

Making Fuel From Algae

Name: _____ Date: _____

Company Name: _____

Congratulations on your new job at an algal biofuel company! Your team is in charge of growing algae for your company, and your goal is to make a profit from this renewable energy source. You must decide how to grow your algae by using your knowledge from homework readings, the provided scientific tables and figures, and your reasoning skills.

First, make you sure you know what factors will affect algae growth.

What are 4 major requirements for algae growth?

- 1.
- 2.
- 3.
- 4.

Brainstorm biotic and abiotic factors that affect how well your algae will grow.

Biotic Factors	Abiotic Factors

Now that you've shown you know what factors will affect algae growth, it's time to make decisions. Discuss with your team and write a short explanation of why you made each decision. You may answer the questions in any order.

Where will you grow your algae in the United States? Choose a state and the general area of that state (for example, western Idaho).

Consider the following while deciding: Where will your water come from? What climate would be ideal? Would there be a lot of precipitation or evaporation?

What water source will you use to grow your algae? Choose between seawater, wastewater, and freshwater.

Consider the following while deciding: What is the cost of the water and the cost to get it to your algae facility? What kinds of algae can grow in this water? Which water sources will you need to add extra nutrients to?

What kind of growth system will you use to grow your algae? Choose between an open pond system and a photobioreactor (closed system).

Consider the following while deciding: What will be the effects on algae if other organisms from the outdoors mix with the algae? What system will be affected by evaporation and precipitation? Which system is more expensive? Which system may need to be cooled off because of overheating?

What kind of algae will you grow? You may choose a certain species, a combination of species, or choose between marine diatoms, freshwater diatoms, marine green algae, and freshwater green algae.

Consider the following while deciding: What kind of environments do different algae prefer? What are the growth requirements of these algae? What kinds of algae grow the quickest? What kinds of algae accumulate the most lipids or oils?

Making Fuel From Algae - **WORKSHEET KEY**

Suggested answers in italics

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First, make you sure you know what factors will affect algae growth.

What are 4 major requirements for algae growth?

- *Water*
- *Light*
- *Nutrients*
- *Carbon dioxide (CO₂)*

Brainstorm biotic and abiotic factors that affect how well your algae will grow.

Biotic Factors	Abiotic Factors
<i>Bacteria that can infect algae</i>	<i>Temperature</i>
<i>Other algae that can compete with the desired algae for nutrients</i>	<i>Precipitation and evaporation (if in an open pond)</i>
<i>Predators that can eat the algae</i>	<i>Light intensity</i>
<i>Birds that can land in algae ponds</i>	<i>Light hours in a day</i>
	<i>Salinity</i>
	<i>pH</i>
	<i>Mixing/water movement</i>
	<i>Oxygen and carbon dioxide levels</i>
	<i>Nutrient concentrations</i>

Now that you've shown you know what factors will affect algae growth, it's time to make decisions. Discuss with your team and write a short explanation of why you made each decision. You may answer the questions in any order.

Note: All of these questions are open-ended. The goal is for students to contemplate different scenarios while making their decision, and use evidence from their reading and the provided tables and figures. Suggested thought processes are written below.

Where will you grow your algae in the United States? Choose a state and the general area of that state (for example, western Idaho).

Consider the following while deciding: Where will your water come from? What climate would be ideal? Would there be a lot of precipitation or evaporation?

Students should discuss the temperature, rainfall, evaporation rates, land types, and how they will get water to their algae facility. They should not choose a location where crops are grown or which has a cold climate or a high annual rainfall. If they are going to use marine algae and seawater, their facility should be located on the coast. They should look at Figures 1 and 2 from the Scientific Evidence packet to get a better idea of climates and locations that are near cheap sources of wastewater (for water and nutrients) and carbon dioxide.

What water source will you use to grow your algae? Choose between seawater, wastewater, and freshwater.

Consider the following while deciding: What is the cost of the water and the cost to get it to your algae facility? What kinds of algae can grow in this water? Which water sources will you need to add extra nutrients to?

Students should consider Table 5 to learn that nutrients in wastewater will help them cut costs since they will not have to buy extra nutrients. They must also consider that they will need to be located near this source of water. No students should choose freshwater unless they have located their facility near the Great Lakes, because freshwater is a scarce resource and an algae facility would put a strain on other industries that need freshwater, such as agriculture. Seawater is a good option because it is a "free" source of water, but must have nutrients added to it and must be cleaned before use. Students may also consider the costs of pumping this water from the locations where it is available.

What kind of growth system will you use to grow your algae? Choose between an open pond system or a photobioreactor (closed system).

Consider the following while deciding: What will be the effects on algae if other organisms from the outdoors mix with the algae? Which system will be affected by evaporation and precipitation? Which system is more expensive? Which system may need to be cooled off because of overheating?

Students should consider the pros and cons in Table 1 and the NERs in Table 2 of the Scientific Evidence packet. They can look at Figures 3 and 4 to get a sense of what the open and closed systems look like. Students should discuss how open systems let in other organisms that may infect, eat, or compete with the algae they are trying to grow. Closed systems prevent other organisms from getting in,

but are more expensive. Closed systems can also overheat and may need to be cooled with water, which will add costs and needed resources to the facility. Open systems are also more susceptible to fluctuating environmental conditions and weather (storms, precipitation) which can harm the algae.

What kind of algae will you grow? You may choose a certain species, a combination of species, or choose between marine diatoms, freshwater diatoms, marine green algae, and freshwater green algae.

Consider the following while deciding: What kind of environments do different algae prefer? What are the growth requirements of these algae? What kinds of algae grow the quickest? What kinds of algae accumulate the most lipids or oils?

Students should consider Figures 5 and 6, and Tables 3 and 4. Their chosen algae should match with what water source they choose (they can only grow marine algae in seawater). Students should choose algae that have high lipid/oil contents, but should also recognize that the total oil produced from the algae culture is the product of the oil content per cell and the total number of cells. Therefore, the lipid content and the algae abundance determine the total amount of oil produced from the algae, so there is a compromise between algae that grow quickly and algae that accumulate a lot of lipids but grow slowly. If students do not want to name a specific alga, they can describe the ideal characteristics of the algae species they will use. They can also choose to mix algae species if they think the increased diversity will lead to increased productivity.