An adaptation is a feature of an organism that promotes its ability to survive and reproduce.

Adaptations can be classified as evolutionary and physiological.

Adaptation is also the process of change. We can say an organism is adapting to its environment if it changes in a way that promotes better survival and reproduction.

Physiological adaptations are usually short-term changes in the biology of individual organisms that occur in response to an environmental stimulus.

Evolutionary adaptations are changes in the characteristics of a population and have a genetic basis. Evolutionary adaptations commonly take several generations to become a common feature of a population.
Physiological Adaptation -
Example - Some fish move from seawater to freshwater during different periods of their lives. When they move, they must respond to changes in the salt concentration in the water around them to keep the proper balance of salt and water in their bodies.

A fish in freshwater has 2 problems - gain of water, loss of salts
   Solution: absorb salt from water at gills, make lots of urine

A fish in seawater has 2 problems - loss of water, gain of salts
   Solution: secrete salt at gills, make very little urine

A fish moving from freshwater to the sea must change the way it regulates salt and water. As its physiological problems change, it shifts from one system for solving its problems to the other. They exhibit sensitivity, regulation, and homeostasis.
Evolutionary Adaptation -

Example - Industrial Melanism in Peppered Moths

Kettlewell worked in England in the 1950s. He noticed that the Peppered Moth (*Biston betularia*) was light colored in unpolluted forests and dark colored in polluted forests.

He asked “Why?” and then proposed an explanation that involved evolutionary adaptation. He proposed that birds and other predators ate more light moths than dark moths in polluted forests, and more dark moths than light moths in unpolluted forests because moths that matched their background were camouflaged and less likely to be seen and eaten.
Kettlewell tested his idea.

He raised both dark and light moths, marked them and released them in equal numbers in polluted and unpolluted forests. He then trapped moths at the edge of the forest to measure their relative survival.

In a polluted forest, Kettlewell recaptured 19% of light moths and 40% of dark moths.

In an unpolluted forest, Kettlewell recaptured 12% of light moths and 6% of dark moths.
The evolution of long necks in giraffes (a hypothesis).

Ancestors of the giraffe had shorter necks than modern giraffes and browsed on tree leaves and shrubs of the African Savannah.

Some had longer necks than others and were able to reach higher branches than others. In times of food shortage, those with the longest necks had a survival advantage. If so, selection has occurred. If neck length variation was not genetically based, then the next generation would not have necks any longer than the average in the previous generation. No evolution would have occurred.

If neck length was due to genetic variation, then the genes for having a long neck would have increased in the population. The new generation would be different from the prior generation, and better suited to survive in their environment - due to their neck length. This is an adaptation.
## Bacteria Have Rapidly Evolved Resistance to Clinical Antibiotics

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Date Introduced</th>
<th>Date Resistance Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillin</td>
<td>1943</td>
<td>1945</td>
</tr>
<tr>
<td>Chloramphenicol</td>
<td>1949</td>
<td>1950</td>
</tr>
<tr>
<td>Erythromycin</td>
<td>1952</td>
<td>1956</td>
</tr>
<tr>
<td>Methicillin</td>
<td>1960</td>
<td>1961</td>
</tr>
<tr>
<td>Cephalothin (first-generation cephalosporin)</td>
<td>1964</td>
<td>1966</td>
</tr>
<tr>
<td>Vancomycin</td>
<td>1958&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1986</td>
</tr>
<tr>
<td>Carbapenems</td>
<td>1985</td>
<td>1987</td>
</tr>
<tr>
<td>Linezolid</td>
<td>2000</td>
<td>2002</td>
</tr>
</tbody>
</table>

<sup>a</sup>Vancomycin was first released in 1958; however, it was not widely used until the early 1980s. From Bergstrom and Feldgarden (2008).
Ciprofloxacin

Antibiotic-sensitive *Campylobacter*

Antibiotic-resistant *Campylobacter*

Dead
Natural selection – due to the interaction of organisms and their environment and results in organisms that have increased abilities to survive or reproduce in their environment.

Artificial selection – due to intentional human control of the survival and reproduction of organisms and results in organisms that suit a human desire – also known as “selective breeding”
Evolutionary adaptations can be subdivided as **structural** and **behavioral**

A structural adaptation involves some part of an organism's body.
- Teeth, Beak, Horns, Claws, Toxins,
- Body coverings: Shells, Quills, Scales, Thorns
- Camouflage
- Mimicry
- Etc., etc….

Organisms often have multiple adaptations to their environment.
Organisms often have multiple adaptations to their environment.
Herbivores, such as deer, have many molars and thick enamel for chewing tough grass and plants.

Carnivores, such as lions, have sharp canines, and slicing molars, to kill prey and tear meat.
Owls have good binocular vision for locating prey accurately.

Ostriches have wide-angle vision for detecting predators.

Adaptations in one feature often occur with trade-offs in other features.
Coloration can be an adaptation

Attraction

![Peacock](image1.png)

![Number of mates vs. Number of eyespots in tail feathers](image2.png)

![Venus flytrap](image3.png)

![Pink flower](image4.png)
Coloration can be an adaptation

Camouflage
Coloration can be an adaptation

Warning coloration is also known as **aposematic coloration**.
Coloration can be an adaptation

Mimicry

- monarch
- viceroy

Model

Mimic

- Coral snake
- Kingsnake
Adaptations can involve reproductive features

Large offspring are able to grow fast enough to avoid being eaten by small predators.

More numerous offspring increase the chance of some avoiding predators.
Adaptations can be structural features that increase reproductive abilities.
Any behavior that increases an organism’s ability to survive and reproduce is a **behavioral adaptation**
Behavioral adaptations can increase reproductive abilities

Mate attraction often involves specific and elaborate behaviors
Migratory behaviors increase survival and reproductive potential by allowing animals to avoid or exploit specific environmental conditions.

- better climate
- better food
- safe place to live
- safe place to raise young
Hibernation, estivation, and dormancy are behaviors that allow organisms to avoid unfavorable environmental conditions.
Learning can be adaptive if it increases an organism’s reproductive potential

(a) Blue jay eating monarch  (b) Vomiting reaction