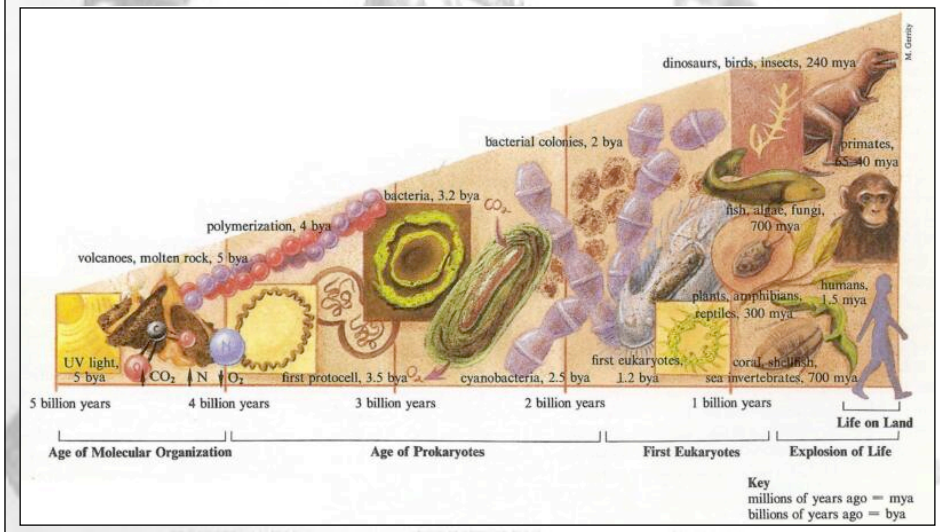
CHAPTER 12

MECHANISMS OF EVOLUTION



12.1 Genetic Variation

- DNA → biological code for inheritable traits
- GENES → units of DNA molecule in a chromosome
- LOCI → location of specific gene on DNA molecules
- DIPLOID → having a full set of chromosomes
- HAPLOID → having half set of chromosomes (gametes)
- HOMOLOGUS PAIRS → copies of sets of genes
  (1 chromosome from male gamete + 1 from female gamete)
- ALLELES → different forms of the same gene (ie. BB,Bb,bb)
- HOMOZYGOUS → identical alleles (ie. BB, bb)
- HETEROZYGOUS → different alleles (ie. Bb)
- GENOME → complete set of chromosomes
- GENOTYPE → description of full set of alleles
- PHENOTYPE → observable traits expressed by alleles

12.1 Genetic Variation

- Variation occurs as the result of genes being combined through sexual reproduction
- During meiosis gene combinations can be determined by the relationship → 2^n ; where n = haploid number
- The combination of gametes also results in variation

12.2 Hardy-Weinberg Principle

- GENE POOL → total of all alleles within a population
- ALLELE FREQUENCY → the proportion of copied genes of a given allele in a population
- Evolutionary changes can be measured by tracking allele frequency

- GENOTYPE FREQUENCY = $\frac{\text{\# of individuals with genotype}}{\text{total population}}$
- p = dominant allele frequency
  = (# homozygous dominant) + (1/2 total # heterozygous)

- q = recessive allele frequency
  = (# homozygous recessive) + (1/2 total # heterozygous)

12.2 Hardy-Weinberg Principle

- H-W Principle states that the "frequency of alleles remains constant" if the following conditions are met:

  i) the population is very large
  ii) mating opportunities are equal
  iii) no mutations occur
  iv) no migration occurs
  v) no natural selection occurs
  (all individuals have an equal chance of reproductive success)

12.2 Hardy-Weinberg Principle

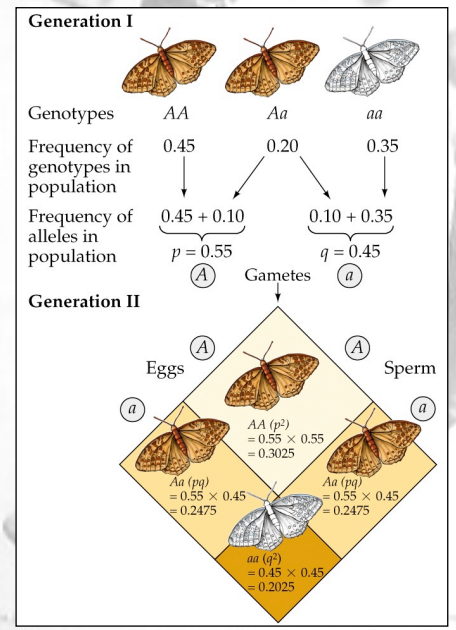
- For a gene with only 2 alleles the following relationships exist:

  p = dominant allele frequency
  q = recessive allele frequency

  i) $p + q = 1$
  ii) $(p + q)^2 = 1^2$
  iii) $p^2 + 2pq + q^2 = 1$

  iv) p^2 = frequency of homozygous dominant allele
  v) $2pq$ = frequency of heterozygous
  vi) q^2 = frequency of homozygous recessive

12.2 Hardy-Weinberg Principle



12.3 Random Change

- Changes in a gene pool can be caused by a number of different factors:

i) Small populations are prone to changes in gene frequency from chance fluctuations

ii) Preferred mates will pass on more alleles than those of less preferred mates in populations where mating opportunities are non-random

iii) Genetic mutations can result in the formation of new alleles or a change in existing alleles thereby changing allele frequency

iv) Open populations (immigration & emigration) remove and/or add alleles to existing populations

v) Natural selection results in an increase of allele frequency of those alleles that are associated with individuals who have the greatest reproductive success

12.3 Genetic Drift

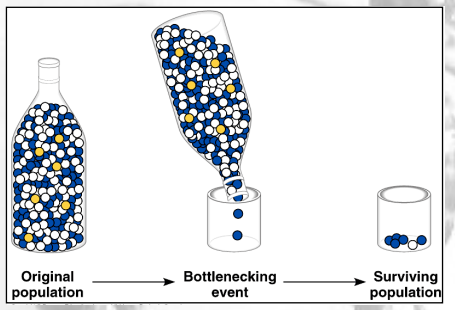
- GENETIC DRIFT → changes to allele frequency resulting from chance (pronounced in small populations)

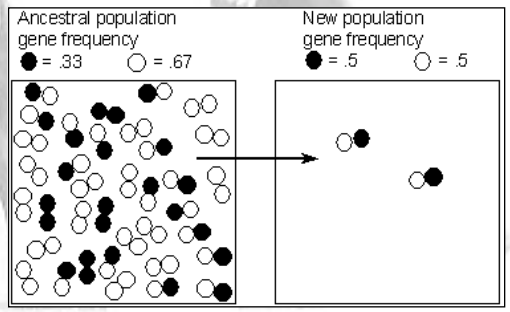
- There are 2 basic types of genetic drift:

i) Bottleneck Effect → resulting from a disaster that drastically reduces population size
(ie. earthquake, volcano, flood, over-hunting)

ii) Founder Effect → resulting from the colonization of a new location by a small number of individuals
(ie. first bird to land on a newly formed volcanic island)

12.3 Genetic Drift





12.3 Genetic Drift

- GENE FLOW → the movement of alleles between one or more populations as the result of emigration and immigration
- GENETIC MUTATION → change in an organism's DNA that creates a new allele
- There are 3 basic types of mutation:

i) Neutral → has no effect on individual

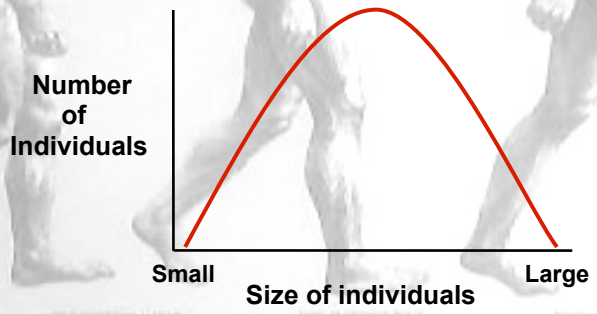
ii) Harmful → has negative effect on individual
→ may cause disruption to cell division, function
→ may cause change in phenotypic expression that inhibits organism

iii) Beneficial → has positive effect on individual
→ may allow cell to produce new protein
→ may cause change in phenotypic expression that gives organism selective advantage

12.4 Patterns of Selection

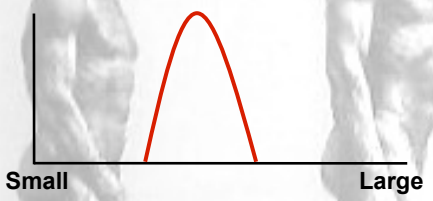
- Natural selection has three modes of action:
  i) Stabilizing selection
  ii) Directional selection
  iii) Disruptive selection

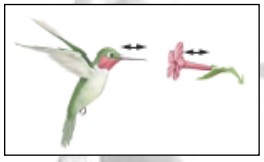
- To illustrate the differences between modes the following model will be used

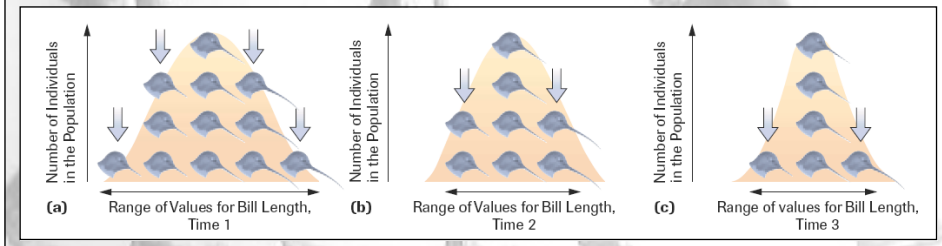


12.4 Stabilizing Selection

- STABALIZING → acts upon extremes and favors the intermediate

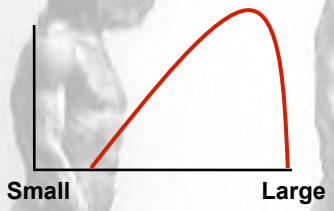


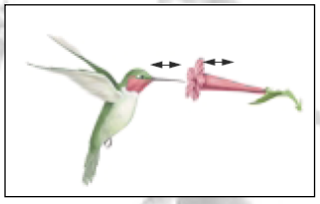


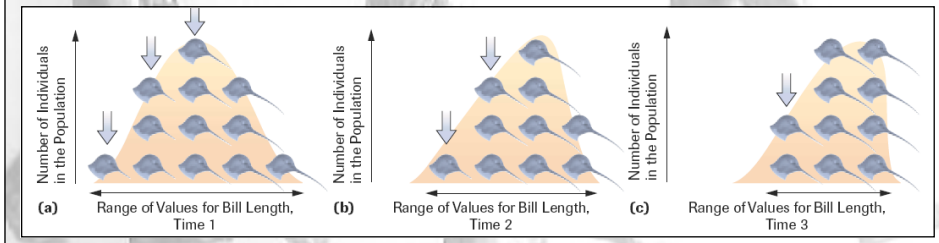


12.4 Directional Selection

- DIRECTIONAL → favors variants of one extreme

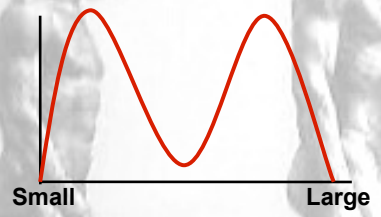


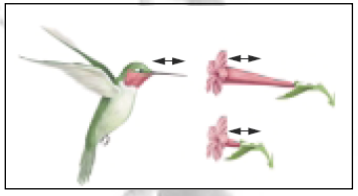


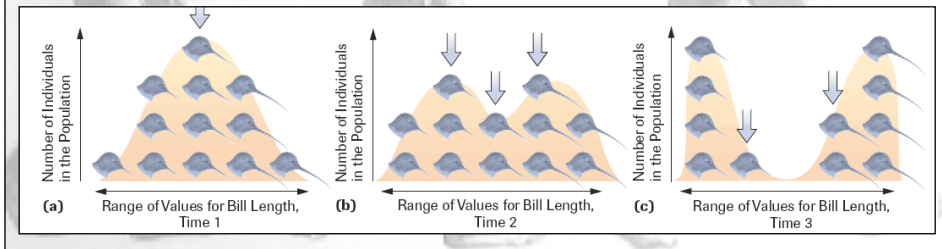


12.4 Disruptive Selection

- DISRUPTIVE →favors variants of opposite extremes





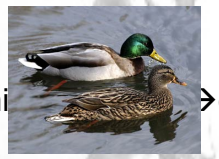


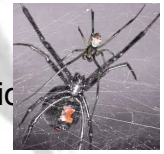
12.4 Sexual Selection

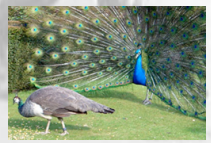
- Sexual selection occurs when mates are chose other than by chance

This can result in:

i) Sexual Dimorphism → visible differences between males & females of a species

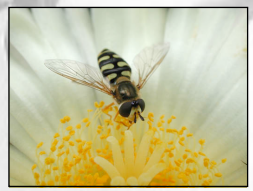



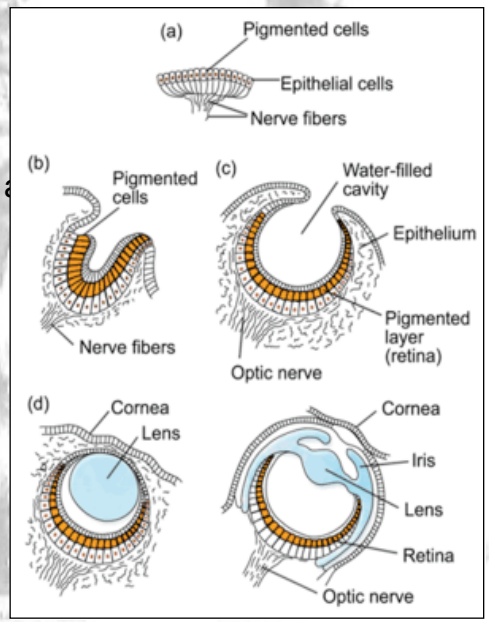





12.5 Cumulative Selection

- Cumulative selection is the notion that many small evolutionary changes can occur over long periods of time and eventually result in a new significant adaptation
- How did eyes structures evolve?
- How did plants develop mechanisms of insect and/or animal pollination?





12.6 Speciation

- Speciation is simply the evolutionary formation of new species
- Evolution at the species level is called MICROEVOLUTION while evolution occurring in taxonomic groups above the species level is called MACROEVOLUTION
- What is a SPECIES?
  → members of groups and/or populations
  → have the ability to interbreed naturally
  → isolated from other groups and evolve independently
- Species can be separated/classified by identification of a "REPRODUCTIVE ISOLATING MECHANISM"
- These mechanisms can be any behaviour, morphological structure, or biochemical trait that prevent members of different species from successfully reproducing

12.6 Speciation

- All REPRODUCTIVE ISOLATING MECHANISMS can be classified into 2 major categories:
  i) Prezygotic & ii) Postzygotic

- Prezygotic mechanisms prevent either the act of mating or the process of fertilization

a) Temporal isolation: Breeding occurs at different times for different species.
b) Ecological isolation: Species breed in different habitats.
c) Behavioral isolation: Little or no sexual attraction between species.
d) Mechanical isolation: Structural differences prevent gamete exchange.
e) Gametic isolation: Gametes die before uniting with gametes of other species, or gametes fail to unite.

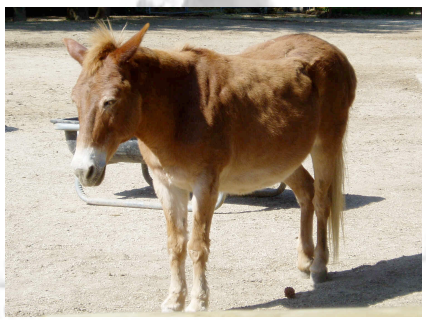
12.6 Speciation

- Postzygotic mechanisms prevent maturation and reproduction of hybrids (interspecies offspring)

a) Hybrid inviability: Hybrid zygotes fail to develop or fail to reach sexual maturity.

b) Hybrid sterility: Hybrid fails to produce functional gametes.

c) Hybrid breakdown: Offspring of hybrids are weak or infertile.



12.6 Speciation