Theories of Evolution

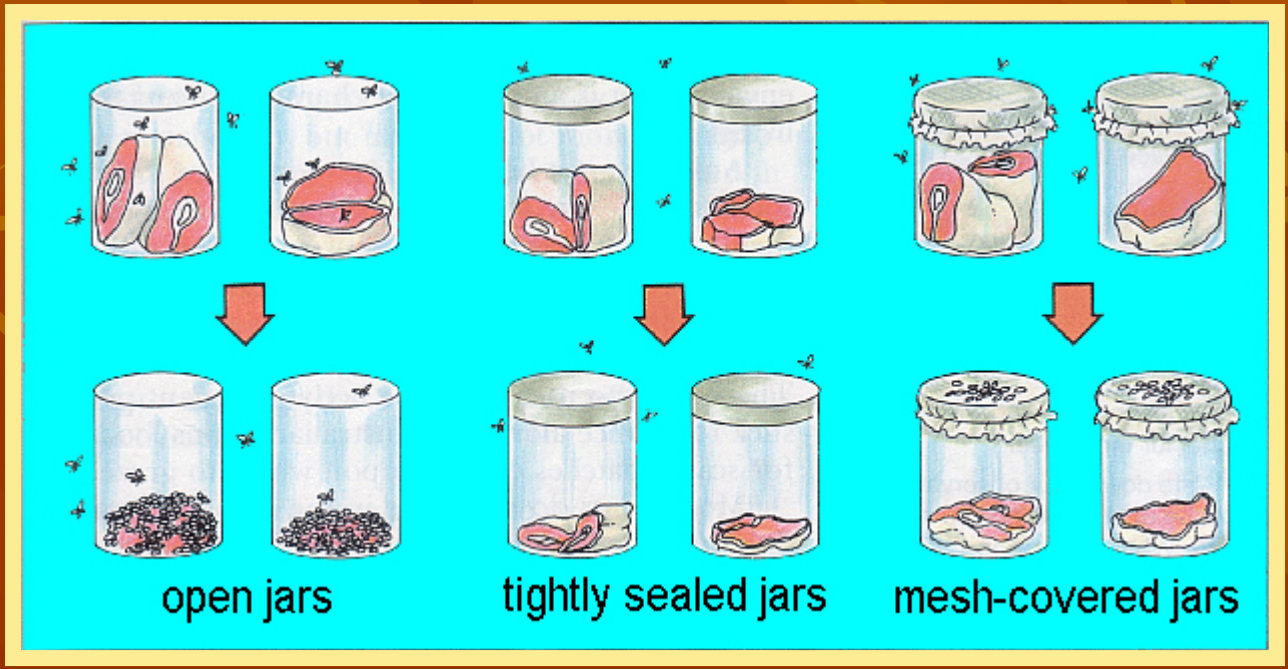
Spontaneous Generation

- **Life forms arise spontaneously from non-living matter.**

- **As late as the 1600s, it was believed that mice could be produced from placing sweaty clothing and husks of wheat in an open-mouthed jar, then waiting for about 21 days, during which time it was alleged that the sweat from the clothing would penetrate the husks of wheat, changing them into mice.**

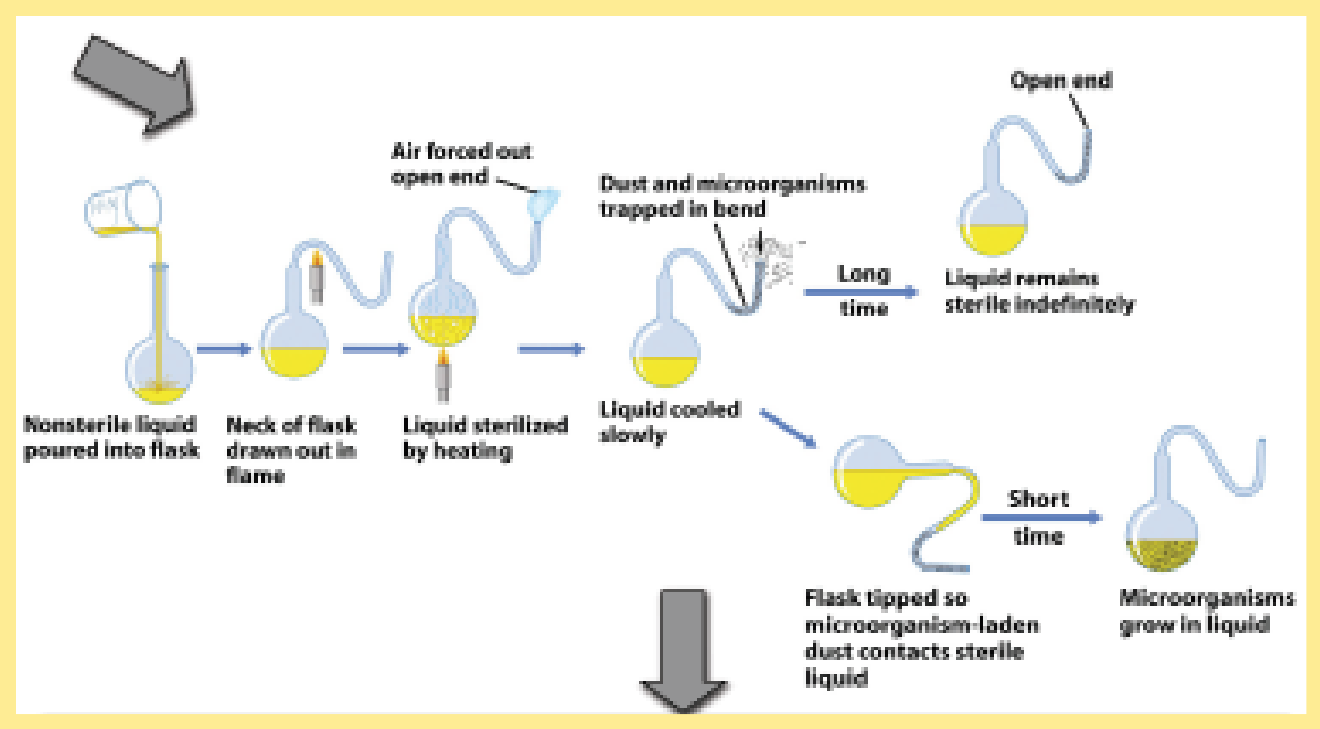
Challenges to Spontaneous Generation

- **Francesco Redi (1668) - Italian physician and poet.**
- **At that time, it was widely held that maggots spontaneously arose in rotting meat.**
- **Redi believed that maggots developed from eggs laid by flies.**



Challenges to Spontaneous Generation

- **Louis Pasteur (1859) – French chemist.**
- **Improving on past methods by other scientists on spontaneous generation, *Pasteur definitively refuted this theory demonstrated that microorganisms are everywhere, even in the air.***

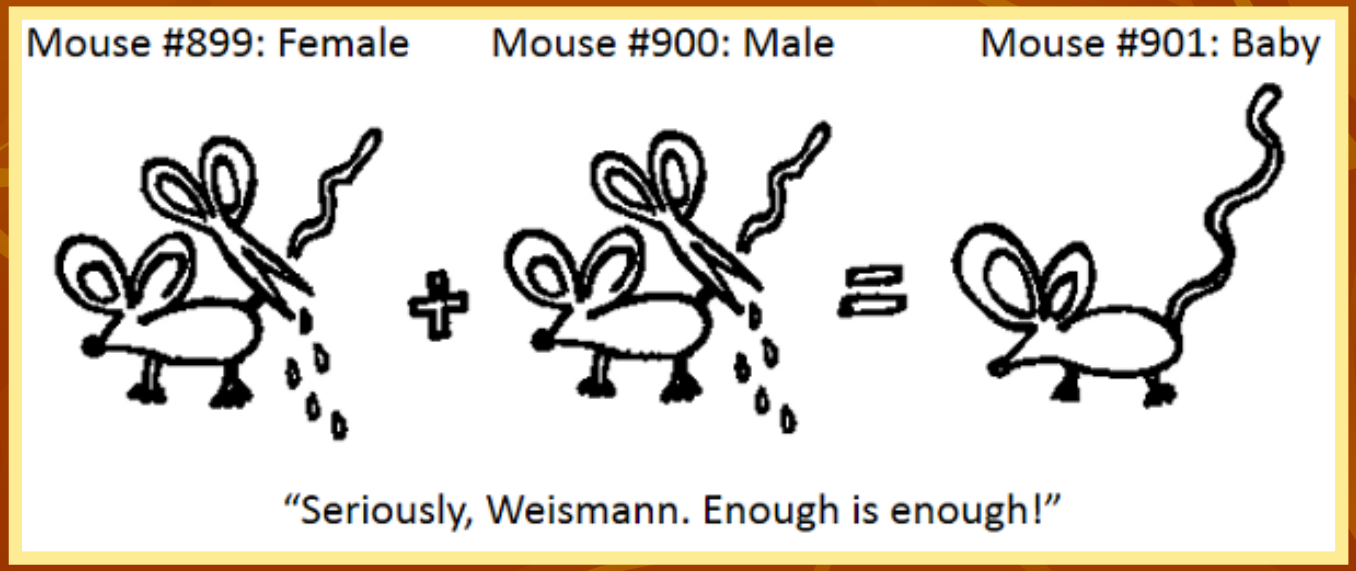


Jean Baptiste Lamarck

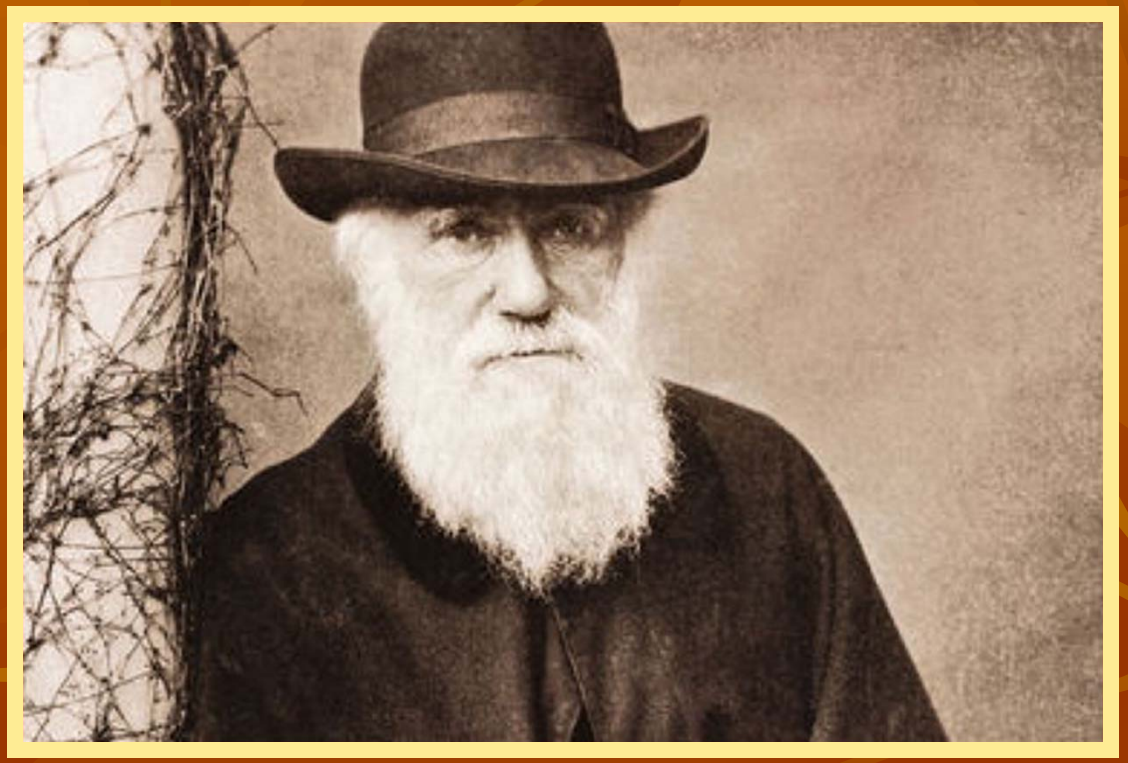
- **Jean Baptiste Lamarck (1774-1829) Although his ideas were eventually discredited, Lamarck is recognized as one of the first individuals who offered explanations for his observations of life.**
- **His theory included:**
  - ***Use and Disuse:*** **organisms developed new variations based on need. If an organism used a specific characteristic a great deal, then it would increase in size. Those traits that were not used often would shrink.**
  - ***Inheritance of Acquired Characteristics:*** **useful characteristics were acquired during the organism's lifetime and passed on to future generations.**

Disproving Lamarck's Theories

- **August Weismann (1834-1914): tested Lamarck's theory of inheritance of acquired characteristics.**
- **He proposed to cut of the tails of white mice and let them mate. He repeated this procedure for 20 generations of mice.**
- **The results……**



Charles Darwin



Charles Robert Darwin was born on 12 February 1809 in into a wealthy and well-connected family. His maternal grandfather was china manufacturer *Josiah Wedgwood*, while his paternal grandfather was *Erasmus Darwin*, one of the leading intellectuals of 18th century England.

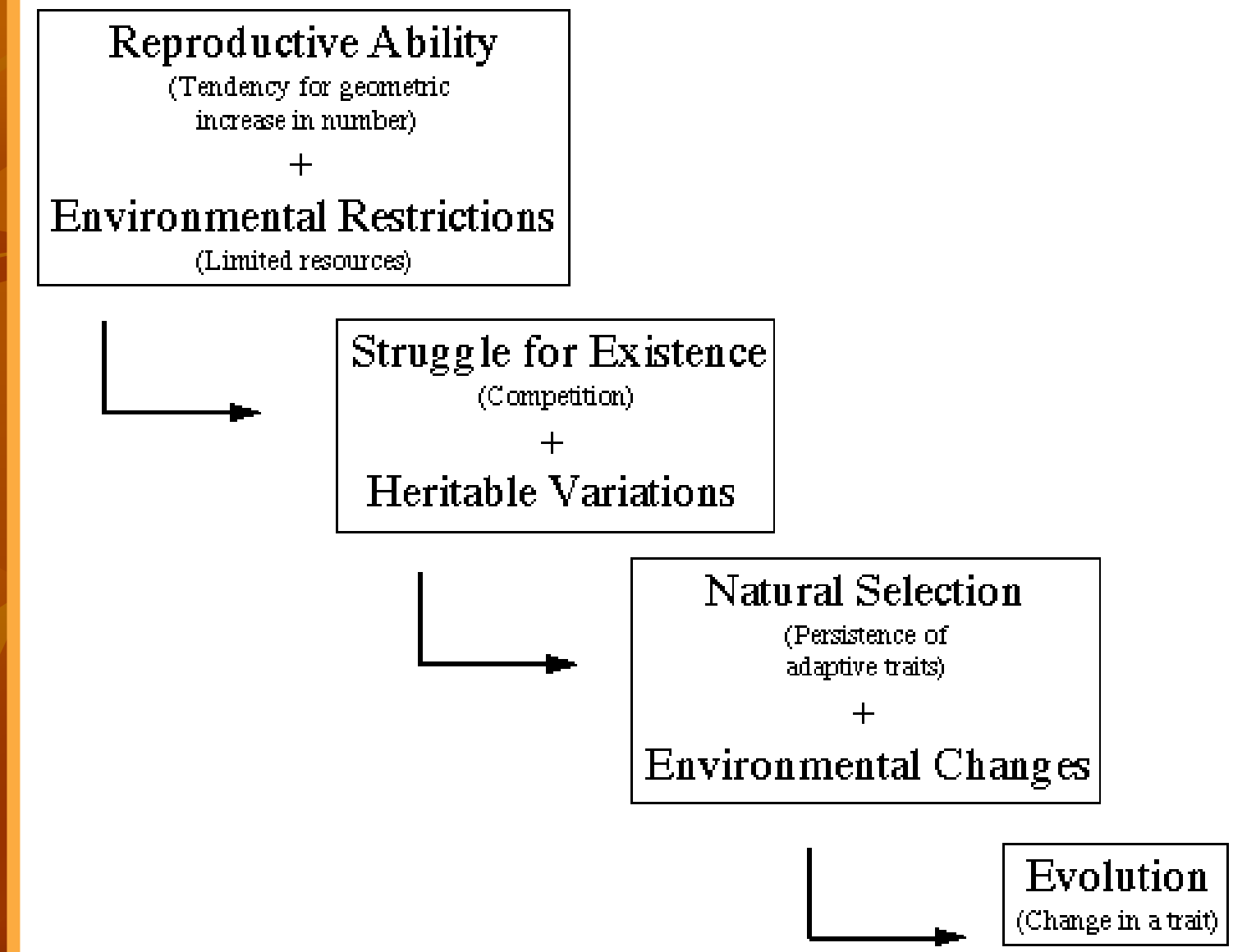
Charles Darwin (cont'd)

- **In 1831, he joined a five year scientific expedition on the survey ship *HMS Beagle.***
- **The breakthrough in his ideas came in the *Galapagos Islands, an* archipeligo 500 miles west of South America.**
- ***Darwin noticed that each island supported its own form of finch which were closely related but differed in important ways.***
- **On his return to England in 1836, Darwin tried to solve the riddles of these observations and the puzzle of how species evolve**
- **He proposed a theory of evolution occurring by the process of natural selection. *Organisms best suited to their environment are more likely to survive and reproduce, passing on the characteristics which helped them survive to their offspring. Gradually, the species changes over time.***

Charles Darwin (cont'd)

- **Darwin worked on his theory for 20 years. After learning that another naturalist, *Alfred Russel Wallace,* had developed similar ideas, the two made a joint announcement of their discovery in 1858. However, they agreed that Darwin would publish his work first –**
- **In 1859 Darwin published his controversial book, *On the Origin of Species by Means of Natural Selection.***
- **Darwin's theory implied that *homo sapiens* was simply another form of animal, perhaps having an evolutionary relationship with apes, challenging the prevailing orthodoxy on how the world was created.**
- **Darwin was vehemently attacked, particularly by the Church.**

Theory of Natural Selection



Natural Selection

- *Overpopulation:* **within a population, more offspring are born than can possibly survive due to carrying capacity of the given environment.**

- *Competition:* **individual in each species, within each generation, compete for limited resources such as food, space, water, light, opportunities to reproduce.**

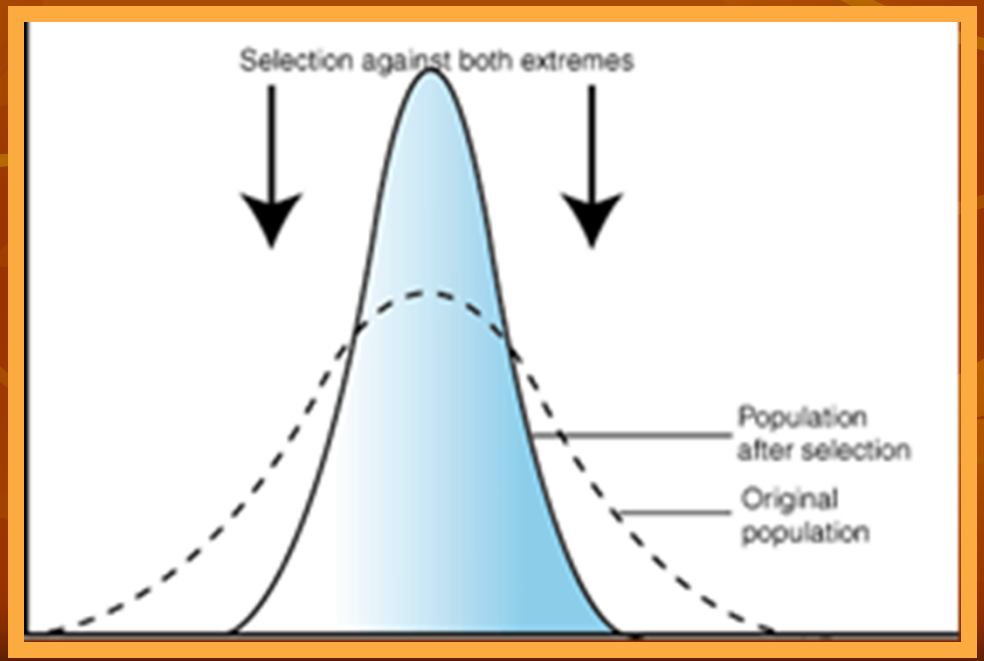
- *Variations:* **members of the same generation show variations in traits that provide a competitive advantage for survival.**

Natural Selection (cont'd)

- *Survival of the Fittest:* **those individuals in the generation that survive are those that are best adapted to their environment. They have the necessary variations to survive. Reproduction: Individuals that survive and reproduce pass these variations to the next generation.**
- *Speciation:* **the offspring of the fittest will inherit the variations that are necessary for survival in that environment. These traits pass from generation to generation.**
- **In a *changing environment,* due variations that occur generation to generation, *a new species may result that is better adapted to their environment.***

Types of Natural Selection

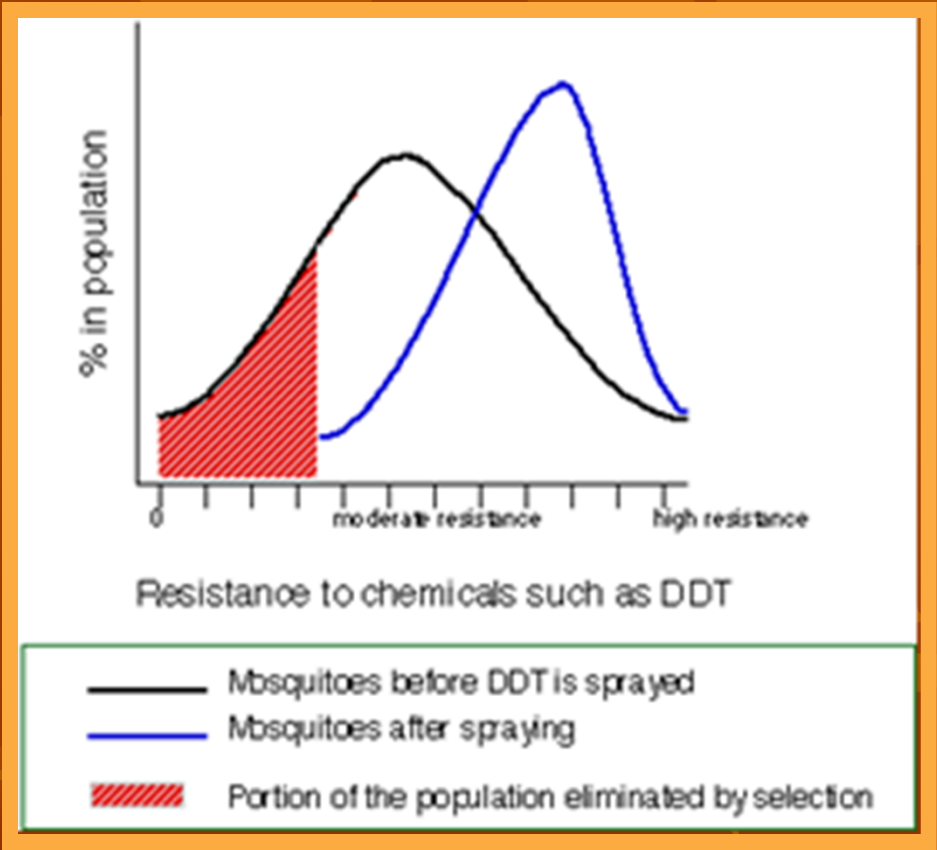
- *Stabilizing Selection:* **selection in the population supports the more common intermediate forms and selects AGAINST organisms with traits from either extreme (if you remember your genetics, the heterozygous form is more common than homozygous dominant or recessive).**



Types of Natural Selection (cont'd)

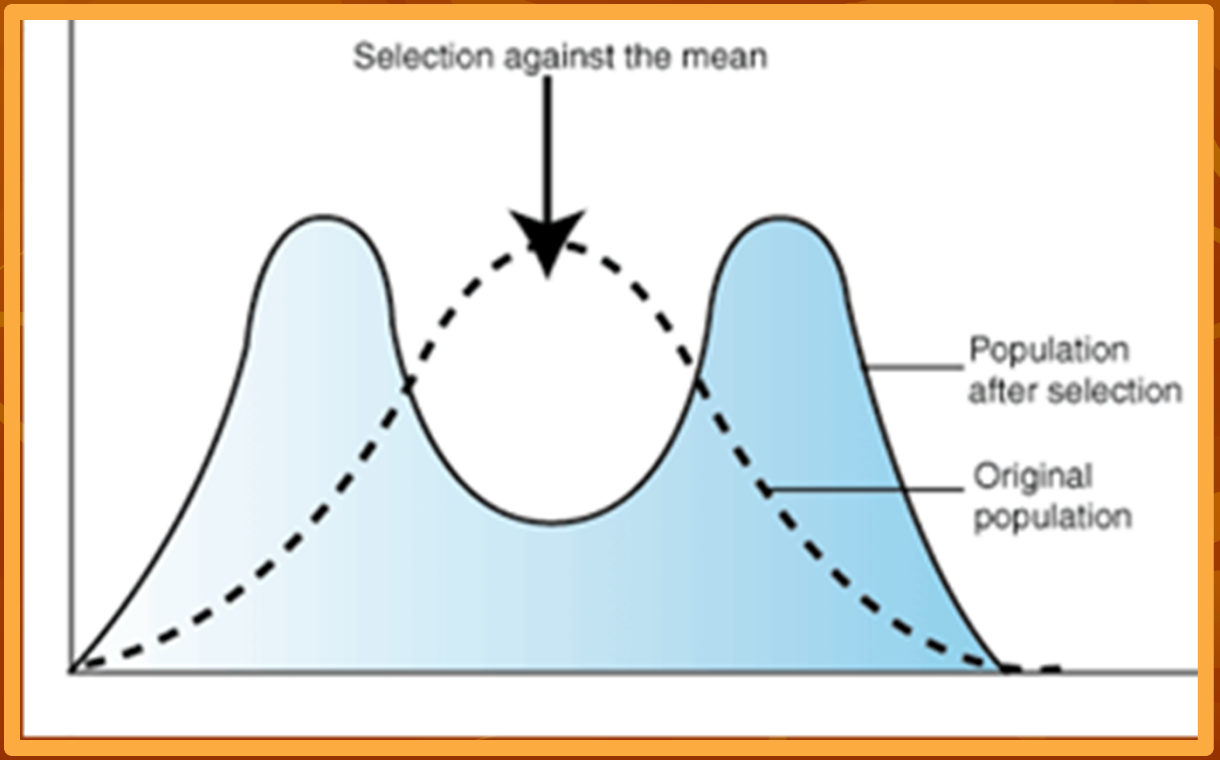
- ***Directional Selection:*** **When individuals at one end of the curve have higher fitness and are favored more than individuals in the middle or at the other end.**

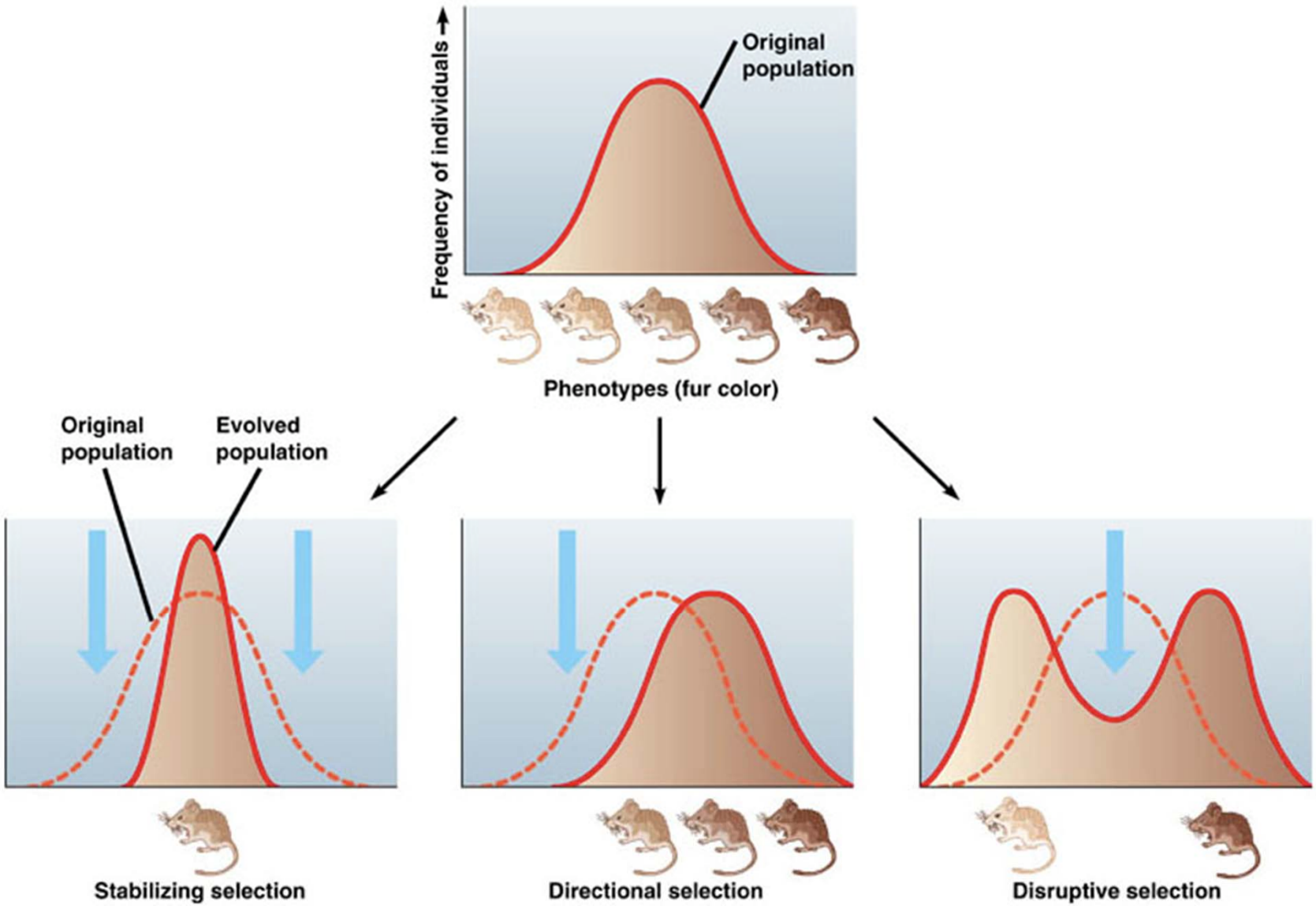
Environmentalists spray pesticide DDT on mosquitoes to stop the spread of malaria and the West Nile virus. Those mosquitoes with a high resistance to DDT will be favored over those who have little or no resistance to DDT.



Types of Natural Selection (cont'd)

- *Disruptive Selection:* **When individuals at both extremes of the (upper and lower ends) of a trait are both more fit and are favored over the average individuals in the population.**




Frequency of individuals
Original population
Phenotypes (fur color)
Original population
Evolved population
Stabilizing selection
Directional selection
Disruptive selection

Modern Evolutionary Theory

- **Combines the concepts of *Darwin's theory of Natural Selection* with the understanding that *variations are the result of random mutations and the shuffling of genes during sexual reproduction.***
  - **Genes of inherited variations that have better *adaptive value*, give an organism a better chance of survival and are passed from parents to offspring.**
  - **These favorable genes tend to increase in frequency in a population over time.**
  - **Genes with low survival value decrease in numbers from generation to generation.**
  - **If the environment changes, genes that were previously neutral or had low survival value may become favorable, and as a result, may increase in frequency over time**

Genetic Variations

- **What Darwin did not know was that variations or differences among offspring are due to *GENETIC VARIATIONS*, which result for the unique combination of traits each organism inherits from its parents.**
- ***Adaptive Value:*** **any trait that helps an organism survive and reproduce in a given environment.**
- ***Selecting Agent:*** **the environment acts as a selecting agent in the sense that organisms with traits that have the best adaptive value for that environment will have a competitive advantage, a greater chance of survival with increased opportunities to mate and pass their genes to the next generation.**

Sources of Variations

- ***Mutations:*** **random changes in the nitrogenous base sequence of the DNA.**
  - **mutations can be random errors that occur when DNA makes copies of itself during normal cell functioning**
  - **some mutations can occur from exposure to certain chemicals (Agent Orange, asbestos, benzene) and radiation (ultraviolet rays, X-rays, nuclear radioactivity)**
  - **If a mutation occurs in a *body (somatic) cell, it ONLY affects that organism.***
  - **If a mutation occurs in a *sex cell (sperm or egg) then that mutation can be passed to the offspring.***

Sources of Variations (cont'd)

- *Genetic Shuffling:* **the sorting and recombination of genes during *meiosis* (the making of sperm and egg that have ½ the normal number of chromosomes than the parent cells) and *fertilization* result in offspring with new and different combination of genes.**
  - ***genetic shuffling through sexual reproduction is the main source of variation in sexually reproducing species.***

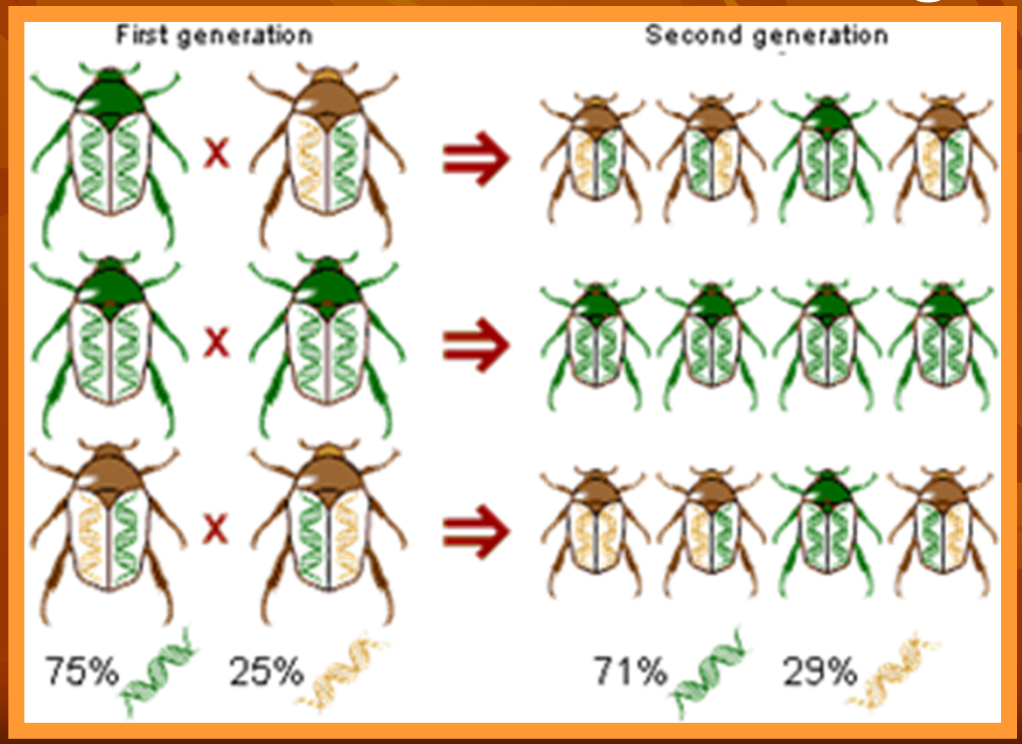
Changing Environments

- **A *changing environment* is the driving force for evolutionary change.**
- **Variations are necessary for a species to continue to survive in a changing environment.**
- **Species with short reproductive cycles that produce many offspring tend to evolve more quickly than species with long life spans and few offspring.**
- **The failure to adapt to a changing environment may result in the death of a species *(extinction)*.**

pocket mouse

Genetic Drift

- occurs in small populations
- certain alleles may be more common in a small population simply due to chance
- over time, this can result in a particular allele to have a higher frequency in the descendants of the original small population

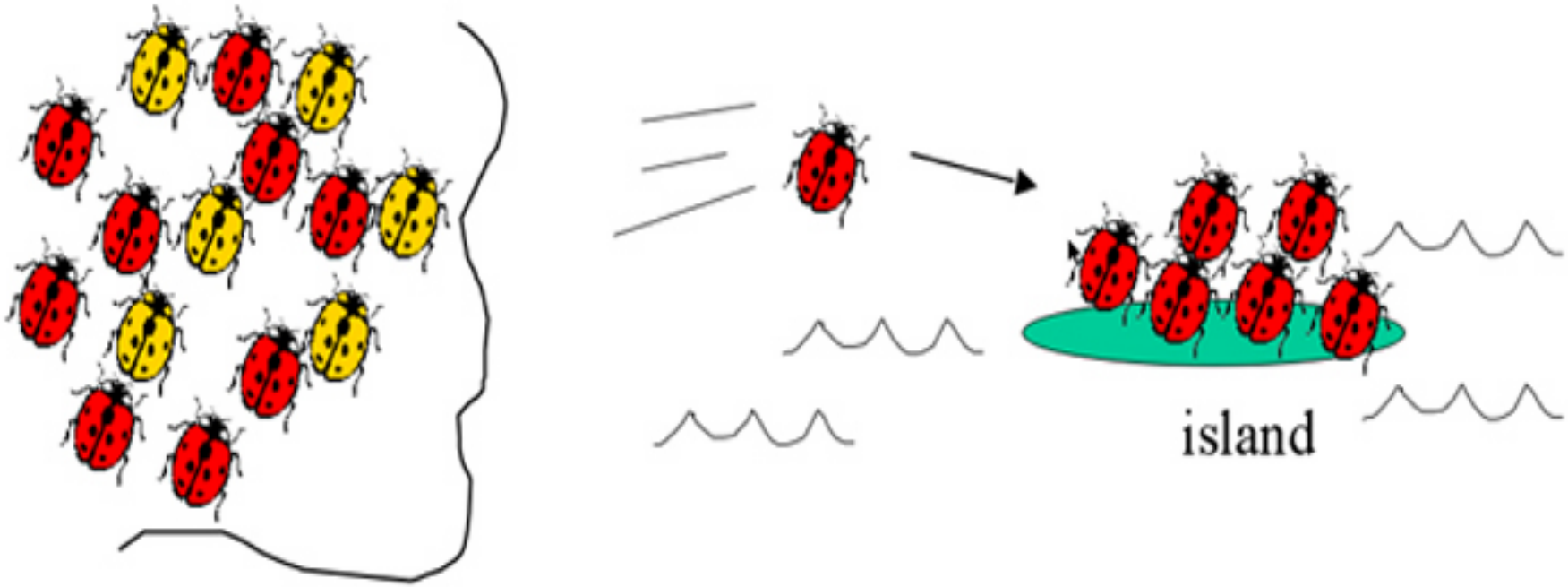


Examples: Genetic Drift

- ***Founder's Effect:***
  - **A small population breaks away from a larger one to colonize a new area –this population most likely is NOT genetically representative of the original larger population.**
  - **Rare alleles may be overrepresented in the smaller population and traits that are not usually seen in the larger population may have a higher frequency of appearance in this smaller population.**

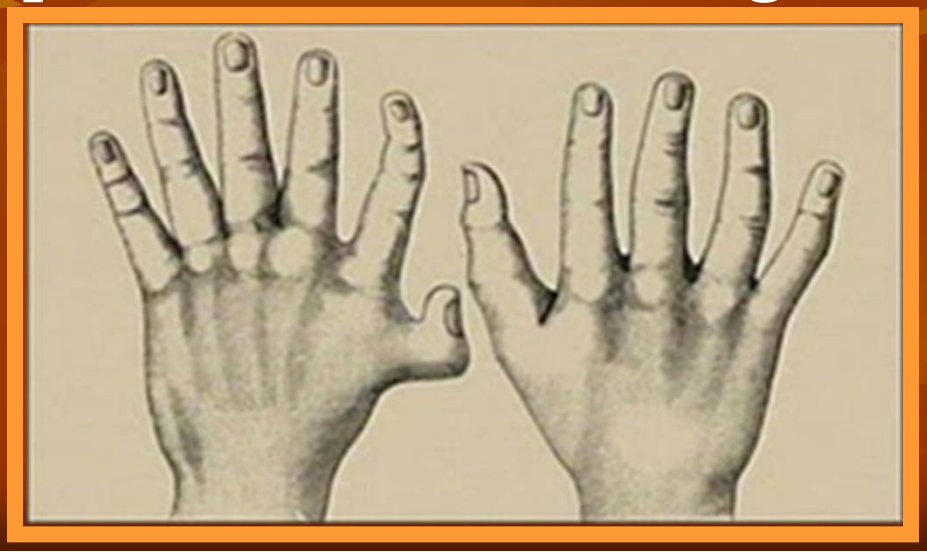
Founder's Effect

- **founder effect**: a few individuals from a population start a new population with a different allele frequency than the original population



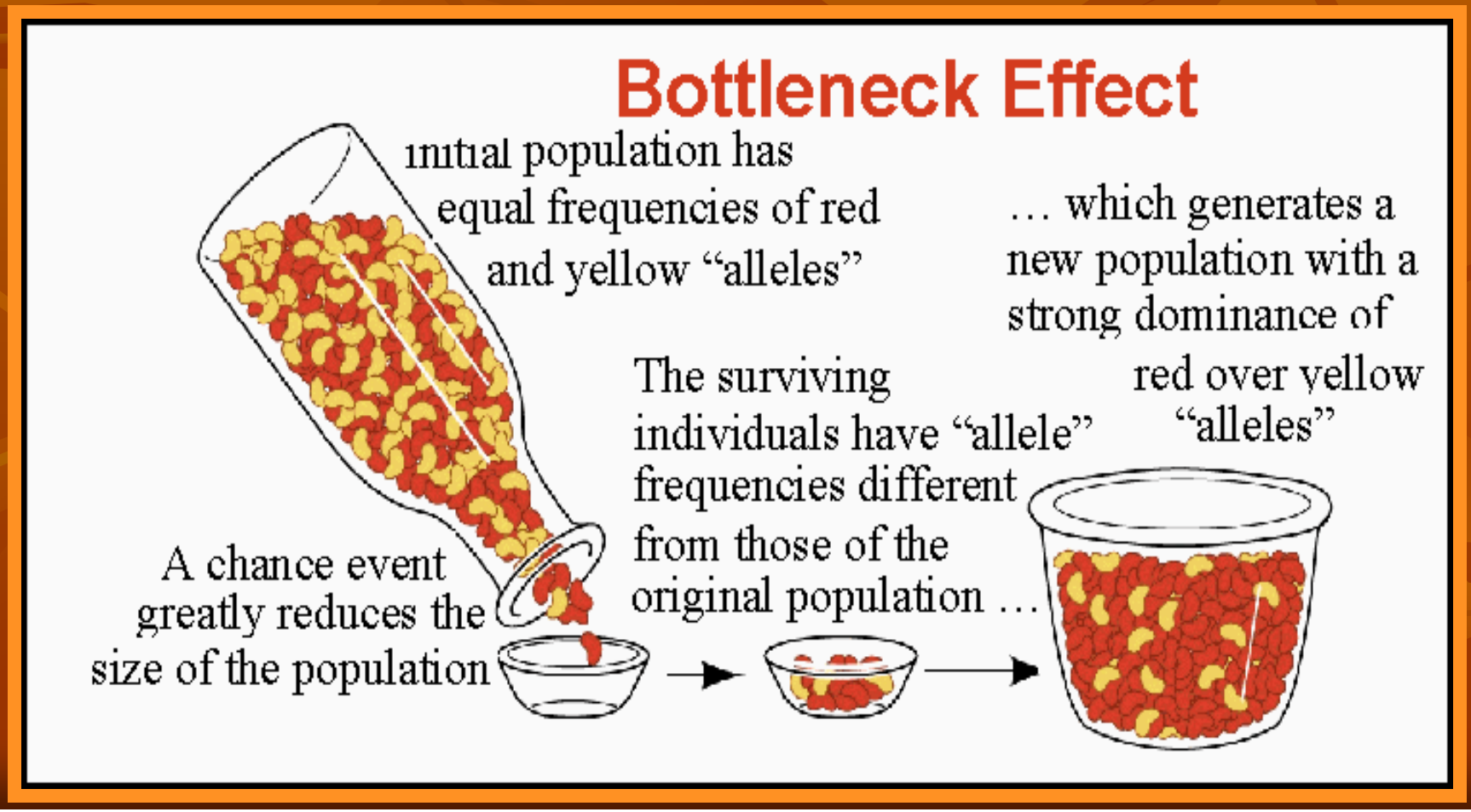
Example:Founder's Effect

- **The Old Order of Amish of Lancaster Pennsylvania, are all descendants from a small group settlers who migrated from Germany to the US in the 1770s. One or more of these settlers carried the rare but dominant gene for polydactyly (having a extra finger or toe). Due to extreme isolation and intermarriage of the close-knit community, this population evidences a high incidence of polydactyly.**



Bottleneck Effect

- **Natural disasters such as fire, earthquake, and flood randomly reduce the size of a population.**



Evolution in a Changing Environment

- *Pesticide resistance:* **the ability of a pest to survive applications of pesticides at rates that once killed most of that species.**
  - **These pests already possess the inherited variation to survive the pesticide and passed from generation to generation, eventually rendering the pesticide useless against these pests.**
  - *Resistance* **most often develops when pesticides are applied at lower-than-recommended rates and when either the same pesticide or pesticides with the same mode of action are repeatedly used.**

Pesticide Resistance