INTRODUCTION TO ECOLOGY ENVIRONMENT AND DEVELOPMENT

WE START HERE….

This course is largely about how the world works. We will be taking a look at the diversity and relationships between the numerous living and non-living systems that surround us all.

For example living systems include bacteria, plants and animals, while non-living systems include such things as soil, air and water. Living and non-living systems are closely linked and each affects the other.

Humans are an inseparable part of these systems and so it makes sense for us how people fit into these systems. The more we learn about how they affect us and the better we understand how our activities affect them, the better the chances are of us helping to maintain the balance of nature in the way our fore parents experienced it.

So let's take a look a look at a few key but simple definitions:

ECOLOGY: the study of relationships between animals and plants and their surroundings.

BIODIVERSITY: the variety of natural life.

NATURAL RESOURCES: naturally occurring features or characteristics of the environment. Natural resources often have significant commercial value. For example, mineral deposits, forests and stocks of edible fish support entire industries. So what are renewable and non-renewable resources…… you tell me?

SUSTAINABLE DEVELOPMENT: the use of available resources to fulfill our needs without threatening the ability of future generations to meet their own needs.

PUTTING THINGS INTO PERSPECTIVE

It is becoming increasingly difficult to appreciate that people and the planet Earth are interdependent. For many of us drinking water is supplied from the tap and food comes from the supermarket. We forget the chain of production and supply that produces our daily meals and links us to basic natural resources like soil and water. Under normal circumstances natural resources maintain and renew themselves. However, poverty, lack of choices, climate in combination with any number of biological, cultural or political factors are making it increasingly difficult for us to use natural resources and our environment in a sustainable manner.

People are at the heart of development but sustainable development depends on maintaining a healthy environment. People's health and quality of life depends on the health of planet Earth. If I have gotten your attention now it means that you should have realized that if we want to maintain the quality of life that we have become accustomed to, we have to become aware (and make others aware) of the issues and practices that are damaging the Earth but we also have to find practical alternatives to current environmentally damaging practices.

EVERTHING IS CONNECTED TO EVERYTHING ELSE

In the human body, that is healthy, from the tiniest cell to the largest organ, everything is interconnected and has a specific function. Everything has a place and a job to do and once something goes wrong, that is we get sick or injured, the effects are felt in more than one way.

The Earth is not dissimilar to the human body. It is like a super organism where we humans, along with plants, bacteria etc are like the cells and tissues that sustain it. Yes, we have the capacity to keep the body (Earth) healthy because we are all connected.

Can you find a connection between bees and the popular soft drink Coca Cola?

THE BASIS OF ECOLOGY

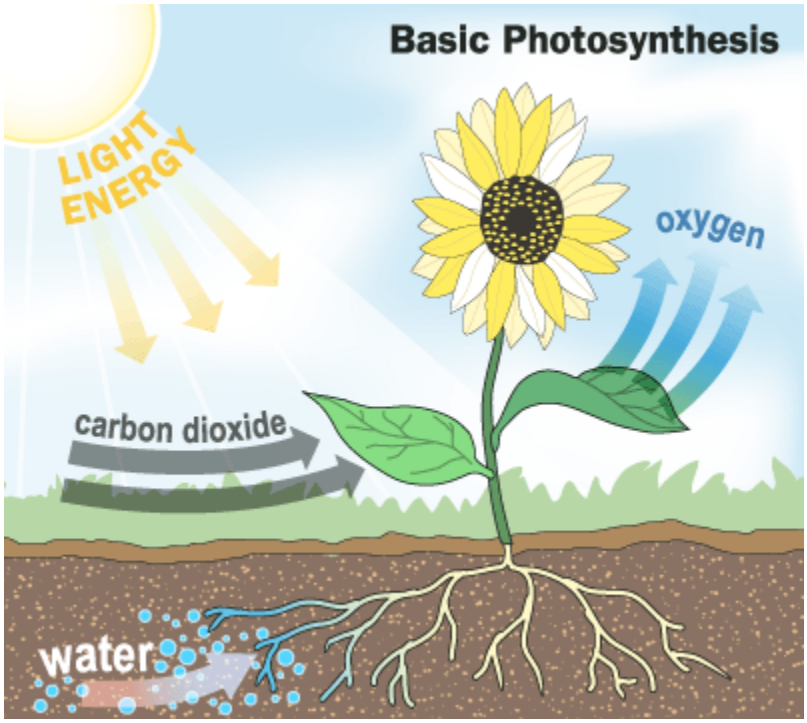
The environment encompasses everything that is around us. Not just other living things but the non-living components like air, water and rocks. Ecology is the study of the complex inter-relationships that exist. The basic principles of ecology are:

1. Everything is connected with everything else
2. Everything must go some where
3. Nature knows best
4. Everything we do has an effect

These rules may seem trivial but they are based on sound scientific research in fields such as energy flow, cycles and ecological communities.

FURNACES, FOOD AND ENERGY FLOW

The single essential requirement of all living things is energy! Nothing works without energy. The energy source for life on Earth is the sun. However, we can not make use of energy directly for the sun – not for biological purposes at least. But solar energy does reach us indirectly through plants. Green plants absorb sunlight, breathe in Carbon dioxide, absorb water and manufacture food products while breathing out oxygen. This process is known as photosynthesis and the food that plants produce is chemical energy that we humans can eat…… sugars of all varieties!



The plant absorbs carbon dioxide from the atmosphere, draws water up through its roots and uses light to *photosynthesize* sugars, which it uses as food. It excretes oxygen as a by-product of the process. Without water, photosynthesis cannot take place.

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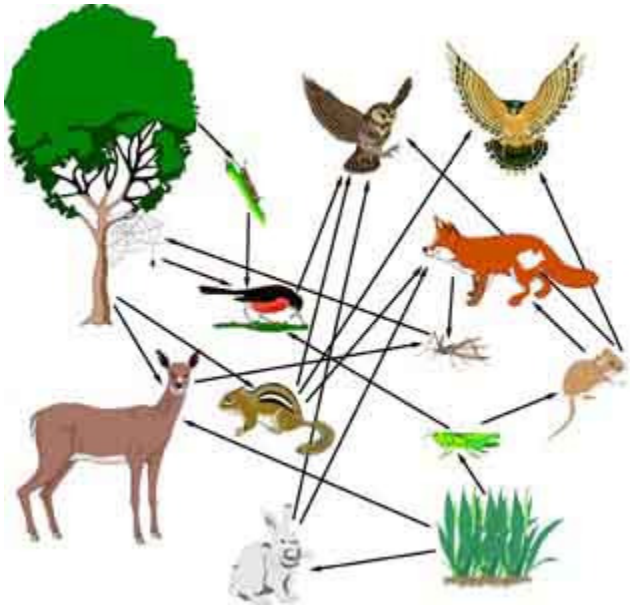
"Fitting Algae Into the Food Web"

Food chains and food webs show the flow of energy through an ecosystem. Food chains are linear depictions of energy flow, while food webs show the multiple interactions among the different types of organisms. Food webs are generally a more realistic portrayal of the energy flow in the system. After all, most organisms eat more than one type of food and can be eaten by more than one type of predator.

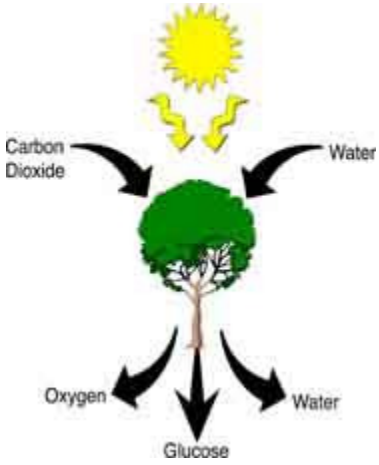
To the left is a typical food chain in a deciduous forest. Grasshoppers eat the grass; grasshopper mice eat the grasshoppers; and owls eat the grasshopper mice.



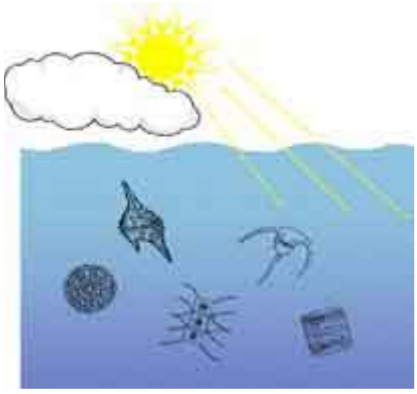
To the right is a more complex portrayal of the same system as a food web. Despite the visual complexity of the diagram, many species and many links between species are not shown.

In both images, the arrows indicate the direction of energy flow.

So where does energy come from? The fundamental energy source for most of the environment is the sun. Photoautotrophs capture the sun's energy and use it to make organic compounds through photosynthesis. The process of photosynthesis transforms carbon dioxide and water into simple carbohydrates. The photoautotrophs then use the simple carbohydrates to build other more complex organic molecules (proteins, lipids and starches) that are either used as building blocks for their cells or are stored for later use. Photoautotrophs are often also called primary producers because they



establish the basis for most other production; they create organic material from inorganic, or non-living, sources.



How do algae fit into the marine food web? The photoautotrophs with which we are most familiar are the trees and flowers that we see everyday on land. However, there are a substantial number of photoautotrophs in the marine environment as well – most of which we can't see without a microscope! Despite their small size, these microscopic primary producers, marine algae and cyanobacteria, are vital to our planet's productivity since they are at the base of the marine food web.

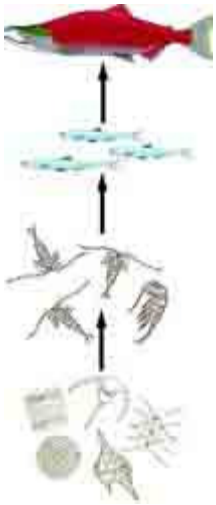
What do we mean by "photoautotroph" and "heterotroph?"

Organisms are given these names according to their mode of nutrition:

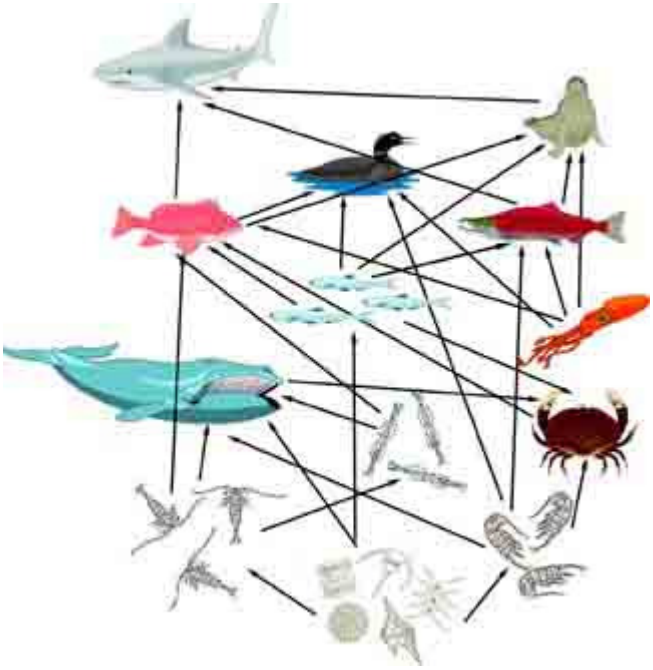
+ ***Photo*** refers to how photoautotrophs get their energy - from the sun.
+ ***Auto*** means "self" and ***troph*** means "feeding." Autotrophs do not require the help of other life forms to get their carbon source (carbon dioxide) since there is plenty of carbon dioxide freely available in the environment.
+ ***Hetero*** means "other" so heterotrophs feed on other organisms. They cannot produce their own food.

What happens further up the food web? Each level of a food web or a food chain is called a trophic or feeding level, and the organisms in the food web are classified by whether they are primary producers or consumers. The consumers in food webs are called heterotrophs and they consume the organic material made by the

autotrophs. Heterotrophs cannot make their own food so they are dependent on the autotrophs for survival.



A simple marine food chain might look like the one to the left. The salmon is the top consumer; the herring are the secondary consumers; and the copepods are the primary consumers. The phytoplankton are the producers.



A more complex marine food web might look like the one to the right. Despite the visual complexity of the diagram, many species and many links between species are not shown. Organisms may have more than one trophic role because they eat a variety of food types.

NOTHING IS LOST IT JUST GOES AROUND AND AROUND AGAIN

If energy, in any form can not be created or destroyed but only transformed it means that it goes around in cycles and in fact it is energy that powers some very important cycles that drive life. These include:

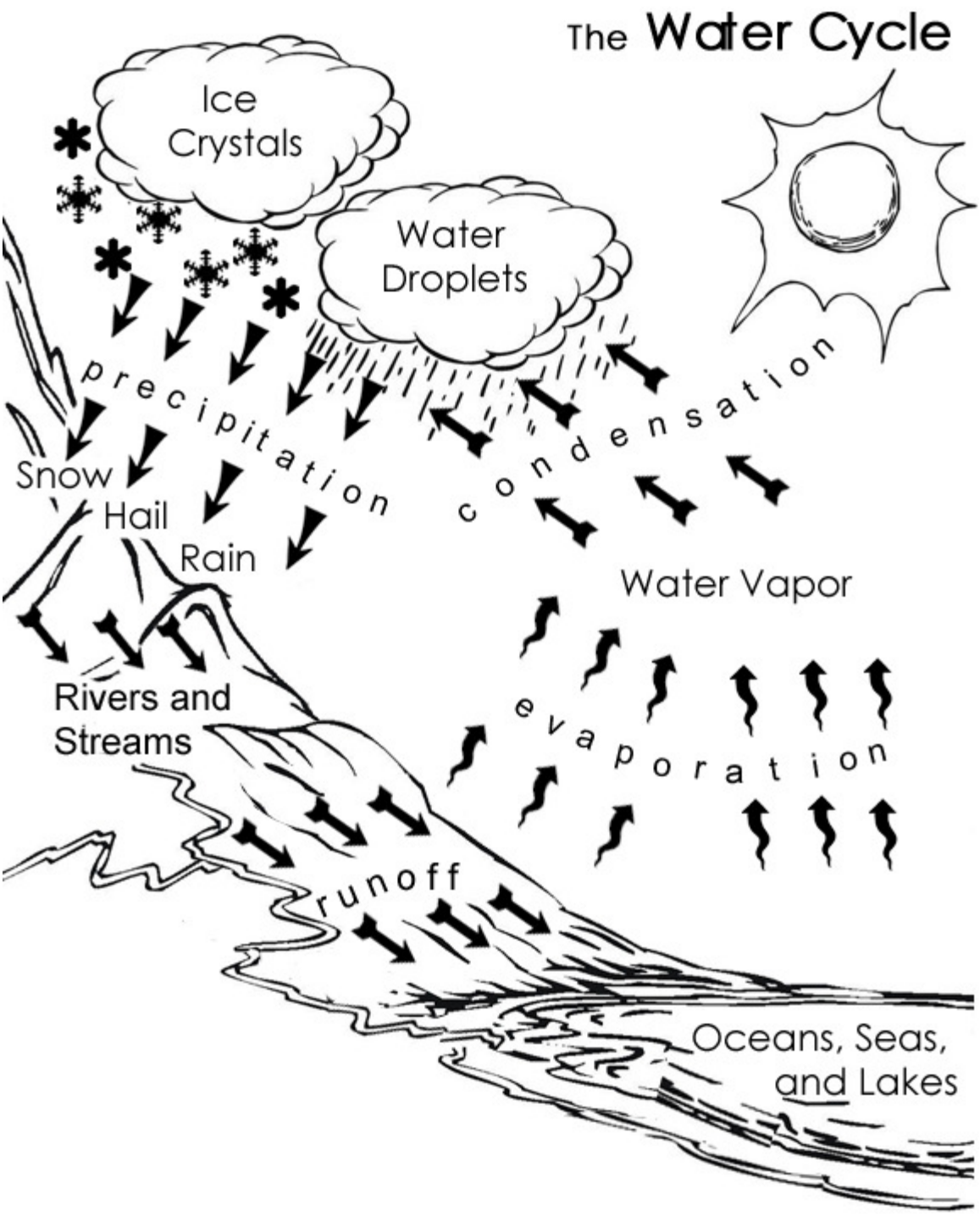
1. The water cycle
2. The Carbon cycle
3. The nitrogen cycle

However, we shall only be looking at the Water and Carbon cycles. If you are interested you can research and read about the more complex Nitrogen cycle.

THE WATER CYCLE

Water may not be alive but it is moving all the time. It moves in oceans in currents and tides but in addition, it moves because of the sun. The sun acts as a furnace which heats up the Earth. This heat energy from the sun causes water to be pulled into the atmosphere by evaporation. In the atmosphere water as water vapour forms clouds and eventually returns to the land or oceans as rain or snow. On land, the water goes into the soil and underlying rocks as ground water or flows directly into streams, rivers or lakes.

See the diagram below



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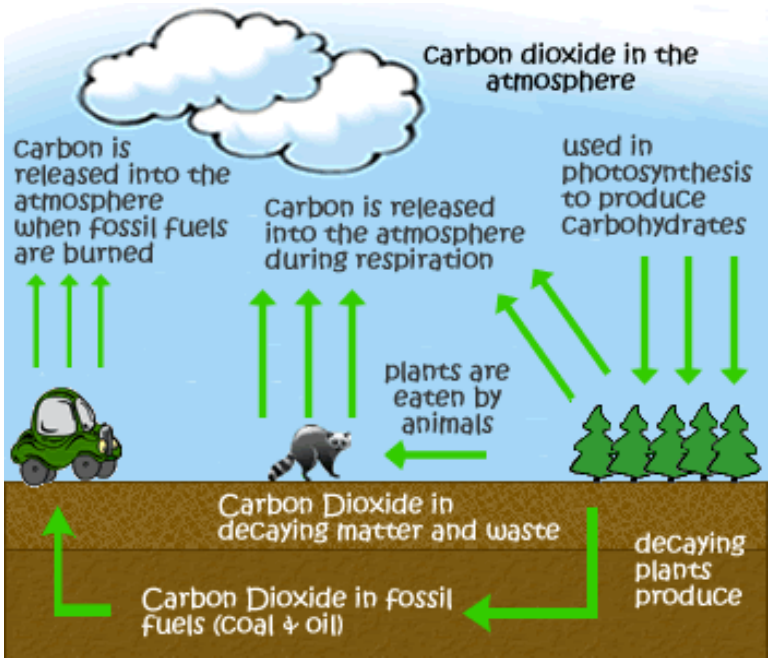
THE CARBON CYCLE

All living things need carbon and are made form it in one form or the other. Fossil fuels like coal and crude oil are the concentrated remains of the carbon from dead plants and animals that have formed over millions of years. The burning of large amounts of fossil fuels and the clearing of large forested areas has resulted in an increase in of carbon dioxide in the Earth's atmosphere. This has lead to the Greenhouse effect but that is for another module.

Carbon cycle processes

If a diagram were drawn showing the different processes that move carbon from one form to another, its main processes would be photosynthesis, respiration, decomposition, natural weathering of rocks, and the combustion of fossil fuels.

Photosynthesis. Carbon exists in the atmosphere as the compound carbon dioxide. It first enters the ecological food web (the connected network of producers and consumers) when photosynthetic organisms, such as plants and certain algae, absorb carbon dioxide through tiny pores in their leaves. The plants then "fix" or capture the carbon dioxide and are able to convert it into simple sugars like glucose through the biochemical process known as photosynthesis. Plants store and use this sugar to grow and to reproduce. Thus, by their very nature as makers of their own food, plants remove carbon dioxide from the atmosphere. When plants are eaten by animals, their carbon is passed on to those animals. Since animals cannot



make their own food, they must get their carbon either directly by eating plants or indirectly by eating animals that have eaten plants.

Respiration. Respiration is the next step in the cycle, and unlike photosynthesis, it occurs in plants, animals, and even decomposers. Although we usually think only of breathing oxygen when we hear the word "respiration," it has a broader meaning that involves oxygen. To a biologist, respiration is the process in which oxygen is used to break down organic compounds into carbon dioxide (CO_2) and water (H_2O). For an animal then, respiration is both taking in oxygen (and releasing carbon dioxide) and oxidizing its food (or burning it with oxygen) in order to release the energy the food contains. In both cases, carbon is returned to the atmosphere as carbon dioxide. Carbon atoms that started out as components of carbon dioxide molecules have passed through the body of living organisms and been returned to the atmosphere, ready to be recycled again.

Decomposition. Decomposition is the largest source through which carbon is returned to the atmosphere as carbon dioxide. Decomposers are microorganisms that live mostly in the soil but also in water, and which feed on the rotting remains of plants and animals. It is their job to consume both waste products and dead matter, during which they also return carbon dioxide to the atmosphere by respiration. Decomposers not only play a key role in the carbon cycle, but also break down, remove, and recycle what might be called nature's garbage.

Weathering of rocks. Not all carbon atoms are always moving somewhere in the carbon cycle. Often, many become trapped in limerock, a type of stone formed on the ocean floor by the shells of marine plankton. Sometimes after millions of years, the waters recede and the limerock is eventually exposed to the elements. When limerock is exposed to the natural process of weathering, it slowly releases the carbon atoms it contains, and they become an active part of the carbon cycle once again

Human-caused increase of carbon dioxide in the atmosphere. In recent history, humans have added to the carbon cycle by burning fossil fuels. Ever since the rapid growth of the Industrial Revolution in the nineteenth century when people first harnessed steam to power their engines, human beings have been burning carbon-containing fuels like coal and oil (called fossil fuels) for artificial power. This constant burning produces massive amounts of carbon dioxide, which are released into Earth's atmosphere. Over the last 150 years, the burning of coal, oil, and natural gas has released some 270 billion tons (245 billion metric tons) of carbon into the air in the form of carbon dioxide.

Luckily, more than half of the carbon dioxide emitted by the burning of fossil fuels is absorbed by the oceans, by plants, and by soils. Regardless, scientists feel fossil fuel consumption could be an example of a human activity that affects and possibly alters the natural processes (photosynthesis, respiration, decomposition) that nature had previously kept in balance. Many scientists believe that carbon dioxide is a "greenhouse gas." This means that it traps heat and prevents it from escaping from Earth. As a result, this trapped

gas leads to a global temperature rise, a natural phenomenon known as the greenhouse effect, which can have disastrous effects on Earth's environment.

TERMS TO REMEMBER AND LEARN ABOUT

Biosphere: The sum total of all life-forms on Earth and the interaction among those life-forms.

Decomposition: The breakdown of complex molecules—molecules of which dead organisms are composed—into simple nutrients that can be reutilized by living organisms.

Fossil fuel: A fuel such as coal, oil, or natural gas that is formed over millions of years from the remains of plants and animals.

Greenhouse effect: The warming of Earth's atmosphere due to water vapor, carbon dioxide, and other gases in the atmosphere that trap heat radiated from Earth's surface.

Hydrocarbons: Molecules composed solely of hydrogen and carbon atoms.

Photosynthesis: Chemical process by which plants containing chlorophyll use sunlight to manufacture their own food by converting carbon dioxide and water to carbohydrates, releasing oxygen as a by-product.

Respiration: The process in which oxygen is used to break down organic compounds into carbon dioxide and water.