

## Processes That Drive the Evolution of Populations



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## Evolution by Natural Selection

*“Those individuals that possess superior physical, behavioral, or other traits are more likely to survive than those that are not so well-endowed. By surviving, they gain the opportunity to pass on their favorable characteristics to their offspring. As the frequency of these characteristics increases in the population, the nature of the population as a whole will gradually change.”*



Charles Darwin  
(1809 – 1882)

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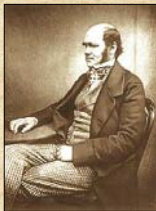
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## Evolution by Natural Selection

Evolution is driven by the interactions of populations, environmental conditions and their effects upon the survival and reproduction of the individuals in those populations (called natural selection).

Evolutionary change usually takes place on the time scale of thousands or millions of years.



**: changes in gene frequency over time.**

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## A Question (?)



Do all individuals in a population possess the same traits (attributes)?



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## A Question (?)



Why do individuals in a population differ slightly in traits? How does this affect the evolution of a population?



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## Variation in a Population



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## Predation as a Process in the Evolution of Populations



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## However . . . . .

What is the advantage of being a fast cheetah?



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## However . . . . .

What is the **dis**advantage of being a fast cheetah?



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## “Runaway Selection for Traits”

What **limits** the expression or variation in a population?



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## What limits Variation?



It is the ultimate goal in life: to **survive** and **reproduce**. Those individuals who are the most successful in survival will have the opportunity to produce the most progeny. Ultimately, the struggle to survive and reproduce will reveal only successful variations.



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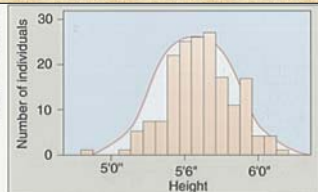
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## Variation in a Population



(a)



(b)

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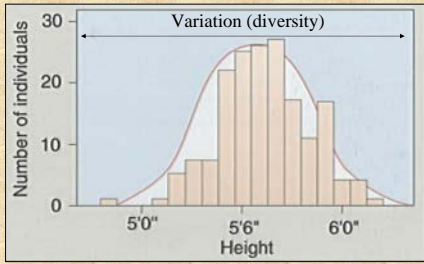
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# Variation in a Population




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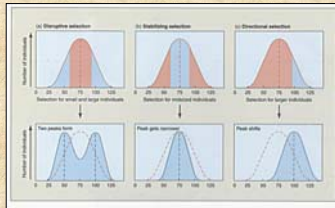
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# Modes of Selection in a Population

1. Directional Selection
2. Stabilizing Selection
3. Disruptive Selection




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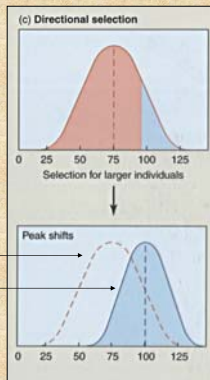
# Modes of Selection in a Population

## 1. Directional Selection

A selective advantage or pressure in one direction.

Examples:

- smaller cheetahs
- insect resistance to pesticides




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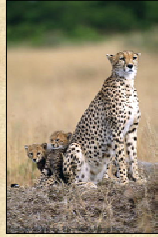
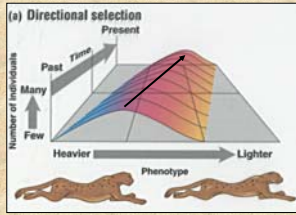
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# Modes of Selection in a Population



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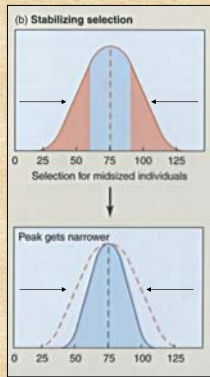
# Modes of Selection in a Population

## 2. Stabilizing Selection

A selective advantage or pressure favoring intermediate types.

Example:

- intermediate height in humans (leave behind more progeny)



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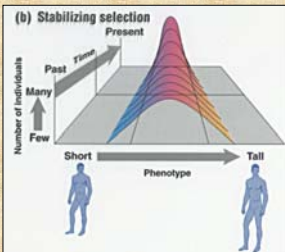
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# Modes of Selection in a Population



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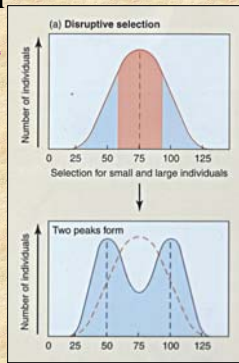
## Modes of Selection in a Population

### 3. Disruptive Selection

A selective advantage or pressure both extremes of a type. Intermediate types are not favored and selected against.

#### Example:

- African *Bematistes* Butterflies



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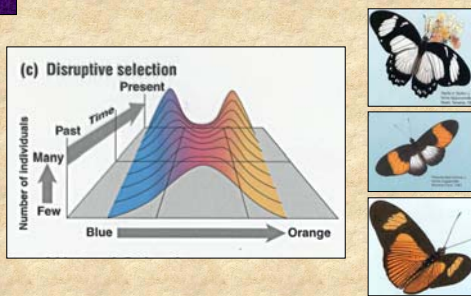
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## Modes of Selection in a Population



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## Evolution by Natural Selection

• **Postulate 1:** Individual members of a population differ from one another in many respects.

- Variations arise purely by chance resulting from random mutations in DNA.
- Differences are obvious in many physical characteristics and extend to molecular level.



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## Evolution by Natural Selection

- **Postulate 2:** At least some of the differences among members of a population are due to characteristics that may be passed from parent to offspring
  - However, the mechanism of inheritance was not understood at this point in time



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## Evolution by Natural Selection

- **Postulate 3:** In each generation, some individuals in a population survive and reproduce successfully but others do not
  - Darwin observed that many more individuals are born than survive
  - Some individuals have more offspring than others

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## Evolution by Natural Selection

- **Postulate 4:** Individuals with advantageous traits survive longest and leave the most offspring, a process known as **natural selection.**



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## Populations Evolve

- Natural selection acts on individuals within a population; however, it is the **population** that changes over time.



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## Natural Selection of Phenotypes

1. The variations on which natural selection works are produced by mutations that arise *spontaneously*.
2. Natural selection selects for organisms that are best adapted to a particular environment.
  - If the environment changes, a previously advantageous trait may become disadvantageous

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## Processes That Drive the Evolution of Populations



Genetic Variation

A constantly-changing environment

Population Interactions  
(e.g. predation)

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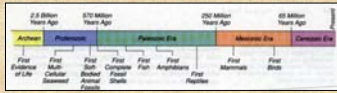
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# Processes That Drive the Evolution of Populations

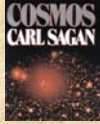


Dr. Carl Sagan (1934 - 1996)

Variation in a population is affected by:

Time  
Natural Selection  
Randomness

ERA	PERIOD	DATE (BCE/CE)
Cenozoic	Oligocene	34
	Neogene	23
	Quaternary	2.6
Mesozoic	Cretaceous	136
	Jurassic	201
	Triassic	252
Paleozoic	Permian	252
	Carboniferous	359
	Devonian	360
Proterozoic	Proterozoic	2500
	Proterozoic	570
	Proterozoic	2500
Archean	Archean	2500




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# Agents of Evolutionary Change

Factor	Description
Mutation	<p>The ultimate source of variation. Individual mutations occur so rarely that mutation alone does not change allele frequency much.</p>

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# Agents of Evolutionary Change

Migration	<p>A very potent agent of change. Migration acts to promote evolutionary change by enabling populations that exchange members to converge toward one another.</p>
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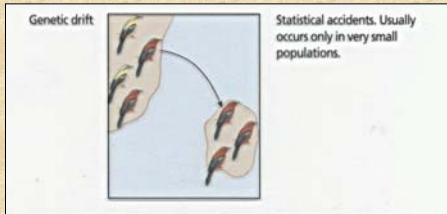
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## Agents of Evolutionary Change



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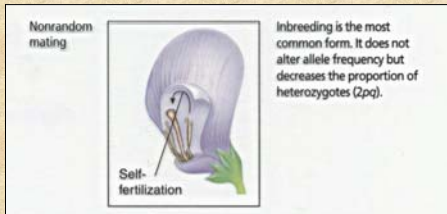
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## Agents of Evolutionary Change



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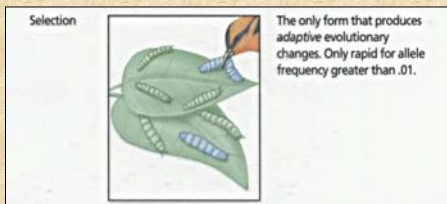
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## Agents of Evolutionary Change



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