The four spheres

Important terms		
four spheres biophysical elements ecosystems lithosphere	abiotic biosphere environment weather	atmosphere biotic hydrosphere

Introduction

There are four interlocking puzzle pieces that create our environment. The puzzle includes biological (living) pieces and physical (non-living) pieces. These four pieces are dependent upon each other. To make the study of the biological and physical elements of the Earth easier to understand, scientists separate these **biophysical elements** into four spheres:

1. Atmosphere
2. Hydrosphere
3. Lithosphere
4. Biosphere

To better understand what these terms mean, it is important to understand that '-sphere' in this instance means 'to surround or encompass'. The following prefixes help us understand the meaning of the four spheres:

- atmo - steam; vapour
- hydro - water
- litho - rock; mineral
- bio - life

The atmosphere

The **atmosphere** is the air that surrounds the Earth. It is always in motion and constantly changing, held in its place by the Earth's gravity. There are about 14 different gases that make up the atmosphere. There are three gases which are most prevalent and compose about 99 percent of the environment. Nitrogen (N2) = over 78 percent, oxygen (O2) = over 20 percent, and argon (Ar) = about 1 percent. Aside from these gases the atmosphere is also made of moisture found within the gases and solid particles, known as **particulate matter**.

The atmosphere is responsible for the weather. All weather occurs within the lower atmosphere. Weather is the short-term change within the atmosphere and is dependent upon several factors:

1. Temperature
2. Precipitation (rainfall)
3. Humidity (moisture in the air)
4. Air pressure (weight of the air)
5. Speed and direction of wind

The atmosphere is made of various 'layers' of air. The layers are separated by invisible 'lines'. These lines separate the changes in temperature that occur with the increase in altitude in the atmosphere.

The bottom layer of the atmosphere is the **troposphere**. The troposphere is where weather happens. It is warmest near the Earth because of the heat rising from the Earth's surface. It becomes colder with altitude.

This layer is separated from the next by the **tropopause.** The tropopause is the point where temperatures change and begin to increase with altitude.

Above the tropopause is the **stratosphere**. There is a large concentration of ozone gas in the stratosphere. The ozone gases absorb most radiant solar energy, protecting the Earth from harmful ultra violet (UV) rays. The stratosphere becomes warmer with increasing altitude, due to the high absorption of solar energy. Temperatures then start to decrease around the imaginary line known as the **stratopause** and continue to decrease rapidly into the next layer.

The **mesosphere** is the coldest of the spheres. It is so cold that water vapours often freeze and create clouds made purely of ice. The mesosphere is separated from the thermosphere by the **mesopause**. This is the point at which the temperature changes again.

The topmost layer is the **thermosphere.** Within this layer, many satellites circle the Earth. Because of the thin air and proximity to the sun, the temperatures in the thermosphere increase and decrease rapidly. Beyond the atmosphere, past the thermosphere, the **exosphere** stretches out into the vast regions of space.

The hydrosphere

Water is life's most important resource. Plants and animals rely on water for survival. Many animals live in the water. The **hydrosphere** encompasses all forms of water in the Earth's environment. This includes the oceans; all water found on the Earth's surface such as lakes, rivers, snow and glaciers; water under the Earth's surface; and water vapour found in the atmosphere.

Much like the gases in the atmosphere, the water in the hydrosphere is always in motion. We can see the flow of rivers and streams and the waves at the beach. The middles of oceans and lakes also move due to wind and temperature changes, which create currents.

The hydrosphere formed in conjunction with the atmosphere. About 3.6 to 4.3 billion years ago, there were many hot molten rocks containing water and gases. When the rocks cooled down and released hydrogen and water vapours into the air, the atmosphere was formed. The water vapours condensed to form clouds. Precipitation fell to the Earth and the hydrosphere was also formed. Oxygen was produced as a by-product of small organisms and plant life.

The lithosphere

The **lithosphere,** which evolved about 4.6 billion years ago, is composed of an outermost layer of hard rock. This outer rock layer is made up of the crust and the first hard layer of mantle. The lithosphere includes various landforms such as mountains and valleys, as well as rocks, minerals and soil. The lithosphere is constantly being shaped by external forces such as sun, wind, ice, water and chemical changes.

There are many different types of rocks that compose the outer crust. These rocks can be grouped into three basic categories based on how they are formed.

1. **Igneous rocks** are formed by the cooling of hot molten rock (magma). When the hot, flowing magma cools, it begins to harden. Once completely cooled it is then an igneous rock.
1. **Sedimentary rocks** are formed from pre-existing rocks. Rocks erode, mix with other dirt, clay and particles and settle together. This mix creates a sedimentary rock.
1. **Metamorphic rocks** are formed by heat and/or pressure from pre-existing rocks.

The lithosphere does not wrap perfectly around the Earth. It is in fact about 15 different pieces of crust that sit on top of a softer layer called the **asthenosphere.** These tectonic plates drift around on top of the asthenosphere and are moving, though too slowly for the human eye to notice. As a result of the plate movement, mountains become taller and valleys grow wider. Scientists believe that the continents, which rest on the various plates, were at one point joined in a single 'super continent' known as **Pangaea** (refer to Topic 2, Chapter 4).

The Earth's surface is composed of the two types of lithospheres: the oceanic and the continental. The **oceanic lithosphere** includes the uppermost layers of mantle topped with the thin but heavy oceanic crust. This is where the oceans of the hydrosphere meet the lithosphere. The **continental lithosphere** includes the uppermost layers of mantle topped with a thick, lighter continental crust. This is where the atmosphere, biosphere and the hydrosphere meet the lithosphere.

The biosphere

The three previous spheres - the atmosphere, the hydrosphere, and the lithosphere - are the **abiotic**, or non-living, parts of the biophysical environment. The fourth sphere, the **biosphere**, includes all **biotic**, or living, parts of the biophysical environment. The biotic elements include all plants and animals.

All life exists in the biosphere. The biosphere cannot survive without elements from all the other spheres. Plants and animals need water from the hydrosphere, minerals from the lithosphere and gases from the atmosphere. The air, water, and land provide homes for all the various forms of life.

The **environment** contains all the factors that surround and influence the biotic and abiotic things within it. The environment is our surroundings. Each living thing within the biosphere inhabits and interacts with the things that surround them. This is their biophysical environment. It is in this environment that we find ecosystems. An**ecosystem** is a smaller function within the environment. It is the unique interaction between the living and non-living elements. An ecosystem is a community functioning together as one unit.

Water

Important terms		
	condensation	convergent
divergent	evaporation	evapotranspiration
groundwater zone		
infiltration	precipitation	saturated
surface run-off	transpiration	water deficiency
water surplus	water table	water vapour flux

History of Water in the Detroit area

Prior to 1610, Detroit was the dominion of Native Americans. Although there were various settlements in the area, the first formal, permanent settlement of Detroit occurred on July 24th, 1701, by French explorer Cadillac. He named it Fort Pontchartrain (after a French Count and politician). In 1751 the name was changed to Fort du Detroit. In 1760 the British took control, and on July 11, 1796 Colonel Hamtramck claimed the city for the United States.

Early residents dipped their buckets in the Detroit River for their water supply. Water was plentiful, people were few, and concerns for hygiene and waste byproducts nonexistent. It was a system that worked… for a while. On June 11, 1805 a major fire (called the Great Fire in most history texts) was the major factor that drove the public to demand a public water system. After the fire, Judge Woodward came up with plans that we have for the layout of Detroit today. However, as Judge Woodward was rather unpopular (he loved to drink and hated to bathe were the most common descriptors he was given), it wasn't until the British occupation in the war of 1812 that reconstruction really happened.

At that time, the city created a system of wells around the town to give people water (and fight fires, which was the main driving force), but these wells dried up in the summer (main fire hazard time) and were shortly abandoned as people returned to the more reliable river. It wasn't until Michigan Governor Cass, on August 5th, 1824 passed a law and a 1 dollar per year tax to Detroit Residence, that a water system such as we know it today was constructed, with water mains (originally constructed out of hollow wooden pipes – not any wood though, Tamarack trees were used exclusively) soon thereafter allowing water to be pumped into individual homes and businesses. Of interesting note; it wasn't until 1836 that Detroit constructed its first sewer.

What is water?

Earth is called the **Blue Planet** because of the way it looks from outer space. About 70 percent of the Earth's surface is covered with water. The majority of this water, about 97 percent, is stored in the salty oceans. Freshwater is contained in frozen form such as glaciers, in liquid form such as rivers, and as groundwater as well as in vapour form such as clouds. Water is made of two gases: hydrogen (H) and oxygen (O). When two hydrogen molecules combine with one oxygen molecule, the result is water (H_2O).

$H + H + O = H_2O$
Water is unique in that it can take three different forms:

1. **Solid** - Water freezes at 0ºC. It is found as snow, ice and hail; along with glaciers at the north and south pole.
2. **Gas** - Water boils at 100ºC. Water vapour is found as steam, fog and clouds.
3. **Liquid** - In between 0ºC and 100ºC water is liquid. This is the water we use every day for drinking, bathing and cooking, as well in industry and agriculture. It is the water in the oceans, rivers, and underground.

The hydrological cycle

The hydrological cycle is the constant flow of water throughout the environment. The amount of water within the hydrological cycle is consistent and it is always in motion. Water is stored in various places, the largest being the oceans. Both freshwater and saltwater enter the atmosphere through a process called **evaporation.** Evaporation occurs when the sun's rays warm the surface of the oceans and lakes. Water vapour forms and rises into the atmosphere. Another way that water moves into the atmosphere is through a process called **transpiration.** Transpiration is essentially plants 'sweating' through their leaves. Together, these processes are called **evapotranspiration**.

Warm air cools when it rises into the atmosphere. Cool air holds less moisture than warm air. Water vapours in the atmosphere attach to each other. This is when **condensation** occurs and clouds are formed.

When a cloud is saturated, **precipitation** occurs. Precipitation is the process of water returning to the Earth's surface from the atmosphere. This is most commonly seen as rain or snow but fog and dew are also forms of precipitation.

Once water is precipitated back to the Earth's surface, it is distributed into the lakes and oceans through **surface run-off** and **infiltration.** Run-off is the flow of water over the land. This generally occurs when the soil is completely saturated, or on surfaces that are unable to readily absorb water, such as pavements. Infiltration is the absorption of water into the ground. Some water stays in the top layers of soil, while the remainder continues to the **groundwater zone**. Groundwater is stored under the surface, or travels to join another body of water.

Water around the world

It is estimated that each person requires an average of 80 liters (about 21 gallons) of water per day to maintain a healthy lifestyle. The actual distribution and use of water, however, significantly varies between countries. While the average person in Madagascar uses only 5.4 liters of water per day, the average person in both the United States and Australia uses about 500 liters of water each day.

The **hydrological cycle** does not result in water being evenly distributed around the world. Some places receive an abundance of precipitation and others do not seem to receive enough. A **water surplus** occurs when the precipitation amount meets or exceeds the amount of water required by the natural vegetation. When the amount of precipitation does not meet the needs of the natural vegetation, there is a **water deficiency** (drought).

Evaporation and precipitation can only occur if there is water available and the temperature is warm enough. The amount of water that the air can hold is dependent upon temperature and air pressure. Warm air can hold more water than cold air. When the air is holding as much water as possible at any given time it is said to be **saturated**.

The difference between the amount of water evaporating (leaving) and the amount of water precipitating (returning) in any given area is called the **water vapour flux**. The middle latitudes generally have more evaporation than precipitation. The lower and higher latitudes generally receive more precipitation than evaporation.

NOTE: we will cover a lot more detail about water when we discuss erosion as well as pollution & resources.

Air and wind

Important terms		
atmospheric circulation coriolis effect isobars trade winds	atmospheric pressure barometer high pressure low pressure westerlies	wind inter-tropical convergence zone (ITCZ) polar winds pressure

What is air?

The air is the atmosphere around us. Air is composed mainly of nitrogen (about 78 percent) and oxygen (about 20 percent), and is constantly moving. The movement of air is called **wind.** Wind can vary in strength and direction and moves both horizontally and vertically.

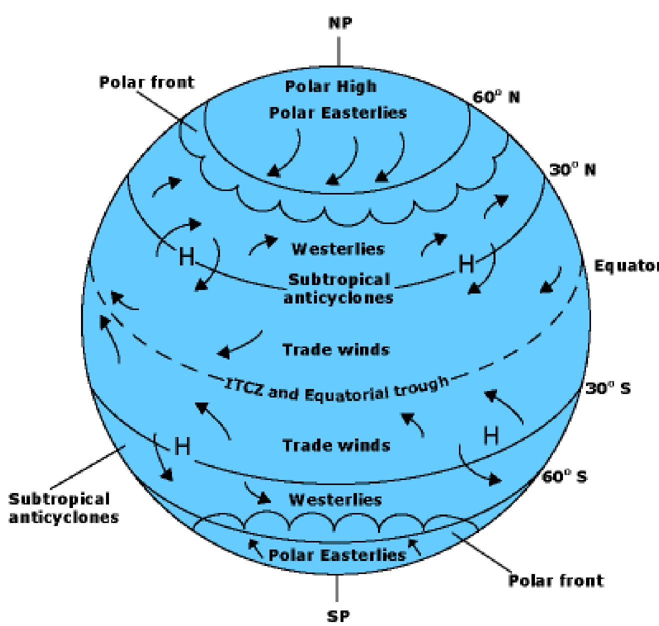
Wind moves from high pressure areas to low pressure areas. **Atmospheric pressure** is measured using a **barometer**. The amount of atmospheric pressure is expressed through **isobars** on a map. Isobars are lines that join places of equal pressure on the Earth in order to show global patterns. Stronger winds are depicted with closer isobars, whereas lighter winds are depicted with more space between the isobars.

Atmospheric circulations

Atmospheric circulation is the movement of air (wind circulation and patterns. **Primary** circulations are founc a regional level. **Tertiary** circulations are found on a lo

Atmospheric circulation is controlled by six regions of winds across the globe. These regions are the same in the northern and southern hemispheres:

1. Polar Winds - north of 60ºN
2. Westerlies - between 30ºN and 60ºN
3. Trade Winds - between equator and 30ºN
4. Trade Winds - between equator and 30ºS
5. Westerlies - between 30ºS and 60ºS
6. Polar Winds - south of 60ºS



There are three main types of vertical circulation cells that contribute to the movement of air and pressure zones around the world. These cells are the same in the northern hemisphere as in the southern hemisphere. These cells interact with the six global regions of wind to create global air circulations.

1. Hadley Cell - 0º to 30º
2. Ferrel Cell - 30º to 50º
3. Polar Cell - 60º to 90º

In the global context, the equator (0°) is a low pressure trough called the **Inter-Tropical Convergence Zone (ITCZ).** It is so named because it is the zone between the tropics and is where the **trade winds** (below 30º) converge. The trade winds on either side of the equator blow towards the equator and to the east. These trade winds are heated by the equatorial region, and rise. The rise of warm air sucks more air into the ITCZ. The upward movement of warm air creates the low pressure trough along the equatorial region. This air moves towards the poles, cools, and descends at a higher latitude.

The Coriolis Effect

The Earth continually rotates on its axis. As a result of this rotation, wind is deflected from its original track. The degree of deflection increases with an increase in latitude. Because of this deflection we see the following wind pattern, known as the Coriolis Effect:

Northern Hemisphere → wind circulations are clockwise
Southern Hemisphere → wind circulations are counter-clockwise

The horizontal movement of wind is greatly affected by the Coriolis Effect. Along the lines of latitude there are **trade winds** which blow towards the east, **westerlies** which blow toward the west and the **polar winds**. The directions of these winds are further deflected to create the circulation patterns previously mentioned.

Pressure systems

Global circulations are marked by high and low pressure areas around the world. This is caused by the meeting of air masses. When air masses move around and collide with one another, a **front** is created. A **cold front** results from the advancing air being colder than the air it meets. A **warm front** results from the advancing air being warmer than the air it meets.

Warm air rises and cool air descends. This is an important feature of pressure systems. When cold air descends, it pushes the lower warmer air outward and creates **high pressure**. When warm air rises it pulls the lower, cooler air up, and creates **low pressure.**

When air masses displace each other, **depression systems** and **anticyclones** are formed.
A **depression** or **cyclone** (these are **not** tropical cyclones or hurricanes) is an area of low pressure. Due to the Coriolis Effect, air circulates around the lowest pressure point. The warm air that rises is quickly cooled with altitude. Cool air holds less water vapour than warm air, so condensation occurs and clouds begin to form. Storms are often the result.

Anticyclones are areas of high pressure. As more cool air descends it is warmed by the lower altitudes. Warm air can hold less water vapour than cold. The warmed air is dry and there are few clouds in the sky.

Note: we will cover a lot more detail about air and the atmosphere when we discuss weather and climate.

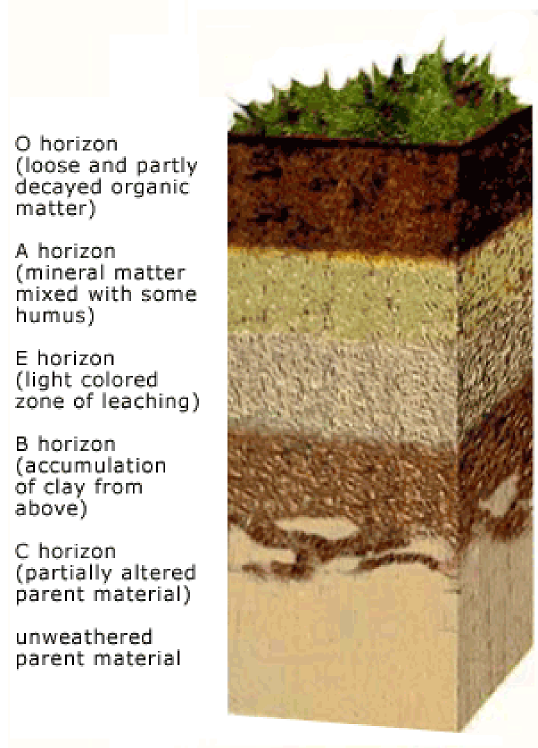
Soil

Important terms			
acidic soils	alkaline soils	bedrock	
density	eluviation	erosion	gleying
humus	leaching	parent material	ped
pore space	regolith	salinisation	soil structure
top soil	subsoil		

What is soil?

Michigan soils are either typically very sandy and gravelly, or very acidic with a lot of clay, due to our recent past (10,000 years or so) ice age and being repeatedly covered by glaciers over the past 2 million odd year time period.. Soil is a very important part of the environment as it is a link between the biotic and abiotic elements. Soils vary with different climates and regions but all are composed of three important ingredients:

1. **Solids** include pieces of weathered rocks, clay and **humus.** Humus is decayed organic material (plants and animals).
2. **Liquids** include water.
3. **Gases** include those of the atmosphere as well as gases released through activity in the soil.



If a section of well-developed soil were cut like a piece of a cake, we would be able to see the different layers within it. There are four main layers, or horizons, of soil. Horizon A is generally known as **top soil**. This is where organic matter decomposes and humus is formed. Horizon B consists of humus mixed with mineral matter. It is generally known as **subsoil**. Horizon C is the **regolith** where we can find weathered rock and rock fragments. Horizon D is the final horizon and consists of solid **bedrock** also known as **parent material.** These horizons are just a starting point. Some horizons may contain several sub-layers while others may contain none.

Soil structure

There are four main characteristics of soil:

1. **Texture** - the size and shape of the particles
2. **Structure** - how the particles are clumped together
3. **Colour** - the darker the soil, the more nutrients it contains
4. **Chemical composition** - the acidity or alkalinity of the soils.

The particles in soil help determine the soil structure. **Soil structure** is the composition of the soil including its **pore space** and **density**. The various materials that affect the pore space and density are clay, silt, sand, gravel and stone. Smaller particles trap more water in the upper regions. Coarse and less dense soils cannot hold many nutrients and water and gases can filter through with ease.

When pieces of soil join into a larger unit, it is called a **ped.** Peds help determine the soil structure based on their size and shape. There are four types of peds:

1. **Granular** - finer pieces allow for ideal flow of water and seed growth
2. **Blocky** - irregularly-shaped blocks allow very little pore space, which hinders plant growth and water movement
3. **Platy** - flat, plate-like sheets that lie horizontally allow very little pore space which hinders plant growth and water movement
4. **Columnar or prismatic** - vertical columns that are dense but allow free movement of water and soil.

Soil processes

Creation

It can take anywhere from 1 to 200 years to form a layer of soil that is about 2.5cm thick. There are four important processes that help create soil:

1. **Input** of material such as water, gases, nutrients, humus, clay, silt, and rocks.
2. **Output** of nutrients from leaching as well as material from **eluviation** when there is a water surplus.
3. **Transfer** of materials and nutrients moved up and down through the soil.
4. **Transformation** of materials through the decay of organic matter and weathering of rocks.

The rate at which soil is composed depends on several environmental factors:

1. climate
2. bedrock or parent material
3. topography (the physical geography)
4. time
5. organisms - type and amount
6. vegetation - type and amount.

There are many processes which play a role in determining the composition of the soil. Some of the processes that make soils unique include the following elements:

Humus is created by the process of dead organic (once living) material decomposing. It becomes a dark, moist substance full of nutrients.

Gleying occurs when there is a water surplus. This means that the soil has become 'waterlogged' because it cannot properly drain. This results in a lack of organic material and nutrients.

Leaching is the loss of nutrients in the top soil due to water dissolving them and carrying them out of the top layers. Soil that has been leached is lighter in colour than soil that is full of nutrients.

Leaching and gleying affect the acidity of the soil. **Acidic soils** are generally found in humid regions because of a water surplus. These are soils that have lost most of their nutrient and salt content due to excessive drainage. This makes it harder for plants to grow. **Alkaline soils** are generally found in dry regions because the lack of rainfall does not drain the salts from the surface layers. These soils may be damaging to plants.

Salinization occurs in dry, arid regions where there is little drainage. Salt is prevalent in these alkaline soils. Western Australia has some of the worst areas of salinization in the world. **Erosion***. Refer animation*

Erosion is the loss of soil material because it has been worn away by natural occurrences. **Weathering** is the breaking down of rocks and soil particles through the processes of wind, water, sunlight, ice and minerals. **Accelerated erosion** occurs when humans interfere with soil. The rate and amount of weathering and erosion depend on the precipitation, temperature, altitude and geology of any given region.

NOTE: We will go into a lot more detail on rocks and soils through the year.

Plants and animals

Important terms	
Plants	Biome, chlorophyll, endemic , flora, glucose, Photosynthesis
Animals	Biodiversity, carnivore, classifications, endangered, endemic, extinction, food web, herbivore, monotreme, omnivore, threatened

Introduction

The sections earlier explained the physical elements within the four spheres. This section will focus on the biological elements within the four spheres. The living elements of the environment are plants and animals. There are so many different types of plants and animals that scientists are constantly discovering new species. It is important to know that plants and animals are part of the biosphere. Not only do living things interact with each other but they also interact with the rest of the environment.

Flora/plants

Australia (as opposed to, say, Michigan) is a unique continent because it contains many **endemic** plants and animals. Endemic plants are those that are naturally occurring in only one certain region of the world. The **flora** of Australia is dominated by only two: the acacia and the eucalyptus. Most varieties of these two plants are endemic to Australia.

Biomes

Climate is the biggest factor in determining which plants grow where. Topography, soil type and animals are also key factors. The climate includes such factors as solar radiation, precipitation and temperature. The vegetation throughout the world can be separated into major groups, known as **biomes**. A global consensus has not been reached on the definition of a biome but it can be determined by various characteristics. The following are just some examples of global biomes. People who are familiar with the game Minecraft should be familiar with the concept of **Biome**.

The forest biome includes all types of forests such as tropical and temperate forests. There is generally the right balance between amount of water, soil and heat to create a flourishing plant life. The Amazon rainforest is a tropical rainforest that receives a lot of annual precipitation and is generally warm. Michigan was mostly forest biome prior to the European colonization, and large parts of Michigan are still covered by forests.

The desert biome has extensive water deficiency. There are few low-lying plants which are generally not close together. Temperatures are often extreme, so the plants in this biome are well-adapted to the surroundings. The large North American Sonora desert spreads from northern Mexico through the southwest United States. This is a warm desert biome characterized by stony and sandy areas as well as mesas and mountains. The Sonora desert receives more rain than any other desert biome.

The savanna is a type of grassland biome. Climate is an important factor in determining different types of grasslands. The African savanna is grassland covered with trees and has a warm climate. There are typically a wet and a dry period.

The tundra biome is extremely cold and for most of the year the temperature is below freezing. Tundra's are often characterized by permafrost. Small shrubs and grasses grow here in summer.

Photosynthesis

Photosynthesis is the process by which plants make food. This is an extremely important process for the biophysical environment. The by-products that photosynthesis produce are the products humans need to survive: water and oxygen.

To make their food, plants need **energy, carbon dioxide** and **water**. Plants receive energy from the sun, water from the ground and carbon dioxide from the atmosphere. All of these ingredients meet in the leaves of a plant. The **chlorophyll**, which we see as the green colour of leaves, uses sunlight energy to convert the carbon dioxide and water into food. This food is called **glucose** and is a carbohydrate. The waste products produced from this process includes water and oxygen.

The following is the equation that represents the process of photosynthesis:

Carbon Dioxide + Water + sunlight => chlorophyll => Glucose + Oxygen + Water
$6CO_2$ + $2H_2O$ + energy => chlorophyll => $C_6H_{12}O_6$ + $6O_2$ + $6H_2O$

Fauna/Animals

Just like plants, animals also have to adapt to their surroundings. Climate, landforms and available resources all influence and determine the types of plants and animals that will survive in specific areas. The ability to adapt to the surrounding environment is part of the process of survival.

For over 130 million years, Australia has been an isolated continent separated from the rest of the world by water. This isolation has made Australia a unique and diverse continent in terms of its native and **endemic** fauna. Egg laying mammals, **monotremes,** and **marsupials** are prime examples of the unique animal life that exists on the Australian continent.

Biodiversity

Animals are intricately linked to their communities. **Biodiversity** plays a large role. If one part of the ecosystem experiences drastic change, the change affects all part of the community. If there is a large variety of plants and animals in a specific area, and the main food source for an animal is depleted, they will have a better chance of finding an alternative. If there is low biodiversity, an animal may have to move elsewhere to find adequate food supply.

The **food web** is a simplistic way of showing the links between animals and their sources of food. This web is also referred to as a food chain. Plants, bacteria and plankton are lowest on the food web. Next are **herbivores** (plant eaters) and small carnivores. Large **carnivores** (meat eaters) and **omnivores** (both plant and meat eaters), such as tigers, bears, killer whales and humans are highest on the web.

If one link in the web disappears, it affects the whole web. As of June 2006 there were over 1,900 species of flora and fauna listed as **endangered** or **threatened.** The 1,176 animals on the list have had their numbers depleted to the point of near **extinction** because of the impact of human lifestyle and the introduction of non-native species to certain ecosystems.

Classifications

Biologists have developed a way to separate different types of plants and animals in order to better study and understand how the natural world is connected. The **classifications** are (in order of general to specific):

1. Kingdom
    - Plants, Animals, Monera, Fungi, Protista
2. Phylum

3. Class
4. Order
5. Family
6. Genus
7. Species.

Each of the classifications in the hierarchy is again divided into subunits. *Kingdom* has five in total. *Order* includes marsupials (kangaroo and koala) and monotremes (echidna and platypus).

Cats, both domestic and wild bobcats, are of the genus *Felis.* Species are very closely related but have evolved separately and cannot successfully interbreed.

Interactions

Plants and animals are constantly interacting with each other and the rest of the environment. One type of plant or animal may group with several others of its type and then form a community with the other plants or animals nearby. An ecosystem is the interaction between a community and its environment. An environment includes all the **biotic** and **abiotic** elements of the world

Organism - population - community - ecosystem - environment

Plants and animals must learn to adapt to their environments. Plants need to be particularly good at adapting because they are stationary. Plants do not have the option to move to a better place if the climate is too cold, too dry or too windy. It is for this reason that many desert plants are low-lying and spread out. It is also the same reason why ferns have developed large amounts of surface space on their leaves without much space in between the leaves. Ferns have developed so they have a better chance at catching some sunlight since they are dwarfed by the taller trees.

Although animals do have the option to move around if conditions are not to their liking, many of them still depend on plants as their main food sources. Where the plants are, the animals are. Where small herbivores are, the larger animals are also there, as seen in the intricately linked food web.

NOTE: OK, let's face it, most of this is covered in your Biology class. However, we will see how many events impact life; often with a focus on human life. We will also reflect on these ideas when we discuss pollution and environmental impacts.

Earth's Spheres Intact

In the above, we went into some good details on the four spheres. These are the **geosphere**, **hydrosphere**, **biosphere** and **atmosphere**. Together, they make up all of the components of our planet, both living and non-living. And while we can describe each individually in terms of its properties and features, you'd have a difficult time finding an example where one sphere doesn't either touch or interact with at least one other.

This is important because these interactions are what drive Earth's processes. Material on Earth doesn't stay how it is. It gets recycled into other phases and forms. Plants in the ground die, and as they are broken down by microorganisms, they become soil, which can then feed new plants. Water cycles through different phases and locations, like when it evaporates from the oceans and then rains down onto the ground or into a lake. Rock also gets recycled under Earth's surface, where it is melted down and then sent back up in volcanic eruptions.

So, now that you know why this is important, let's look at some examples of how these interactions occur between the four spheres of Earth.

How the Spheres Interact

Pretty much any event on Earth is going to involve more than one sphere. Let's look at a fairly simple example to begin with: volcanoes. Volcano eruptions are events in the geosphere because this is both rock being pushed out from under the surface as well as a change in the surface land itself.

Volcanoes also spew a lot of gas and particulate matter into the atmosphere, as well as send hot lava flowing down mountainsides, disrupting the biosphere. Water will condense around that particulate matter in the atmosphere, so now we've involved the hydrosphere as well. You can see how this 'simple' example quickly got quite complicated!

Let's look at another event to see how the spheres interact. Humans use a variety of natural resources to generate power, such as plant material, oil, natural gas, wind, water and sunlight. You can see right away that we've involved all of the spheres already, even before we started talking about how we harness these resources! We use corn for ethanol (the biosphere), oil and natural gas for heating homes and fueling cars (the geosphere) and the wind (the atmosphere) and water (the hydrosphere) for electricity.

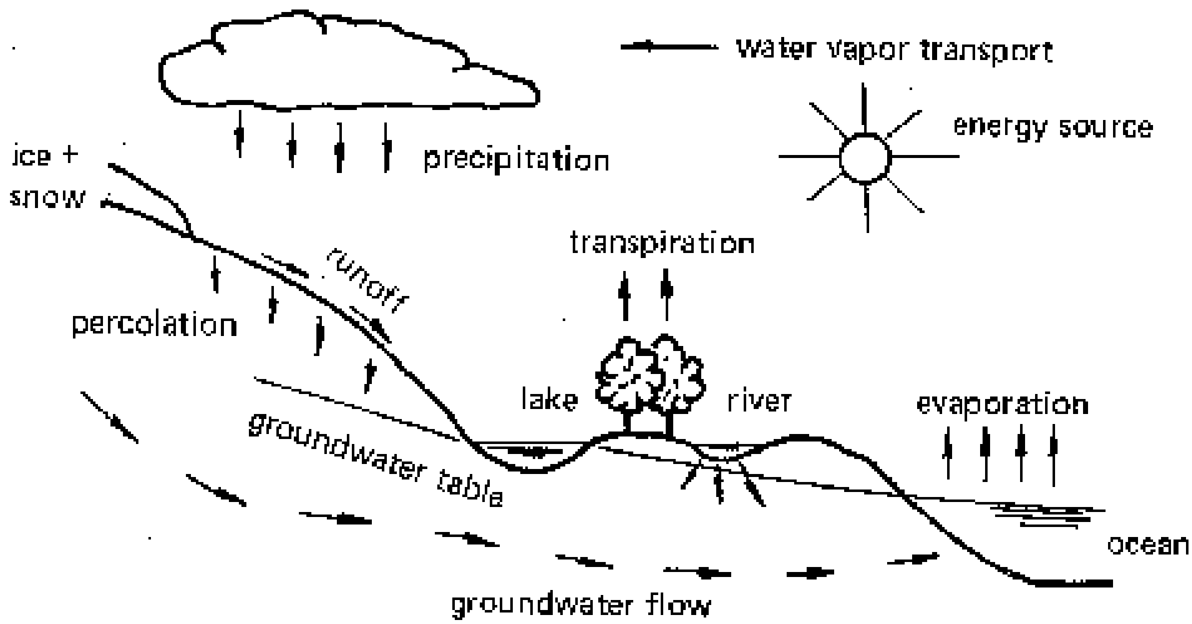
Now let's look at an example that's a bit trickier - clouds. Clouds form when water droplets condense around dust particles in the air. But wait - does this mean that clouds are part of the hydrosphere because they're water? Or does it mean that they belong to the atmosphere because they're in the air?

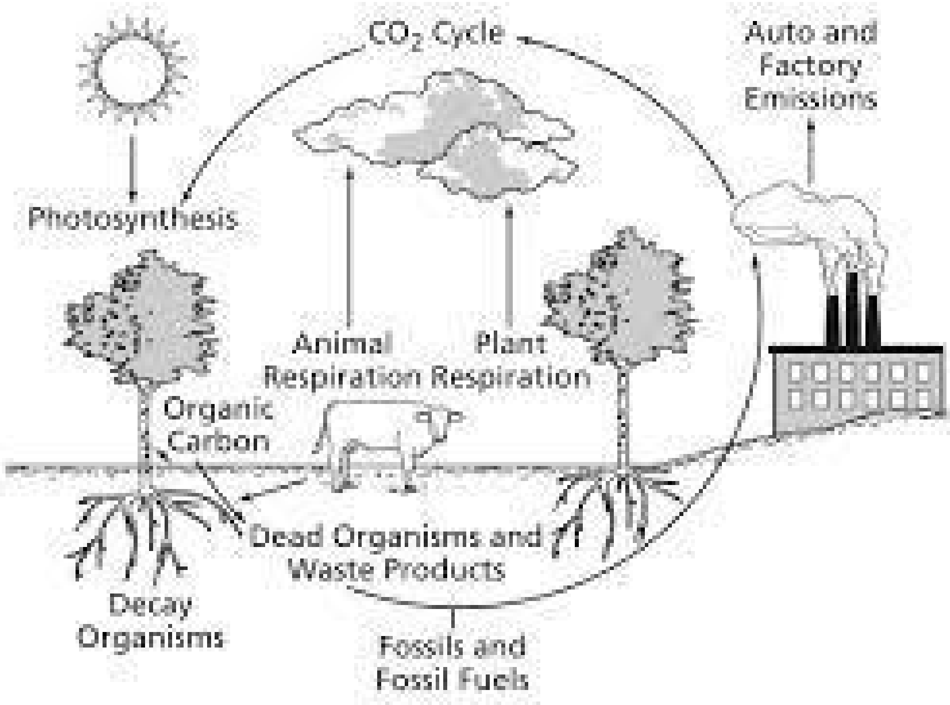
And what about groundwater? Is this part of the geosphere because it's in the ground or considered part of the hydrosphere because it's still water, no matter where it's found? Or is this part of the biosphere because the soil is also filled with living things of all shapes and sizes?

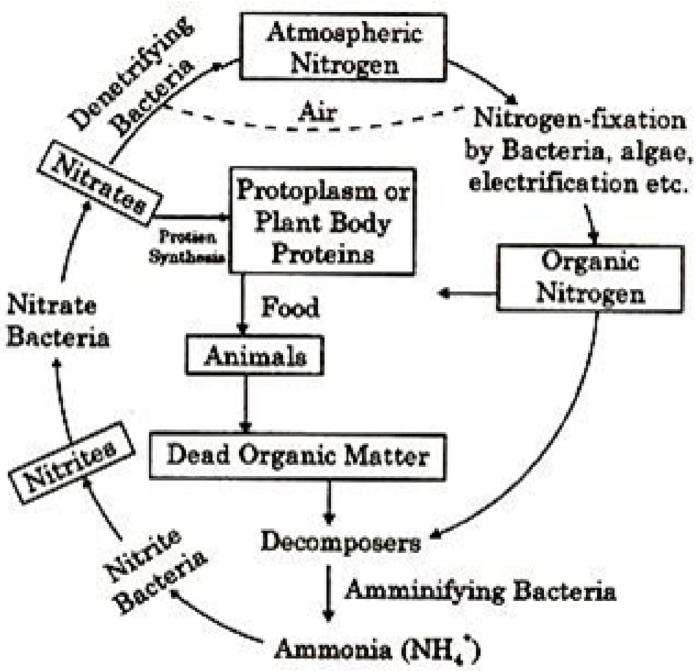
The Cycles

Important terms	
Rain/Water Cycle	Evaporation, Transpiration, Condensation, Precipitation, Run Off, Infiltration
Carbon Cycle	Respiration, diffusion, photosynthesis, fossil fuel
Nitrogen Cycle	Denitrification, decay, nitrate, nitrite, ammonia, nitrogen fixing, fertilizer, plant & animal
Rock Cycle	Metamorphic, Sedimentary, Igneous, pressure, erosion (aka weathering), deposition, magma, sediment, heat

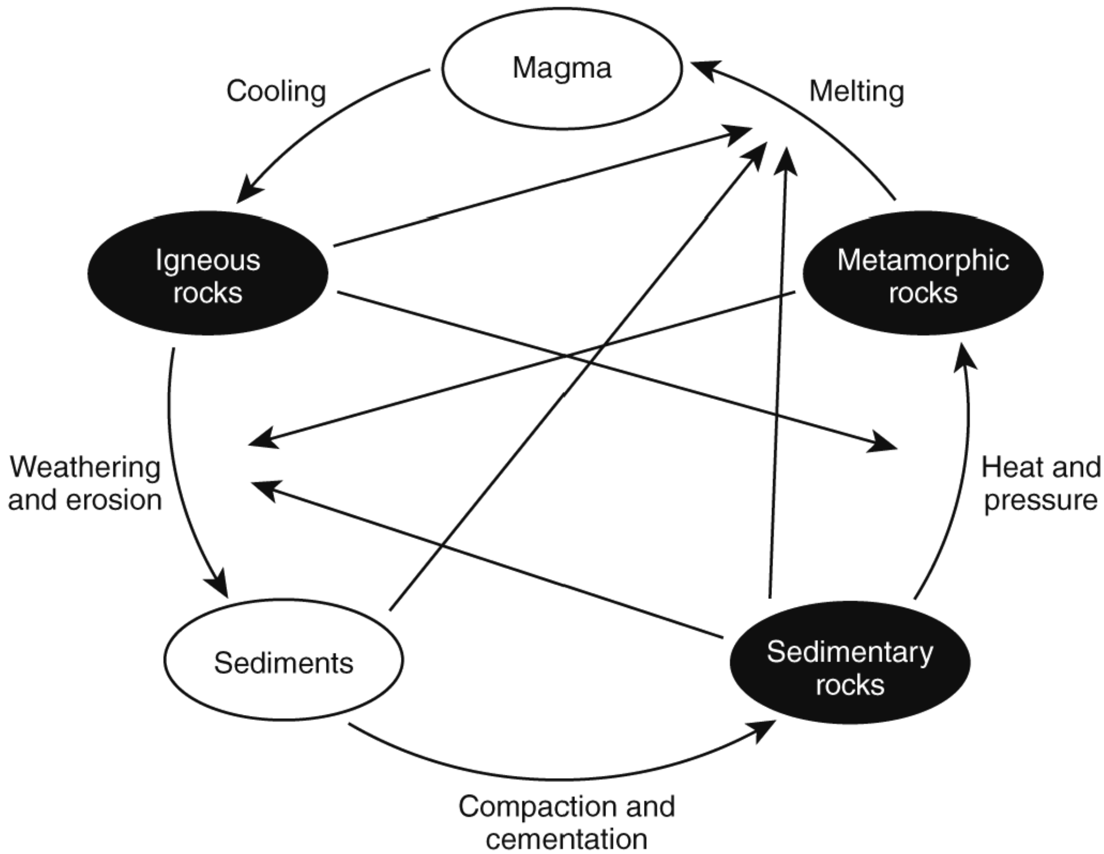
So, the above 4 cycles are not the only cycles here on planet earth, but these 4 are what are generally considered the most common ways of showing the interactions between the various spheres. I personally find it easier to understand the relationships of these cycles by looking at diagrams. However, if you are not sure of the difference of, say, nitrate and nitrite, than looking at some diagrams might not mean as much to you as it should. You will, through the course of the year, be expected to memorize two of these cycles and be able to reproduce them – the rain (often called water) cycle and the rock cycle. Chances are you memorized the carbon cycle in biology, and at least discussed the nitrogen cycle there.


water vapor transport
energy source
precipitation
ice +
snow
transpiration
runoff
percolation
lake
river
evaporation
groundwater table
ocean
groundwater flow





Nitrogen-Cycle


Magma
Cooling
Melting
Igneous rocks
Metamorphic rocks
Weathering and erosion
Heat and pressure
Sediments
Sedimentary rocks
Compaction and cementation