9TH GRADE BIOLOGY
LEARNING PACKET
Scientific Method

Science is an organized way of gathering and analyzing evidence about the natural world. The goals of science are to provide natural explanations for events in the natural world and to use those explanations to make useful predictions. Science is different from other human works in the following ways:

- Science deals only with the natural world.
- Scientists collect and organize information about the natural world in an orderly way.
- Scientists propose explanations that are based on evidence, not belief.
- They test those explanations with more evidence.

Methodology for scientific investigation involves:

- Making an **observation**: Observation involves the act of noticing and describing events or processes in a careful, orderly way. Scientists use their observations to make inferences. An **inference** is a logical interpretation based on what scientists already know.
- Suggesting hypotheses: A **hypothesis** is a scientific explanation for a set of observations that can be tested in ways that support or reject it.
- Testing the hypothesis: Testing a hypothesis often involves designing an experiment. Whenever possible, a hypothesis should be tested by a **controlled experiment** - an experiment in which only one variable (the **independent variable**) is changed. The variable that can change in response to the independent variable is called the **dependent variable**. The **control group** is exposed to the same conditions as the experimental group except for the independent variable. It shows what would happen if no variable were changed.
- Collecting, recording, and analyzing **data** or information gathered during the experiment.
- Drawing conclusions based on data and sharing the conclusion with others.

QUESTIONS-

1. What is science?
2. What are the goals of science?
3. Read the following experimental scenario and identify the components of the scientific method:

A student investigated whether ants dig more tunnels in light or in the dark. She thought that ants used the filtered light that penetrated the upper layers of earth and would dig more tunnels during the daytime. Ten ant colonies were set up in commercial ant farms with the same number and type of ants per ant farm. The same amount of food was given to each colony, and the colonies were kept at the same temperature. Five of the colonies were exposed to normal room light, and five were covered with black construction paper so they did not receive light. Every other day for three weeks the length of the tunnels was measured in millimeters using a string and ruler. Averages for the light and dark groups measurements were then computed. The averages were listed in the following chart:

Length of Tunnels (mm) Constructed by Ants if different Light Conditions

Day	Light	Dark
1	5	7
3	10	15
5	20	25
7	26	32
9	32	47
11	50	62
13	61	93
15	66	110
17	90	115
19	95	120
21	103	136

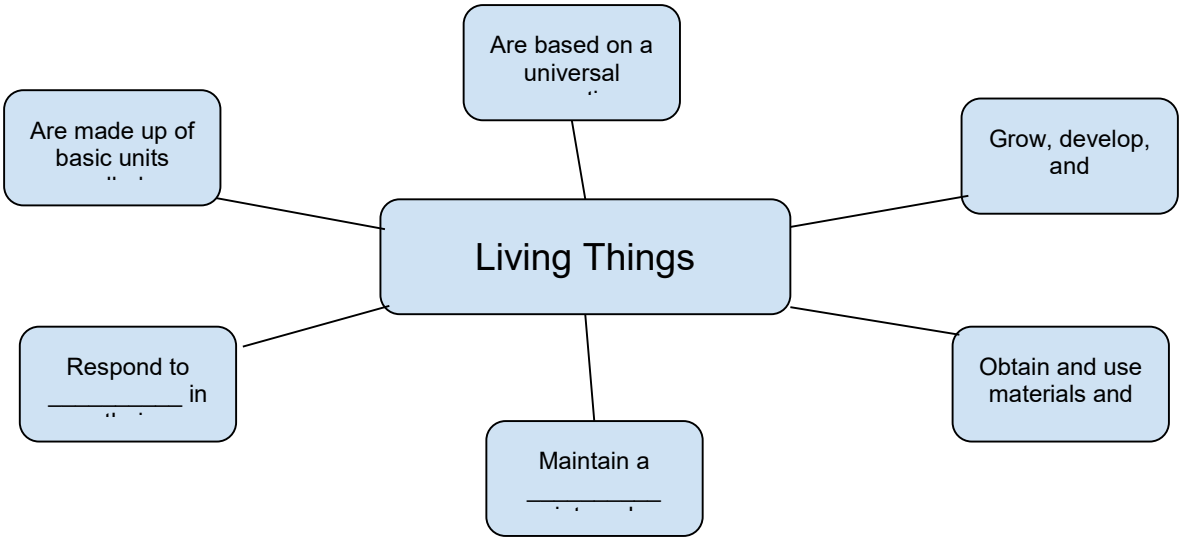
On separate lined paper and graph paper, answer the following questions:

A. List all materials needed to do this experiment.
B. What is the hypothesis of the experiment? (not the definition)
C. Write a statement of support or non-support for the hypothesis using the available data.
D. What is the independent variable in the experiment? (not the definition)
E. What is the dependent variable in the experiment? (not the definition)
F. Is there a control, and if so, what is it?
G. What are the constants in this experiment? (not the definition)
H. What are some sources of experimental error?
I. What type of graph would be best to display this data (circle, bar, or line)?
J. Create a graph of the data. Include a title, labeled independent and dependant variables, units, and numbers.

Biology is the study of life. Living things share certain characteristics: they are made of cells and have a universal genetic code, they obtain and use materials and energy to grow and develop, they reproduce, they respond to signals in their environment (**stimuli**), they maintain a stable internal environment, and they change over time. The study of biology involves several interconnected **big ideas:**

- **Cellular basis of life.** Living things are made of cells.
- **Information and heredity.** Living things are based on universal genetic code written in a molecule called **DNA**.
- **Matter and energy.** Life requires matter that provides raw material, nutrients, and energy. The combination of chemical reactions through which an organism builds up or breaks down materials is called **metabolism**.
- **Growth, development, and reproduction.** All living things reproduce. In **sexual reproduction**, cells from two parents unite to form the first cell of a new organism, In **asexual reproduction**, a single organism produces offspring identical to itself. Organisms grow and develop as they mature.
- **Homeostasis.** Living things maintain a relatively stable internal environment.
- **Evolution.** Taken as a group, living things evolve, linked to a common organism.
- **Structure and function.** Each major group of organisms has evolved structures that make particular functions possible.
- **Unity and diversity of life.** All living things are fundamentally similar at the molecular level.
- **Interdependence in nature.** All forms of life on Earth are connected into a biosphere - a living planet.
- **Science as a way of knowing.** Science is not a list of facts, but a "way of knowing."

Complete the graphic organizer:



Questions:

1. The genetic molecule common to all living things is _____.

2. The internal process of _____ enables living things to survive changing conditions.

3. Living things are capable of responding to different types of _____.

4. Living things have a long history of _____ change.

5. The continuation of life depends on both _____ and _____ reproduction.

6. The combination of chemical reactions that make up an organism's _____ help to organize raw materials into living matter.

7. Pick two of the big ideas from the list and describe how they are interconnected. You may write in the space provided below.

Ecology

Ecology is the scientific study of interactions among organisms and between organisms and their environment.

- Earth's organisms live in the **biosphere**. The biosphere consists of the parts of the planet in which life exists.
- Ecologists may study different **levels of ecological organization**:
    - An assemblage of **individuals** that belong to the same species and live in the same area is called a **population**.
    - An assemblage of different populations that live together in an area is called a **community**.
    - An **ecosystem** includes all the organisms that live in a particular place, together with their physical environment.
    - A group of ecosystems that have similar climates and organisms is called a **biome**.
    - All Earth's biomes together make up the **biosphere**.
- Ecosystems include biotic and abiotic factors
    - A **biotic factor** is any living part of an environment.
    - An **abiotic factor** is any nonliving part of an environment.
- Ecologists use three basic methods of research: observation, experimentation, and modeling.

Questions:

1. What is ecology?
2. What does the biosphere contain?
3. Write each level of organization on the picture below:

4. Explain the relationship between ecosystems and biomes.
5. Using the picture from #3 as an example, list three biotic and three abiotic factors.

Biotic factors	Abiotic factors

Producers and Consumers

In any ecosystem there is energy, and producers & consumers. Sunlight is the main source of energy for life on Earth. Organisms that can capture energy from sunlight or chemicals and use that energy to produce food are called **autotrophs**, or primary **producers**.

- The process in which autotrophs capture light energy and use it to convert carbon dioxide and water into oxygen and sugars is called **photosynthesis**.
- The process in which autotrophs use chemical energy to produce carbohydrates is called **chemosynthesis**.

Organisms that rely on other organisms for their energy and food are called **heterotrophs**, or **consumers**. There are many different types of heterotrophs:

- **Herbivores**, such as cows, obtain energy by eating only plants.
- **Carnivores**, such as snakes, eat only animals.
- **Omnivores**, such as humans, eat both plants and animals.
- **Detritivores**, such as earthworms, feed on dead matter.
- **Decomposers**, such as fungi, break down organic matter.
- **Scavengers**, such as vultures, consume the carcasses of other animals.

Fill in the table using the above information and prior knowledge:

Type of heterotroph	Definition	Two examples
Herbivore		Cow,
	Heterotroph that eats animals	
Omnivore		Humans,
Detritivore		
Decomposer		
Type of heterotroph	Definition	Two examples
	Heterotroph that consumes the carcasses of other animals, but that does not typically kill them itself	

Energy flow in Ecosystems/Food chains and Food Webs

Energy flows through an ecosystem in one direction from primary producers to various consumers.

- A **food chain** is a series of steps in which organisms transfer energy by eating and being eaten. Producers, such as floating algae called **phytoplankton**, are at the base of every food chain.
- A **food web** is a network of all the food chains in an ecosystem. Food webs are very complex. Small disturbances to one population can affect all populations in a food web. Changes in populations of **zooplankton**, small marine animals that feed on algae, can affect all of the animals in the **marine** (in the ocean) food web.

Each step in a food chain or food web is called a **trophic level**. Producers make up the first trophic level. Consumers make up higher trophic levels. Each consumer depends on the trophic level below it for energy.

An **ecological pyramid** is a diagram that shows the relative amounts of energy or matter contained within each trophic level in a food chain or food web. There are three types of energy pyramids:

- **Pyramids of energy** show relative amounts of energy available at different trophic levels.
- **Pyramids of biomass** show the total amount of living matter (biomass) at each trophic level.
- **Pyramids of numbers** show the relative numbers of organisms at each trophic level.

Questions:

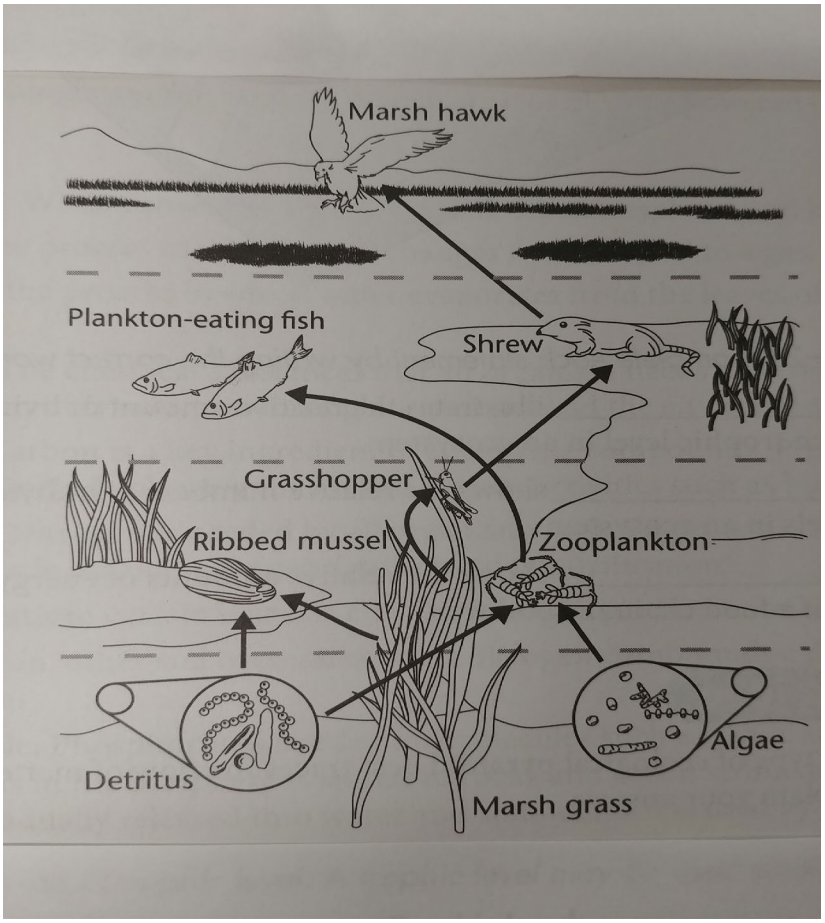
1. Draw arrows to show how energy moves through this food chain. Write producer, herbivore, or carnivore under each organism.

Phytoplankton Zooplankton Sardine Squid Shark

_____ _____ _____ _____ _____

2. What would happen to this food chain if a disturbance caused a serious decline in the shark population? What if there were a serious decline in the phytoplankton population?

3. Use the picture to match the organism with its trophic level:



Organism	Trophic Level
_____algae	A. primary producer
_____grasshopper	B. first level consumer
_____marsh grass	C. second level consumer
_____marsh hawk	D. third level consumer
_____plankton-eating fish	
_____ribbed mussel	
_____shrew	
_____zooplankton	

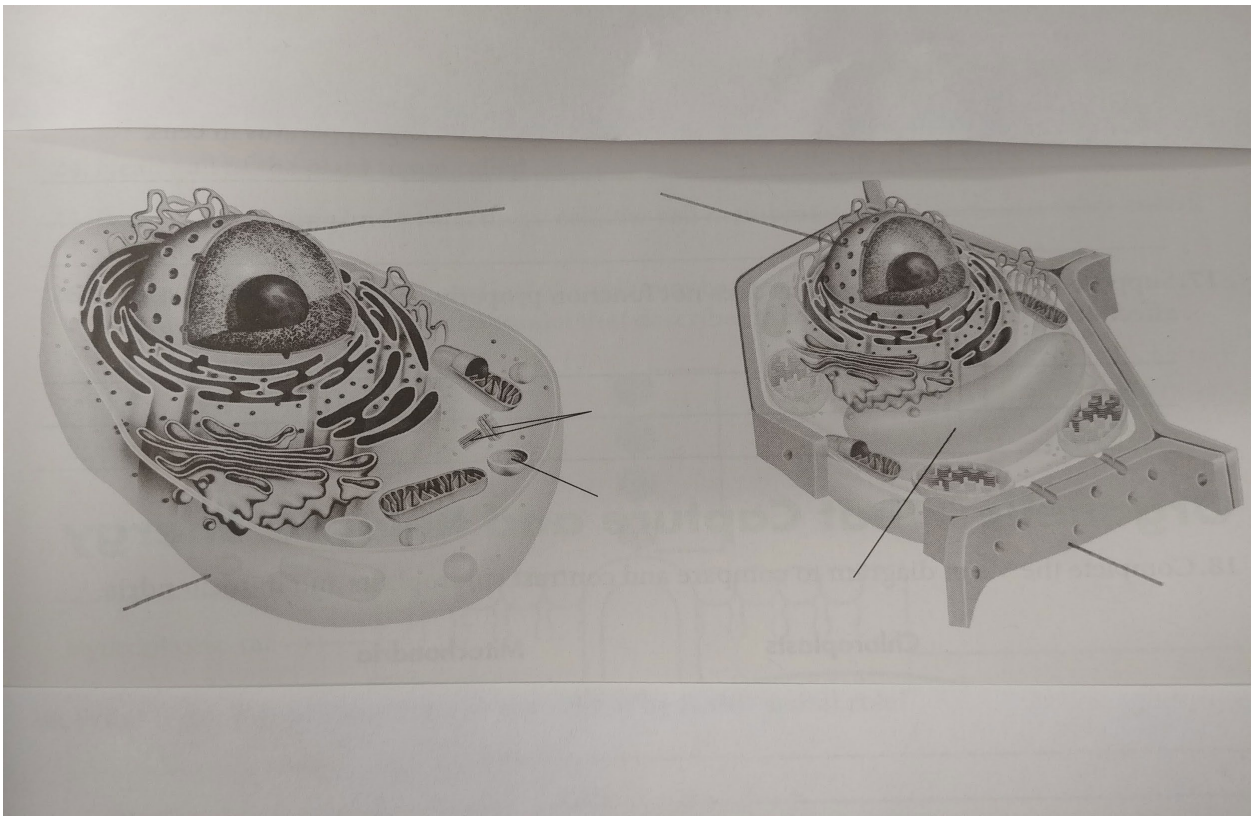
Cell Structure and Function

Using online resources fill in the following table:

Cell Organelle	Function within the Cell
Cell membrane	
Cell Wall	
Cytoplasm	
Ribosome	
Endoplasmic reticulum (ER)	
Nucleus	
Vacuole	
Lysosome	
Centrioles	
Golgi structure, Golgi body, Golgi apparatus	
Mitochondria	
Chloroplasts	
Cytoskeleton	

1. Why is the role of lysosomes vital to the life of a cell?
2. What are two roles of the central vacuole in plant cells?
3. What is the difference in rough ER and smooth ER?

Using the terms, *cell membrane, central vacuole, centrioles, nucleus, cell wall, and lysosome*, label the 6 indicated parts of the cells below. One of the terms will be used twice.



The Cell Cycle

The **cell cycle** is a series of events in the growth and division of a cell. In eukaryotic cells, the cell cycle has several stages or phases. The first stage is called **interphase**. In this phase the cell grows (**G1 phase**), replicates its DNA (**S phase**), produces more organelles (**G2 phase**), and finally, divides (**M phase**). The M phase includes **mitosis** (division of the nucleus) and **cytokinesis** (division of the cytoplasm).

Mitosis occurs in 4 stages:

- **Prophase**- a cell's genetic material condenses, **spindle fibers** form, and the nuclear membrane breaks down.
- **Metaphase**- replicated **chromosomes** line up along the equator of the cell and spindle fibers connect to the **centromeres**.
- **Anaphase**- sister **chromatids** separate and are moved toward the **centrioles** as the spindle fibers contract
- **Telophase**- chromosomes begin to unwind and the nuclear membrane reforms.

Cytokinesis is different in animal and plant cells.

- In animal cells, the cell membrane draws in and pinches off, forming two new **daughter cells**.

- In plant cells, a **cell plate** forms, followed by a new cell membrane, and a new cell wall forms between the two new daughter cells.

Questions:

1. Match the description of the event with the phase of mitosis in which it occurs.

_____ The chromosomes separate and begin to move to opposite sides of the cell.

_____The chromosomes become visible, and the centrioles take up position on opposite sides of the cell.

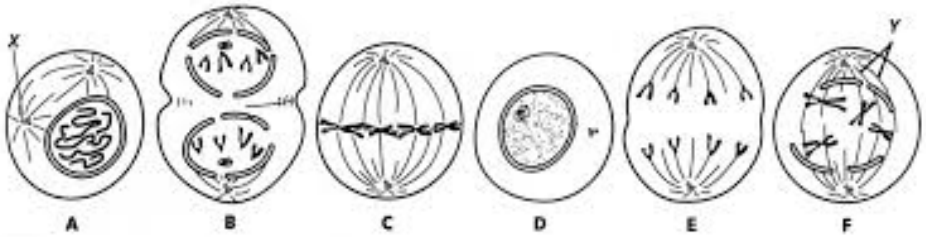
_____A nuclear membrane reforms around the Chromosomes, and the nucleus becomes visible in the daughter cells.

_____The chromosomes line up across the center of the cell.

A. Telophase
B. Prophase
C. Metaphase
D. Anaphase

2. During prophase, when cell chromosomes become visible, what are the replicated strands of DNA called? What is the name for the area where the replicated strands are joined together/held together?

3. Using the terms *interphase, early prophase, late prophase, metaphase anaphase, and telophase*,identify the phases of the cell cycle pictured:



A_____

B_____

C_____

D_____

E_____

F_____

The Structure of DNA

DNA, or deoxyribonucleic acid, is a nucleic acid made up of nucleotides joined into long strands or chains by covalent bonds. Nucleotides may be joined in any order. The structure of DNA is a double helix, or twisted ladder shape.

- A DNA **nucleotide** is a unit made of a nitrogenous base, a 5-carbon sugar called deoxyribose, and a phosphate group.
- DNA has four kinds of nitrogenous bases: adenine, guanine, cytosine, and thymine.
- The two strands of DNA in the double helix run in opposite directions to each other, with the nitrogenous bases in the center.
- Each strand carries a sequence of nucleotides, arranged almost like letters in a 4-letter alphabet for recording genetic information.
- Hydrogen bonds hold the strands together. The bonds are easily broken, allowing DNA strands to separate.
- Hydrogen bonds for only between certain base pairs- **adenine with thymine**, and **cytosine with guanine**. This is called **base pairing**.

Many scientists contributed to figuring out the structure of DNA:

- Erwin Chargaff showed that the percentages of adenine and thymine are almost always equal in DNA. The percentages of guanine and cytosine are also almost always equal. This is Chargaff's Rule of base pairing.
- Rosalind Franklin's X-ray diffraction studies revealed the double helix structure of DNA.
- James Watson and Francis Crick built a model that explained the structure of DNA.

Questions:

1. The building blocks of DNA are _____.

2. Nucleotides in DNA are made of three basic components: a sugar called _____, a _____, and a _____ base.

3. DNA contains four kinds of nitrogenous bases: _____, _____, _____, and _____.

4. In DNA, _____can be joined in any order.

5. The nucleotides in DNA are joined by _____ bonds.

6. Predict the complementary DNA strand that would be created with the following strand during replication: GAG TAG CAC ACG TCG CAT

7. Fill in the table describing each scientist's contribution to solving the structure of DNA.

Scientist	Contribution
Erwin Chargaff	
Rosalind Franklin	
James Watson and Francis Crick	

8. Why are the strands of a DNA molecule said to be complementary?

9. If the base sequence on a separated strand of DNA is CGTAGG, what will the base sequence of its complementary strand be?