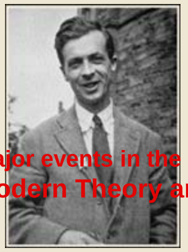

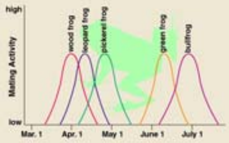

Major events in the history of Biology: Modern Theory and more

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

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In this lecture topic

- How can Mendelian genetics be use to explain natural selection in populations?
- Allele frequencies and evolution – Hardy-Weinberg.
- Sources of variations in alleles.
- What is a species and how do new species arise?
- The importance of systematics?

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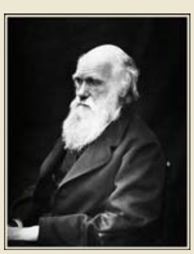
Even today there is no 1 way of defining a species, even today

Darwin's five theories

- No constancy of species
- Common ancestry
- Gradual changes
- Natural selection (microevolution)
- Multiplication of species



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Important stages in the history of Biology

Modern theory and more

- **Synthetic (Modern) theory of evolution**
  - **Population genetics and natural selection based on Mendelian genetics**

Huxley
(1887-1975)

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Lamarck said individual is importan = wrong

Darwin said the population is more important

Microevolution

- **Evolutionary changes that result from changes in allele frequencies in a population, or in chromosome structure or numbers due to mutation and recombination.**

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Some basic terms for microevolution

- **Allele**
- **Phenotype**
- **Genotype**
- Homosygous
- Heterozyggous
- **Dominant and recessive**

phenotype might not perfectly demonstrate genotyupe(dominant allele does not let recessive allele be demonstrated

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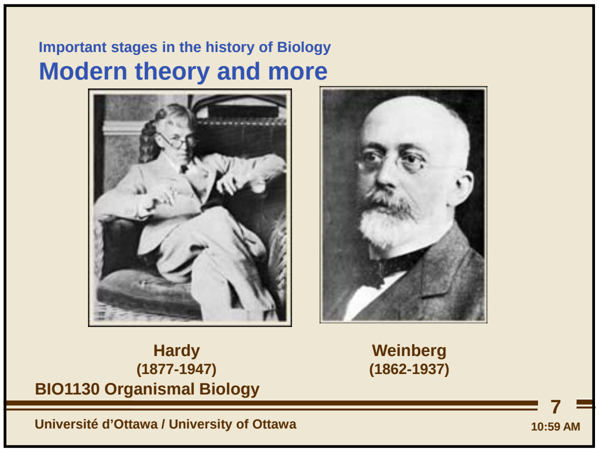
Important stages in the history of Biology
Modern theory and more
Hardy
(1877-1947)
Weinberg
(1862-1937)
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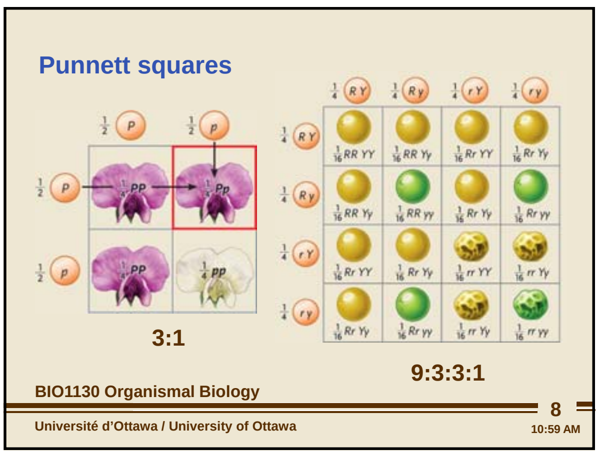
Punnett squares
3:1
9:3:3:1
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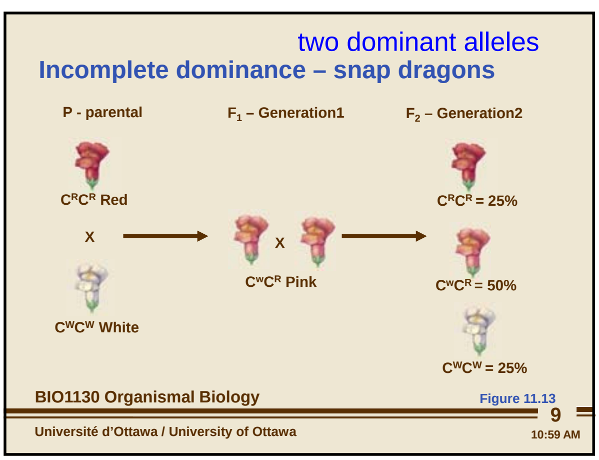
two dominant alleles
Incomplete dominance – snap dragons
P - parental
F1 – Generation1
F2 – Generation2
CRCR Red
X
CWCW White
CWCR Pink
CRCR = 25%
CWCR = 50%
CWCW = 25%
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Figure 11.13
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Modern theory and more

Genotype and allele frequencies

Phenotype	Genotype	Number	Genotype frequency	Total C^R alleles	Total C^W alleles
	C^RC^R	450	450/1000 = 0.45	2x450 = 900	0X450 = 0
	C^RC^W	500	500/1000 = 0.50	1x500 = 500	1x500 = 500
	C^WC^W	50	50/1000 = 0.05	0x50 = 0	2x50 = 100
	Total	1000	0.45 + 0.50 + 0.05 = 1.0	1400 p = 0.7	600 q = 0.3

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Using the Hardy-Weinberg Principle

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

	C^R frequency p=0.7	C^W frequency q=0.3
C^R frequency p=0.7	0.42 $C^RC^R = p^2$	0.21 $C^RC^W = pq$
C^W frequency q=0.3	0.21 $C^WC^R = pq$	0.9 $C^WC^W = q^2$

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this can prooves evolutions, b/c if these alleleic frequencies change it shows that they have evolved/changed

Hardy-Weinberg principle's assumptions

- No natural selection
- Random mating
- No mutation
- No genetic drift – population is large
- Gene flow

genetic drift over a large pop ratios works but in a small pop. there coudl be huge differences, basically a statistical bump

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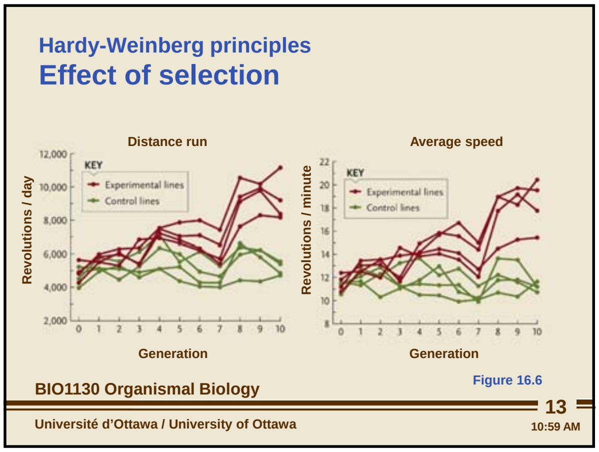
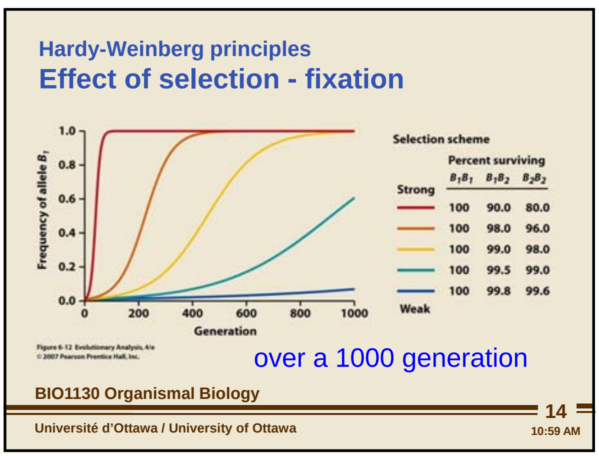
Modern theory and more



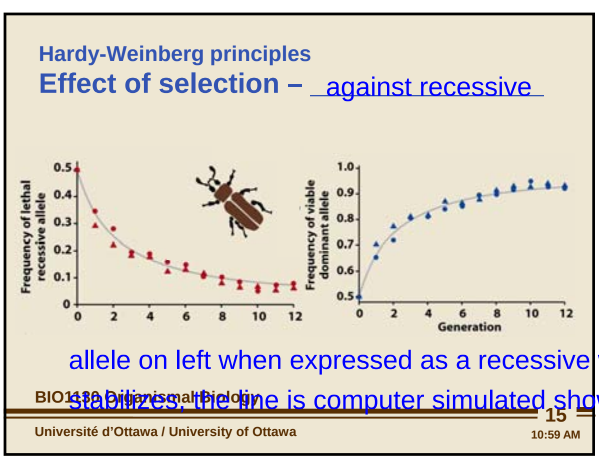
Behaviour is genetic, changes inf requencies of behaviour by ~~breeding for it.~~
For example mice active and inactive
breding actiev mice togethor and breeding inactive mice together(activity determined by time spent inside the wheel)
you could essentially breed for sdiffernet behaviours, basically can breed for complex behaviours simply



over a 1000 generation

basically what happened is tghey selectively killed a certain allele by killing moreof it, this is called slection pressure and can ~~fix tghe genes by puting pressure one allele to dis~~appear, the variation disappears
Agricylture puts selective pressure on traits, basically having less variation, this is occuring but it is artifiical
3 varieties of potatoes, 1 variety of bananas(is being killed by a mtype of mold that it can't fight off)
bred the flavour out of the tomato(by breeding it for shipping, safe and ripeing off the vine, this is strong selective pressure the consious artifiical selection. we want as much genetic diversity in a popualtions as possible.

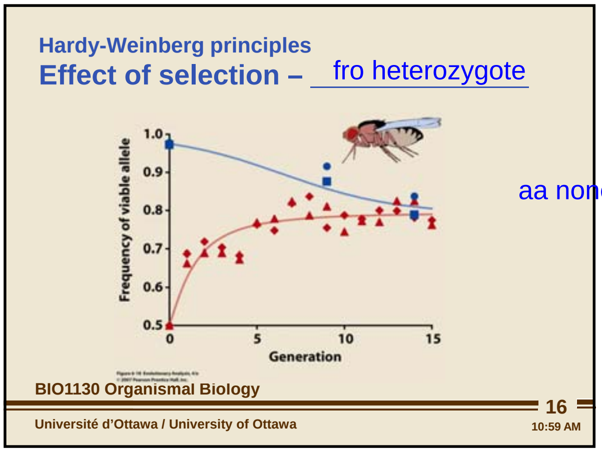
right now people are going around the world trying to find the genetic variability again to put inot the population.



against recessive

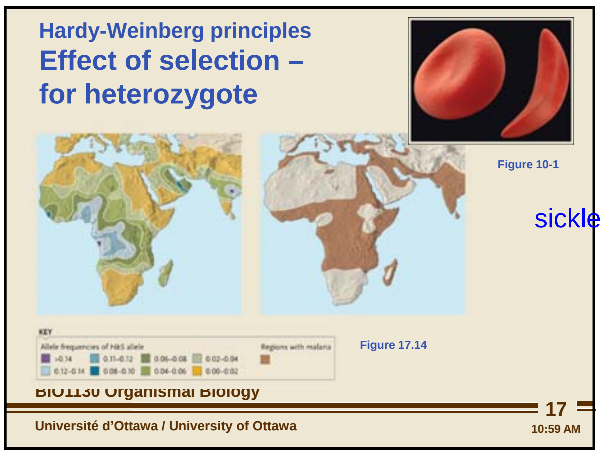
allele on left when expressed as a recessive will kill the owner, basically in nature the bad allele almost disappears but stabilizes, the line is computer simulated showing thatthe two experiemtns resulted in very good frequencies

Modern theory and more



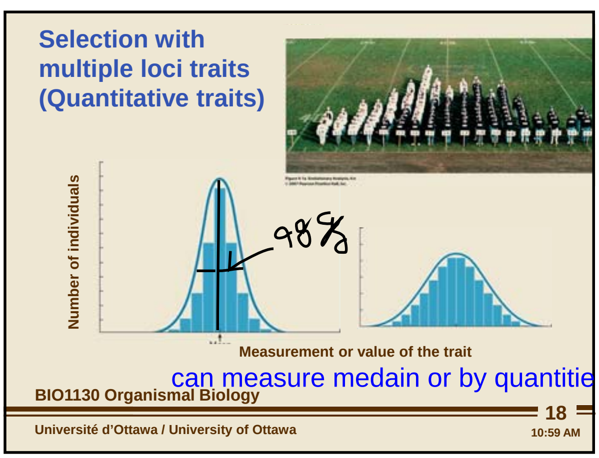
aa none AA high with small Aa

even though recessive when expressed kill organism , the heterozygote however make the two balance out again, showing that thre heterozygote somehow is favoured



sickel cell helps resist malaria, b/c the sickle cell in heterzygote is removed from bloodstream and body b/c they're damaged, and therfore some resistence to malaria is formed. B/c malaria is being removed from body while also removing sickel cell

sickle cell anemia- when sickled, not as much oxygen is carried

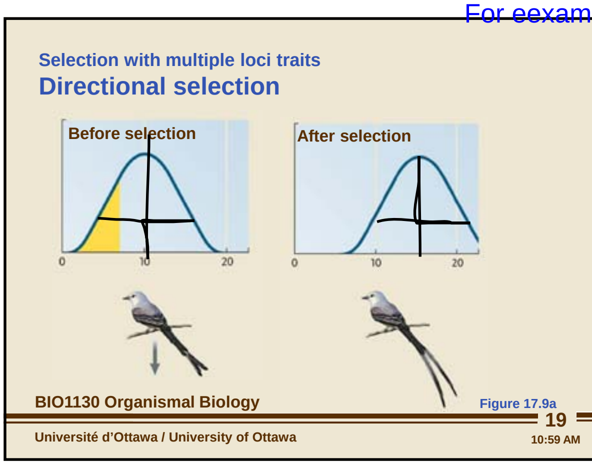


can measure medain or by quantitie of pop on eithetr side of the median

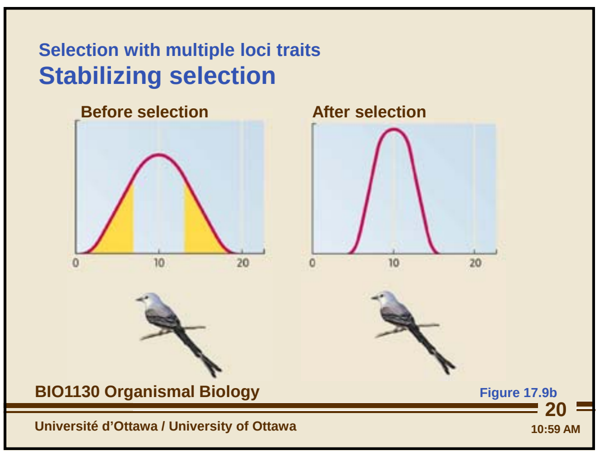
Hieght is caused b y both genetics and food therfoer there are two factors that cause height sto be smaller

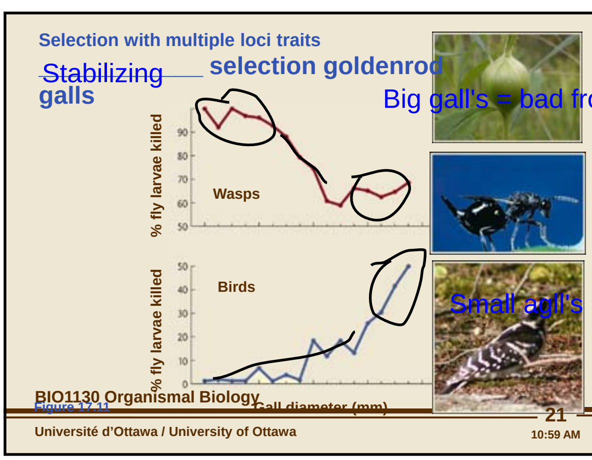
Modern theory and more

For eexample females elect mates due to tail length, birds



Basically the population average changes to ghacving longer tails, but the spread remains the same, there is still the same % of pop on ewither side of the median, the median just happnes to be longer



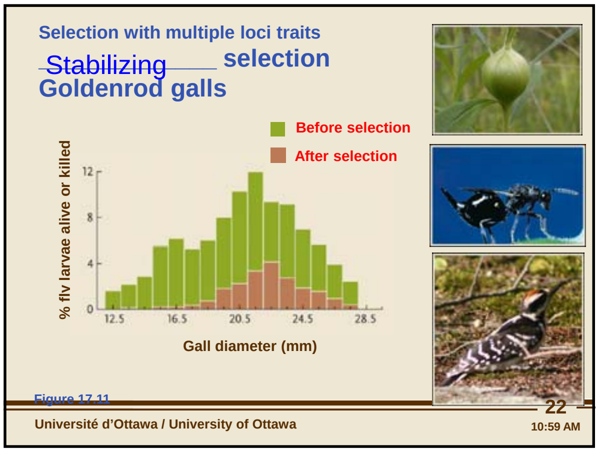


Stabilizing

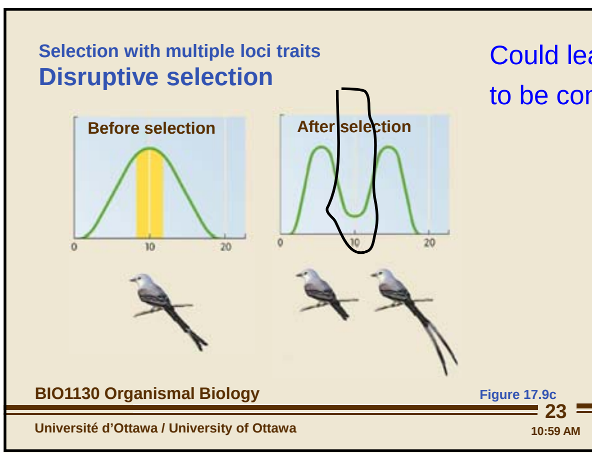
Big gall's = bad fro wasps, can't lay eggs in them

Small agll's = bad for birds, can't handle them/break them to small

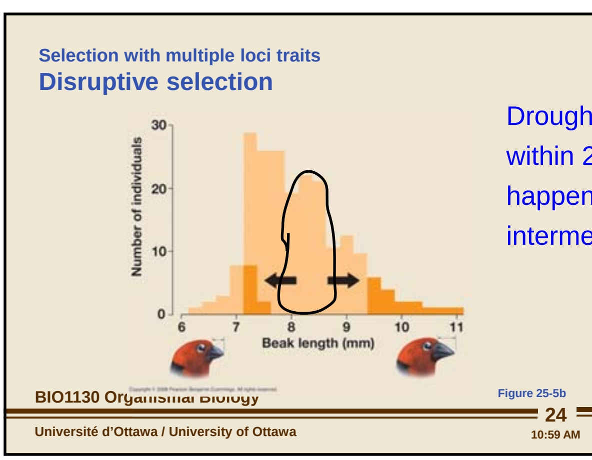
Modern theory and more



Therefore b/c the two big and two small gal"s get eaten and the intermediate galls end up providing the right amount of insect larvae to the pop. so with predatore thay stabilize to outer range, or if their is no predators, they stabilize out to either side



Could lead to speciation, b/c the two groups could become more different enough to be considered differnet specie



Drought hit galapogos- medium sized seeds disappeared within 2 generations after drought as beak size persisted, disruptive selection happened and the two extreme's of beak sizes became more prominent with the intermediate sizes almost disappearing

these are non-mendelian ytraits that do not follow hard-wineberg rules

Hardy-Weinberg principle's assumptions

- No natural selection
- Random mating
- No mutation
- No genetic drift – population is large
- Gene flow

Assumption= every individual has the equal opportunity with any other meber of the pop

Hardy-Weinberg principles
Nonrandom mating - Inbreeding

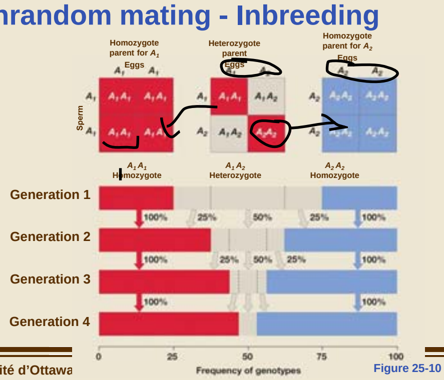
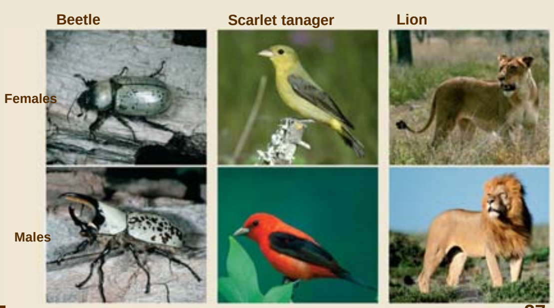


Figure 25-10

Every egneration, more and more of the two extremes of the homozygosity appear while heterozygotes disappear, basically ~~the disease like traits stop being suppresed by the~~ heterozygit therfoerr ehoweveer this nto an example of evolution frequency of alleles stay the same however they get shuffled around to the two extremes

Hardy-Weinberg principles
Nonrandom mating - Sexual dimorphism



Hardy-Weinberg principles

Nonrandom mating - sexual selection

- Sexual selection
  - On males – female choice
  - On males – competition
    - Combat
    - Sperm competition
    - Infanticide

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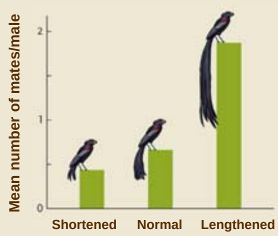
Hardy-Weinberg principles

Sexual selection female choice

riflebird

Tail feathers



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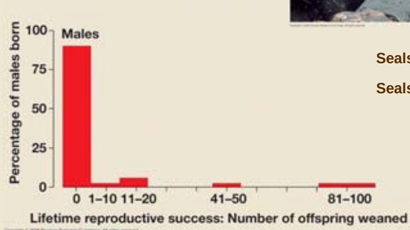
Hardy-Weinberg principles

Sexual selection Male competition - combat



Seals V1

Seals V2

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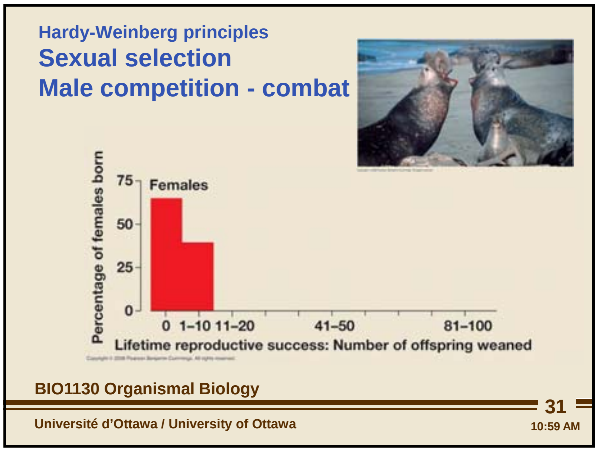
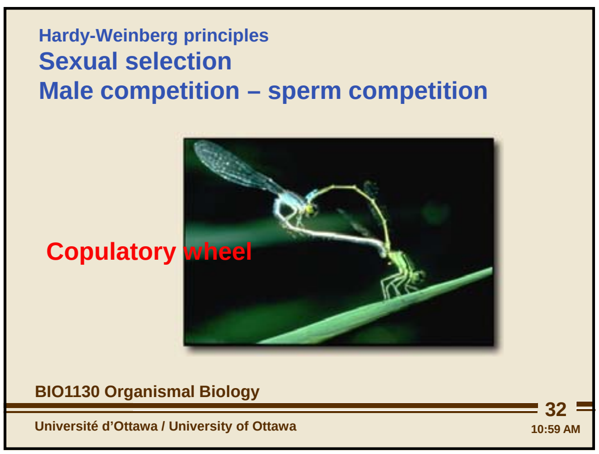
Modern theory and more



basically for evry large group of female there is 1 large male that ebats up all other seals and br3eeds a large group of females, therfore 1 male has many offspring, most males have next to none, and most femals only have 10ish b/c they are only being bred by one male



Basically he stays for along time, connected to force his sperm into the female and then plug it up so another male wont impergnate her, also goes other way around the female can jettison the plug and let out the sperms if the male wasn't dominan/strong enough

Male lion kills all pups of previous alpha

Hardy-Weinberg principle's assumptions

- No natural selection
- Random mating
- No mutation
- No genetic drift – population is large
- Gene flow

therfore hardy-weinberg doesn't really cover all of these different things like competition,etc...

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Hardy-Weinberg principles
Mutation

- Beneficial
- Neutral(regions of dna that aren't critical)
- ~~Negative~~

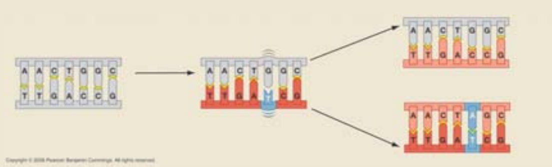

Figure 16-20

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Genetic code

	U		C		A		G		
U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys	U
	UUC		UCC		UAC		UGC		C
	UUA	Leu	UCA		UAA		UGA		A
	UUG		UCG		UAG		UGG	Trp	G
C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg	U
	CUC		CCC		CAC		CGC		C
	CUA		CCA		CAA	Gln	CGA		A
	CUG		CCG		CAG		CGG		G
A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser	U
	AUC		ACC		AAC		AGC		C
	AUA		ACA		AAA	Lys	AGA	Arg	A
	AUG	Met	ACG		AAG		AGG		G
G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly	U
	GUC		GCC		GAC		GGC		C
	GUA		GCA		GAA	Glu	GGA		A
	GUG		GCG		GAG		GGG		G

KEY
Ala = alanine
Arg = arginine
Asn = asparagine
Asp = aspartic acid
Cys = cysteine
Gln = glutamine
Glu = glutamic acid
Gly = glycine
His = histidine
Ile = isoleucine
Leu = leucine
Lys = lysine
Met = methionine
Phe = phenylalanine
Pro = proline
Ser = serine
Thr = threonine
Trp = tryptophan
Tyr = tyrosine
Val = valine

Figure 14-5

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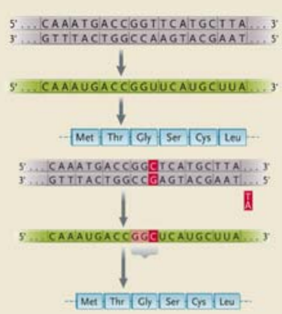
Hardy-Weinberg principles

Mutation

- Point mutations
  - Silent
  - Missense
  - Nonsense
  - Frame shift
- Chromosomal mutations

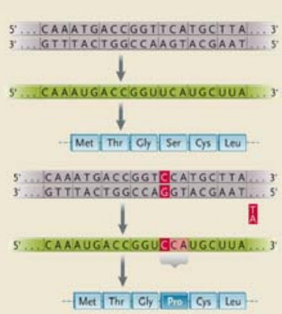
Silent



no effect

Missense

- Normal:
  the one big fly
  had one red eye
- Missense:
  thr one big fly
  had one red eye.



reads everything wrong

Modern theory and more

Hardy-Weinberg principles
Mutation – sickle cell

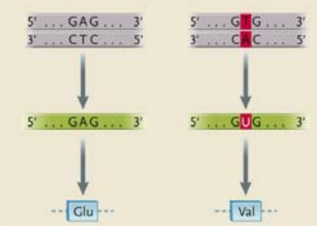
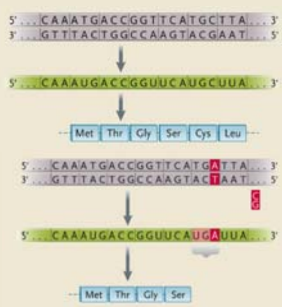


Figure 14-21

Figure 10-1

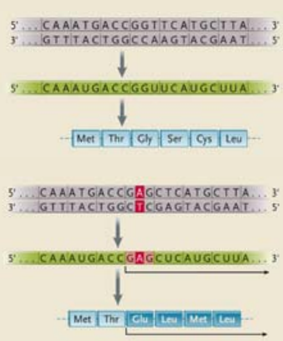
Nonsense

- **Normal:**
  the one big fly had one red eye
- **Nonsense:**
  the one big



Frame shift

- **Normal:**
  the one big fly had one red eye
- **Frame shift:**
  the one rbi gfl yha don ere dey

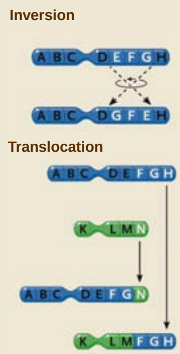


Modern theory and more

Hardy-Weinberg principles
Mutation

- Point mutations
- Chromosomal mutations
  - Inversions
  - Translocation
  - Deletion
  - Duplication
  - Crossing over
  - Polyploidy
  - Genome duplication

Figure 12-11



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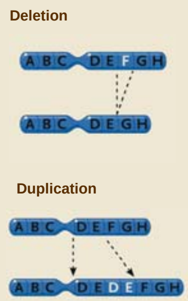
chromsosome muttations are what really cause problems
textbook- but the disease are not in the key words

Hardy-Weinberg principles
Mutation

- Point mutations
- Chromosomal mutations
  - Inversions
  - Translocation
  - Duplication
  - Deletion
  - Crossing over
  - Polyploidy
  - Genome duplication

Figure 12-11



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Hardy-Weinberg principles
Chromosomal mutations – crossing over

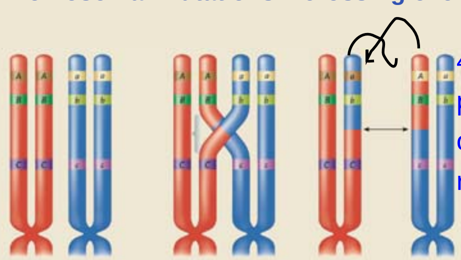

Figure 10-14

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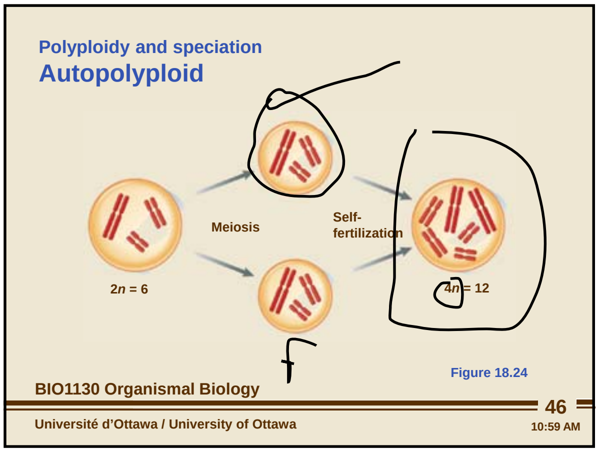
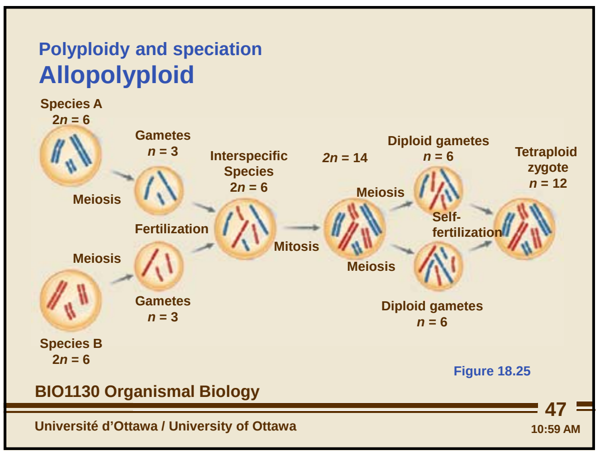
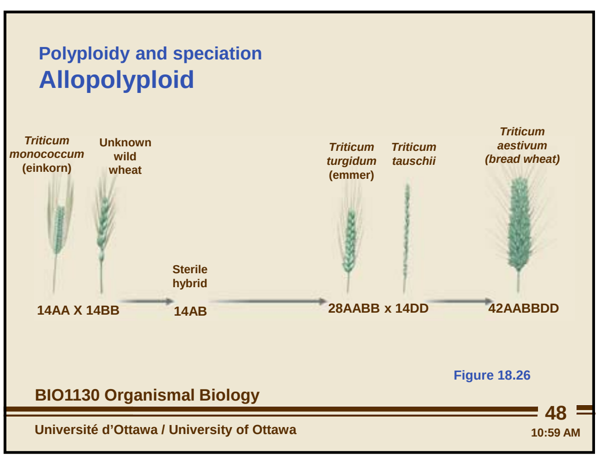
4 distinct variants, but chromosone can crossover 3 or more times(giving potentially billions or hundreds of billions of different possibilities, and this all occurs solely in meiosis- which is veryy important for variation, one of the reasons that sex is so important

Modern theory and more



We believe that our morphology is this autopolyploid, ajs happened twice , our # of chromosomes doubled, which is why we have 4 times as many as our ancestors
fish have had this happen a third time





pollyploidy- there were three commo ancestors

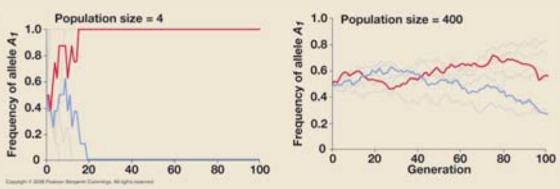
and our normal wheat has 3 time s as many chromsone as any one of thes ocmmon ancestors

Modern theory and more

Hardy-Weinberg principle's assumptions

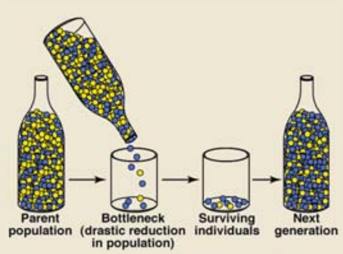
- No natural selection
- Random mating
- No mutation
- No genetic drift – population is large
- Gene flow

Hardy-Weinberg principles
Genetic drift



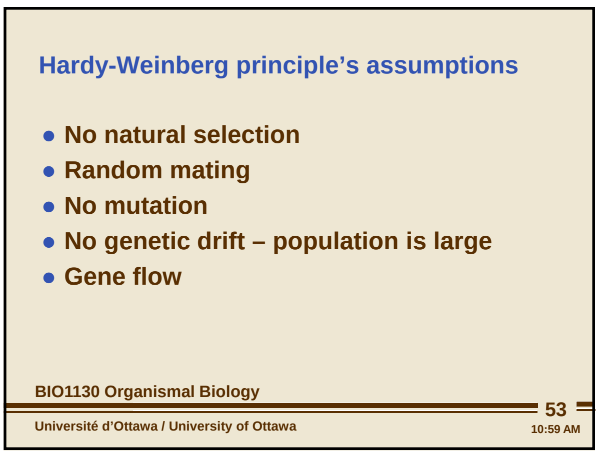
will shift to one extre,e or another if the population is to small

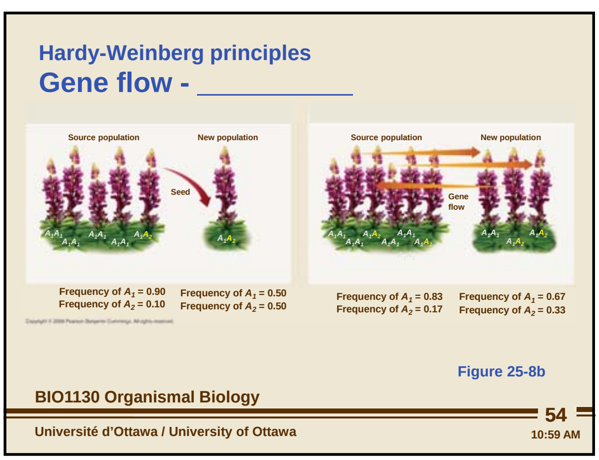
Hardy-Weinberg principles
Genetic drift – bottle neck effect



this is a problem with thge bison, ther wer 750 bison left, and now all of them are descendant sof those 750
also happened with elphant seal(30 individuals on west coast) and killer whales

population that arrives to small area, small genetic variability, bascially small orginal variability
bottleneck of peopl from france to quebec city, bottleneck from Quebec City to Le Saygenay, 600 individuals went up, 300'000 are there now with lots genetic variability(mormons, amish etc... have similar)

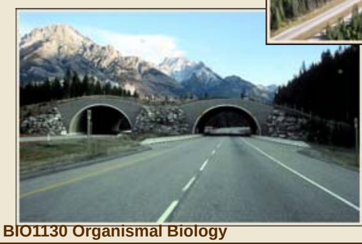




Modern theory and more

Hardy-Weinberg principles

Gene flow – migration



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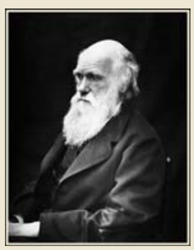
Darwin's five theories

- No constancy of species
- Common ancestry
- Gradual changes
- Natural selection (microevolution)
- Multiplication of species



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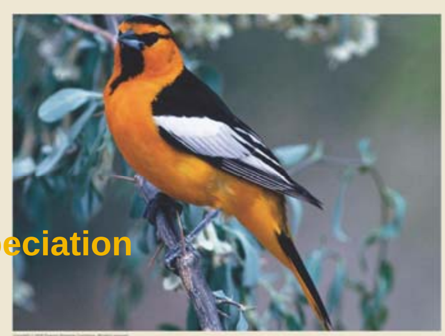
---------stop here and study fro midterm



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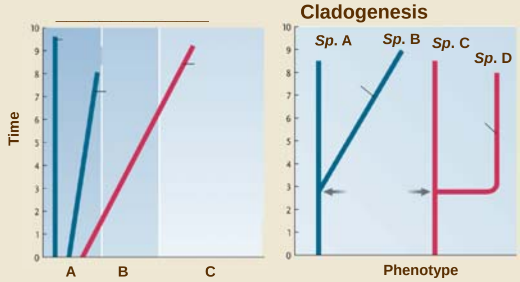
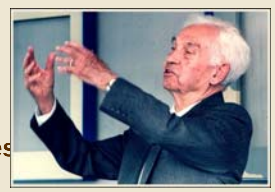
Modern theory and more

Rate of evolutionary change



Species concepts – what is a species?

- Biological species
- Ecological species
- Morphospecies
- Phylogenetic species



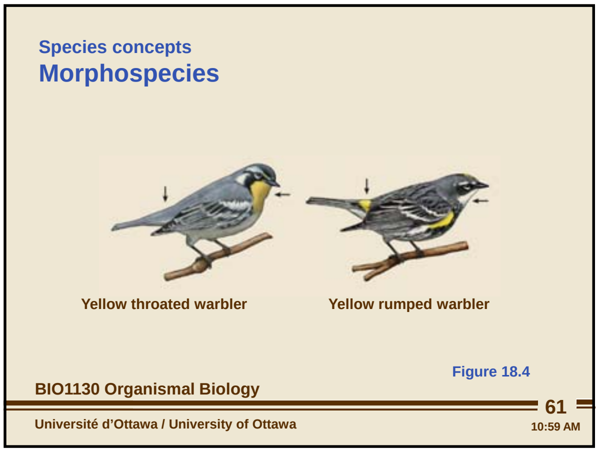
Mayer
(1904-2005)

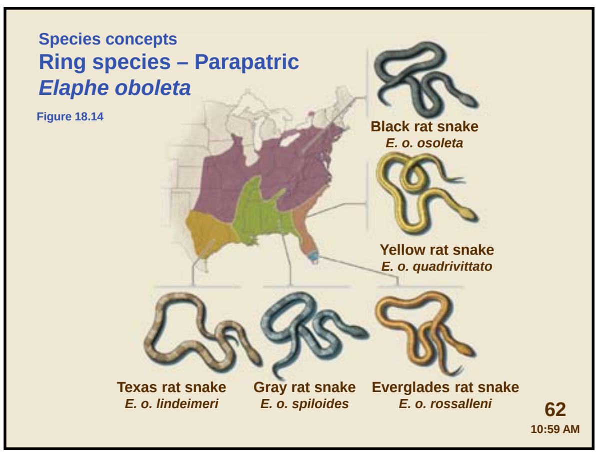
Species are groups of actually or potentially interbreeding populations, which are reproductively isolated from other such groups.
Ernst Mayer (1942)

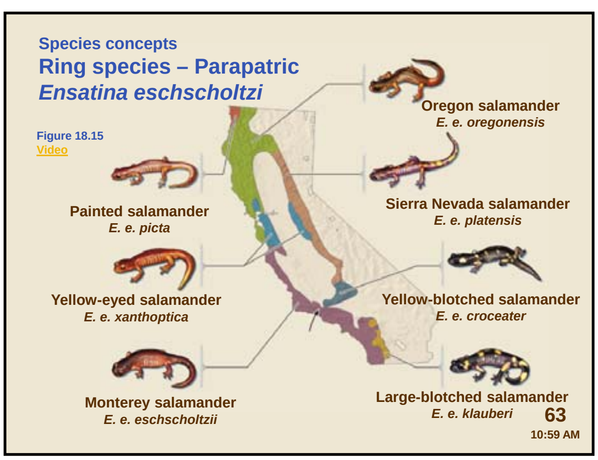
Species concepts

- Biological species
- Ecological species*
- Morphospecies
- Phylogenetic species

Modern theory and more







Second contact – Hybridization outcomes

- Fusion of the populations
- Reinforcement
- Hybrid zone formation
- Extinction of one population
- Creation of a new species

Allopatric Speciation - Vicariance

Figure 18.18

Allopatric Speciation - Dispersal

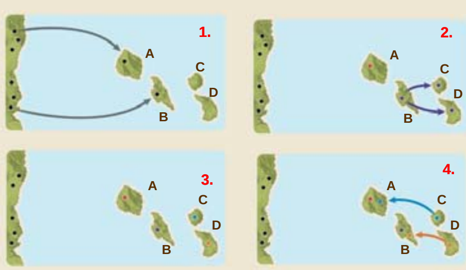
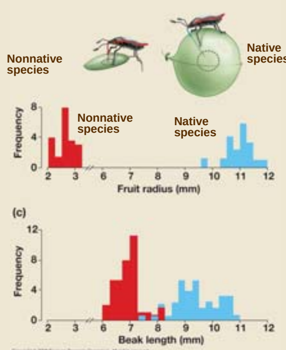


Figure 18.18

Grylloblattid – Ice age vicariance

Video

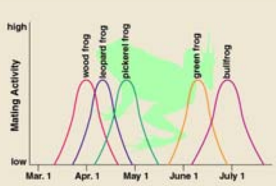
Sympatric speciation



Biological species

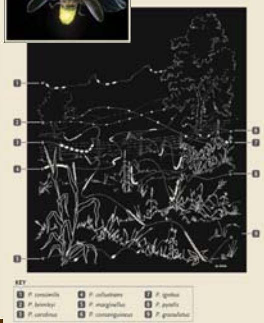
Reproductive isolation

- Prezygotic isolation
  - Ecological
  - Temporal
  - Behaviour
  - ________________
  - Gametic
- Postzygotic isolation



Modern theory and more

Biological species
Reproductive isolation



- Prezygotic isolation
  - Habitat
  - Temporal
  - Behaviour
  - ______________
  - Gametic
- Postzygotic isolation

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Biological species
Reproductive isolation

- Prezygotic isolation
  - Habitat
  - Temporal
  - Behaviour
  - ______________ comit orchid
  - Gametic
- Postzygotic isolation

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Biological species
Reproductive isolation

- Prezygotic isolation
  - Habitat
  - Temporal
  - Behaviour
  - ______________
  - Gametic
- Postzygotic isolation

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Biological species

Reproductive isolation

- Prezygotic isolation
- Postzygotic isolation
  - Hybrid inviability
  - Hybrid sterility
  - Hybrid breakdown

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Important stages in the history of Biology

20th century: Modern biology

- Cellular respiration, ATP and mitochondia (1930-1950)
- Ecology (1940's)
- DNA is the genetic materials (1943)
- DNA structure (1953)
- Gene regulation (1961)
- Genetic code (1960's)
- Recombinant DNA experiments (1970's)
- Cloning of a mammal (1997)
- Human genome sequence (2000)

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Types of taxonomies

- Folk
- Artificial
- Mechanical
- Natural (Evolutionary)
- Cladistic (Phylogenetic)

Hennig
(1913-1976)

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Modern theory and more

Phylogenetic tree

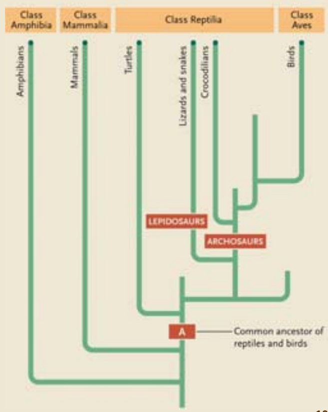

Figure 18.13a

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Cladogram

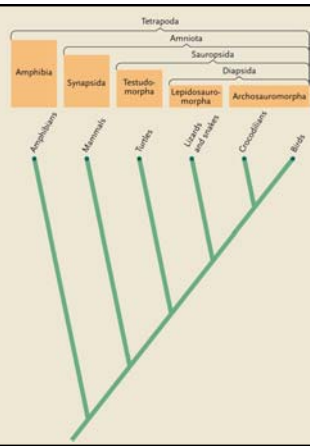

Figure 18.13b

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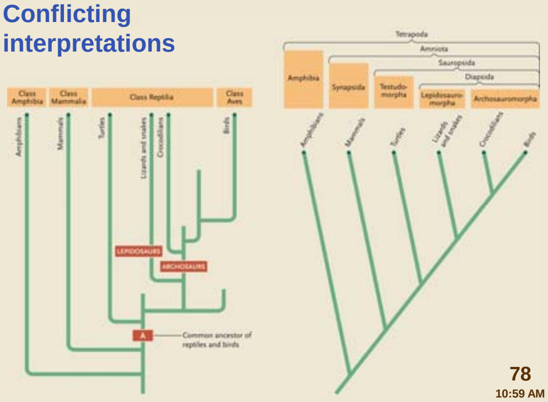
Conflicting interpretations



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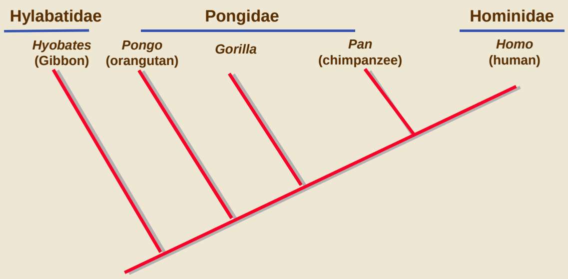
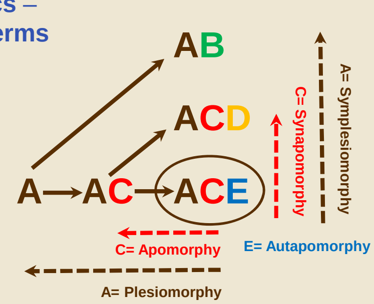
Conflicting interpretations



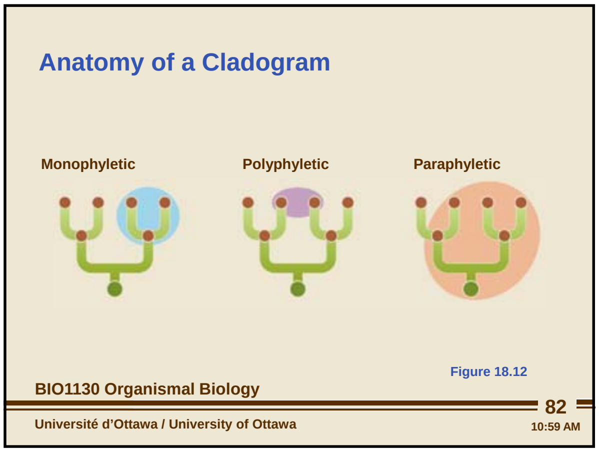
Cladistics - Useful terms

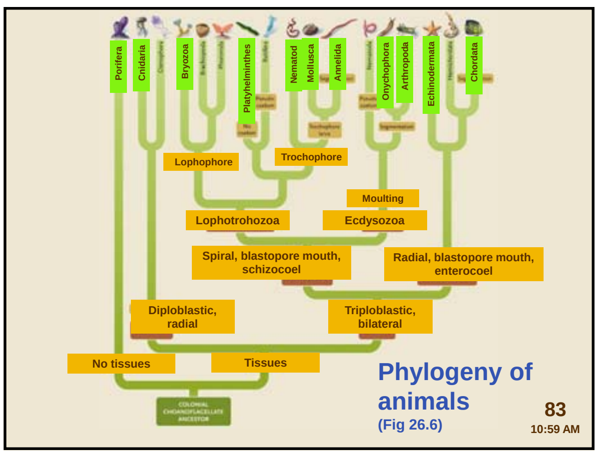
- **Apomorphies**
  - Derived characters within a group (evolutionary lineage)
- **Plesiomorphies**
  - Primitive characters within a group
- **Synapomorphies**
  - Derived characters shared between groups
- **Symplesiomorphies**
  - Shared primitive characters that are shared between groups

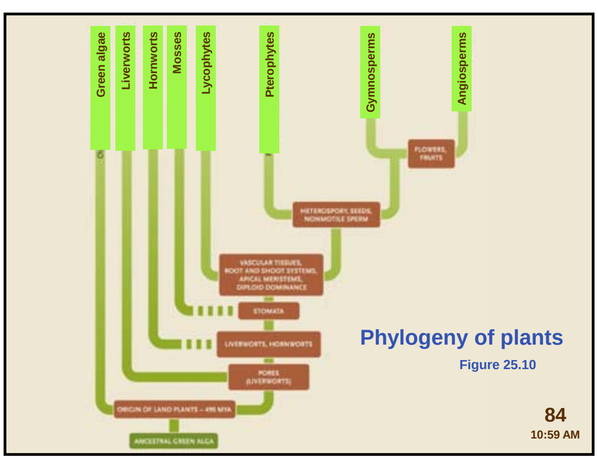
Cladistics – Useful terms



Modern theory and more







Cladogram construction

Springtail	Silver fish	Dragon fly	Cockroach	Beetle	Fly	
0						Double jointed mandible
0						Two pairs of wings
0						Folding wing mechanism
0						Metamorphosis
0						Reduction of wings to haltere

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Cladogram construction

Springtail	Silver fish	Dragon fly	Cockroach	Beetle	Fly	
0	1					Double jointed mandible
0	0					Two pairs of wings
0	0					Folding wing mechanism
0	0					Metamorphosis
0	0					Reduction of wings to haltere

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Cladogram construction

Springtail	Silver fish	Cockroach				
0	1	1				Double jointed mandible
0	0	1				Two pairs of wings
0	0	1				Folding wing mechanism
0	0	0				Metamorphosis
0	0	0				Reduction of wings to haltere

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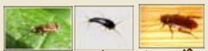
Cladogram construction



Springtail	Silver fish	Cockroach	Fly			
0	1	1	1			Double jointed mandible
0	0	1	1			Two pairs of wings
0	0	1	1			Folding wing mechanism
0	0	0	1			Metamorphosis
0	0	0	1			Reduction of wings to haltere

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Cladogram construction

Springtail	Silver fish	Cockroach	Fly	Dragon fly		
0	1	1	1	1		Double jointed mandible
0	0	1	1	1		Two pairs of wings
0	0	1	1	0		Folding wing mechanism
0	0	0	1	0		Metamorphosis
0	0	0	1	0		Reduction of wings to haltere

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Cladogram construction

Springtail	Silver fish	Cockroach	Fly	Dragon fly	Beetle	
0	1	1	1	1	1	Double jointed mandible
0	0	1	1	1	1	Two pairs of wings
0	0	1	1	0	1	Folding wing mechanism
0	0	0	1	0	1	Metamorphosis
0	0	0	1	0	0	Reduction of wings to haltere

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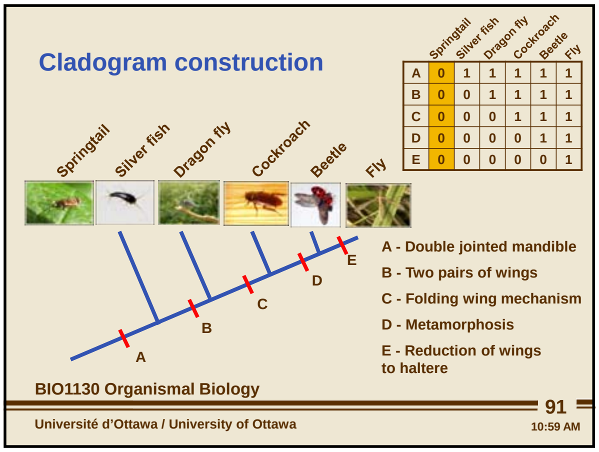
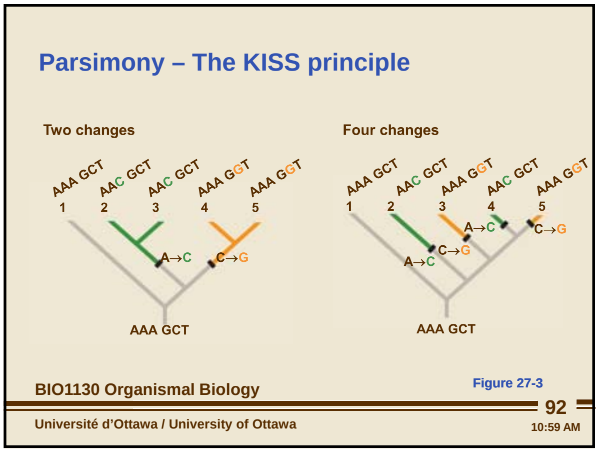
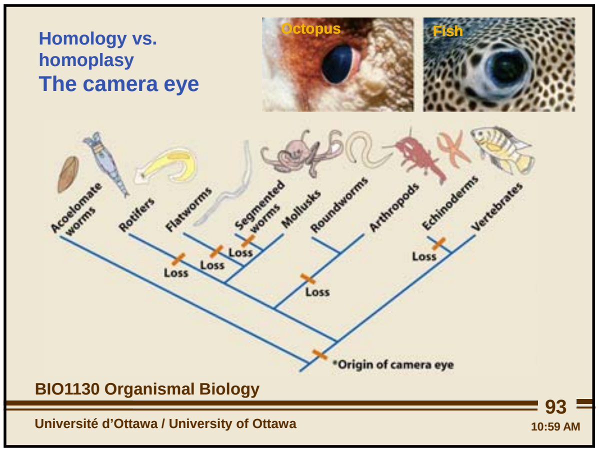
Modern theory and more

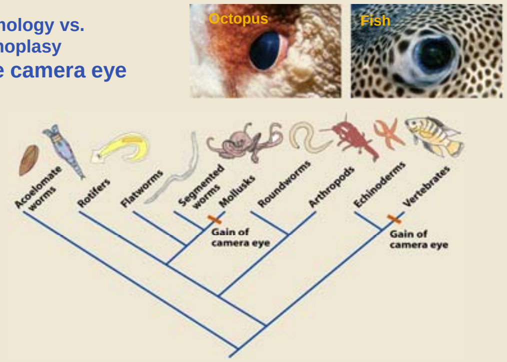


	Springtail	Silver fish	Dragon fly	Cockroach	Beetle	Fly
A	0	1	1	1	1	1
B	0	0	1	1	1	1
C	0	0	0	1	1	1
D	0	0	0	0	1	1
E	0	0	0	0	0	1





Homology vs. homoplasy
The camera eye



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Species concepts – what is a species?

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