

## INTRODUCTION

### I. Course Information

**LIVING PLANET** is a self-paced course based on a series of twelve video episodes produced by the BBC and narrated by David Attenborough. This study guide has been written to guide you through the class.

**LIVING PLANET** is an overview of world ecology. Over the course of this semester, you will be introduced to several ecosystems, such as deserts, grasslands and mountain peaks. David Attenborough, the narrator, discusses where these ecosystems are found and the features of each. He also examines the plants and animals that are found there and discusses any special adaptations that allow them to be successful.

**The video episodes have been divided into 6 units.** Each unit consists of two videotapes and the corresponding material in the study guide. Read the material in the study guide (CONCEPTS) before watching the tape. There is additional information on certain issues that will be discussed in the tape. As you watch the tape, look for examples of these concepts. The exam questions are based on **all** material covered in this study guide.

There are **twelve video episodes** in **LIVING PLANET**. As a general rule, one ecosystem is discussed in each episode. For example, Episode 3 discusses the different types of temperate forests -- coniferous forests and broad-leaved forests. Attenborough discusses the location of the coniferous forests, the climate and the characteristics of conifers that allow them to survive under these conditions. He then discusses conditions and characteristics of broad-leaved forests.

As you watch the tapes, pay close attention to the characteristics of each ecosystem. Look for the problems that face organisms and different ways plants and animals have **solved** the problems. Look for **adaptations** (changes) that have occurred in the organisms.

Remember, this is global ecology. You should know where these ecosystems are found and any differences between similar ecosystems. For example, where are the coniferous forests located? How are they different from broad-leaved forests? Where are the broad-leaved forests found? What are the differences between coniferous forests of Europe and coniferous forests of North America? Are there any differences between different types of broad leaved forests?

Don't just ask **how** they are different. Start asking **why** they are different. Are the differences due to temperature? rainfall? altitude? Does one desert get more rainfall than another desert? Does one grassland have better soil than another?

## **SPECIFIC INFORMATION**

Specific information about the course will be discussed in the instructor's syllabus. You will be given a syllabus during orientation. You are required to complete an orientation session, whether online or in person.

## **ADDITIONAL REFERENCES**

If you need or want additional information about topics covered in this course, don't forget to use the ACC Library. Ecology books will have information on ecological principles. Geology books will discuss fossils, volcanoes, volcanic islands and continental drift. On reserve at many ACC Libraries, you will find David Attenborough's companion book, *Living Planet*. His book can be a very valuable resource for students. Ask for help from the instructor or a reference librarian. Many students have bought the book *Living Planet* from online sources, such as amazon.com or barnesandnoble.com. If you have problems understanding his British accent, you might find the book to be very useful.

Many people have problems with world geography. If this is true for you, you are not the only one. Apparently, most Americans cannot pick out which continent is Africa, much less know where to find the Himalayas or the Hebrides. Don't despair. There are many world atlases in the ACC Libraries. There is also an excellent map in the back of Attenborough's book, right before the index. Use them. You will have a much clearer mind picture of where deserts or mountains or grasslands are located.

Throughout this study guide, we refer you to recent articles from magazines such as *National Geographic*. These magazine articles are pointed out because we feel they would supplement the material in this course. It is not mandatory that you read these articles. However, if you want additional information, these are a good place to start.

A former student sent this great web site that is cosponsored with the National Geographic Society. It features an interactive map of the terrestrial ecoregions of the world, many of which you will visit in this course with David Attenborough. One feature of the site is images from the various areas as well as information on the region. We highly recommend it to you:

<http://www.nationalgeographic.com/wildworld/terrestrial.html>

## **II. Geography**

This section contains some basic information you need to know about geography to understand the material presented in the Concepts and in the Video Episodes. Many of the features are illustrated on Maps 1 and 2 below. You can use the blank world map on page ii to practice identifying some of the features described here.

## A. Global Terms

1. Equator - an imaginary line around earth midway between poles
2. Poles (North Pole and South Pole) - the northern and southern-most points on the earth
3. Longitude - units of east-west measurement around the earth. These are the **vertical** lines.
4. Latitude - units of north-south measurement around the earth. These are the **horizontal** lines that go around the earth. The location is always given as latitude first, then longitude.
5. Hemisphere - half of the earth (north/south or east/west)
6. Axis - an imaginary line running through the earth between the poles
7. Rotation - movement of the earth around its axis
8. Revolution - movement of the earth around the sun (orbit)

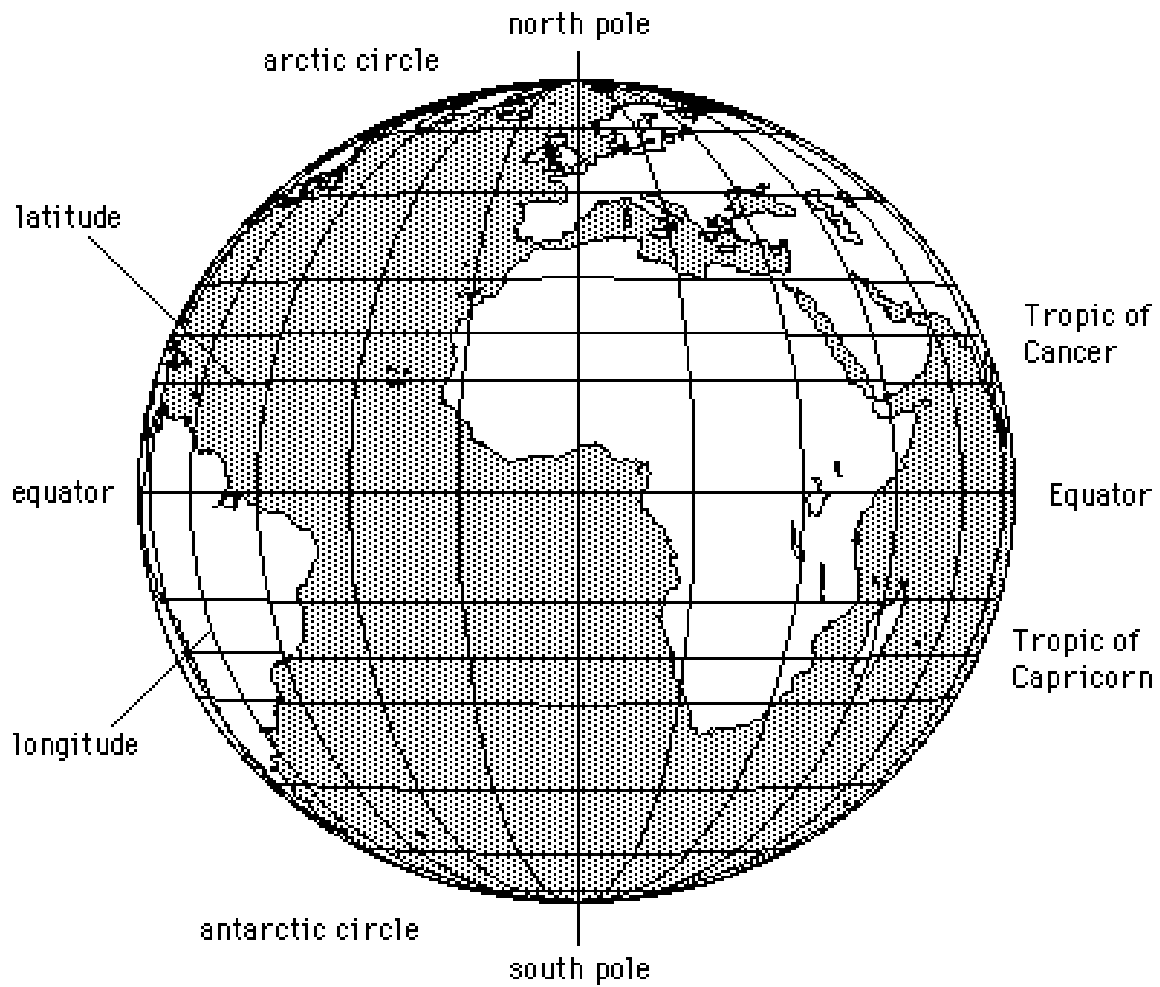
This is a simple but useful website that explains latitude and longitude:

<http://geography.about.com/cs/latitudelongitude/a/latlong.htm>

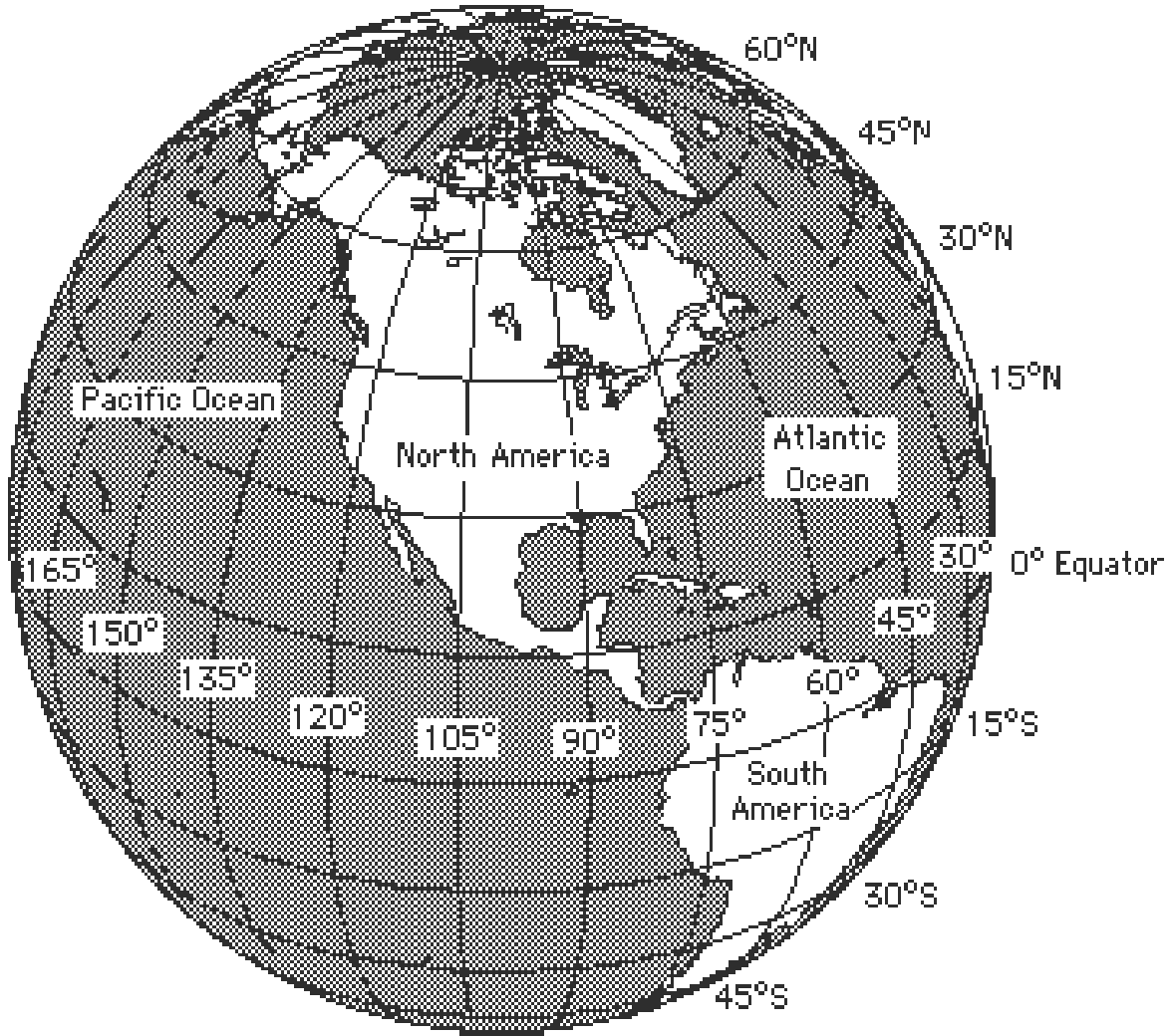
## B. Physical Geography

1. Continent - a large land mass (there are 6 continents: Africa, Antarctica, Australia, Eurasia, North America, South America)
2. Ocean - a large body of salt water (there are 5 oceans: Atlantic, Antarctic, Arctic, Indian, Pacific)
3. Sea - usually refers to a body of salt water, smaller than and often more shallow than an ocean (examples: Baltic, Caribbean, Mediterranean)
4. Atmosphere - the air above the surface of the earth
5. Altitude - height of an object above the average level of the oceans (mean sea level)

# The Earth Map 1



# The Earth Map 2



### III. Biogeography

#### A. What is biogeography?

**Biogeography** is a branch of science that attempts to explain the distribution of species on the earth. In the broadest sense, it not only explains why each currently living species is located where it is, but also reaches back in time to explain why extinct species lived where they did and why they don't live there any more. Biogeographers also use principles they have learned from living and extinct species to make predictions about the future distribution of species or about when a species might become extinct. Biogeography looks at many different factors to find explanations for species distribution: physical conditions, evolutionary history, barriers and species interactions. These factors can usually explain why one species lives in one place and not everywhere on the earth.

Think about what the earth would be like if species distribution were random, if none of the factors mentioned above had anything to do with where a species lives. We could simulate a situation like this by putting the names of all species on pieces of paper and putting them in a box. Then for each type of habitat, we would pull out a certain number of slips of paper that would determine what species would live there. We might get polar bears in the tropical rain forest, orchids on the tundra, oak trees on the bottom of the ocean, or whales on the prairie. An even more general approach would be to distribute all species everywhere. But these approaches show us what we already know--that living things cannot survive just anywhere. Whales can die when out of the water for even a few hours, so they would never survive on land. On the other hand, trees wouldn't do well on the bottom of the ocean where there is no light for photosynthesis.

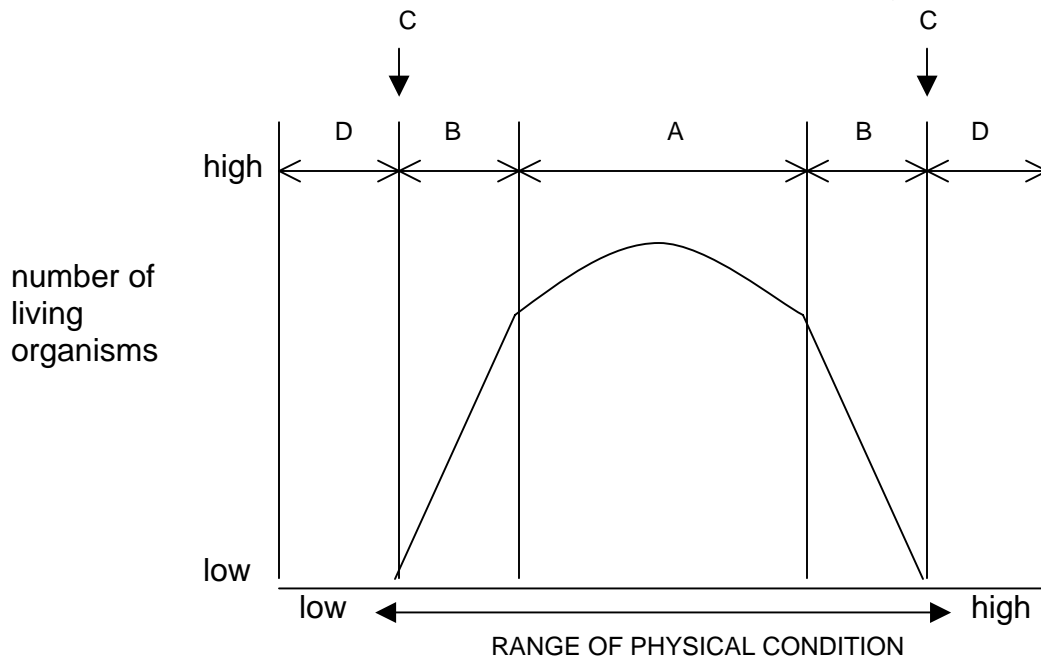
The basic theme of the Living Planet video series, and of this course, is examining the reasons behind the distribution of plants and animals on the earth. The approach taken in each episode is to look at a habitat like desert or grassland and to examine some of the adaptations that allow species to survive there. This part of the study guide will explain each group of factors in advance so that the examples seen in the videos will make more sense. **Physical factors** such as temperature, light and moisture (for terrestrial organisms), or salinity, light and water pressure (for aquatic organisms) are one of the main things that determine where on the earth a species can survive (section B.). Over the millions of years of the earth's history, the continents have been moving around, changing the climate of the land masses and joining or separating bodies of water. As the land masses moved, they took species with them, altering their previous distribution (section C1.). Species distribution is also determined by where a species could spread, or disperse, from its point of origin. Dispersal of a species has been limited by barriers like rivers, mountain ranges, glaciers and oceans (section C2). Interactions between species may have one of two effects on species distribution. If one species competes with another, one or both of their ranges is likely to be smaller than the range determined by physical conditions and barriers alone. On

the other hand, if one species depends on another, we are likely to find them always in the same place.

## B. Physical Biogeography

### 1. Tolerance

Each species on the earth has a range of physical conditions within which they can survive that can be called their tolerance zone. This zone can be described for many physical factors (like temperature or pH) by a tolerance graph:



- A. **optimal range** - range of physical factor within which most individuals survive
- B. **stress zones** - zones at ends of optimal range in which very few individuals survive
- C. **tolerance limits** - upper and lower limits beyond which no individuals survive
- D. **lethal zones** - zones outside of tolerance limits where no individuals survive

The optimal zone is the range of a physical factor (like temperature) within which most individuals of a species can not only survive but also thrive. Most members of a species live on a part of the earth that has physical conditions that are within the species' optimal range. Just above and below the optimal zones are regions in which the physical conditions are not optimal, but in which some individuals of the species would still be able to survive. These are called stress zones because they cause some form of physical stress in the organisms living under those conditions.

Let's look at a specific example, a plant. This plant species has an optimal temperature range of 15 to 25 degrees Celsius ( $^{\circ}\text{C}$ ). At temperatures above  $25^{\circ}\text{C}$ , the heat causes the plant to lose more water by evaporation through its leaves than it can

replace through its roots. Its leaves wilt, and photosynthesis (the process by which the plant uses solar energy to make food for itself) stops. If the plant is in these conditions for long enough, it will make less food than individuals of the same species that are living in their optimal temperature zone. It will not be able to grow as fast, and may not be able to make flowers or seeds at all. At the other end of the temperature range, individuals of this species living in regions where the temperature is cold (less than 15°C) have other problems. The cold slows down chemical reactions in their cells, making photosynthesis, growth, and reproduction slow down also. In this case, the plants living in cold regions have the same end result as plants living in hot regions. Many individuals of this species will not be able to tolerate the stress caused by either heat or cold, and they will die. Even if they don't die, they won't make as many seeds as individuals living in the optimal temperature zone, and fewer seeds means fewer individuals in the next generation. So the number of living individuals in the stress zones is always smaller than the number living in optimal conditions.

Going back to the graph, the tolerance limits are the absolute limits above or below which NO members of the species could survive. Outside of the tolerance limits are the lethal zones, where no members of the species can live. For the plant, if the upper tolerance limit for temperature is 30°C, any plant subjected to that temperature for more than a few minutes or hours would die.

Tolerance is the most basic factor that determines where on the earth a species can live. The other factors (evolutionary history, barriers, species interactions) can limit a species' distribution even more, but they can never allow a species to live outside of its tolerance limits. Because of this, we can make a general statement that the greater the tolerance range, the larger the geographical area over which the species is distributed.

## 2. Limiting Factors

A limiting factor is any condition or factor that exceeds an organism's tolerance range. Depending on where it lives, each species is subject to several limiting factors. For terrestrial organisms (species that live on land), the limiting factors are usually climate (temperature and precipitation), light, soil structure and nutrients. Other factors such as oxygen level in the atmosphere and periodic fires are more specific limiting factors for some species. Aquatic organisms (those that live in the water) are limited by salinity, temperature, current, pH, dissolved oxygen, light, and water nutrient level. Altitude affects not only temperature (see below) but also the level and timing of precipitation.

The physical characteristics of an organism's environment (temperature, pH, light, etc.) are called abiotic factors. But the environment also contains biotic (living) components. The biotic components include all living organisms found in a particular region. This includes cyanobacteria (or blue greens), bacteria, algae, plants, fungi and animals. The living organisms have important roles in an ecosystem. Bacteria and fungi are **decomposers**, responsible for breaking down urine, feces, dead wood, fallen

leaves and carcasses into their smallest components. This process returns nutrients (such as carbon, oxygen, iron, nitrogen, potassium) to the environment so the nutrients can be reused. **Producers** include plants, cyanobacteria, algae and other organisms that carry out **photosynthesis**, using water, carbon dioxide and the energy of sunlight to produce food. **Herbivores** are animals that get their food by directly eating the photosynthesizers. Other animals are **predators**, eating the herbivores.

In many cases, the types of plant life will determine the types of animals found in an area. If an animal such as a fox squirrel needs acorns and nuts to survive winter, you will not find fox squirrels living in the desert where the plant community is composed of cacti.

The video episodes will tell you about how organisms live under different physical (abiotic) conditions. But for the most part they won't tell you why those particular conditions exist in specific regions of the earth. That's the purpose of the next section.

### 3. Physical Conditions that Affect the Distribution of Species

- The distribution of terrestrial (land-living) species is affected mainly by climate and soil characteristics:

#### a. Climate

Climate has two main components: temperature and precipitation. Both of these vary in different parts of the earth due to several factors, although not necessarily the same factors for both. Ocean currents and wind patterns modulate basic temperature and precipitation patterns, mostly by redistributing air and water.

- **Temperature**

Temperature limits the distribution of species because if it is too low it lowers an organism's metabolism too much for it to maintain cellular activity. In extreme cases, the formation of ice crystals inside cells when they freeze damages the cell so that even if it thaws out, it cannot survive. On the other hand, temperatures that are too high cause damage to proteins in the organism's body, a condition that can also be fatal.

Because temperature varies daily and seasonally in many parts of the earth, the species that live there have to be able to tolerate a range of temperatures.

The temperature in any given place on the earth depends mainly, but not exclusively, on its latitude and its altitude:

- ***Effect of Latitude on Temperature***

As you move either north or south away from the equator, two things happen to make the temperature decrease:

- 1) solar radiation is spread over a larger area due to angle of incidence of solar radiation
- 2) solar radiation has to pass through more of the atmosphere before it hits the earth's surface

- ***Effect of Altitude on Temperature***

As you move up from mean sea level, the temperature generally decreases. This is because as you go higher, the atmospheric pressure decreases, which means the air is less dense (there are fewer molecules per liter), and that means that the molecules of the air cannot hold as much heat.

- ***Effect of Ocean Currents on Temperature***

Ocean currents are defined as the movement of surface water caused by the rotation of the earth and the action of wind on the water. The currents affect air temperature in coastal more strongly than inland areas. The Gulf Stream is a current in the North Atlantic Ocean. It sweeps downward past Africa, then turns when it reaches the equator and moves westward towards South and Central America. Those land masses in turn deflect the current northwards along the eastern coast of the United States. From there it continues eastward across the Atlantic towards Europe, which deflects it southwards past the coast of Africa. It makes a big clockwise circle in the North Atlantic Ocean. As it flows along the equator, the water warms up. Later, when this warm water moves along the eastern coast of the U.S. and past Europe, it gives up some of the heat. The climates of the coastal areas that are passed by the Gulf Stream are much warmer and more mild than they would be expected to be based only on their latitude and altitude.

Another example is the Humboldt Current. It carries cold polar water from the Antarctic up past the western coast of South America. The effect there is to make the climate cooler than would be expected based on latitude and altitude.

- **Precipitation**

Precipitation is the amount of rain, snow, sleet or any water that falls from the sky. In many parts of the earth, there is seasonal variation in the amount of precipitation (such as wet in the winter but dry in summer) or the form of precipitation (snow in the winter and rain in the summer). Here are some of the factors that determine how much precipitation a given area of the earth receives:

- ***Effect of Latitude on Precipitation***

At the equator the sun has its greatest effect and it heats up the air, which rises. It also evaporates water from the planet's surface into the air. As the air rises, it cools off. When it cools off, the moisture condenses into larger droplets of water and falls back onto the surface as rain. Therefore, areas close to the equator have high rainfall.

The air, which is much dryer now, continues to rise and is forced to turn north or south. At about 30 degrees north and south of the equator, the cool, dry air descends back towards the surface. This is called a subsidence zone. Most of the deserts of the world lie near 30 degrees north or south because of the dry air.

Solar energy creates three of these circular air movement patterns called convection cells in each hemisphere--north and south. But only the cell nearest the equator (the one described above) is used as an explanation for climate later in this book.

- ***Effect of Rain Shadows on Precipitation***

Rain shadows exist in areas where mountain ranges block the prevailing winds coming inland from the ocean. For example, on the west coast of North America the wind is coming from the west across the Pacific Ocean. As air moves over the ocean it picks up evaporating water. Soon after this moist air reaches the mainland, it runs into mountain ranges. To get past the mountains, the air has to go over them. This cools the air, and a lot of the moisture in the air condenses and falls as rain on the windward side of the mountain range (windward means the side the wind is coming from). The air that gets over the mountains is very dry, and it usually causes dry conditions and even deserts on the leeward side of the mountains (leeward means the side away from the wind). Thus we have a lush temperate rain forest on the coast of Washington and Oregon, and farther inland on the other side of the mountains there are very dry conditions, almost like a desert.

- **Wind**

Wind – the movement of air – is responsible for the redistribution of heat and moisture in the atmosphere, so it has an effect on climate also. Surface winds between the equator and 30 degrees latitude flow towards the equator. In the temperate zone (30 to 60 degrees) surface winds flow away from the equator. And in the polar zones they flow towards the equator again.

If this were the only factor affecting wind direction, most parts of the world would have northerly or southerly winds most of the time. There is another important force that alters the patterns caused by convection currents. It is called the Coriolis effect and it is caused by the earth's rotation acting on the northerly and southerly winds. It causes surface winds going south to be deflected slightly to the west, and surface winds going north to be deflected towards the east.

## **b. Soil Characteristics**

You may be wondering why soil has anything to do with the distribution of animals. The effect is indirect: plant species only grow in areas where both climate and soil conditions are appropriate. Because animals need plants for food and sometimes shelter, animal distribution depends on plant distribution. So both plants and animals are affected by soil conditions.

- **Nutrients**

Nutrients are materials used for growth and maintenance in living things. In terrestrial systems, plants get their nutrients from soil, and animals get their nutrients from plants. The major nutrients that plants require from the soil are nitrogen, phosphorus and potassium (they get other chemicals such as carbon and oxygen from the air). Plants also need several trace minerals such as calcium, iron, magnesium, etc. The nutrient content of soil depends largely on the mineral content of the rocks it is made from (limestone, granite, basalt, etc.). Some types of rock have very high or low levels of some minerals, so soil based on them might be deficient in one or more nutrients. This in turn would limit the types of plants that could survive in that soil.

Most nutrients from the soil that are taken up and used by plants eventually end up being returned to the soil by decomposition after the plant (or the animal that ate it) dies. Sometimes the return of nutrients to the soil is speeded up by fire (Unit 2). You will learn about the carbon, nitrogen, and phosphorus cycles later in the course.

- **Particle Size and Shape**

The mineral component of soil comes in different sizes and shapes. Sand consists of large rounded particles. It drains well but does not hold water. So after a rainfall, the soil dries very quickly. Clay is made of small flat flakes. Because of the way these particles fit together, clay soils do not drain well, but they do hold water. Silt is very small, fine particles and has a moderate ability to drain and also to hold water. Many regions of the earth have soils that are various combinations of sand, clay and silt. Some regions have predominantly one or another of these particle types. Many plants are adapted to a specific type of soil because of its drainage and water holding characteristics in addition to its nutrient content.

- **Organic Content**

The organic material of soil consists of dead plants and animals and animal feces in various stages of decomposition. Organic material in the soil serves as an additional source of nutrients for plants, and also adds to the water-holding capacity of the soil.

- The distribution of aquatic (water-living) organisms is affected by light, temperature, nutrients, salinity, water pressure, and oxygen levels. Marine organisms (organisms

that live in the oceans) are also affected by currents and tides. Most of these factors will be discussed in detail in units 4, 5 and 6.

- Whether they are terrestrial or aquatic, the presence of certain chemicals can be a real challenge for organisms. For example, many plants cannot live in a soil that has a high salt content. Many animals cannot live in salt water.

## C. Historical or Evolutionary Biogeography

Physical factors are not the only things that affect the distribution of species on the earth. The location of the continents and how they were connected to each other has affected the distribution of species both on the land and in the oceans. To get some background, we need to look at the mechanisms that have been changing the location and connections of the land masses and oceans.

### 1. Plate Tectonics and Continental Drift

- The crust of the earth is not one solid mass, but is divided into sections called "plates". The crust sits on the mantle, which is made of molten (liquid) rock. The crust is much cooler than the mantle, so the molten rock that is next to the crust cools down and sinks down into the mantle. At the same time but in different places, hot molten rock from lower regions of the mantle rises towards the crust. If it cannot go through the crust, it is forced to flow underneath the crust and creates currents. Friction between the mantle and the crust moves the continental plates in the direction of these currents. This movement is called continental drift.

You can see a simulation of this process at:

<http://www.scotese.com/newpage13.htm> ("Continental Drift Animations") or <http://www.pbs.org/wgbh/aso/tryit/tectonics/intro.html>

- The continents move as a result of plate tectonics. Where two plates are moving towards each other, either one dips below the other (subduction), or they collide, pushing upwards to form mountains. Subduction usually is accompanied by volcanic activity. In areas where two plates are moving apart, magma rises through the rift and solidifies, adding new crust. Over millions of years, continental drift has caused 1) land masses and oceans to separate and rejoin, 2) mountain ranges to be formed and 3) volcanic islands to be formed. These processes will be described in more detail in Unit 1.
- About 250 million years ago (MYA), the earth's land masses were all stuck together in a supercontinent called Pangaea. Continental drift split and rejoined the land masses several times over those 250 million years. The series of boxes below shows the approximate sequence of events that separated them:

250 MYA	Pangaea						
150 MYA	Laurasia			Gondwana			
100 MYA	North America	Eurasia	India	South America/Africa		Antarctica/Australia	
now	North America	Eurasia		South America	Africa	Antarctica	Australia

India eventually moved north and joined with Eurasia. It is still pushing against the Eurasian continent, forming the Himalayan mountains. South America and Africa were split apart and are still being pushed away from each other by the Mid-Atlantic Ridge. You will learn more about these events in Unit 1.

## 2. Species Distribution

If evolutionary history were not a factor in the distribution of species, then we would expect to find each species everywhere there is appropriate habitat. For example, there is penguin habitat in the Northern Hemisphere, but no penguins occur there naturally. There is sloth habitat in Africa, but no sloths (they are found in South America). The reason for this is that a species is found in an area because it either 1) evolved in that area or 2) dispersed to that area. Current species distribution is the result of evolution and dispersal on land masses and oceans that have been periodically separated and rejoined throughout Earth's history.

Although this is a big topic, you only need to know a couple of facts about it to understand the material in this course:

- a. Closely related species that are found on different continents are usually there because those land masses were joined at some point in the past. As one species is broken into separate populations (such as being on different continents when the land masses separate), each population begins to change in different ways. If there is enough change, the populations will become new species. This is the basic concept of speciation by which most species are produced.
- b. Isolated land masses often contain many unique species.
- c. Species that depend on each other occur in the same areas. In some cases this is because of a symbiotic relationship. In other cases it may be because one species needs the other species for food or shelter.

## IV. Evolution and Natural Selection

### A. Evolution

Simply put, **evolution** means **genetic change over time**. Evolution does **not** happen to an individual; evolution takes place with a **group** of individuals (a population).

### B. Darwin and Natural Selection

The theory of **natural selection** was proposed by Charles Darwin. He did **NOT** develop the idea of evolution; he did develop the first generally accepted mechanism to explain how evolution could take place.

Darwin suggested that organisms had many more offspring than actually survived to reproduce. Therefore, there was a “struggle for survival” among various individuals. He proposed that certain conditions existed in an environment that favored the survival of certain individuals more than others. In other words, some individuals have characteristics that are “better suited” for the environment than others. If these characteristics could be passed on to their offspring, then the offspring that received these “better” traits might also have a better chance to survive and reproduce. Over time, there are more and more members of the population with these “better” traits. Notice that it is not enough just to have “better traits”. Those traits must be passed on to offspring. Survival of the **fittest** means survival of those organisms that have the **most** offspring that in turn go on to reproduce. This concept is often misunderstood; it does **not** mean survival of the strongest, fastest or “best” organisms.

Let’s look at a very simple example: mice that live in White Sands, New Mexico, a habitat with white sand dunes and little vegetation. Assume that these mice come in three colors: black, gray and white. As the mice go about their daily business, predators have a very easy time picking out the black mice on a white background. The gray mice are also relatively easy to spot. Predators have more difficulty in spotting the white mice on the white sands. Over time, the majority of the mice **who survive and live long enough to reproduce** are white – so most of the offspring are white (who in turn must live long enough to reproduce and pass their white genes on to their offspring, and so on). Does this mean that “white coat color” is automatically a better color for a mouse? Not if the mouse lives in a prairie or a forest or on a lava bed. In those places, a white mouse is a “fast food lunch” for a predator – quick and easy to find.

So, from an evolutionary standpoint, what is more important? Survival or reproduction? Think about this from the standpoint of passing your genes on to the next generation? From an evolutionary point of view, reproduction is more important.

**Websites:** [http://www.pbs.org/wgbh/evolution/library/11/2/e\\_s\\_4.html](http://www.pbs.org/wgbh/evolution/library/11/2/e_s_4.html)  
<http://www.nclark.net/SurvivaloftheSneakiest.doc>

## V. Evolutionary Adaptation

### A. What is an adaptation?

An adaptation is any trait that allows an organism to be successful (to survive and reproduce in) a given environment. These traits might be physical traits such as thick fur, large flowers, good eyesight, or the presence of antifreeze in the body fluids. They might also be behavioral traits such as hunting techniques (for predators) or evasion techniques (for prey). Interactions with other species can also be adaptations if they improve the evolutionary success of a species.

As an example, cushion plants (in the genus *Saxifraga*) live in cold environments, such as mountain peaks or tundra. They have several adaptations to cold conditions, including: (1) the plant has a small body which hugs the ground, thus avoiding the harsh winds, (2) the plant roots in protected rock crevices, (3) it is dormant through the long winter months and thus grows very slowly, (4) it flowers very quickly once the snow is gone, and (5) it also produces new plants by growing runners from the original plant.

Many people are confused about the concept of adaptation. A plant or animal does not decide to adapt to certain conditions. Adaptation is NOT a matter of choice. The organism either has the ability to survive under certain conditions or it does not. If it does not, the plant or animal either dies or leaves. For example, if the climate changes and becomes extremely cold, some plants cannot survive the new conditions. As they die out, only the plants that can tolerate the cold will be able to grow and reproduce, passing on their "cold-tolerant" traits to their offspring. The "cold-tolerant" plants are thus described as being adapted to the environmental condition of extreme cold.

### B. Where do adaptations come from?

Adaptations are traits that organisms inherit from their parents. They are NOT physical characteristics that are acquired after birth. They are also NOT a matter of choice--an organism is either born with these traits or without them.

### C. Why are certain traits inherited?

Species generally produce more offspring than are needed to maintain the population (replace the parents), and not all of those offspring survive. In general, the ones that do survive are the ones that are best able to survive in the particular environment in which they live, and are also able to reproduce successfully. Reproduction passes the adaptations to new generations of the same species.

## VI. Taxonomic Classification/Scientific Nomenclature

Taxonomy is the process of identifying and classifying species. It is used to group similar organisms based on shared characteristics, which become more specific as the groups get smaller. It assumes that similar organisms have properties in common and that similar organisms are closely related to each other. This way of organizing life is useful because if we know something about one member of a group, we should be able to apply that knowledge to other members of the same group.

There are definite levels of categories. The following scheme begins with the largest category (grouped together based on very broad characteristics) and goes toward the smallest category (based on very specific characteristics). We will use the fox squirrel to illustrate.

### 1. Levels of Taxonomic Classification

Kingdom: Animalia  
Phylum: Chordata  
Class: Mammalia  
Order: Rodentia  
Family: Sciuridae  
Genus: *Sciurus*  
Species: *Sciurus niger*

Each species has its own scientific name. The name is made of two Latin words. All fox squirrels have the scientific name of *Sciurus niger*. All gray squirrels have the scientific name of *Sciurus carolinensis*. Since fox squirrels and gray squirrels are members of the same genus, they are thought to be closely related. Since the second word is different, (*niger* versus *carolinensis*), the two squirrels belong to different species. They do not mate and produce fertile offspring under natural conditions.

### 2. Definition of Species

The word species is generally used to represent a collection of similar organisms that are capable of interbreeding under natural conditions and producing fertile offspring. One example is the familiar fox squirrel (*Sciurus niger*). Fox squirrels can breed with each other but do not breed with gray squirrels (*Sciurus carolinensis*), which are a different species.

## VII. Ecology

Ecology is the study of relationships between organisms and their environment or surroundings. The environment itself has been described already under Physical Biogeography. But there is another way to look at ecology--these relationships can be studied at different levels:

**Population** - a group of individuals (of the same species) found in one geographic area. For example, all of the blue catfish found in Town Lake would represent a population.

**Community** - composed of all living organisms found in one geographic area. For example, all of the fish, plankton, plants, algae, turtles and other organisms in Town Lake would be a community. Often scientists study just part of the group of organisms that are found in a specific area. For example, they may just look at the plants, in which case they are studying the plant community. They may just look at the insects, in which case they are studying the insect community.

**Ecosystem** - all living organisms plus all physical characteristics of the environment (precipitation, climate, temperature, etc.) found in a geographic area. The Sahara Desert is an example of an ecosystem. Once again, scientists may focus on particular aspects of the ecosystem instead of trying to look at the entirety. They might just look at nitrogen cycling or energy flow through the ecosystem. They might focus just on soil characteristics and soil organisms, in which case they are studying the soil ecosystem.

## VIII. Metric System

Measurements and distances in the videos are given in both metric and English units. Here are some of the conversion factors:

1 mile = 1.6 kilometers	1 kilometer = 0.6 miles
1 mile = 5,280 feet	1 kilometer = 1,000 meters
1 inch = 2.54 centimeters	1 meter = 39 inches or 1.094 yards
1 kilogram = 2.2 pounds	1 meter = 100 centimeters
1 pound = .454 kilograms	1 meter = 1,000 millimeters

## References

Campbell, Neil A and Jane B. Reece. *Biology*, 6<sup>th</sup> ed. Benjamin Cummings, 2002.

Cox, C. Barry and Peter D. Moore. *Biogeography, an ecological and evolutionary approach*, 5/e. Blackwell Science, 1993.

**CONCEPTS STUDY QUESTIONS FOR INTRODUCTION:**

1. Look at the following map of the world and answer the questions below.



- a. Fill in the three labels on the left side of the map.
  - b. The numbers at the base of the map represent \_\_\_\_\_.  
(Choose between *latitude* and *longitude*.)
  - c. The numbers on the right side of the map represent \_\_\_\_\_.  
(Choose between *latitude* and *longitude*.)
  - d. The spot marked “X” is located at approximately \_\_\_\_\_° latitude and \_\_\_\_\_° longitude. (Don't forget to include N, S, E, or W.)
2. What is the difference between latitude and longitude?
3. What is the difference between the earth's revolution and the earth's rotation?



6. Define limiting factor. Compare and contrast the limiting factor of terrestrial organisms with those of aquatic organisms.

7. Compare and contrast biotic and abiotic factors. Give examples.









18. Describe the concepts of evolution and natural selection.

19. Describe the concept of evolutionary adaptation.



24. Compare and contrast populations, communities and ecosystems.

25. Be familiar with the portion of the metric system listed in the introduction.