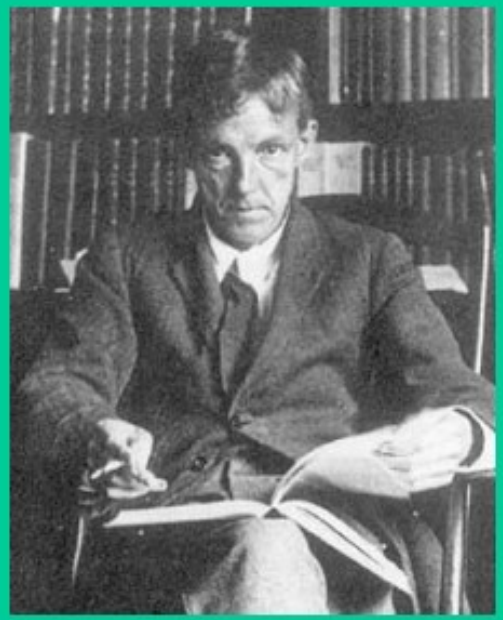
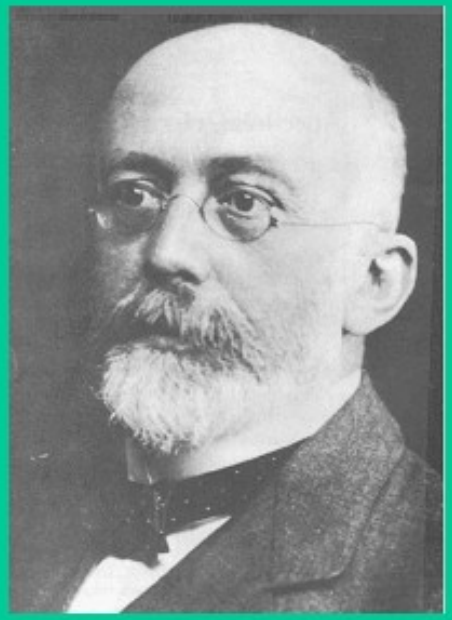
# When does the Hardy-Weinberg equilibrium apply?



Godfrey Harold Hardy
1877-1947



Wilhelm Weinberg
1862-1937

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# Conditions necessary for HW equilibrium:

1. Large population
2. Random mating
3. No genetic drift
4. No gene flow - migration
5. No natural selection
6. No mutations

# Hardy-Weinberg and Evolution

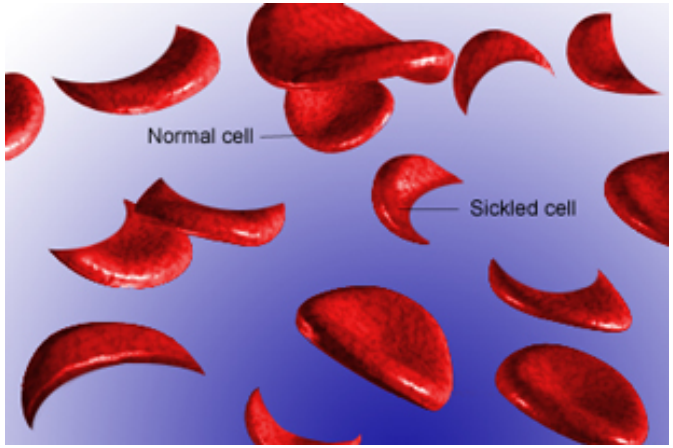
**Changes in HW equilibrium = evolutionary change**

**Factors that bring about evolutionary change (messes up Hardy-Weinberg)**

1. **Small population**
2. **Non-random mating**
3. **Genetic Drift**
4. **Migration (gene flow)**
5. **Natural selection**
6. **Mutation**

# 1. Mutations

- **Changes in DNA**
- Inheritable
- Occur during ***Meiosis***
  - Spermatogenesis
  - oogenesis




- **2 types of mutations**
  - **Chromosome mutation** → gain or loss of a chromosome (e.x. Down's syndrome)
  - **Point (gene) mutation** → change in a gene on a chromosome (e.x. Sickle celled anemia, Tay Sachs disorder)

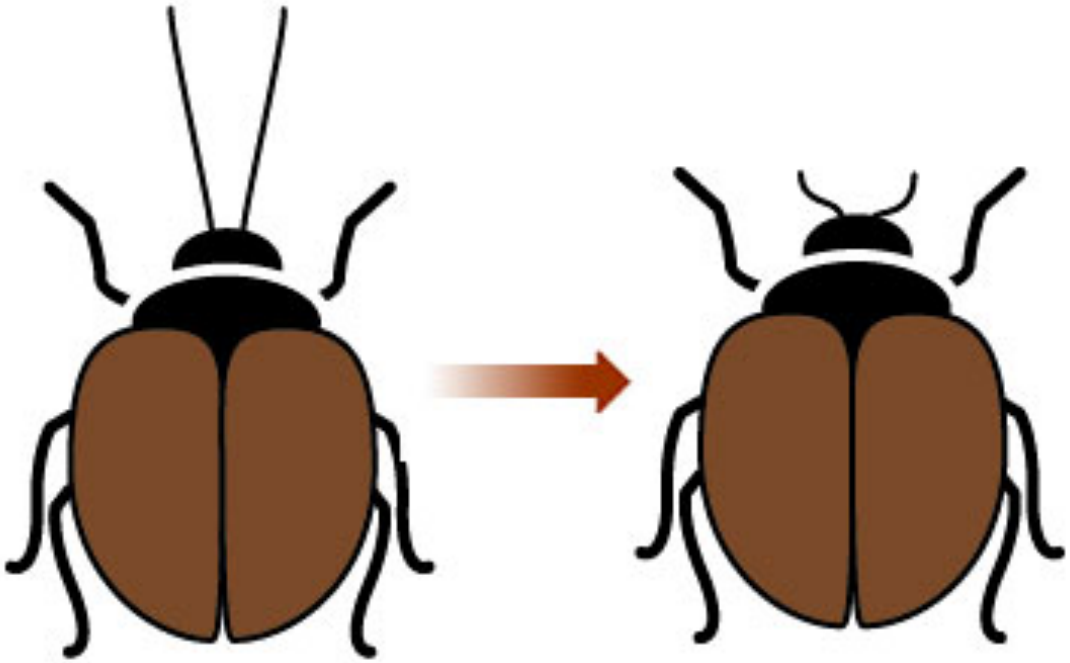
# 1. Mutations

- Usually show up in the ***homozygous recessive genotype***
  - Therefore they remain **hidden in a generation** through the **heterozygous (Rr)** genotype

**Mutations → genotypic *VARIATIONS***

- Mutations are the **original source** of variation
- Mutation rates through evolution were **extremely slow**, but resulted in a ***change in species*** to better their chances for survival
- May be beneficial in one environment and **detrimental** in another
- Survival of the "**fittest**"

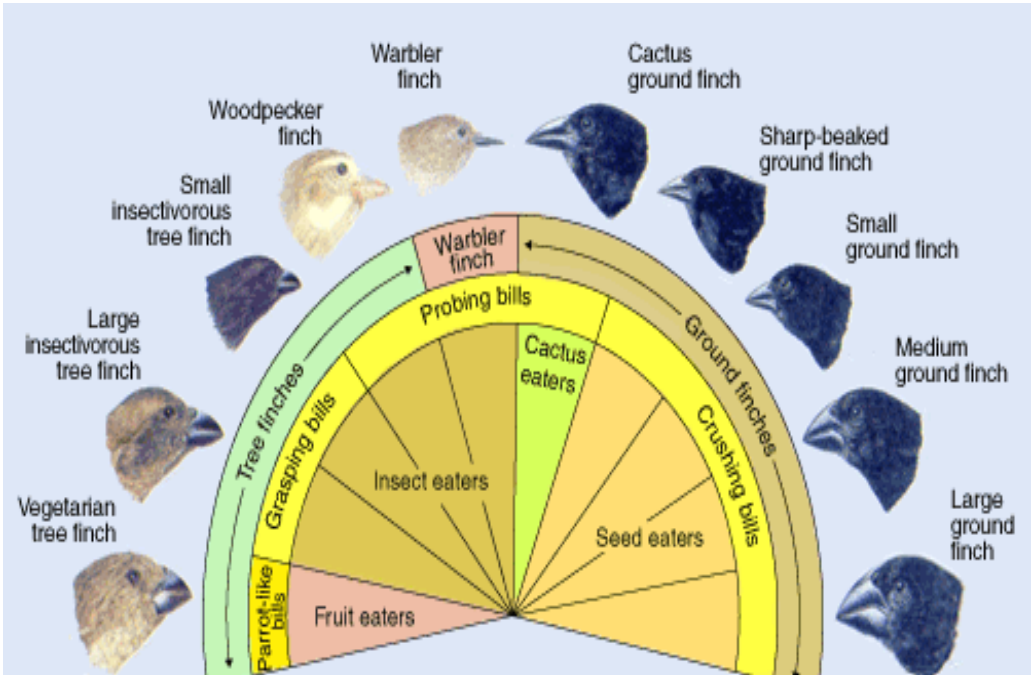
# 1. Mutations



Environmental change selects for short antennae

# When is a trait beneficial in one environment but detrimental in another?

- Darwin's Finches
- Beak shape determines environment in which a finch can survive
- Short beaked finches better at eating and gathering seeds
- Long beaked finches better at searching for "grubs" in the mud
- Over time, mutations in beak shape genes, allowed specific types of finches to survive in specific environments



# 2. Genetic Drift

- Also known as **"random genetic drift"**
- When a population size ***decreases*** → genetic drift occurs
- Results from ***chance events*** → natural disaster, human interference, migration, unsuccessful matings, deaths
- End up with ***changes in frequencies*** of alleles in a population based on chance events

# 2. Genetic Drift & *Founder Effect*

## Founder Effect

- **The Founder Effect** → extreme example of genetic drift
- ***Founder Effect***: loss of genetic variation when a new population is created from a ***small subset of a larger population***
    - New population has a **disproportionate frequency of alleles** of the "founders" of that population
    - Ex. Amish communities

# 2. Genetic Drift & ***Founder Effect***

***(EG) Ellis-van Creveld syndrome***

- Short stature, polydactyly, hole in heart chamber
- More frequent in Amish community because "**founders**" carried the recessive allele
- Short stature is in 7% of Amish population while in most others it is **.1%**
- Passed the **alleles** to offspring

**Small community → allele contained in the community → increased frequency of syndrome**

# 2. Genetic Drift & ***Bottleneck Effect***

## Bottleneck Effect

- **Occurs when <u>a few members</u> survive a widespread elimination of a species**

**Cheetahs in Africa**

-12,000 years ago 75% were wiped out

-Low genetic diversity has led to them having poor sperm quality, infectious disease susceptibility, kinked tails, and dental problems

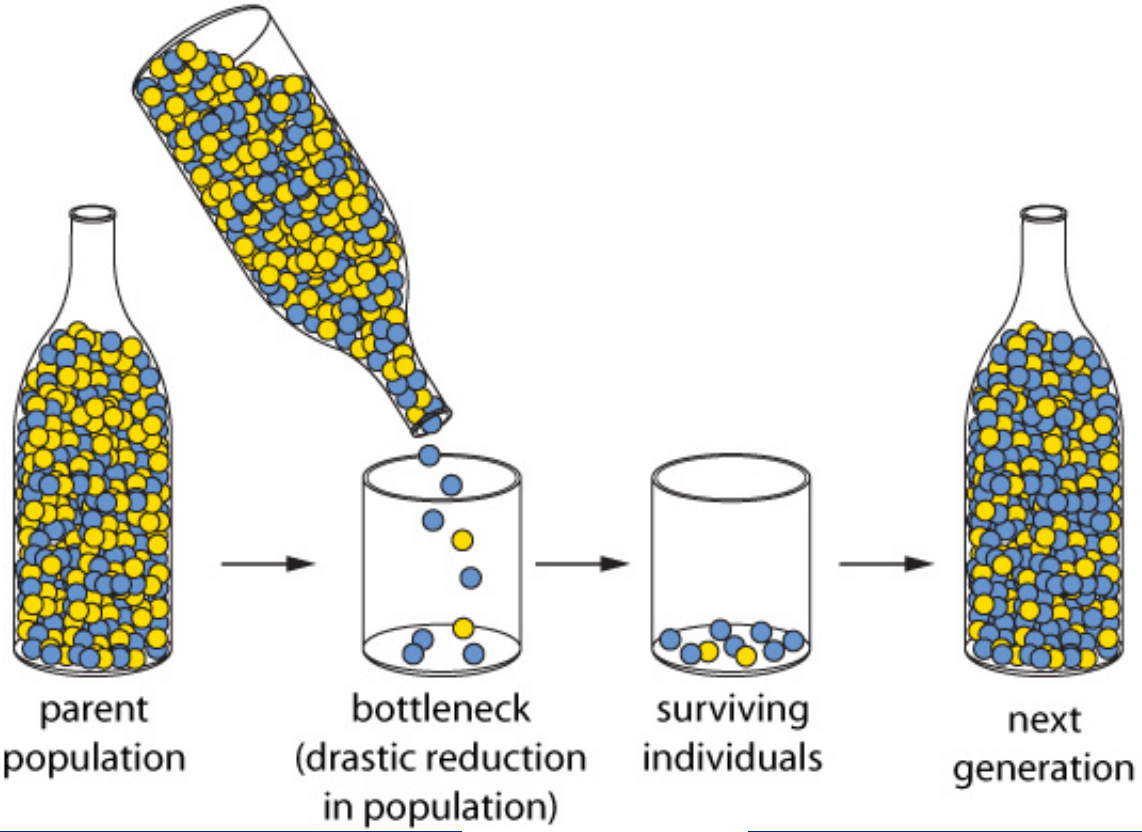
**Elephant Seals**

-hunted to 50-100 individuals

-now are over 30,000 but not very genetically different from each other

- **Drastically reduced population leads to decreased genetic variation**

# 2. Genetic Drift & Bottleneck Effect




Equal number of blue and yellow alleles

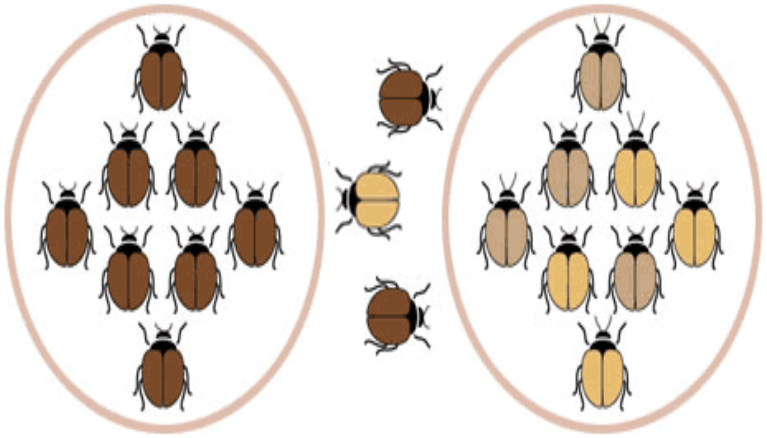
Fewer yellow alleles = lower genetic diversity

# 3. Migration

"Gene flow"

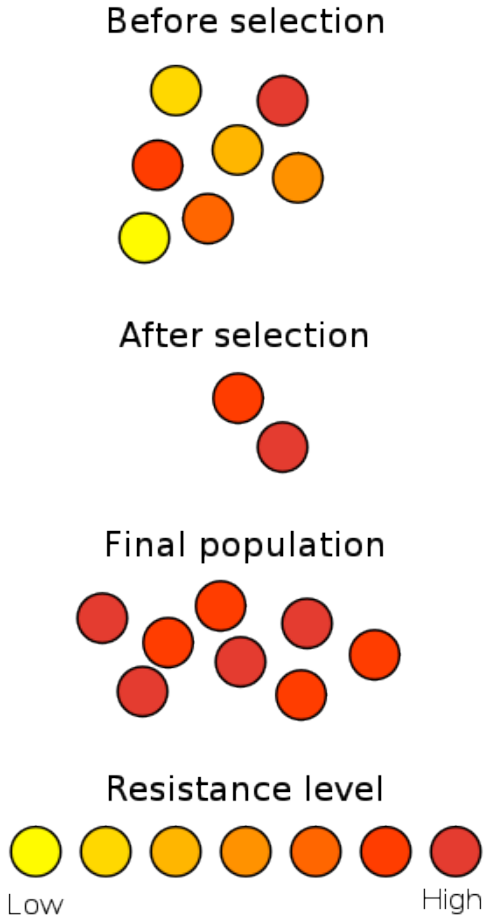
- ***Immigration*** → movement of members of a species ***into*** a population
  - Genes **ADDED**
  - Gene pool **EXPANDS**
- ***Emigration*** → movement of members of a species ***out of*** a population **(exit)**
  - Genes **REMOVED**
  - Gene pool **CONTRACTS**

- **Gene frequencies change**



# 4. Natural Selection

- Primary *mechanism of* ***evolution***
- Survival of the "fittest"
  - Organisms **best suited for a given environment** will survive and pass their genes on to the next generation

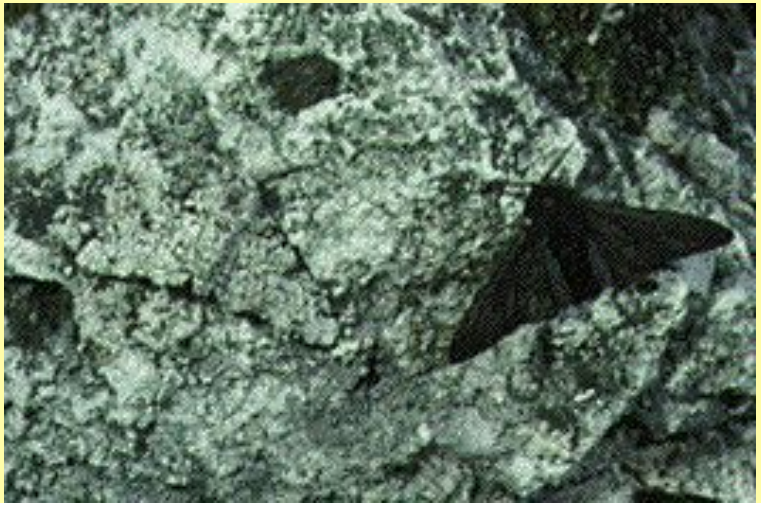



resistance to antibiotics grows though the survival of individuals less affected by the antibiotic. Their offspring inherit the resistance.

# The Peppered Moth

## Pre-Industrial Revolution in England

- Birds ate dark moths because they stood out on white bark
- Light colored moths were **selected for** because they are camouflaged on white bark

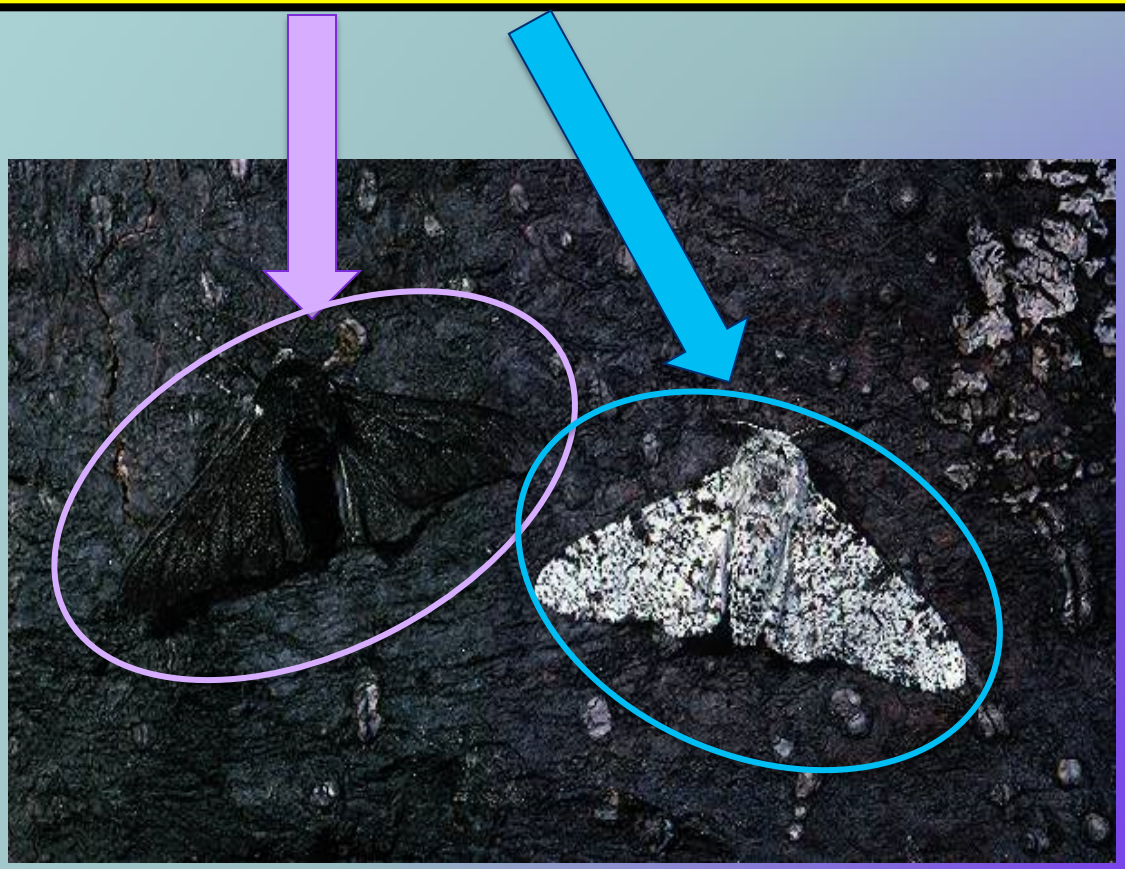


## Post-Industrial Revolution

- Birds ate white moths because they stood out on dark bark
- Dark colored moths were **selected for** because they are camouflaged on dark, polluted bark

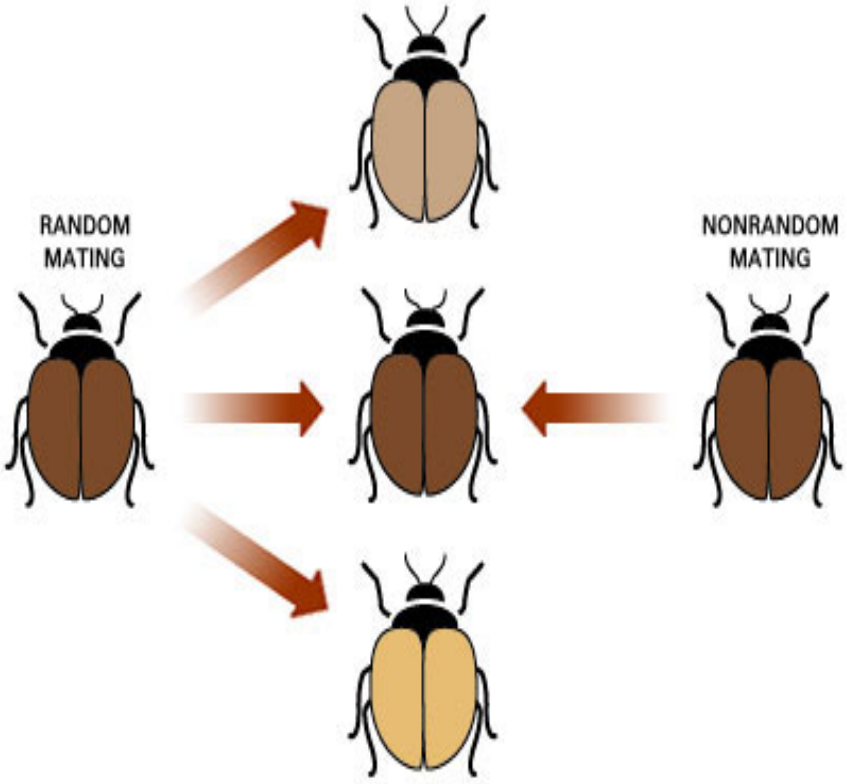
**Organisms that are selected for have a greater chance of survival.**

**Organisms that are selected against have a lower chance of survival.**



# 5. Non-random mating

- Selective breeding
  - Individuals **seek** mates within a small population
  - Particular genes are **selected for** during non-random mating
- Non-random mating is a form of **Natural Selection** → contributes to evolution

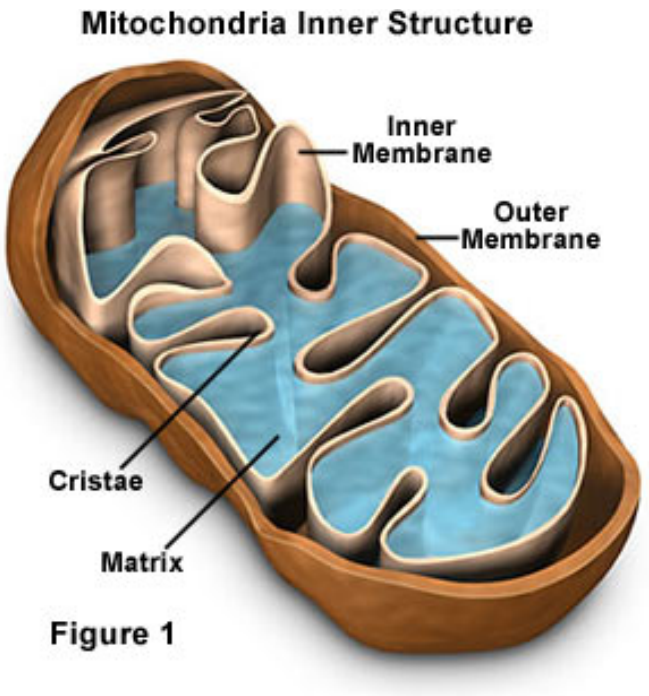



Bozeman: Summary of factors that cause evolution 7:39
http://www.youtube.com/watch?v=lk4_alocyHc

# Mitochondrial DNA & Evolution

## Mitochondria

- the "power plant" of the cell (production of ATP – fuel for cell activity)
- **contain their own DNA (mtDNA)** **in small looping chains**
- Since mitochondria contain mtDNA, they can be used to study evolutionary relationships




Mitochondrial DNA (mtDNA) is also useful in tracing **maternal** lineages.

# mtDNA used to trace extinct **maternal** lineage from recovered mummies

**Check out this website for tutorial on how a variety of factors effect evolutionary change in populations.**

# Adaptation

Are these happy face spiders all the same species?

Yes, they are all members of the same species.  They freely mate and have similar reproductive behaviours. They live in Hawaii.

# Meet the Liger!

Meet Hobbs the ‘Liger’

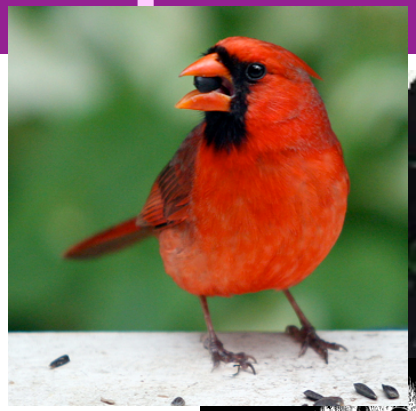
- cross between a male lion and a female tiger
- sterile male
- challenges geographic isolation because **interbreeding between species occurs, BUT ligers are typically sterile** therefore this is ‘unsuccessful breeding’

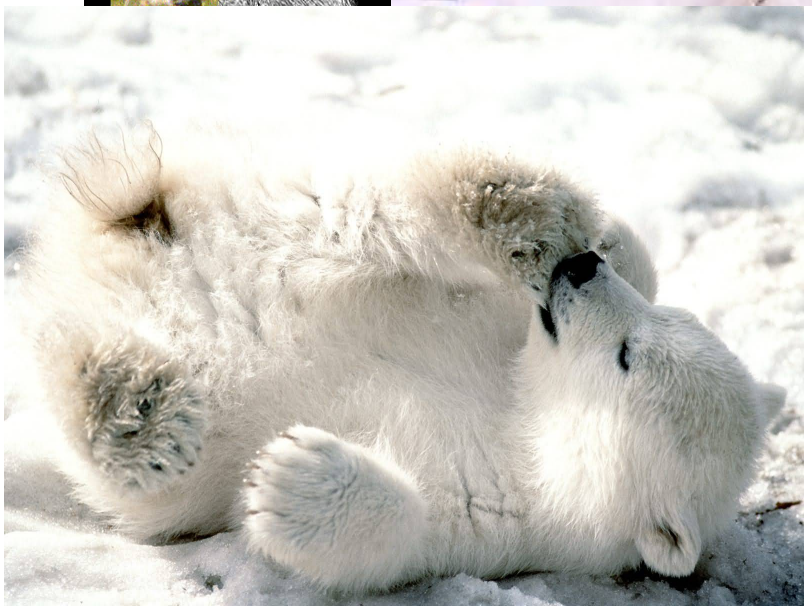
# Adaptations

- Adaptations are ***inherited traits*** **that improve the chances of survival and reproduction of organisms**
- 3 types
  1. Physical Adaptations
  2. Behavioural Adaptations
  3. Physiological Adaptations

# Physical Adaptations

- **Structural/anatomical adaptations**
- **In birds**
  - **Wings**
  - **Feathers**
- Opposable thumb in Panda Bears
- Polar bears - Black skin and hollow hairs



# Behavioral Adaptations


1. **Courtship**- mating ritual
2. **Migration**- geese fly south for winter
3. **Nocturnalism**- active during the night
4. **Metabolism**- how fast an individual uses food for energy
5. **Hibernation** – sleeping through the winter
6. **Estivation** - slowing of metabolism in some animals during a hot or dry period

Lyre bird: http://www.youtube.com/watch?v=VjE0Kdfos4Y&safety_mode=true&persist_safety_mode=1&safe=active
Bird of paradise: http://www.youtube.com/watch?v=HyvxlUpEjgI&safety_mode=true&safe=active&persist_safety_mode=1


# Physiological Adaptations

- **Pheromones**
  - chemicals secreted by organisms to attract or repel other organisms
    - Examples: Sexual attractants or alarms
  - **Poison glands (frogs)**
- **Enzymes -** control bodily functions
- **Venom** by snakes
- **Toxins** produced by plants & animals (skunk, sea anemones)