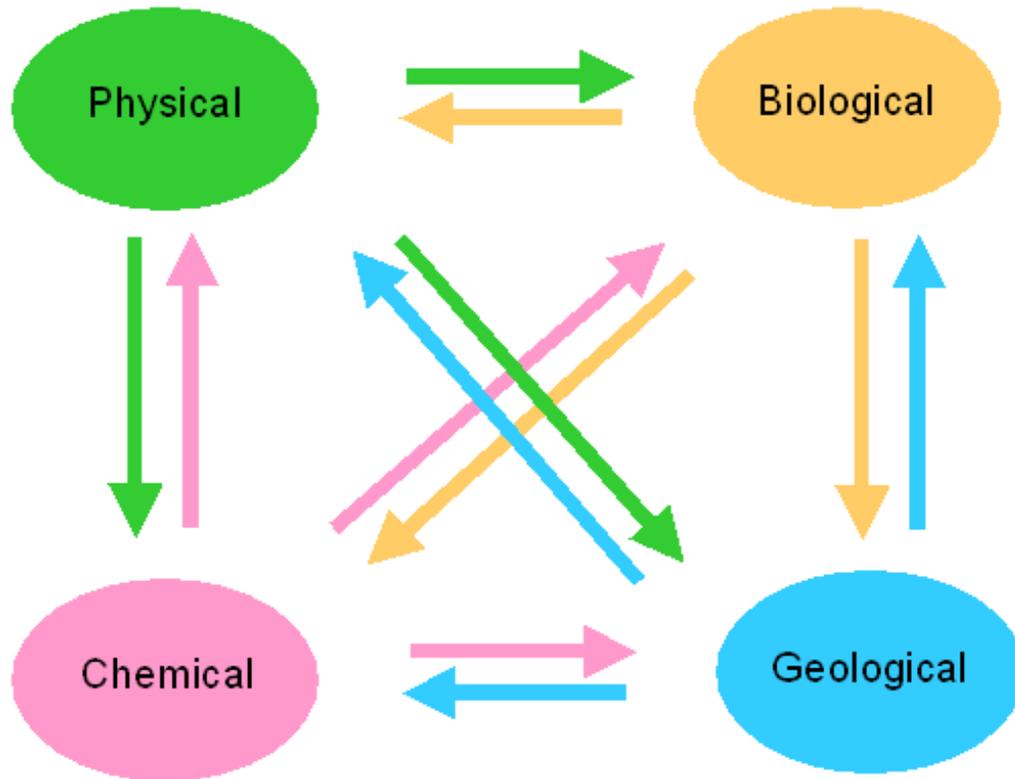


## Student Resource

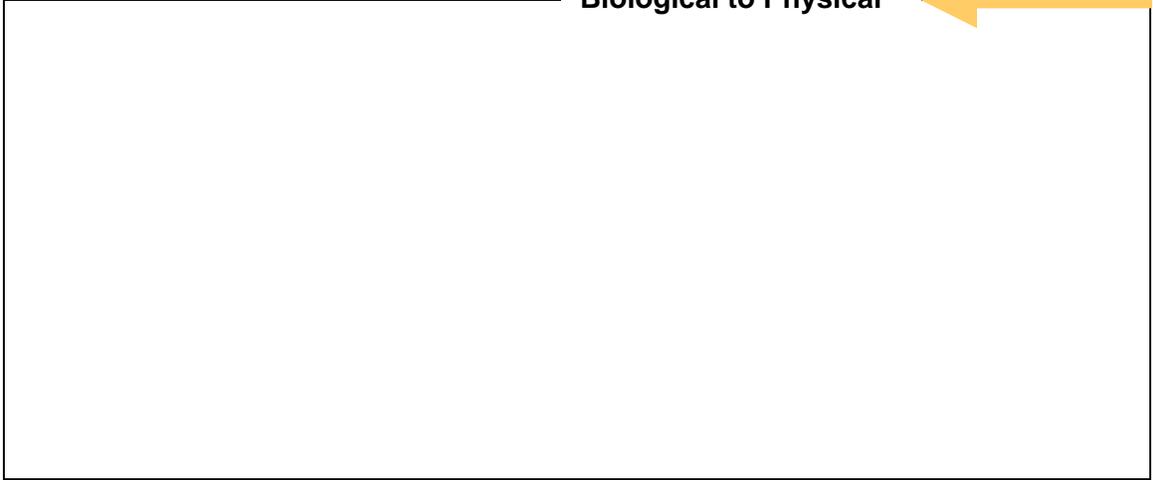
### Interactions in the Ocean

**Directions:** Research the interactions between the **Physical**, **Biological**, **Chemical** and **Geological** parameters of Glacier Bay. Start each interaction with the word **because**. The first is done for you.

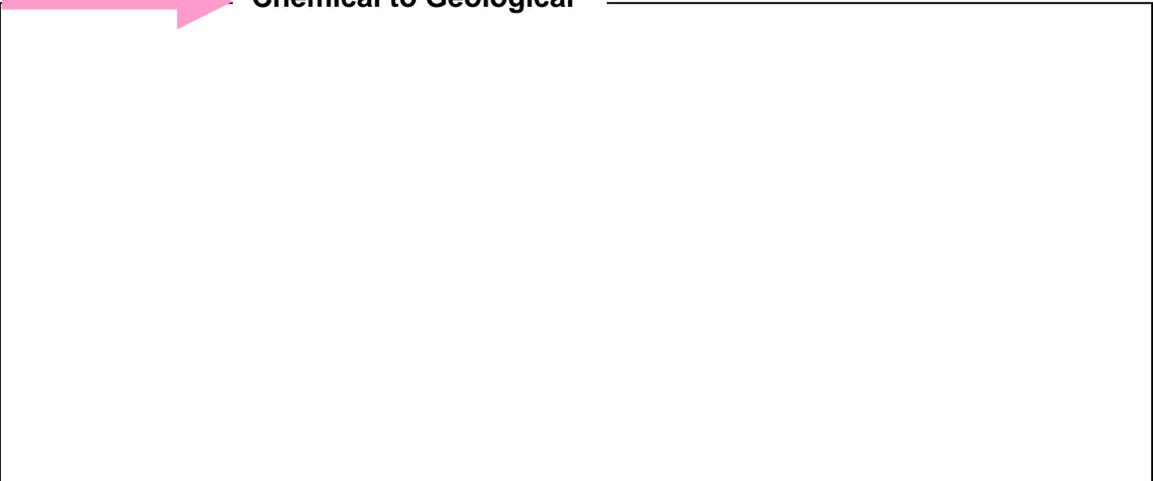


1. **Because** glaciers created the complex variety of environments, many different living creatures can live in it.
2. **Because**

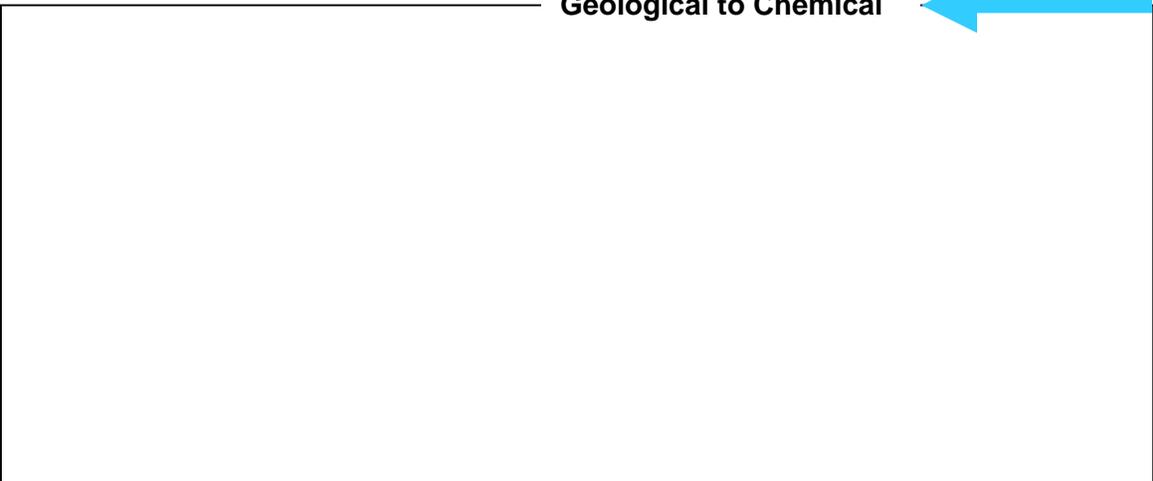
**Biological to Physical**



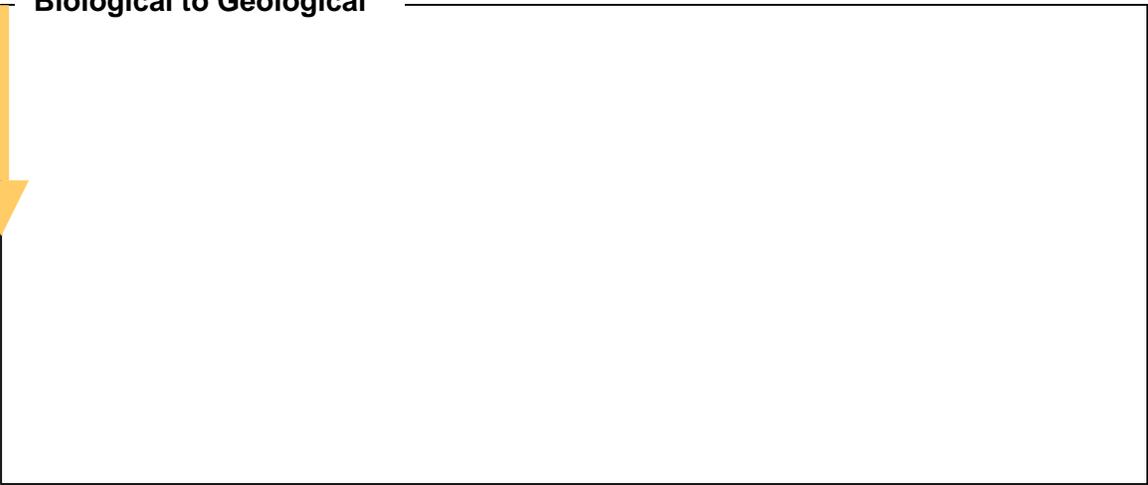
**Chemical to Geological**



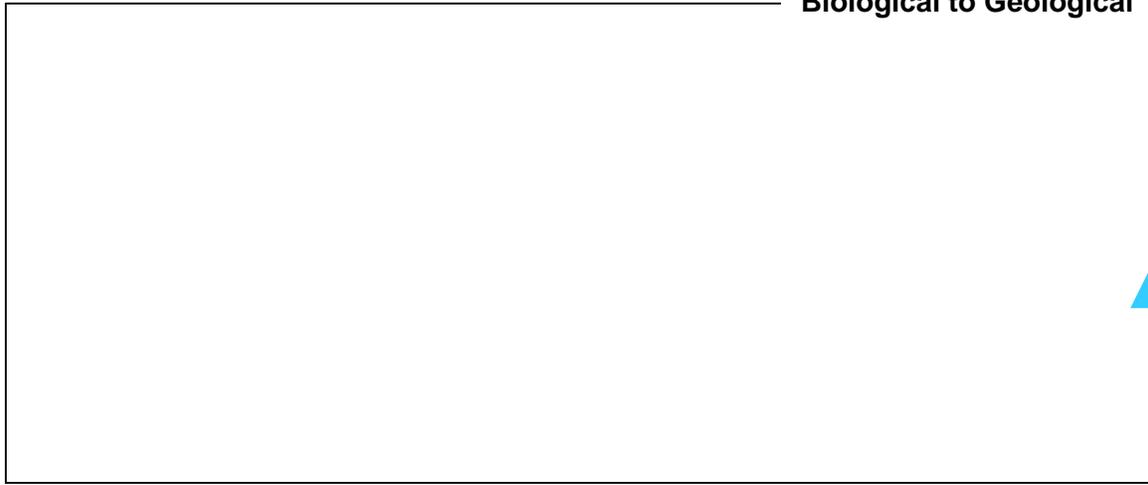
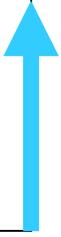
**Geological to Chemical**



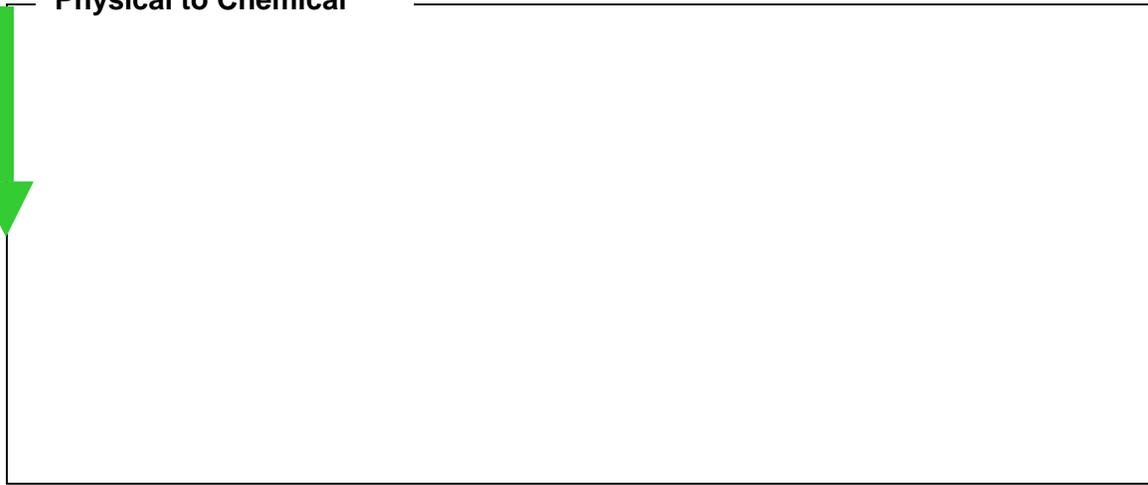
**Biological to Geological**



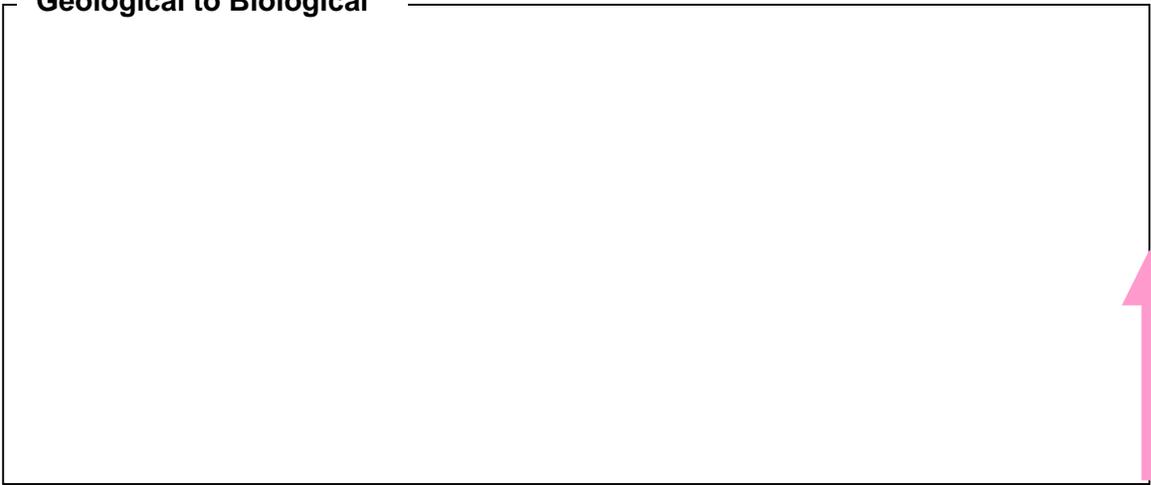
**Biological to Geological**



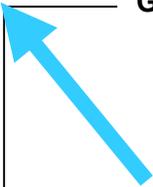
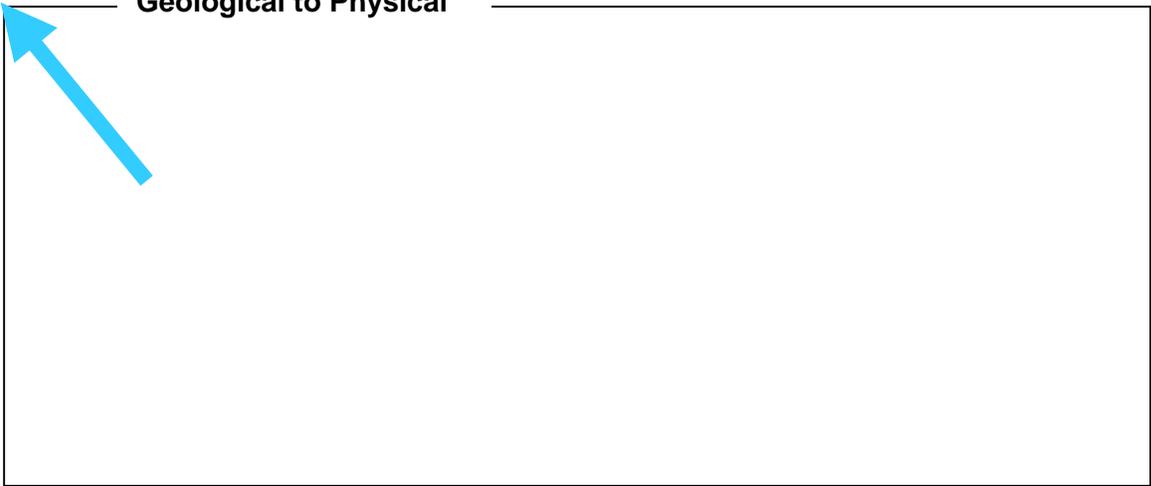
**Physical to Chemical**



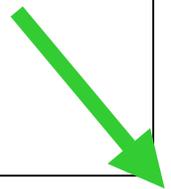
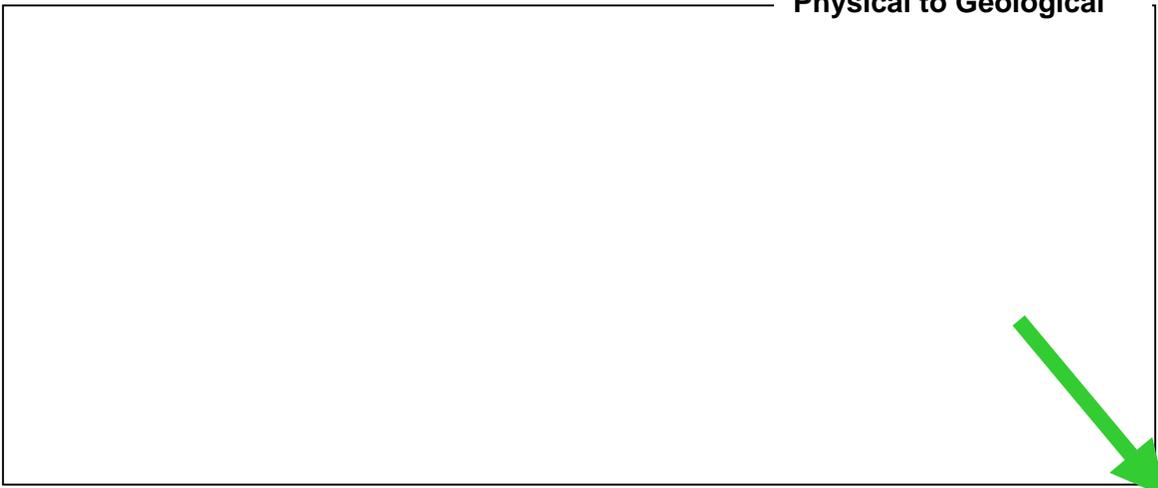
**Geological to Biological**



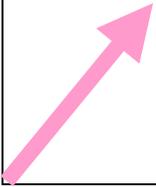
**Geological to Physical**



**Physical to Geological**



**Chemical to Biological**



**Biological to Chemical**



## **Answers to the Worksheet: Relationships in the Ocean**

### **Physical to Biological**

- When big tides and strong currents collide with the sills and constrictions, upwelling and mixing of the waters occur in the deep. This constant mixing of oxygen-saturated, nutrient-rich waters allows the development of a highly biodiverse marine system.
- The shallow band of water at the top of the stratified water column is warmed by the sun, resulting in 2-3 phytoplankton blooms that occur between spring and fall.

### **Biological to Physical**

- The otters' love of sea urchins has cut their population to such a degree that giant and bull kelps can form forests under the sea.

### **Chemical to Geological**

- 

### **Geological to Chemical**

- Freshwater from melting glaciers and a wide variety of freshwater streams deliver a more or less constant supply of freshwater to the salty ocean waters.

### **Geological to Biological**

- The marine substrates left by the retreating glaciers provide good ground in which a wide variety of living creatures can hide or hunt.
- The complex structure carved by glacial retreat provides habitats that range from deep water to rocky islands to rocky intertidal beaches. These diverse habitats allow many different kinds of animals to thrive.

### **Biological to Geological**

- As living creatures die or are killed, their remains drop to the ocean floor to become part of the substrate.

### **Chemical to Physical**

- This fresh water forms an upper layer of water, a few meters thick, that flows toward the sea, picking up some salt water from below and carrying it along on its current. A layer of salt water from the ocean balances the outward flow.
- The estuarine flow that has its genesis at the glacial faces results in a highly stratified water column in the deep bays or "valleys" of the ocean environment.

### **Physical to Chemical**

- When big tides and strong currents collide with the sills and constrictions upwelling and mixing of the waters in the deep. This causes a constant mixing of oxygen-saturated, nutrient-rich waters. Fresh water floats on salt water because it is less dense. Salt water is denser and very cold. It sinks below the less dense fresh water.

### **Geological to Physical**

- Glaciers carved huge valleys and left behind many terminal moraines (piles of rock left over as glaciers retreated, called *sills*) in the ocean. These huge gouges and rock piles became a wide variety of underwater environments when the ocean invaded.
- Sills tend to be at or near the mouths of inlets and other areas where the faces of tidewater glaciers once stood still for a time. Like speed bumps, sills partially obstruct the bay's strong underwater currents, causing **upwellings** and **tide rips** similar to rapids in a river.

#### **Physical to Geological**

- The warming earth has caused the glaciers to retreat faster than ever.

#### **Biological to Chemical**

- The death of living creatures adds nutrients to the waters for other living creatures to use.

#### **Chemical to Biological**

- Phytoplankton photosynthesize using carbon dioxide, nutrients from the deep waters and the sun's energy.