Genes, Variation and Evolution

16-1 and 16-2

What is the difference between an adaptation and an acquired characteristic?

- Acquired characteristic – something you change about yourself.

- Adaptation – a genetic trait that you inherit that makes you better suited for your environment

Where do adaptations come from?

- Natural Variation – within a species there are many differences
- Offspring look different from parents
- Members of the same species can breed *and produce fertile offspring*
- Donkey + horse = infertile mule

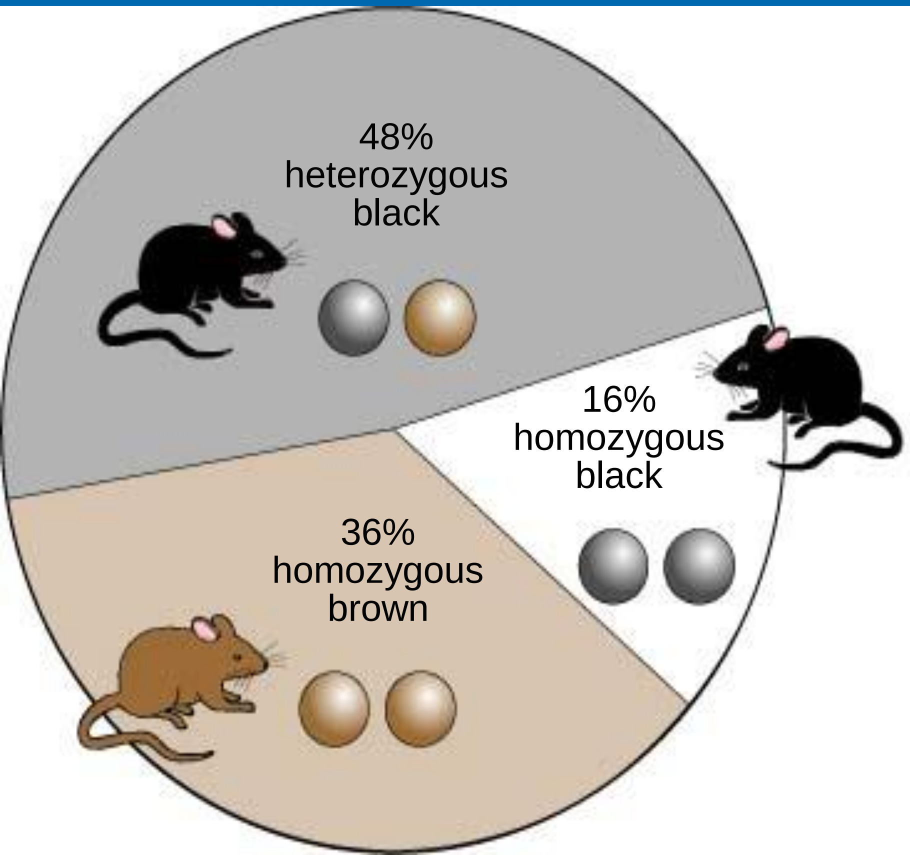
Gene Pool

- Population – members of a species in a certain area
- Gene pool = all the genes within that population

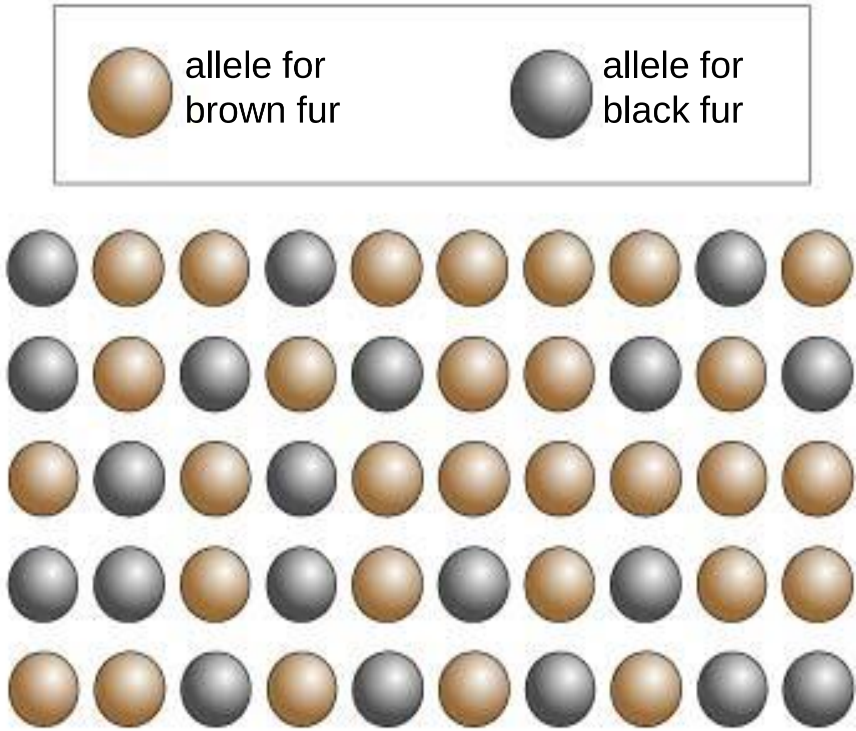
Relative Frequency

- Percentage of each allele for a certain gene within a population

Sample Population



Frequency of Alleles



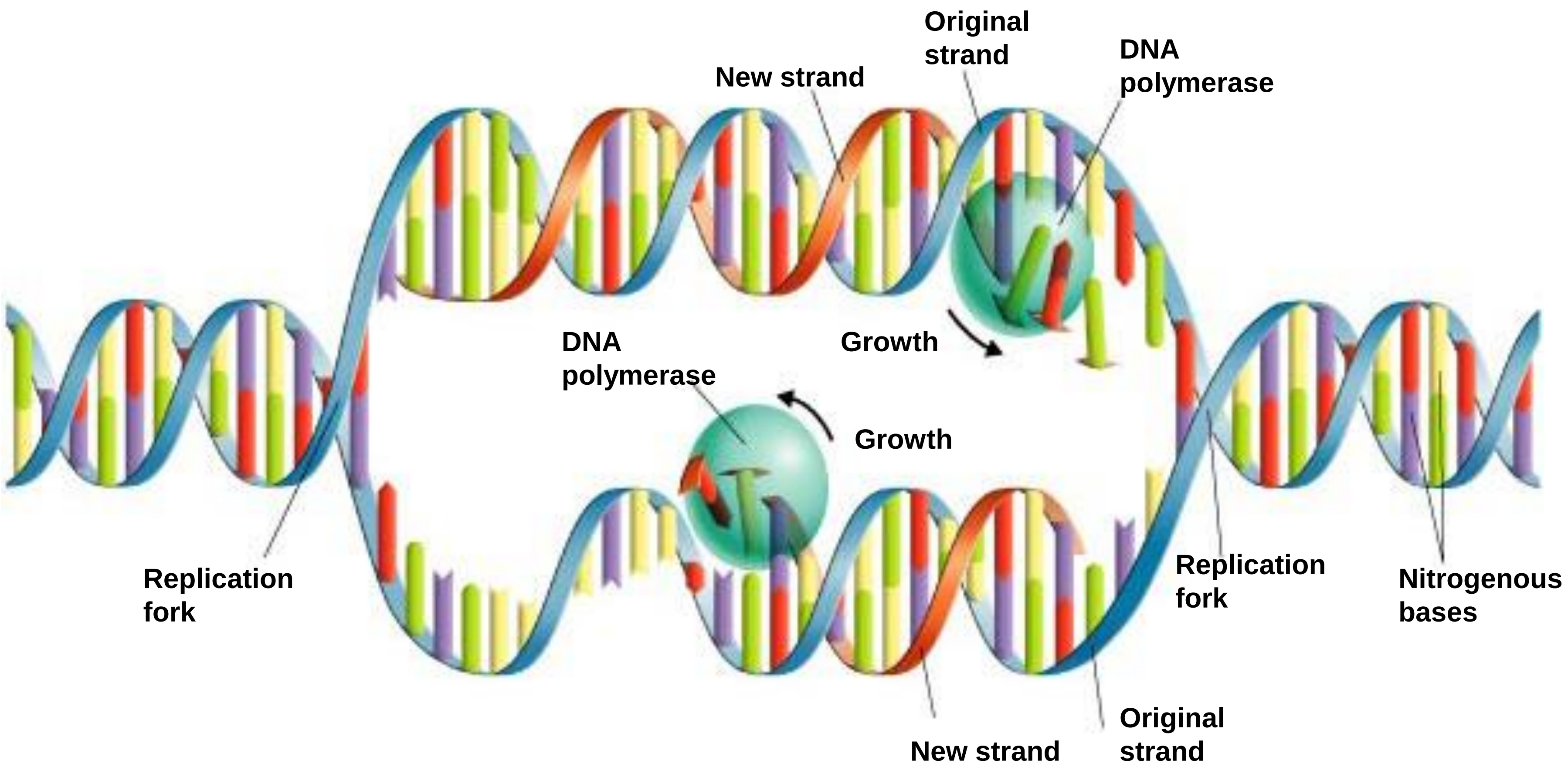
Why so much variation?

- Mutations – mistakes in genetic message
- Replication – DNA is copied
- Transcription – mRNA is made from DNA
- Translation
  - mRNA is read by ribosomes
  - tRNA delivers amino acids
  - Protein is made

http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/dna-rna2.swf

DNA Replication

- DNA molecule is duplicated or copied
- DNA polymerase – enzyme



http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/transcription.swf

Transcription

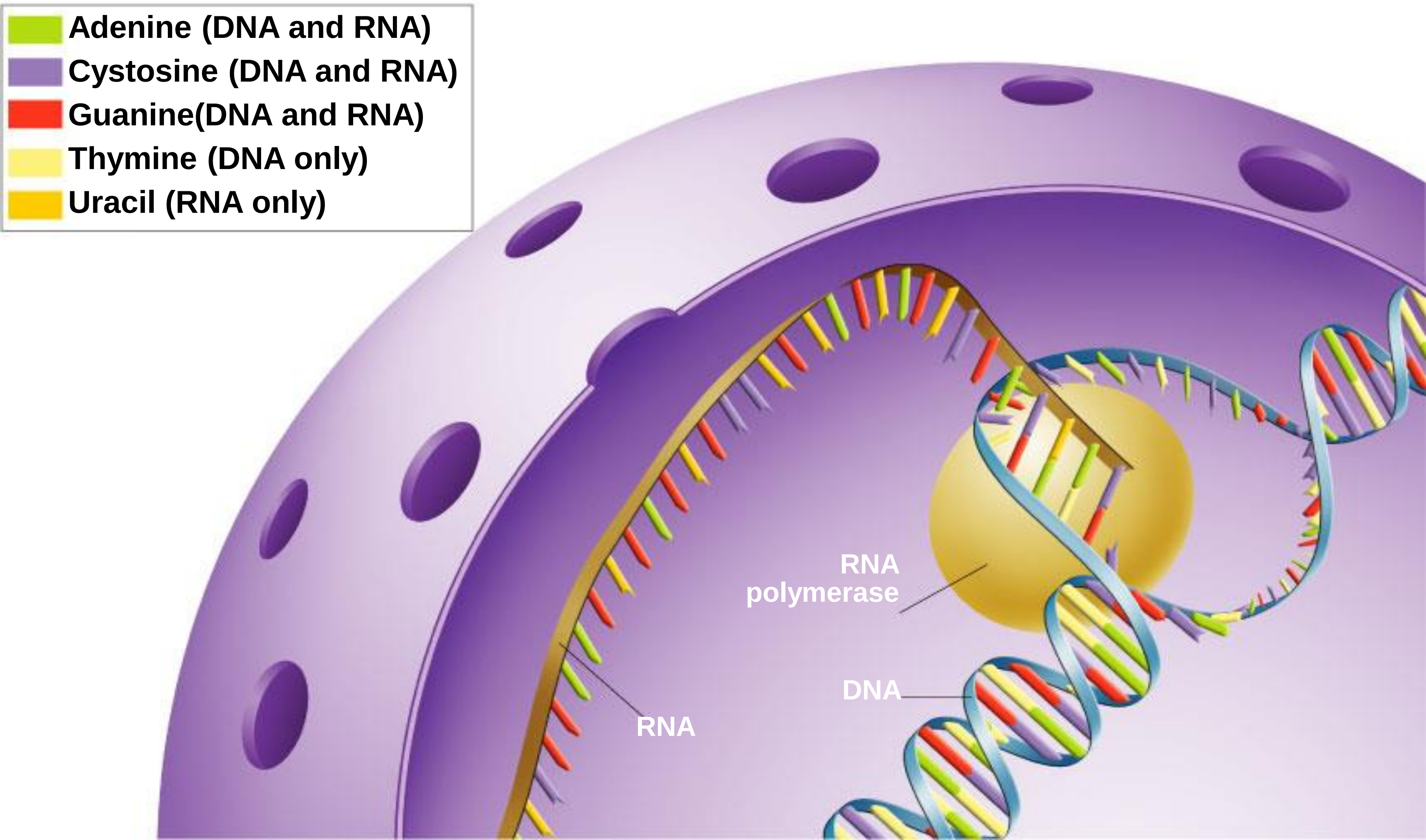
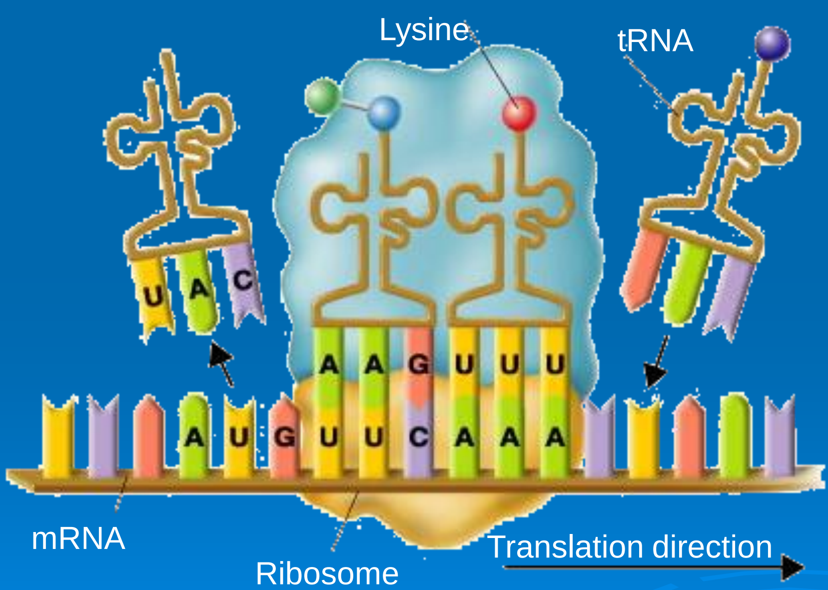
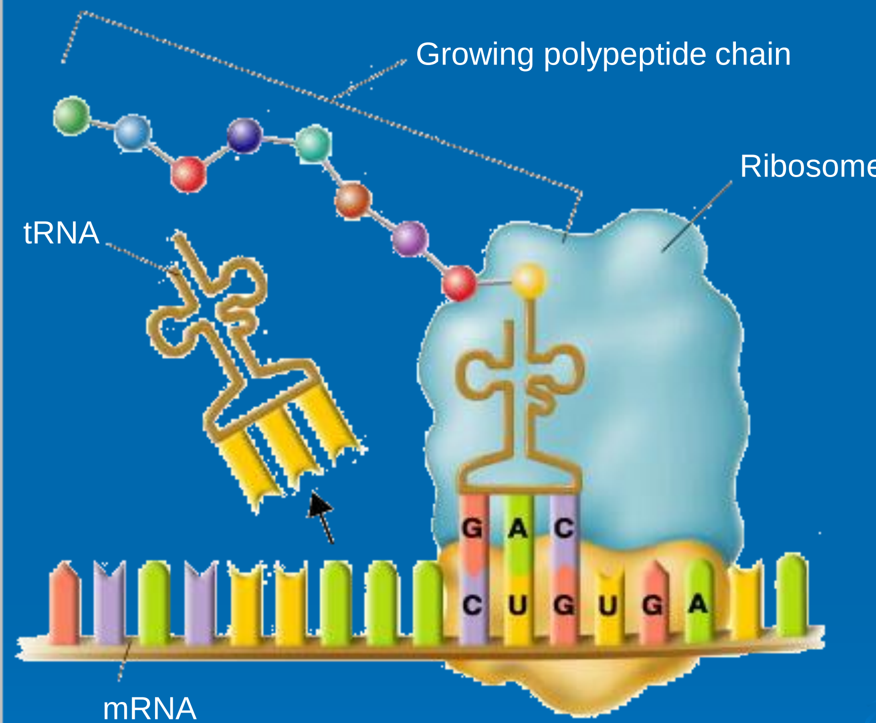


Figure 12–18 Translation (continued)

The Polypeptide "Assembly Line"
The ribosome joins the two amino acids—methionine and phenylalanine—and breaks the bond between methionine and its tRNA. The tRNA floats away, allowing the ribosome to bind to another tRNA. The ribosome moves along the mRNA, binding new tRNA molecules and amino acids.





Completing the Polypeptide
The process continues until the ribosome reaches one of the three stop codons. The result is a growing polypeptide chain.

http://www.stolaf.edu/people/giannini/flashanimat/molgenetics/translation.swf

Gene Shuffling

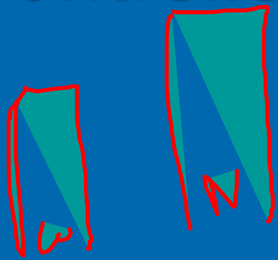
Meiosis http://www.sumanasinc.com/webcontent/animations/content/meiosis.html

- alleles assort independently during gamete formation
- Crossing over

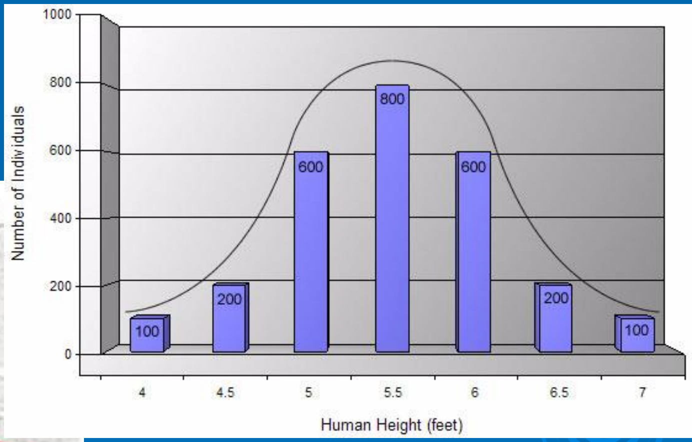
- ½ chromosomes come from mother
- ½ chromosomes come from father
- Sexual reproduction produces many different phenotypes
- Sexual reproduction doesn't change the relative frequencies of alleles

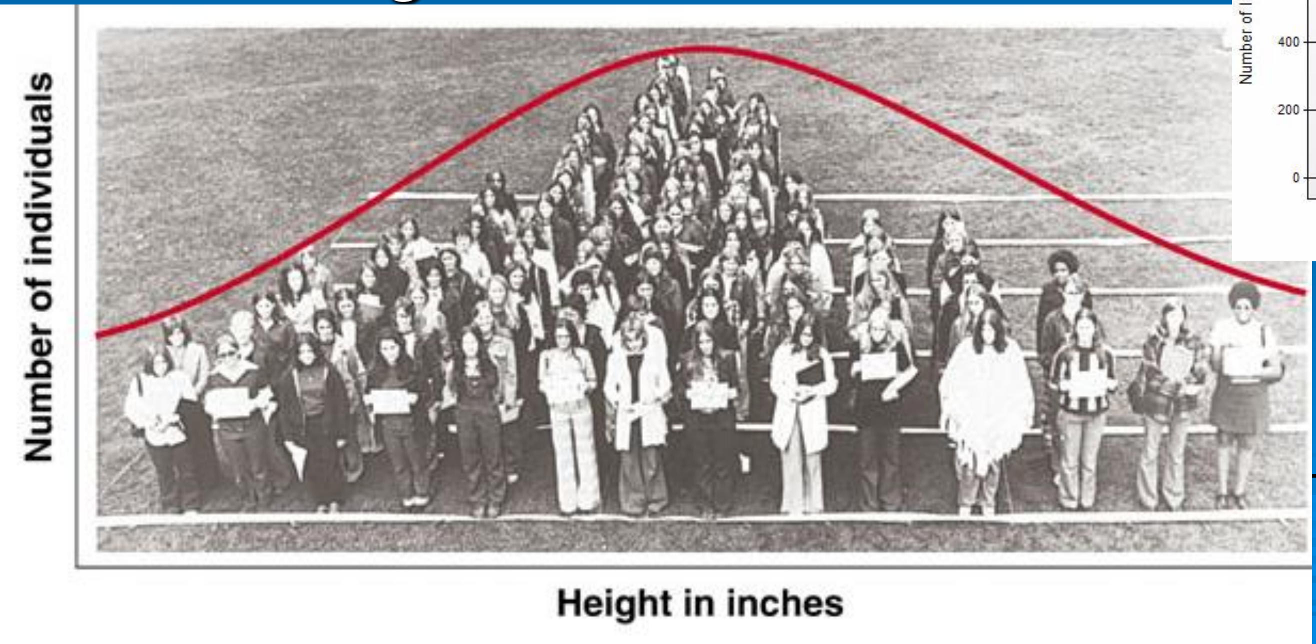
Single Gene vs. Polygenic traits

- Single gene traits are controlled by only one gene
  - Widow's peak



- Polygenic traits are controlled by many alleles
  - Height





Natural Selection on Single Gene traits

- Natural Selection can lead to changes in allele frequencies
- If relative frequencies change, the phenotypes in the population will change
- How can fatal alleles be preserved in the gene pool?

GG, Gg

gg

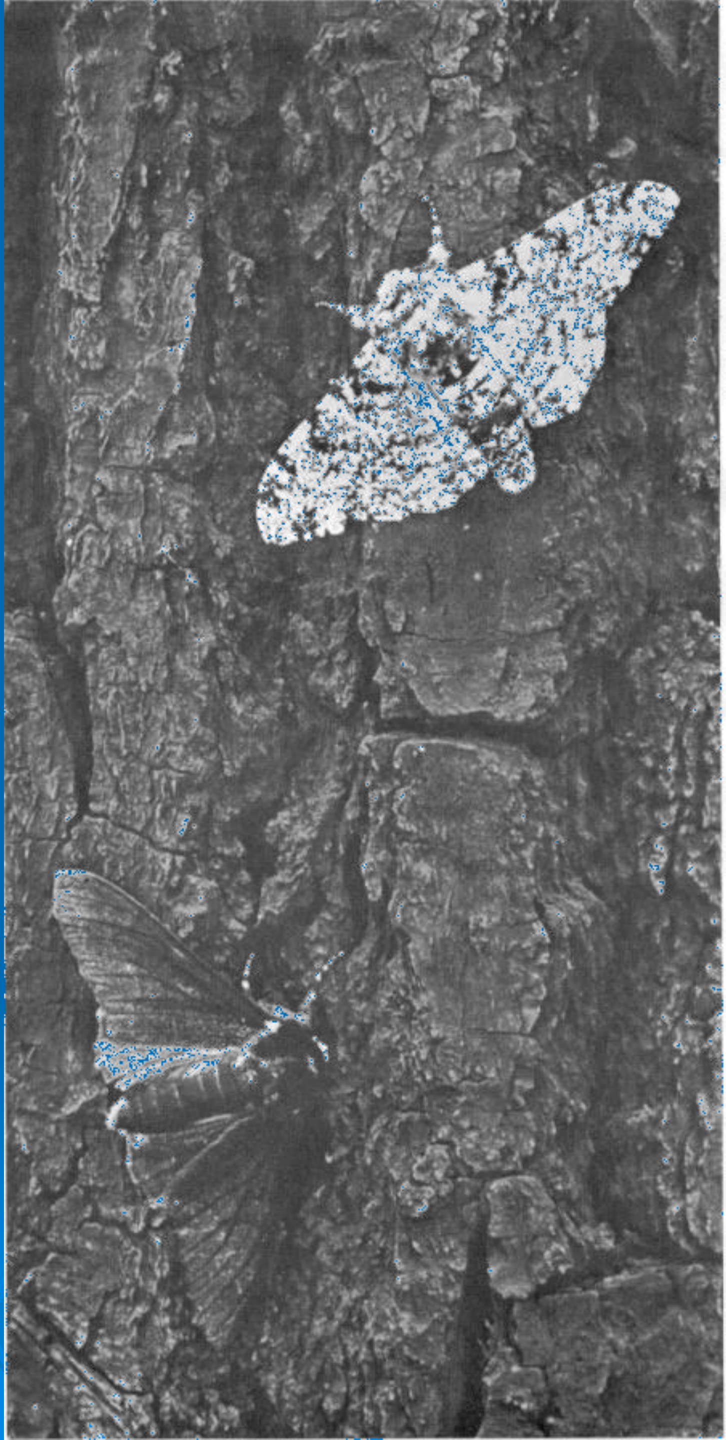
How does Natural Selection affect populations?

- Natural Selection works on phenotypes, not genotypes.
- Natural selection can change the relative frequency of alleles over time
  - When an individual dies w/out reproducing his alleles are removed from the population.
- Evolution = any change in the relative frequency of alleles in a population’s gene pool
- Evolution changes POPULATIONS, not individuals

Natural Selection on Single Gene Traits

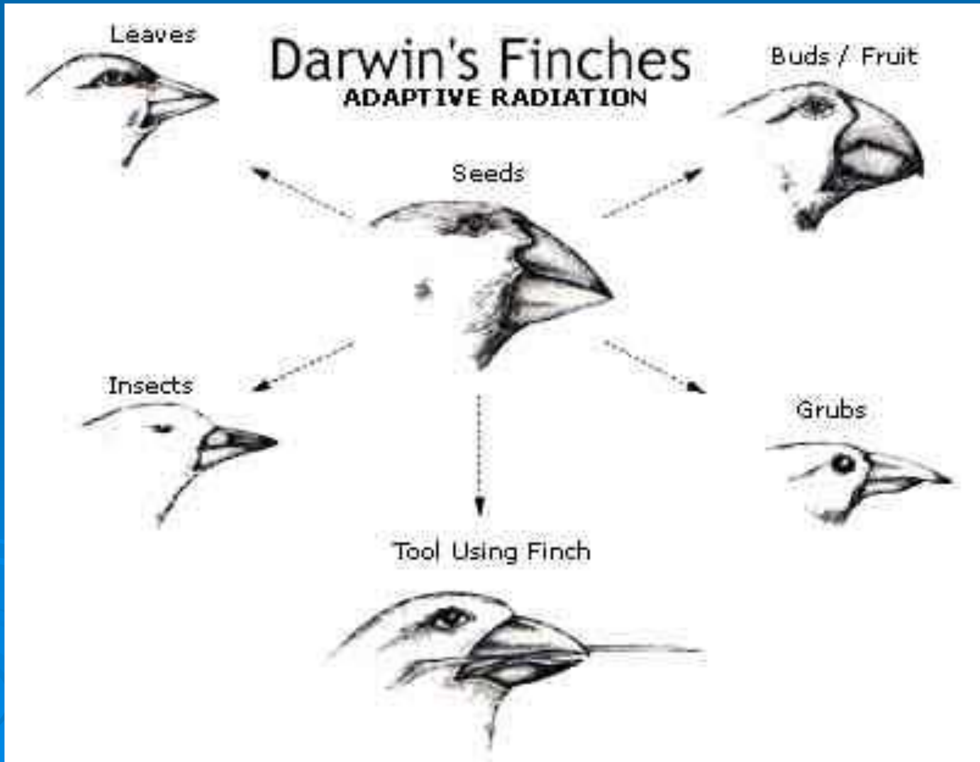
- Example: Pepper moth in England
- Wing color controlled by one gene
- Normally, white wings are better camouflaged.
- Relative allele frequency: 90% white, 10% black

- After industrial revolution, black wings were better camouflaged.
- Relative frequency : 90% black, 10% white
- Most fit Phenotype survives to pass on alleles.
- If White allele is dominant, could it be eliminated?
- What if white allele is recessive?



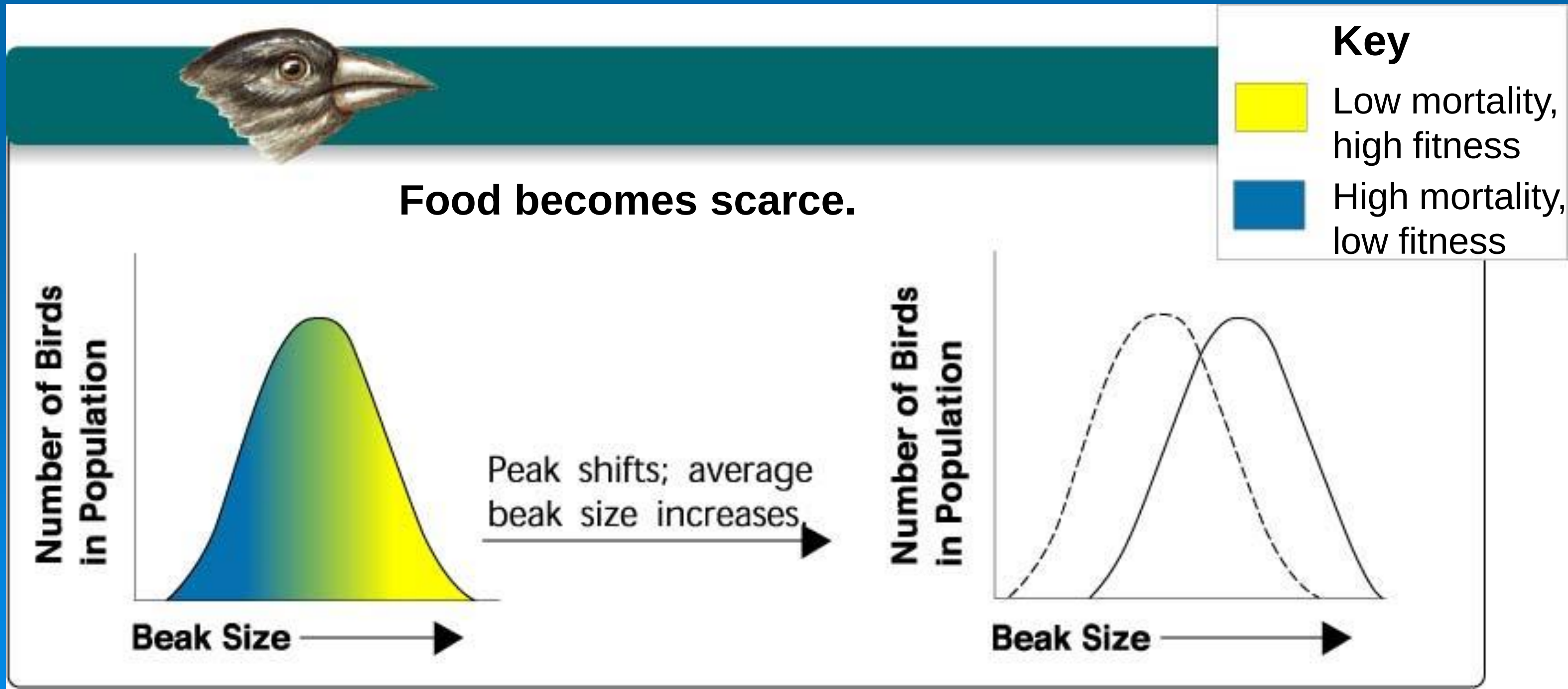
Natural Selection on Polygenic Traits

- Polygenic traits produce many phenotypes
- Forms a bell curve
- Directional Selection
- Stabilizing Selection
- Disruptive Selection



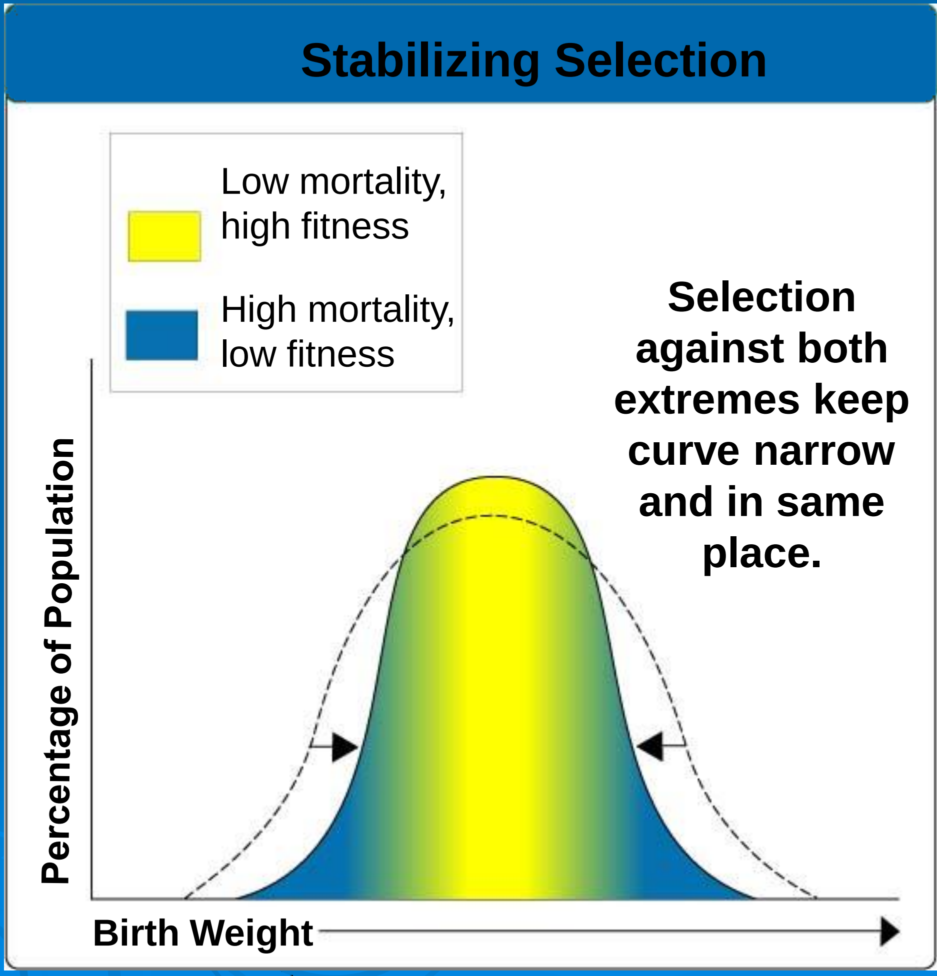
Directional Selection

- Individuals at one end of curve have higher fitness
- Food is scarce, birds with bigger beaks survive longer
- Over time the beak size of the population increased



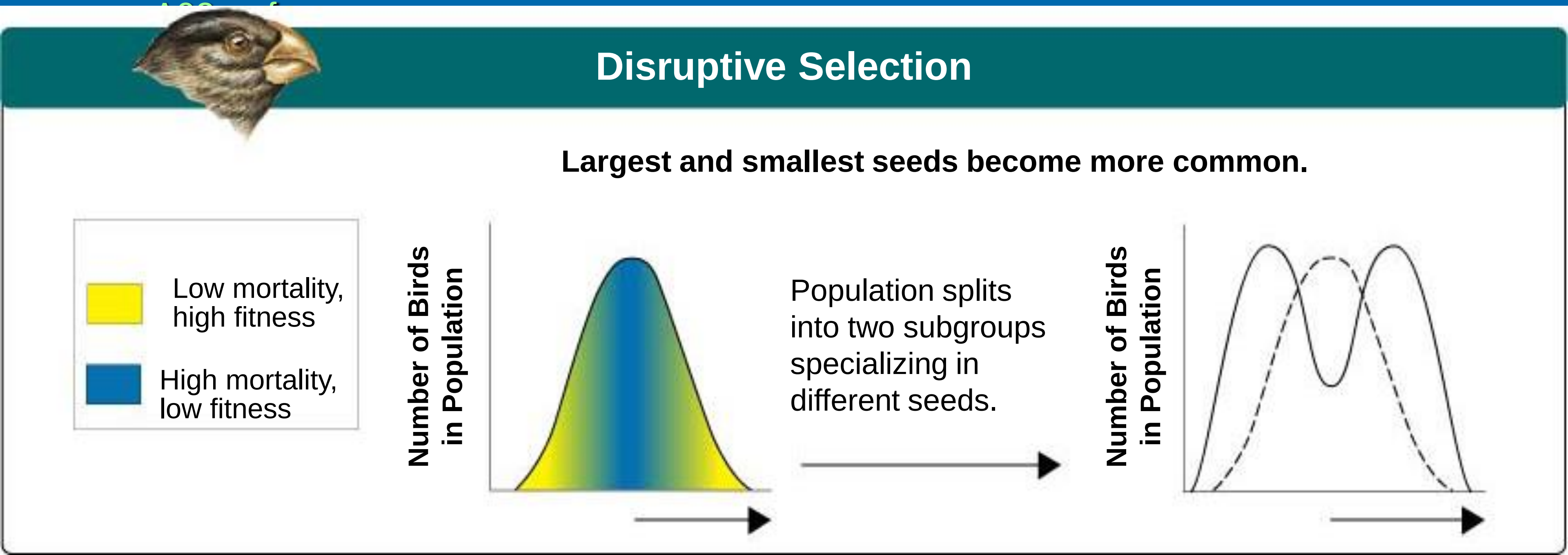
Stabilizing Selection

- Individuals in the middle of the curve are most fit
- Individuals at extremes are not fit
- Birth weight:
  - too small = unhealthy
  - Too big = difficult birth or unhealthy
- Population shifts towards the middle



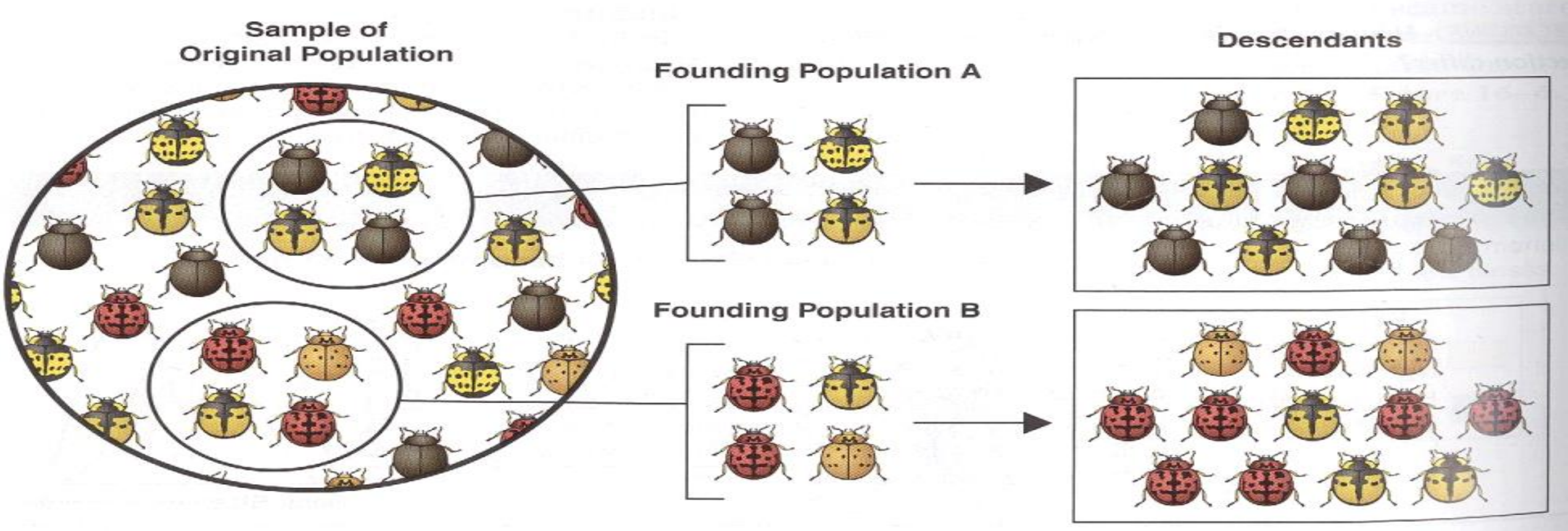
Disruptive Selection

- Individuals at upper and lower end of curve are most fit
- Can cause population to split into two distinct phenotypes
- Galapagos Finches and beak size
  - http://wps.pearsoncustom.com/wps/media/objects/3014/3087289/Web_Tutorials/17_

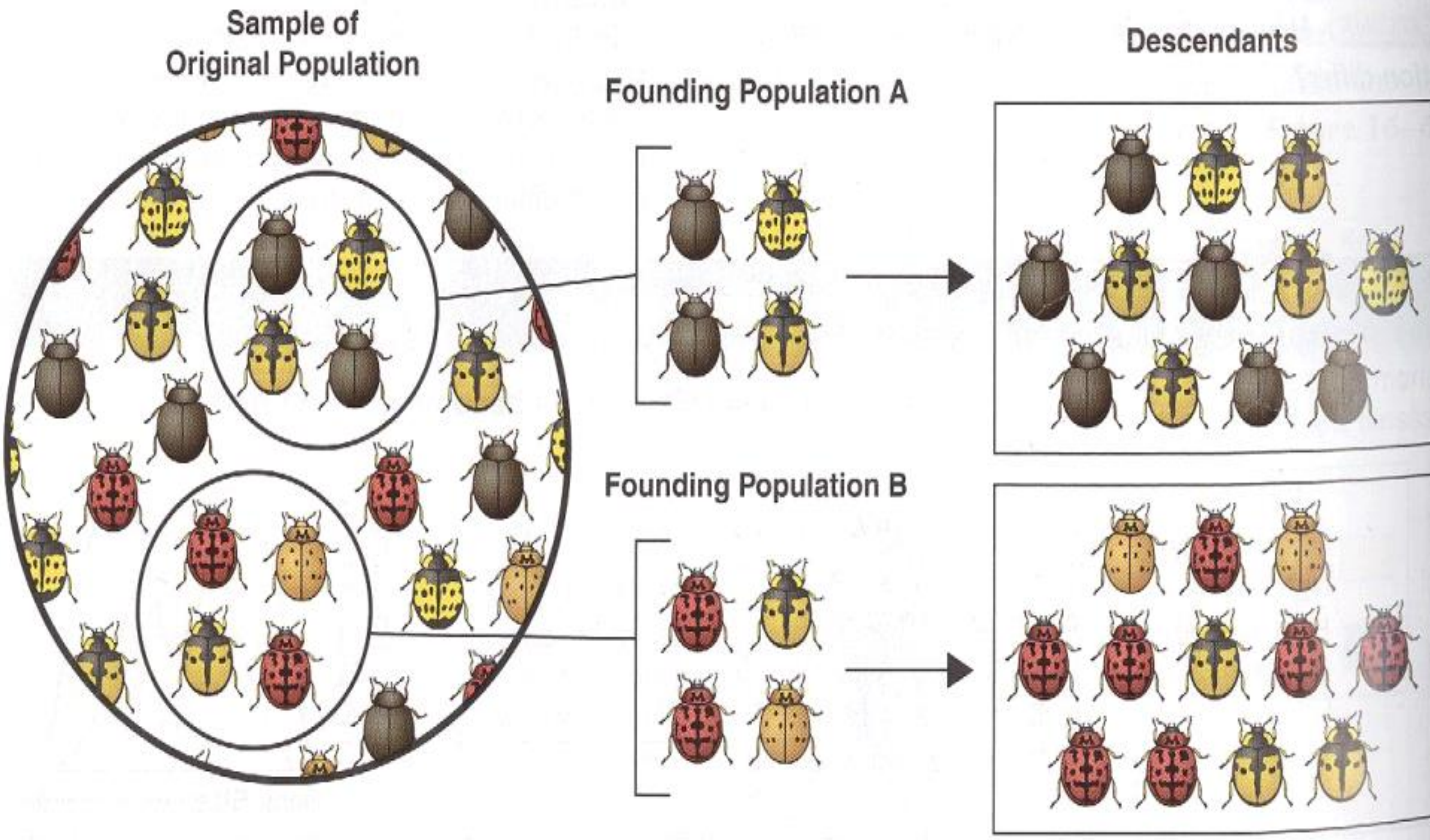


Genetic Drift

- Small populations – An allele may become more frequent by chance
- Founder Effect – small group of individuals colonize a new habitat
  - Population contains only alleles found in founding generation

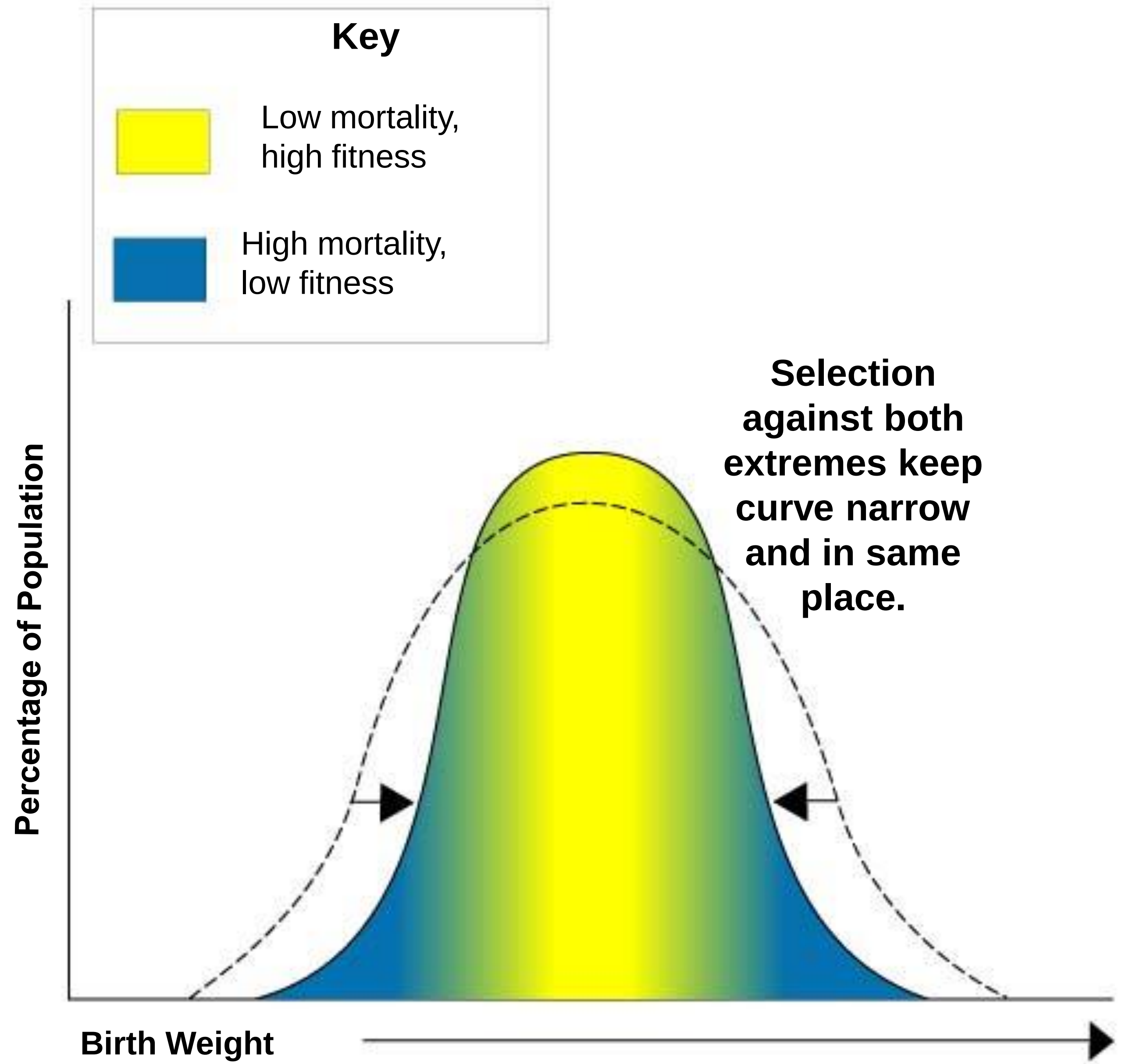


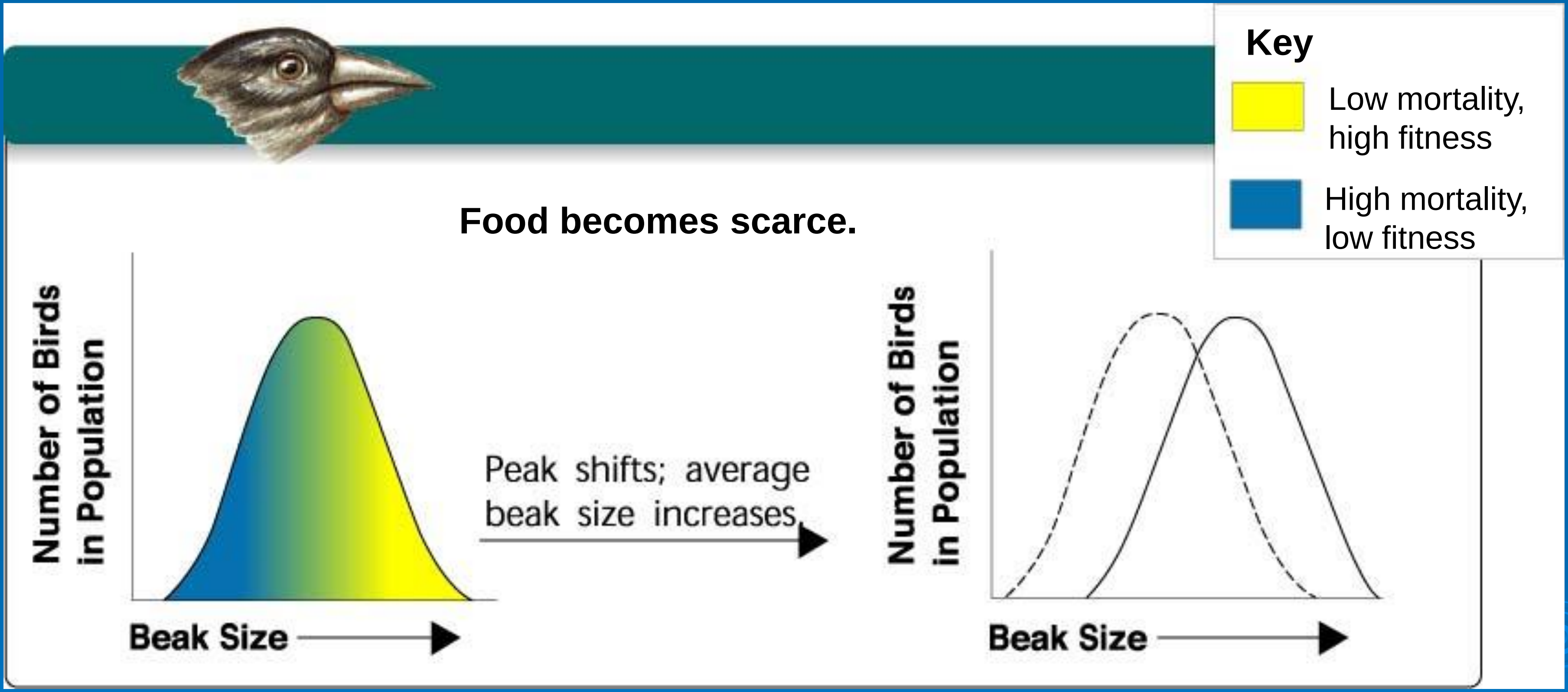
Founder Effect

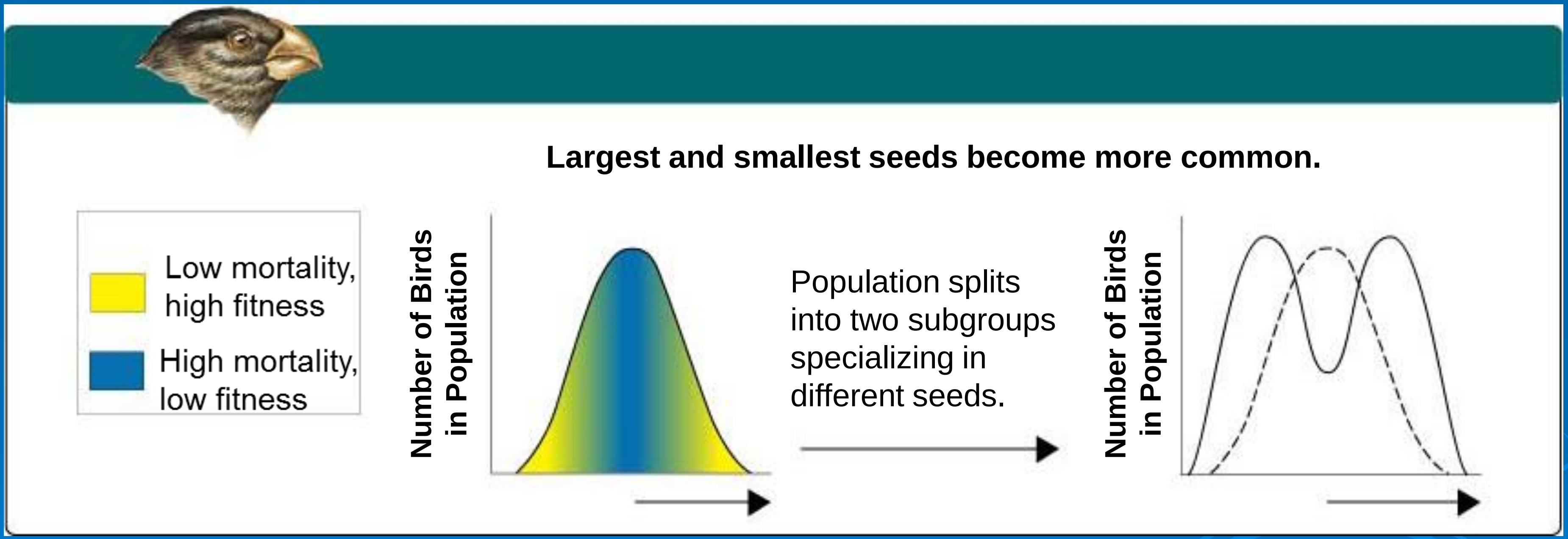


Hardy-Weinberg principle

- Genetic Equilibrium – allele frequencies remain constant *if . . .*
- Random Mating
- Large Population
- No movement into or out of population
- No mutations
- No natural Selection


Key
Low mortality, high fitness
High mortality, low fitness
Selection against both extremes keep curve narrow and in same place.
Percentage of Population
Birth Weight


Key
Low mortality, high fitness
High mortality, low fitness
Food becomes scarce.
Number of Birds in Population
Beak Size
Peak shifts; average beak size increases
Number of Birds in Population
Beak Size


Largest and smallest seeds become more common.
Low mortality, high fitness
High mortality, low fitness
Number of Birds in Population
Population splits into two subgroups specializing in different seeds.
Number of Birds in Population