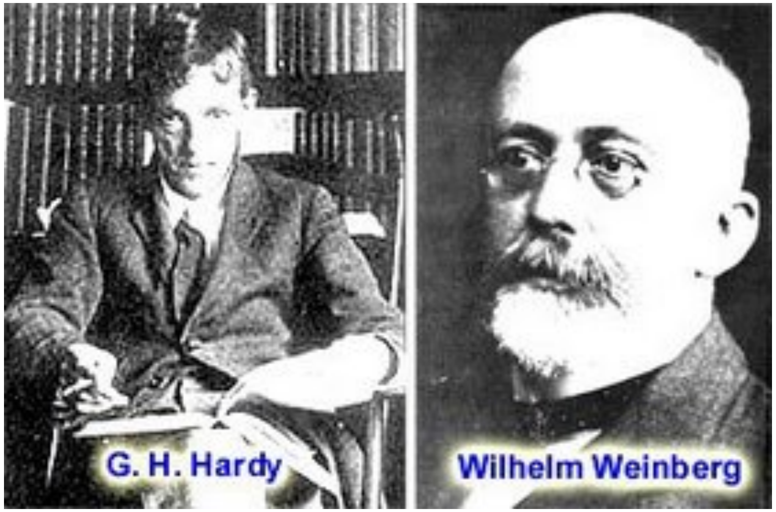
EVOLUTIONARY PROCESSES

Hardy-Weinberg Principle

- GH Hardy & Wilheim Weinberg (1908)
  - Developed mathematical model
  - Analyzing consequences of mating of individuals
  - What happens if *all* individuals of a population breed



Gene pool concept

- Hardy and Weinberg
  - All gametes of generation are a single group
    - Gene pool
  - Gametes of gene pool combine randomly
  - Calculations predict frequency of genotypes in a population

Hardy-Weinberg Principle

- Simple population
  - Two alleles: A_1 & A_2
  - Frequency of $A_1 = p$
  - Frequency of $A_2 = q$
  - $p + q = 1$
- Possible genotypes
  - A_1A_1: p^2
  - A_2A_2: q^2
  - A_1A_2: $2pq$

	p	q
p	p^2	pq
q	pq	q^2

Hardy-Weinberg Equation

- $p^2 + 2pq + q^2 = 1$
  - Individuals can only have 1 of 3 genotypes
  - Sum of genotypes must equal 100%

	p	q
p	p^2	pq
q	pq	q^2

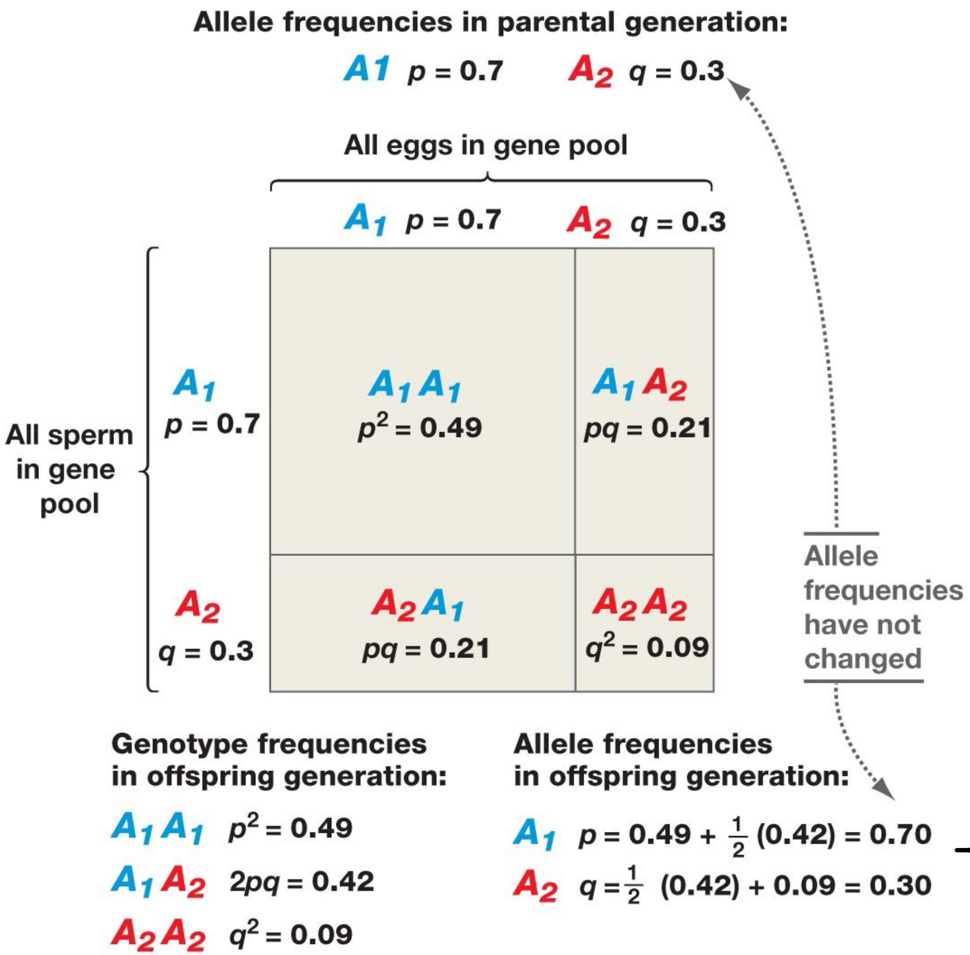
Hardy-Weinberg Principle

- Prediction 1: Genotype frequencies can be calculated from parental allele frequencies

Hardy-Weinberg Principle

- Prediction 1: Genotype frequencies can be calculated from parental allele frequencies
- Prediction 2: Offspring allele frequencies are the same as parental allele frequencies
  - Allele frequencies don't tend to move toward 0.5
  - Dominant alleles don't tend in increase in frequency

H-W: allele frequencies principle



$$A_1: p_{offspring} = p^2_{parent} + \tfrac{1}{2}(2p_{parent}q_{parent})$$
$$A_2: q_{offspring} = q^2_{parent} + \tfrac{1}{2}(2p_{parent}q_{parent})$$

Hardy-Weinberg Principle

- If allele frequencies change through generations (P1 and/or P2 not met), then the population is either:
  - Evolving
  - Nonrandom mating
  - or both

H-W: practice

You should be able to answer these questions for the exam.

If a parent population has a frequency of an allele (A_1) of 0.2, answer the following questions according to the Hardy-Weinberg principle.

- What is the allelic frequency of allele A_2 in the parental population.
- What is the expected genotypic frequency of A_1A_1 of the next generation?
- What is the expected genotypic frequency of A_1A_2 of the next generation?
- What is the expected genotypic frequency of A_2A_2 of the next generation?
- What is the expected phenotypic frequency of the dominant phenotype of the next generation?
- What is the expected phenotypic frequency of the recessive phenotype of the next generation?

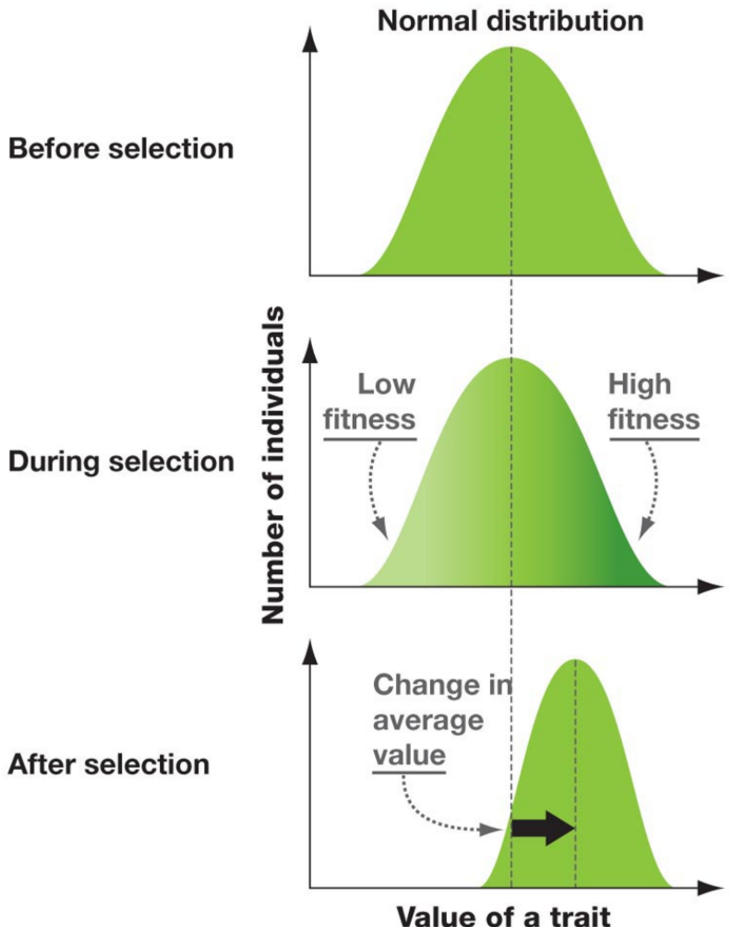
Assumptions of Hardy-Weinburg

- Used as a *null model*
- Assumptions
  - Mating is random
  - None of 4 mechanisms of evolution acting
    - No natural selection
    - No genetic drift
    - No gene flow
    - No mutations

H-W as a null hypothesis

- H-W tells what to expect if *no* evolution is occurring and mating is random
- If frequencies do change, something else is at work

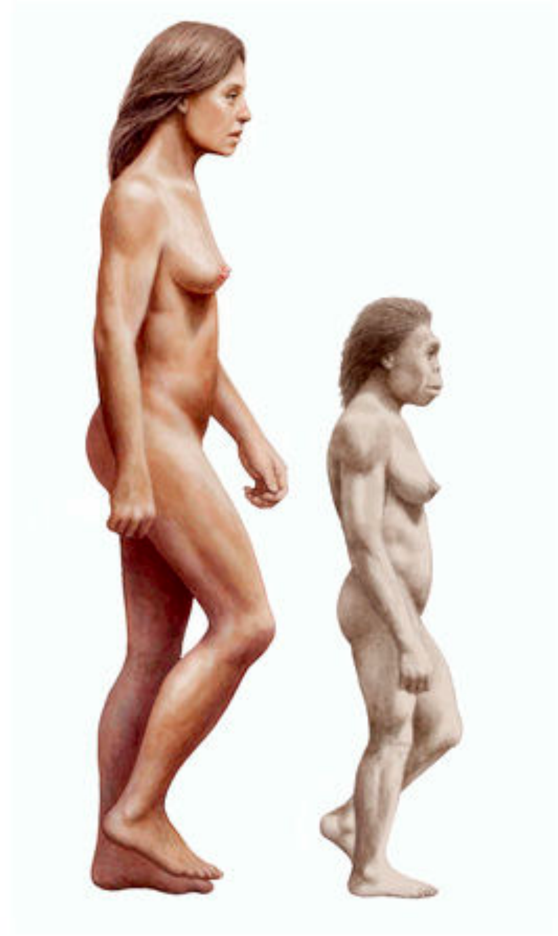
Directional Selection



- Frequency of one allele increases
- Disadvantageous alleles are lost
- e.g. Giraffe’s neck

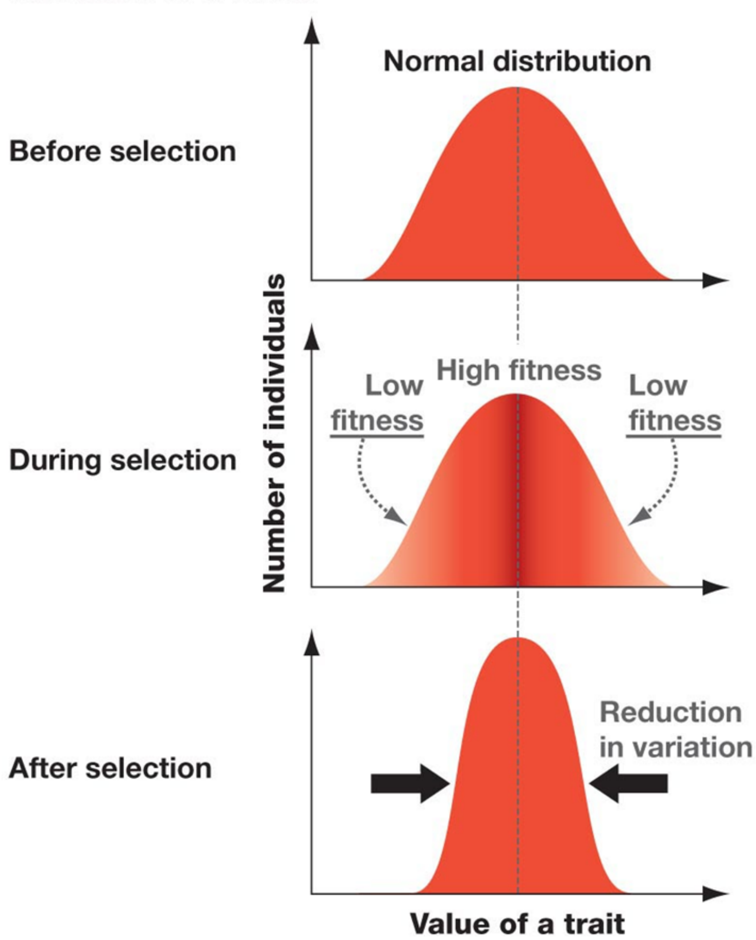
Directional Selection

- Island dwarfism
  - *Homo florensis*
  - Elephants
  - Chameleons

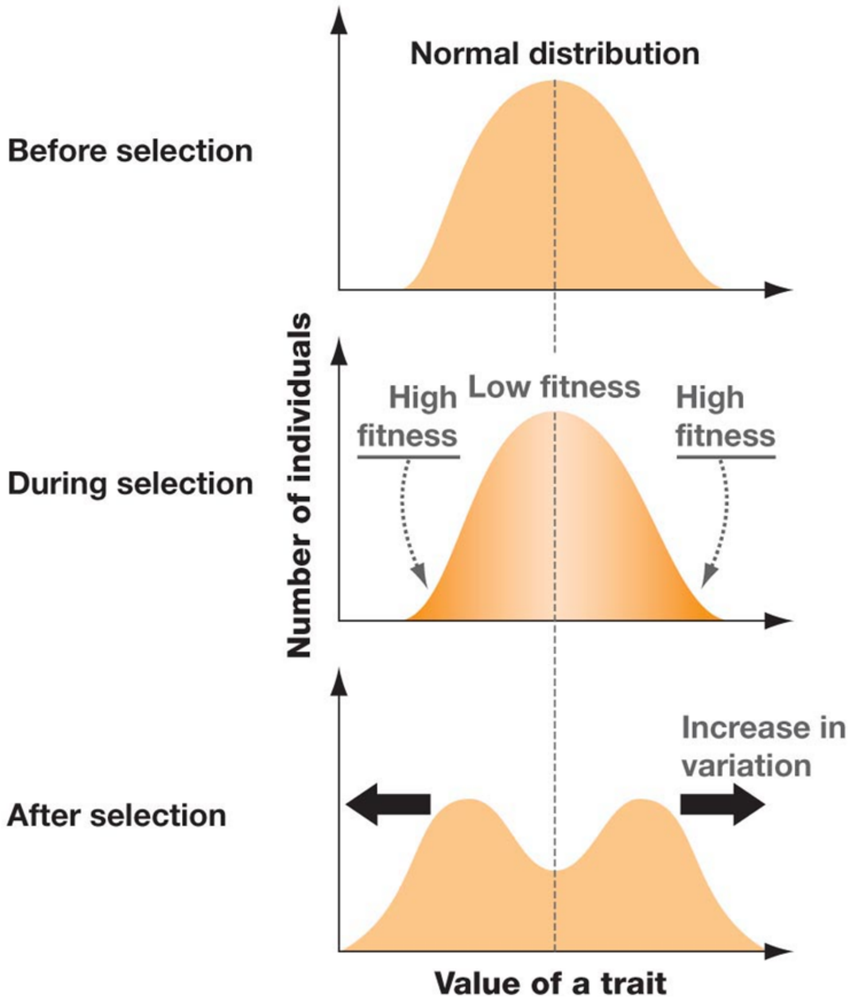


Stabilizing selection

- Intermediate traits reproduce more
  - Higher fitness
- No change in average value of trait
- e.g. human birth weights vs. mortality

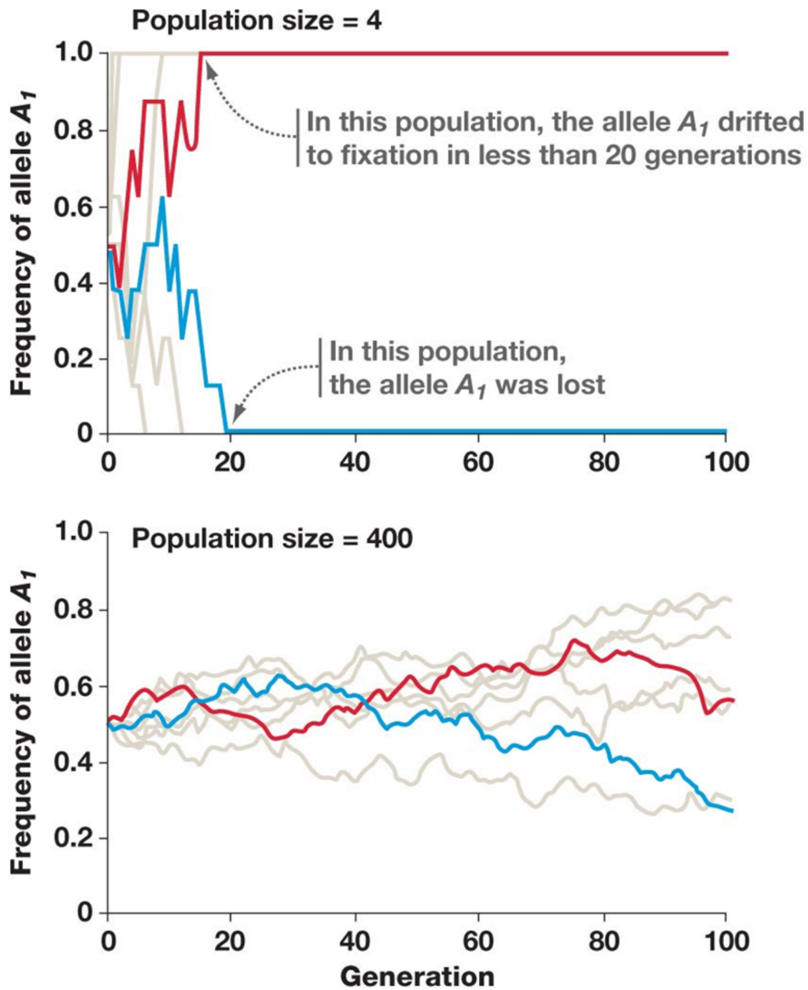


Disruptive selection



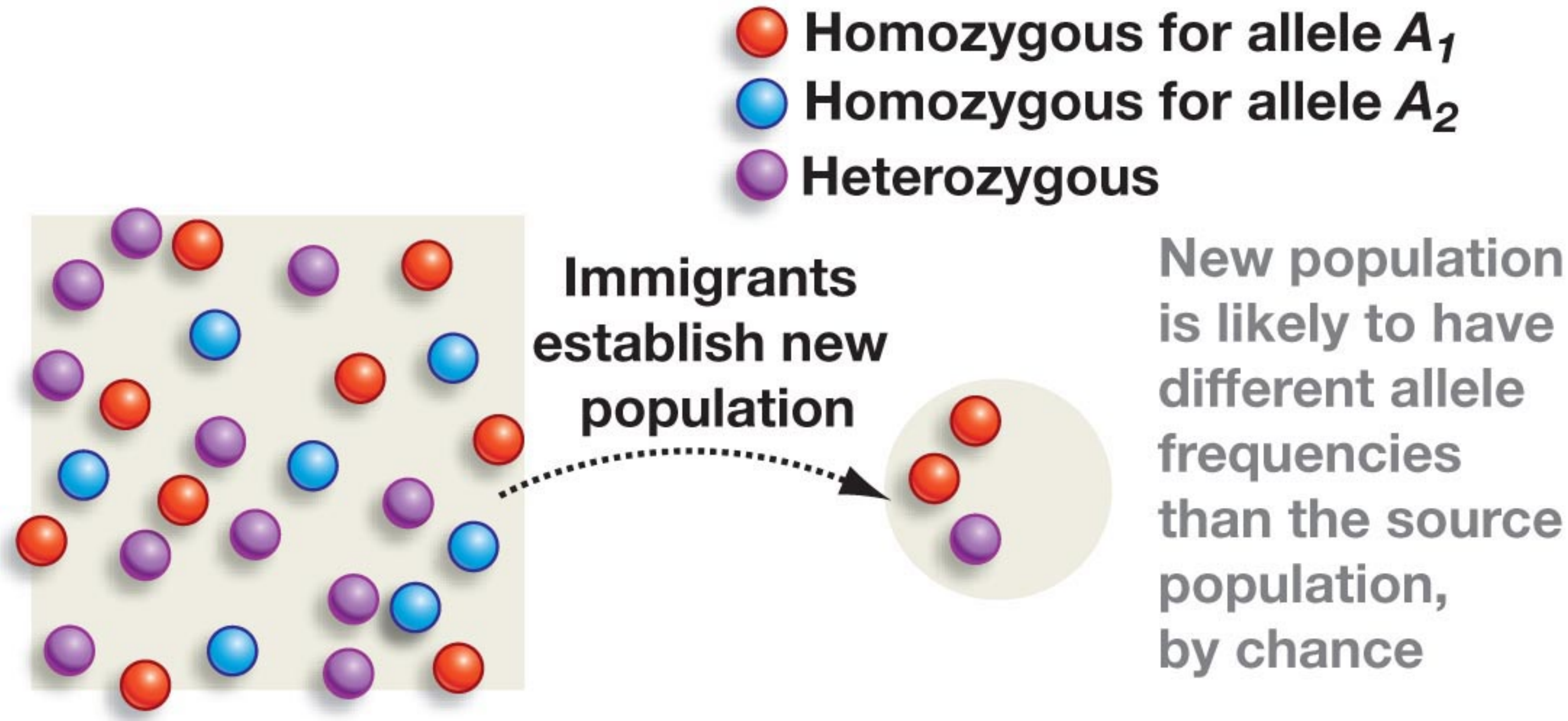
- Extreme phenotypes are more fit than intermediate ones
- Can cause speciation
  - Formation of new spp.
  - Individuals of one extreme mate with like individuals
- Black vs. white rabbits

Genetic drift



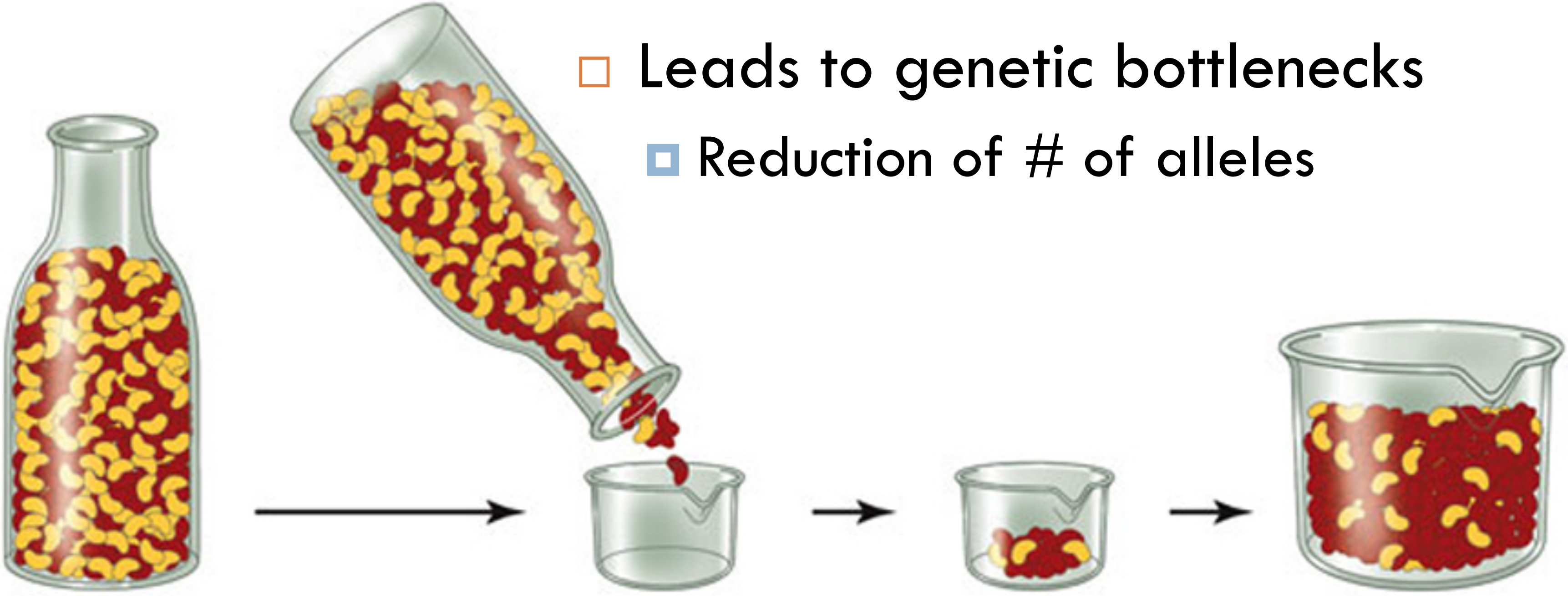
- Change in allele frequencies
  - due to chance
- Allele frequencies drift up and down over time
  - Random loss of genotypes
- More pronounced in small populations

Founder effect

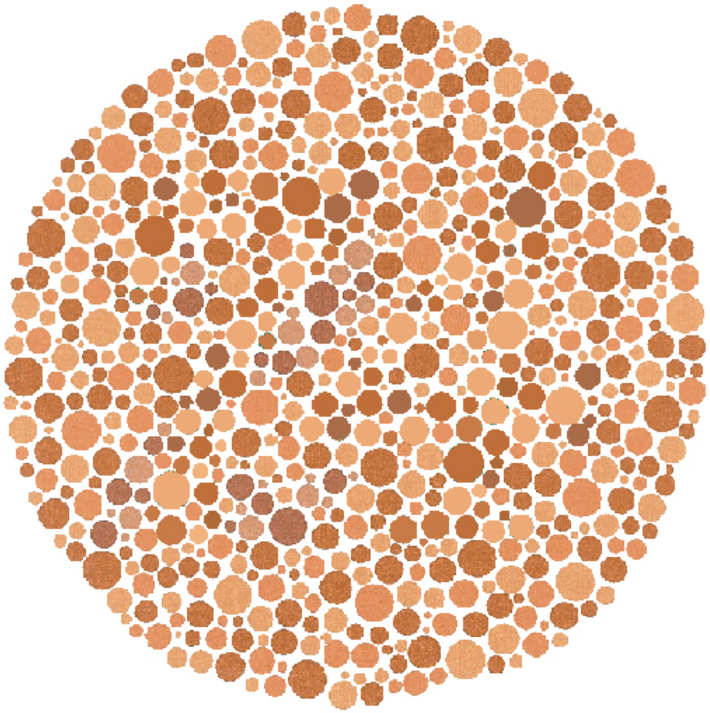


Population Bottlenecks

- Cause of genetic drift
- Causes:
  - Disease outbreaks
  - Natural catastrophes
- Leads to genetic bottlenecks
  - Reduction of # of alleles



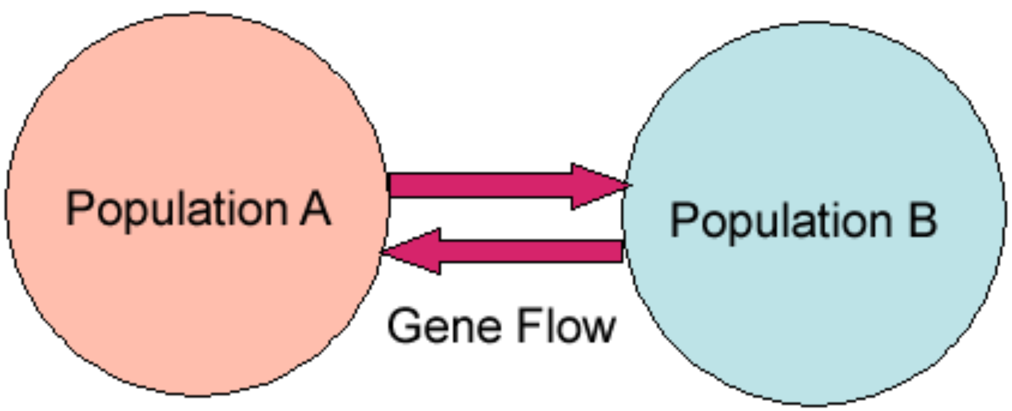
Population Bottlenecks



- Example
  - Pingelap Atoll
    - Only 20 survived typhoon (1775)
    - Most survivors had allele for color-blindness
    - Most modern islanders are completely color blind

Gene flow

- = movement of alleles from one population to another
- Greater gene flow = greater homogenization
  - Reduces genetic differences b/n populations



Mutation

- Most evolutionary mechanisms reduces diversity
- Mutation increases diversity
  - Creating new alleles
- Mutations are random with respect to fitness
  - Most lower fitness
  - Rarely produces beneficial allele
    - Increases in frequency over time
- Primary evolutionary force for unicellular organisms

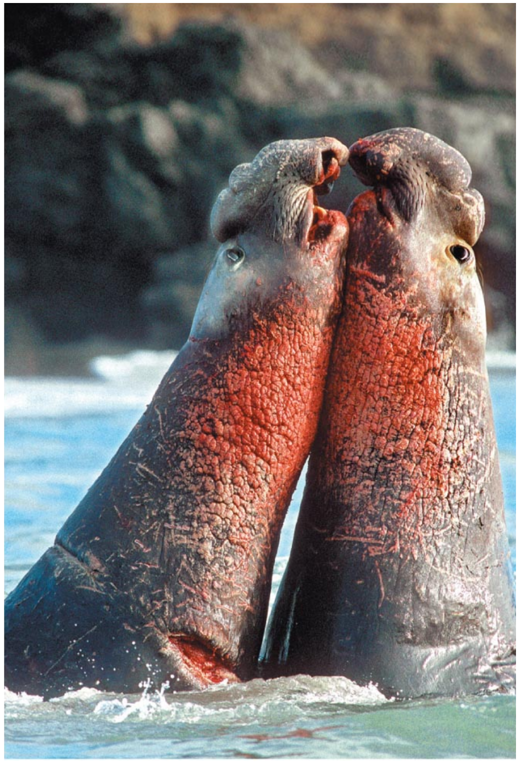
Sexual selection

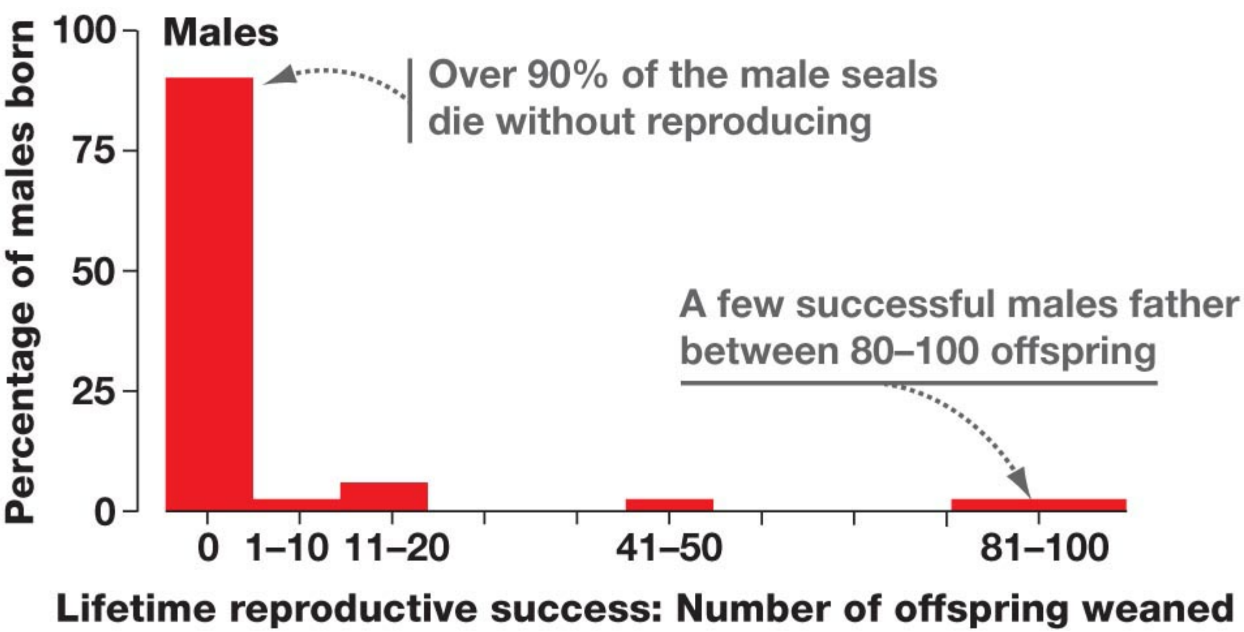
- Occurs when individuals differ in ability to attract mates
- Special form of natural selection
- Hardy-Weinberg ignored this

Sexual selection

- Why?
  - Females invest more
    - Fitness is resource-dependent
  - Males
    - Fitness limited to ability to mate
- Theory
  - Females are choosy
  - Males compete
  - Sexual selection act strongly on males

Male-male competition





Sexual dimorphism