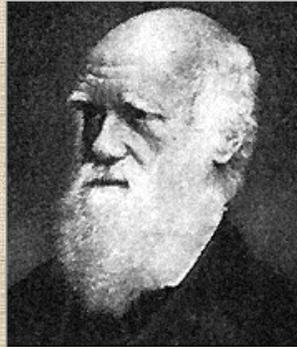


# The Theory of Evolution

Change over time



Lamarck



Darwin



Malthus

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Evolution

1

## 1. What is evolution?

- a) Microevolution- change of allele frequency within a population over time (not disputed)
- b) Population- same species living together - same place, same time
- c) Macroevolution- origin of new species (clashes with some religious beliefs)
- d) Species- a group of organisms that are closely related and can mate to produce fertile offspring
- e) Gene pool- ALL alleles in the population

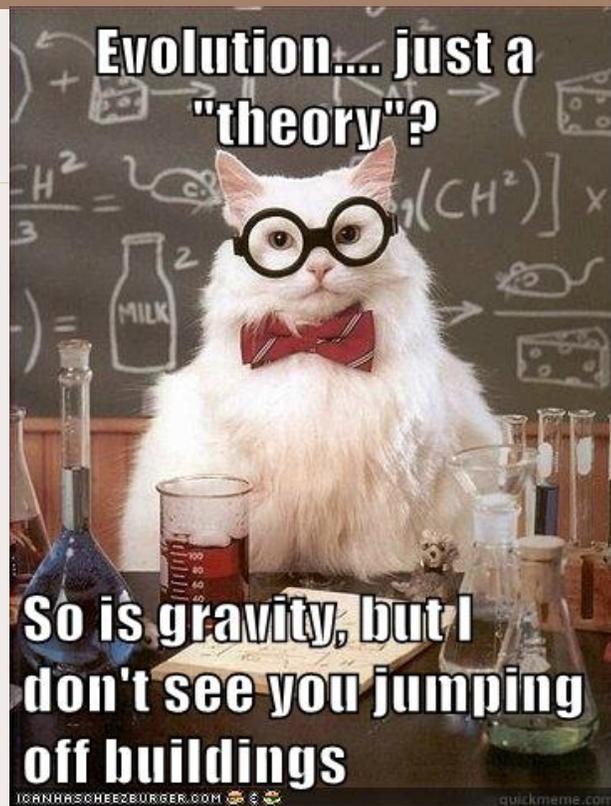
Why is Evolution So Controversial, anyway?

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Clip #7

2

- Clip #1 isn't evolution just a theory?



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## 2. Influences on Darwin

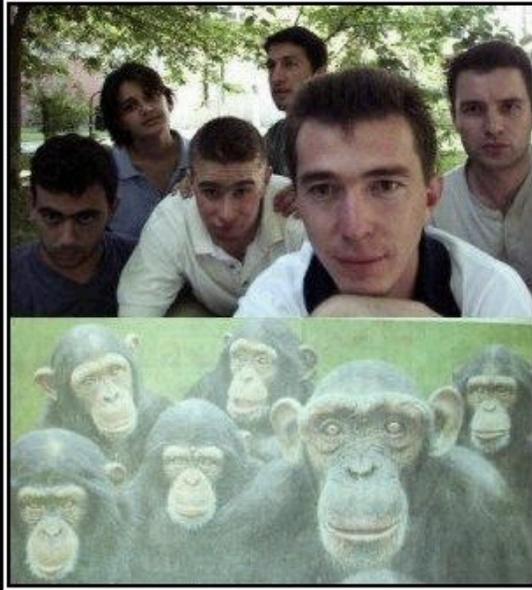
- A. Lamarck- spontaneous generation\* AND use/disuse theory

Clip2 who was Charles Darwin?

\* Oops, we now know flies come from fly eggs, remember Virchow?

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## EVOLUTION

Do you believe it now?

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## Lamarck's Use/Disuse Theory



Giraffes who stretch their necks to reach tall branches will pass on the long neck characteristics to their offspring.

**FALSE**

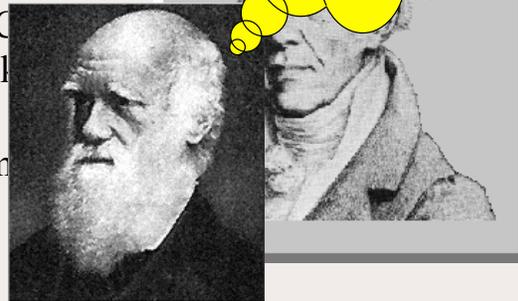
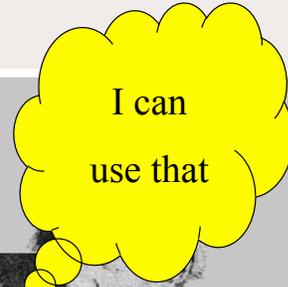
Example: Mice whose tails are cut off do not have mice with no tails

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# Was Lamarck right about anything?

- Coined the term invertebrates
- Living things cannot be living if they don't have cells
- Offspring get traits from parents
- Offspring get traits from parents
- Earth was immensely old
- (Implied environmental) C and grandchildren of smokers increase risk of asthma
- Not right about women, many times

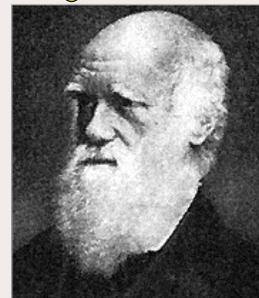
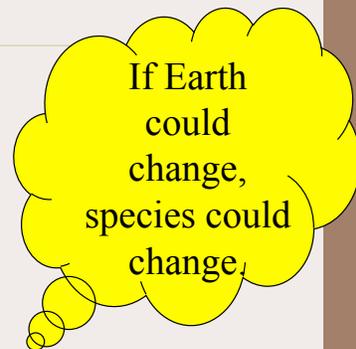


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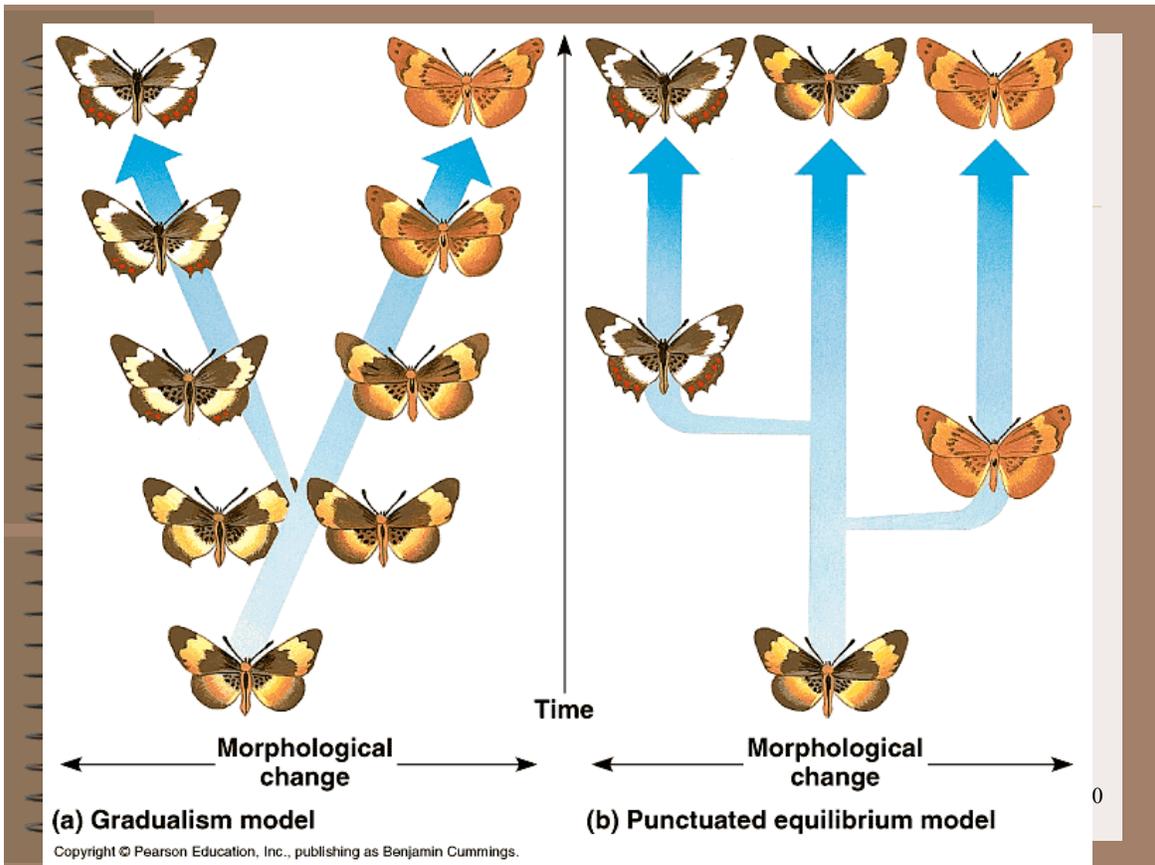
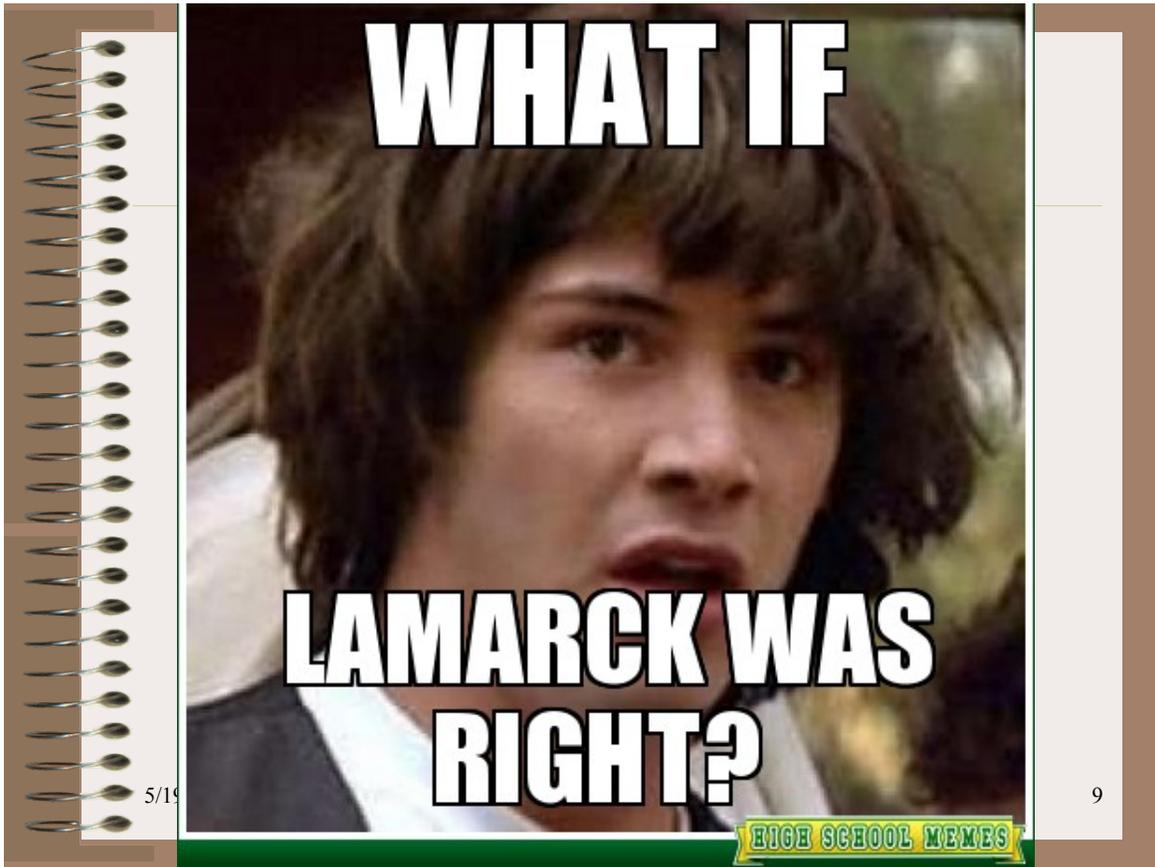
## 2. Influences on Darwin (continued)

- B. Geologist (Charles) Lyell  
Earth changed over time
- C. Geologist- (James) Hutton-  
gradualism due to  
uniformitarianism
- D. Punctuated equilibrium (1972)  
due to catastrophic changes



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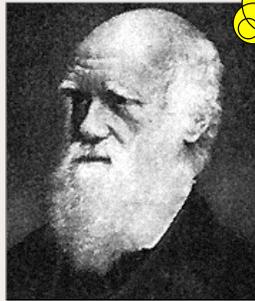
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## 2. Influences on Darwin (continued)

- E. (Thomas) Malthus described how food and other resources limit human population growth  
(Certain individuals die due to lack of food)

If population size in humans is limited, how about animals?



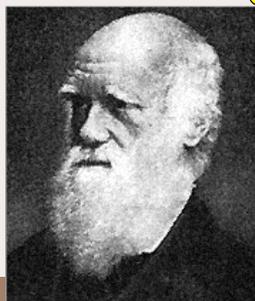
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## 3. Darwin's Data

- A. Collected fossils  
B. Finches on the mainland differed from island species- food changed, beaks changed  
C. Descent With Modification  
D. Biogeography- study of past and present geographic distribution of organisms

Finches get their beak shape from their parents (Lamarck)



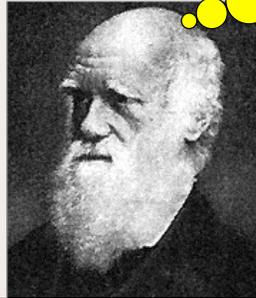
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## 4. The book

- a) 1858 – Wallace – Evolution article
- b) 1859 Darwin's book, The Origin of Species

I better write my book before Wallace scoops me!

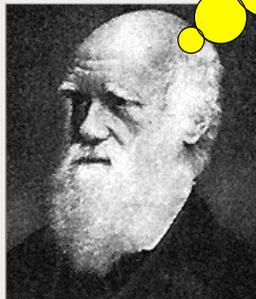


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**Brilliant!**

Hey, wait a tick, those people that survive must have some advantage. Those with the advantage will pass their genes on to future generations!



This works for other organisms!

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## 5. Causes of Evolution

- A. Natural selection- better suited organisms survive to reproduce- frequency of phenotypes shift (see last sentence page 483 \*)

*\* “Natural selection operates on individual organisms, but the changes it causes in allele frequency show up in the population as a whole”*

Clip #6 Why does evolution matter now?

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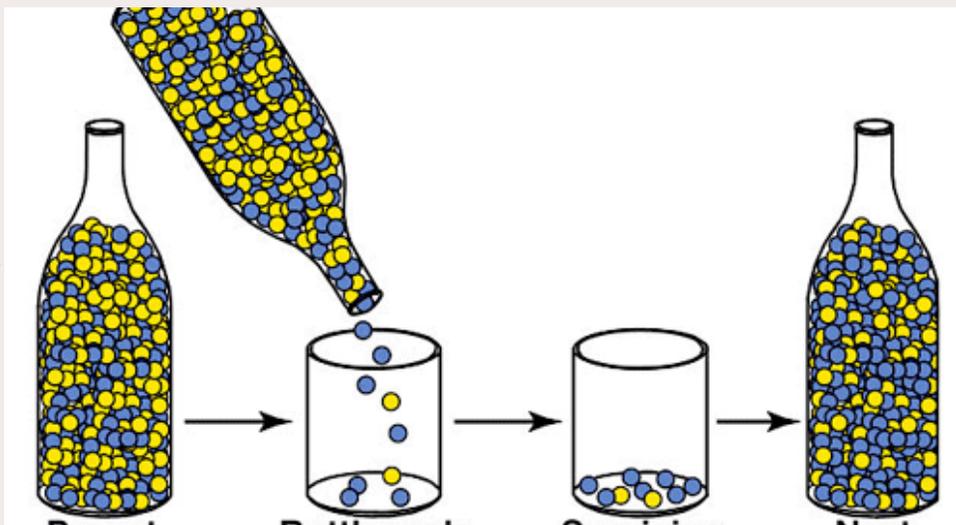
## 5. Causes of Evolution

B. Genetic drift- random change NOT due to natural selection- 2 examples

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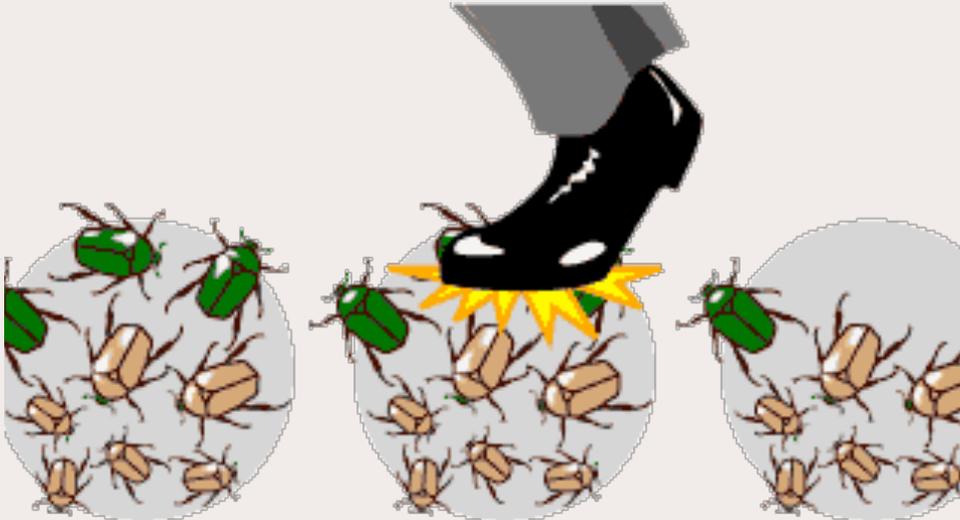
**Bottleneck effect:** A few survive a natural disaster- less genetic diversity in new generation



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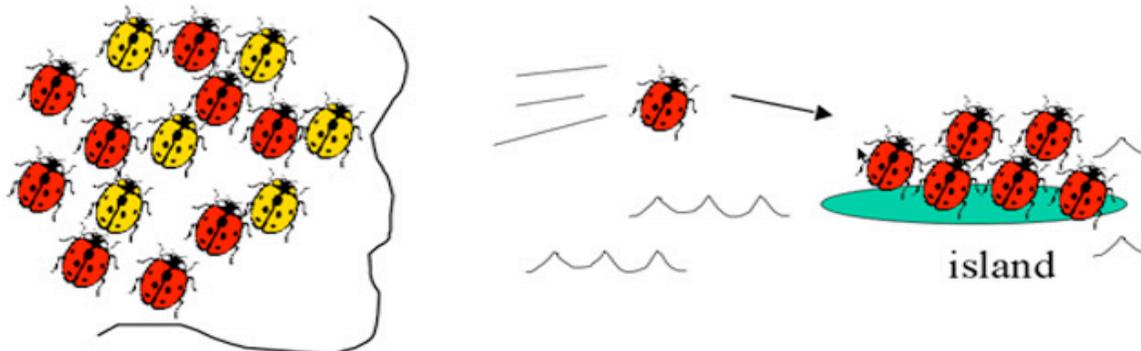
OOPSIE! Green went away- had nothing to do with fitness



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**Founder effect-** a few individuals from a population start a new population with a different allele frequency than the original population



## 5. Causes of Evolution (continued)

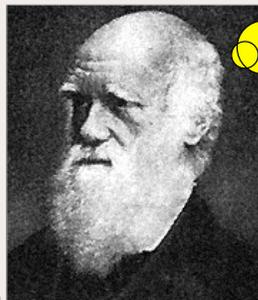
- C. Gene flow- immigration, emigration, birth, death
- D. Mutation – random change of DNA (can be helpful, harmful or have no effect)

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## 6. Nature...

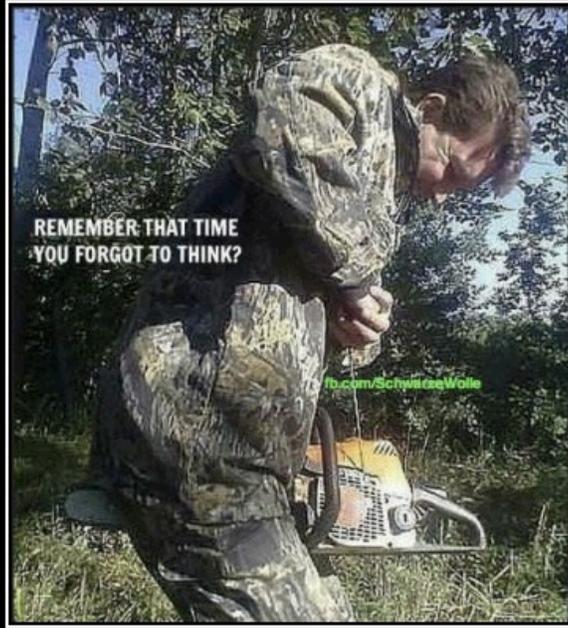
changes species by selecting traits. Nature “selects” the parents for each new generation



Clip 6- why does evolution matter now?

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## DARWIN AWARD

in 3 ..... 2 ..... 1 .....

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## 7. Natural Selection- Why?

- A. Genetic Variation
- B. Overproduction of offspring
- C. Struggle to survive- competition
  - A trait that makes an organism more suited is called an adaptation
- D. Differential reproductive success

clip #4

[How does Evolution really work?](#)

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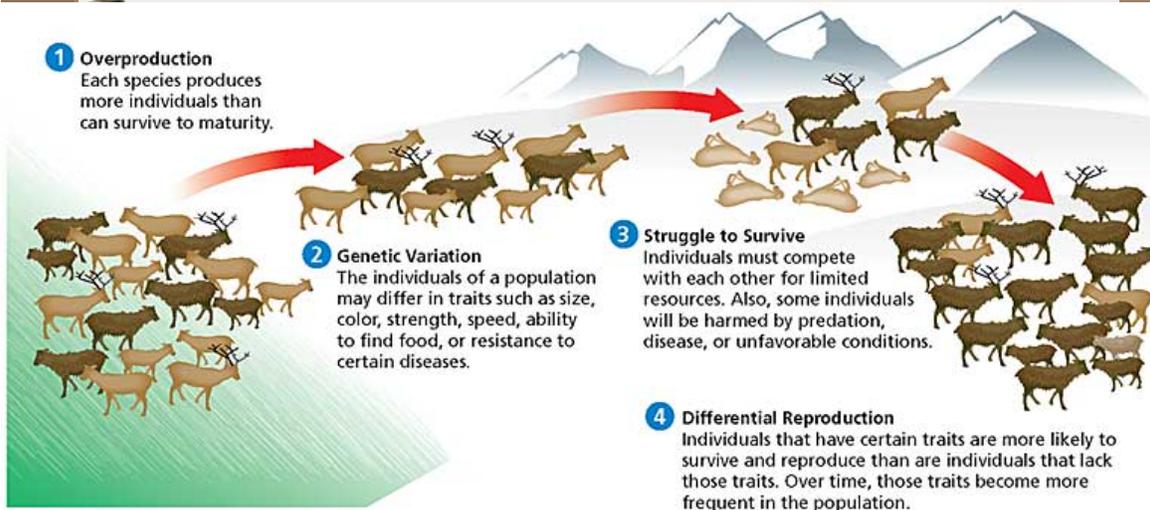


# NATURAL SELECTION

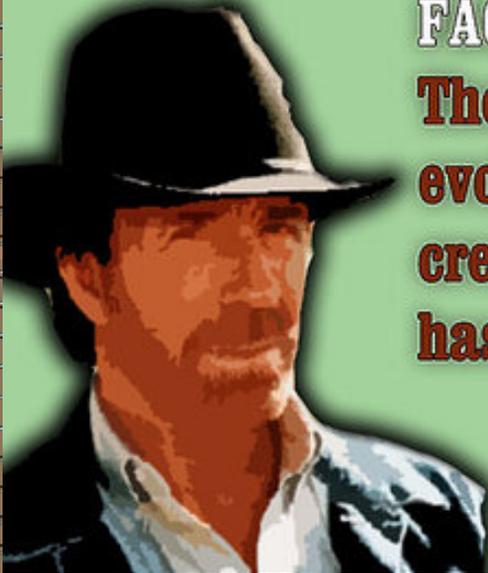
You notice how most of them are actually leaning TOWARD impending doom?

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## Natural Selection



# RANDOM CHUCK NORRIS FACTS



## FACT #2:

**There is no theory of evolution. Just a list of creatures Chuck Norris has allowed to live.**

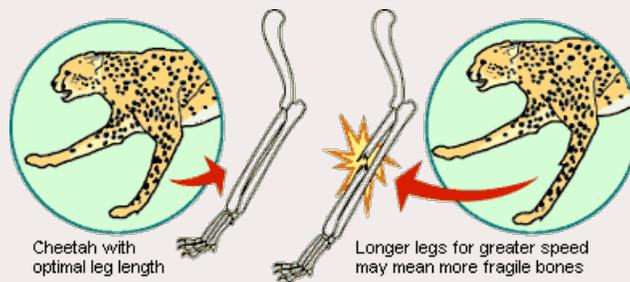
8. Fitness- a measure of an individual's heritable contribution to future generations

- A. It's NOT.... being the biggest (smartest, fastest, most/least colorful)
- B. It IS... leaving the most descendants
- C. Sexual selection- select mate based on heritable traits
- D. Mating successfully\*= winning  
(\**producing live offspring that can reproduce*)
- E. Adaptations- increase fitness
- F. Mutations (helpful/harmful) drive natural selection

# More on fitness: camouflage- important to some, not others

- [Camouflage video](#)

**Survival of the fit enough-** you don't  
have to be "faster than the bear"



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A. Homologous  
structures &  
development

B. Analogous  
structures

9.  
Evidence-  
describe and give  
examples  
(p.468-470)

(clip 3 How do we know  
evol happens?)

C. Vestigial  
structures

D. Molecular  
Biology

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A. Convergent evolution

B. Adaptive radiation/  
divergent evolution

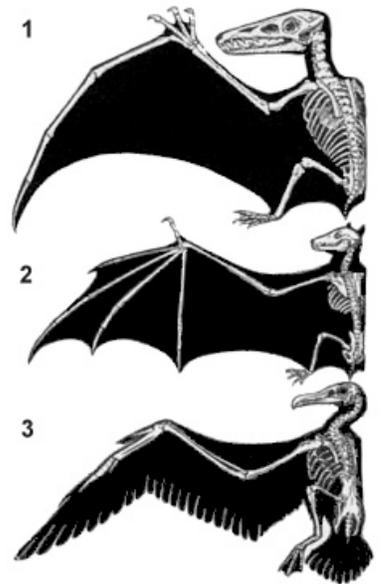
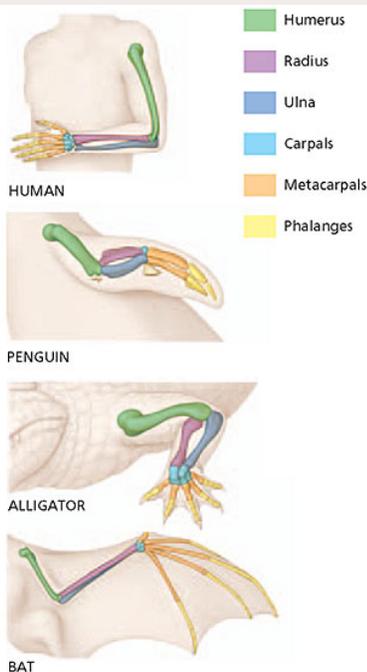
10.  
Types of  
Evolution-  
describe & find  
examples  
p.551

C. Artificial Selection  
Page 457-458

D. Co-evolution

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The wings of pterosaurs (1), bats (2) and birds (3) are analogous: they serve the same function and are similar in structure, but each evolved independently.



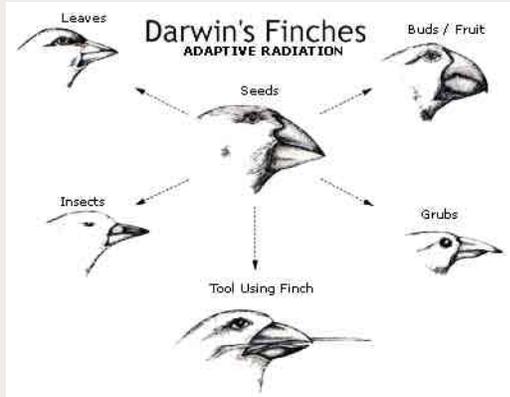
Dewclaw  
In dogs

Visual Concept

## Hemoglobin Comparison

Clip 5  
Did humans  
evolve?  
Relative vs  
ancestor.

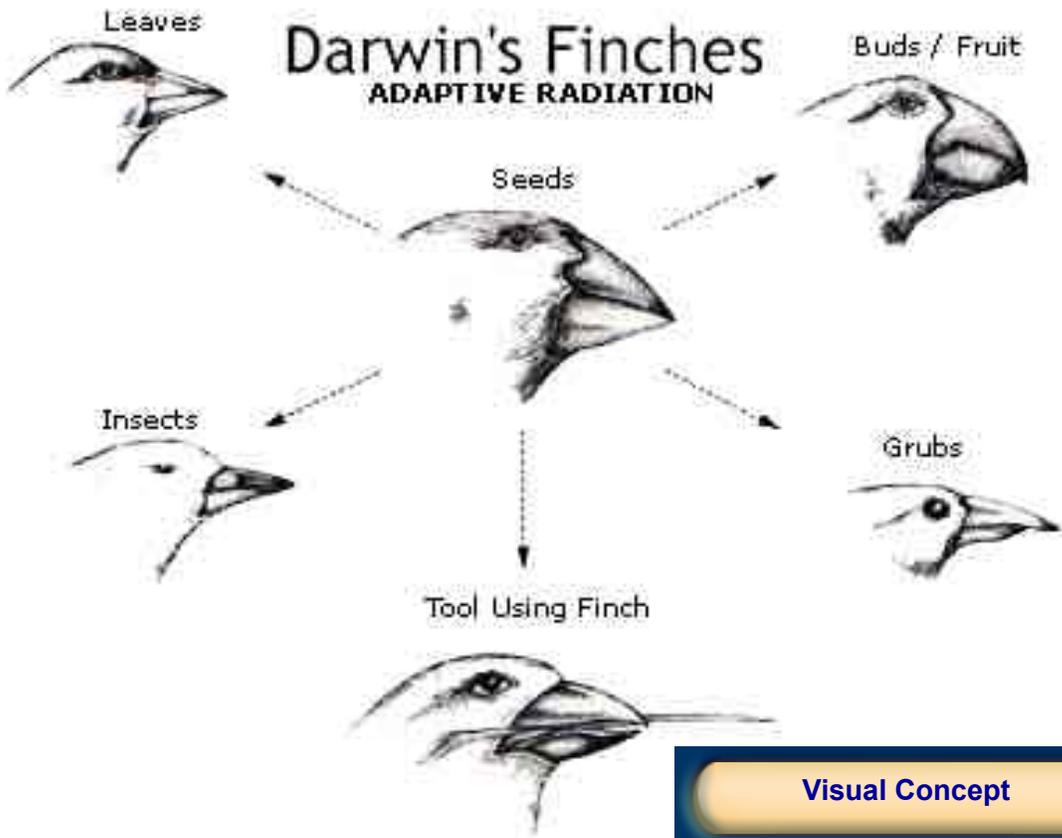
Species	Amino Acid Differences from Human Hemoglobin Protein
Gorilla	1
Rhesus monkey	8
Mouse	27
Chicken	45
Frog	67
Lamprey	125



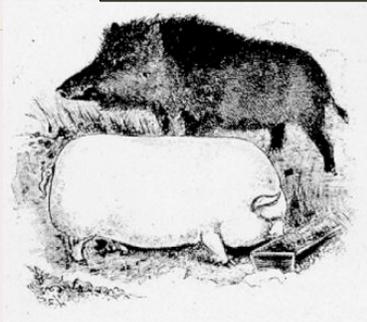
Visual Concept

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Visual Concept

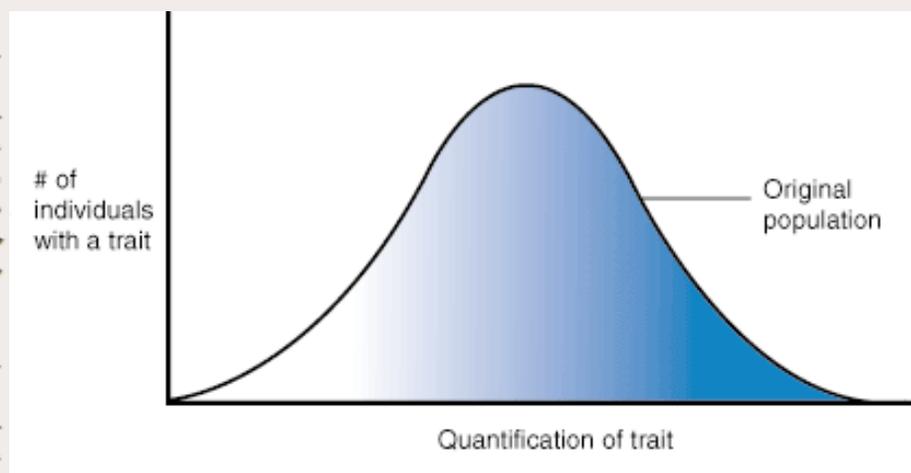


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# 11. Natural Selection Patterns- driven by fitness

## a) Normal "bell curve" distribution



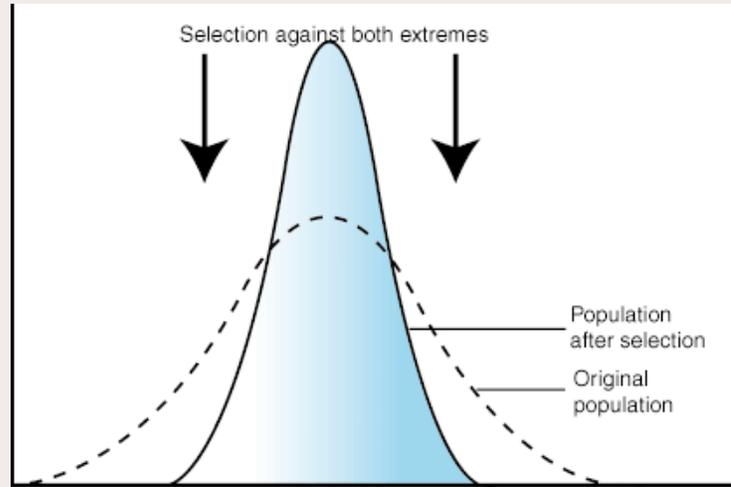
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.... Then something happens to change this

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## 11. Natural Selection Patterns- driven by fitness

### b) stabilizing selection- Against both extremes



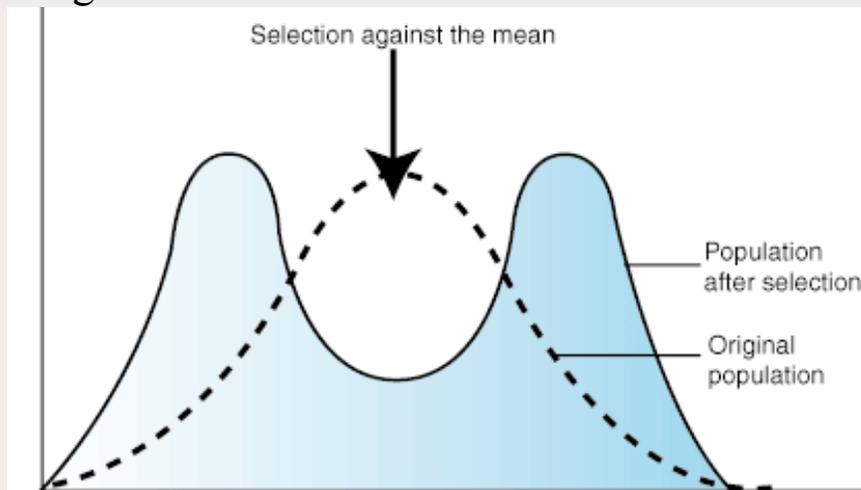
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Ex: Plant height- too tall wind damage, too small sunlight, animal birth weight

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## 11. Natural Selection Patterns- driven by fitness

### c) Disruptive selection- outer ends have higher fitness



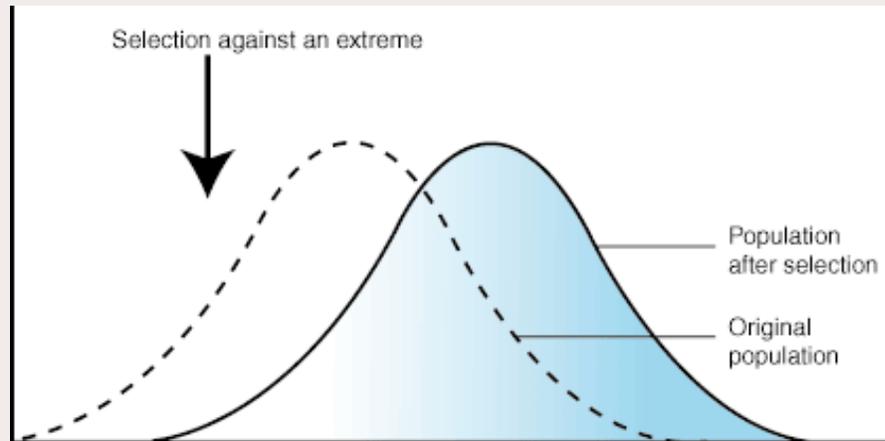
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Imagine plants that are pollinated by 3 different pollinators- short, medium and tall. Something happens to the medium pollinators, only the short and tall get pollinated and leave seeds.

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## 11. Natural Selection Patterns- driven by fitness

### d) directional- phenotypes shift in one direction



Consider giraffe neck length- too short they get out competed  
Or hummingbird bill length

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## 12. Reproductive isolation mechanisms that lead to speciation (A, B, C & D are pre-zygotic)

- A. Organisms can't or won't reproduce
- B. Behavioral isolation- rituals differ
- C. Geographic isolation- physical barrier
- D. Temporal Isolation- timing is wrong
- E. Over time the "isolation" leads to speciation- interbreeding does not happen
- F. Post-zygotic- can mate, but offspring are not born alive or not fertile (or their offspring are nonviable or infertile)

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### 13. Hardy Weinberg (HW) Equilibrium

allele frequencies should remain constant unless one or more factors change the alleles

- A. Mutations can't occur
- B. Individuals can't enter or leave POP
- C. POP is large
- D. Individuals mate randomly (no sexual selection)
- E. Natural selection can not occur

(the "equilibrium" is equilibrium of alleles. FYI  
Hardy Weinberg never occurs!)

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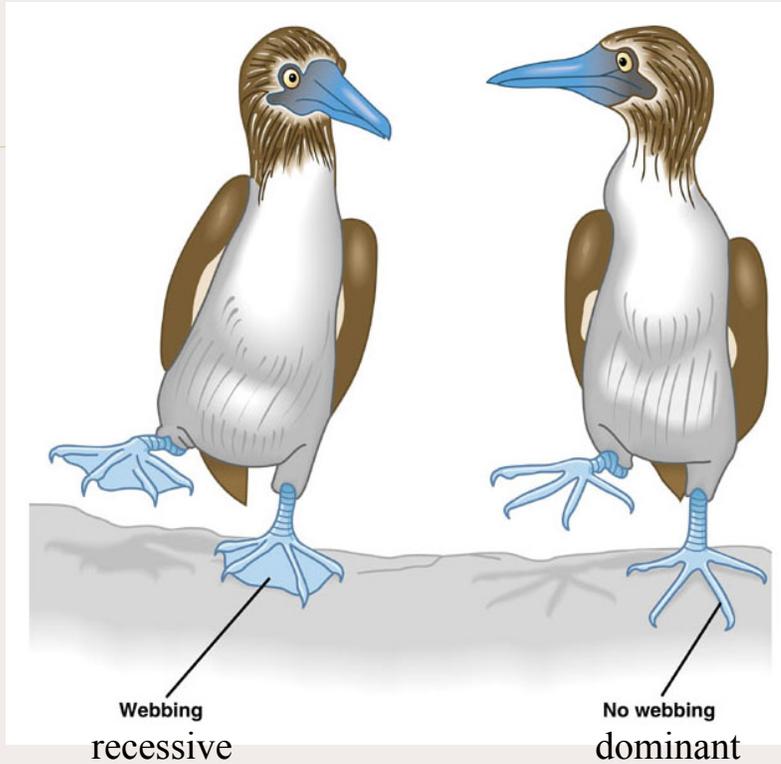
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### 14. HW Equations

- A.  $p + q = 1$
- B.  $p^2 + 2pq + q^2 = 1$  where....
  - $p$ =dominant allele (%)
  - $q$ =recessive allele (%)
  - $p^2$ =homozygous dominant \*
  - $q^2$ =homozygous recessive \*
  - $pq$ =heterozygous \*
  - \* = alleles expressed as a %
  - Hint: find the frequency of alleles first

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## Example

500 BF Boobies-  $W$ = non webbed feet,  $w$ = webbed feet

In 500 birds, 20 have webbed feet

1. How many have non- webbed & of those how many heterozygous?
2. Find  $W$  and  $w$  using Hardy-Weinberg

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# Answer

20/500 are ww, the frequency of ww is .04

$$ww = q^2$$

$$.04 = q^2$$

$$q = 0.2$$

$$p = 1 - 0.2 = 0.8$$

$$p^2 = 0.8 \times 0.8 = 0.64$$

$$0.64 \times 500 = 320$$

$$2pq = \text{heterozygous} = 2 \times 0.8 \times 0.2 = .32 \times 500 = 160$$

$$320 + 160 + 20 = 500 \text{ individuals}$$

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Phenotypes			
Genotypes	WW	Ww	ww
Number of animals (total = 500)	320	160	20
Genotype frequencies	$\frac{320}{500} = 0.64$	$\frac{160}{500} = 0.32$	$\frac{20}{500} = 0.04$
Number of alleles in gene pool (total = 1,000)	640 W	160 W + 160 w	40 w
Allele frequencies	$\frac{800}{1,000} = 0.8 W$	$\frac{200}{1,000} = 0.2 w$	

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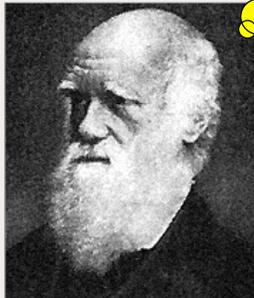
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Recombination of alleles from parent generation

		Sperm	
		<i>W</i> sperm $p = 0.8$	<i>w</i> sperm $q = 0.2$
Eggs	<i>W</i> egg $p = 0.8$	$WW$ $p^2 = 0.64$ 	$Ww$ $pq = 0.16$ 
	<i>w</i> egg $q = 0.2$	$wW$ $qp = 0.16$ 	$ww$ $q^2 = 0.04$ 

Next generation:

Genotype frequencies	0.64 $WW$	0.32 $Ww$	0.04 $ww$
Allele frequencies	0.8 $W$		0.2 $w$



A. Homologous structures- similar structure, different function, arm human/ wing bat, common ancestor embryology

B. Analogous structures- perform a similar function, no common ancestor, wing bat/ wing fly

9. Evidence- describe and give examples

C. Vestigial structures- remnant from a once useful organ, appendix human, pelvic bone in whale

D. Molecular Biology comparing nucleotide sequences how closely related 2 organisms are: insulin, hemoglobin

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A. Convergent-evolution toward similar characteristics, no common ancestors shark fin, dolphin fin

B. Adaptive radiation/ Divergent-common ancestor, evolves into different species. Darwin's finches, red fox, kit fox

10 Types of Evolution- describe and find examples

C. Artificial Selection- human breeder chooses characteristic for next generation, dog breeding and farming

D. Co-evolution 2 or more species developed adaptation to each other's influence rabbit faster, fox run faster

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