Satellites and Bottlenecks:

Genetic Management of Captive Butterfly Populations

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What we will cover

- Why are genetic considerations important?
- How is genetic diversity measured?
  - Basic DNA Structure
  - DNA Polymerase
  - Polymerase Chain Reaction (PCR)
  - Microsatellite DNA
- Steps to take to avoid inbreeding

Why genetic management is a concern

- Species of concern often small, genetically closed (no new input) populations
- This situation often results in increased inbreeding
- Inbreeding reduces fitness in a variety of ways
- Bottlenecking is the significant reduction in genetic diversity of a population

How Genetics can be problematic in lab cultures

- Selection
  - Selection for traits that result in increased fitness in the lab
  - Lack of selection against traits that reduce fitness in the wild
- Inbreeding

Genetic Issues - Selection

- All populations are subject to natural selection
- Reduced selection and increased survival in lab
- Selection for traits that increase fitness in lab
- Lack of selection against traits that reduce fitness in the wild
- Loss of diversity, increase in frequency of possibly deleterious traits

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The problems with inbreeding

Study by Saccheri et. al.

Bicyclus anynana

- Repeated bottlenecks in lab
- Significant reductions in egg production, hatching
- Significant increase in eclosure of malformed adults
- Others have reported decreased mating

Genetic Issues - Inbreeding

Extinction of the Large Blue in Britain

Maculinea arion

- Extinction in 1979
- Last colony in prolonged decline (bottleneck)
- Low egg production in 1977- semi-captive colony established
- Final generation adults failed to pair

Conclusion:
Loss of genetic diversity is bad

How is genetic diversity measured?

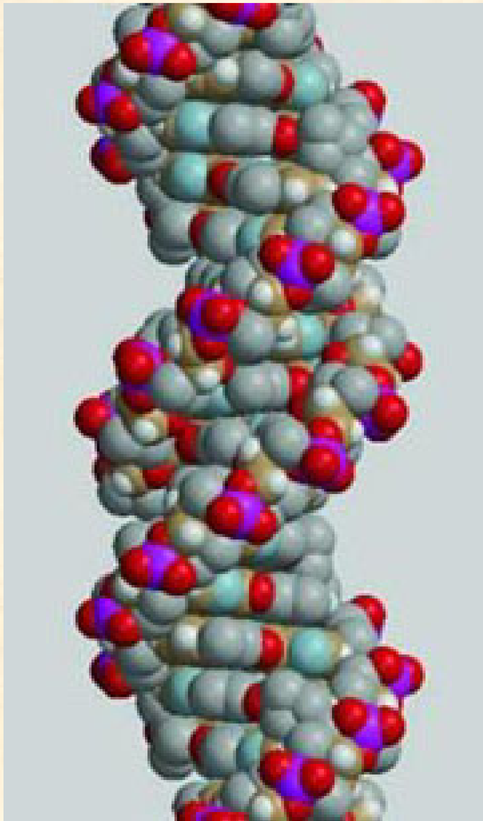
Heterozygosity is determined by performing F-statistics on PCR products amplified at microsatellite loci

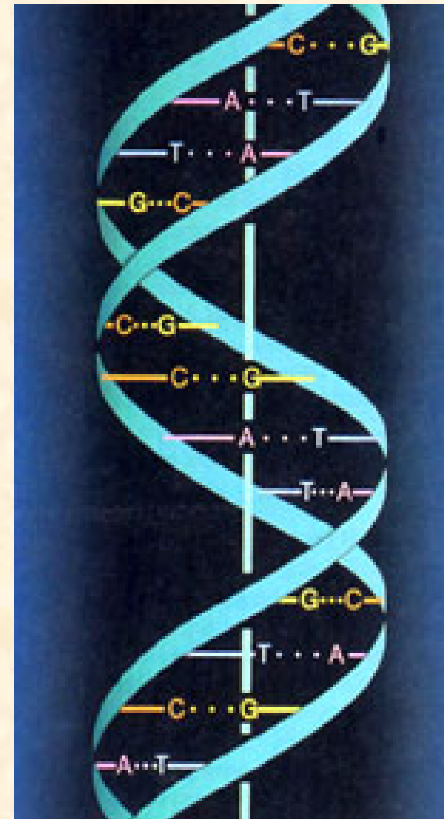
What the heck does that mean?

Measuring genetic diversity

- We will look at 2 tools
  - PCR (a process)
  - Microsatellite sequences (a particular kind of DNA sequence)
- To understand PCR, we need to know some basic DNA structure, and a bit of information about polymerase enzymes

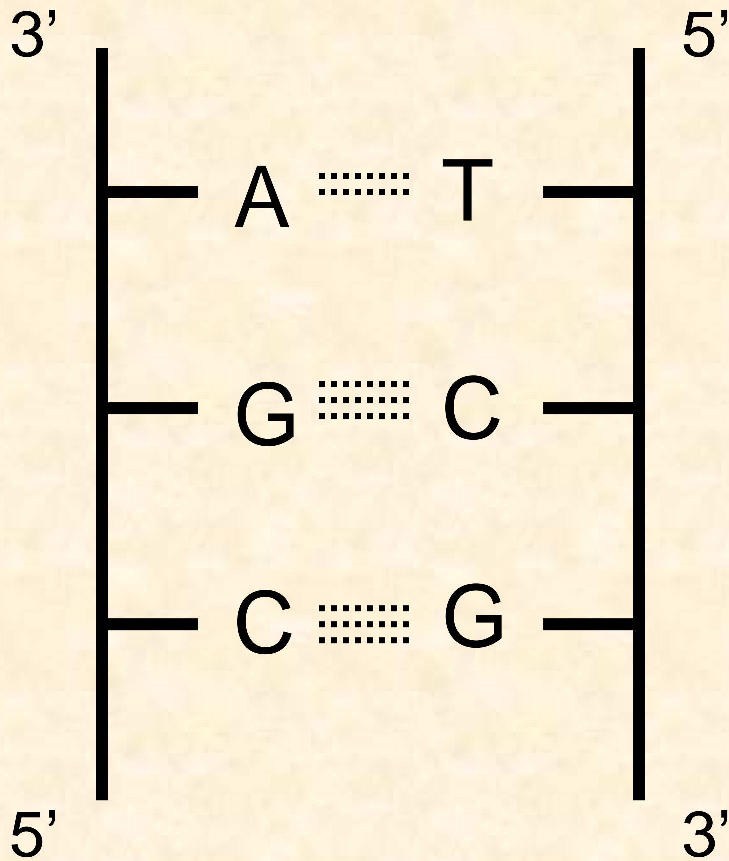
DNA Structure





DNA Structure

Unwind the double helix for clarity



- Strands held together by hydrogen bonds
- H-bonds can be reversibly broken by heating
- 4 Chemically distinct bases
- Bases complementary
- Strand ends distinct
- Strands anti-parallel

DNA Polymerase

- DNA polymerase catalyzes the copying of DNA
- Polymerase only works on single stranded DNA
- Polymerase only extends chains, doesn’t initiate new ones
- Nucleotides are added to 3’ ends only

Elongation of a DNA primer by a polymerase

Polymerase Chain Reaction PCR

- Copies specific DNA regions
- Creates huge numbers of copies ($>10^6$)
- Can use tiny amounts of starting material
- Copied DNA is called template
- Uses 2 small synthetic DNAs called primers