NATURAL SELECTION

It is the process in which individuals or organisms that have certain inherited traits tend to survive and reproduce at higher rates than other individuals because of those traits.

Theory of Natural Selection

1. Overproduction

All living organisms tend to produce more offspring than what the environment can naturally support, leading to a situation called **overpopulation.**
For example, a plant might release hundreds of seeds, or a fish may lay thousands of eggs.

However, not all these offspring survive to adulthood. The reason is that the environment has limited resources such as food, water, space, and shelter. When too many individuals are born, they start to compete for these scarce resources. This competition creates a natural pressure where only some organisms will manage to survive and grow.

2. Struggle for Existence

Because the resources in any environment are limited, there arises a constant struggle among organisms to survive. This is known as the **struggle for existence**. Organisms compete for essential things like food, water, space, and mates.

This competition happens both within a species (**intraspecific**) and between different species (**interspecific**). For example, two lions might fight over the same prey, or a deer and a rabbit might compete for the same grass. Only those organisms that are better adapted to their environment and more efficient in using resources will survive.

3. Variations

Every individual in a species is slightly different from others. These differences are known as **variations**. Variations can occur due to genetic changes, mutations, or mixing of genes during reproduction. Some variations may be useful (like better camouflage or faster running speed), while others may not make a difference or could even be harmful. Natural selection only works on **existing variations**—it does not create them. The presence of variation is essential because it gives nature something to "select" from. Without variation, evolution would not be possible.

4. Natural Selection and Survival of the Fittest

Nature selects individuals that have favourable variations, meaning traits that help them survive better or reproduce more effectively. This idea is often called **"survival of the fittest."**
The term "fittest" doesn’t mean the strongest physically, but rather those best suited to their environment.
For example, in a cold environment, animals with thicker fur might survive better. These fit individuals are more likely to survive and pass on their beneficial traits to the next generation.

Meanwhile, individuals who are less fit may die earlier or reproduce less. Over time, this leads to more individuals in the population having the advantageous traits.

5. Origin or Formation of New Species

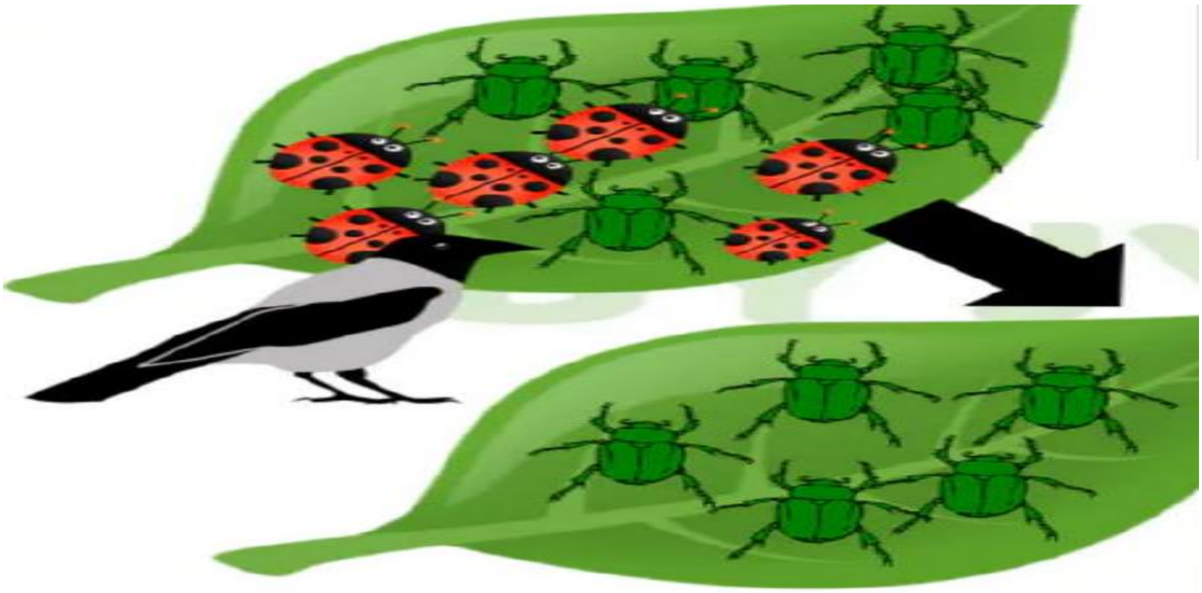
As favourable traits continue to be selected over many generations, a population may begin to change significantly. If this process goes on for a long enough time, and the changes are large enough, it can eventually lead to the creation of a **new species**. This process is called **speciation**.
It usually happens when groups of the same species become isolated from each other (like on different islands), face different environments, and adapt in different ways. Over thousands or millions of years, these groups can become so different that they can no longer breed with each other, and thus, a new species is born.

Two Main Factors Behind Natural Selection

1. Struggle for Existence
This is the first and most basic step in natural selection. Because the resources available in any environment are limited and cannot support all individuals, there is always a **scarcity of resources**. This leads to **competition** among individuals of the same species. Since all of them rely on the same food, water, or shelter, not everyone will get what they need. This struggle ensures that only the best-adapted individuals survive and reproduce, contributing to the evolution of the species.

2. Survival of the Fittest

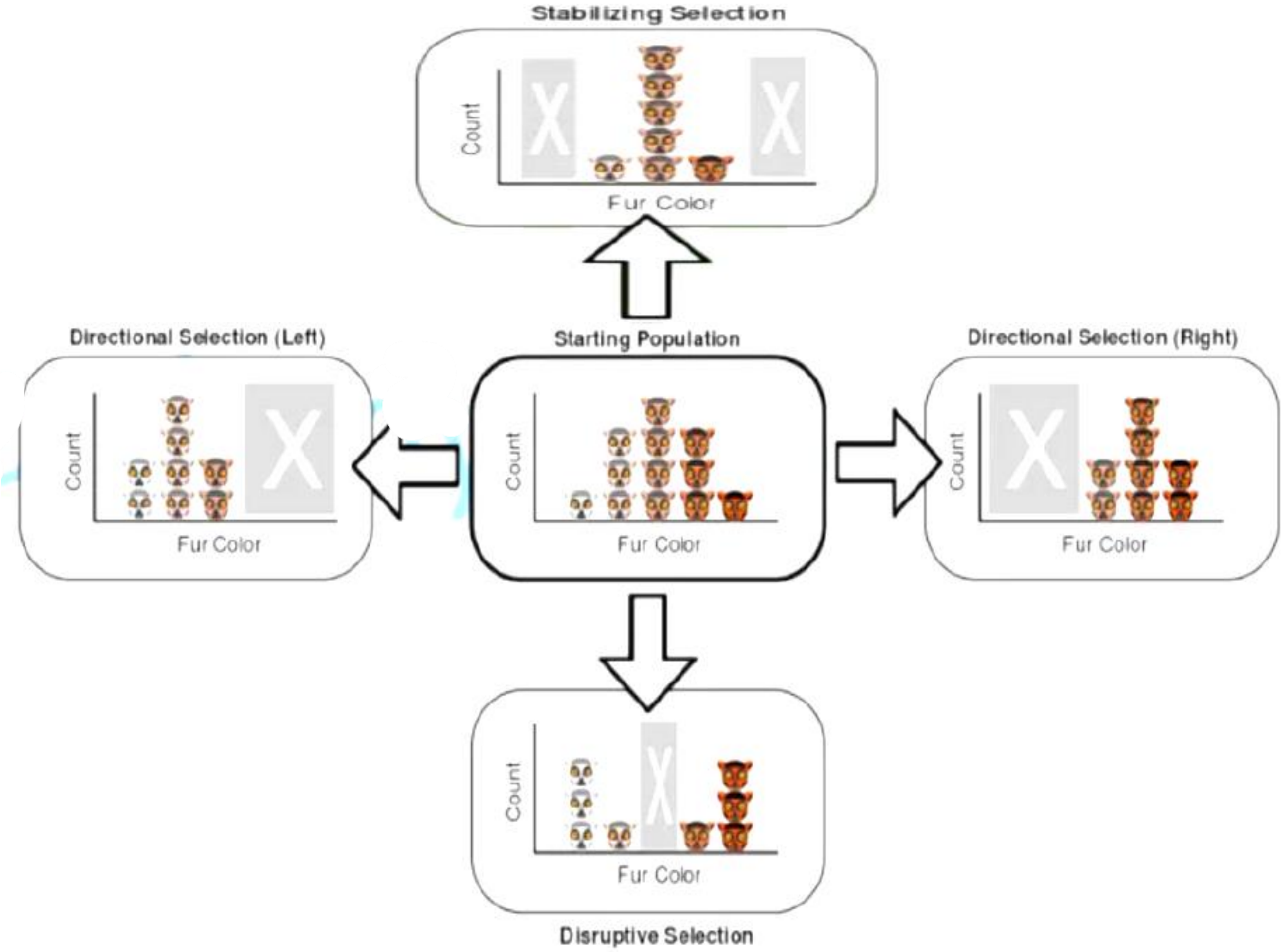
Following the struggle for existence, only those individuals who have **beneficial traits**—the fittest—are likely to survive. These traits help them escape predators, find food, resist diseases, or cope with harsh environments. As a result, they are more likely to **live longer and reproduce**, passing on their helpful traits to their offspring. On the other hand, individuals without these advantages may **die or fail to reproduce**, and their traits disappear from the population over time. This natural filtering process shapes the direction of evolution.



Traits (phenotypes) that provide a **survival or reproductive advantage** are favored. These traits are passed on to the next generation, shaping the evolution of the species. Therefore, **natural selection favors only the fittest phenotypes**

MODE OR TYPES OF NATURAL SELECTION

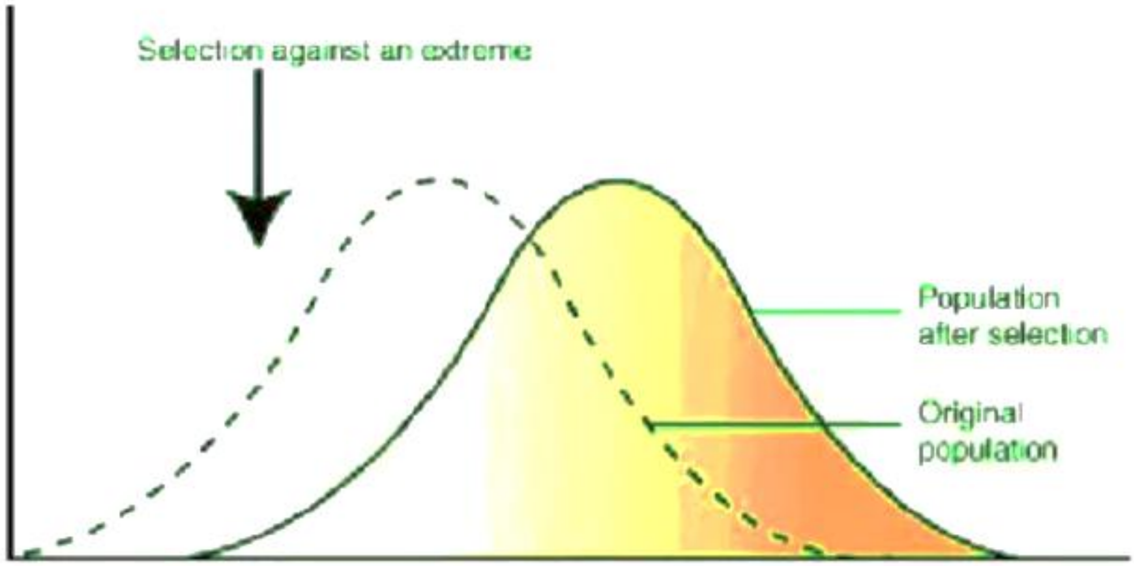
Natural selection can alter the frequency distribution of heritable traits in three ways, depending on which phenotype in a population are favoured.
The following three types of natural selection have been categorized by population geneticists: directional, stabilizing and disruptive (diversifying).

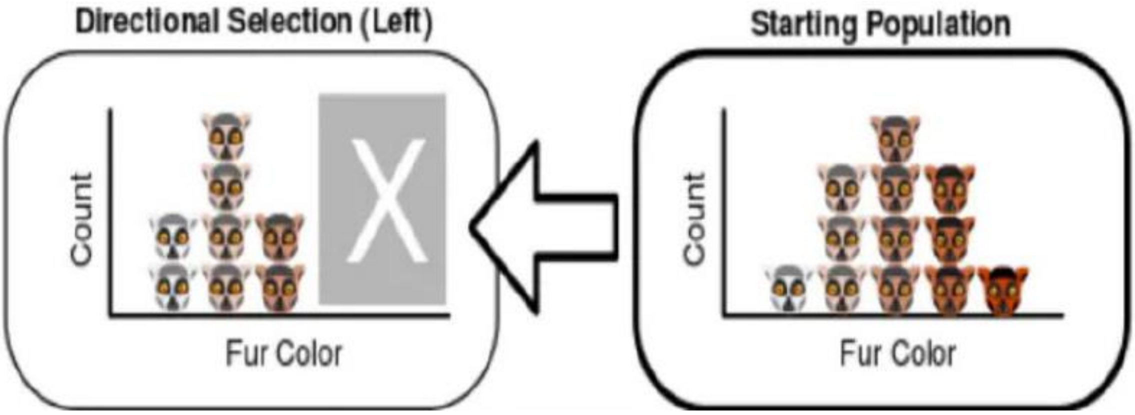


1. Directional or Progressive Selection

Directional selection is a type of natural selection where one extreme (advantageous) form of a trait is favoured over the average or the other extreme. This causes the entire population to gradually shift toward that favoured extreme trait over time.

Reason: It is common when a populations environment changes or when members of a population migrate to a new (and different) habitat.





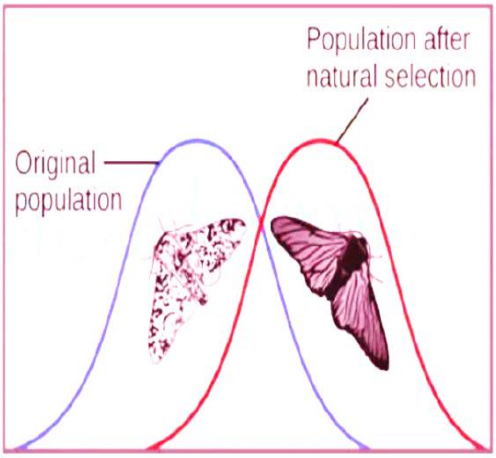
In directional selection, individuals that show one extreme of a phenotypic trait are more likely to survive and reproduce than others. Over time, more individuals in the population begin to show this extreme trait.

Directional selection often occurs when the **environment undergoes a major change**, such as a shift in climate, food availability, or predator pressure. It also happens when a population **moves to a new habitat** that has different conditions from the old one. In these new or altered environments, traits that were once neutral or even disadvantageous may now provide a survival advantage, prompting natural selection to act in a new direction.

As more individuals with the favoured extreme trait survive and reproduce, the **average value (mean) of that trait begins to shift**. Over generations, the population's overall characteristics begin to lean more toward the selected extreme.

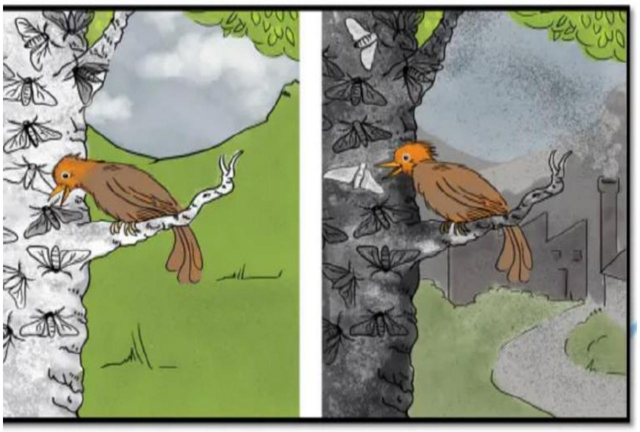
Favours accumulation of those mutation that increase the fitness in the changing environment and eliminates normal or average individuals.

The Industrial Melanism provide example of directional selection .



Light-colored peppered moths are better camouflaged against a pristine environment; likewise, dark-colored peppered moths are better camouflaged against a sooty environment. Thus, as the Industrial Revolution progressed in nineteenth-century England, the color of the moth population shifted from light to dark, an example of directional selection.

EXAMPLE #1 **Industrial Melanism in England**



There is a sub-species of this moth, *Biston* carbonaria, where a genetic mutation has led to the moth being dark with light patches

Biston Betularia carbonaria

Darker form (*carbonaria*)

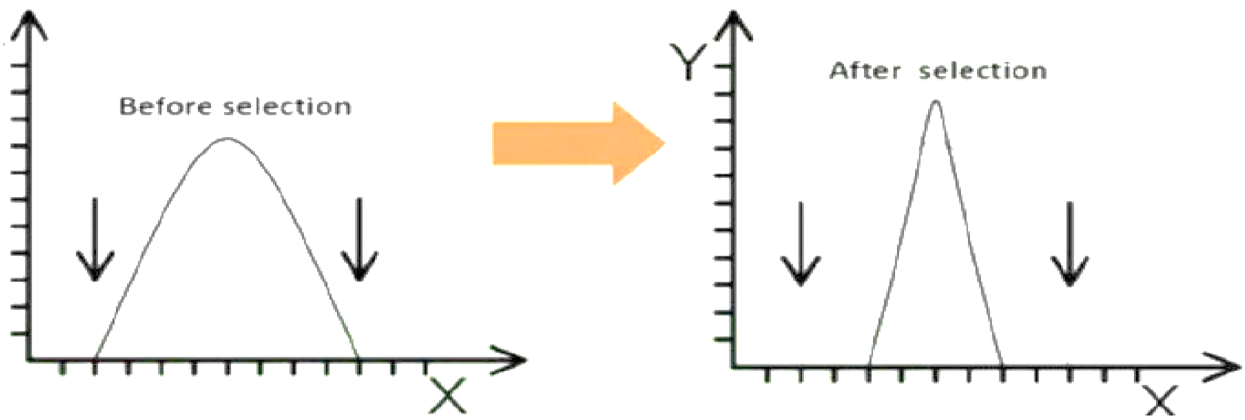
Biston Betularia typica

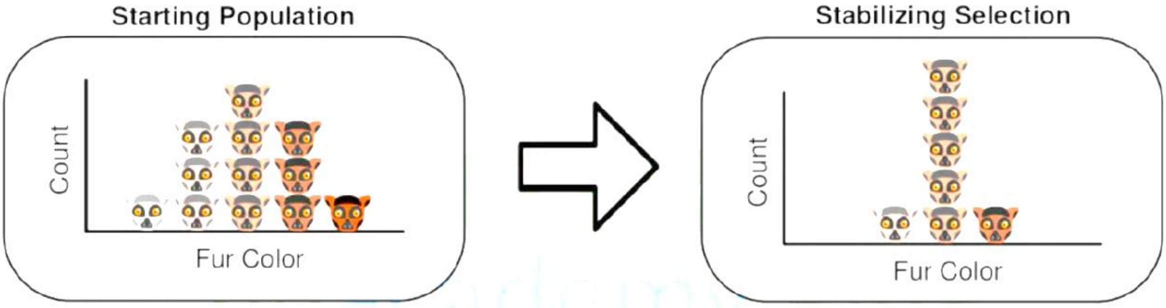
Lighter moth (*typica*)

2. Stabilizing or normalizing Selection

It describes the change when extreme individuals are eliminated from the population. So, the intermediate values for a given trait are favoured over the extreme values. The result of this process is a reduced variability in the population. Most selection that occurs in populations is stabilizing and homeostatic, because it tends to maintain the status of the particular phenotypic character.

The shape of the curve tends to narrow through continual elimination of the less adapted individuals.





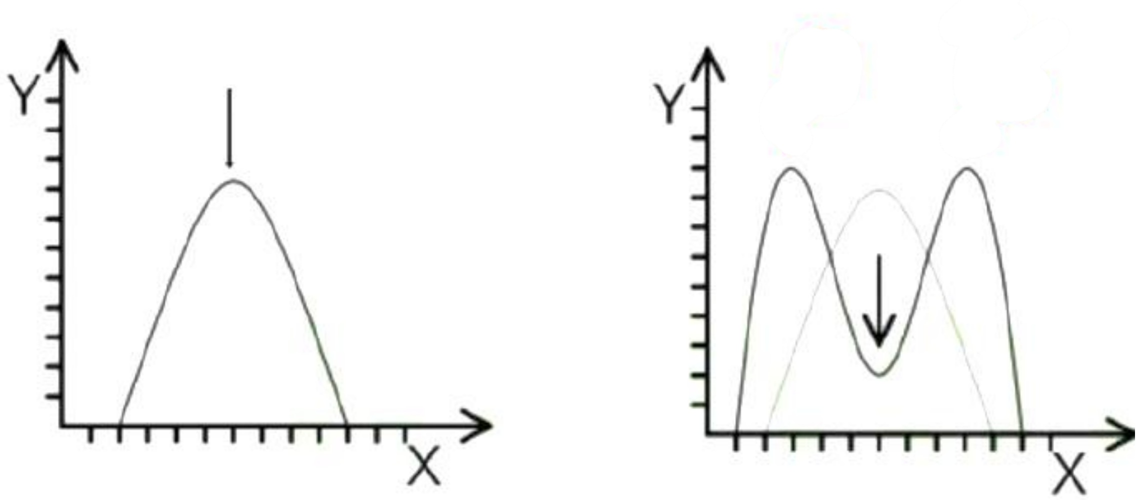
Reason: Acts to keep a population well adapted to its environment.
Operates in a constant and unchanging environment.
Graphical curve of population, it is bell shaped

Stabilising/Normalising Selection EXAMPLES

1. The birth weight of newborns provides a good example of a human character that has been subjected to stabilizing selection The optimum birth weight is 6.8-8.8 pounds (3-4kgs); newborn infants less than 5.5 pounds and greater than 10 pounds have the highest probability of mortality.
   Given the strong stabilizing influence of weeding out the extremes, the optimum birth weight is associated with the lowest mortality.

2. Robin bird egg: clutch size of robin birds is 4

3. <u>Disruptive or Diversifying Selection</u>



This form of selection occurs when the extreme values have the highest fitness and the intermediate values are relatively disadvantageous in terms of reproductive effectiveness. It is, essentially, selection for diversification with respect to a character.

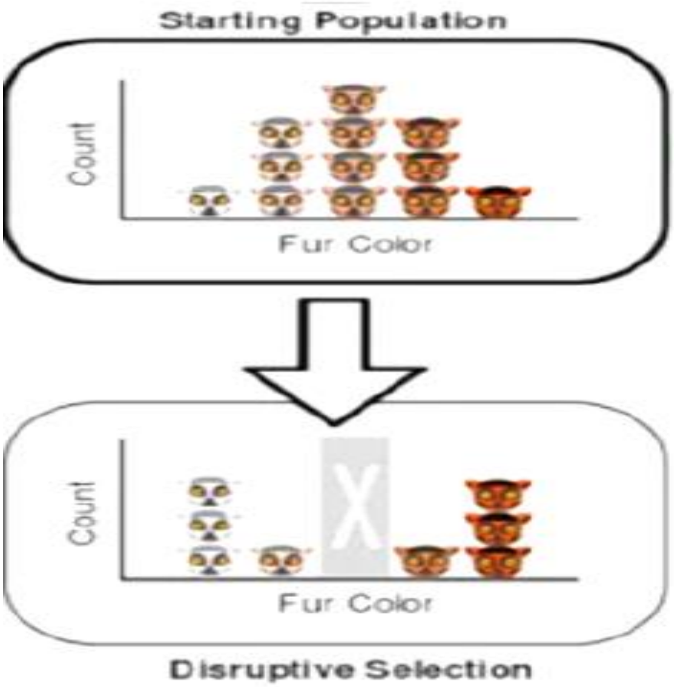
Disruptive selection is a **type of natural selection where animals or plants with very different (extreme) traits survive better, while those with average traits do not do as well.**

Disruptive selection is the opposite of stabilizing selection. Instead of favoring average traits (like stabilizing selection does), it removes or reduces the average traits and supports the extreme ones.

Different areas in the environment put different pressures on the population. One area might favor one extreme trait, while another area favors the opposite trait. This causes the population to split.

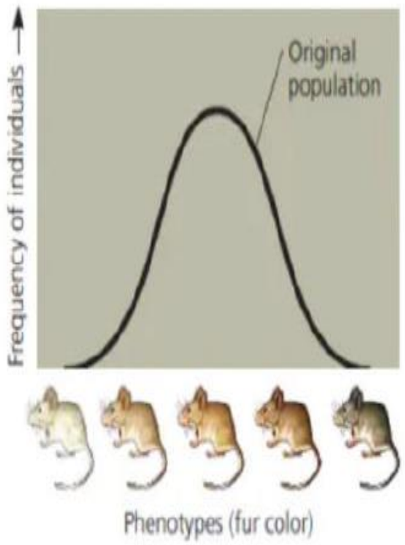
It removes most of the individuals that have average traits. As a result, the population ends up with two groups—each with an extreme trait. This creates a graph with two peaks (called a bimodal graph) instead of one in the middle.

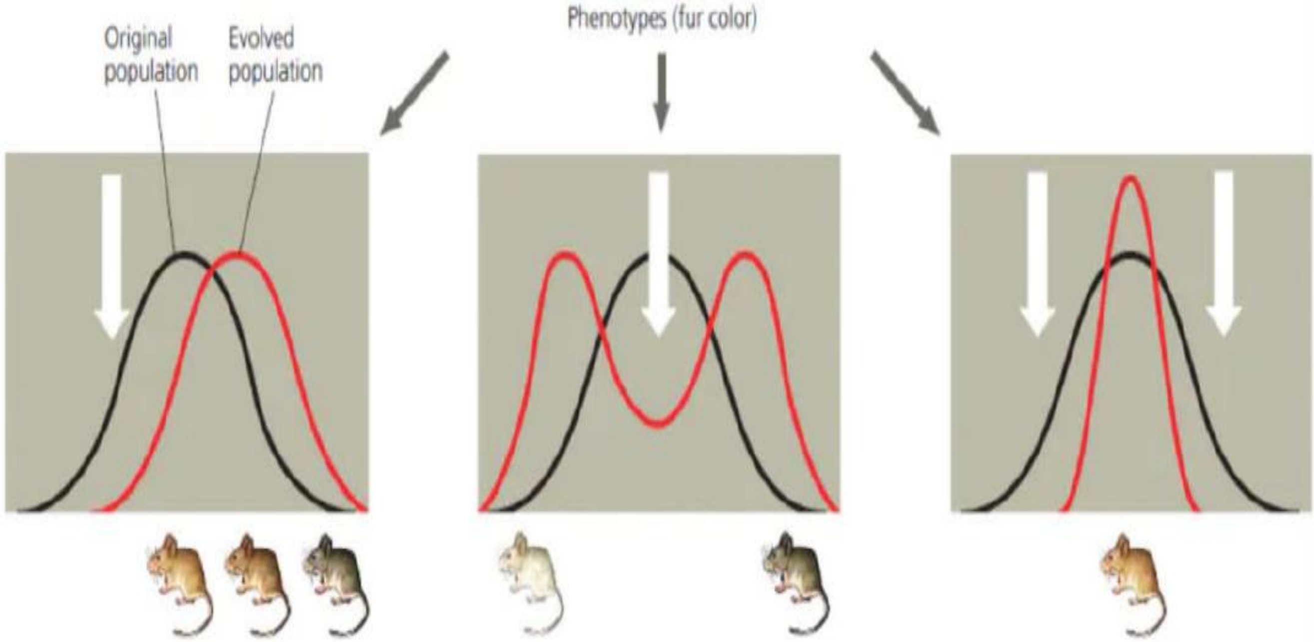
"Reason → Extreme values have highest fitness. Intermediate or mean values are relatively disadvantageous."



One example is a population of black-bellied seed cracker finches in Cameroon whose members display two distinctly different beak sizes. Small-billed birds feed mainly on soft seeds, whereas large-billed birds specialize in cracking hard seeds. It appears that birds with intermediate-sized bills are relatively inefficient at cracking both types of seeds and thus have lower relative fitness.

▼ Figure 23.13 Modes of selection. These cases describe three ways in which a hypothetical deer mouse population with heritable variation in fur coloration might evolve. The graphs show how the frequencies of individuals with different fur colors change over time. The large white arrows symbolize selective pressures against certain phenotypes.





(a) Directional selection shifts the overall makeup of the population by favoring variants that are at one extreme of the distribution. In this case, lighter mice are selected against because they live among dark rocks, making it harder for them to hide from predators.

(b) Disruptive selection favors variants at both ends of the distribution. These mice have colonized a patchy habitat made up of light and dark rocks, with the result that mice of an intermediate color are selected against.

(c) Stabilizing selection removes extreme variants from the population and preserves intermediate types. If the environment consists of rocks of an intermediate color, both light and dark mice will be selected against.