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Topic: Carbon Cycle Modeling Lab

Summary: There are four stations where students practice and build the concept that carbon cycles between reservoirs. Each station represents a lesson, and student cycle through the stations to learn from each lesson.

Goals & Objectives: Students will define key vocabulary words pertaining to the carbon cycle. Students will identify where carbon atoms are stored on Earth. Students will collaborate to solve real world examples and problems about the carbon cycle. For example, students will be asked to make a connection between the food they eat (their source of carbon) and exercise (how they release carbon) to the processes photosynthesis and cellular respiration. Students will calculate the net movement of carbon around the globe to see that there is an increase of carbon going to the atmosphere. Students will then make a prediction based on this data.

NGSS Standards: HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

CCSS Math Standards: HSN-Q.A.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. HSN-Q.A.2. Define appropriate quantities for the purpose of descriptive modeling.

Time Length: 2-3 days

Prerequisite Knowledge: What are the reactants and products of photosynthesis and cellular respiration, what are carbon reservoirs, and how to write a CER paragraph.

Materials:

- 6 Large whiteboards
- 12 Dry erase markers (4 red, 4 black, 2 green, 2 blue) and towels for erasing
- 8 Chemistry model kits (12 Carbon, 36 Hydrogen, 36 Oxygen, 100 bonds)

Modeling Activity Set-up:
The number of stations is designed around a class size of 40 students. You can set-up the stations on lab tables or different areas around the room. There will be 4 different stations and in order to accommodate all students in the class, each station is replicated, creating a total of 8 stations. The placement of the stations is important as students move through the stations is based on their prior knowledge.

- Station 1 are for carbon cycle reservoir modeling. A large white board, 4 different colors of dry erase marker, and a towel is needed per station. Tape the carbon cycle reservoir modeling directions to the top of each white board for students to use.
- Station 2 are for law of conservation of matter modeling. Students will use biochemistry modeling kits with 12 carbon, 36 hydrogen, 36 oxygen atoms and 100 bonds for each

station. You can place the ball atoms and stick bonds into a tub or bucket to make sure they don't roll of the table. Tape the law of conservation of matter modeling directions to each table for students to use.

- Station 3 are for claim evidence reasoning peer writing. A large white board, one black and one red colored dry erase marker, and a towel is needed per station. Tape the claim evidence reasoning paragraph directions to the top of each white board for students to use.
- Station 4 are for carbon flow modeling. A large white board, 4 different colors of dry erase marker, and a towel is needed per station. Tape the carbon flow modeling directions to the top of each white board for students to use.

Procedures:

1. Pass out the handout to all students.
2. Review page one of the handout as a class by defining and giving an example of each vocabulary word. Make sure to write your definitions and examples on the teacher white board in front of the class.
3. Walk around to each of the stations and explain what student will be doing at each station.
4. You will assign students to their groups by asking them to go to their assigned station. These groups are based on prior knowledge and level of difficulty. Station 1 build knowledge about where carbon is located on Earth and that knowledge will be used for stations 3 & 4. Stations 2 build a foundation on what molecules are involved in photosynthesis and cellular respiration. This information is used in stations 3 and 4. The most difficult stations are 4 as they involve math and the use of prior knowledge. Use the following example of which group of students go to which station.
    a. Grouped students with the lowest grade in the class will start at station 1.
    b. Grouped students with a C grade start at station 2.
    c. Grouped students with a B grade start at station 3.
    d. Grouped students with an A grade start at station 4.
5. Once all of the student are assigned. Students will go to their stations and start by reading the prompt to begin.
6. After about 20 minutes, all student rotate in the following order:
    a. Station 1 go to station 2
    b. Station 2 go to station 3
    c. Station 3 go to station 4
    d. Station 4 go to station 1
7. The teacher's job while students are at their stations is to help and to initial off when students finish a task on their paper. You initial in the box next to the question.
8. After about 10 minutes, remind the CER paragraph station students to switch stations and to peer edit using their red marker.
9. After about 15 minutes, the time planner needs to remind the CER paragraph station students to go back to their original station and write a final draft of their CER individually. Initial in the box on their handout that they completed the rough draft and peer edit on the white board.

Accommodations: Differentiation has been incorporated in several aspects of this lesson.

1. The type of activities involve collaboration and listening (auditory), diagrams (visual), and building molecules (kinesthetic).

2. Which station each group is placed is based on the groups' prior knowledge. The groups with the highest grade in the class started off with the most difficult stations that required them to use their prior knowledge while the groups with the lowest grade in the class start off refreshing / building that prior knowledge.
3. When the group with high grades go to the Carbon Cycle Modeling station, they are also presented with challenge questions to continue their academic growth.

Editable DOCX File and Answer Key:

Available at www.ngsslifescience.com

Name: _____ Row: _____

Date:_____ Period:_____

Carbon Cycle Modeling Lab

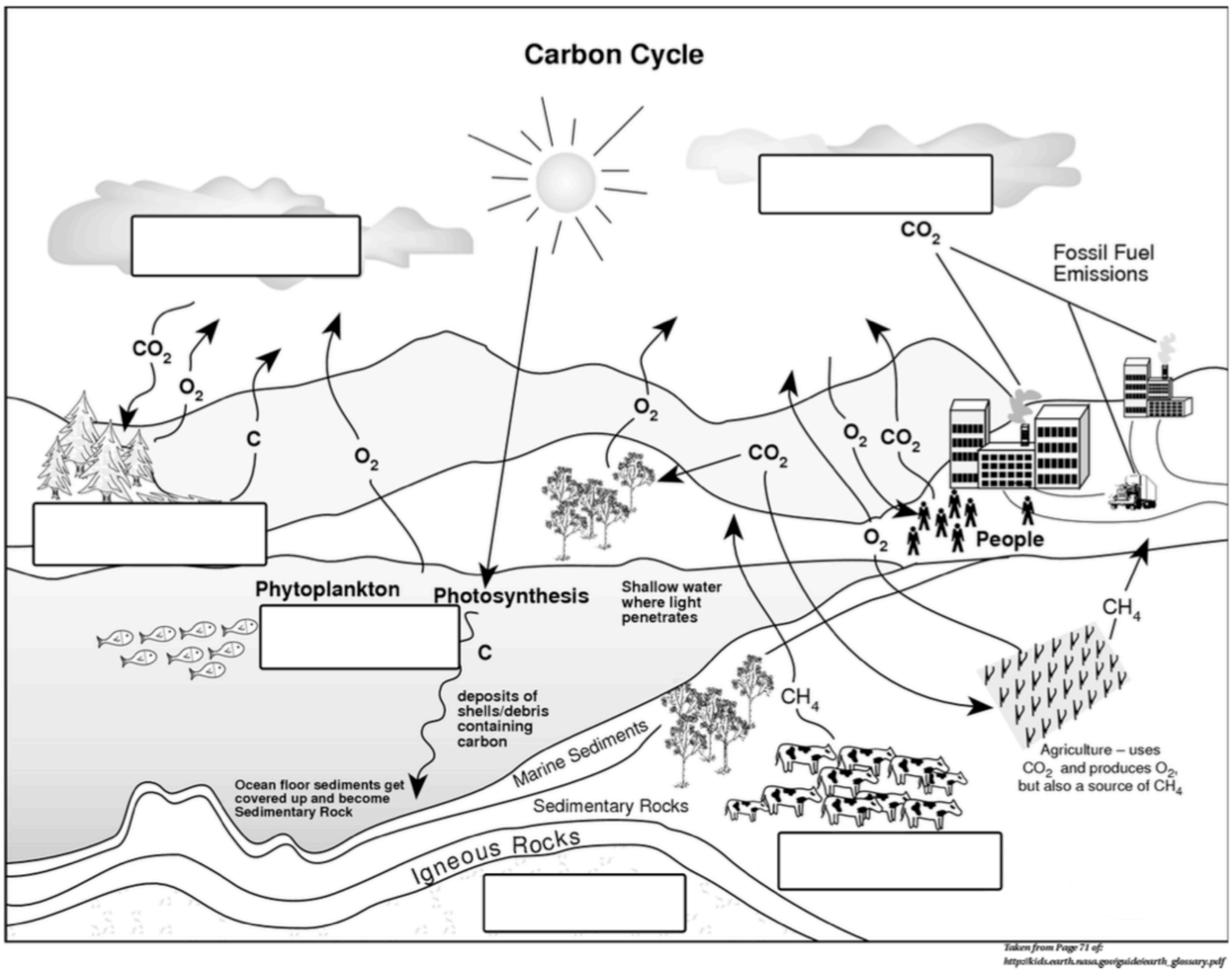
Word	Definition	Example	Image
Conservation	Act of preserving	_____ the environment is called environmental conservation.	
Mass	The number of atoms in an object	Scientists use a scale to _____ _____ of atoms.	
Photosynthesis	$6\ CO_2 + 6\ H_2O \rightarrow$ $1\ Glucose + 6\ O_2$	All food originated in plants because of _____	
Cellular Respiration	$1\ Glucose + 6\ O_2$ $\rightarrow \quad 6\ CO_2 + 6\ H_2O$	Animals and plants make usable chemical _____ by doing cellular respiration	
Atmosphere	All _____ _____ on Earth.	Carbon dioxide in the atmosphere is _____ _____	
Hydrosphere	All of the _____ on Earth.	_____ _____ are good examples of the hydrosphere.	
Geosphere	All of the _____ _____ on Earth.	When organisms decompose, some of their carbon is stored in _____ _____ called the geosphere.	
Units	GtC/y = Gigatons of carbon per year		

1) The Law of Conservation of Mass:
The law of conservation of mass states that _____ cannot be created nor destroyed, only _____.

Carbon Cycle Reservoir Modeling:

Draw a 2D representation of the carbon cycle onto your white board. Your picture can look like the picture below. Once you have drawn the 2D diagram, make sure to label each of the reservoirs. Call over the teacher to initial once you have completed the model. Make sure to write fill in the boxes in the diagram for question 2 and write in the features you could use to identify each reservoir for question 3. Based on what you just modeled, answer question 4.

2) Write in the reservoir names in each of the boxes below.



Taken from Page 71 of:
http://kids.earth.nasa.gov/guide/earth_glossary.pdf

3) Write the characteristics (features used to identify it) of each reservoir below.

Biosphere:

Hydrosphere:

Geosphere:

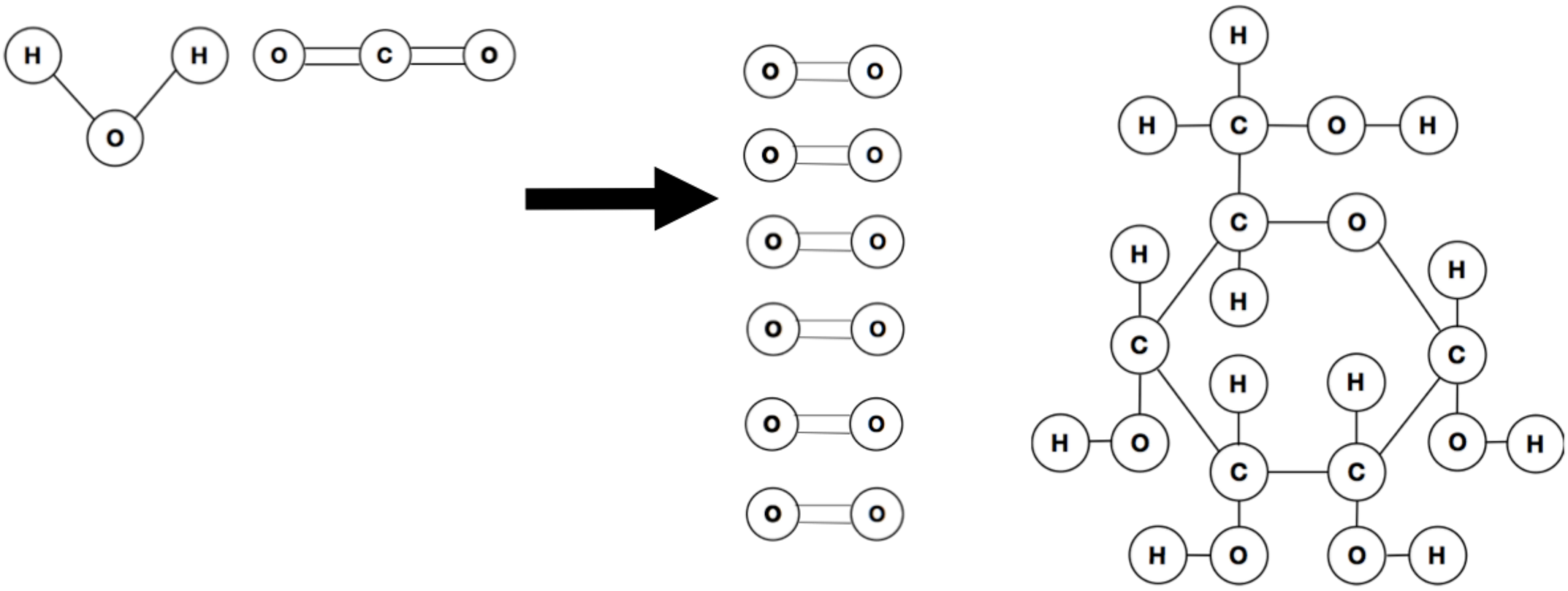
Atmosphere:

Challenge Question: *Label 5 of your arrows on the white board the processes that moves carbon from one reservoir to another reservoir.*

Law of Conservation of Matter Modeling:

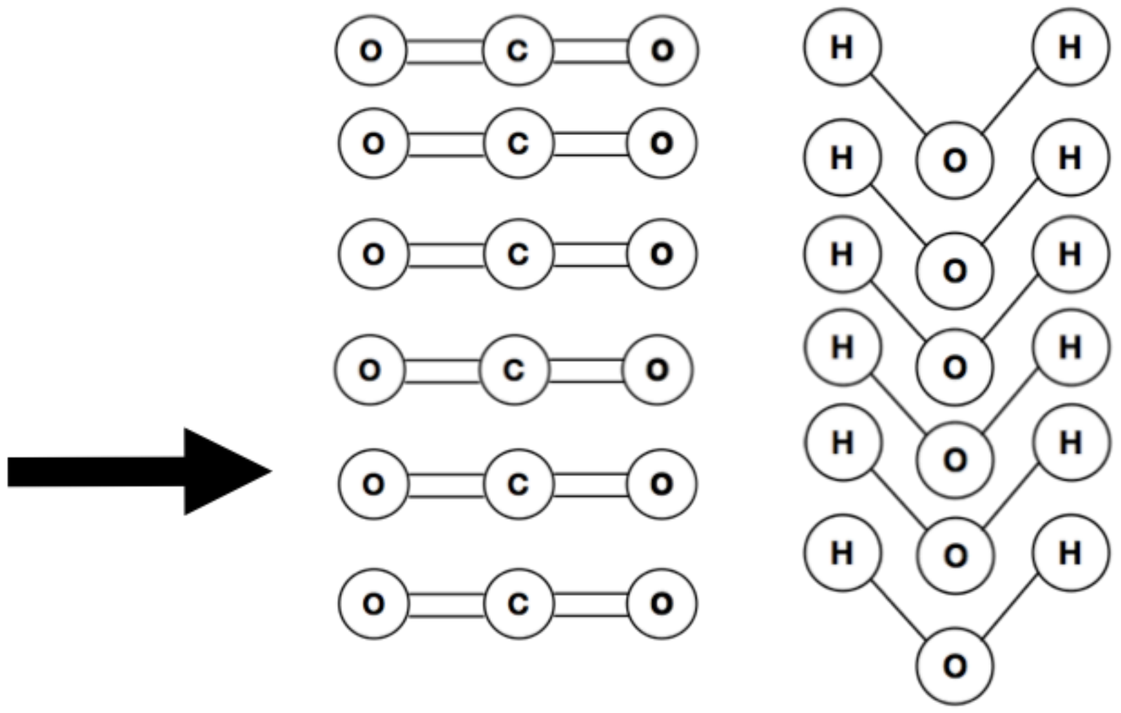
Your goal is to demonstrate your understanding of photosynthesis and cellular respiration by making physical representations of the molecules needed in photosynthesis and cellular respiration. First, you will build the reactants (inputs) of photosynthesis. Question 5 on the left side gives you a clue on the chemical structure of the reactants of photosynthesis. Once you have built the photosynthesis reactants, call over the teacher for him/her to initial off your completion. Next, you will break apart the molecules you just made and now make the reactants to cellular respiration. Use the products (outputs) of question 5 as an aide to the chemical structure of the reactants of cellular respiration in question 6. Draw in the reactants (inputs) for both photosynthesis and cellular respiration below. Once completed, break apart the oxygen gas and glucose molecules.

5) ***Photosynthesis:*** Demonstrate your understanding of the law of conservation of mass by **drawing in the required number of CO_2 and H_2O** molecules to balance the reaction below.



C = _____ H = _____ O = _____

6) ***Cellular Respiration:*** Demonstrate your understanding of the law of conservation of mass by **drawing in the required number of Glucose and O_2** molecules to balance the reaction below.



C = _____ H = _____ O = _____

Claim Evidence Reasoning Paragraph:

On the white board and ***using your black marker***, you will write a rough draft CER paragraph. Sentence one is your claim that answers the following question "How is your diet and exercise part of the carbon cycle". Sentence two cites evidence (could be from the chemical modeling of photosynthesis & cellular respiration) that your diet is part of the carbon cycle, and sentence three is about the science explaining why that evidence supports your claim. Sentence four cites evidence (could be from the chemical modeling of photosynthesis & cellular respiration) that exercising is part of the carbon cycle, and sentence five is about the science explaining why that evidence supports your claim. After about 10 minutes, your group will switch with the other CER group where you can review and ***peer edit their CER using your red marker***. You may not erase any work the other group did. After about 5 minutes, your group will go back to your station and review any revisions the other group may have made. Write your final draft below ***by yourself, not group based***.

☐ **7) Write a 5 sentence claim evidence reasoning paragraph on how your diet (gaining weight) and exercise (losing weight) is part of the global carbon cycle. Use the sentence frames below to start each sentence.**

I claim that _____

My evidence that my diet is part of the carbon cycle is _____

_____

The science relating this evidence to my claim is _____

_____

My evidence that exercising is part of the carbon cycle is _____

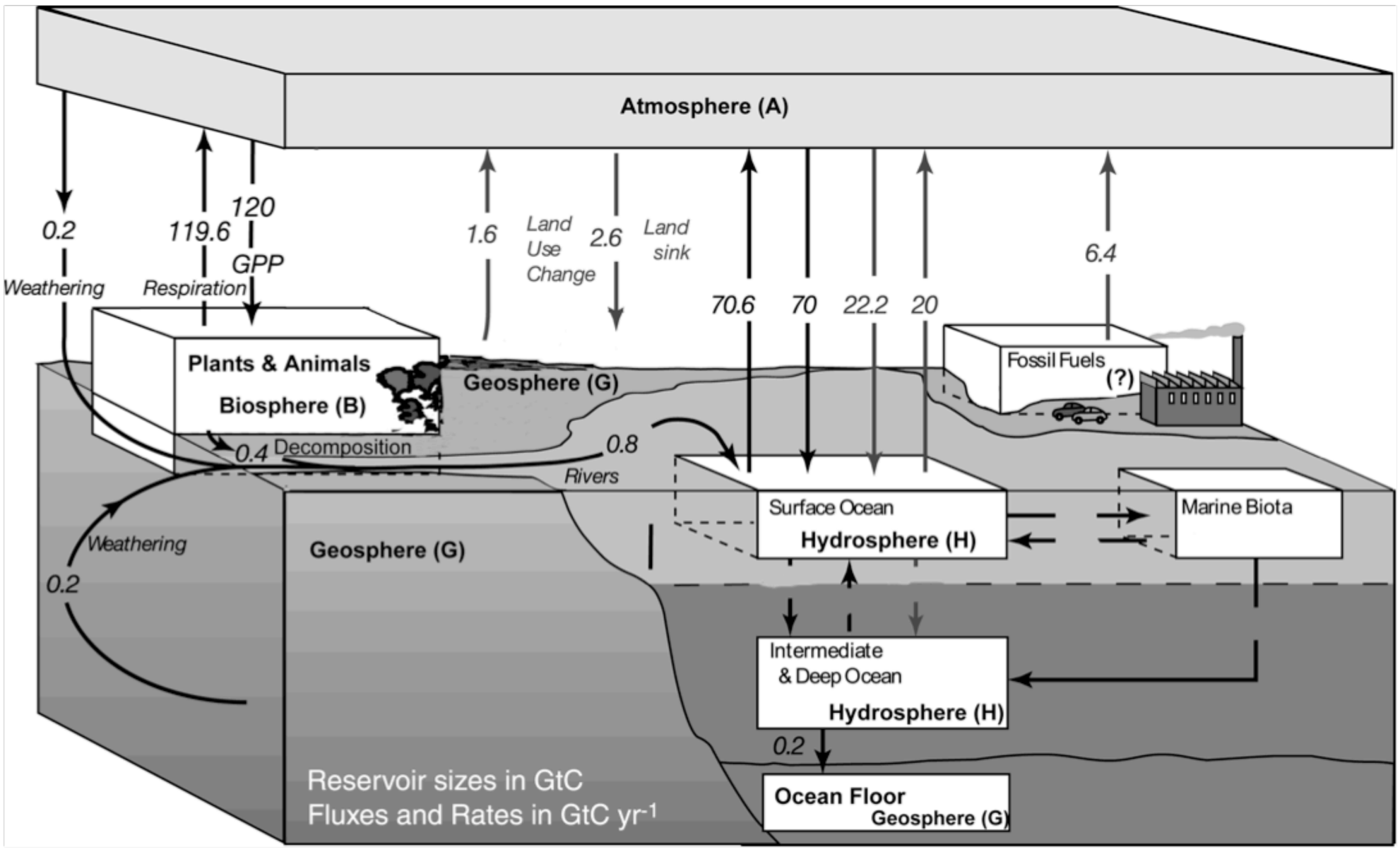
_____

The science relating this evidence to my claim is _____

_____

Carbon Flow Modeling:

Draw a 2D representation of the movement of carbon atoms. Your picture can look like the picture in question 8. Calculate the total number of atoms that would be in each reservoir. Call over the teacher to initial once you have calculated the net carbon flow in each reservoir. Make sure to write your answers with work shown for question 8. Lastly discuss in your group and then make a prediction on the global effects of having more carbon in question 9.



8) Using the model above, what is the net change (Δ) in carbon GtC/y for each reservoir? (Show your work)

(A) Atmosphere:

(B) Biosphere:

(H) Hydrosphere:

(G) Geosphere:

Which reservoir is having the largest increase in carbon atoms? _____

9) Predict what would be the consequences to this increase in carbon atoms in that reservoir over many years. _____

_____