Abiotic factors are non-living, but are extremely important to all cells as well as the entire organism. Cells live within a narrow range of abiotic factors. Beyond that range of tolerance, cells and organisms may not survive.
Abiotic Factors
3.2.2

Upon successful completion of this unit, you should be able to do the following:

1. Explain why cells exist within a narrow range of abiotic factors.

2. List, describe, and explain eight abiotic factors.

3. Explain how each abiotic factor interacts with cells.

4. Be able to use the following words correctly:

<table>
<thead>
<tr>
<th>abiotic</th>
<th>light</th>
<th>toxin</th>
</tr>
</thead>
<tbody>
<tr>
<td>biotic</td>
<td>water</td>
<td>mutation</td>
</tr>
<tr>
<td>abiotic factor</td>
<td>oxygen</td>
<td>cancer</td>
</tr>
<tr>
<td>pH</td>
<td>carbon dioxide</td>
<td>photosynthesis</td>
</tr>
<tr>
<td>temperature</td>
<td>radiation</td>
<td>aerobic respiration</td>
</tr>
</tbody>
</table>
Cells exist within a very narrow range of environmental conditions. Sudden changes in these environmental conditions may cause great stress or even death to living organisms. Non-living environmental conditions that affect living organisms are called abiotic factors.

REMEMBER THIS!!!
Abiotic factors are non-living.

We normally list the following 8 abiotic factors:

1. pH
2. temperature
3. light
4. water
5. oxygen
6. carbon dioxide
7. radiation
8. toxic substances

Each of the 8 abiotic factors is important to the well-being of all living organisms, including humans. If even one of the abiotic factors is beyond what a cell can tolerate, then the cell either has to move, suffer, or perhaps even die.

REMEMBER THIS!!!
If even one of the abiotic factors is beyond the range that a cell can tolerate, then the cell must move to a different area, suffer, or die.

Let’s see how the various abiotic factors affect the cells. You will need to know the following information.
1. **pH**

   pH is the measure of whether something is an acid, neutral, or a base. In biology, we are concerned about the pH of a cell and the pH of the environment of the cell. The **pH scale ranges from 1 to 14**. Numbers lower than 7 are acids. Lower numbers are strong acids, so pH of 2 is a stronger acid than pH of 6. Numbers higher than 7 are bases. Higher numbers are stronger bases, so pH of 13 is a stronger base than pH of 9. The number 7 is neutral.

   Most living things, including humans, live within a very narrow pH range. Most living things need a pH near 7, or neutral. If a cell is placed in a strong acid or strong base, its enzymes and proteins will be denatured and destroyed.

   **Interesting Scientific Fact:** The pH inside of a cell is very important. If a cell is unable to get rid of carbon dioxide (a waste product of respiration), the pH inside the cell begins to become more acidic. If the condition continues, the cell dies. If enough cells die, the whole organism dies.

2. **Temperature**

   Temperature is the measure of how much heat something contains. Temperature shows whether something is hot or cold. **Living organisms exist within a very narrow temperature range**. Some living things respond best in warm temperatures, like the Rattlesnakes of the Southwest. Other living things prefer the cooler climates of the north, like Polar Bears. **All living things have a preferred temperature range**. A Polar Bear would not survive in the heat of the Southwest. A Southwest Rattlesnake would not survive in the cold temperatures of Alaska.

   The temperature inside of a cell is very important. If the cell is allowed to cool off too much it dies because the enzymes that control vital chemical reactions in the cell slow down too much. This is what can happen when animals are exposed to cold temperatures for a long time, like falling into icy water. A cell can also die if it becomes too hot because the enzymes and proteins are denatured, or destroyed. This can happen when animals are exposed to extreme heat, such as an animal locked in a car during the summer with the windows closed. In both cases, if the temperature inside of the cell becomes too cold or too hot, the cell dies.

   **Interesting Scientific Fact:** Your internal body temperature is considered normal if it is near 98.6 °F. Your body has a very narrow range of temperatures. If your temperature gets above 105 °F or below 93 °F, then you are probably very sick and need immediate medical help.
3. Light

All living things prefer certain levels of light. Some living things, like plants, require certain levels of light for photosynthesis to occur. Some living things require a lot of light. Examples of this type of organism are the grasses that thrive in the areas near the equator. They receive a lot of light!

All living things have a light level they prefer. If the light level changes away from their preferred level, they have to move, suffer, or die.

REMEMBER THIS!!
Light is required for photosynthesis to occur. Some green plants can survive with low levels of light while others require stronger light. No green plant can photosynthesize in the dark. If green plants die because of a lack of light, it affects all of the other organisms in their food web. Maybe even you!

4. Water

Water is essential for all living things. Water is needed for photosynthesis and all chemical reactions that a cell needs to survive. Remember, water dissolves most substances and allows them to react. Blood is made mostly of water, which is why blood can dissolve all the minerals and nutrients and oxygen your cells need. It also dissolves the CO2 and waste to take away from your cells. If a cell has too little or too much water, it can die because it would not get the nutrients and oxygen it needs, remove CO2 and waste, and perform vital chemical reactions.

Interesting Scientific Fact: A unicellular organism that is taken from salt water and placed in fresh water absorbs water because of osmosis and may burst. Likewise a unicellular organism taken from fresh water and placed in salt water will lose water and shrink because of osmosis. In both cases, if not returned to their native environment, the cells will die.

5. Oxygen

Oxygen is a colorless, odorless gas that is found in the atmosphere. It is made as a waste product by green plants during photosynthesis. Oxygen is also very important to animal cells. All cells need oxygen to perform aerobic respiration. Remember, aerobic respiration is the process that cells use to create ATP energy. Aerobic respiration breaks apart glucose to make ATP, the energy molecule. The cells then use the ATP for energy. So, without oxygen, the cells could not make energy. With no energy, the cells would die.
6. **Carbon Dioxide**

Carbon dioxide is a colorless, odorless gas that is found in the atmosphere. It is made by animals during aerobic respiration. Although carbon dioxide is a poison to animal cells, it is essential to green plant cells. **Plants require carbon dioxide during photosynthesis.** Remember, during photosynthesis, green plants mix carbon dioxide from the atmosphere and water through their roots while using the energy of light to make glucose and the waste gas oxygen. This is important because all cells use glucose as an energy source and to build other molecules for use by the cell. **If the amount of carbon dioxide is too low or too high, the cells usually die.**

| Interesting Scientific Fact: Most people think we breathe to bring oxygen into our body. While this is true, we actually breathe to rid our body of carbon dioxide. A build up of carbon dioxide is a quicker death than a lack of oxygen. |

7. **Radiation**

Radiation is invisible energy. We know that radiation travels in waves. Light, heat, X-rays, and ultraviolet light are all examples of radiation. **Some radiation is harmless, but certain types of radiation, like gamma and ultraviolet, and over-exposure to certain types of radiation can damage the DNA inside the nucleus of a cell.** This damage may result in DNA mutations or even cancer. Mutations are changes in the DNA structure that may be lethal or may create a different trait or traits within an organism. **Cancer is defined as the uncontrollable division of cells. Cancer often makes the cells useless.** Although most radiation is harmless, cells exposed to certain types of radiation, or over-exposed to certain types of radiation can be damaged or destroyed.

8. **Toxins**

Toxins are poisons. Toxins can be man-made or natural. The poison released during a rattlesnake bite is a toxin. Toxins often interfere with the ability of a cell to perform its function. Natural toxins are helpful to certain animals because it allows them to capture prey and defend themselves. However, the victim whether accidental or on purpose may die.

| REMEMBER THIS!!! |
| **Cells live within a narrow range of abiotic factors.** Too much or too little of any abiotic factor may damage or destroy a cell or the entire organism. |
Question 1. Without looking, list the abiotic factors.

Question 2. For each abiotic factor, complete the following:

a. Describe the abiotic factor

b. Explain how the abiotic factor may help or hurt the cell.

Summary
Abiotic Factors
3.2.2

A cell interacts with and uses many nonliving factors. These are called abiotic factors. These factors include the pH level, the temperature, light, water, oxygen, carbon dioxide, radiation, and toxins.

The pH level is a measure of how acidic or basic the environment around a cell is. The cell is full of proteins, all providing a vital role for the cell. In a strongly acidic environment, most proteins uncoil, or become denatured. Once denatured, a protein can no longer do its job. Therefore, the pH level around a cell is very important to the cell. If its proteins cannot do their job, the cell will
die.

The **temperature** around a cell is very important to the chemical reactions in the cell. If the temperature is low, then the molecules that need to react to keep the cell alive will move too slowly. If the temperature is too high, then the proteins that act as enzymes in the cell will become denatured and no longer will the reactions take place. A cell in an environment that is too cold or too hot could die.

**Light** is essential to cells that use photosynthesis to make their own food. These cells trap the sun's energy using chlorophyll, a green pigment. Too little light could cause these cells to die from starvation. However, light is often absorbed and turned into heat. If too much light produces too much heat, it could cause a cell to die.

**Water** is essential to a cell for the cellular reactions that take place require water. It is the medium that dissolves the reactants and allows them to collide and produce new substances that the cell needs. Too little water could cause a cell to die. Too much water can also harm a cell, because the cell could burst.

**Oxygen** is very important to the cell for without it, aerobic respiration cannot take place. Aerobic respiration breaks apart sugar and makes ATP for the cell to use for its energy needs. Many reactions in a cell require ATP, so without oxygen, a cell could die because it would not have enough ATP.

**Carbon dioxide**, a colorless gas, is essential for algae and plants. It is used in the process called photosynthesis. In this process, algae and plants take carbon dioxide and water and use the sun's energy to build these materials into glucose. This is important because glucose provides energy to the cell and can be used to build other molecules needed by the cell.

**Radiation** is invisible energy, except for light, that travels in waves. Light, heat, x-rays, and ultraviolet waves are all different forms of radiation. Some radiation is harmless but x-rays and ultraviolet radiation can damage the DNA inside the nuclei of cells. This damage may lead to cancer or may lead to mutations. Cancer is the uncontrollable division of cells. Mutations are changes in DNA that result in a different trait or traits within the organism.

**Toxins** are poisons. These poisons can be natural or synthetic (manmade). For example, the poison in rattlesnake’s fangs is a natural toxin. These toxins interfere with the cell’s ability to make ATP. They bind to molecules that are needed to complete the process of aerobic respiration. Therefore, cells die when toxins prevent them from making ATP.
Abiotic Factors
Self Test

Matching

_____ 1. abiotic factors
a. a colorless gas needed for photosynthesis

_____ 2. pH level
b. poisons

_____ 3. temperature
c. invisible energy that can damage DNA

_____ 4. light
d. invisible gas needed for aerobic respiration

_____ 5. water
e. liquid in which cellular reactions take place

_____ 6. oxygen
f. how acidic or basic a solution is

_____ 7. carbon dioxide
g. the amount of heat possessed by molecules

_____ 8. radiation
h. nonliving factors

_____ 9. toxins
i. energy needed for photosynthesis

True or False

_____ 1. An abiotic factor is a living thing that a cell interacts with.

_____ 2. An abiotic factor is a nonliving thing that a cell interacts with.

_____ 3. The pH level affects a cell because if it is too acidic, the cell’s proteins can be denatured.

_____ 4. The temperature affects a cell because if it is too low, the cell’s proteins can be denatured.

_____ 5. The temperature affects a cell because if it is too high, the cell’s proteins can be denatured.
6. Light is essential to cells for it is necessary for aerobic respiration.
7. Light is essential to cells with chlorophyll for it is necessary for photosynthesis.
8. Water is essential to cells because they are thirsty.
9. Water is essential to cells because the cellular reactions that go on in a cell must be done in solution.
10. Oxygen is important to a cell for it is required for photosynthesis.
11. Oxygen is important to a cell for it is required for aerobic respiration.
12. Carbon dioxide is important to a cell for it is required for photosynthesis.
13. Carbon dioxide is important to a cell for it is required for aerobic respiration.
14. Radiation can harm the cell membrane of a cell.
15. Radiation can harm the DNA in a cell.
16. Cancer is caused by radiation.
17. Cancer is caused by toxins.
19. Mutations are caused by radiation.
20. Mutations are caused by toxins.
1. _________________ is a very important process to cells for it is how glucose can be made for food.
2. Photosynthesis will not take place unless a plant or algae cell has enough _______________ and _____________________.
3. Glucose is broken down in the cell by the process of aerobic respiration with the help of _________________.
4. These reactions require enzymes, special proteins that will denature in _______________ or ________________________.
5. __________________________ cause the molecules involved in these reactions to slow down and not react as quickly.
6. _________________ is required in each cell to be the solvent for all of the reactions, so the reactants can move about.
7. _________________ can damage the DNA inside the nucleus of a cell, resulting in _________________________ or _________________________.
8. _________________ are poisons that can interfere with a cell’s ability to make ATP, causing the cell to die.
9. Abiotic, or _________________ factors are very important to the life of a cell.
Answer the Following

1. List the abiotic factors that affect a cell.

2. What occurs if the pH level around a cell becomes too acidic?

3. What occurs if the water temperature around a cell becomes too high?

4. What occurs if the water temperature around a cell becomes too low?

5. For what does a cell need light?

6. Why is water essential to a cell?
7. For what purpose does a cell need oxygen?

8. For what does a cell need carbon dioxide?

9. How does radiation affect a cell? What effects might it produce?

10. What are toxins and what do they do that is harmful to cells?