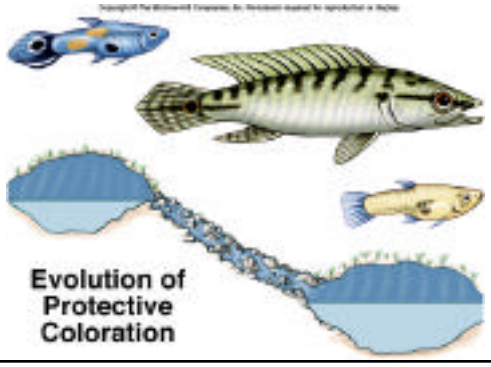
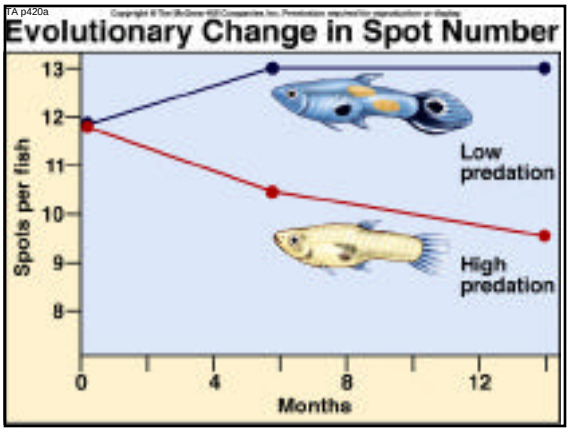
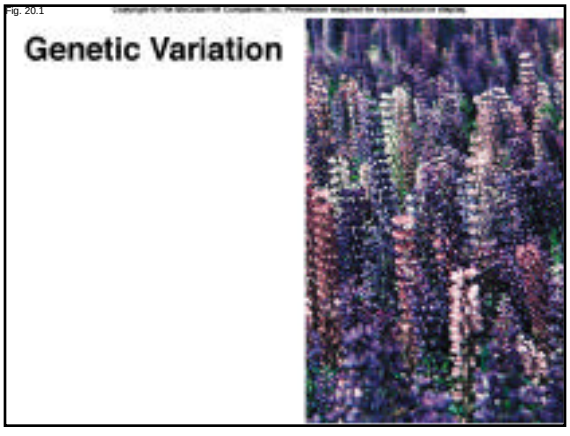
Population Genetics

Evolution of guppies





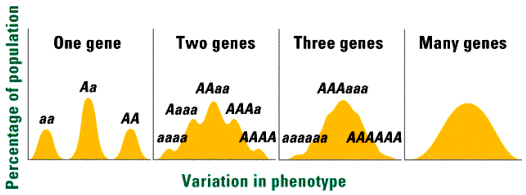


Traits (Gene variation)

✓ Recessive
- ✒Light skin
- ✒Straight hair
- ✒Type O blood
- ✒Normal hip joints

✓ Dominant
- ✒Dark skin
- ✒Curly hair
- ✒Type A or B blood
- ✒Dislocated hip at birth

Genetic variation



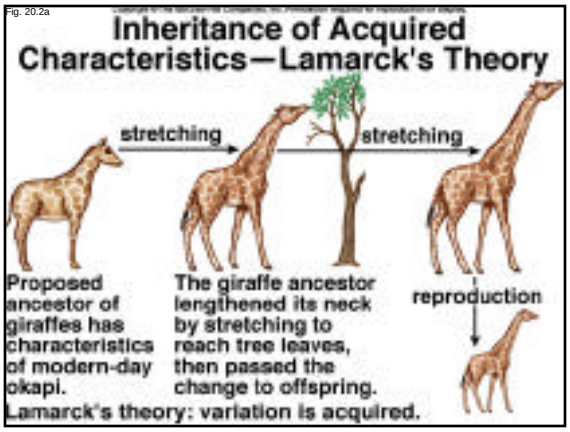
Most traits are polygenic

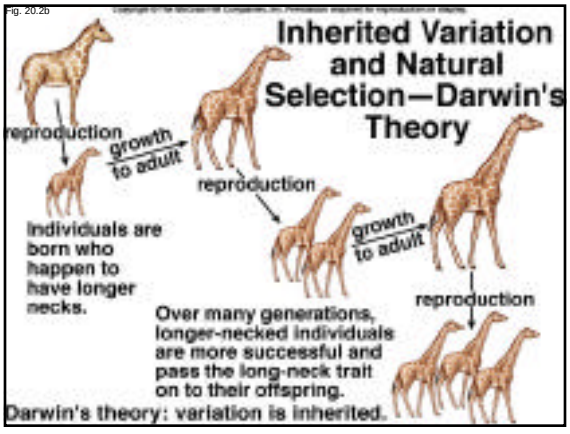
Factors influencing variation

- ✓The rate at which mutations accumulate in the DNA.
- ✓The rate by which changes spread through the population.
- ✓The rate by which deleterious mutations are eliminated from a population by natural selection.

Population genetics

- ✓Explains the processes by which variation is generated and passed on within populations of organisms in precise mathematical terms.
- ✓Describes microevolution or the changes in the frequencies of alleles in a population.





Hardy-Weinberg Equilibrium

✓A stable distribution of genotypic frequencies is maintained by a population from generation to generation.

Allelic frequency

✓Proportion of number of copies of a given allele in a population to the sum of all alleles in the population.

✓Example:

- ✒353 AA Black cats
- ✒494 Aa Brown cats
- ✒153 aa White cats

Calculating allelic frequencies

$$f(A) = \frac{2(353) + 494}{2(1000)} = 0.6$$

$$f(a) = \frac{494 + 2(153)}{2(1000)} = 0.4$$

Therefore, f(A) + f(a) = 1

or p + q =1

$$(p + q)^2 = 1^2$$

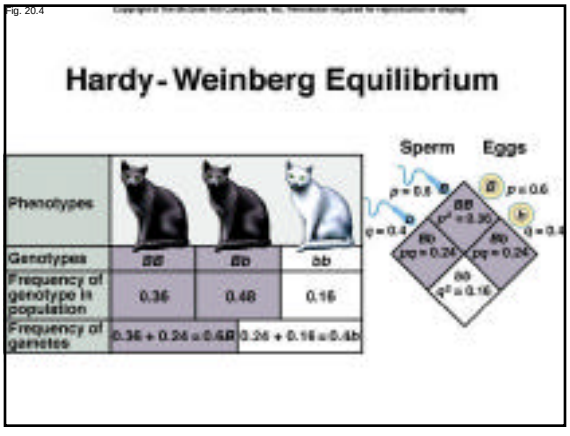
$$p^2 + 2pq + q^2 = 1$$

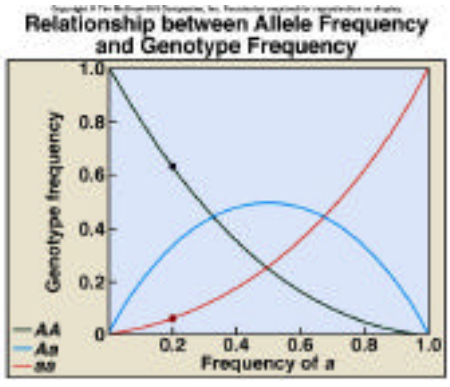
$$p^2 = (0.6)^2 = 0.36$$

$$2pq = 2(0.6)(0.4) = 0.48$$

$$q^2 = (0.4)^2 = 0.16$$

Reproduction does not change allelic frequencies





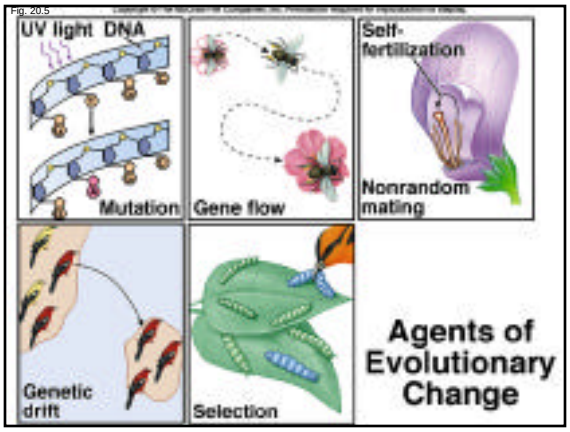
Assumptions

✓No mutation
✓No selection
✓No migration (Gene flow)
✓No genetic drift

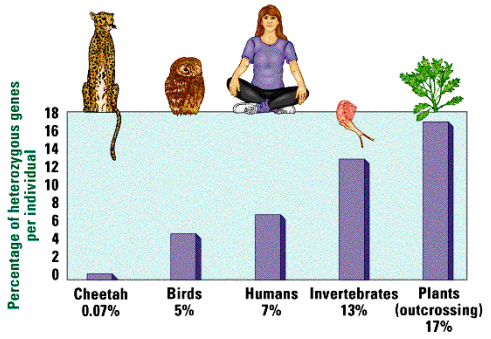
✓No non-random mating
- ➨No inbreeding
- ➨No phenotypic assortative mating

Table 20.1 Agents of Evolutionary Change

Factor	Description
Mutation	The ultimate source of variation. Individual mutations occur so rarely that mutation alone does not change allele frequency much.
Gene flow	A very potent agent of change. Populations exchange members.
Nonrandom mating	Inbreeding is the most common form. It does not alter allele frequency but decreases the proportion of heterozygotes.
Genetic drift	Statistical accidents. Usually occurs only in very small populations.
Selection	The only force that produces adaptive evolutionary changes.

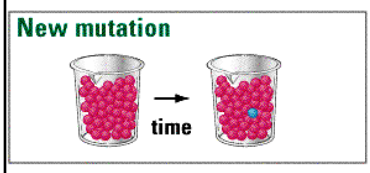


Humans are heterozygous in 7% of their 100,000 genes.



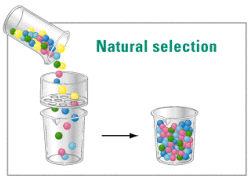
New mutation

✓Mutations will either be eliminated or spread through a population.
✓Ultimate source of genetic variation



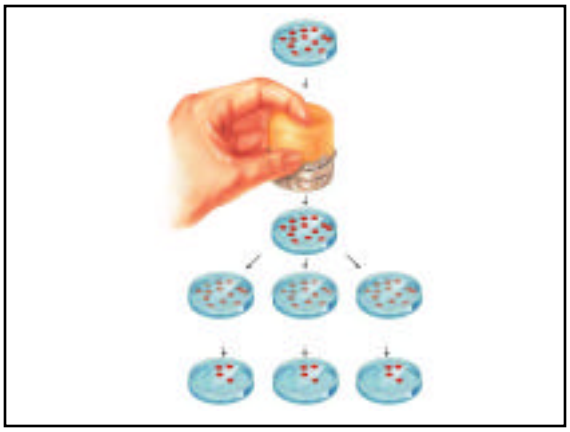
Natural selection

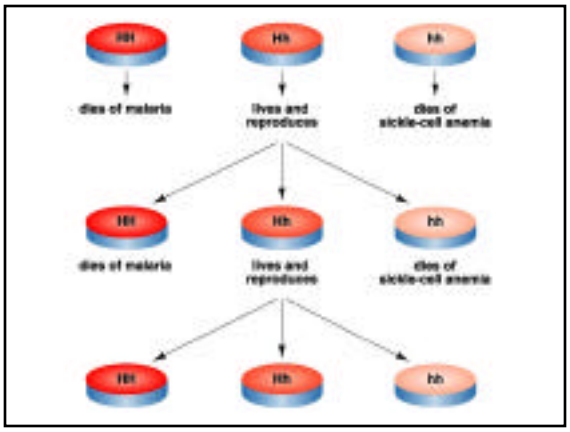
✓Reduces the frequency of deleterious alleles.



Artificial selection

Fig. 20.7





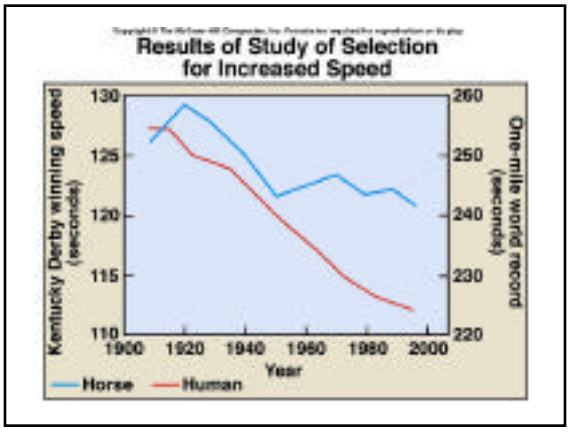
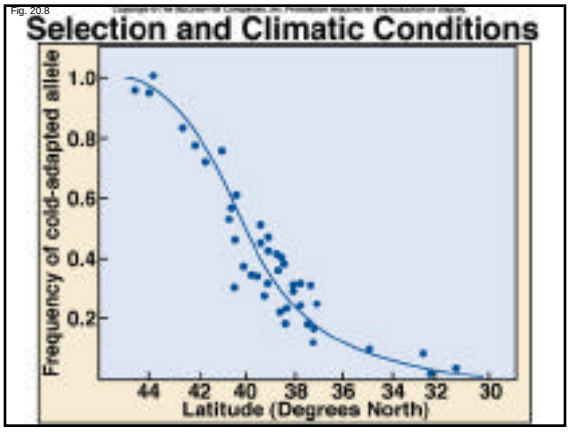
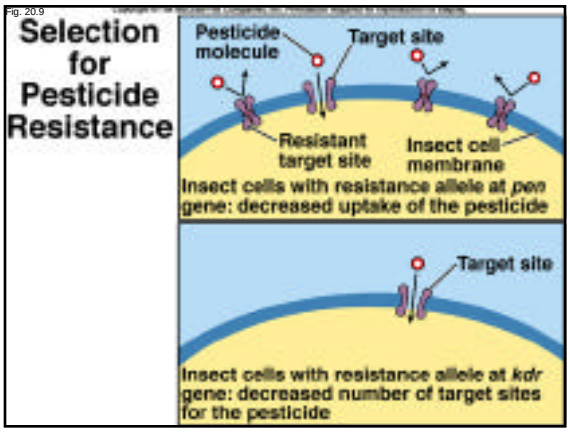


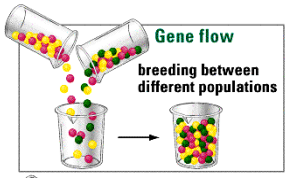
Fig. 20.8

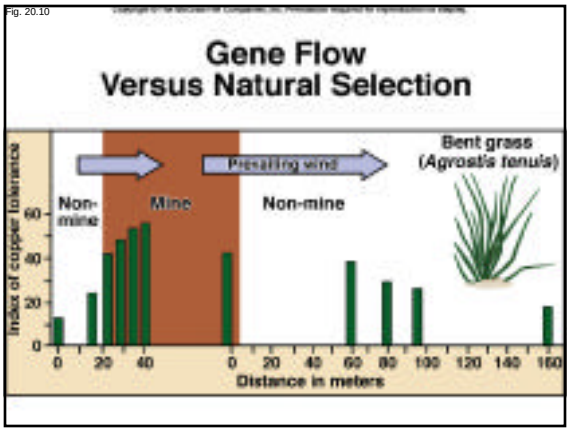




Gene flow

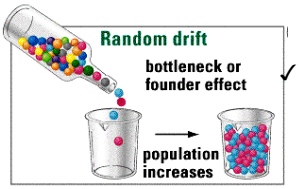
- ✓ Breeding between populations.
- ✓ Immigration of individuals into a different population brings new alleles into the gene pool.

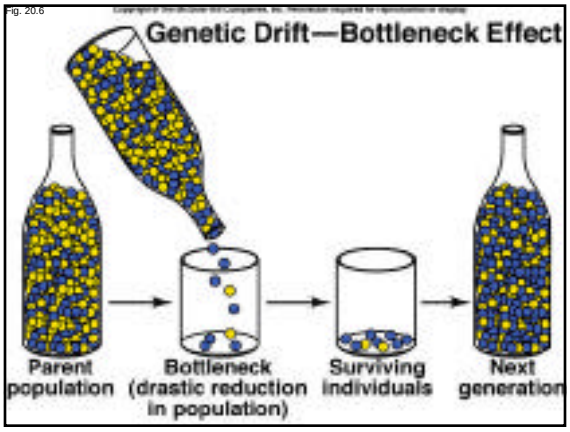


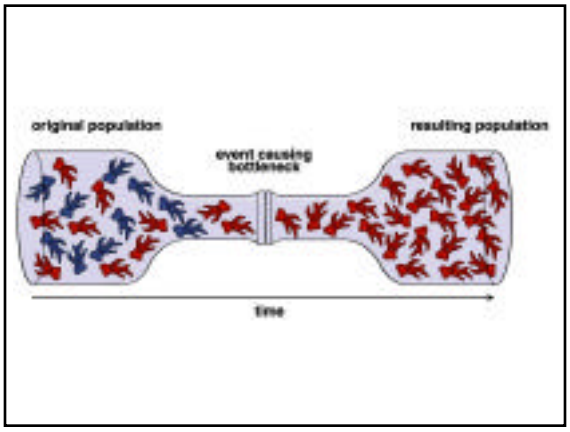


Random drift

- ✓ Change in gene frequency due to random events in a small population.
- ✓ Bottleneck or founder effect is observed when a small subset of a population founds a new population.

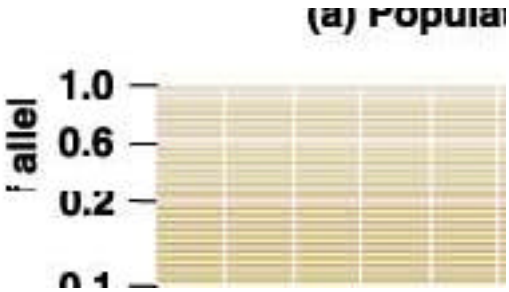




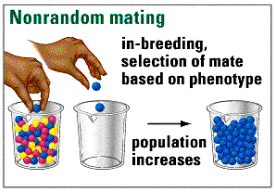


Northern Elephant seal

Cheetah



Nonrandom mating



- ✓ Assortative mating is where individuals express preference with whom they mate.
- ✓ Inbreeding is an extreme form of assortative mating

Fig. 20.11

Heterozygous advantage

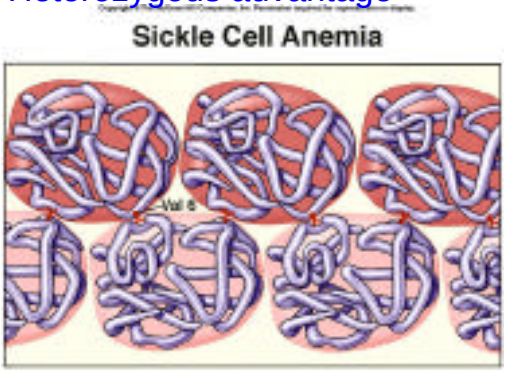
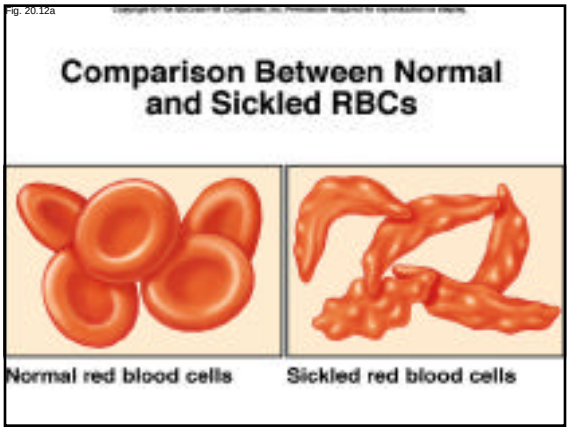
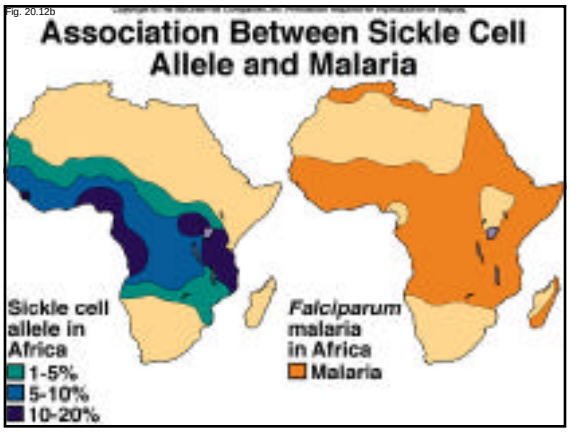


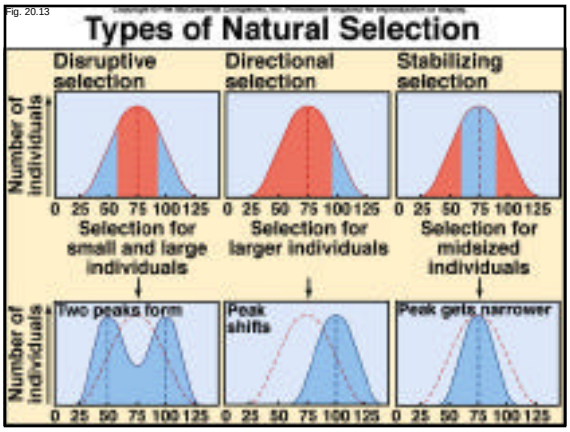
Fig. 20.12a

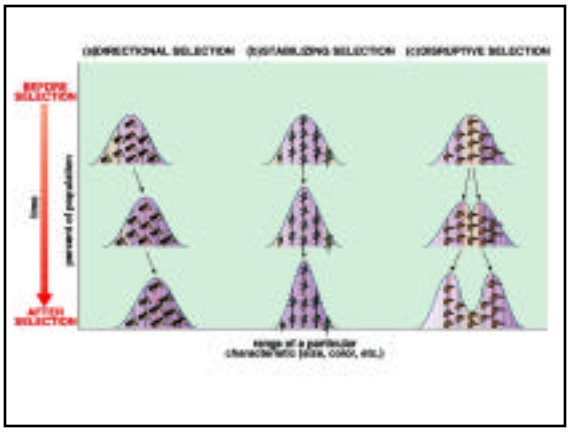




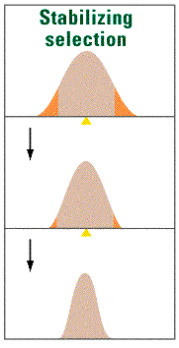
Sexual selection

- ✓Female choice (male choice)
  - ✒Male courtship behavior
- ✓Male competition
  - ✒Competition for territory and access to females
  - ✒Leave more descendants

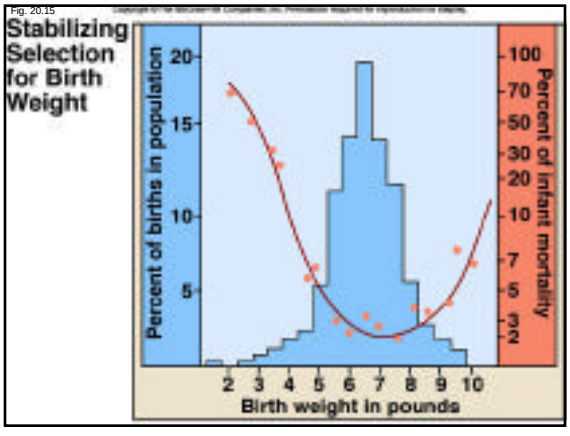




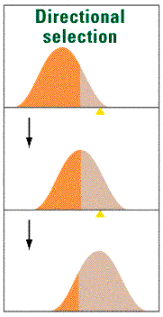
Stabilizing selection



- ✓The extremes of a phenotype are selected against, so that the average phenotype is advantageous.
- ✓Ex. Wasps: the average wasps will survive the winter better.

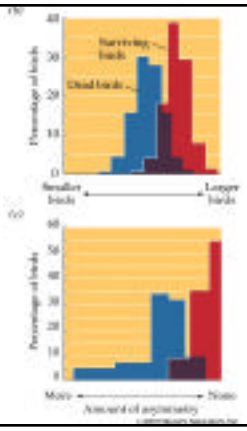


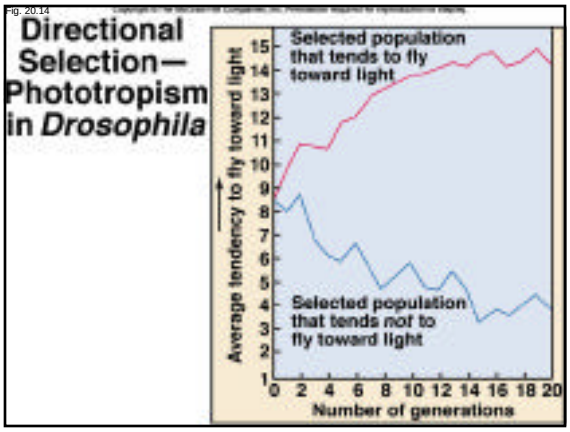
Directional selection



- ✓ The frequency of one or more traits is increased to favor one allele form over the other form.
- ✓ Ex. Industrial melanism, pesticide or antibiotics

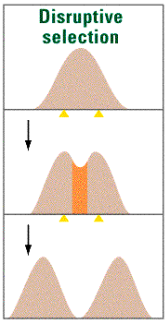
Directional selection



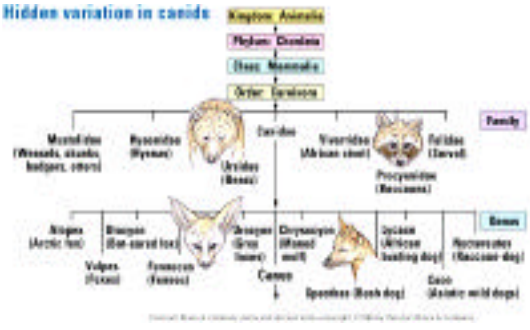


Directional selection

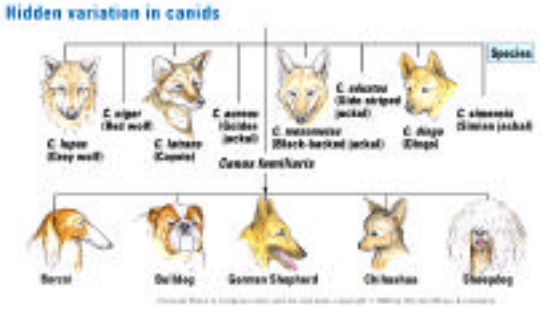
Disruptive selection

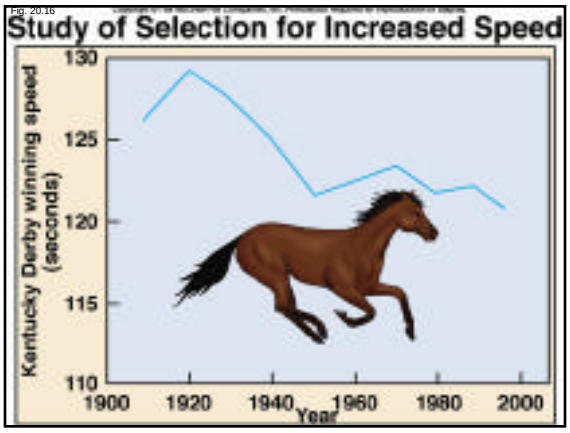


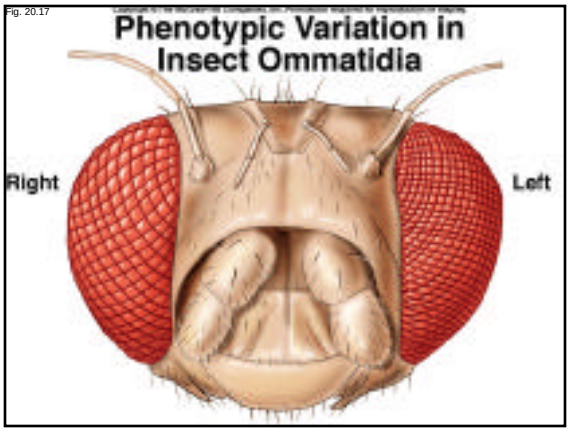
- ✓ Increases the extremes of phenotypes in a population, so that intermediate forms are selected against.
- ✓ Ex. African swallowtail butterflies The extremes are spared - the intermediates are eaten.

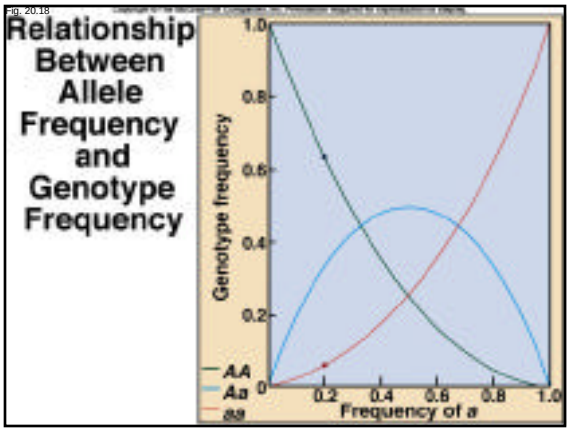


Directional selection









The End.

Species (modern)

✓Gene pool

✒Alleles are exchanged among a population

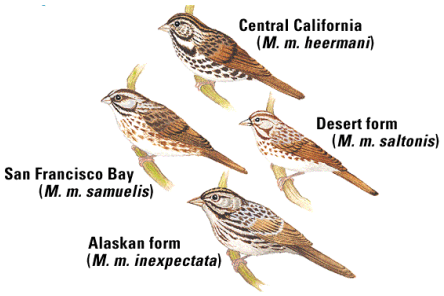
➪The largest unit of a population of similar organisms in which gene flow is possible

Species (traditional definition by Mayr)

✓Breed Naturally

- ✒"Groups of actually or potentially interbreeding populations, which are reproductively isolated from other such groups"

Hybrids



Subspecies of the song sparrow, *Melospiza melodia*

3 strategies of speciation

✓Allopatric speciation

- ✒Geographical isolation

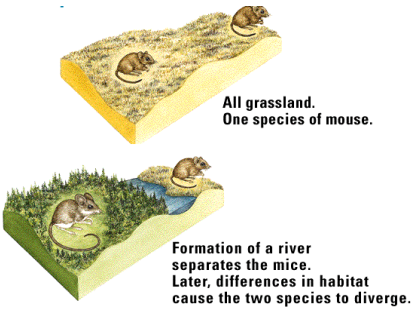
✓Parapatric speciation

- ✒Intermediate between allo-and sym-patric speciation
- ✒Some contact exists between species.

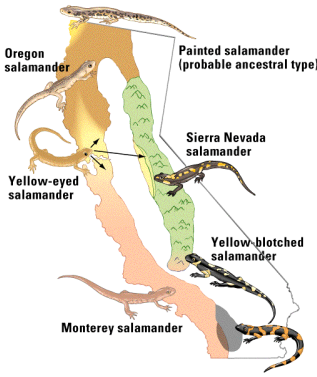
✓Sympatric speciation

- ✒Change in the same place

Allopatric speciation

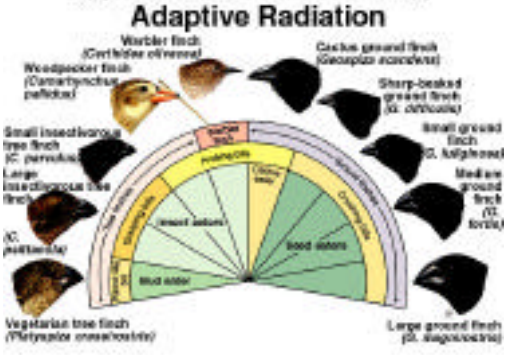


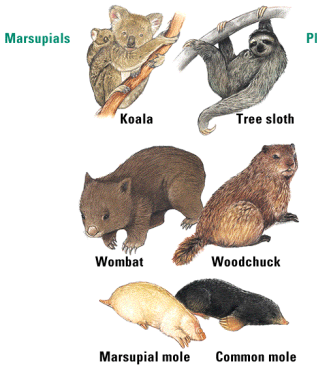
Periodic Isolation



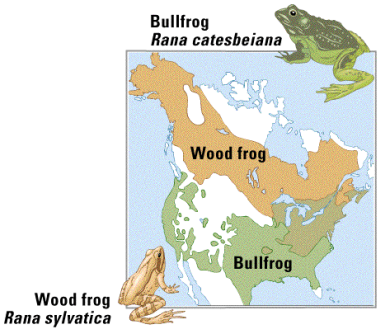
Sympatric speciation

Adaptive Radiation

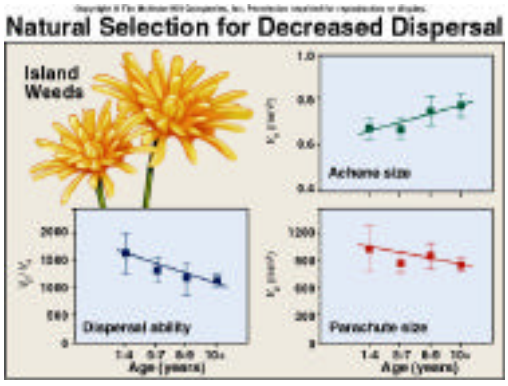


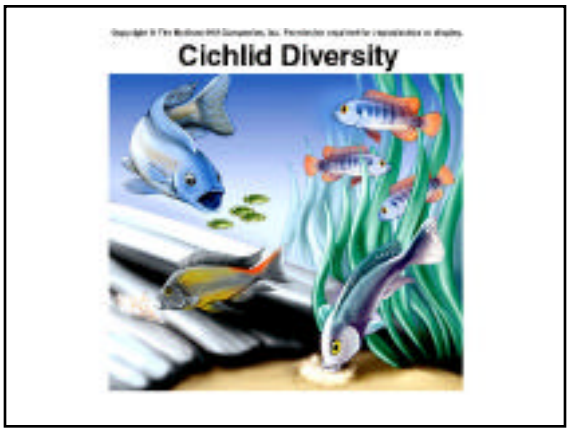


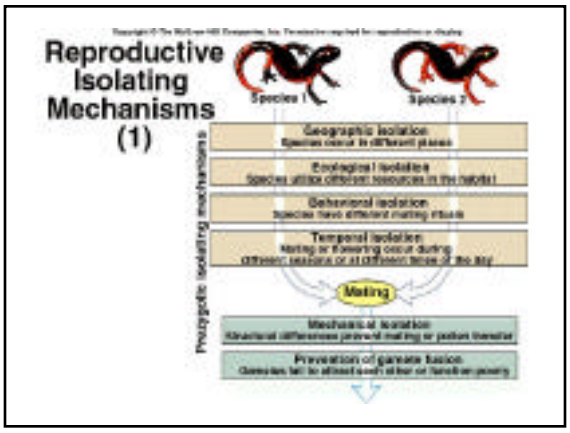
Convergent Evolution

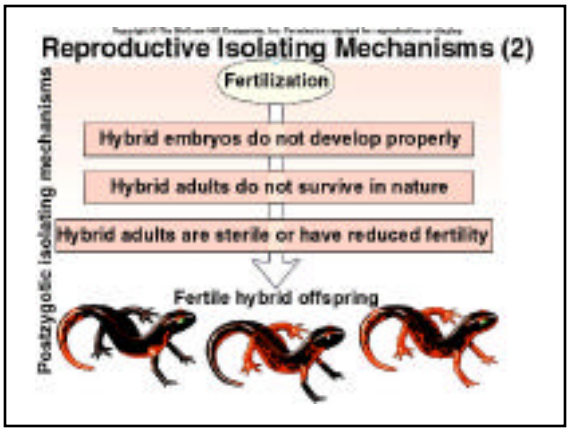


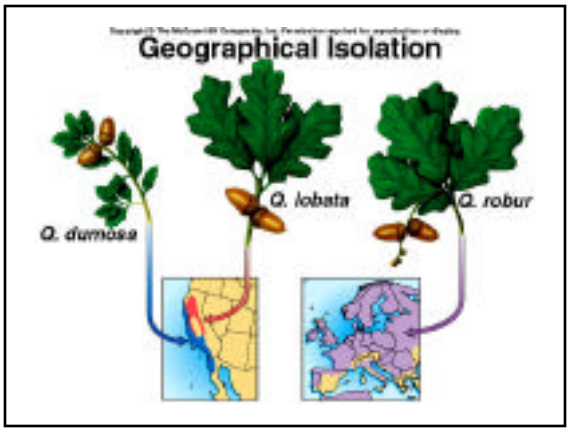
Natural Selection for Decreased Dispersal

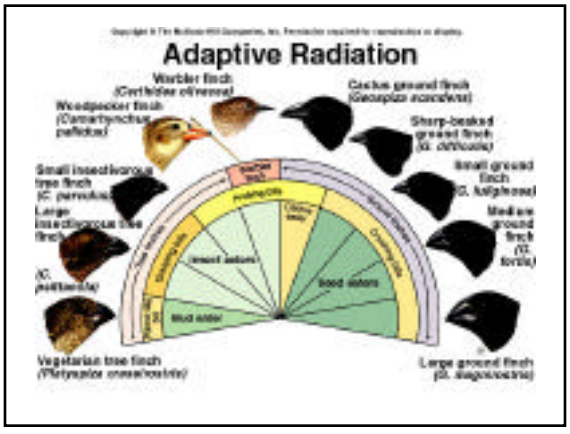












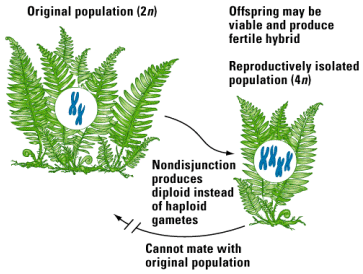
Barriers that isolate populations

✓Prezygotic barriers prevent syngamy.
- ✒Ecological isolation
- ✒Temporal isolation
- ✒Behavioral isolation
- ✒Mechanical isolation
- ✒Gametic isolation

✓Postzygotic barriers make the zygote inviable.

Reproductive Isolation

Reproductive isolation by polyploidy



Patterns of descent

- ✓Divergent evolution
  - ➨Separation of one species into two species.
  - ➨Adaptive radiation
- ✓Convergent evolution
  - ➨Independent development of similar features.

Alcohol Dehydrogenase (low Temperarute)