

# Microevolution



**Microevolution & Speciation**

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**In this lecture topic**

- What is microevolution?
- Allele frequencies and evolution – Hardy-Weinberg.
- Sources of genetic variation in alleles.
- What is a species?

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hardy weinberg mostly cant be used to study population due to lack of allelic frequencies

microevolution in textbook \_\_\_\_\_

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Important stages in the history of Biology

**20th century**

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



Huxley (1887-1975)

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Huxley combined concept that was given by mendel to understand heredity

-mendel-alles seperate and were later combined  
-eukaroytes

Huxley-took mathematical of alleles and applied to population of organisms

-using exact same concept as mendel

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# Microevolution

**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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-phenotype can also change not just by hereitable allaes also the arragnments of genes, mutations and reorganizations.  
 -changes in chromossomes

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**Incomplete dominance – snap dragons**

P - parental      F<sub>1</sub> – Generation1      F<sub>2</sub> – Generation2

$C^R C^R$  Red       $C^R C^R$  Pink       $C^R C^R = 25\%$

X      X       $C^R C^W = 50\%$

$C^W C^W$  White       $C^W C^W = 25\%$

BIO1130 Organismal Biology Figure 11.13 5  
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if you cross two individuals, homozygous everyone is heterozygous, incomplete dominance and are pink. everyone is pink  
 The second cross results in 25% in homozygous red and 25% is homozygous white and 50% pink.

-if you take every seed and they are planted the resulting ratios will be the same no matter what value is used.  
 -perfect mathematical perdicatibility.

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**Genotype and allele frequencies**

Phenotype	Genotype	Number	Genotype frequency	Total C <sup>R</sup> alleles	Total C <sup>W</sup> alleles
	C <sup>R</sup> C <sup>R</sup>	450	450/1000 = 0.45	2x450 = 900	0x450 = 0
	C <sup>R</sup> C <sup>W</sup>	500	500/1000 = 0.50	1x500 = 500	1x500 = 500
	C <sup>W</sup> C <sup>W</sup>	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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if you have a population of same organisms, which are isolated; and did an inventory. These are the results.

-the ratio of these two alleles are 70 % red and 30% white.

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# Microevolution

**Using the Hardy-Weinberg Principle**

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

	$C^R$ frequency $p=0.7$	$C^W$ frequency $p=0.3$
$C^R$ frequency $p=0.7$	 $C^R C^R = p^2$	 $C^R C^W = pq$
$C^W$ frequency $p=0.3$	 $C^W C^R = pq$	 $C^W C^W = q^2$

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-based on original frequency the further generations can be predicted.  
- any value can be used.

-empirical measure was given to see if allelic population were changing in a population.  
-change= microevolution.  
-Mathematical mechanism to describe evolution.

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**Allele frequencies in populations**  
(Each of the 20 adults produces 10 gametes)

Initial allele frequencies in gametes

A	a
0.6	0.4

• A:  $2 \times 36 + 48 = 120/200 = 0.6$   
• a:  $48 + 2 \times 16 = 80/200 = 0.4$   
• Final = Initial frequency

Final allele frequencies

A	a
0.6	0.4

Number of eggs

Number of adults

Number of juveniles

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-stable with no microevolution.

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**Hardy-Weinberg principle's assumptions**

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

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-defines when something is not happening.  
-These are the five things that cause change/

- mutation=one gene turn into something else, therefore not the allele present  
-natural selection= when certain traits are favored cancelling out others  
-genetic drift=pop isnt isolated and other organisms add genes to pop.  
-random mating= no preference of alleles

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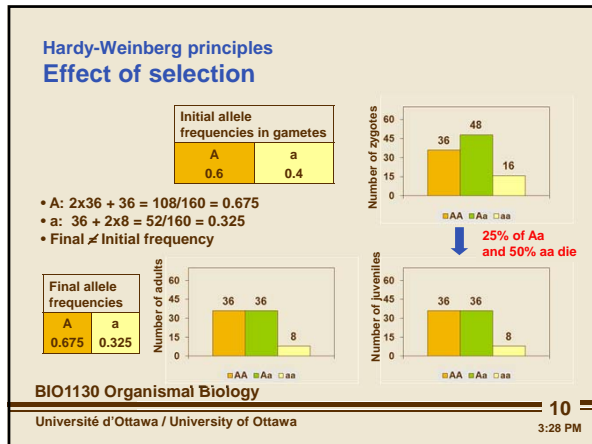


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# Microevolution



-double recessive causes 50% to die  
 - causing the loss of alleles

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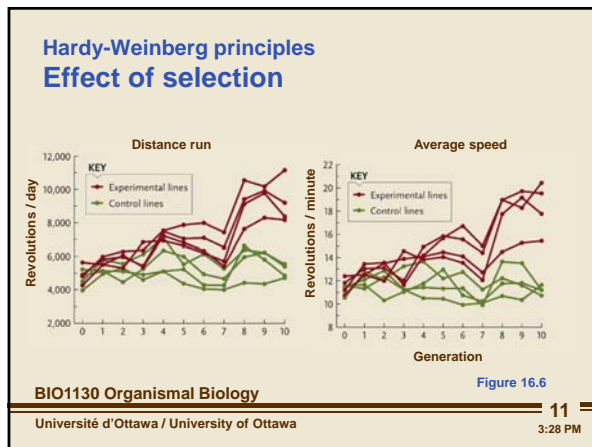
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saw how often mice got on treadmill, and how fast it spun.

-if activity levels are heritable, therefore the behaviour would increase in that population.  
 - see behaviour change in allelic frequency.

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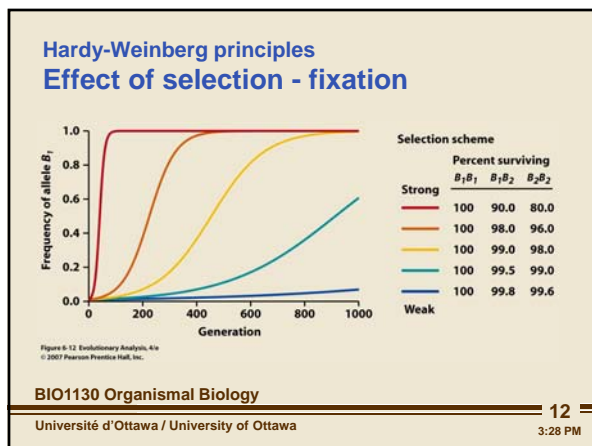
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-dont see major change in alleles in a population.  
 -traits dont just disappear.  
 -when more are killed of the traits are preferred.  
 -alles or traits not favored in severe selection will disappear.  
 -in mild they will shift a bit, but wont disappear.  
 -lost genetic variability due to fixation.  
 -natural selection will not eliminate an allele it will drive it down but never disappear. Keep the same variability as much as possible.

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# Microevolution

**Hardy-Weinberg principles**  
**Effect of selection – against recessive**

Initial allele frequencies in gametes	
A	a
0.6	0.4

A:  $2 \times 36 + 48 = 120/168 = 0.714$   
a:  $48 + 0 = 48/168 = 0.286$   
Final  $\neq$  Initial frequency

Final allele frequencies	
A	a
0.714	0.286

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**Hardy-Weinberg principles**  
**Effect of selection – against recessive**

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- even when we kill, the homozygous recessive, the allele is still never lost just in low levels.
- starts with heterozygous due the recessive not in population. therefore needs heterozygous is required.
- the allele will not eliminate , always gets maintained.
- selection against recessive will not loose gene.

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**Hardy-Weinberg principles**  
**Effect of selection – for heterozygote**

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- heterozygote advantage.
- small number of heterozygote falls back to same level. sustaining the gene at a higher level than expected

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**Hardy-Weinberg principles**  
**Mutation – sickle cell anemia**

BIO1130 Organismal Biology Figure 14-21

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- causes hemoglobin substitution, becomes crested.
- you fail to make standard red blood cells, not loading with oxygen properly. (homozygous)
- heterozygous anemia will fight the sickle cells. to be able to remove those cells

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**Hardy-Weinberg principles**  
**Effect of selection – for heterozygote**

BIO1130 Organismal Biology Figure 16.14

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- where malaria is, a sickle cell gene is being held in a population in heterozygous .
- adv is that malaria is readily enetering sickle cell and red blood
- therefore allowing malaria get rid of due to heterzygous sickle cells.
- natural level of sickle cell giving them protection against malaria.

-heterozygous

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**Quantitative variation**

BIO1130 Organismal Biology Figure 16.3

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- not based on allelic frequency.
- these are examples of normal distribution.
- some are extremely low, some very high and majority in the middle.

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# Microevolution

**Selection with multiple loci traits**

- Directional selection
- Stabilizing selection
- Disruptive selection



Figure 17.10 Evolutionary Analysis, 6/e  
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normal distribution of height.

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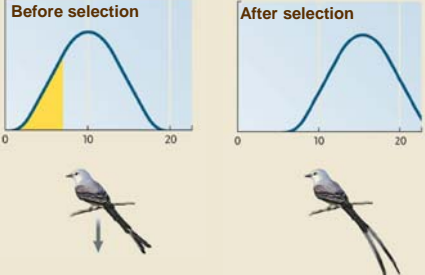
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**Selection with multiple loci traits**  
**Directional selection**



BIO1130 Organismal Biology Figure 16.9a

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selecting against the extremes, the short tail males never find females=no offspring, the small genes disappear and causing a change in direction of the mean.

\*directional selection\*

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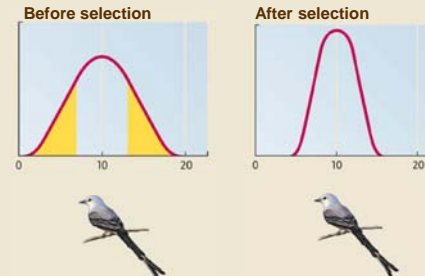
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**Selection with multiple loci traits**  
**Stabilizing selection**



BIO1130 Organismal Biology Figure 16.9b

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-selecting against the extremes.

-not too long tails, and short tails, just right

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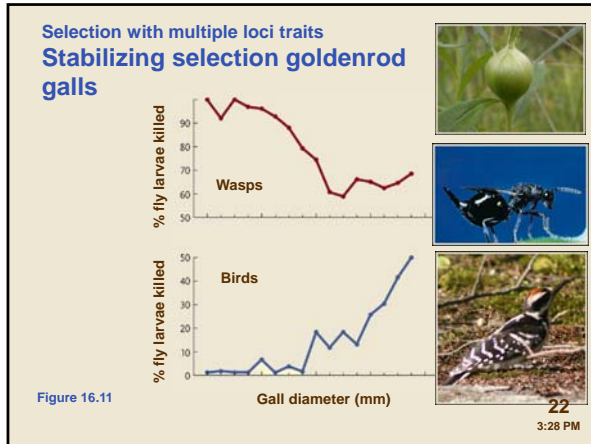
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# Microevolution



- a fly lays egg inside the golden rod.
- parasitic wasp want to use the gol. laying an egg inside the magot who is eating the gol.
- the wasp larva is eating the magot, magot is eating the gol.
- smallest are parasites by the wasp.
- magots that produced in small gols are in danger of being killed of by wasps .
- the biggest gols are being killed by woodpeckers.
- survivors are the medium sized.

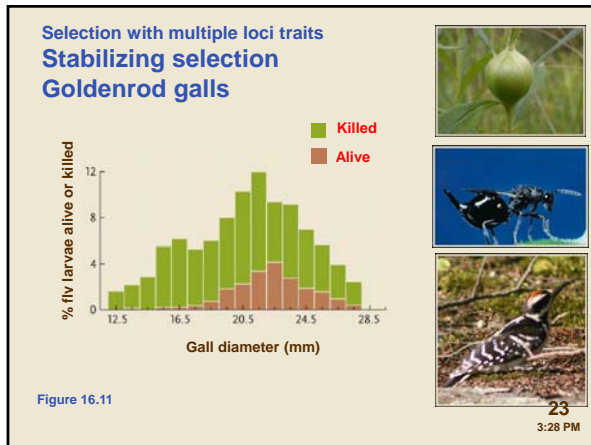
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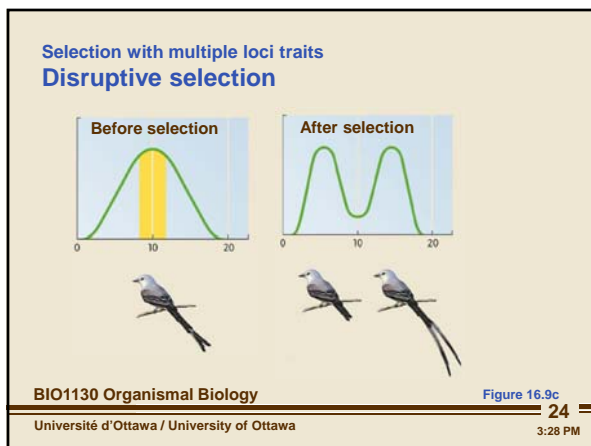
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- medium can be disadvatage.

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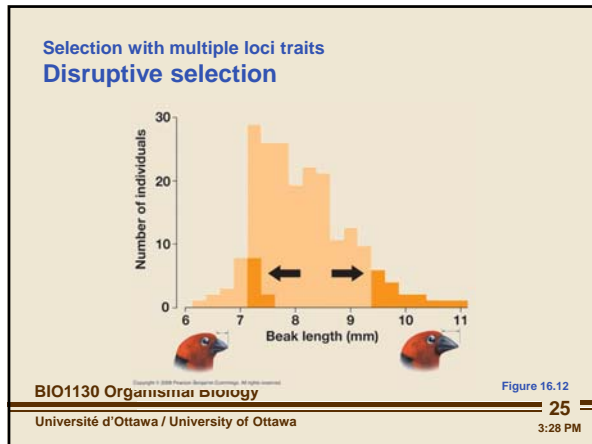


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# Microevolution



- beak=seed cracker
- there were various sizes of seed on the galapagos.
- drought caused middle range plants seeds were dormant.
- this caused the middle sized beaks to disappear.
- differentiating two different populations.

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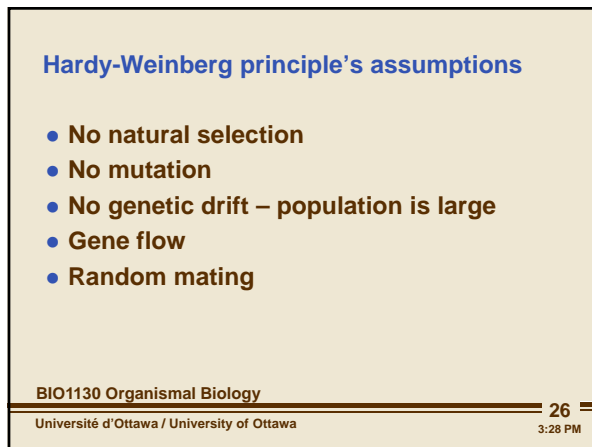
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-REVIEW



- genetic drift is about having a large population.
- law of average, and randomness , not allowing the predictable average.

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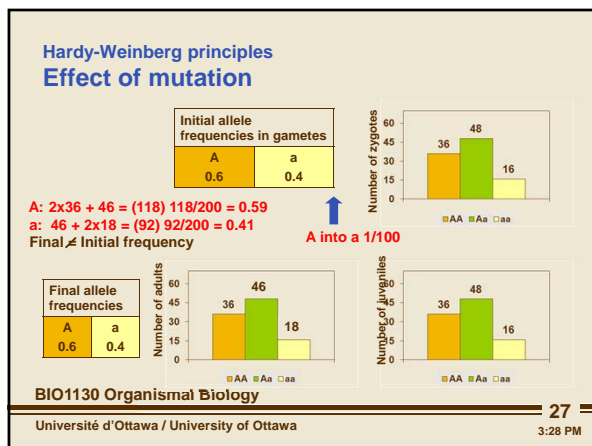
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- all of a sudden there is a change in a frequency of alleles due to mutation.

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# Microevolution

**Hardy-Weinberg principles**  
**Mutation**

- **Beneficial**
- **Neutral**
- **Deleterious**

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BIO1130 Organismal Biology Figure 16-20

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-driving force for prokaryotes, for eukaryotes has little or no effect.  
 -every organism will accumulate 2 mutations.  
 -Dna replication system is fine tuned to ensure mutations dont occur, if they do they are corrected. if base pair does change they are manly neutral (having no effect).  
 - only in one allele, however there is always a back up.

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**Genetic code**

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

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

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-ucag third triplet- wobble effect.

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**Hardy-Weinberg principles**  
**Mutation**

- **Point mutations (the one big fly had one red eye)**
  - Silent wobble effect
  - Missense (thr one big fly had one red eye)
  - Nonsense (the one big) stop codon
  - Frame shift (the one rbi gfl yha don ere dey)
- **Chromosomal mutations**

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# Microevolution

**Hardy-Weinberg principles**  
**Mutation**

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

**Inversion**

**Translocation**

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chromosomes arms are wrapped tightly they become in center to become split by spindle fibres, very often there are breaks if so they are quickly sealed.

- inversions do occur, when they break they become attached to another arm (translocation)
- set of genes may have adv/ or disadv.

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**Hardy-Weinberg principles**  
**Mutation**

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

**Deletion**

**Duplication**

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duplication- of chromosomes  
genome duplication- instances in animals when whole genome is duplicated. there are two. if one genome takes catalytic ability to act on different substrate it is not detrimental because the first one is still doing its job.

- in vertebrate lineage. actually an invertebrate at that time, duplicated its genome to create jaws etc..
- in chordates, genome duplication was so perfect.
- gives freedom to explore other aspects.

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**Hardy-Weinberg principles**  
**Chromosomal mutations – crossing over**

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- most important
- when they allign during meiosis. they can break in chromosomes, will switch between the same section.
- when the repair is done there is mixing between maternal and paternal
- one purely paternal and maternal and one that is completely mixed.
- very common, not by one gene, by whole chunks.

-most variability in eukaroytes occurs through this

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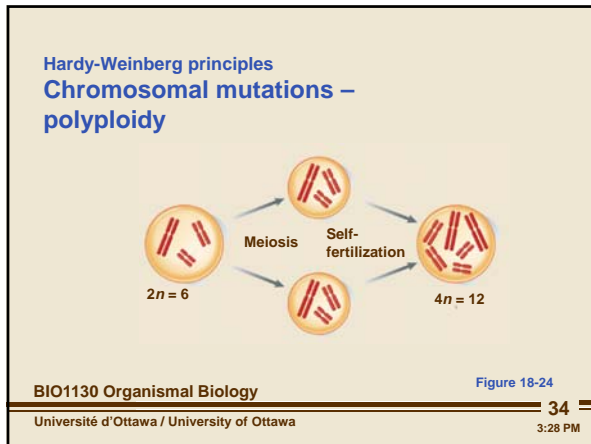


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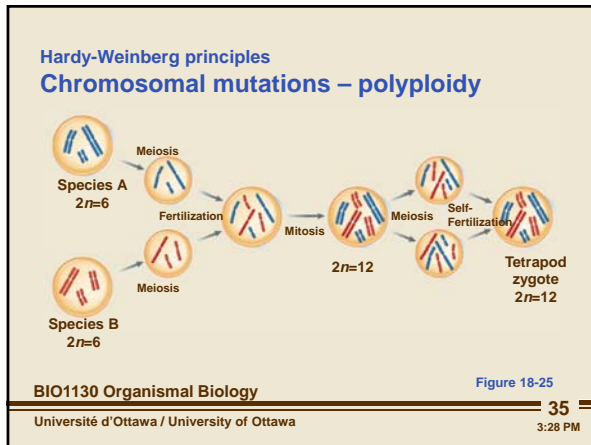


- self-fertilize, plants
- meiosis fails, instead of haploid gametes they get diploid. when they fuse they create tetraploid.
- frequently.
- diploid and tetraploid can never mate.
- polyploidy generates new organisms.
- agriculture :) b/c polyploid create bigger seeds etc.

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- when gametes fuse they duplicate to get to meiosis and thus create a new species.
- shuffling of chromosomes is where vast majority of variability comes from

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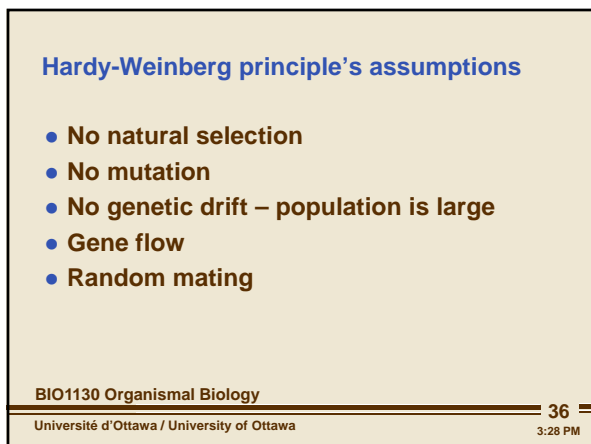
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# Microevolution

**Hardy-Weinberg principles**  
**Genetic drift**

Initial allele frequencies in gametes	
A	a
0.6	0.4

• A:  $2 \times 31 + 49 = 111/200 = 0.555$   
 • a:  $49 + 2 \times 20 = 89/200 = 0.445$   
 • Final  $\neq$  Initial frequency

Final allele frequencies	
A	a
.555	.445

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**Hardy-Weinberg principles**  
**Genetic drift**

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gene may disappear if calculation was not done properly.

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**Hardy-Weinberg principles**  
**Genetic drift – bottle neck effect**

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- is a large population that undergoes a sudden reduction in size.
- this is due to a small sample size.
- the population crashes to a few individuals losing genetic variability
- examples include american bison.
- 750 bison have been used as a genetic stock. they have heritability issue due to small population causing a decrease in gene set.
- all organisms kept in zoos, massive bottle neck effect.

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# Microevolution

**Hardy-Weinberg principles**  
**Genetic drift – Founder affect**



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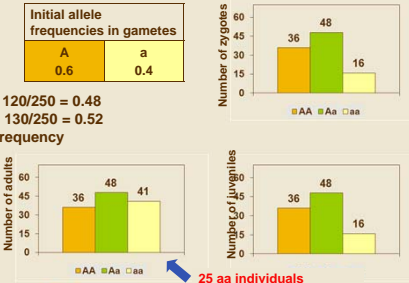
- when a population of organisms migrate or moves to area where they have never been and sets up a population.
  - new france\*
  - founding effect population of french people brought over.
  - when it became apparent that it was a good agricultural part the founding effect grew again.
  - muscular dystrophy is high in this area.
  - small population of original religious groups are also an example.
  - founders have different allelic change.
  - conserving a massive bottlenecking effect.
- 

**Hardy-Weinberg principles**  
**Gene flow - migration**

Initial allele frequencies in gametes	
A	a
0.6	0.4

• A:  $2 \times 36 + 48 = 120/250 = 0.48$   
 • a:  $48 + 2 \times 41 = 130/250 = 0.52$   
 • Final  $\neq$  Initial frequency

Final allele frequencies	
A	a
0.48	0.52

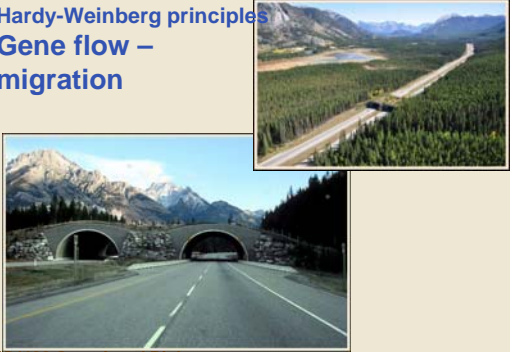


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- inflow of genes- (migration) b/w isolated populations.
  - ties back into bottlenecking and founder effect.
  - bottle neck population A has certain genomic frequency different than B or C.
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- 
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**Hardy-Weinberg principles**  
**Gene flow – migration**



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- bridging habitat
  - populating them either habitat to try and bridge them together.
  - Migration occurs b/w two sides.
  - causing gene flow.
  - hoping to recapture genetic variability.
  - wide to wide conservation corridor.
  - trying to get rid broken up habitats.
  - changes genetic variability.
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# Microevolution

## Hardy-Weinberg principle's assumptions

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

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-random mating= all individuals should have an equal chance to mate with each other.  
 -noth was only natural selection.

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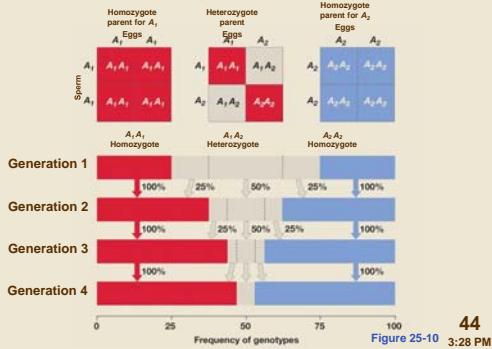


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## Hardy-Weinberg principles Nonrandom mating - Inbreeding



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Figure 25-10 3:28 PM

-when one generation mates with progeny of next generation "hemophilia", "habsburg"  
 - changing the degree of homozygoisty .  
 - if homozygous condition is detrimental it become more prominent, but doesnt change gene frequency.

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## Hardy-Weinberg principles Nonrandom mating - Sexual dimorphism



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-where one specis has a very different appearances.  
 -male mostly shows dimorphism.  
 -2 reproductive strategies  
 Female =limited reproductive amount. (# of eggs) therefore wants the best quality male.  
 Male= the male is not limited, wants to spread it as many ways as possible.

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# Microevolution

**Hardy-Weinberg principles**  
**Nonrandom mating - sexual selection**

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

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-female is making choice amongst male, and males are competitive  
 - therefore non-random mating - (brid dance)  
 -males engage in competition

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**Hardy-Weinberg principles**  
**Sexual selection**  
**female choice**

riflebird  
Tail feathers

Mean number of mates/male

Tail Feather Length	Mean number of mates/male
Shortened	~0.5
Normal	~1.0
Lengthened	~2.0

Shortened Normal Lengthened

Figure 16-13

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-female choice  
 - big tail= high energy  
 - experiment= took birds and cut their tails and wove them on to the short tail birds, and females chose the bird with big tails.

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**Hardy-Weinberg principles**  
**Sexual selection**  
**Male competition - combat**

Seals V1  
Seals V2

Percentage of males born

Lifetime reproductive success: Number of offspring weaned	Percentage of males born (V1)	Percentage of males born (V2)
0	~90	~0
1-10	~5	~10
11-20	~0	~5
41-50	~0	~2
81-100	~0	~1

Males

Lifetime reproductive success: Number of offspring weaned

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- one male that mainly mates with one male.

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# Microevolution

Hardy-Weinberg principles  
Sexual selection  
Male competition - combat



Percentage of females born

Lifetime reproductive success: Number of offspring weaned	Percentage of females born
0	75
1-10	40
11-20	10
41-50	5
81-100	2

Lifetime reproductive success: Number of offspring weaned

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for the most part one male is dominant, because they battle it out.

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Hardy-Weinberg principles  
Sexual selection  
Male competition – sperm competition



Copulatory wheel

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-males compete with each to get their sperm to the egg.  
- no random mating

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Hardy-Weinberg principles  
Sexual selection  
Male competition – infanticide



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- lion groups mainly females, and one male.  
- when one male gets removed the new lion kills all lion cubs b/c they contain the other males genes

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# Microevolution



**Speciation**

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**Species concepts – what is a species?**

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

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

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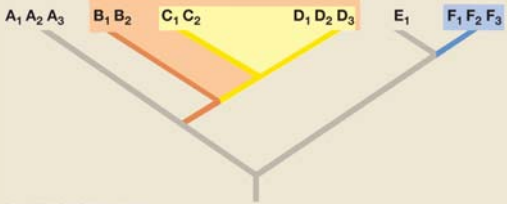
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interbreeding population that are reproductively isolated. biological species- major issues, that these organisms are reproductively isolated, because they produce sexually, eliminating two major domains. -this concept only works with living things. -asexually- all bacteria are not allowed to have genus species names. -can't prove reproductive isolation with fossils.

ecological species- species performing life cycles in the same way, even though they might not be interbreeding. It has no relevance because they are just grouped together based on the environment, even though they contain many species

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**Species concepts**  
**Phylogenetic species**



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-arises from cladistics. - the organisms at the tip are organisms that are defined as species. -cladograms never stop branching, you can overlay with morphology such as fossils and maybe you can then say this fossil matches with this organism.

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# Microevolution

Species concepts  
**Morphospecies**



Yellow throated warbler      Yellow rumped warbler

Figure 18.4

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-tells difference  
-early taxonomy  
- they have distinguishing elements.

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Species concepts

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

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subspecies: there is an artificial barrier, the isolated mechanism is driving the two species apart

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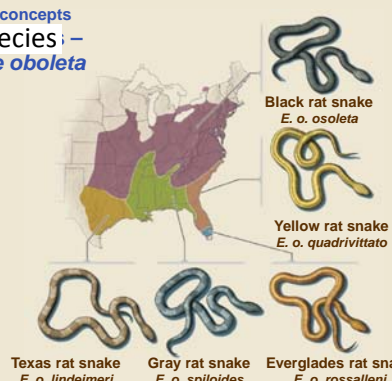
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Species concepts  
Subspecies: –  
**Elaphe oboleta**

Figure 19.12



Black rat snake  
*E. o. osoleta*

Yellow rat snake  
*E. o. quadrivittata*

Texas rat snake  
*E. o. lindeimeri*

Gray rat snake  
*E. o. spiloides*

Everglades rat snake  
*E. o. rossalleni*

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slowly change in appearance.

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# Microevolution

**Species concepts**  
**Ring species –**  
*Ensatina eschscholtzi*

Figure 19.13  
Video

Oregon salamander  
*E. e. oregonensis*

Sierra Nevada salamander  
*E. e. platensis*

Painted salamander  
*E. e. picta*

Yellow-eyed salamander  
*E. e. xanthoptica*

Yellow-blotched salamander  
*E. e. croceator*

Large-blotched salamander  
*E. e. klauberi*

MONTEZUMA SALAMANDER  
*E. e. eschscholtzii*

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READ TEXTBOOK FOR THIS PART.

- subspecies, a physical barrier is created in between, these are examples of subspecies.
- subspecies are organisms that are on their way to some sort of isolation.
- blend in using blotches/ blend using mimicry of poisonous newts.
- the mating resulted in wrong blotching and colouration, therefore resulting in disruptive selection.

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**Biological species**  
**Reproductive isolation**

- **Prezygotic isolation**
  - Ecological
  - Temporal
  - Behaviour
  - Mechanical
  - Gametic
- **Postzygotic isolation**

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- ecological- leopard and wood frog dont have the same habitat, or bull frog. therefore no connection.
- behavioral- TEXT

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**Biological species**  
**Reproductive isolation**

- **Prezygotic isolation**
  - Habitat
  - Temporal
  - Behaviour
  - Mechanical
  - Gametic
- **Postzygotic isolation**

Figure 19.14

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- behavioral- they flash signals at each other, and as they flash they mean something. For each species.
- the pulse sequences are species specific, they mate based on the flash sequence.
- the females sometimes lure in a male and eat them to create more protein, meaning more eggs.

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# Microevolution

Biological species  
**Reproductive isolation**

- **Prezygotic isolation**
  - Habitat
  - Temporal
  - Behaviour
  - **Mechanical** comit orchid
  - Gametic
- **Postzygotic isolation**




Figure 19.15

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lock nad key mechanisms

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Biological species  
**Reproductive isolation**

- **Prezygotic isolation**
  - Habitat
  - Temporal
  - Behaviour
  - Mechanical
  - **Gametic**
- **Postzygotic isolation**



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eggs will not be fertilized with any sperm, it has to recognize the species to fertilize.

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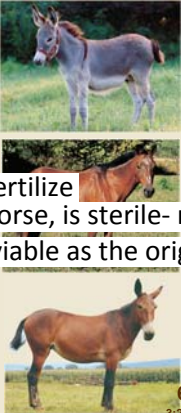
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Biological species  
**Reproductive isolation**

- **Prezygotic isolation**
- **Postzygotic isolation**
  - **Hybrid inviability** never fertilize
  - **Hybrid sterility** donkey-horse, is sterile- meaning it cant further produce
  - **Hybrid breakdown** is not viable as the originals



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# Microevolution

**Allopatric Speciation - Vicariance**

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when environments sperate due to physical barries and evolve so differently that when barrier is removed the species wont cross

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PANGĒA

**Allopatric Speciation - Dispersal**

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the founder effect-  
if the subset of a population or a population, when they move around, the founder effect that goes to the extreme, and the population became dispersed and different species.

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**Grylloblattid – Ice age vicariance**

Video

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-survivor of the last ice age.  
-holding on to this will kill it.  
-they tapped in refugee area, like humans did when they first came to north america

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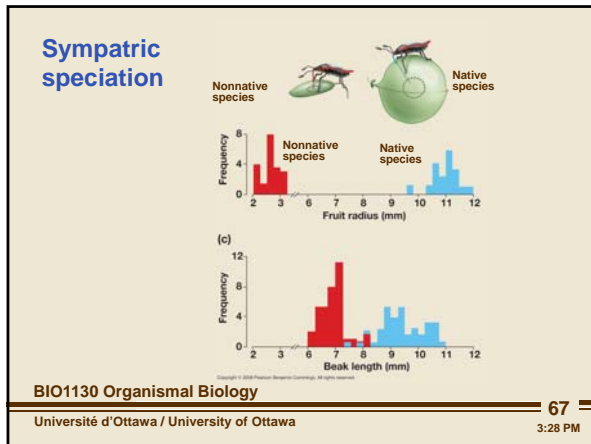
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# Microevolution



- where you get speciation occurring in the same environment.
- perfect replica of disruptive selection.
- can occur in the same location, doesn't have to have a geological separation.

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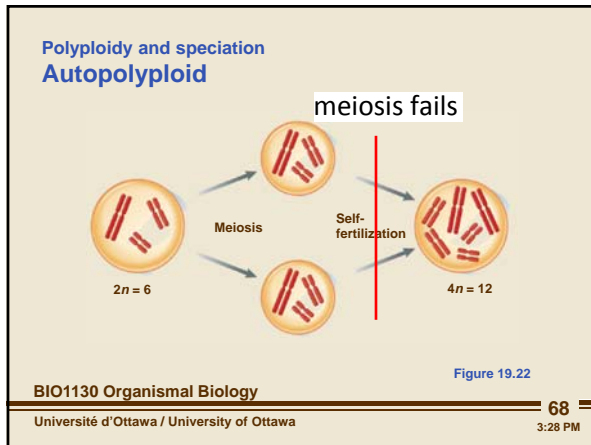
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never interbreed.

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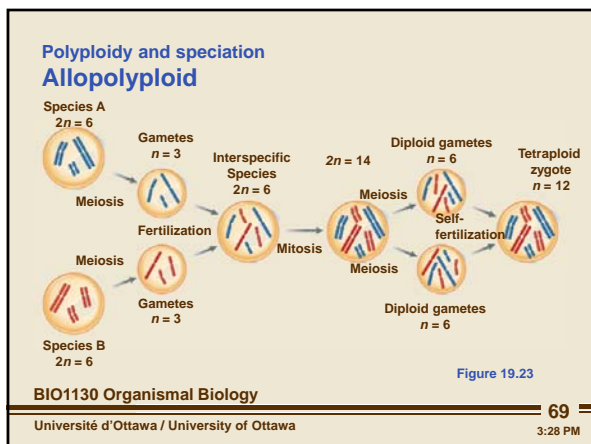
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when the isolation mechanism breaks down, and two different species combine to create a mixture of the two.

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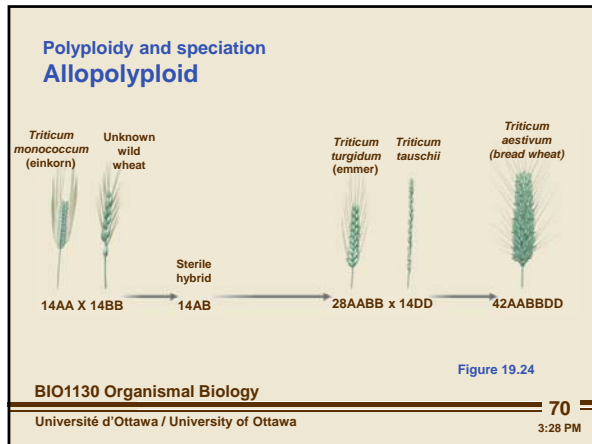


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# Microevolution



-3 different species

- the big seeds were used for next years plants., then the seed matures it will get blown off by the wind.

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