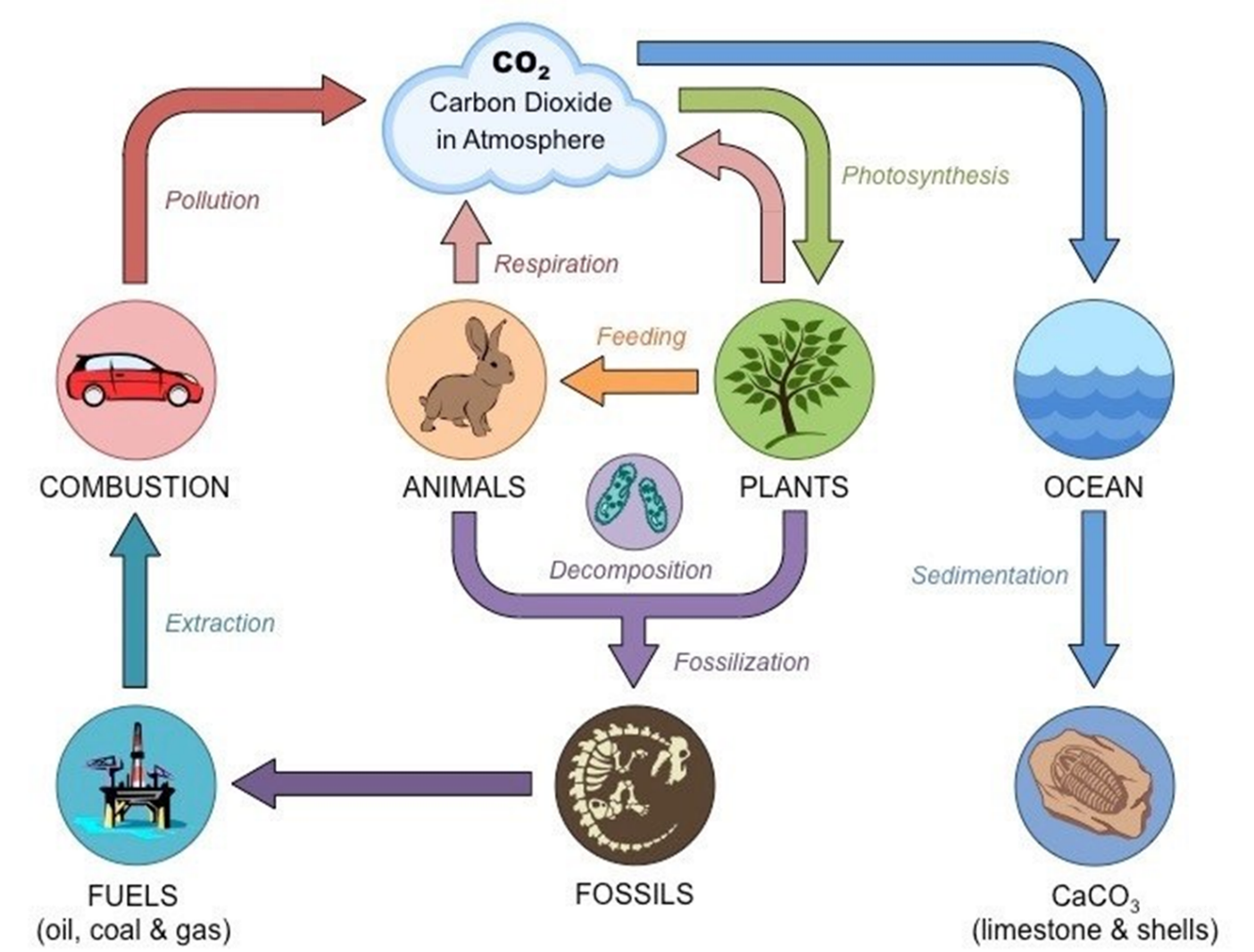
**Name**:

**Essential Question**: How does temperature impact Gross Primary Productivity?

**Part I: Background**

Sketch and/or explain the basics of the carbon cycle**:**

****

**Define** the following and explain their role in the carbon cycle:

**Carbon Stock –** The amount of carbon pulled out of the atmosphere and now stored within the forest ecosystem

**Carbon Flux –** Carbon that is exchanged between the earth’s carbon pools

**GPP –** annual gross CO2 sequestration (gross primary productivity). This is the carbon the trees hold inside themselves and pull out of the atmosphere

**Atmospheric Carbon –** Carbon Dioxide, this is the carbon in the atmosphere as opposed to that held in the bodies of living things or otherwise within the Earth

**Part II: Structured Inquiry**

Write down the **essential question** you will be answering today:

How does temperature impact Gross Primary Productivity?

The **Protocols** for this study are already input into ForC. You do not need to do anything. The protocols were developed by researchers using a standardized approach to monitor GPP, and collect mean annual temperature.

**Data Collection** was also done by researchers in the field for individual studies. The ForC database (<https://forc-db.github.io/>) collected data from multiple studies other questions can be asked. Your specific question deals with GPP and temperature. Define the following terms and determine which temperature and GPP should be placed.

**Independent variable**: Mean temperature

**Dependent variable**: GPP

Write your **hypothesis** about how you think temperature might impact Gross Primary Productivity:

(various possible answers)

**Data Processing**: Follow the instructions on the PPT or follow along with your instructor to get the data into a scatter plot in Excel. Use the following link to access the data: ( <https://github.com/forc-db/ForC/blob/master/educational%20resources/ForC_GPP_and_temperature.csv>)

Write down some initial observations once you have the chart complete. What seems to be happening?

As temperature rises GPP rises, there seems to be a correlation between the two values

**Data Analysis**: Answer the following

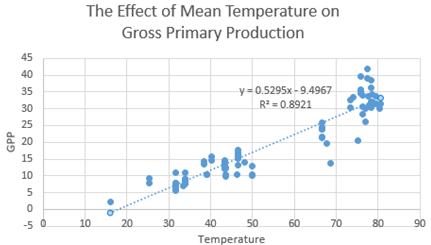
What is a linear regression line? A linear regression line has an equation of the form Y = a + bX, where X is the independent variable and Y is the dependent variable. The slope of the line is b, and a is the intercept (the value of y when x = 0).

Write down your liner regression equation: y= 0.5295x -9.4

What is an R squared value and how do you interpret it? value is a statistical measure of how close the data are to the fitted regression line, measured from 0 to 1.

Write down your R squared value: .89

**Import your data from Excel**. Make sure that you have your x and y axis labeled, the graph is titled, and includes a short description



As temperature rises as a function of different habitats the primary productivity increases.

**Think/Pair/Share**: You have now spent some time processing real data provided by the ForC database through ForestGEO (of the Smithsonian Institution). But what does it actually mean? Write down what you THINK it means (don’t worry if you’re wrong, you just need to have something in the blank here).

I **THINK** the data is showing that:

Careful of what students might share! It seems very clear that an increase in temperature means and increase in GPP and that IS true, but remember that these values came from all over the world. This doesn’t mean if we just started to cook plants up to higher temperatures they would be more productive. This means that plants that evolved in areas of higher temperature also have higher GPP. This is a good chance to discuss what linear regressions do and do not reveal.

Students might have a wide range of statements here, though likely centering on “temp up means GPP up” and that IS true as far as the data indicate, but make sure that they fully understand what’s going on.

Because:

Now talk to a partner/group member about what the data shows. What is the effect of mean temperature on gross primary production?

(variety of answers)

8) **Conclusion**: Write a concluding paragraph on the impacts of mean temperature on gross primary production. Be sure to structure include an introduction sentence (on the forest carbon cycle), clearly state your hypothesis, background on ForC, the methods we used as a class, and a reference to your graph and R squared value. Avoid words like “prove” and make sure to explain what the data “suggests.”

(make sure students restate everything that is significant. This should be similar to an abstract section)

**Extension**: Using what you have learned what you can say about the GPP of forests at the equator vs forests growing far north or south of the equator?

At the equator have a higher rate of GPP than those further away

Using your graph what is the GPP approximate in the following cities?

Miami, FL, USA: Average Annual Temperature 77°F:

Iqaluit, Canada: Average Annual Temperature 15.3°F:

Washington, DC, USA: Average Annual Temperature 64.8°F :

In the coming years as carbon dioxide continues to accumulate in our atmosphere it is likely the temperature is going to rise. Based on your graph this rise in temperature could be associated with increased plant productivity. Does this mean global warming will **always** be good for plant growth? Why or why not? Explain (you may want to watch <https://svs.gsfc.nasa.gov/vis/a010000/a010600/a010630/index.html> for some background information)

The very purpose of this section is for students to think about the limits of the data. Just because there is a clear and strong correlation it doesn’t mean that global warming will cause plants everywhere to be more productive. The data show clearly a correlation between temperature and GPP of plants in completely different locations