal present

Example: Write the name for $Mg(NO_3)_2$

1) Write the cation name first, then name the anion.
   - monoatomic anions use the "ide" suffix
     - Here we notice that the anion is a **polyatomic ion**. Get the name from the polyatomic ion table (in your notes or textbook). *You will be given a copy of the polyatomic ion table on your exams.*
     - <u>Do not</u> change the suffix to "ide" with polyatomic ions:

magnesium nitrate

2) If the cation is one of the transition metals with various charges, write the charge using parenthesis and Roman numerals after the metal name.
   - Not necessary here, there is not a transition metal present

Writing the Names of Ionic Compounds

Example: Write the name for CuF_2

1) Write the cation name first, then name the anion.
   - monoatomic anions use the "ide" suffix

copper fluoride

2) If the cation is one of the ***transition metals*** with various charges, write the **charge using parenthesis and Roman numerals** after the metal name.

copper(?) fluoride

- We must figure out what the charge is on the copper, we can deduce the charge on the transition metal cations from the charge on the anions
  - Recall that the total charge for any compound must equal zero.
  - Since there are two fluorides, each with a charge of (1-) and there is only one copper, we can conclude that the charge on the copper must be (2+).
    - You can think of this as the reverse criss-cross! See chapter 3 notes for more details.

copper(II) fluoride

write the **charge in parenthesis in Roman numerals after the cation name**

Write the names of the following compounds:

See next page for key

$NaCl$ _____

$Fe_2(CO_3)_3$ _____

$Cu(OH)_2$ _____

$(NH_4)_2SO_4$ _____

$LiNO_3$ _____

$BaSO_4$ _____

$Mg(NO_3)_2$ _____

$AgCl$ _____

$Al(OH)_3$ _____

$CaSO_4$ _____

FeS _____

$FeCl_3$ _____

NaI _____

$MgCO_3$ _____

KEY

$NaCl$ sodium chloride

$Fe_2(CO_3)_3$ iron(III) carbonate

$Cu(OH)_2$ copper(II) hydroxide

$(NH_4)_2SO_4$ ammonium sulfate

$LiNO_3$ lithium nitrate

$BaSO_4$ barium sulfate

$Mg(NO_3)_2$ magnesium nitrate

$AgCl$ silver chloride

- (note: silver is one of the transition metals that only occurs as a (1+) ion)

$Al(OH)_3$ aluminum hydroxide

$CaSO_4$ calcium sulfate

FeS Iron(II) sulfide

$FeCl_3$ iron(III) chloride

NaI sodium iodide

$MgCO_3$ magnesium carbonate

Chemistry
Day 14, 15, 16

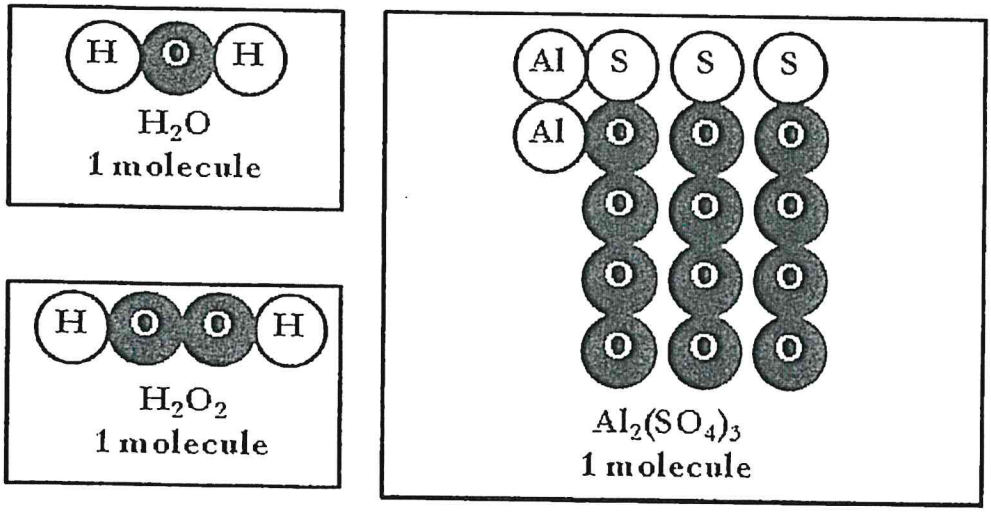
Name: _____ Date: _____ Period: _____

Balancing Chemical Equations

Why?

In a chemical reaction, matter cannot be created or destroyed. The mass of the reactants in a chemical reaction must be equal to the mass of the products. It is not possible to start a chemical reaction with 2 atoms of hydrogen and produce 2 atoms of gold. Similarly, it is not possible to start a chemical reaction with 2 atoms of hydrogen and produce only 1 atom of hydrogen. When a chemical equation is written, the same number of each type of atom must appear on both the product and reactant side.

Model 1



1) According to Model 1, how many atoms of hydrogen and oxygen are in 1 molecule of water, H_2O?

2) According to Model 1, how many atoms of hydrogen and oxygen are in 1 molecule of H_2O_2, hydrogen peroxide?

3) According to Model 1, how many atoms of aluminum, sulfur, and oxygen are in 1 molecule of aluminum sulfate, $Al_2(SO_4)_3$?

4) How many atoms of hydrogen and oxygen are in 2 molecules of water?

5) How many atoms of hydrogen and oxygen are in 8 molecules of hydrogen peroxide?

6) How many atoms of aluminum, sulfur, and oxygen are in 3 molecules of aluminum sulfate?

7) How would you indicate 2 water molecules using chemical symbols?

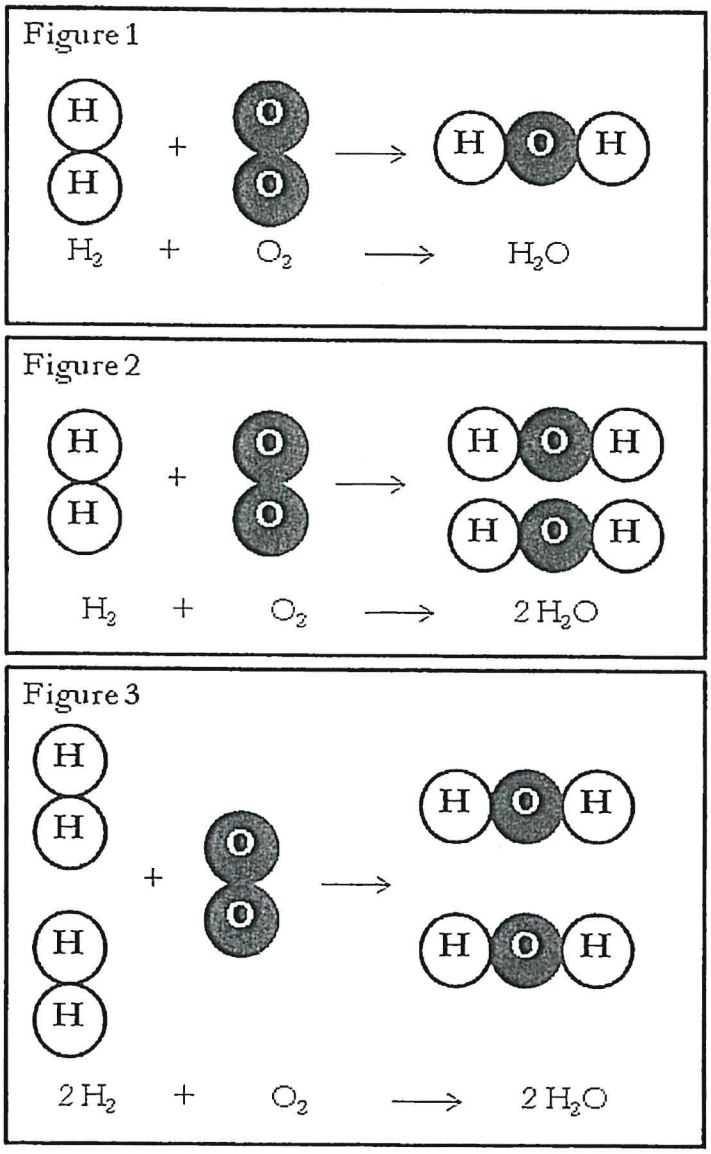
8) Using complete sentences, explain the difference between the chemical formulas shown below.

$4\ H_2O$ and H_8O_4

Read This!

In a chemical equation, two types of numbers can be used to represent the number of atoms involved in the reaction. The first type of number is called a **subscript**. Subscripts are written after the element symbol in a chemical formula to indicate the number of atoms present in the compound. The second type of number is called a **coefficient**. A coefficient is a number placed in front of a chemical formula to indicate the number of atoms or molecules involved in a chemical reaction. Chemical equations should always be balanced; that is a chemical equation should have the same number of atoms on both the reactant and product side of the equation. When balancing a chemical equation, **subscripts** are never changed. A **coefficient** can be used to ensure an equal number of atoms are found in both the reactant and product side of a chemical equation.

Model 2



9) In Figure 1, how many molecules of reactants are shown? How many molecules of products are shown?

10) Explain, using complete sentences, why the reaction represented in Figure 1 **is not** balanced.

11) In Figure 2, how many molecules of reactants are shown? How many molecules of products are shown?

12) Using complete sentences, explain why the reaction represented in Figure 2 **is not** balanced.

13) In Figure 3, how many reactant molecules are shown? How many product molecules are shown?

14) Using complete sentences, explain why the reaction represented in Figure 3 **is** balanced.

15) Write a balanced chemical equation to show how hydrogen and oxygen combine to produce water.

Read This!

Model 3 below illustrates the Haber process, a method used to produce ammonia that was developed during World War I. When the Allies blocked off all trade routes going to and from Germany, the Germans lost access to their source of sodium nitrate and potassium nitrate which were needed to make explosives. In response to the need for a source of nitrates, chemist Fritz Haber developed what is now known as the Haber Process, which combines molecular nitrogen from the air with molecular hydrogen to form ammonia gas. (Note: air is 78% nitrogen, so this synthesis is very clever because air is free and abundant.) Using the Haber Process, the Germans had an uninterrupted source of nitrogen in a form that could be used to make the nitrates needed for explosives. (http://haberchemistry.tripod.com/)

Model 3

Figure 4

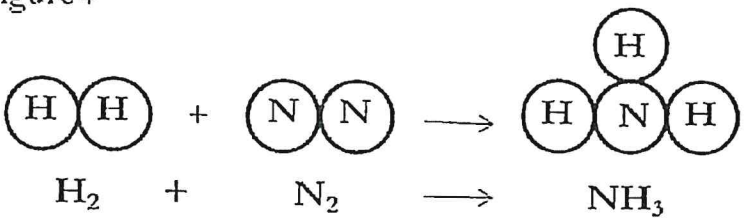


Figure 5

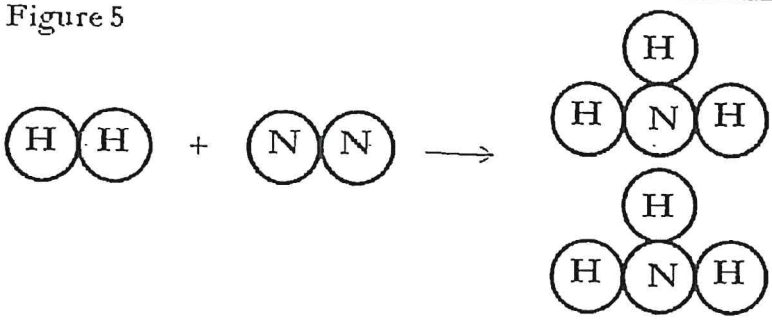
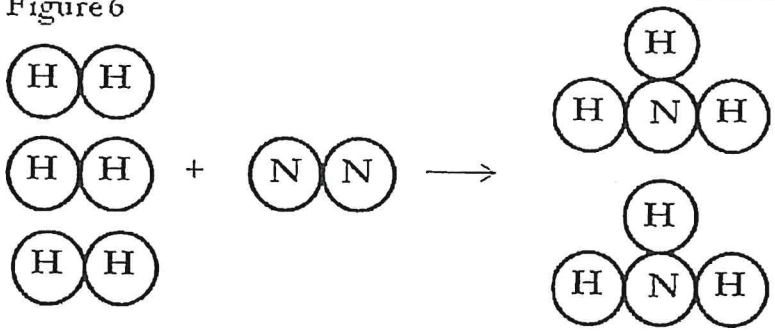


Figure 6



16) Describe what is depicted in Figure 4.

17) Does Figure 4 represent a balanced chemical equation? Why or why not? Explain your reasoning in terms of the type and number of each atom present.

18) Describe what is depicted in Figure 5.

19) Does Figure 5 represent a balanced chemical equation? Why or why not? Explain your reasoning in terms of the type and number of each atom present.

20) Describe what is depicted in Figure 6.

21) Does Figure 6 represent a balanced chemical equation? Why or why not? Explain your reasoning in terms of the type and number of each atom present.

22) Write a balanced chemical equation for the synthesis of ammonia from hydrogen and nitrogen gas.

Extension Questions

Using the smallest whole number coefficients, balance the following reactions. Draw diagrams like those in Model 3 for Equations 1, 2, and 6. You may use the space on the back of this sheet for your diagrams.

1) _____ $HgO \rightarrow$ ___ Hg + ___ O_2

2) _____ Fe + _____ $O_2 \rightarrow$ _____ Fe_2O_3

3) _____$KClO_3 \rightarrow$ ____ KCl + ____ O_2

4) _____ $Ca(OH)_2$ + _____ $H_2SO_4 \rightarrow$ _____ HOH + _____ $CaSO_4$

5) _____ Cu + _____ $AgNO_3 \rightarrow$ _____ $Cu(NO_3)_2$ + _____ Ag

6) _____ C_2H_6 + _____$O_2 \rightarrow$ _____ CO_2 + _____ H_2O

Bailey

AP Chemistry Instruction Sheet

March 17 and 18th -Guided notes for Chemical Equilibrium Unit 13

March 18- Chemical Equilibrium problems

March 19th- 2 beginning pH problems and 2 Chemical equilibrium problems.

Monday March 23rd – March 28- Keq and Ice Problem worksheet

Monday March 30- April 3rd- pH problems- 1 per day
And Guided Notes Unit 6 Thermochemistry

Bailey

Name: Forensics Days

Flower Structure and Reproduction

10, 11, 12, 13

Flowers are the plant's reproductive structures. Angiosperms are types of plants that bear fruits and flowers. Flowers are usually both male and female, and are brightly colored to attract insects to help them carry pollen used for sexual reproduction. Not all flowers are colorful, though. These flowers usually use the wind for pollination.

Parts of the Flower

The receptacle is the part of the branch on which a flower forms. Color the receptacle (B) brown. Sepals are leaf like structures that surround and protect the flower before it blooms. Color the sepals (C) green. Petals are the colorful part of the flower that attracts insects and even other small animals, such as mice, birds, and bats. Color the petals (D) a bright color of your choice. All flowering plants have flowers, but some are not brightly colored. The petals of these flowers are reduced or absent and the plant relies on the wind or water for pollination.

The flower has both male and female reproductive parts. The female reproductive structures are called carpels. In most flowers, the carpels are fused together to form a pistil. Color the pistil (P) pink. The pistil has three parts, which can be seen, in the box labeled "pistil". The stigma at the top is often sticky and is where the pollen attaches. Color the stigma (J) purple. The style is the long tube that attaches the stigma to the ovary. Sperm from the pollen will travel down this tube to the ovules. The ovules, or eggs, are stored in the ovary until they are fertilized. Plants can only fertilize eggs of the same species. Special chemicals prevent sperm from fertilizing the eggs of flowers that are not the same kind. Color the style (K) red, and the ovary (L) pink. Color the ovules (O) black.

The male reproductive structures are called the stamens. Color the stamens (H) blue. Each stamen consists of an anther (A), which produces pollen, and a filament (F), which supports the anther. In the box labeled "stamen" color the anther dark blue, and the filament light blue. Pollen produced by the anther is carried by insects or other animals to the pistil of another flower where it may fertilize the eggs.

Plant Reproduction

Sexual reproduction in plants occurs when the pollen from an anther is transferred to the stigma. Plants can fertilize themselves: called self-fertilization. Self-fertilization occurs when the pollen from an anther fertilizes the eggs on the same flower. Cross-fertilization occurs when the pollen is transferred to the stigma of an entirely different plant.

When the ovules are fertilized, they will develop into seeds. The petals of the flower fall off leaving only the ovary behind, which will develop into a fruit. There are many different kinds of fruits, including apples and oranges and peaches. A fruit is any structure that encloses and protects a seed, so fruits are also "helicopters" and acorns, and bean pods. When you eat a fruit, you are actually eating the ovary of the flower.

Questions

1. What is an angiosperm?

2. The flower attaches to what part of the plant?

3. Why are flowers brightly colored?

4. Name two mammals that might pollinate a plant.

5. If the petals of a flower are reduced or absent, how is the plant pollinated?

6. The female reproductive structures are called the:

7. Name the three parts of the pistil:

8. Where are the ovules stored?

9. Name the two parts of the stamen:

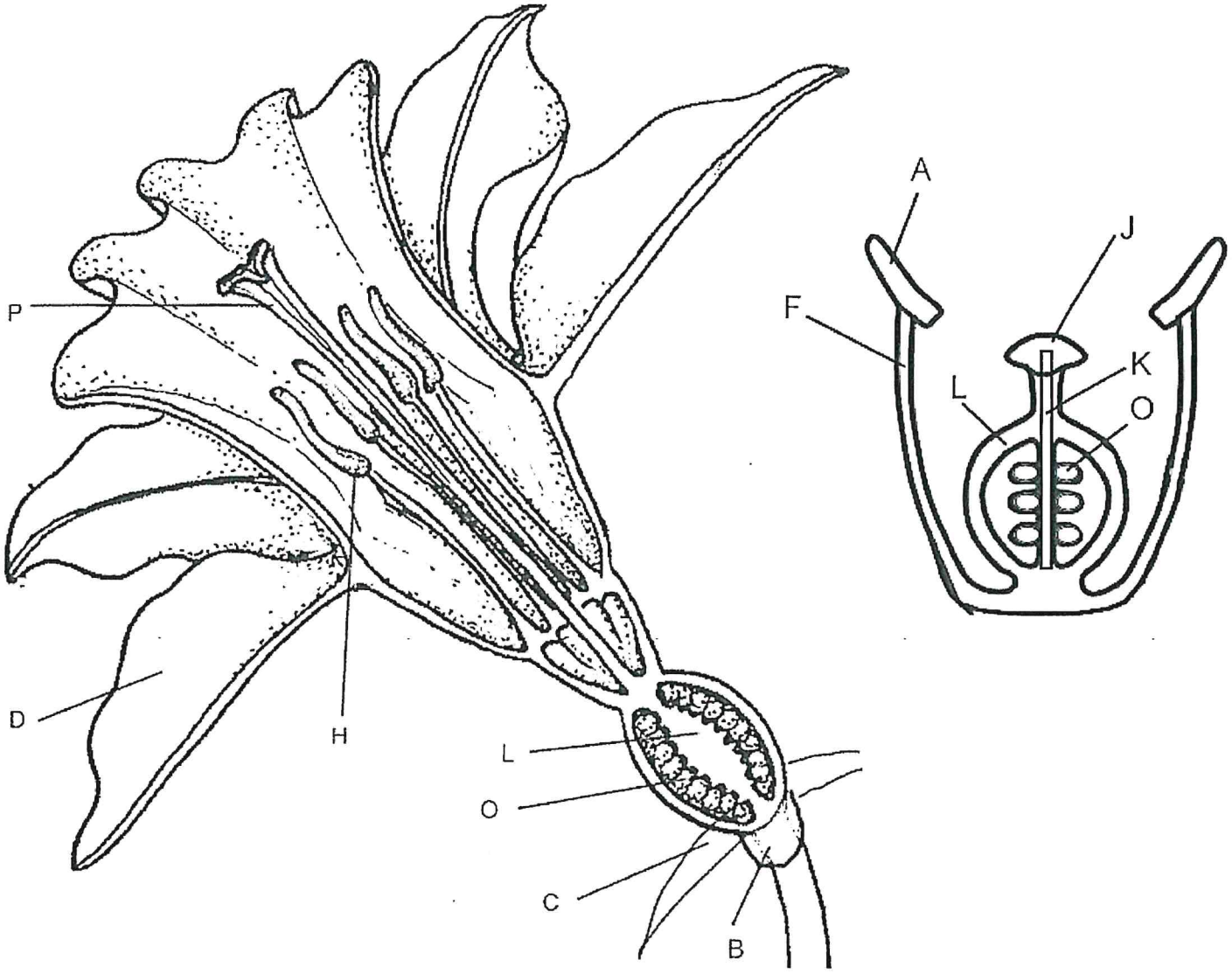
10. Describe sexual reproduction in plants.

11. The ovary develops into what structure?

12. Define fruit.

13. Some flowers are not brightly colored at all, but have a very pungent odor that smells like rotting meat. How do you think these flowers are pollinated?

14. In many flowers, the pistils and stamens reach maturity at different times. Considering what you know about pollination, why would this be an advantage to the plant?


P
D
H
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O
C
B
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J
F
K
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O

Bailey

Name: Forensics Days 14,15,16,17

Comparing Monocots and Dicots

Both monocot and dicot seeds develop in similar ways and have the same parts. There are a few minor differences: monocots start out with one seed leaf, while dicots have two. The technical word for seed leaf is cotyledon: you can find it on the coloring sheet; it is the first leaf to emerge from a developing seed. **Color all the cotyledons (A) on the seeds dark green**. As a seed, both monocots and dicots are covered by a seed coat. **Color the seed coat (B) yellow**.

The seed consists of the outside seed coat and a large area called the endosperm which functions as a source of reserve materials and food for the developing embryo. As germination occurs, the endosperm will be broken down and used by the plant. **Color the endosperm blue (C).**

Germination occurs when the seed begins to sprout, usually in the spring and under appropriate conditions the radicle, the part of the seed that will become the root, begins to elongate and grow downward. **Color the root brown (D)**. Meanwhile, the coleoptile begins to grow upward. The coleoptile is a sheath that encloses the shoot of the embryo. The primary function of the coleoptile is to provide protection to the developing shoot as it is passing through the soil. **Color the coleoptile orange (E)**. Extending out from the coleoptile is the shoot. **Color the shoot purple (F)**.

Eventually adult leaves grow on the plant. **Color these leaves light green. (G)**

Adult Monocots and Dicots

Angiosperms are divided into two classes, the monocots and the dicots. The majority of flowering plants are dicots. Dicots include maples, oaks, and magnolias. Monocots are grasses, wheat, corn, and rice. Most of our food supply comes from monocots. The diagram compares the differences between the two.

First of all look at the roots. The root of a monocot is called a fibrous root and the root of a dicot is a taproot. Notice how taproots have one main part - called the primary root. In a taproot the primary root grows very large and small roots spread out from it. Fibrous roots, on the other hand, do not have very large primary roots, and many small roots develop and remain near the surface. **Color the taproot dark brown and the fibrous root light brown.**

Monocots and dicots also differ in their leaf structure. Adult monocots usually have parallel venation, whereas dicots have net-like venation. For monocots and dicots, **color the leaves green and outline the veins in a darker green**. The flowers of monocots and dicots differ in the number of petals they have. Monocots tend to have flower parts that occur in 3's (3, 6, 9, 12...). Dicot flowers usually have 4 to 5 petals. **Color the monocot flower purple, and the dicot flower pink** (make sure all petals are colored). Stems hold the flowers up and attach the leaves, **color the stems blue.**

Monocot and dicots also differ in the way their vascular systems are arranged. In monocots, the vascular bundles are scattered throughout the stem. In dicots, the vascular bundles are arranged in a ring. **Color the vascular bundles in both types of plants purple (V), color the stems blue**.

Questions:

1. Give two examples of plants that are monocots. _____
2. Give two examples of plants that are dicots. _____
3. What is a cotyledon? _____
4. What is the radicle? _____
5. What is the coleoptile? _____

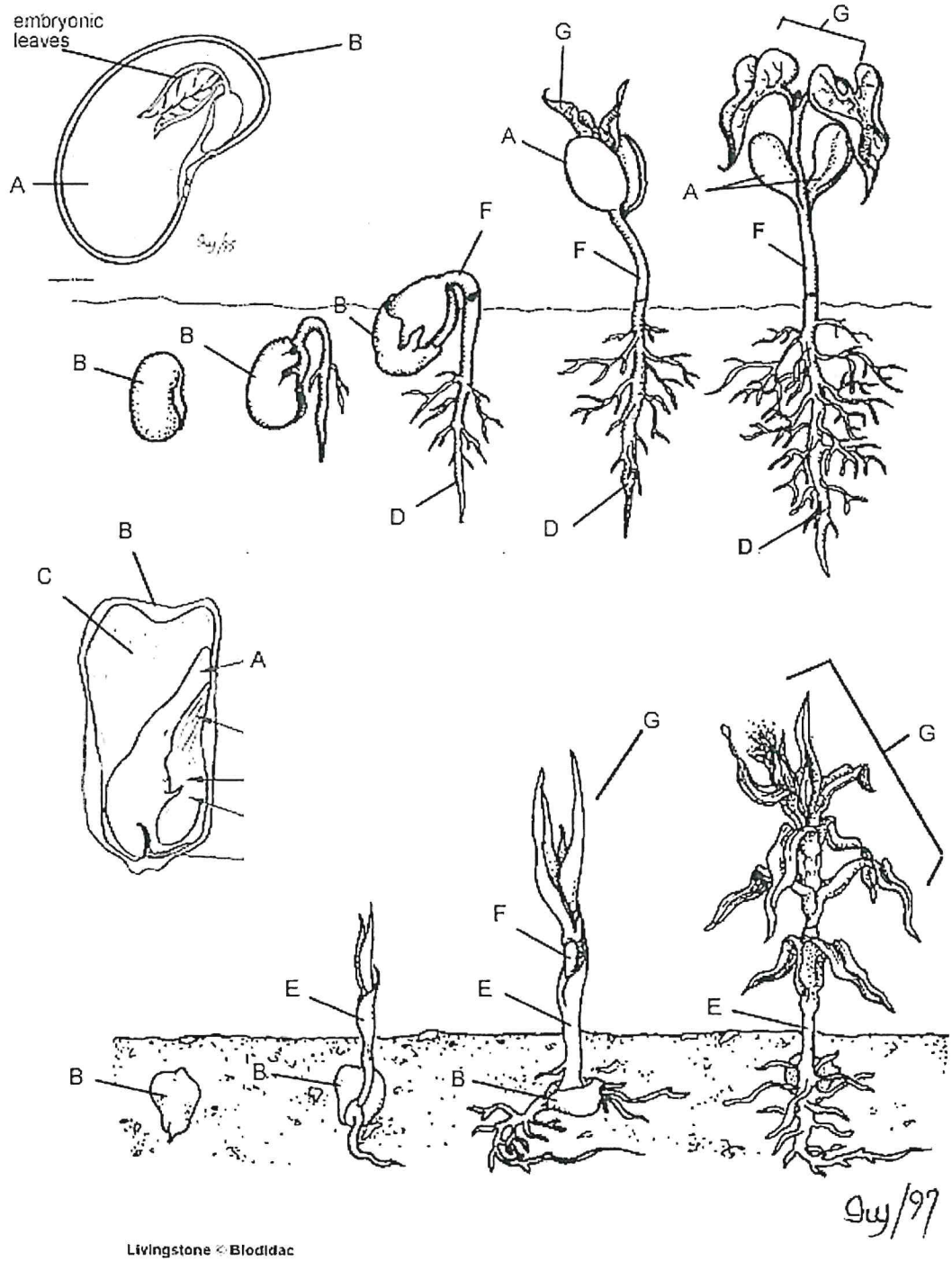
6. What is the function of the endosperm? _____

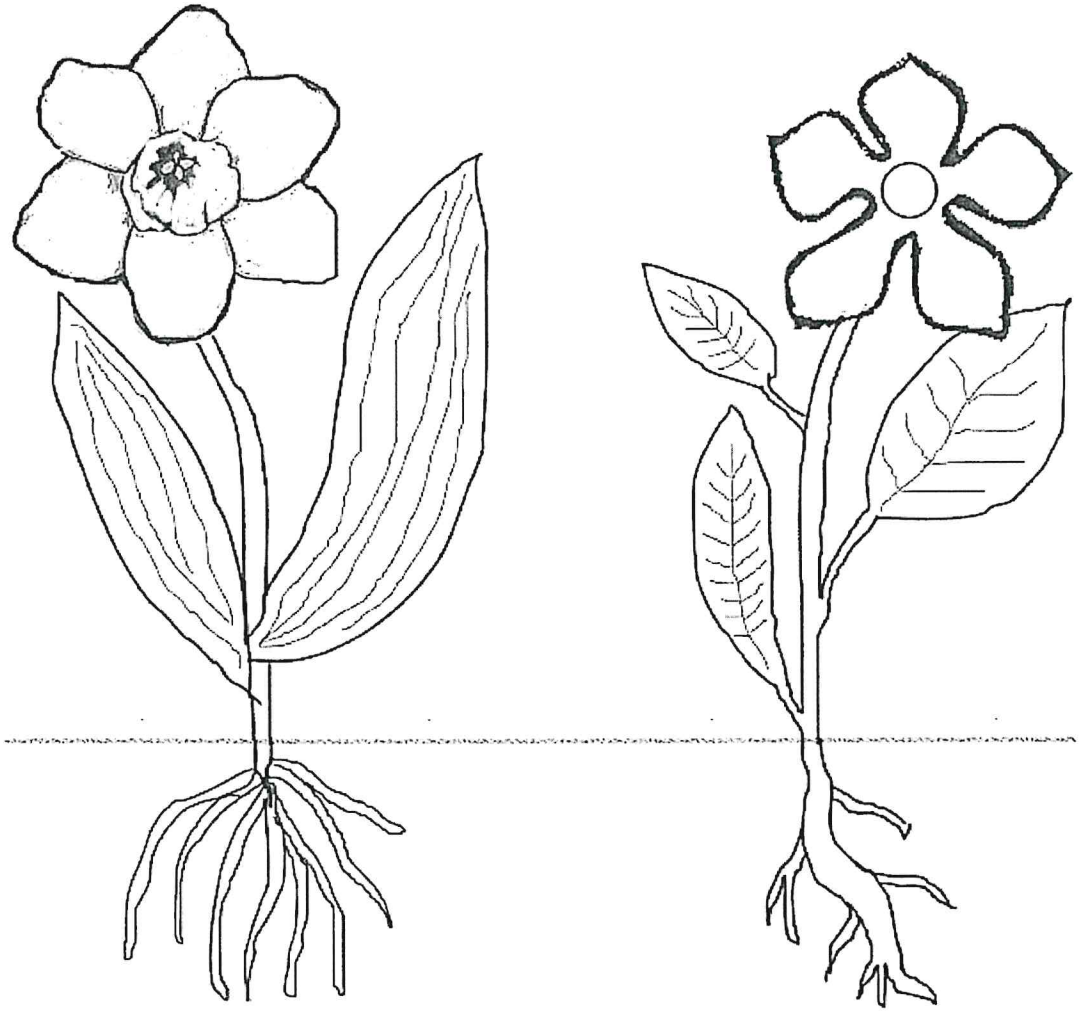
7. Fill out the table below.

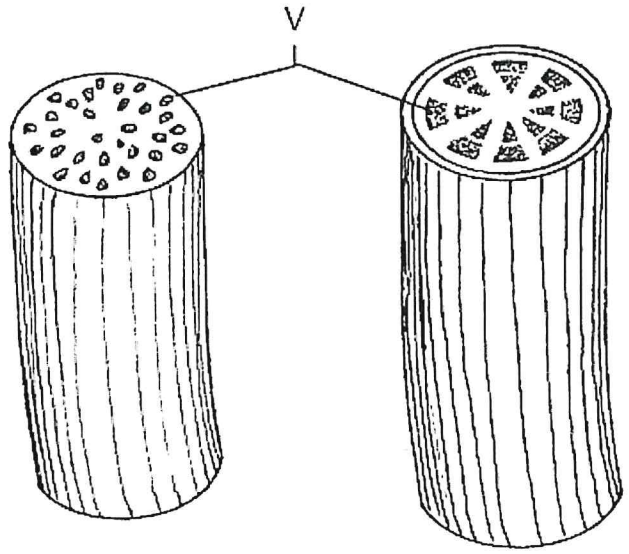
	Number of Seed Leaves	Type of Leaf Venation	Number of Flower Parts	Type of Roots	Example
Monocot					
Dicot					

8. An unknown plant is brought to you and your job is to determine whether it is a monocot or a dicot. You observe that the plant has 6 petals and its leaves have parallel veins. Is it a monocot or a dicot?

COLORING






V

Integrated Science 2 McClelland

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NTI Day 12	
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NTI Day 13	
Ch. 4 Lesson1 Quiz	Ch. 4 Lesson1 Quiz
NTI Day 14	
Ed Learning Read Chapter 4 Lesson 2 Engage and Exploration 1	Read Chapter 4 Lesson 2 Engage and Exploration 1 Pages 192-196

*Take handwritten notes.
Take a picture if you can and send to me to get a grade.
If you cannot take a picture drop off notes
20 points

NTI Day 15	
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Int. Sci 2 (cont.)

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Exploration 3

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Exploration 3
Pages 199-203

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Checkpoints
Questions 1-6

Do Lesson Self-Check on page 204

Questions 1-6

NTI Day 18
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Do Lesson Self-Check
Checkpoints
Questions 7-11

Do Lesson Self-Check on page 204

Questions 7-11

NTI Day 19
Ch. 4 Lesson 2 Quiz

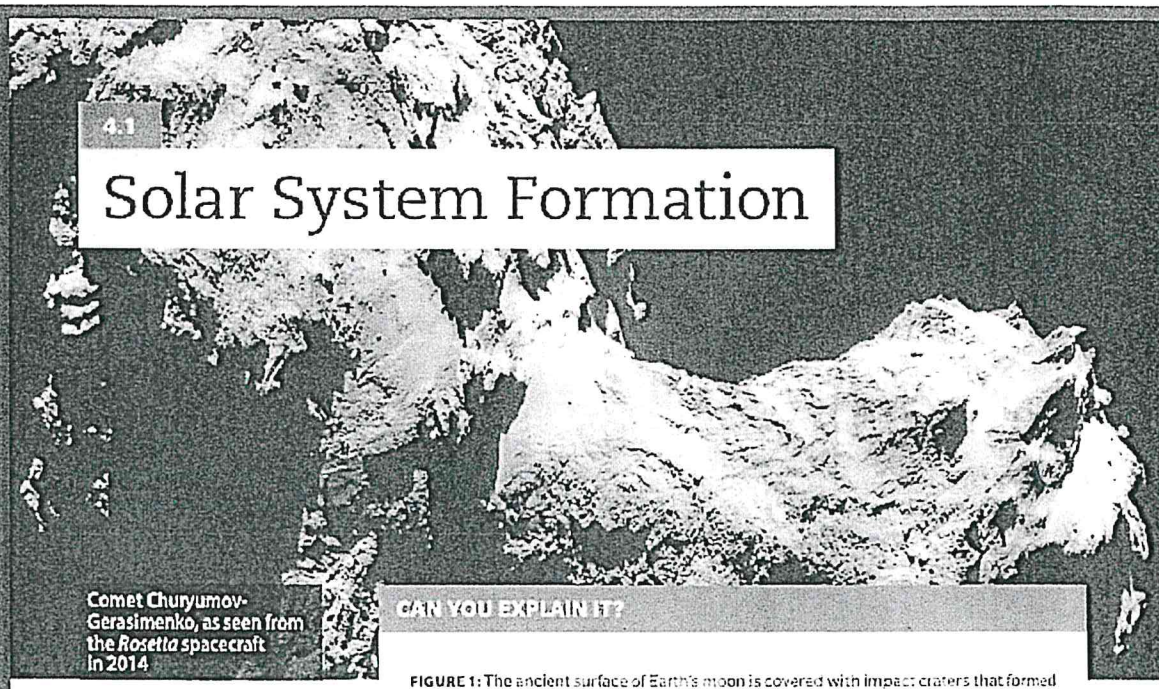
Ch. 4 Lesson 2 Quiz

NTI Day 20
Ed Learning
Read Chapter 4 Lesson 3
Engage and Exploration 1

Read Chapter 4 Lesson 3
Exploration 1
Pages 199-203

4.1

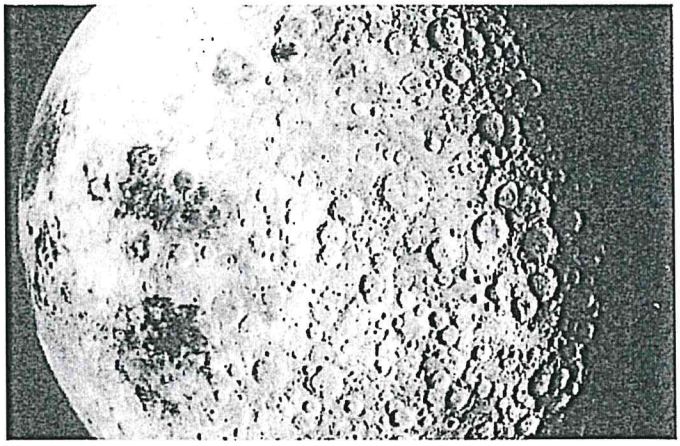
Solar System Formation



Comet Churyumov-Gerasimenko, as seen from the *Rosetta* spacecraft in 2014

CAN YOU EXPLAIN IT?

FIGURE 1: The ancient surface of Earth's moon is covered with impact craters that formed when other objects smashed into it and exploded.



On the lunar surface, nested impact craters ranging in size from microscopic to hundreds of kilometers in diameter cover the desolate moonscape. They bear witness to the violent history of the early solar system. On Earth's mostly watery surface, reminders of this period are harder to find. What is there to be learned from impact craters on the moon and on Earth?

Explain Why doesn't Earth's surface show the same violent history as the moon's surface?

Gather Evidence Record observations about the composition and structure of the solar system and the objects that make it up. As you explore the lesson, gather evidence that can be used to explain how the solar system formed.

The Solar System

If you compare a model of the solar system made today with models constructed in the past, you will find that they are different. The solar system itself has not changed significantly over the past 2000 years, but our understanding of it has.

Solar System Models

What comes to mind when you think about the solar system? You might remember seeing a recent full moon, the shimmering light of a distant star, or the brightness of a nearby planet. Like you, ancient people also noticed the objects in the night sky.

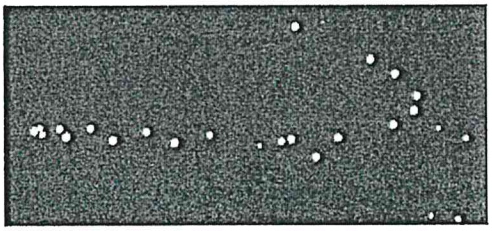


FIGURE 2: From night to night, some objects in the sky appear to wander relative to the background of stars. This figure shows the path of an object studied by ancient observers.

Explain What is a possible cause of the apparent motion of the object shown in Figure 2?

Early astronomers made careful observations to construct explanations and build models of the solar system. They were familiar with the daily motion of the sun and moon and discovered that throughout the year, different groups of stars appeared in the night sky. They also identified five starlike objects that wandered back and forth relative to more distant stars and called them planets. Based on their observations, these observers developed the geocentric model of the solar system. In this model, all the objects in the sky moved in circular paths around Earth. The paths of Mars, Jupiter, and Saturn had loops called epicycles that help explain and predict their apparent back-and-forth motion.

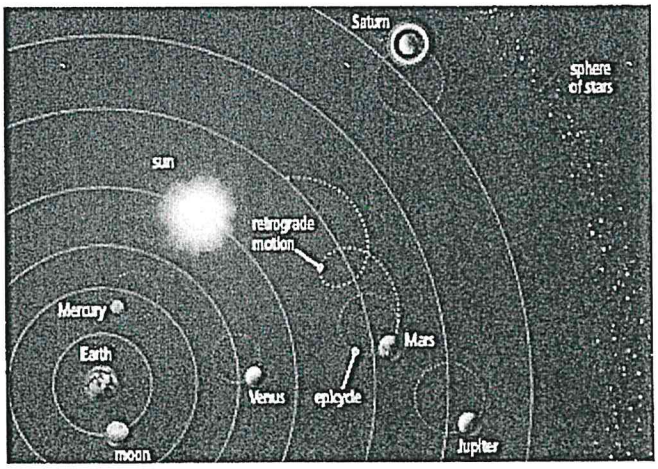


FIGURE 3: Geocentric models of the solar system explain careful observations such as the apparent motion of the sun, moon, planets, and stars across the sky.

The geocentric model explained observations well enough for hundreds of years. It also fit well with the thinking of the time—that Earth, being the most important object, lies at the center of the universe and that objects orbit in perfect circles.

However, as observers gathered more and more precise data, they needed to modify the model to make it more consistent with observations. It slowly became apparent that models with Earth at the center of the solar system and models with perfectly circular paths, or orbits, could not accurately predict astronomical events. By the 17th century, the geocentric model with circular orbits had been replaced by a heliocentric model with slightly elongated orbits.

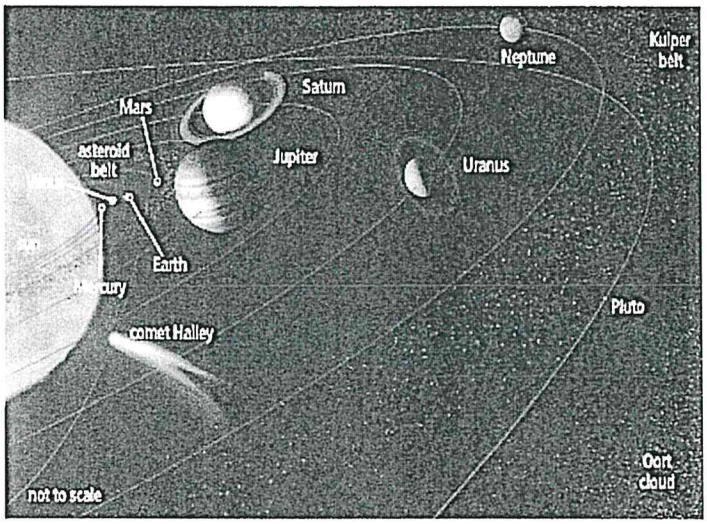
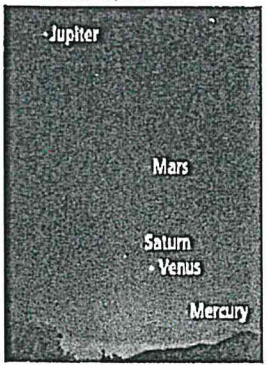


FIGURE 4: This modern heliocentric model of the solar system is consistent with detailed observations and measurements made from Earth and from space, using modern technology.

FIGURE 5: Mercury, Venus, Mars, Jupiter, and Saturn can all be seen without a telescope and thus have been known to us for thousands of years.



Solar System Components

Compare the modern model of the solar system with the geocentric model. You should notice the difference in its organizing structure, with the sun at the center, and the addition of more objects.

Since the heliocentric model was first introduced in the 1500s, it has been modified even further, primarily with the help of telescopes and space probes.

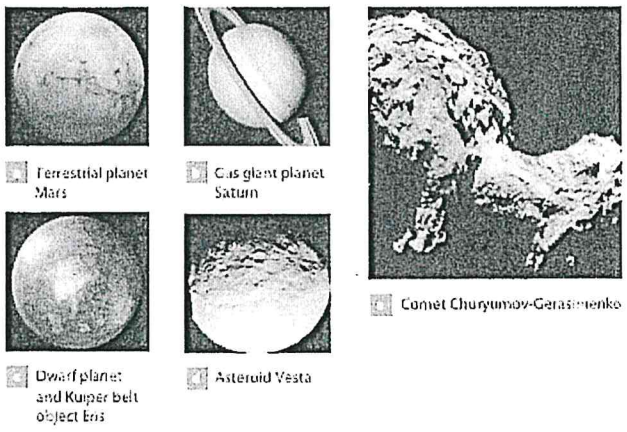
With Earth-based telescopes, scientists discovered the asteroid belt, Uranus, Neptune, and Pluto. With space-based telescopes, space probes, and landers, they have been able to discover more objects and also better understand the composition and motion of these objects.

Explain The geocentric model of the solar system was used by most observers to describe the solar system until the 17th century when they began to accept the heliocentric model. Why do you think the geocentric model was popular for so long? What do you think caused people to begin to favor the heliocentric model?

Telescopes also enabled astronomers to make much more precise measurements of the locations of stars at different times of year, which enabled them to calculate distances to stars. Once this was possible, astronomers realized that stars are much farther away than the planets and are not part of the solar system at all.

Our understanding has also changed as a result of unusual astronomical events. For example, before the late 1700s, scientists generally did not consider comets to be part of the solar system. But in 1758, a comet that had appeared 75 years earlier returned as predicted by Edmund Halley, proving that at least some comets do orbit the sun.

FIGURE 6: More precise observations lead to a better classification of solar system objects.



Terrestrial planet Mars

Gas giant planet Saturn

Comet Churyumov-Gerasimenko

Dwarf planet and Kuiper belt object Eris

Asteroid Vesta

Explain Compare the components of the geocentric and the modern heliocentric model. Why does the modern model include so much more detail than models developed hundreds of years ago?

Collaborate With a partner, compare characteristics of different types of objects in the solar system. Research specific examples of each type of object to support your comparisons.

Models Change

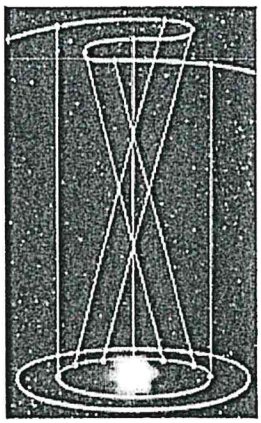
A modern, heliocentric model of the solar system includes eight major planets, hundreds of moons, an asteroid belt, and objects in regions beyond the orbit of the major planets. It includes solid bodies (rock and solid ice), atmospheres, and different forms of energy. Objects interact through matter, gravity, light, and magnetic fields. The model is based on many different types of observations, which are ongoing.

The heliocentric model helps astronomers understand what they observe. It also helps them make accurate predictions. The winding path of Mars, as seen from Earth, makes sense if you model both of these objects' orbits around the sun. Earth orbits faster and sometimes passes Mars. As Earth passes, Mars seems to move backward.

Today, many people, including astronomers, still use a geocentric model to describe common events such as sunrise and sunset. The model is simple enough to be useful, though only within limits.

Model How would Earth appear to move if you were viewing from Mars? Use people or objects to model how the position of a moving object changes relative to distant objects as you pass.

FIGURE 7: Apparent motion of Mars as viewed from Earth



EXPLORATION 2

Solar System Formation

Gather Evidence Assuming the solar system is a closed system (no material has entered or left the system since it began to form), what was the composition of the material that the solar system came from?

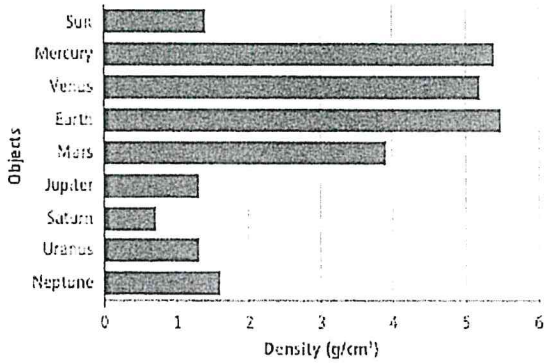
Our current model of the solar system illustrates our understanding of its structure and composition as it exists today. By studying its characteristics and gathering evidence, scientists developed a model to explain how the solar system and Earth formed.

Observations and Characteristics

How is matter distributed in the solar system? There are trillions of tons of material in the solar system, but it is not distributed evenly throughout. More than 99.8% of the mass of the solar system, or about 1.99×10^{30} kg, is found in the sun. Most of the rest is concentrated in the planets. The sun is composed almost entirely of hydrogen and helium. All other elements make up only about 2% of the composition of the sun.

Analyze Compare the densities of the inner and outer planets. What can explain these differences?

FIGURE 8: Comparing the masses and densities of the planets and sun confirms the fact that material is not mixed evenly throughout the solar system.

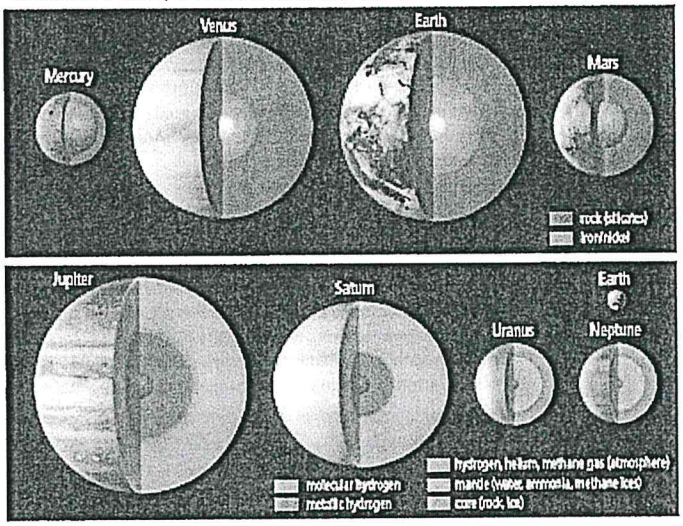


The sun may have most of the mass in the solar system, but Mercury, the smallest planet, has more than three times its average density. How is that possible? Recall that density is the ratio between the mass and volume of a substance. The sun is the largest object in the solar system, larger than Jupiter, the largest planet.

What else do you notice about the relative average densities of the inner and outer planets? What about their relative sizes? The inner planets have relatively high average densities, while the outer planets have very low average densities. However, although they are less dense, the outer planets are much more massive. In fact, together, the outer planets contain more than 99% of the total mass of the planets.

Explain What is the relationship between the size, mass, average density, composition, and location of the planets?

FIGURE 9: The density of a planet reflects its composition and structure.



Examine the chart below. How do distance from the sun and composition of the class of object seem to be related? The objects seem to be sorted based on composition and distance from the sun. The inner planets and the asteroid belt are rich in materials such as iron and silicates. These materials can condense at temperatures such as those that exist near the sun. The outer planets and the objects of the Kuiper Belt and the Oort cloud are rich in materials that condense mostly at low temperatures, such as those that exist farther away from the sun. These materials, known as volatiles, evaporate quickly at typical Earth temperatures and pressures.

Objects in the Solar System

[illegible]	[illegible]	[illegible]	[illegible]
terrestrial planets	inner solar system	0–2	rock and metal
asteroids	asteroid belt	2–5	rock and metal
moons	inner and outer solar system	1–30	rock and metal
gas giants	outer solar system	5–30	gas, ice, and metal
dwarf planets and **short-period comets	Kuiper Belt	30–50	rock and ice
**long-period comets	Oort cloud	5000–100 000	rock and ice

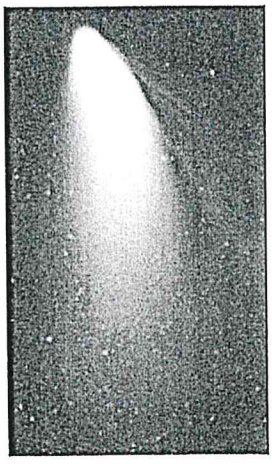
*AU: astronomical units; 1 AU = the average distance between Earth and the sun
** Refer to the length of a comet's orbit

As comets approach the sun, in elongated orbits that can take hundreds of years, they provide evidence to explain the difference in composition between groups of objects in the solar system. Comets are made of dust particles trapped in a mixture of frozen water, carbon dioxide, methane, and ammonia.

Explain How do you think the compositions of the planets reflect the distribution of different types of material early in the evolution of the solar system?

Explain Spectroscopic measurements, or measurements of wavelengths of reflected sunlight, revealed that the tail of Comet Hale-Bopp is made of dust and gases such as water, carbon dioxide, methane, and ammonia. What does this suggest about the composition of a comet and the region in which comets formed?

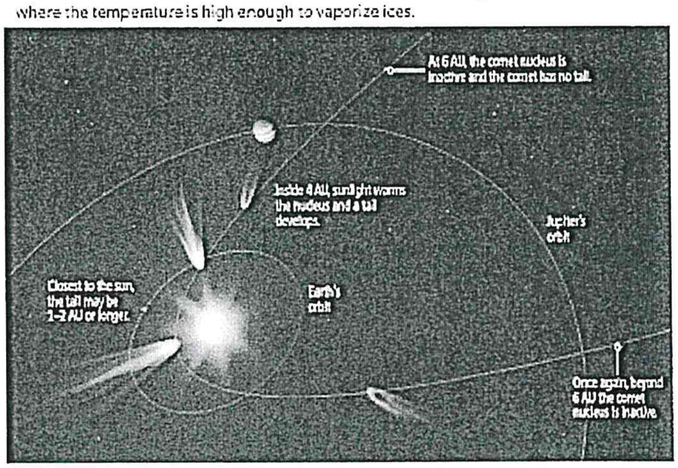
FIGURE 10: Comet Hale-Bopp forms a tail of vapor as it approaches the sun.



When a comet moves close to the sun, within a region called the *frost line*, located between the asteroid belt and Jupiter, energy from the sun heats up the comet's icy surface causing it to form a tail, or coma. The coma points directly away from the sun and lengthens as it draws nearer. It disappears once the comet moves away from the sun and beyond the frost line.

Explain How does the composition of the objects in the solar system appear to be related to distance from the sun? Use evidence and reasoning to support your claim.

FIGURE 11: The tail of a comet forms when the comet enters a region of the solar system where the temperature is high enough to vaporize ices.



Finally, studying the shape of the solar system and the motion of objects within it can help develop a model of its formation. Most of the objects in the solar system orbit the sun on roughly the same plane. Thus, the solar system is essentially disk-shaped, with a bulge in the center. All of the objects revolve around the sun in the same direction that the sun spins: counterclockwise as viewed from above the sun's north pole.

Beginning and Formation

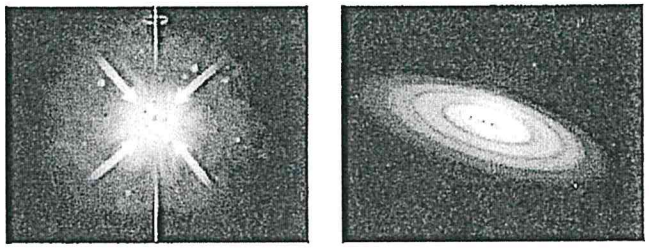
Scientists infer that the solar system began as a cloud of dust, ice, and gas, called a nebula, roughly 4.6 billion years ago. With powerful telescopes, we have observed distant nebula in space. According to the nebular theory, the cloud collapsed to form the sun, planets, and all of the other solar system objects that exist today.

About 4.6 billion years ago, some force disturbed the nebula, causing it to collapse under its own gravity. This could have been a result of gravity from a star passing by or the shockwave from an exploding star. Whatever the cause, as the nebula collapsed and became smaller, its density and temperature increased. Material began to coalesce and accumulate in the center. As more and more material accumulated, the gravitational pull toward the center increased.

FIGURE 12: The solar system began in a nebula like this, as a swirling cloud of hydrogen and helium gas, dust (including minerals), and ices of water, methane, and carbon dioxide.

Explain What is the evidence and reasoning supporting the claim that the solar nebula was composed primarily of hydrogen and helium, with smaller amounts of other elements such as iron, silicon, and oxygen?

FIGURE 13: Cloud collapse and flattening

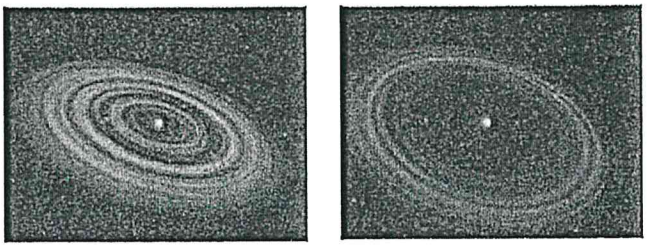


Collapse The nebula collapsed. Matter spirals toward the center.

Flattening The cloud flattened into a disk as it collapsed.

Because the nebula was rotating to begin with, it began to rotate even faster as it collapsed. This happens because as the distance of a particle from the center decreases, its velocity increases. As the nebula was getting smaller and denser, it also began to flatten. Material slowly accumulated not only in the center but also in one plane circling the center.

FIGURE 14: Protosun and planet formation



Fusion As fusion began, energy was released, heating up the surrounding disk and pushing volatile materials outward.

Accretion Near the protosun, iron, nickel, and silicates came together to form the inner planets. Ice accreted in the cooler outer part of the solar system, while hydrogen and helium accumulated around larger planets.

As material accumulated in the center of the rotating disk, the gravitational pull of the center increased, causing even more material to accumulate. As the central mass grew, its density, pressure, and temperature increased. At some point, the pressure and temperature at the center of this mass became so great that hydrogen atoms began to fuse, releasing enormous amounts of energy. The center mass became a star, emitting both light and streams of charged particles known as the solar wind.

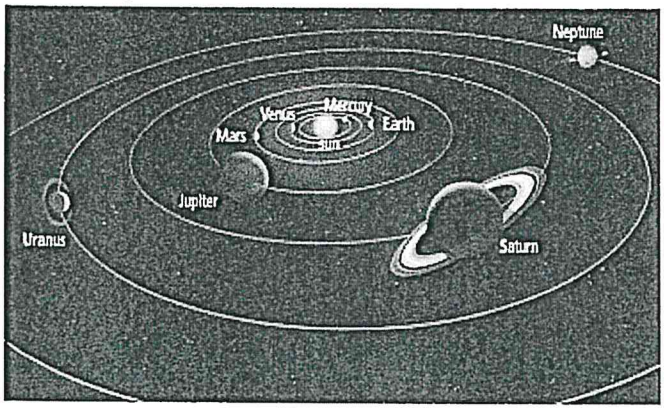
The energy emitted by the sun caused the surrounding disk to heat up even more. The high temperatures near the young sun kept volatile materials such as water, carbon dioxide, ammonia, and methane in that region in gas form. At the same time, the solar wind pushed these materials, along with leftover hydrogen, helium, and other light gases, toward the outer part of the disc, leaving behind only those materials that could remain solid at high temperatures.

Gather Evidence
According to the nebular theory, as the nebula collapsed, it began to rotate. All of the material began to move in one direction around the center. What observations about the solar system today support this claim?

Gather Evidence
What is the evidence that volatile materials were pushed away from the center of the solar system and out toward the outer part of the disk?

Meanwhile, dust was accumulating in certain regions of the flattening disk. As some material started to coalesce into bigger and bigger clumps, the gravitational pull of those clumps increased, pulling in more material. Some dust formed rocks, which came together to form larger rocks, which came together to form large objects called planetesimals, which eventually came together to form planets.

FIGURE 15: Clearing While the solar wind blew the remaining gas and tiny dust particles out of the system, the newly formed planets swept up larger pieces of loose debris, clearing their orbits of materials.



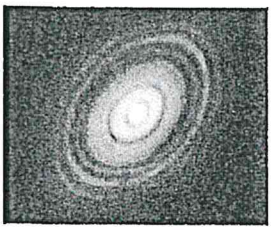
In the inner part of the solar system, only dust was available to form the planets, and they stopped forming when they ran out of iron and silicate materials. But in the outer, cooler part of the solar system, the planets continued to grow as volatile materials condensed to form ice. The outer planets became so massive that their gravitational pull was strong enough to hold onto hydrogen and helium gas as well.

As the planets accreted, the energy of the colliding objects was transformed into thermal energy. The original solid material that had accumulated from the nebula melted. Denser materials such as iron sank toward the center of the bodies, pushing lighter materials such as silicates upward.

By the time the surfaces of the inner planets had cooled enough to form crusts, most of the material in the disk had been incorporated into the planets—but not all. Enough was left over that the surfaces continued to be pelted by rocks for millions of years, leaving impact craters as evidence. Material between Jupiter and Mars never accumulated to form a single planet and instead remains as the asteroid belt, while material beyond Neptune seems to be distributed in a wide band called the Kuiper Belt.

Extrasolar System Observations

FIGURE 16: HL Tauri, a young sun-like star located 450 light years from Earth



Did the solar system really form from a collapsing cloud of dust and gas? Are there other solar systems out there, and if so, did they form in the same way? The nebular theory was originally developed based only on observations of our solar system. For many years, it was impossible to confirm the model because we had only one example of a solar system, and of course, we are not able to travel back in time.

Recent surface-based observations have revealed that in fact there are uncountable solar systems in the universe. We now not only have images of some of these systems and planets, but we also have images of young stars surrounded by disks of gas and dust—protoplanetary disks. These observations of other systems confirm many of our ideas, but they cause us to question others. For example, in some systems, Jupiter-sized planets made of very low density material orbit extremely close to their stars. It is possible that these planets formed farther from their stars and their orbits decayed.

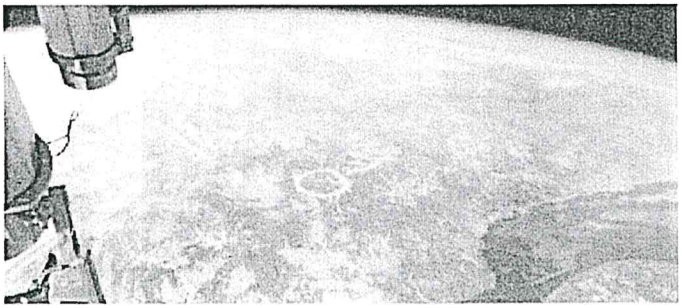
Evaluate *Why* are observations of objects outside our solar system important for evaluating the nebular theory of solar system formation?

EXPLORATION 3

Evidence of Earth's Early History

The solar system and Earth formed roughly 4.6 billion years ago through the collapse of cloud of gas and dust. What evidence can we use to attempt a reconstruction of the early history of Earth and its neighbor?

FIGURE 17: Manicouagan impact crater, Canada

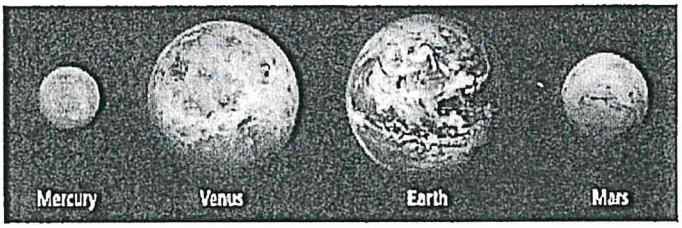


Explain The surface of Mercury shows abundant evidence for accretion in the form of impact craters covering the surface. If Earth formed at the same time as Mercury and through the same process of accretion, why does Earth have so few craters?

From Physical Characteristics

Each of the terrestrial planets has a hard, rocky crust. All but Mercury are surrounded by thin atmospheres of gas. Only Earth has liquid water on the surface. Mercury and the moon are covered in impact craters, but Earth and Venus have very few. What can the number and condition of craters on a planet reveal about its geologic history?

FIGURE 18: Earth is the largest and densest of the four terrestrial planets.



Explain Earth and the other terrestrial planets are much smaller, denser, and less massive than the outer planets, and they are composed of silicate rock and metal rather than gases and ices. What does this tell you about Earth's early history?

We know through direct observations and through inferences that internal and surface processes have changed Earth's surface significantly since it formed. This is also true for Mars and Venus and to a lesser extent for the moon and Mercury. As a result, much of the evidence for Earth's early history has been erased. However, we can infer something about its history by its structure.

Earth and the other planets are differentiated: they have layers of increasing density toward the center. This tells us that the bodies were once molten, allowing dense material to sink, pushing lighter materials to the surface. The energy that caused early Earth to melt is thought to have come in part from the energy of trillions of tons of rock colliding—transforming energy of motion into thermal energy that melted the planet.

Impact craters are evidence that planets formed and grew through accretion—the coming together of smaller objects in space. There are very few impact craters remaining on Earth's surface—most have been weathered and eroded. However, the moon shows a better record of impacts, providing evidence that accretion continued well after planets had formed. Many meteorites appear to be unchanged since the solar system formed. Because the minerals that make up these rocks formed when the planets formed, they have been used to estimate the composition of the early solar system and the age of Earth.

Engineering

Design an Impact Crater Investigation

FIGURE 19: The Barringer Crater (Meteor Crater) in Arizona is 1200 m across and 170 m deep.

Until the 1950s, most scientists didn't agree on the origins of craters. Some scientists designed lab experiments to model impact crater formation. Others conducted field studies. Ultimately, scientists were able to use what they learned to figure out how craters on Earth and in the solar system formed. We now know that Meteor Crater formed 50 000 years ago when an asteroid 50 m across struck Earth at 65 000 km/h.

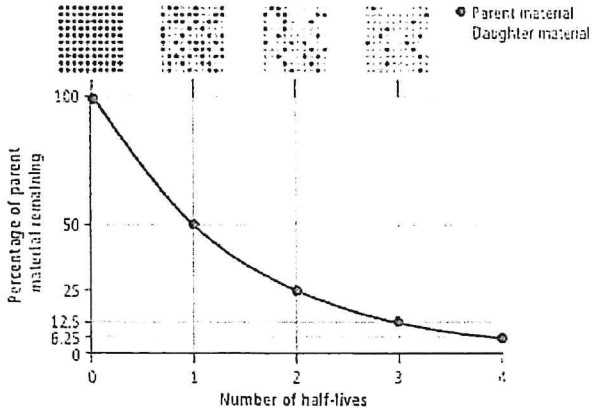
Investigate Plan and design an investigation to learn more about impact craters. What materials would you use to represent Earth's surface and meteorites? What independent variables could you test? What dependent variables could you measure? What variables would you need to control during the investigation? What questions would this investigation help answer?

Absolute Age

Explain Briefly explain what Earth's composition, its size and mass relative to other planets, and the presence of impact craters on it and other objects in the solar system indicate about the formation of the solar system and Earth's history.

Evidence from the composition and structure of solar system objects provide clues about how it formed, but how do we know when it formed and how old the objects in it are? The most important evidence comes from radioactive decay.

FIGURE 20: Over the course of one half-life, half the parent atoms in a sample decay to form daughter atoms.

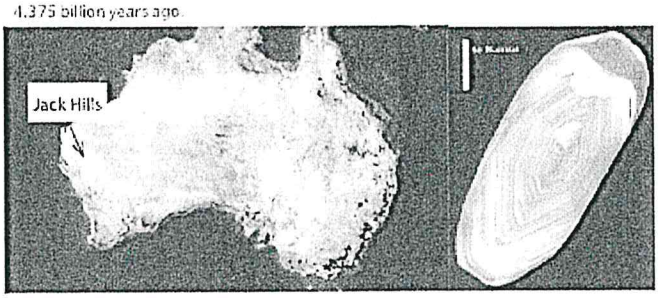


Problem Solving

Use graphs to model how systems change over time. This graph in Figure 20 shows how the percentage of the parent material changes as it decays. If you know the ratio of parent to daughter atoms in the sample, you can use a graph like this to figure out how old the sample is.

Some rocks and minerals contain trace amounts of elements that change, or decay, from one form to another. These radioactive elements decay at a constant rate that is not affected by the environment or by the passage of time. The graph in Figure 20 shows how a radioactive sample decays at a constant rate from parent material to daughter material. The time when exactly half of the starting parent material remains in the sample is called a half-life.

FIGURE 21: Oldest-known minerals Radiometric dating of zircon crystals such as this one from the Jack Hills in Australia reveals that they may have formed as long as 4.375 billion years ago.



Because of plate tectonics, there are very few rocks on the surface that can provide evidence for conditions early in Earth's history. However, geologists make inferences from the samples available. Earth's age can be estimated by measuring the absolute age of ancient materials such as meteorites, rocks from the moon, and minerals in ancient rocks on Earth that contain radioactive elements.

The oldest rocks collected from the moon are about 4.5 billion years old and are thought to be nearly as old as the moon itself. For example, the oldest mineral crystals analyzed so far, which appear to have formed when Earth was less than 200 million years old, provide evidence that Earth had a continental crust and likely even surface waters. However, because there are so few samples of rocks and minerals this old, it is difficult to confirm the result. There are still many outstanding questions, such as when did the crust, oceans, and atmosphere form? When did plate tectonics start? When was Earth hospitable for life?

Earth's Beginnings

When exactly did Earth accrete most of its mass? When did large objects stop crashing into Earth on a regular basis? It is hard to say. Most of Earth's mass probably accumulated during the first few tens of millions of years of its formation. Scientists think that about 4.5 billion years ago a smaller planet smashed into Earth, forming the moon. Recent models suggest that between 4.5 and 3.8 billion years ago Earth may have been hit by numerous giant asteroids. These impacts would have mixed, melted, and buried rocks on the surface and boiled off the early oceans.

Explain The moon provides some of the most direct evidence supporting the claim that Earth was bombarded during its early history. What is the form of this evidence, and what is the reasoning that connects this evidence to the claim?

Hands-On Lab

Simulation of Nuclear Decay
Use pennies and paper to simulate nuclear decay and generate data for analysis.

Explain Why do you think it is difficult to determine the age of Earth with radiometric dating of minerals that formed on Earth?

Collaborate
What can be inferred about Earth from the discovery of a crystal that has a radiometric age of 4.375 billion years? What cannot be inferred?

EVALUATE

CAN YOU EXPLAIN IT?

FIGURE 24: Impact craters on the moon's surface record part of the solar system history.

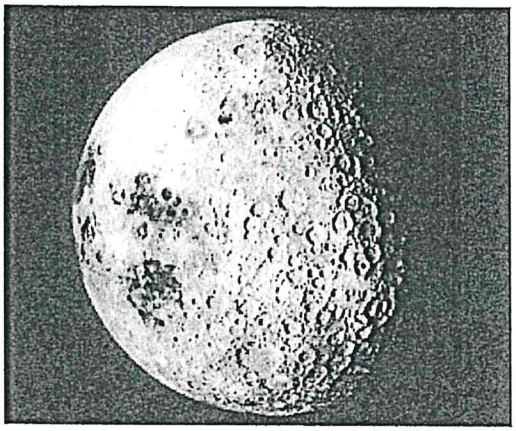
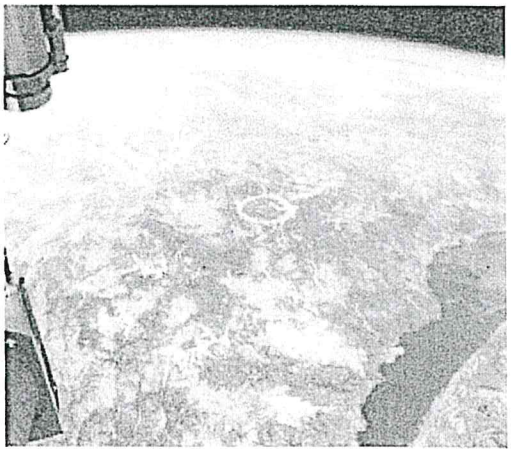


FIGURE 25: Manicouagan crater in Québec, Canada



Take another look at this picture of the moon. On Earth, evidence of this early, violent period in the history of the solar system has been erased by the processes that tear down and build up the land. The Manicouagan impact crater in Canada, believed to be the oldest crater on Earth, is only about 214 million years old.

Radiometric evidence from lunar rock samples brought back to Earth suggests that most of the lunar craters formed within a narrow period of time around 4 billion years ago. Scientists can draw conclusions about the early history of the moon based on this evidence. They can also make inferences about conditions on Earth, other planets and moons, and the solar system at the time the craters were formed.

The radiometric evidence from lunar rock samples confirms that the moon already had a solid surface 4 billion years ago. It also suggests that there was a sudden increase in the number of impactors—asteroids, comets, and other solar system debris—at the time. Evidence suggests that this increase lasted approximately 200–300 million years.

Today, large asteroid and comet impacts on planets and moons are very rare. However, every year for a few days during mid-July to mid-August, Earth passes through the Perseid Cloud. Small debris, left over by a comet that crosses Earth's orbit every 133 years, strike Earth and burn up in its atmosphere.

Explain What can the existence of craters on the moon and on other planets tell us about the early history of solar system?

EVALUATE

CHECKPOINTS

Check Your Understanding

1. Although the geocentric model of the solar system was incorrect, there were aspects of it that were relatively accurate. Identify which components of the geocentric model (prior to the 1700s) are accurate and which are inaccurate.
   a. The sun orbits Earth.
   b. The moon orbits Earth.
   c. Planets are closer than stars.
   d. Orbits and epicycles are perfectly circular.
   e. Saturn is farther away from Earth than Jupiter.
   f. Stars are farther away than planets but not much farther away.

2. Over the centuries, scientists have constructed models and explanations of the solar system based on evidence and reasoning. Compare the evidence and reasoning used to support the geocentric model with the evidence and reasoning used to support the modern model of the solar system.

3. A model for how the solar system formed must explain observations and reasoning. Identify each statement as an example of an observation or reasoning. If a statement is false or invalid, identify it as such.
   a. Most of the mass of the solar system is in the sun.
   b. The sun is composed primarily of hydrogen and helium.
   c. The sun formed more than 13.8 billion years ago when the universe formed.
   d. Most objects in the solar system orbit the sun in the same direction.
   e. If most of the mass of the solar system is in the sun and the sun is mostly hydrogen and helium, then the solar system must primarily be hydrogen and helium.

4. Modern telescopes have allowed us to see far beyond the solar system. We have been able to capture images of nebulae, regions where stars are forming, stars of different ages, and planets that orbit other stars. Write two scientific questions about solar system formation that observations of other nebulae, stars, and solar systems can help us answer.

5. Complete items a–c to demonstrate how a systems approach can be used to describe the solar system and its formation.
   a. What are the primary components of matter in the solar system?
   b. What are the energy components of the solar system?
   c. Identify some processes that are at work (or have been at work) in the system.

6. Use the following words and phrases to complete the paragraph below describing events in the formation of the solar system.

increased	*planetesimals*
dust particles	*gravity*
fusion	*accretion*
flattened	*collapse*
solid core	*star*
cloud of dust and gas	*massive bulge*

The solar system began as a swirling _____. Some disturbance caused the cloud to _____. As this happened, the density, temperature, and pressure within the cloud _____. As material swirled toward the center, the cloud _____ into a disk. A _____ developed at the center of the disk as mass accumulated there under the force of _____. At some point, _____ began and the bulge became a _____. At the same time, in the surrounding disk, _____ came together to form rocks. These rocks came together to form _____ which grew larger through _____ to form the inner planets and the _____ of the outer planets.

7. Zircon crystals, which form in igneous and metamorphic rocks, contain trace amounts of uranium-238, a radioactive element which decays to lead-206 over time. Scientists measure the ratios of U-238 and Pb-206 to estimate when the crystal formed. The half-life of U-238 is about 4.5 billion years.
   a. If the ratio of U-238 to Pb-206 atoms is 1:1, how old is the zircon crystal?
   b. A scientist measures the U-238:Pb-206 ratio of a single sample from a rock from the continental crust. The ratio is 1:3. What can the scientist conclude from this sample alone?

8. Which of the following observations support or are explained by the nebular theory (as outlined in this lesson)?
   a. Planets orbit in one direction around the sun.
   b. Venus has a thick atmosphere of carbon dioxide.
   c. The inner planets are denser, smaller, and less massive than the outer planets.
   d. Helium and hydrogen gas are evenly distributed in the solar system.
   e. In other solar systems, there are giant, low-density planets orbiting very close to their stars.

MAKE YOUR OWN STUDY GUIDE

In your Evidence Notebook, design a study guide that supports the main ideas from this lesson:

1. The solar system consists of a star orbited by smaller objects made of rock, ice, and gas.
2. Models of the solar system have changed over time based on improved observations, improvements in technology, and changes in scientific thinking.
3. The solar system is thought to have formed about 4.6 billion years ago from a giant cloud of gas, dust, and ice that collapsed to form the sun and planetary bodies.
4. The nebular theory explains observations of the solar system and is supported by observations of other solar systems.

Remember to include the following in your study guide:

- Support main ideas about the composition, structure, and formation of the solar system with details and examples.
- Record explanations for the structure and composition of the solar system.
- Describe how the solar system has changed over time and how it has remained the same.

Name: _____ Date: _____

Unit 4 Lesson 1
Lesson Quiz

Quiz: Solar System Formation

Read each question. Circle the letter of the correct answer.

1. Which of these separates the outer planets from the inner planets?

   A. the Kuiper Belt

   B. the asteroid belt

   C. the Great Red Spot

   D. a large magnetic field

2. Aside from Mercury's slow rotation, what is a factor that contributes to the planet's daily temperature fluctuation of about 600 °C?

   A. its dense atmosphere

   B. its core of rock and ice

   C. its close proximity to the sun

   D. its heavy, rocky, waterless terrain

3. When early Earth's atmosphere formed, which gases were lost because Earth's gravity was too weak?

   A. oxygen and helium

   B. helium and nitrogen

   C. hydrogen and ozone

   D. helium and hydrogen

4. Which of these are small bodies from which planets originated during the early formation of the solar system?

   A. comets

   B. asteroids

   C. planetesimals

   D. protoplanets

5. Why does the moon have more impact craters on its surface than Earth does?

   A. Earth's gravity causes more objects to collide with the moon than with Earth.

   B. Most of Earth's impact craters have been destroyed by plate tectonics and erosion.

   C. Earth's magnetic field deflects more objects than the very weak magnetic field of the moon does.

   D. The rocks that compose the moon's surface are more easily deformed than Earth's surface rocks.

6. Where did the materials that formed Earth come from?

   A. the Oort cloud

   B. the Crab nebula

   C. the solar nebula

   D. the remnants of a black hole

7. In what way is Earth like the other inner planets?

   A. It has a relatively high density.

   B. It has liquid water on its surface.

   C. It has a mostly hydrogen and helium core.

   D. It revolves around the sun in 24 hours or less.

Read each statement. Write your answer on the lines.

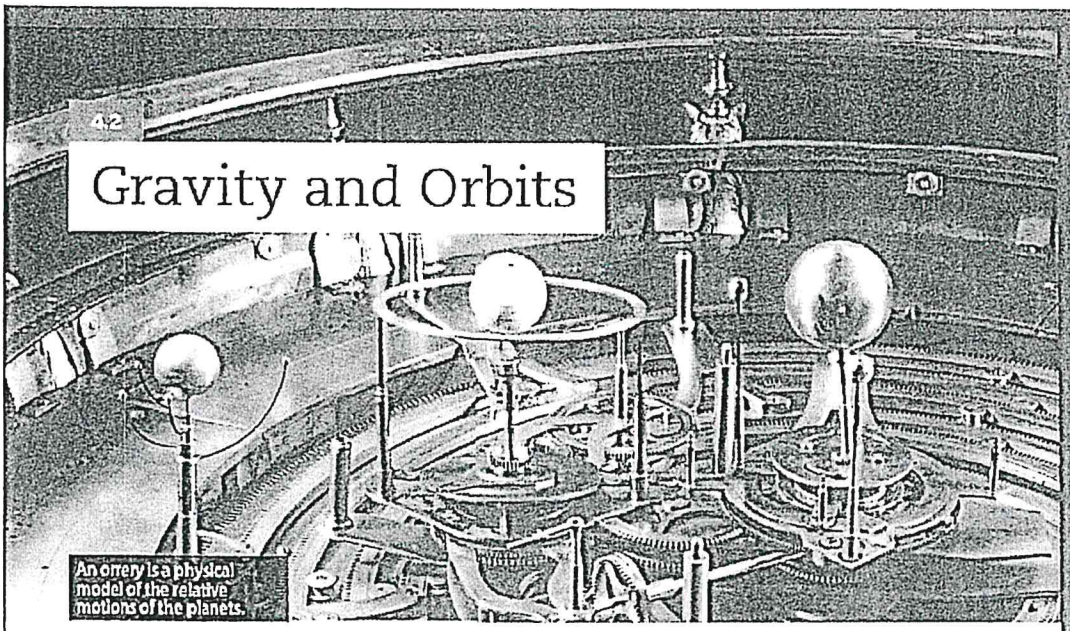
8. Why was Earth extremely hot when it first formed?

9. How does the distance from the sun affect the composition of planets and other bodies?

10. The moon has many impact craters. Why doesn't Earth's surface show the same violent history as the moon's surface?

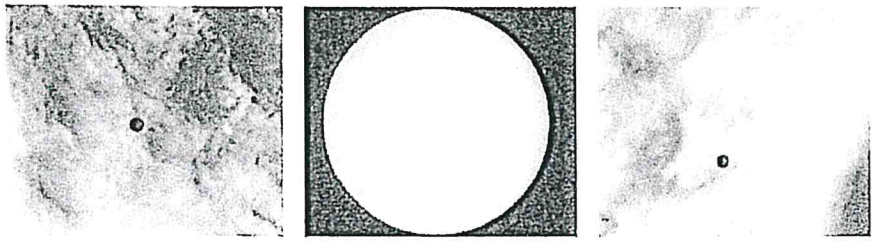
4.2

Gravity and Orbits



An orrery is a physical model of the relative motions of the planets.

FIGURE 1: Mercury's transit of the sun in 2016



Gather Evidence As you explore the lesson, gather evidence about how solar system bodies behave.

Mercury and Venus are closer to the sun than Earth is, and sometimes we can see them move in front of the sun. This is a rare astronomical event called a *transit*. In the above images, you are seeing Mercury cross between the sun and Earth. Mercury appears as a tiny black dot on the surface of the sun.

The movements of planetary bodies appear to go from left to right, or right to left depending on how the planet is moving relative to Earth and where the observer is standing on Earth.

Analyze How does Mercury appear to be moving relative to Earth? Why do you think the motion is so different from Earth's motion?

Planetary Motion

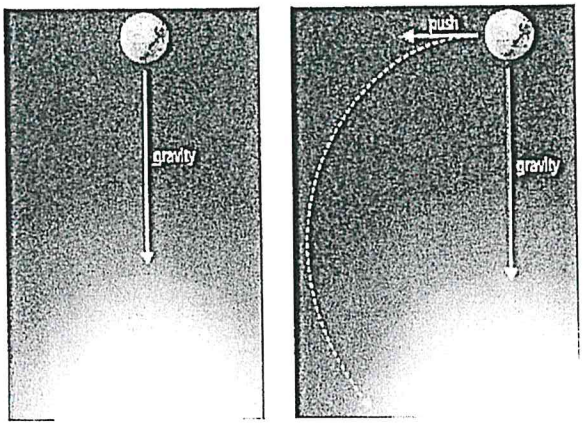
Planets are always moving. Even the name *planet* comes from the Greek word for "wander." Ancient astronomers noticed that planets appeared to drift across the night sky, unlike the apparently fixed stars behind them. Modern astronomers have more sophisticated ways of observing planetary motion and have been able to study the particular paths that follow around the sun.

Predict Why do you think the planets are in motion? What would happen if a planet were suddenly stopped?

One feature that is consistent for all planets in our solar system is the curved paths that they take through space. No planet travels in a straight line; rather, they all move in closed loops around the sun. Though astronomers have long known this to be the case, it is only in the last few hundred years that we have been able to explain why this occurs.

Collaborate With a partner, consider a hypothetical planet that is not moving relative to the sun. What would immediately follow the scenario presented in Figure 2a?

FIGURE 2: The motion of imaginary planets near the sun



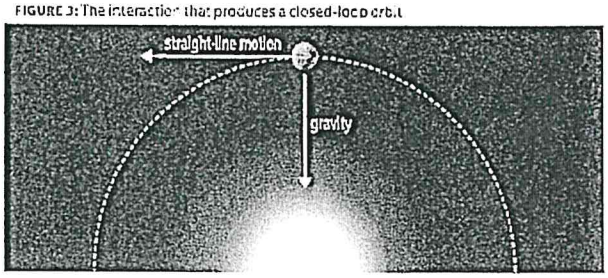
a. A stationary planet

b. A planet given a small push

Predict The planet is given a small push, as shown in Figure 2b. What would happen to the planet immediately after the push?

If a planet were to somehow stop moving relative to the sun, we would witness the planet fall into the sun in the same way that a dropped baseball would fall toward Earth. Suppose that we could give the planet a small "push," as in Figure 2b. In that case, the planet would follow a trajectory similar to a thrown baseball on Earth before ultimately crashing into the sun.

FIGURE 3: The interaction that produces a closed-loop orbit

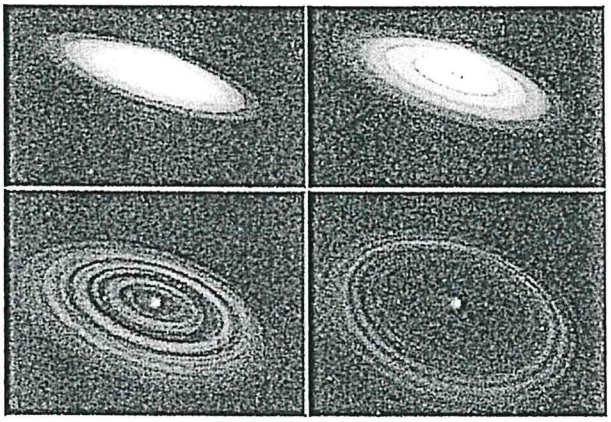


Collaborate The planet is given a large push, as shown in Figure 3. With a partner, discuss what would immediately follow in the scenario.

If there were no sun, planets would tend to move in a straight line at a steady velocity until they interacted with something else. The reason planets do not move in a straight line is that the gravitational attraction between the sun and the planet tends to pull the planet toward the sun. As this pull is happening, the planet still has a component of straight line motion at its initial velocity. The interaction between the planet's straight line motion and gravitational attraction produces a closed-loop path called an orbit. All solar system bodies are in an orbit around the sun or one another.

Predict What could have provided the "push" for objects in the modern solar system?

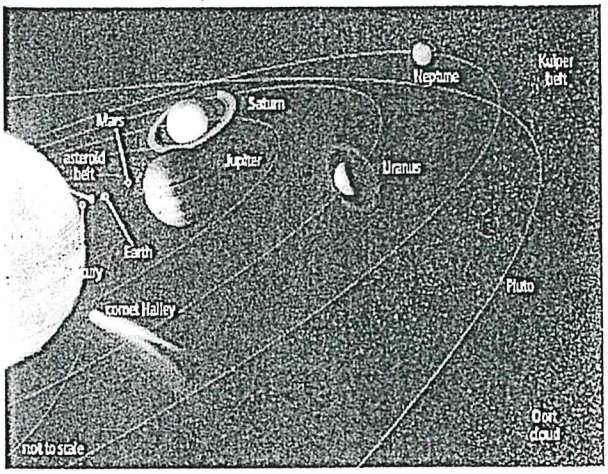
FIGURE 4: The formation of the solar system



Planets in our solar system were never "pushed" into their orbits; they all gained their orbital velocity in the early days of the solar system. When the proto-planetary dust cloud collapsed, its overall motion became part of the overall motion of the early planets

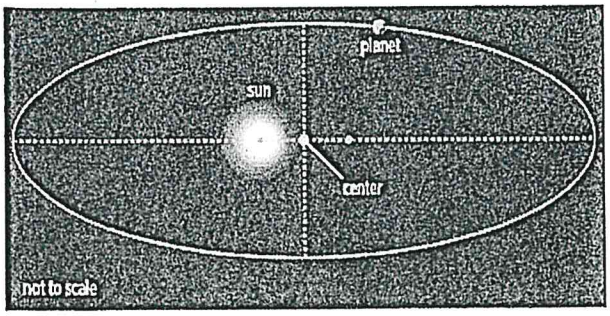
Orbit Shape and Mechanics

FIGURE 5: The modern solar system



The orbit developed in the example of Figure 3 is fairly similar to the orbits of most modern-day planets. Each orbit is not a perfect circle but is actually an oval, or an ellipse. The sun is not quite at the center of each orbit. A 17th century German astronomer and scientist named Johannes Kepler developed three laws to describe the nature of planetary motion. Kepler's first law states that the orbit of a planet is an ellipse with the sun at a focus, one of the two defining points of the ellipse. For a circle, both foci are at the center of the circle. An ellipse has symmetry along two lines, each called an axis. There is a long axis and a short axis. The foci of an ellipse lie on the long axis and are equally spaced from the center.

FIGURE 6: Kepler's first law

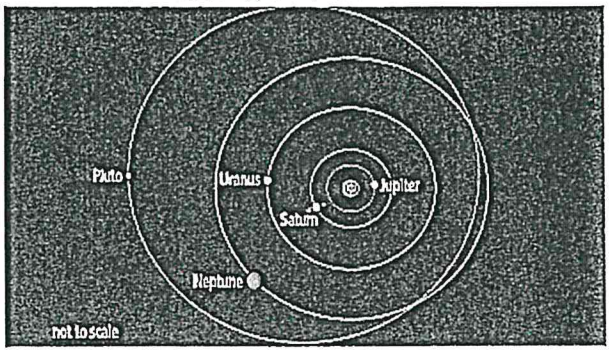


Hands-On Lab

Modeling Orbits Use a model to study the elliptical orbits of planets.

Gather Evidence Describe the ellipses in the image shown. Which orbits appear to be nearly circular? Which orbits appear stretched?

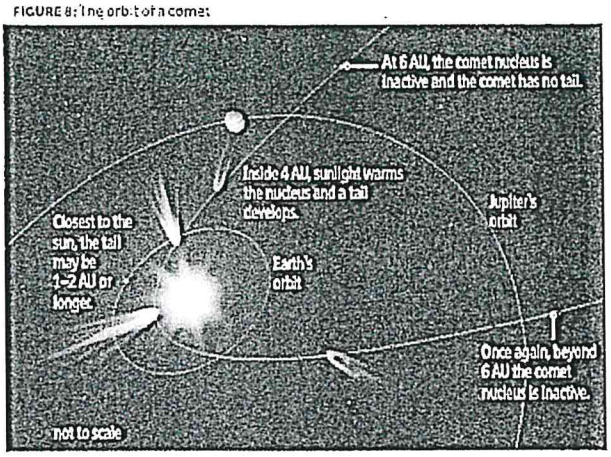
FIGURE 7: The shapes of modern-day planetary orbits



Although all orbits are elliptical and have the sun positioned at one focus of the ellipse, not all orbits are alike. Ellipses range from almost circular to stretched ovals. The degree of elongation of an elliptical orbit is called eccentricity (ranging from 0 to 1). A circle has an eccentricity of zero. The more stretched an orbit appears, the greater its eccentricity and the closer its value approaches 1.

Explain Look at the comet in Figure 8. Describe the comet's orbit in terms of eccentricity.

FIGURE 8: The orbit of a comet



As can be seen in Figure 8, the eccentricity of the orbits of solar system bodies varies considerably. In fact, eccentricity is one of the factors that is considered in defining the different types of solar system bodies. Pluto, a dwarf planet, has a highly eccentric orbit, while comets can have even more eccentric orbits.

Explain What path do the planets of our solar system take around the sun? Why?

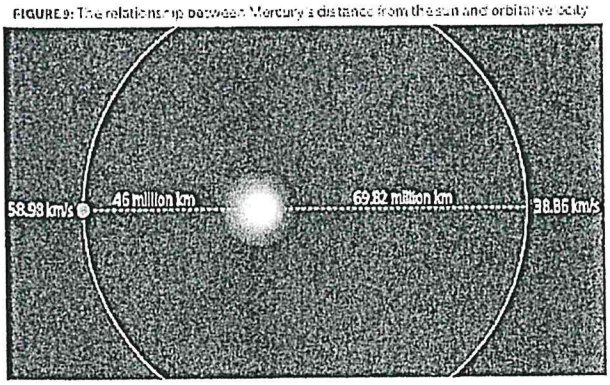
Measuring Interplanetary Distances

Measurements of interplanetary distances and motion can be made using a geometric method known as parallax. Parallax is the apparent shift of an object with respect to the background. As Earth revolves around the sun, astronomers measure an object's apparent shift against the background of more distant bodies from two different locations on Earth or at two different times.

In 1672, Italian astronomer Giovanni Cassini was able to use the parallax method to compute the approximate distance of Mars from Earth. Cassini made observations of Mars from Paris, while a colleague made observations at the same time from French Guiana in northern South America. In 1761, by observing the planet Venus against the background of the solar disk from different locations on Earth, astronomers were able to determine the approximate distance of Earth from the sun.

Analyze Do objects closer to or farther from Earth have a greater change in apparent position as Earth moves?

FIGURE 9: The relationship between Mercury's distance from the sun and orbital velocity



Changes in Velocity Within an Orbit

Kepler's second law of planetary motion describes orbital velocity. Kepler discovered a unique relationship when he drew a line from a planet to the sun, which lies at one focus of its elliptical orbit. He found that a planet moves more rapidly when it is closer to the sun and less rapidly when it is farther from the sun. This change in velocity happens because as a planet moves around its orbit, it sweeps out equal areas in equal times. Near the sun, when the planet is moving faster, it sweeps out an area that is short but wide. Far from the sun, a planet sweeps out an area that is long but narrow in an equal amount of time.

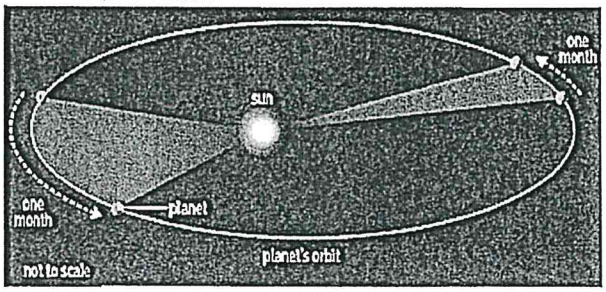
Mercury has an orbit that is highly eccentric. Mercury's orbit passes about 46 million km from the sun at it closest, but at it farthest the orbit is 70 million km from the sun. When nearest the sun, Mercury reaches its maximum orbital velocity of 58.98 km/s, and when farthest from the sun Mercury reaches its minimum orbital velocity of 38.86 km/s.

Collaborate What do you think happens to the speed at the different regions? Recall that generally velocity is the ratio of distance over time.

Hands-On Lab

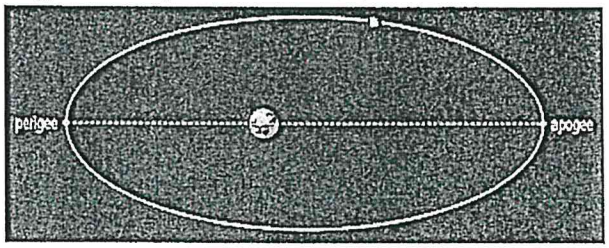
Moons of Jupiter Perform calculations to model and explain the orbits of Jupiter's moons.

FIGURE 10: Kepler's second law



Predict The moon is in an elliptical orbit around Earth. When do you think the moon would appear to move across the sky the fastest?

FIGURE 11: The moon follows an elliptical path around the Earth. The elliptical shape is exaggerated in this diagram. The moon's actual orbit is much closer to a circle.



Problem Solving

Orbital Velocity Consider doubling the average orbital radius of Mercury. The planet would have double the distance to travel. What effect would you predict this change would have on the planet's average velocity?

Relating Planetary Orbits and Time

When Kepler looked at how long it took for the planets to orbit the sun and at the sizes of their orbits, he found a further relationship. He discovered that the square of the orbital period—the time it takes a planet to complete one full orbit around the sun—was proportional to the cube of the planet's average distance from the sun. This is Kepler's third law of planetary motion. When the units are years for the orbital period and astronomical units (AU) for the distance, the law can be written: (orbital period in years)^2 = (average distance from the sun in AU)^3 or $P^2 = a^3$. This law is true for every planet in the solar system.

Using Kepler's second law together with his third law tells us that the more distant planets in the solar system move at slower speeds in their orbits around the sun than planets located closer to the sun. For example, Neptune, the most distant planet in the solar system, has the lowest mean orbital velocity of any of the planets at 5.43 km/s. Mercury, located closest to the sun, has the greatest mean orbital velocity of the planets at 47.87 km/s.

Explain How are distance from the sun and orbital velocity related?

[illegible] the Motion of Planets

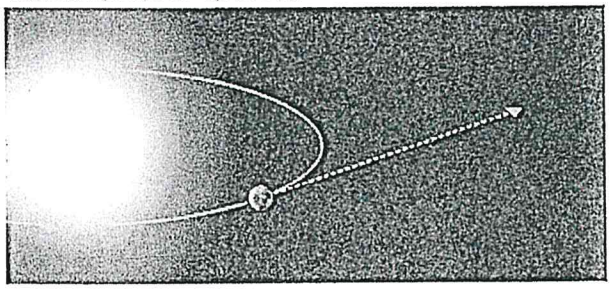
Kepler's laws help scientists describe *how* planets move around the sun, but they do not explain *why* planets move around the sun in varying orbits. To do that, we will need to include the contributions of 17th-century physicist and mathematician, Isaac Newton.

Predict Without the sun, planets would move through space in a straight line. What do you think pushes them from this straight path?

Gravity

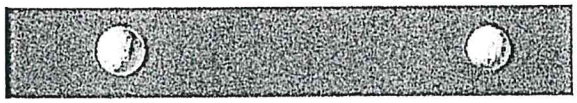
As you've already discovered, gravity is responsible for the shape of orbits. Gravity is the natural attraction between physical bodies due to their masses. Their masses produce a force, which is a push or a pull in a particular direction. However, gravity only pulls—it doesn't push. Two objects pull on each other with equal force.

FIGURE 12: Trajectory of an imaginary planet without the influence of the sun

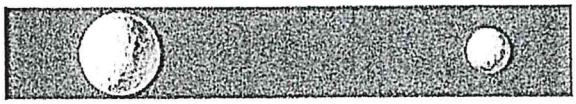


An object in space keeps moving because there is no friction to slow it down. The force of gravity from a massive object, such as the sun, can pull an object and change its path into a closed orbit. A continuous force is needed to maintain the orbit. As you will see, the force depends on mass and distance, so it varies over an elliptical orbit.

FIGURE 13: A change in mass directly affects the gravitational force experienced by both bodies.



The objects are of equal mass.



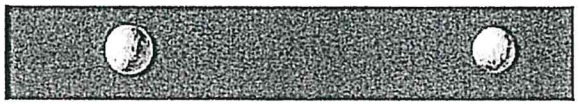
The object on the left is of greater mass.

Collaborate In Figure 13, which pair of objects do you think would experience the larger gravitational force? Why?

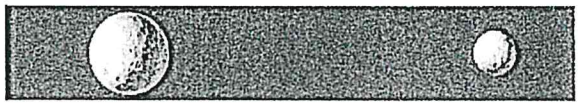
Sir Isaac Newton studied the relationship between the motion of the planets and the force of gravity. In his investigation, he found that more massive objects experience a greater gravitational pull.

The relationship between mass and gravity is linear, which means that any change in mass is reflected in the pull of gravity. For example, doubling the mass of one object in a system would double the pull of gravity on the objects in the system.

FIGURE 14: Mass affects the gravitational force experienced by both bodies.



The objects are of equal mass (M).

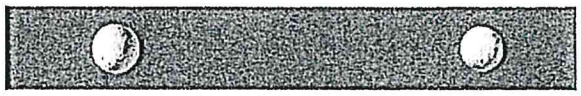


The object on the left has a mass of 2M.

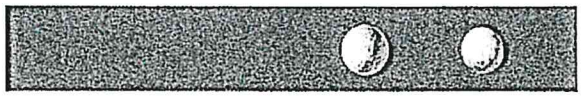
Explain Assuming that the planets in both Figures 14a and 14b are the same distance apart, how does the strength of the gravitational force between the planets in 14a differ from that between the planets in 14b?

Sir Isaac Newton also discovered a relationship between the distance separating objects and the gravitational pull they experience. Objects far away from one another experience a smaller gravitational force than they would if they were closer together. This relationship is not linear, however. The gravitational pull experienced by two objects decreases proportionally to the distance between them *squared*. For example, doubling the distance separating two objects would actually result in them experiencing one-fourth the gravitational pull.

FIGURE 15: Distance affects the gravitational force experienced by both bodies.



Objects are a distance of 3D (D = distance) apart.



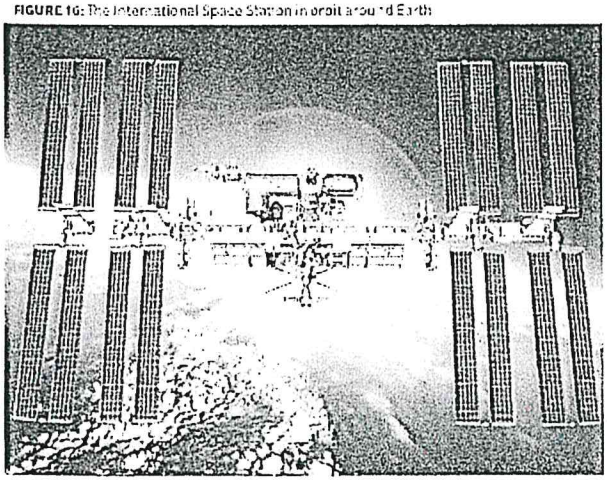
Objects are a distance of 1D apart.

Explain In Figure 15, how would the strength of the gravitational force between the planets in 15b differ from that between the planets in 15a?

Real Orbits

Orbits are elliptical. The distance is constantly changing, so the force is constantly changing. The force due to gravity also changes the speed of the object in an elliptical orbit. The object speeds up and slows down. Mercury and Mars both have enough change in speed and distance as they move in their orbits that early astronomers noticed the changes.

FIGURE 16: The International Space Station in orbit around Earth



An orbit can change over time. The gravitational force from one planet can change the orbit of another planet. The International Space Station uses engines to routinely change the altitude of its orbit around Earth. This allows the station to avoid potentially damaging debris and counteract the drag caused by the very thin high atmosphere.

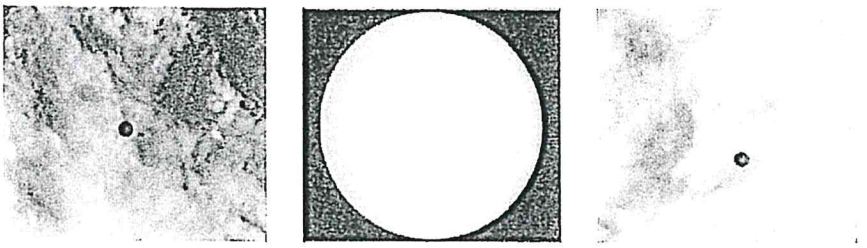
Collaborate What do you think would happen to the orbit of a body if its velocity was increased? What would happen if it was decreased?

If a force causes an object to speed up while moving along its orbit, the distance—the axis of the orbit—will increase. If a force slows the object, the orbit will become smaller. The International Space Station sometimes gets a "push" from other vehicles to raise its speed and orbit. Orbital vehicles are often slowed down at the end of their lifetimes to cause their orbit to degenerate into the atmosphere where they disintegrate.

Explain Describe the relationship between gravity and planetary motion. What aspects will have the greatest influence on the orbits of objects?

EVALUATE

FIGURE 18: Mercury's transit of the sun in 2016



Mercury has a very strange orbit that scientists have only recently been able to explain. It has a very high eccentricity compared to Earth, and sometimes it looks as though it's moving backward. Because it is so close to the sun, it is heavily influenced by the sun's gravity. Sometimes, Mercury is very close to the sun and only 46 million km away. At its farthest point from the sun, it is 70 million km away.

For a long time scientists could not determine the orbit of Mercury. Some scientists thought there was a smaller planet or an asteroid belt near Mercury affecting its orbit, but they could not locate any objects nearby. Mercury's orbit is constantly changing. If a pin were stuck in the center of the orbit, the ellipse of Mercury's orbit would rotate around the pin. This is called *precession*. Scientists had a hard time explaining the precession of Mercury's orbit until Einstein developed his theory of general relativity in 1915. The theory describes the relationship between gravity, space, and mass. Any object orbiting as close to the sun as Mercury will experience this orbit precession affect because space is slightly warped by the sun's enormous gravity at these distances. Some scientists think that an impact from an asteroid may have set Mercury into its strange orbit.

Explain How does Mercury appear to be moving relative to Earth? Why do you think its motion is so different from Earth's?

Check Your Understanding

1. Which object has the greatest eccentricity in its orbit?
   a. Pluto
   b. Saturn
   c. Jupiter
   d. Neptune

2. What gave planets their initial velocity?
   a. gravity
   b. sun
   c. the formation of the solar system
   d. Kepler's third law

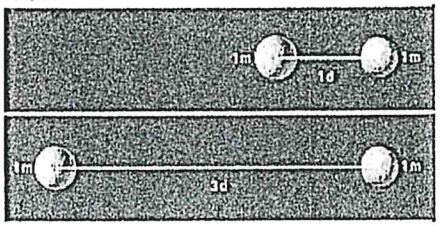
3. Using Newton's Law of Gravitation, if there are two objects exerting the force of gravity on each other and the mass of one of the objects is quadrupled, then the force between them is
   a. doubled.
   b. quartered.
   c. tripled.
   d. quadrupled.

4. Match the phrase from Kepler's laws to the quick descriptor:

a. Kepler's 3rd law	1. The elliptical path of the planets around the sun includes the center of the sun at one focus.
b. Kepler's 1st law	2. The ratio of squares of the periods of two planets is equal to the ratio of cubes of the average distance from the sun.
c. Kepler's 2nd law	3. This law describes an imaginary line from the center of the sun to the center of the planet that sweeps through equal areas in equal time intervals.

5. For Figure 19, which statement accurately describes the difference between the gravitational force experienced by the top and bottom objects?

FIGURE 19: The bottom objects of the same mass (m) are separated by three times the distance (d) between the top objects.



   a. The force between the top objects is one third that of the bottom objects.
   b. The force between the top objects is three times that of the bottom objects.
   c. The force between the top objects is one ninth that of the bottom objects.
   d. The force between the top objects is one half that of the bottom objects.

6. Using Newton's law of gravitation, if there are two objects exerting the force of gravity on each other and the mass of both of the objects is halved, then the force between them is
   a. doubled.
   b. quartered.
   c. tripled.
   d. quadrupled.

7. How does the ISS help manage space junk?
   a. It alters its own orbit to avoid known space junk.
   b. It slows down the orbit of the decommissioned satellite.
   c. It speeds up the orbit of the decommissioned satellite.
   d. It places a decommissioned satellite in a graveyard orbit.

8. Consider the orbital period and average distances from the sun for the planets listed below:

a.	Mercury	0.2	0.4
b.	Earth	1	1
c.	Saturn	29.5	9.5
d.	Neptune	165	30

Using the $\frac{P^2}{d^3}$ = constant ratio described in this unit, what is the approximate constant for each planet?

9. What are the foci of an ellipse?
   a. the farthest points from the center
   b. points near the center (lying along the long axis)
   c. the closest points to the center
   d. points near the center (lying along the short axis)

10. At which point in its orbit is a planet traveling the fastest?
   a. when it is farthest from the sun
   b. when it is traveling towards the sun
   c. when it is traveling away from the sun
   d. when it is closest to the sun

11. Which of these statements accurately describes how a satellite stays in orbit?
   a. It is outside of Earth's gravity.
   b. It is continuously falling and missing the Earth.
   c. Its thrust is stronger than Earth's gravitational pull.
   d. It is moving so fast that gravity doesn't affect it

In your Evidence Notebook, design a study guide that supports the main ideas in this lesson.

Remember to include the following information in your study guide:

- Use examples that model main ideas.
- Record explanations for the phenomena you investigated.
- Use evidence to support your explanations. Your support can include drawings, data, graphs, laboratory conclusions, and other evidence recorded throughout the lesson.

Name: _____ Date: _____

Unit 4 Lesson 2
Lesson Quiz

Quiz: Gravity and Orbits

Read each question. Circle the letter of the correct answer.

1. Which law describes the speed at which objects travel at different points in their orbits?

   A. law of ellipses

   B. law of periods

   C. law of eccentricity

   D. law of equal areas

2. What does Kepler's first law call the paths that planets follow as they orbit the sun?

   A. circles

   B. periods

   C. ellipses

   D. epicycles

3. Kepler's third law describes the relationship between the average distance of a planet from the sun and which property of the planet's motion?

   A. inertia

   B. orbital period

   C. gravitational pull

   D. average temperature

4. Kepler's second law states that equal areas are covered in equal amounts of time when an object does what?

   A. orbits the sun

   B. spins on its axis

   C. completes an eclipse

   D. travels one light-year

5. What effect does the elliptical orbit of the moon around Earth have?

   A. The orbit is not predictable.

   B. The orbit affects the changes in Earth's seasons.

   C. The distance between Earth and the moon changes yearly.

   D. The distance between Earth and the moon varies over a month's time.

6. According to Kepler's first law, the orbit of a planet is an ellipse with what object at or near the focus?

   A. its star

   B. its moon

   C. its center

   D. the galactic center

7. What is happening to the orbital velocity of Earth as it gets closer to the sun?

   A. It is getting faster.

   B. It is getting slower.

   C. It remains the same.

   D. It varies depending on the current cycle of the sun.

Name: _____ Date: _____

Unit 4 Lesson 2
Lesson Quiz

Read each statement. Write your answer on the lines.

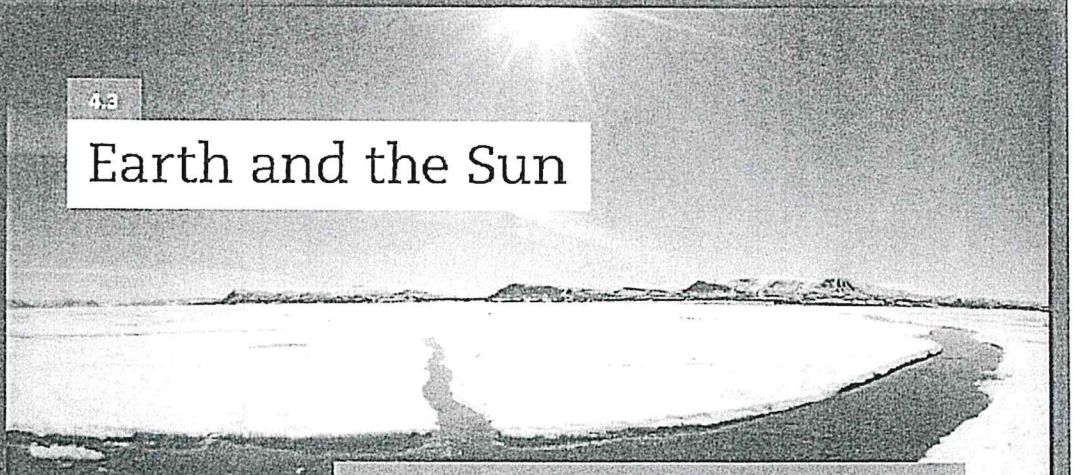
8. Describe the shape of the ellipse a planet forms if its orbital velocity remains the same during one complete orbit of its star.

9. How would increasing the mass of an object affect its gravitational force?

10. Describe Newton's law of gravitation. Give an example of this law at work.

4.3

Earth and the Sun



Earth and the sun interact through energy.

CAN YOU EXPLAIN IT?

FIGURE 1: Between 850 and 630 million years ago, Earth may have been almost completely covered in ice.

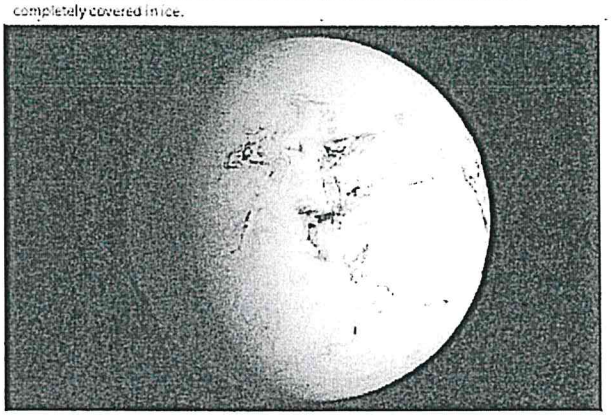


Image Credit: © Nature Throughout, III © the Author/Science Source

Gather Evidence As you explore the lesson, gather evidence to help explain how the amount of solar energy reaching Earth changes over time and how these changes can affect Earth's global climate.

About 10% of Earth's surface today is covered in ice. Massive ice sheets cover most of Antarctica and Greenland, while sea ice covers the Arctic Ocean. Glaciers are also found in temperate and even tropical latitudes, but only at very high elevations where the air is significantly cooler than it is at sea level. Hundreds of millions of years ago, however, conditions may have been very different.

Evidence for glaciers at sea level near the equator suggests that Earth was much colder than it is today. Why would Earth have been significantly colder in the past?

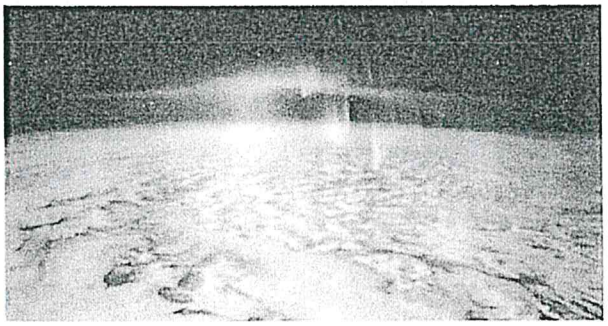
Infer Where do you find ice sheets on Earth today? What are conditions like in these places? Use evidence to make an inference about Earth's conditions 700 million years ago, when ice sheets and glaciers where found near the equator.

The Earth-Sun System

Think about the last time you went outside. How does the interaction between Earth and the sun affect your life? Most of what we see outside during the daytime is visible because of sunlight. The warm air, wind, and rain that we feel exist because of the sun's energy.

In addition to light, the sun also emits streams of charged particles called the solar wind. Earth's magnetic field—which originates in Earth's core—exerts a force on those particles, causing them to deflect toward the poles. There they interact with the gases in Earth's atmosphere, causing the greenish-purplish glow of the aurora. The aurora is an example of the many interactions in the Earth-sun system.

FIGURE 2: An aurora, as seen from the International Space Station in 2012, is the result of the interaction between the solar wind and Earth's magnetic field and atmosphere.



Analyze Think about your everyday experiences. How are they affected by your interactions with the sun or by Earth's interactions with the sun?

Earth-Sun System Components

Suppose you travel back in time to Earth's past and find yourself on a planet that is covered in ice—snowball Earth! How would you go about understanding this frozen version of Earth? You learned that in science it is useful to think of events or phenomena as occurring within a system. Large-scale changes to Earth may involve many of its systems. A change that affects Earth's temperature may also involve Earth-sun system interactions.

Matter and energy are components of the Earth-sun system. Most of the matter and the energy in the system is concentrated in the sun. Composed mostly of hydrogen and helium atoms, the sun is 330 000 times as massive as Earth and has a volume at least 1 300 000 times as great as Earth's. Though matter is concentrated in the sun, Earth has a greater average density. Earth has an average density more than five times as great as the average density of the sun. It has a thin atmosphere made up mostly of nitrogen and oxygen, a solid surface that is largely covered in water, rock, ice, and living things, and a dense metallic core made of nickel and iron. Earth is orbited by the moon, a small rocky body without a significant atmosphere.

Hands-On Lab

Earth-Sun Motion Design an experiment to measure the movement of Earth.

Predict Choose a force, a form of energy, or a motion that is important to the interactions between Earth and the sun. How would your experience on Earth be different if that force, energy, or motion changed or did not exist?

The Earth-sun system includes not only Earth and the sun and the materials they are made of, but also the solar energy emitted from the sun, the gravitational forces keeping the objects close together and moving in their orbits, and the processes that are affected by sunlight and gravity.

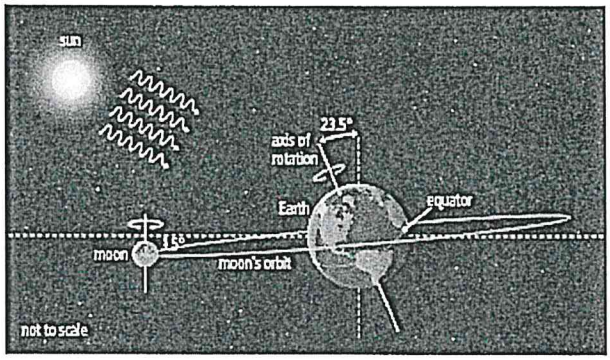
Every 365 days, Earth completes one orbit around the sun. Earth's orbital motion is important, because it ensures that Earth stays at approximately the same distance from the sun throughout the year and receives a steady supply of energy from it. Although the total amount of energy that Earth receives does not change significantly throughout the year, the way that energy is distributed on the surface does vary.

Approximately once every 24 hours, Earth completes one rotation on its axis. This rotation results in the cycle of day and night. Earth's axis is not perpendicular to its path around the sun. Instead, it is constantly pointed toward Polaris—the North Star. As Earth orbits the sun, the orientation of its axis stays the same relative to Polaris, but it changes relative to the sun. In January, for example, the North Pole is pointed away from the sun, while in July it is pointed toward the sun.

Earth-Sun-Moon System Interactions

Interactions between Earth and the sun occur mainly through gravity and energy. The gravitational effects of the sun on Earth's surface are very difficult to notice. These effects are easier to observe when the moon is included as part of this system.

FIGURE 3: The force of gravity and inertia keeps the moon in orbit around Earth and the Earth-moon system in orbit around the sun.



Model Make a drawing to compare the location of the moon relative to the sun and Earth during the new moon with the location of the moon during the first quarter. How does this model help explain the difference between spring tides and neap tides?

Gravity

Tides are an example of how Earth, the sun, and the moon interact through gravity. Figure 4 shows the position of the moon relative to Earth and the sun at four different times in the moon's orbit. The difference between high and low tide is greatest at the new and full moon, and least during the first- and third-quarter moons. The changing gravitational interactions between the moon, sun, and Earth as the moon orbits Earth cause the difference between these tides, known as spring and neap tides.

FIGURE 4: Although the moon's gravity is the main reason for tides on Earth, the sun's gravity also has an effect.

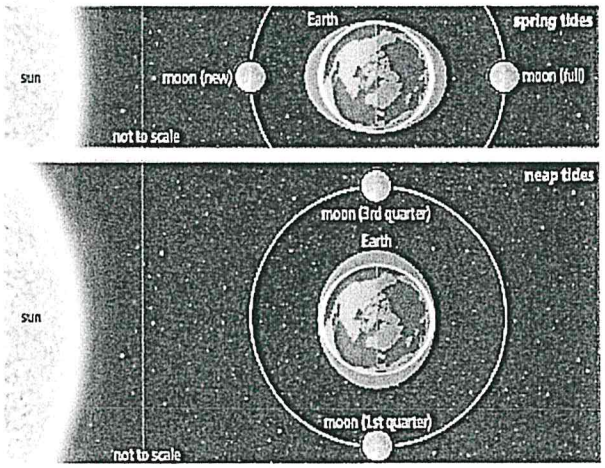
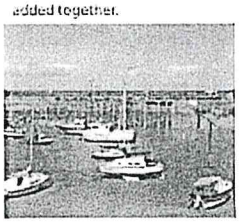


FIGURE 5: Extreme low and high tides occur when the effects of the gravitational pull of the sun and the moon are added together.



The gravitational force between Earth and the sun is, in part, responsible for Earth's motion in space. At any given time, a planet is moving through space in two directions: straight forward and straight toward the center of the sun. Where do these two motions come from? A planet's forward motion is a result of its inertia, the tendency to keep moving as it has been moving since it formed. The motion toward the sun is a result of the gravitational force between the sun and the planet. The planet continuously accelerates toward the sun. It doesn't fall into the sun because of its inertia.

Earth's orbit is not perfectly circular. As a result, the distance between Earth and the sun varies slightly throughout the year. In January, Earth is about 5 million km closer to the sun than it is in July. Because the gravitational pull between two objects increases with decreasing distance, objects orbit faster when they are closer. In January, Earth moves through space slightly faster than it does in July.

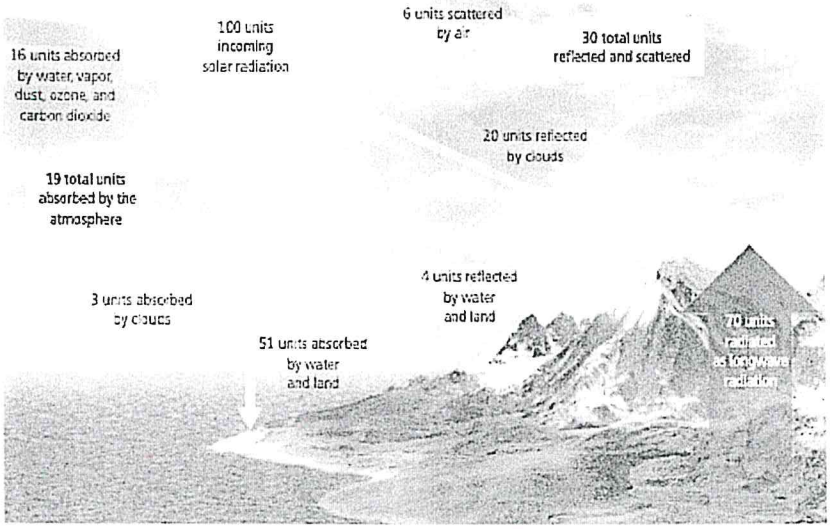
Explain How does gravity affect the motion of Mercury relative to the sun? How is this effect similar to and different from the effect of gravity on the motion of the Earth-moon system around the sun?

Energy

Solar energy travels through space in the form of electromagnetic radiation. Of the light emitted by the sun, 41% is visible light, another 9% is ultraviolet light, and 50% is infrared radiation.

FIGURE 6: Light is emitted by the sun and then absorbed, reflected, refracted, and radiated by materials on Earth's surface and in the atmosphere.

FIGURE 7: Earth's surface energy budget The total amount of energy reflected and emitted by Earth is equal to the total amount that reaches Earth from the sun.



When solar energy reaches Earth, it interacts with the atmosphere and surface. Some is reflected off clouds, land, water, and ice. Earth is visible from space because of the sunlight that reflects off it. Light that is not reflected is absorbed by rock and water on the surface and by gases in the atmosphere. Once light is absorbed, it causes the material to heat up. The ground is hotter during the day than at night, because it absorbs sunlight. As a material heats up, it emits energy in the form of invisible infrared radiation. Earth's surface radiates infrared energy out toward space, but some is absorbed by Earth's atmosphere.

Math connection

Calculate The albedo of a surface is a measure of how reflective it is. To calculate the albedo, divide the amount of solar energy reflected by the surface by the total amount of solar energy that reaches Earth. What is Earth's albedo?

Overall, the amount of solar energy that reaches Earth from space is balanced by the amount that is reflected and radiated back to space. However, gases in the atmosphere, known as greenhouse gases, absorb and give off infrared radiation. As a result, Earth's atmosphere absorbs some of the outgoing radiation and keeps it in the Earth system for a while, which raises Earth's surface temperature. This process is called the *greenhouse effect*.

Without the greenhouse effect, much of Earth's heat energy would be lost almost immediately to outer space. Earth's average surface temperature would be about 33°C cooler than it is now. The greenhouse effect has helped Earth thrive as a planet. Recently, however, there has been such a significant increase in the levels of carbon dioxide in the atmosphere that Earth's energy budget may be out of balance. Many scientist warn of the possibilities of global climate change.

Predict Think about how light moves through different materials. What are some factors that could change the amount of sunlight absorbed by Earth's surface and atmosphere?

EXPLORATION 2

Solar Energy in Earth's Systems

Energy is continuously moving outward from the sun in all directions. The amount of energy that reaches Earth does not change significantly from hour to hour, day to day, or even month to month. In spite of this, however, we can feel differences from place to place and from season to season.

Energy in Systems

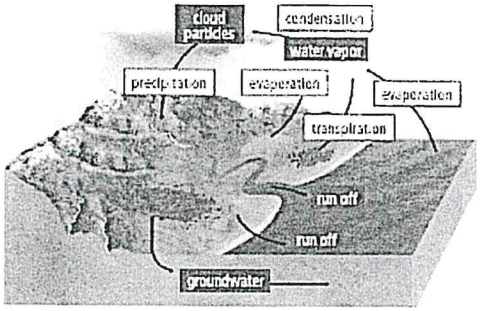
A diagram of Earth's energy budget is a model showing the ways that energy moves to and from Earth. What this model does not show is how solar energy flows within Earth's systems. It does not show all the ways that the flow of solar energy influences Earth's surface—how it affects the atmosphere, the hydrosphere, lithosphere, or the biosphere. When we study the importance of solar energy to Earth systems, it is useful to examine what happens when the amount of solar energy in a location changes.

FIGURE 8 Snow melts and flowers start to bloom in the late winter and early spring.

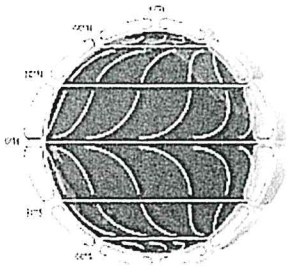
You learned that when solar energy reaches Earth, it interacts with matter on the surface and in the atmosphere. While the amount of energy emitted by the sun is nearly constant, its distribution over Earth's surface changes. During the spring, the amount of energy reaching a particular part of Earth increases. With more direct sunlight and more hours of daylight, the amount of energy absorbed by the ground increases. The ground heats up more and emits more energy, warming the air above. The warmer air, along with the increase in intensity of light and the switch from snowfall to rain, causes the snow to melt. The meltwater seeps into the ground. With less snow reflecting the sunlight, more light is absorbed by the ground. The warmth and water trigger the growth of spring flowers. Once the plants are above ground, their leaves use the sunlight and water during the process of photosynthesis, converting sunlight into chemical energy within the plant. Animals such as deer and squirrels eat the flowers, using the stored sunlight in them to live and grow.

Explain Do you agree or disagree with the following statement? Without the sun, there would be no changes in the weather on Earth. Use reasoning to support your argument.

FIGURE 9: Solar energy drives the water cycle and the global wind systems.



Water changes phases as it moves through the water cycle. These changes are driven by energy from the sun.



Uneven heating of Earth's surface results in global winds. Rising warm air and sinking cool air currents (red and blue arrows) form patterns that produce surface winds (white arrows).

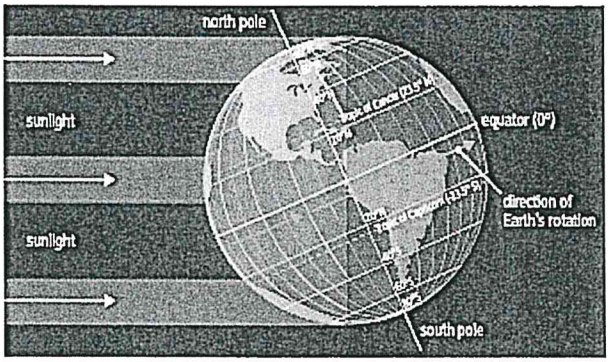
Collaborate With a partner, explain how each part of the water cycle would be affected if the amount of solar energy reaching the surface in a given place changed. Use reasoning to support your explanations.

Sunlight has a profound effect on individual Earth's systems. It is a major factor in Earth's global cycles and processes. Sunlight provides the energy that causes water to change form as it moves through the water cycle. Solar energy drives local and global wind patterns, which develop as the sun heats up parts of Earth more, or more quickly, than other parts of the planet. Differences in weather from place to place, and changes in weather from day to day, are also a result of differences in the way sunlight interacts with Earth's different surfaces over distance and time. Because the sun is the main source of energy for living things on Earth, sunlight is also key in the cycling of carbon and oxygen between the atmosphere and living things. Plants, for example, use more oxygen in spring and summer when the length of day and sunlight intensity increases.

Distribution of Solar Energy on Earth's Surface

If you live in a region with distinct seasons, you are familiar with the cyclic pattern of temperature, precipitation, and daylight change that occurs during the year. These changes are a result of Earth's shape, the tilt of its axis, and its orbit around the sun.

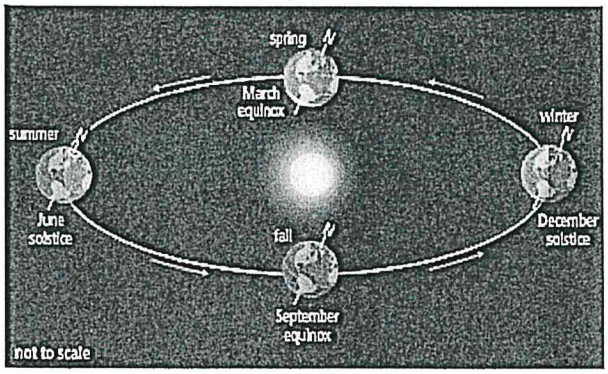
FIGURE 10: Earth's shape and axial tilt affect the amount of energy received by different regions of the planet.



Therefore, the total amount of solar energy that tropical regions receive is significantly greater than that of polar regions. This difference in energy distribution affects climate and drives the movement of winds and ocean currents.

Because Earth's tilt relative to the sun changes as it orbits the sun, the concentration of sunlight in any given area changes throughout the year. This results in seasons. During the June solstice, when the North Pole is tilted toward the sun, the sunlight is most intense at 23.5°N of the equator. The Northern Hemisphere experiences the warmer temperatures and longer days of summer, while the Southern Hemisphere experiences winter. During the December solstice, when the North Pole is tilted away from the sun, sunlight falls most directly at 23.5°S of the equator. The Northern Hemisphere experiences lower temperatures and shorter days of winter, while the Southern Hemisphere experiences summer. During the spring and fall equinoxes, in March and September, respectively, Earth's axis is not tilted away or toward the sun, and sunlight is most intense at the equator. All areas of Earth receive 12 hours of daylight, and there is no difference in the amount of energy received by either hemisphere.

FIGURE 11: Seasons in the northern hemisphere



The effect of seasonal changes on temperature and daylight are most dramatic near the poles and least dramatic near the equator. In March and September, both poles experience 12 hours of daylight. But in December, the North Pole is pointing away from the sun at such an angle that the region does not experience any hours of daylight whatsoever. At the same time, the South Pole is pointing toward the sun at such an angle that it experiences a full 24 hours of daylight. This situation is reversed in June. At the equator, however, the difference in intensity of light and number of daylight hours changes much less throughout the year than it does at the poles.

Explain In January, the days are longer and the weather is warmer in South America than in North America. Explain this difference in terms of interactions between Earth and the sun.

Hands-On Lab

Positions of Sunrise and Sunset Collect and analyze data describing the positions of sunrise and sunset, and then make predictions for future months.

Model Make a sketch that shows why the intensity of sunlight differs from place to place because Earth is spherical. Use the sketch to show why areas that are tilted directly toward the sun receive more solar energy than those that are not.

Earth-Sun System and Climate Change

Studying the current conditions of the Earth-sun system helps us understand Earth's daily and seasonal changes in weather, differences in climate from place to place, and Earth's global climate conditions in general. However, evidence in the rock and fossil record suggests that Earth's global climate has changed significantly in the past. Earth has experienced much cooler and much warmer periods. The current variations of the Earth-sun system cannot explain these changes. Could solar radiation, Earth's tilt, and its orbit have changed over time, and if so, could these factors explain changes in Earth's climate?

Solar Variability

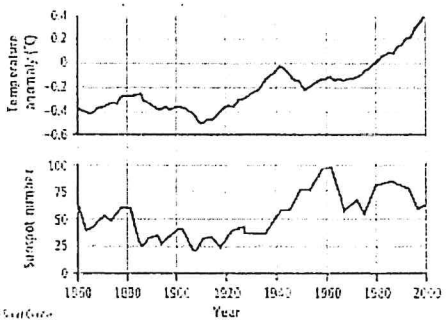
Since 1978, scientists have used satellites to measure the amount of sunlight that reaches the top of the atmosphere. Measuring sunlight away from Earth's surface allows us to see patterns that are related to the amount of energy given off by the sun, rather than daily and seasonal patterns related to Earth's rotation and orbit.

For centuries, scientists have known that the amount of energy emitted by the sun changes over time. It fluctuates on a cycle of about 11 years. For example, in 1999 the sun emitted about 0.1% more energy than in 1996, but about the same as it did in 1988. It turns out that the amount of energy that the sun emits is related to sunspot activity. Sunspots are darker spots within the sun's bright surface. The number of sunspots visible each month varies between almost 0 to nearly 200. In general, the more sunspots there are, the more energy is being emitted by the sun.

This relationship between sunspots and solar energy is very useful. We have only a few decades of actual measurements of solar energy, but we have more than 400 years of scientific observations of sunspots, beginning with Galileo in 1610. We can therefore use historical records of sunspots to infer changes in solar energy.

Analyze Describe the relationship between sunspot activity and average change in air temperature between 1860 and 1960. What explains this relationship?

FIGURE 12: Plots showing sunspot activity and solar energy reaching Earth's upper atmosphere



How do changes due to sunspot activity affect Earth's climate? By comparing graphs of sunspot cycles and average global temperature change over time, it becomes apparent that even a small change in energy emitted by the sun does affect Earth's climate. Perhaps the most dramatic example is known as the Maunder Minimum. Between 1645 and 1700, there were very few sunspots. This corresponded to a particularly cold period in Europe, part of a period known as the Little Ice Age.

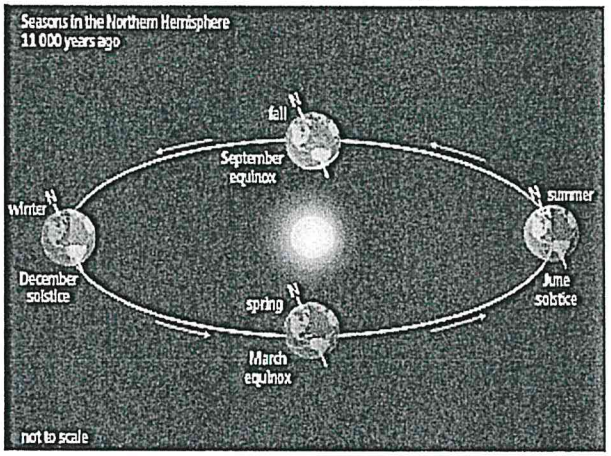
In addition to the 11-year sunspot cycle, the sun appears to go through other longer period cycles as well. As the sun ages, it is becoming hotter and brighter. However, this change is very slow.

Predict Suppose the sun went through several decades of very low sunspot activity. How could this affect Earth's surface? Support your prediction with evidence and reasoning.

Changes in Earth's Motion

The amount of energy that reaches Earth depends not only on the amount of energy emitted by the sun, but also on changes in Earth's motion in space.

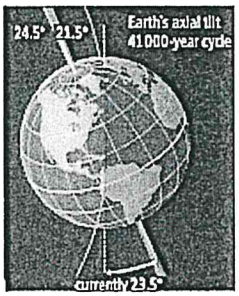
FIGURE 13: Earth's orbit can be more or less circular. Its eccentricity, or how much it deviates from a circle, changes over periods of about 100 000 years and 413 000 years.



At its closest point, Earth is 147.1 million km from the sun. At its farthest point, it is 152.1 million km from the sun. As a result, about 7% more solar energy reaches Earth in January than in July. Over time, however, Earth's orbit becomes more elliptical and less elliptical, or eccentric. As a result, the difference between its closest and farthest approach to the sun changes. When Earth's orbit is more circular, Earth spends more time closer to the sun. When Earth's orbit is more eccentric, Earth spends more time farther from the sun.

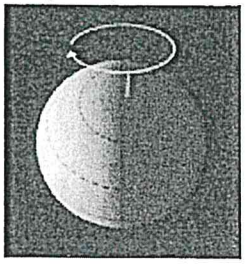
Changes in the eccentricity of Earth's orbit can affect the differences between seasons. For example, if Earth is closer to the sun during the summer, summer will be slightly warmer. Eccentricity can also affect the total amount of energy received from the sun. When Earth's orbit is more circular, it receives slightly more solar energy during the year than when it is more elliptical. This results in slight fluctuations in temperature over tens of thousands of years.

FIGURE 14: Earth's tilt varies between 21.5° and 24.5° over a period of about 41 000 years.



Analyze How might changes in eccentricity affect the amount of solar energy reaching Earth?

FIGURE 15: The direction that Earth's axis points in space changes slowly over time.



Earth is currently tilted about 23.5° relative to its orbital plane. However, about 10 000 years ago Earth's tilt was about 24.5°, and 30 000 years ago its tilt was about 22.2°. The more Earth's axis is tilted, the greater the differences between seasons—winters are colder and summers are warmer. The smaller the tilt, the less the weather changes from season to season. Scientists think that axial tilt affects global climate—not just seasonal changes. When the tilt is smaller, less winter snow melts during the cooler summers. This can result in the expansion of glaciers and ice sheets.

Presently, Earth's axis points toward Polaris, the North Star. Over a period of about 26 000 years, however, the axis itself rotates. This motion is called precession, and it is similar to the wobble of a spinning top. Because of precession, the direction that Earth's axis points in space changes, which affects the timing of the seasons. Today, for example, summer in the Southern Hemisphere occurs when Earth is closest to the sun. However, 11 000 years ago, Earth's axis pointed in the opposite direction, just as it does today, and summer occurred in the Northern Hemisphere when Earth was closest to the sun.

Independently, the effect on seasons or global climate of each of these changes in Earth's motion in space—its eccentricity, tilt, and precession—is clear. But because all of these changes occur at the same time, understanding the combined effect is complicated. Scientists use mathematical and computer models to understand the combined effects of Earth's motion in space.

Model Make a sketch to show what Earth would look like at different points in its orbit if its axis were pointing to a different star in space. How might this change affect seasons on Earth? Use reasoning to support your claim.

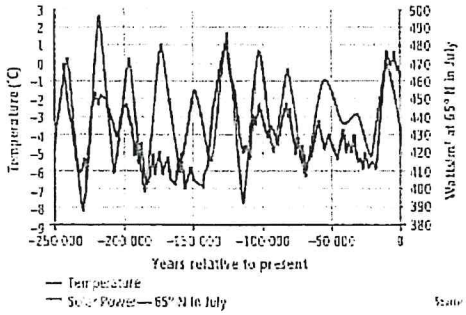
Explain Earth has gone through many cycles of ice ages followed by periods of warmer climate. How might these cycles be related to patterns of solar output and patterns of change in Earth's motion in space?

Evidence of Past Climate

Evidence shows that over thousands of years, Earth has gone through many glacial periods. These periods are separated from each other by interglacial periods—periods of warmer weather, melting of ice sheets, and rises in sea level. But how can we determine the timing of glacial and interglacial periods?

Analyze Describe the relationship between solar energy reaching the Northern Hemisphere in July to average air temperature in Antarctica. What could explain the relationship?

FIGURE 16: Geologists compared temperature data to Milankovitch models to test the hypothesis that ice ages are a result of changes in Earth's motion in space.



Source: NASA data

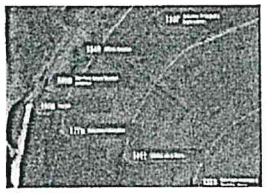
Image Credit: Peter Simmon, NASA Goddard Space Flight Center

In the early 20th century, Serbian scientist and engineer Milutin Milankovitch developed a model to show how a combination of changes in Earth's motion would affect solar radiation reaching the Northern Hemisphere and, therefore, Earth's glaciation patterns. When Milkankovitch developed his model, it was difficult to put precise dates on when each glacial and interglacial period occurred.

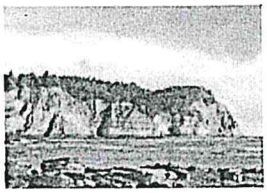
In the 1970s, scientists developed new methods for estimating global temperatures using natural recorders of climate variability, such as tree rings, fossils, and glacial ice cores. Scientists study the texture and composition of layers in ice cores to infer the timing and duration of glacial and interglacial periods. The graph in Figure 16 combines data from Antarctic ice cores with calculations of solar radiation to show global changes in Earth's temperature over time. In order to accurately time interglacial and glacial periods, scientists study the ratio of different types of oxygen in ice cores and in the shells of marine fossils. They also measure the thickness of annual growth rings in old and fossilized trees to determine past climate conditions.

Patterns

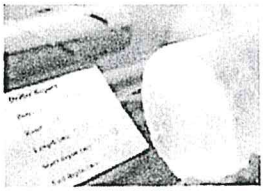
FIGURE 17: Patterns in tree rings, ice cores, layers of sedimentary rock, and locations of rocks transported by glaciers all reveal that Earth has gone through cycles of cooler and warmer climates.



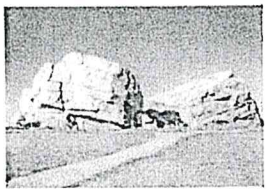
Tree rings reveal information about climate when the tree was growing.



Rock layers contain fossils that can be used to figure out ocean temperatures.



Ice cores can be used to infer snowfall rates and air temperature.



Glacial erratics are evidence that ice once covered an area.

Pattern Evidence

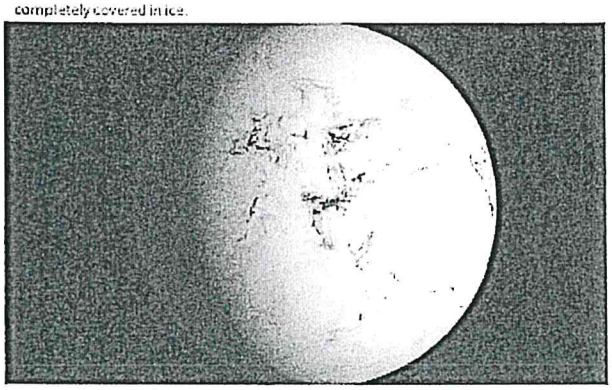
In order for an idea to be accepted as scientific theory, it must not only make sense theoretically and mathematically, it must also be supported by an abundance of evidence. Milankovitch's idea that patterns of changes in Earth's motion cause patterns of change in Earth's climate is supported by many observations and measurements from many different places on Earth.

Evaluate Which of the types of evidence shown in the images are most useful for constructing a record of climate change over thousands or millions of years? Use reasoning to support your response.

Predict How could you use an understanding of Earth's motion in space to predict changes in global climate over the next few hundred thousand years? How could it be possible to predict future climate with complete accuracy?

CAN YOU EXPLAIN IT?

FIGURE 19: Between 850 and 630 million years ago, Earth may have been almost completely covered in ice.



Ice sheets currently cover most of Antarctica and Greenland. The North Pole itself is an ocean, which is almost permanently covered in sea ice. Glaciers are also found in temperate and even tropical latitudes. Glaciers like these, including the Furtwangler Glacier located almost on the equator at the summit of Mt. Kilimanjaro, are found at very high elevations, where the air is significantly cooler than it is at sea level.

It is not surprising that the geologic record holds evidence for the existence of glaciers and ice sheets in the past. Twenty thousand years ago, for example, a vast ice sheet extended as far south as New York and Pennsylvania. The evidence for these ice sheets, along with vast quantities of other evidence, indicates that at the time Earth was about 5 °C cooler than it is today. Evidence from sedimentary rocks and fossils also shows that Earth has gone through major changes in climate over the past 600 million years.

What is surprising, however, is the evidence that earlier in Earth history—around 700 million years ago—the entire Earth could have been covered in ice. Geologists refer to this possible period as the Snowball Earth. What could cause Earth to become covered in ice? What caused other major changes in climate shown in the rock and fossil record? Geologists think that changes in climate are a result of a combination of factors, including changes in energy radiated by the sun, changes in Earth's orbit and tilt, changes in the composition of the atmosphere, episodes of volcanism and mountain building, and changes in the locations of continents and oceans.

Explain What conditions affect how warm Earth's surface is? What could have been different 700 million years ago that resulted in more of Earth's surface being covered in ice?

EVALUATE

CHECKPOINTS

Check Your Understanding

1. A system can be described by its components and the processes that occur within it.

   Identify the components of matter, energy, and force in the Earth-sun system.

   a. matter:_____

   b. energy:_____

   c. force:_____

2. Give examples of processes that occur within the Earth-sun system:

   a. process that involves energy only: _____

   b. process that involves interaction between force and matter: _____

   c. process that involves interaction between energy and matter: _____

3. Which of the following statements accurately describe interactions in the Earth-sun system? Choose all that apply.

   a. Without gravity, Earth would not move at all through space.

   b. Different regions of Earth receive different amounts of solar energy.

   c. As Earth warms up, the amount of energy emitted by the sun increases, decreasing volcanic activity on Earth's surface.

   d. If Earth were not tilted, it would be heated evenly over the entire surface.

   e. Energy absorbed by Earth's surface flows into Earth's interior to keep it warm.

   f. The total amount of energy that reaches Earth depends on its distance from the sun.

4. A student wants to explain why polar climates are cooler than tropical climates. Describe a 3D model that the student could make out of simple materials in order to explain this. Explain what each part of the model represents and how the student would use the model to explain differences in climate.

5. Organize the following statements into four cause-and-effect pairs.

   - Earth's tilt increases.
   - Sunspot activity increases.
   - The timing of the seasons changes.
   - More radiation is emitted by the sun.
   - Earth's axis and orbit precess (wobble).
   - Earth receives slightly less solar radiation.
   - Seasonal differences in weather are greater.
   - Earth's orbit becomes more eccentric (more elliptical).

6. For each change, identify the timescale over which the change occurs: hours, months, years, thousands of years, or billions of years.

   a. Earth rotates on its axis.

   b. The tilt of Earth's axis changes.

   c. The sun gets hotter as it evolves.

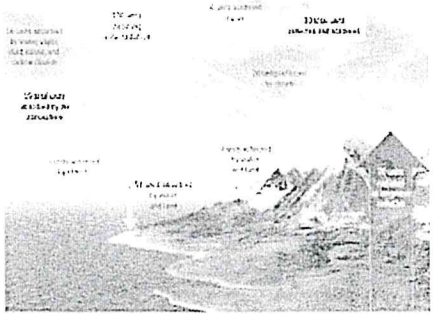
   d. The shape of Earth's orbit changes.

   e. The orientation of Earth's axis changes as it orbits the sun.

   f. The number of sunspots observed increases and decreases.

7. Scientists think that between 1645 and 1715, the sun went through a period of emitting less solar energy. The image below shows Earth's energy budget today.

FIGURE 20: Earth's surface energy budget.



Describe three ways that the energy budget diagram for 1645–1715 would be different.

8. How and why could a change in solar output affect Earth's water cycle?

9. Which of the following are most likely causes of glacial periods over the past 2 million years? Choose all that apply.
   a. decrease in tilt of Earth's axis
   b. increasing eccentricity of Earth's orbit
   c. decreasing rate of fusion in the sun over time
   d. decreasing volcanic activity on Earth's surface
   e. increasing difference between high and low tides
   f. decreasing force of gravity between Earth and the sun
   g. increasing frequency of comets entering the inner solar system

10. Which of the following are Milankovitch cycles? Choose all that apply.
   a. eccentricity
   b. sunspot cycle
   c. precession
   d. axial tilt

11. Explain how changes in the tilt of Earth's axis can affect the differences between seasons.

12. At what time of year is the North Pole in complete darkness?
   a. during the June solstice
   b. during the spring equinox
   c. during the fall equinox
   d. during the December solstice

13. When it is summer in Australia, it is
   a. fall in the United States
   b. winter in the United States
   c. spring in the United States
   d. summer in the United States

14. Which of the following methods would scientists use to determine global changes in Earth's climate over time?
   a. by examining ice cores
   b. by examining tree rings
   c. by examining sedimentary strata
   d. by examining glacial eccentrics

15. What aspect of Earth's orbit changes in cycles of 23 000 years? Of 41 000 years? of 100 000 years?

16. What is the variation in the periodicity of long-term changes in eccentricity?
   a. 25 700 years
   b. 100 000 and 413 000 years
   c. 41 000 years
   d. 23 000 years

17. What would be consequence for incoming solar radiation and the seasons if Earth had no tilt? a 90° tilt?

18. In approximately 13 000 years, Earth's axis will point toward the star Vega. Twenty-six thousand years from now, where will Earth's axis be pointing?

MAKE YOUR OWN STUDY GUIDE

In your Evidence Notebook, design a study guide that supports the main ideas in this lesson:

- The sun and Earth are part of a system of interacting components of matter and energy.
- Almost all of Earth's surface energy originate as sunlight.
- Sunlight affects different parts of Earth in different ways depending on latitude, time of year, and surface characteristics.
- Gravity holds Earth in orbit around the sun, ensuring that a steady supply of energy reaches Earth.
- Changes in the amount of energy emitted by the sun and the amount reaching Earth in total and at different times of year can affect Earth's global climate.

Remember to include the following information in your study guide:

- Support main ideas about Earth-sun interactions with specific examples.
- Record explanations for patterns in the interactions between Earth and the sun.
- Evaluate evidence for the effects of changes in the Earth-sun system over time.

McClelland

Anatomy and Physiology

NTI Day 11
Fill in Guided notes Contraction Physiology Page 1
Using Muscular System PowerPoint Slides 16-35
Take picture or screen shot and send for daily grade

NTI Day 12
Fill in Guided notes Contraction Physiology Page 2
Using Muscular System PowerPoint Slides 16-35
Take picture or screen shot and send for daily grade

NTI Day 13
Fill in Guided notes Contraction Physiology Page 3
Using Muscular System PowerPoint Slides 16-35
Take picture or screen shot and send for daily grade

NTI Day 14
Muscular System Quizizz

NTI Day 15
Skeletal Muscle Physiology Practice Worksheet Page 1

NTI Day 16
Skeletal Muscle Physiology Practice Worksheet Page 2

NTI Day 17
Skeletal Muscle Physiology Practice Worksheet Page 3

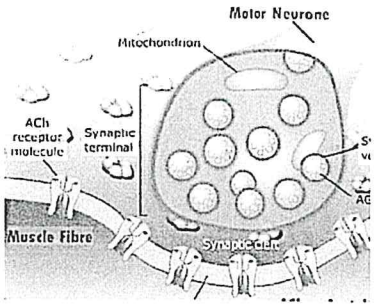
NTI Day 18
Fill in Guided notes Movement and Muscles Page 1
Using Muscular System PowerPoint Slides 36-46
Take picture or screen shot and send for daily grade

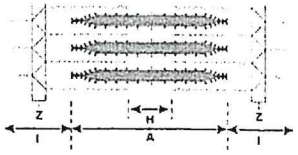
NTI Day 19
Fill in Guided notes Movement and Muscles Page 2
Using Muscular System PowerPoint Slides 36-46
Take picture or screen shot and send for daily grade

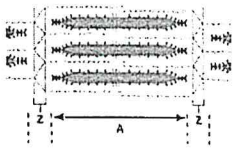
NTI Day 20
Muscular System Quiz Part 3

Muscular System Notes Part 2: Contraction Physiology

Questions	Notes
List the steps of muscle stimulation by a nerve impulse.	I. Physiology of Muscle Contraction • Skeletal muscles must be _____ _____ (motor neuron) to contract A. Transmission of Nerve Impulse to Muscle ○ **Step 1**: Nerve releases a _____ _____ (_____) ○ **Step 2:** Neurotransmitter causes the muscle cell membrane gates to open ○ **Step 3:** Ions (Na^+ & K^+) exchange places causing the sarcoplasmic reticulum to _____ ○ **Step 4:** This release of Ca^+ _____ as the actin filaments slide past the myosin filaments
What ion is responsible for starting a muscle contraction?	
When does a muscle contract?	B. The Sliding Filament Theory of Muscle Contraction • _____ - a muscle contracts when the thin filament in the muscle fiber slides over the thick filament • Activated by _____ and _____ (Ca^{2+}) ions •
Describe the sliding filament theory of muscle contraction.	○ **Step 1:** An influx of Ca^{2+} causes thick myosin filaments to form _____ with the thin actin filament by exposing the binding site on actin. ○ **Step 2:** The crossbridges change shape as it pulls on _____ which slides towards the center of the sacromere in the _____ ○ The distance between the Z line decreases, _____ _____.
List the steps of sliding filament theory.	○ **Step 3:** The crossbridges detach from the actin filament when _____ bonds to myosin head. ○ **Step 4:** The _____ gets ready to bond to actin again using ATP energy. ○ The cycle is repeated on another site of the actin filament.

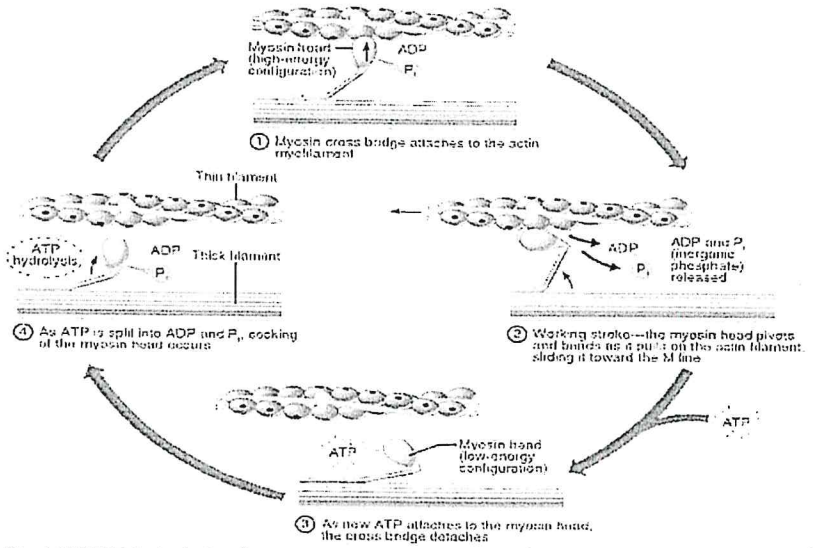






Recognize the steps of sliding filament theory in a diagram.

Sliding Filament Theory:



Recognize the M line, Z line, actin, and myosin filaments.

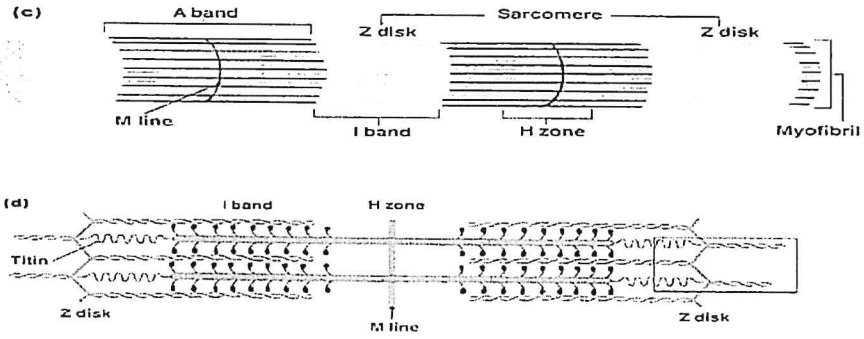


Fig. 12-3

What determines the strength of a muscle contraction?

C. Contraction of a Skeletal Muscle
- Muscle fiber contraction is "_____"
- Within a skeletal muscle, not all fibers may be stimulated during the same interval
- Different combinations of muscle fiber contractions may give differing responses
- Graded responses – different degrees of skeletal muscle shortening
- _____ = constant contraction or tetanus

What do muscles use for energy?

D. Muscle Response to Strong Stimuli
- Muscle _____ depends upon the _____ stimulated
  - More fibers contracting results in greater muscle tension
- Muscles can continue to contract unless they run out of _____ _____
  - One molecule of ATP supplies enough energy for one actin and myosin cross-bridge

Muscular System
Chapter 7

What type of activities is creatine phosphate used for?

Does cellular respiration require oxygen?

How much ATP is produced during cellular respiration?

How long do activities last?

What molecule is broken down?

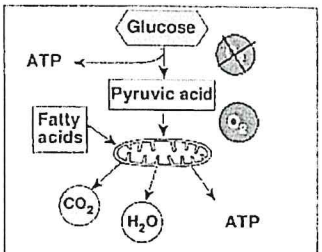
Does this require oxygen?

II. Energy for Muscle Contraction

- _____
  - Bonds of _____ are broken to _____
  - Only 4-6 seconds worth of ATP is stored by muscles

Three ways for muscle to make energy (ATP)

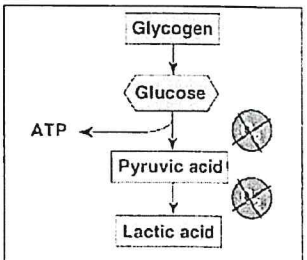
1. _____
   - Creatine phosphate is a high-energy compound and is the fastest way to make ATP available for muscles
   - Used for activities lasting _____
   - _____ (no oxygen needed)
   - Reaction:
     - Creatine phosphate + ADP → creatine + ATP
   - Creatine phosphate is made when a muscle is at rest
2. _____
   - Mitochondria uses _____ molecules _____ in the presence of oxygen
     - Provides most of a muscle's ATP
   - _____
   - _____ (needs oxygen)
   - Used for activities lasting _____
   - Reaction:
   - $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + energy$
   - 1 glucose = _____
3. _____
   - Reaction that breaks down glucose without using _____
   - Used for activities lasting _____
   - _____ (no oxygen needed)
   - Reaction:
   - Glucose → pyruvic acid + 2 ATP → lactic acid
     - Lactic acid is also produced causing pain in the muscle
- Heavy breathing after exercise is a sign of _____
- A marathon runner is exhausted after crossing the finish line because they have depleted not only their oxygen but their glucose as well
- It takes up to two days to replace all of the glucose in the muscles and glycogen in the liver



(c) Aerobic mechanism (oxidative phosphorylation)

Energy source: glucose; pyruvic acid; free fatty acids from adipose tissue; amino acids from protein catabolism

Oxygen use: Required
Products: 36 ATP per glucose, CO_2, H_2O
Duration of energy provision: Hours



(b) Anaerobic mechanism (glycolysis and lactic acid formation)

Energy source: glucose

Oxygen use: None
Products: 2 ATP per glucose, lactic acid
Duration of energy provision: 30–60 sec

QUIZIZZ

NAME : _____

CLASS : _____

DATE : _____

Muscular System

20 Questions

1. How many types of muscles are there?

- [ ] a) 2
- [ ] b) 4
- [ ] c) 3
- [ ] d) 1

2. What are the characteristics of the cardiac muscle?

- [ ] a) Involunatary
- [ ] b) Found in the heart
- [ ] c) Banded Appearance
- [ ] d) Dense connective tissue packaging

3. Smooth Muscle is found in the?

- [ ] a) Heart
- [ ] b) Facial
- [ ] c) Organs
- [ ] d) Legs

4. The connective tissue sheath that surrounds a muscle fasciculus is the

- [ ] a) epimysium
- [ ] b) endomysium
- [ ] c) perimysium

5. given the following events:1.acetycholine broken down 2.acetylcholine moves across the synaptic cleft 3.action potential reaches the terminal branch (presynaptic terminal) 4.acetylcholine combines with a receptor molecule on a skeletal muscle (postsynaptic membrane) 5.action potential produced in skeletal muscle cell
Choose the arrangement that lists the events in the order the occur at a neuromuscular injunction

- [ ] a) 2,3,4,1,5
- [ ] b) 3,2,4,5,1
- [ ] c) 3,4,2,1,3
- [ ] d) 4,5,2,1,3

6. Muscles that oppose one another are

☐ a) synergist
☐ b) hateful
☐ c) prime movers
☐ d) antagonists

7. Muscles are composed of which of the following?

☐ a) Lipids
☐ b) Protiens
☐ c) Carbohydrates
☐ d) Fats

8. Which of the following is defined as the ability of an object to quickly return to the original shape and size?

☐ a) Elasticity
☐ b) Excitibility
☐ c) Flexibility
☐ d) Extensibility

9. Which of the following is defined as the ability to change or be changed according to circumstances?

☐ a) Elasticity
☐ b) Excitability
☐ c) Flexibility
☐ d) Extensibility

10. Which of the following is NOT a type of muscle?

☐ a) Rough
☐ b) Smooth
☐ c) Cardiac
☐ d) Skeletal

11. Skeletal muscles are responsible for which of the following?

☐ a) Movement of the body
☐ b) Movement of the heart
☐ c) Movement of the ligaments
☐ d) Movement of the extremities

12. Which of the following describes the sarcomere?

☐ a) The basic unit of muscle's cross-striated myofibril
☐ b) . A protein band which defines the boundary between one sarcomere
☐ c) Various muscle proteins
☐ d) Contains the protein, actin

13. Which of the following describes muscle bundles?

☐ a) Long, multi-nucleated, thread-like cells
☐ b) Set of muscle fibers grouped together
☐ c) Considered to the cell of the muscle
☐ d) Organelles which are unique to muscle tissue

14. Skeletal muscles are attached to which of the following?

☐ a) Bones and ligaments
☐ b) Ligaments and tendons
☐ c) Tendons and bones
☐ d) Bones and fat

15. Muscles are needed for what?

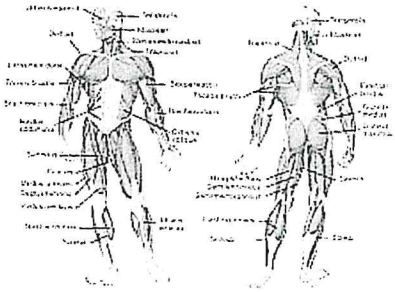
☐ a) movement
☐ b) decoration
☐ c) pump blood
☐ d) no one knows

16. Smooth muscle is located where?

☐ a) heart
☐ b) bones
☐ c) toes
☐ d) internal organs

17. The nerve releases a chemical called a

☐ a) neurotransmitter
☐ b) neuron
☐ c) myofibril
☐ d) cell

18. 

What are the two classifications of muscles in your body?

☐ a) Voluntary and Controllable
☐ b) Flabby and Strong
☐ c) Involuntary and Voluntary
☐ d) Hard and soft

19. How do pairs of skeletal muscles work together?

☐ a) while one contracts, the other returns to original length
☐ b) both muscles contract at the same time
☐ c) both muscles relax at the same time
☐ d) 1 muscle pulls on the bone and the other pulls on the first muscle

20. Which 2 systems work together to help a person stand erect?

☐ a) skeletal / muscular
☐ b) skeletal / digetive
☐ c) skeletal / respiratory
☐ d) skeletal / cardiovascular

Review Worksheet: Skeletal Muscle Physiology

Identify the choice that best completes the statement or answers the question.

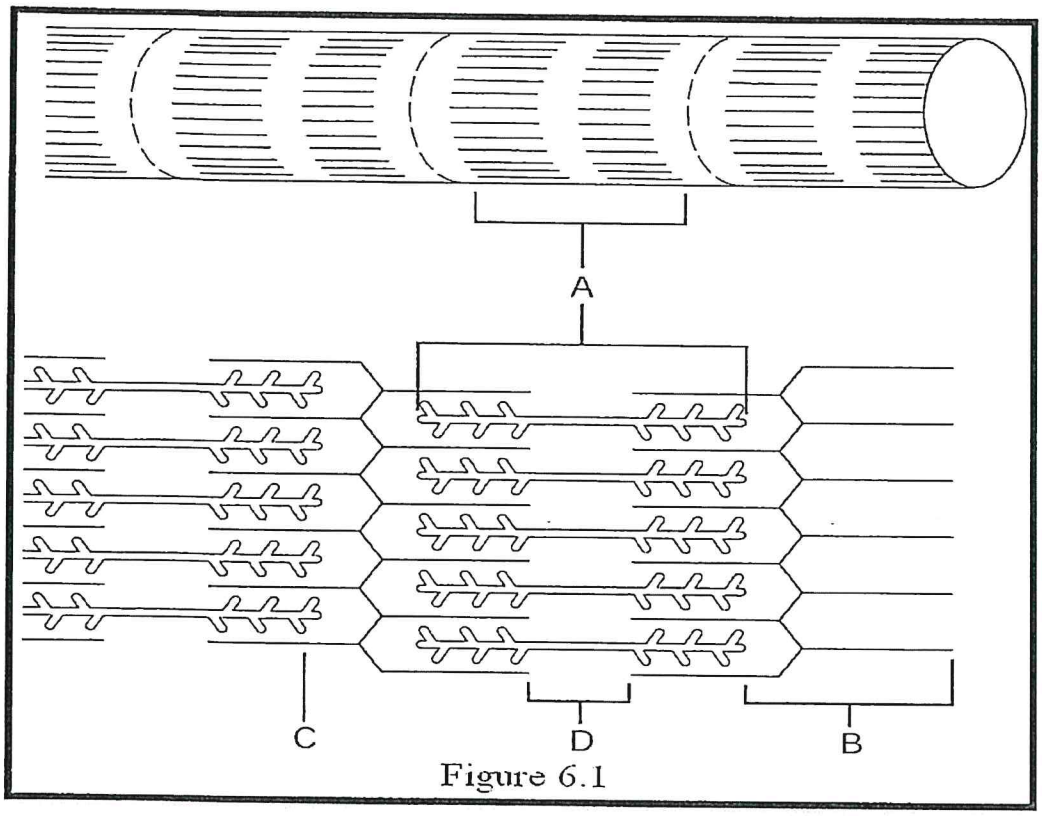


Figure 6.1

Using Figure 6.1, match the following:

1. The I band within a skeletal muscle fiber is indicated by ____.

   a) Label A b) Label B c) Label C d) Label D

2. The A band within a skeletal muscle fiber is indicated by ____.

   a) Label A b) Label B c) Label C d) Label D

3. The H zone, located within the A band, lacks thin filaments and is represented by ____.

   a) Label A b) Label B c) Label C d) Label D

4. The myofilament composed of actin is indicated by ____.

   a) Label A b) Label B c) Label C d) Label D

Review Worksheet: Skeletal Muscle Physiology

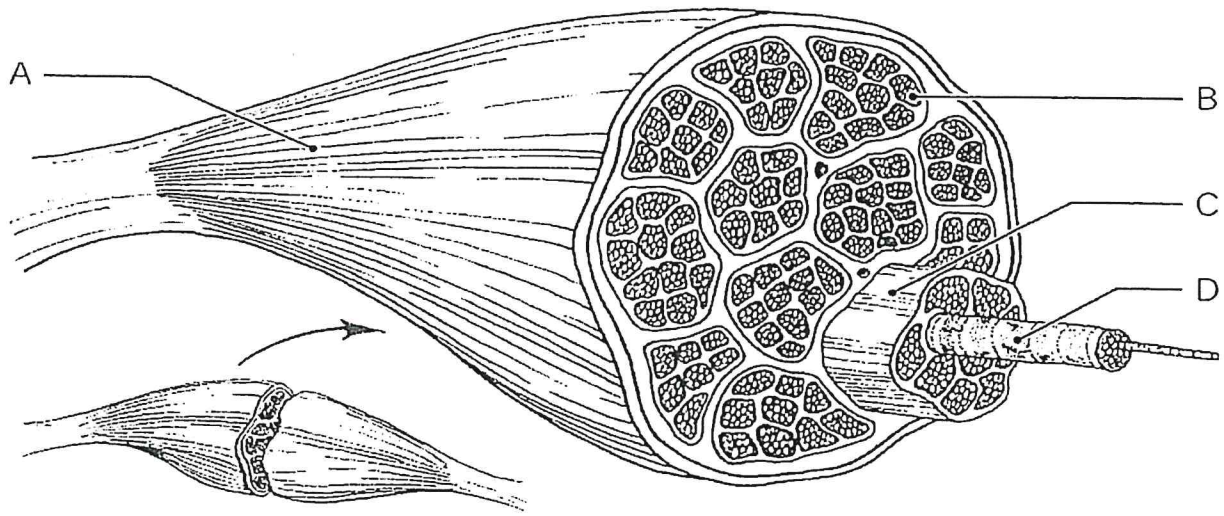


Figure 6.2

Using Figure 6.2, match the following:

5. The epimysium is represented by ____.

a) Label A b) Label B c) Label C d) Label D

6. The perimysium wraps a fascicle of muscle cells and is represented by ____.

a) Label A b) Label B c) Label C d) Label D

7. The muscle fiber (cell) is indicated by ____.

a) Label A b) Label B c) Label C d) Label D

8. The endomysium that wraps individual muscle fibers is indicated by ____.

a) Label A b) Label B c) Label C d) Label D

9. Striated involuntary muscle tissue is classified as ____ muscle.

a) skeletal b) cardiac c) smooth d) either smooth or skeletal

10. The epimysium covering on the outside of the muscle can blend into cordlike ____ or sheetlike ____.

a) tendons; aponeuroses b) ligaments; tendons c) fascia; ligaments d) aponeuroses; ligaments

11. The ____ is an organelle that wraps and surrounds the myofibril and stores calcium.

a) cross bridge b) sarcomere c) sarcolemma d) sarcoplasmic reticulum

12. Striated involuntary muscle tissue found in the heart is ____.

a) smooth muscle b) skeletal muscle c) dense regular d) cardiac muscle e) dense irregular

Review Worksheet: Skeletal Muscle Physiology

Match the following:

a) smooth muscle tissue
b) skeletal muscle tissue
c) cardiac muscle tissue

13. Voluntary muscle tissue

14. Muscle tissue found only in the heart

15. Muscle tissue that forms valves to regulate the passage of substances through internal body openings

16. Muscle tissue that is multinucleate

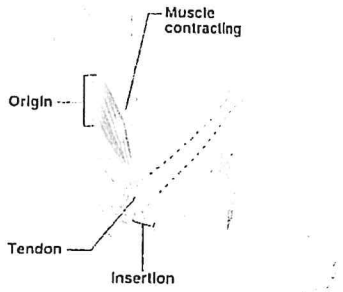
17. Muscle tissue composed of branching cells and intercalated discs

18. Muscle tissue that activates move food through the digestive tract

19. Performs rhythmic contractions controlled by electric impulses

20. Muscle tissue that maintains posture, body position, and stabilizes joints

Muscular System Notes Part 3: Movement & Muscles

Questions	Notes
Describe the two attachment points?	I. Body Movements & Muscles • Movement is attained due to a muscle moving an attached bone • Muscles are attached to at least two points o _____ - attachment to a moveable bone o _____ - attachment to an immovable bone 
Describe the types of body movements?	A. Types of Ordinary Body Movements • _____ - decreases angle of joint and brings two bones closer together • _____- increases angle of joint • _____- movement of a bone in longitudinal axis, shaking head "no" • _____ - moving away from the midline • _____ - moving toward the midline • _____ - cone-shaped movement, proximal end doesn't move, while distal end moves in a circle.
What are the criteria used to naming a muscle?	B. Types of Muscles • _____ - muscle that does most of the work • _____ - muscle that helps a prime mover in a movement • _____ - muscle that opposes or reverses a prime mover o Antagonist muscle pairs work opposite one another o Ex. _____ (flexion of forearm) and _____ (extension of forearm) C. Naming of Skeletal Muscles • _____ of muscle fibers o Example: rectus (straight), orbicularis (circular) • _____ of the muscle o Example: maximus (largest), minimus (smallest), longus (long), brevis (short) ▪ _____ of the muscle o Example: pectoralis (chest), external (outside), frontalis (frontal)

(Naming continued)

- _____
  - Example: triceps (three heads)
- _____ of the muscles _____ and insertion
  - Example: sterno (on the sternum)
- _____ of the muscle
  - Example: deltoid (triangular)
- _____ of the muscle
  - Example: flexor and extensor (flexes or extends a bone)

What are some of the effects of aging on muscles?

II. Affects of Aging on Muscles

- Muscles that are not used are _____ then by _____
- With age comes degeneration of mitochondria due to exposure to oxygen and free radicals
- Changes in the nervous system and endocrine system also effect structure and function of muscles
- _____ as we age but _____ can stimulate _____

What are some disorders of the muscular system?

III. Disorders relating to the Muscular System

- _____: inherited, muscle enlarge due to increased fat and connective tissue, but fibers degenerate and atrophy
- _____: lacking a protein to maintain the sarcolemma
- _____: progressive weakness due to a shortage of acetylcholine receptors
- Sprain verses Strain
  - _____ - overstretching of a muscle near a joint
  - _____ - twisting of a joint leading to swelling and injury to ligaments, tendons, blood vessels and nerves
- Myalgia and Tendinitis
  - _____ - inflammation of muscle tissue (arthritis on previous slide)
  - _____ - inflammation of the tendon due to strain of repeated activity

Muscular System Pt 3 Quiz

1. What are the two points of muscle attachment?

2. The point of attachment on the moveable bone is called the?

3. The point of attachment on the immoveable bone is called the?

Match the terms with the correct definition

4.	Flexion	a. Muscle that helps a prime mover
5.	Extension	b. Muscle that opposes or reverses a prime mover
6.	Rotation	c. Decreases angle of joint and brings two bones closer together
7.	Abduction	d. Increases angle of joint
8.	Adduction	e. Cone-shaped movement, proximal end doesn't move, distal does
9.	Circumduction	f. Movement of a bone in a longitudinal axis
10.	Prime Mover	g. Moving toward midline
11.	Synergist	h. Moving away from midline
12.	Antagonist	i. Muscle that does most of the work

13. -23 What are 5 of the 7 ways that muscles are named? Give an Example of each.

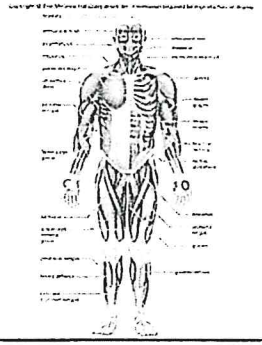
1. a. b.
2. a. b.
3. a. b.
4. a. b.
5. a. b.

24. What happens to muscles when they are not used?

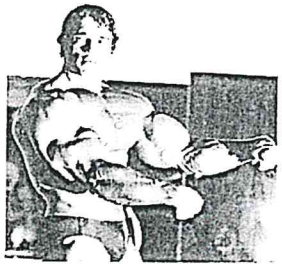
25. _____- inherited, muscle enlarge due to increased fat and connective tissue, but fibers degenerate and atrophy.

26. _____ -lacking a protein to maintain sarcolemma
27. Which is worse a sprain or a strain? Explain.

Muscular System

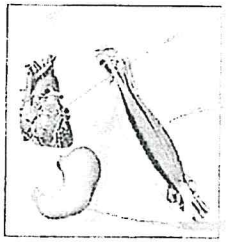


Chapter 7



The Muscular System

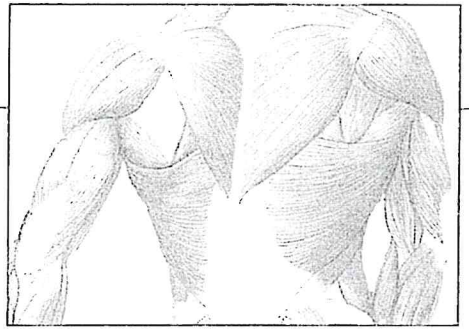
- Muscles are responsible for all types of body movement – they contract or shorten and are the machine of the body
- Three basic muscle types are found in the body
  - Skeletal muscle
  - Cardiac muscle
  - Smooth muscle



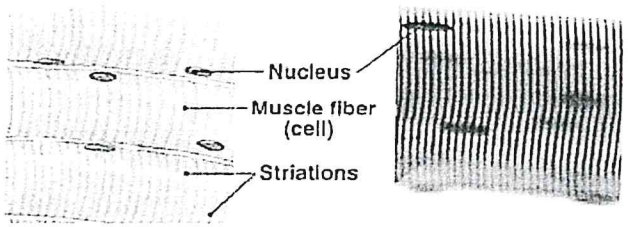
Cardiac muscle cell

Skeletal muscle cell

Smooth muscle cell

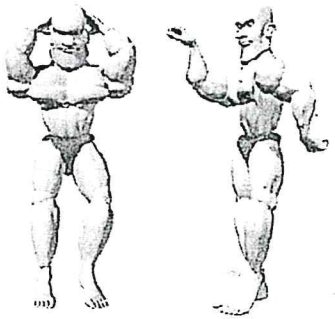


(a) Skeletal muscle



Function of Muscles

- 1. Support the body
- 2. Allow for movement by making bones and other body parts move
- 3. Maintain constant body temperature

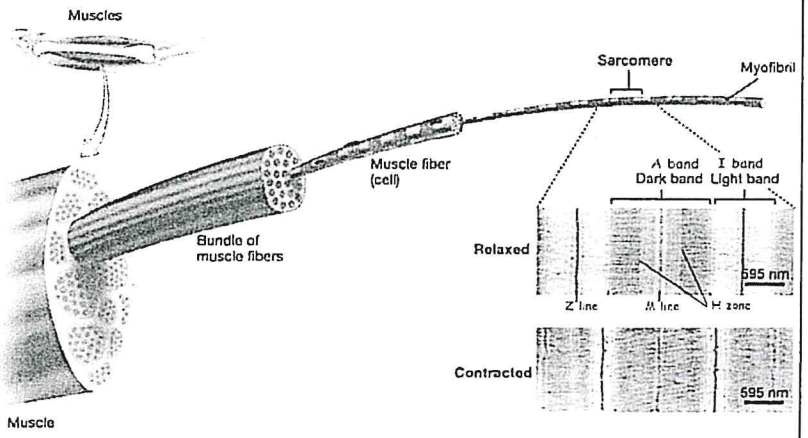


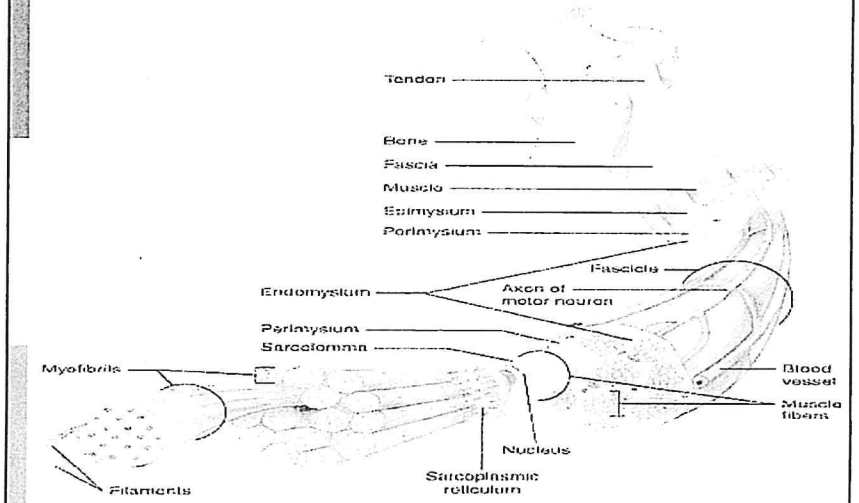
- 4. Assist in movement of cardiovascular veins and lymph
- 5. Protect internal organs and stabilize joints

Organization of Skeletal Muscle

Muscle belly → **Fascicle:** a bundle of muscle fibers → **Muscle Fiber:** muscle cell → **Sarcomere:** units of myofibrils responsible for the striated appearance

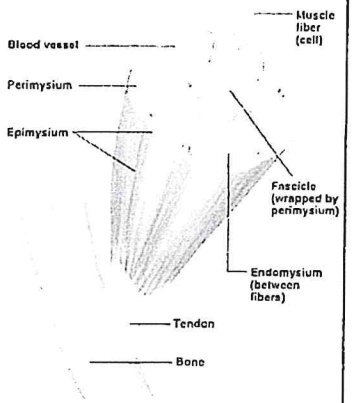
Myofibrils: structures that make up a muscle fiber ← **Myofilament:** protein filaments that make up a sarcomere → **Myosin:** thick filaments; **Actin:** thin filaments





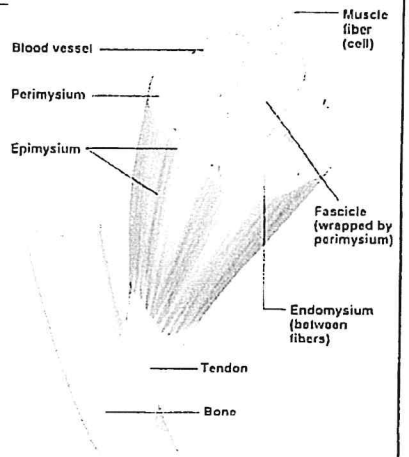
Coverings of a Skeletal Muscle

- Skeletal muscles are organs
  - They contain muscle fibers, nerves, and blood vessels
  - Connective tissue membranes separate each muscle structure
- Fascia – layer of fibrous tissue that separates muscles from each other and from the skin



Coverings from largest to smallest

- Epimysium – covers the entire skeletal muscle
- Perimysium – surrounds a bundle of muscle fibers (fascicle)
- Endomysium – surrounds a single muscle fiber (cell)

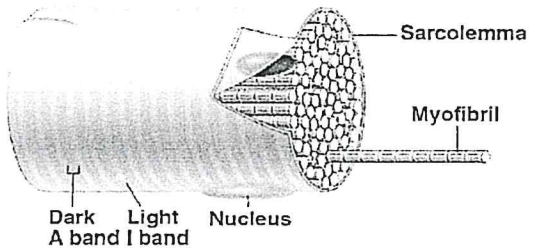


Skeletal Muscle Attachments

- Epimysium blends into a connective tissue attachment
  - Tendon – cord-like structure
- Sites of muscle attachment
  - Bones
  - Cartilages
  - Connective tissue coverings

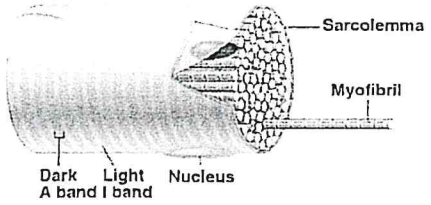
Microscopic Anatomy of Muscle Fiber (muscle cell)

- Cells are multinucleate
- Nuclei are just beneath the membrane

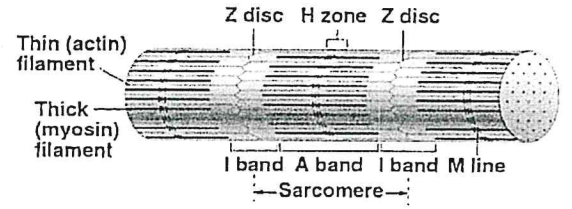


(a) Segment of a muscle fiber (cell)

- Sarcolemma – specialized plasma membrane
- Sarcoplasmic reticulum – specialized smooth endoplasmic reticulum involved in muscle contraction



(a) Segment of a muscle fiber (cell)



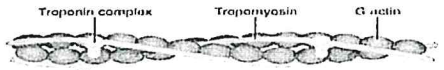
(b) Myofibril or fibril
(complex organelle composed of bundles of myofilaments)

- Myofibril
  - Bundles of myofilaments
  - Myofibrils are aligned to give distinct bands
    - Light band = "I band"
    - Dark band = "A band"

- Sarcomere
  - Contractile unit of a muscle fiber
  - Organization of the sarcomere
    - **Thick filaments** = myosin protein

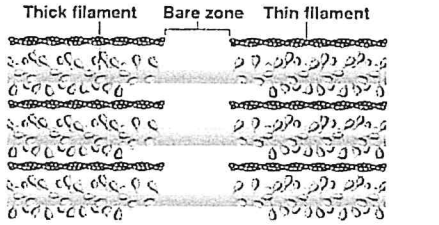
(a) Myosin molecule

- **Thin filaments** = actin protein

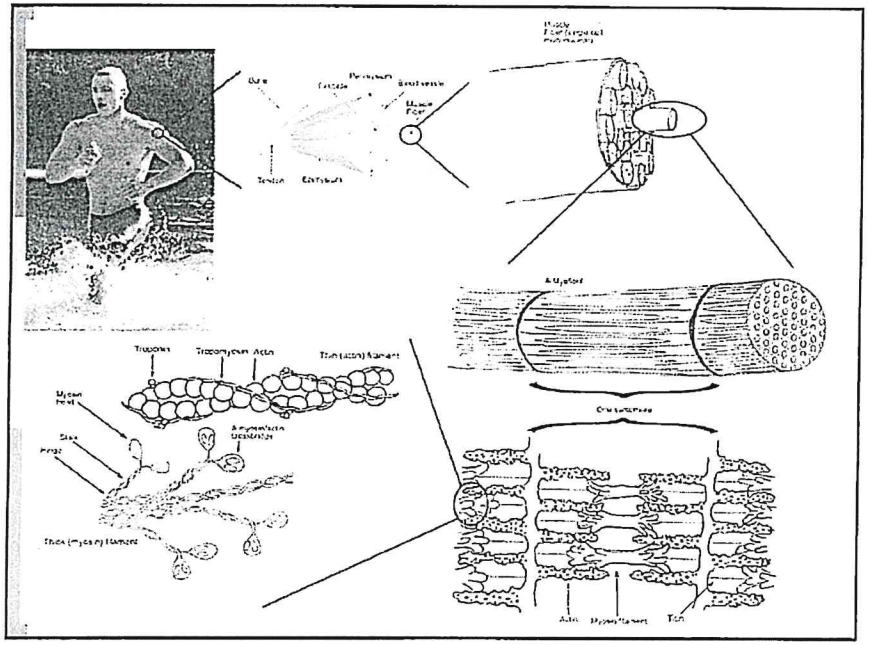


(c) Portion of a thin filament

- Myosin and actin overlap somewhat in the sarcomere
- Myosin filaments have heads (extensions) that can "grab" onto actin forming a cross-bridge

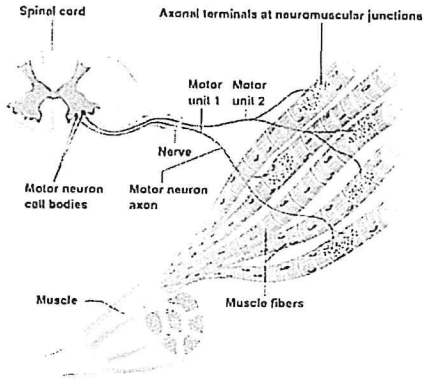


(d) Myofilament structure (within one sarcomere)



Physiology of Muscle Contraction

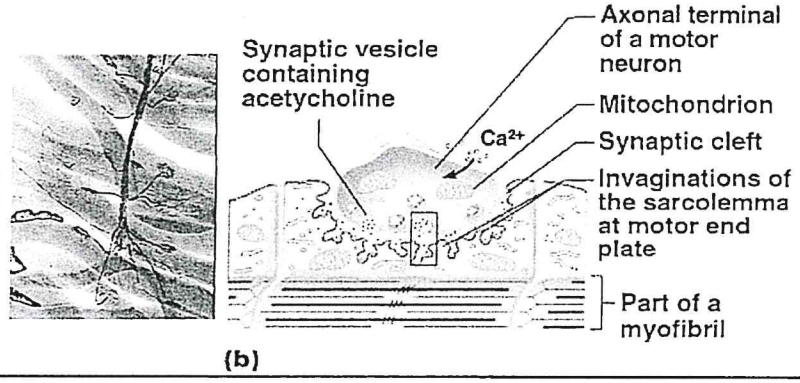
- Skeletal muscles must be stimulated by a nerve (motor neuron) to contract



(a)

Transmission of Nerve Impulse to Muscle

- **Step 1:** Nerve releases a neurotransmitter (acetylcholine)



(b)

- **Step 2:** [illegible] causes the muscle cell membrane gates to open
- **Step 3:** Ions (Na^+ & K^+) exchange places causing the [illegible]
- **Step 4:** This release of Ca+ starts the [illegible] as the actin filaments slide past the myosin filaments

The Sliding Filament Theory of Muscle Contraction

- Sliding Filament Model - a muscle contracts when the thin filament in the muscle fiber slides over the thick filament
  - Activated by ATP and calcium (Ca+) ions

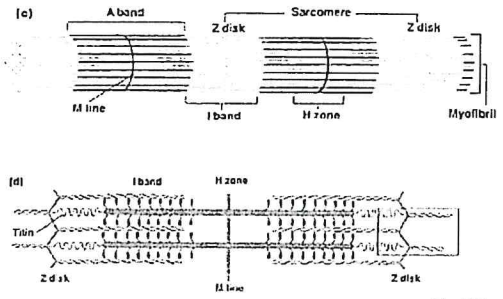
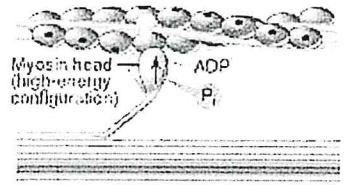


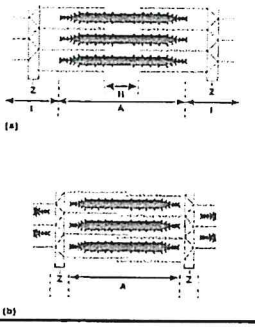
Fig. 12-3

The Sliding Filament Theory of Muscle Contraction

- 1) An influx of Ca^{2+} causes thick myosin filaments to form crossbridges with the thin actin filament by exposing the binding site on actin

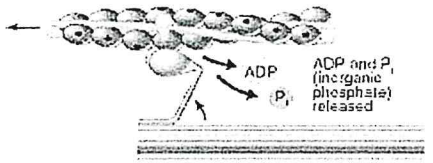


① Myosin cross bridge attaches to the actin myofilament

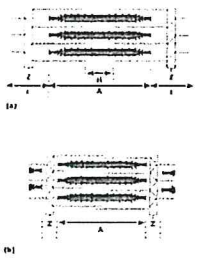


The Sliding Filament Theory of Muscle Contraction

- 2) The crossbridges change shape as it pulls on filaments which slides towards the center of the sacromere in the power stroke
  - The distance between the Z line decreases, shortening the muscle.

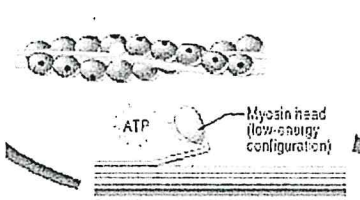


② Working stroke—the myosin head pivots and bends as it pulls on the actin filament, sliding it toward the M line

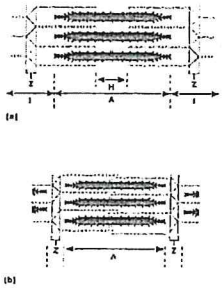


The Sliding Filament Theory of Muscle Contraction

- 3) The crossbridges detach from the actin filament when ATP bonds to myosin head.

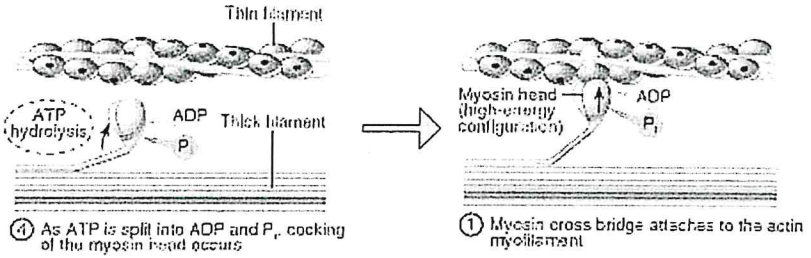


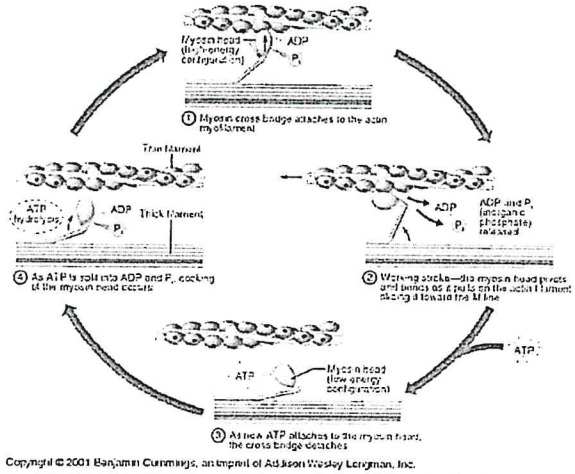
③ As new ATP attaches to the myosin head, the cross bridge detaches

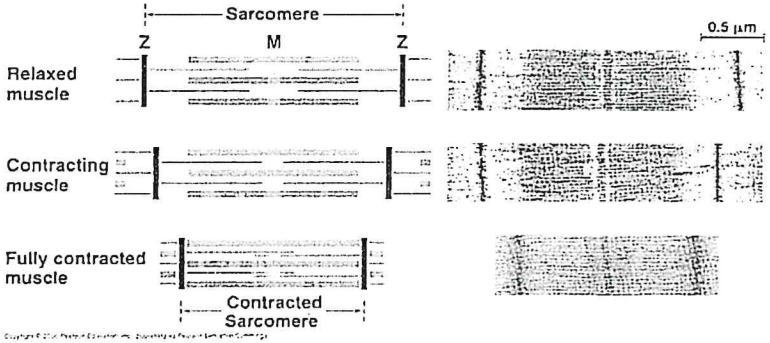


The Sliding Filament Theory

- 4) The myosin head gets ready to bond to actin again using ATP energy
  - The cycle is repeated on another site of actin filament using the stored ATP energy







Muscle Contraction

- Cycle of Muscle Contraction

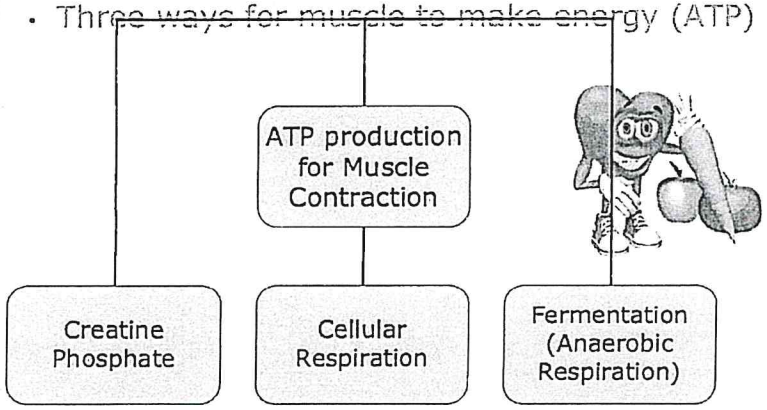
Contraction of a Skeletal Muscle

- Muscle fiber contraction is "all or none"
- Within a skeletal muscle, not all fibers may be stimulated during the same interval
- Different combinations of muscle fiber contractions may give differing responses
- Graded response – different degrees of skeletal muscle shortening
  - Rapid stimulus = constant contraction or tetanus

- Muscle force depends upon the number of fibers stimulated
  - More fibers contracting results in greater muscle tension
- Muscles can continue to contract unless they run out of ATP or Ca^{2+}
  - One molecule of ATP supplies enough energy for one actin and myosin cross-bridge

Energy for Muscle Contraction

- Muscles use stored ATP for energy
  - Bonds of ATP are broken to release energy
  - Only 4-6 seconds worth of ATP is stored by muscles
- Three ways for muscle to make energy (ATP)

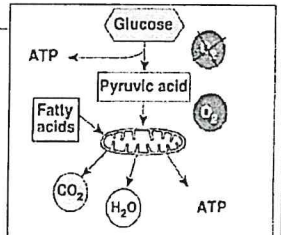


1. Creatine Phosphate

- **Creatine phosphate is a high-energy compound and is the fastest way to make ATP available for muscles**
- Used for activities lasting < 15 seconds
- **Anaerobic (no oxygen needed)**
- **Reaction:**
  - Creatine phosphate + ADP → creatine + ATP
- **Creatine phosphate is made when a muscle is at rest**

2. Cellular Respiration

- **Mitochondria use glucose molecules to make ATP in the presence of oxygen**
  - **Provides most of a muscle's ATP**
- Aerobic (needs oxygen)
- Used for activities lasting hours
- Reaction
  - $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$ energy
- 1 glucose = 36 ATP



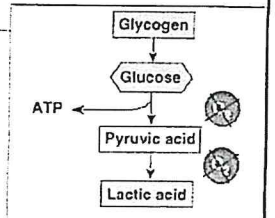
(c) Aerobic mechanism (oxidative phosphorylation)

Energy source: glucose; pyruvic acid; free fatty acids from adipose tissue; amino acids from protein catabolism

Oxygen use: Required
Products: 36 ATP per glucose, CO_2, H_2O
Duration of energy provision: Hours

3. Anaerobic Respiration/ Fermentation

- **Reaction that breaks down glucose without oxygen**
- **Used for activities lasting 30 – 60 seconds**
- Anaerobic (no oxygen)
- **Reaction**
  - **Glucose → pyruvic acid + 2 ATP → lactic acid**
- Lactic acid **is also produced and causes pain in the muscle**

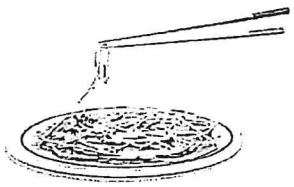


(b) Anaerobic mechanism (glycolysis and lactic acid formation)

Energy source: glucose

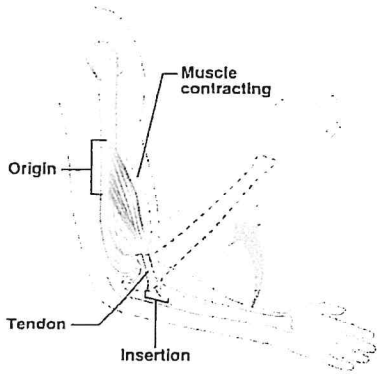
Oxygen use: None
Products: 2 ATP per glucose, lactic acid
Duration of energy provision: 30–60 sec

- Heavy breathing after exercise is a sign of oxygen deficiency
- A marathon runner is exhausted after crossing the finish line because they have depleted not only their oxygen but their glucose as well
- It takes up to two days to replace all of the glucose in the muscles and glycogen in the liver



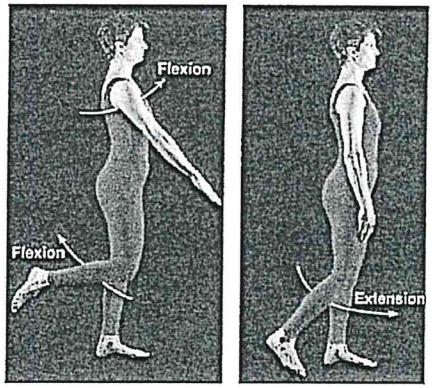
Muscles and Body Movements

- Movement is attained due to a muscle moving an attached bone
- Muscles are attached to at least two points
  - **Insertion** – attachment to a moveable bone
  - **Origin** – attachment to an immovable bone



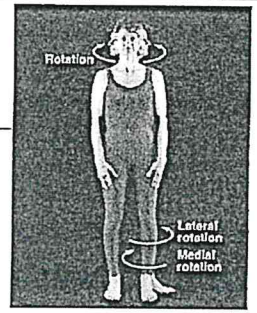
Types of Ordinary Body Movements

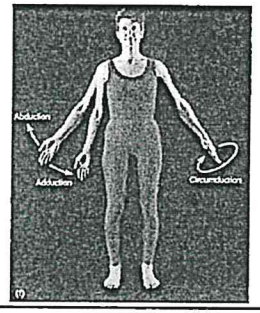
- **Flexion** – decreases angle of joint and brings two bones closer together
- **Extension**– increases angle of joint



(a) Flexion and extension of the shoulder and knee

- **Rotation**- movement of a bone in longitudinal axis, shaking head "no"
- **Abduction** – moving away from the midline
- **Adduction** - moving toward the midline
- **Circumduction** - cone-shaped movement, proximal end doesn't move, while distal end moves in a circle.





Types of Muscles

- Muscles work in opposing pairs
  - Ex. Biceps (flexion of arm) and Triceps (extension of arm)
- **Prime mover** – muscle that does most of the work
  - **Synergist** – muscle that helps a prime mover in a movement
- **Antagonist** – muscle that opposes or reverses a prime mover

Naming of Skeletal Muscles

- **Direction** of muscle fibers
  - Example: *rectus* (straight), *orbicularis* (circular)
- **Relative size** of the muscle
  - Example: *maximus* (largest), *minimus* (smallest), *longus* (long), *brevis* (short)
- **Location of the muscle**
  - Example: *pectoralis* (chest), *external* (outside), *frontalis* (frontal)
- **Number of origins**
  - Example: *triceps* (three heads)

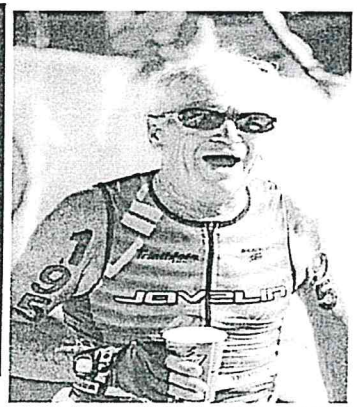
- **Location** of the muscles **origin** and insertion
  - Example: *sterno* (on the sternum)
- **Shape** of the muscle
  - Example: *deltoid* (triangular)
- **Action** of the muscle
  - Example: *flexor* and *extensor* (flexes or extends a bone)

Affects of Aging on Muscles

1. Muscles that are not used are replaced by connective tissue then by fat
2. With age comes degeneration of mitochondria due to exposure to oxygen and free radicals
3. Changes in the nervous system and endocrine system also effect structure and function of muscles
4. Muscles become weaker as we age but exercise can stimulate muscle build-up

- She is 86 years young and a body builder.
- He is 80, and the oldest Iron man triathlon participant.

(1.2 mile swim, a 56-mile bike and a 13.1 mile run = 70.3 miles.)

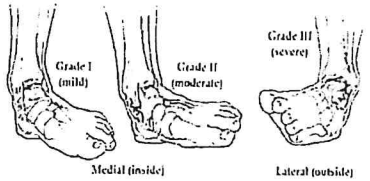


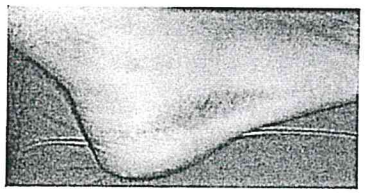
Disorders relating to the Muscular System

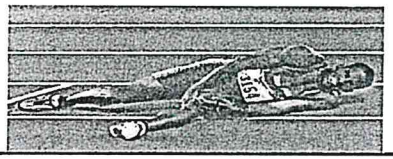
- **Muscular Dystrophy**: inherited, muscle enlarge due to increased fat and connective tissue, but fibers degenerate and atrophy
- **Duchenne MD**: lacking a protein to maintain the sarcolemma
- **Myasthenia Gravis**: progressive weakness due to a shortage of acetylcholine receptors

Sprain verses Strain

- **Strain** – overstretching of a muscle near a joint
- **Sprain** – twisting of a joint leading to swelling and injury to ligaments, tendons, blood vessels and nerves







Myalgia and Tendinitis

- **Myalgia** – inflammation of muscle tissue (arthritis on previous slide)
- **Tendinitis** – inflammation of the tendon due to strain of repeated activity