

# Microevolution

**Microevolution**



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**In this lecture topic**

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

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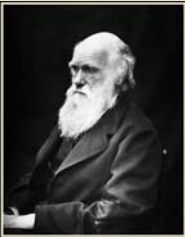
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**Important stages in the history of Biology**  
**19th century: Modern biology**



**Darwin**  
(1809-1882)

**Wallace**  
(1823-1913)

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# Microevolution

## Darwin's five theories

- No constancy of species
- Common ancestry
- Gradual changes
- Population change (multiplication of species)
- Natural selection

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## Mendel (1822-1884)



- Rediscovered 1900.
- Law of segregation of characters
- Law of independent assortment

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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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# Microevolution

**Microevolution**

- Evolutionary changes that result from changes in Allele Frequencies in a population, or in chromosome structure or numbers due to species (?) and recombination.

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**Some basic terms for microevolution**

- Allele
- Phenotype
- Genotype
- Homozygous
- Heterozygous
- Dominant and recessive

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
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**Incomplete dominance – snap dragons**

P - parental	F <sub>1</sub> – Generation1	F <sub>2</sub> – Generation2
 C <sup>R</sup> C <sup>R</sup> Red	 C <sup>R</sup> C <sup>W</sup> Pink	 C <sup>R</sup> C <sup>R</sup> = 25%
X  C <sup>W</sup> C <sup>W</sup> White		 C <sup>R</sup> C <sup>W</sup> = 50%
		 C <sup>W</sup> C <sup>W</sup> = 25%

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Figure 11.1399:58 AM

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# Microevolution

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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Using the Hardy-Weinberg Principle			
$p^2 + 2pq + q^2 = 1$	C <sup>R</sup> frequency p=0.7	C <sup>W</sup> frequency p=0.3	
C <sup>R</sup> frequency p=0.7	 C <sup>R</sup> C <sup>R</sup> = p <sup>2</sup>	 C <sup>R</sup> C <sup>W</sup> = pq	
C <sup>W</sup> frequency p=0.3	 C <sup>W</sup> C <sup>R</sup> = pq	 C <sup>W</sup> C <sup>W</sup> = q <sup>2</sup>	

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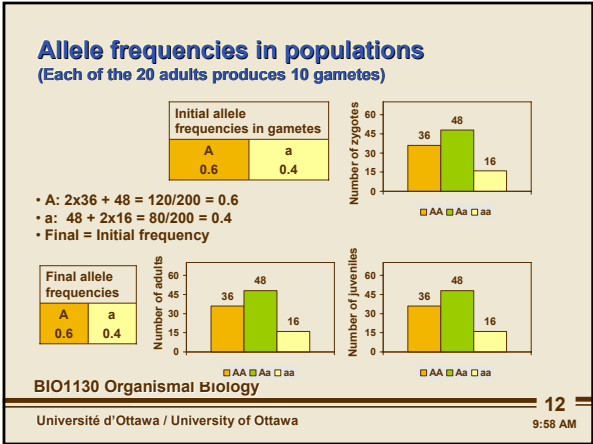
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### Hardy-Weinberg principle's assumptions

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

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### Hardy-Weinberg principles

**Initial allele frequencies in gametes**

Allele	Frequency
A	0.6
a	0.4

**Final allele frequencies**

Allele	Frequency
A	0.6
a	0.4

**Number of adults**

Genotype	Number
AA	36
Aa	48
aa	16

**Number of zygotes**

Genotype	Number
AA	36
Aa	48
aa	16

**Number of juveniles**

Genotype	Number
AA	36
Aa	48
aa	16

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### Hardy-Weinberg principles

#### Effect of selection

**Initial allele frequencies in gametes**

Allele	Frequency
A	0.6
a	0.4

**Final allele frequencies**

Allele	Frequency
A	0.675
a	0.325

**Number of adults**

Genotype	Number
AA	36
Aa	36
aa	8

**Number of zygotes**

Genotype	Number
AA	36
Aa	48
aa	16

**Number of juveniles**

Genotype	Number
AA	36
Aa	36
aa	8

25% of Aa and 50% of aa die

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Hardy-Weinberg principles  
Effect of selection

Allele frequencies		
	Expected	Observed
$p^2$	0.36	0.456
$2pq$	0.48	0.439
$q^2$	0.16	0.105

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Hardy-Weinberg principles  
Effect of selection

Distance run

Average speed

Figure 17.6

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Hardy-Weinberg principles  
Effect of selection - against recessive

Selection scheme

	Percent surviving		
	$B_1B_1$	$B_1B_2$	$B_2B_2$
Strong	100	90.0	80.0
	100	98.0	96.0
	100	99.0	98.0
	100	99.5	99.0
Weak	100	99.8	99.6

Frequency of allele  $B_1$

Generation

Figure 9-12 Evolutionary Analysis, 4/e  
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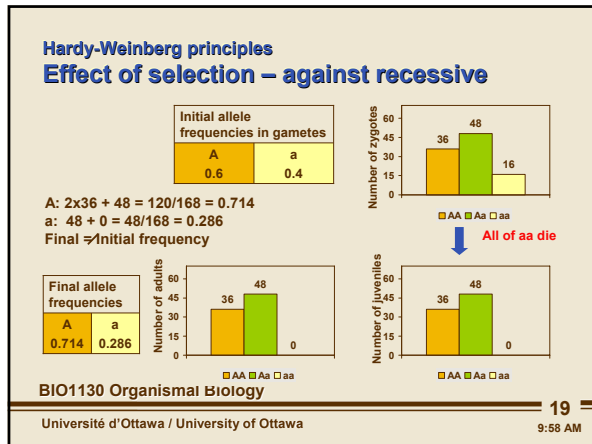
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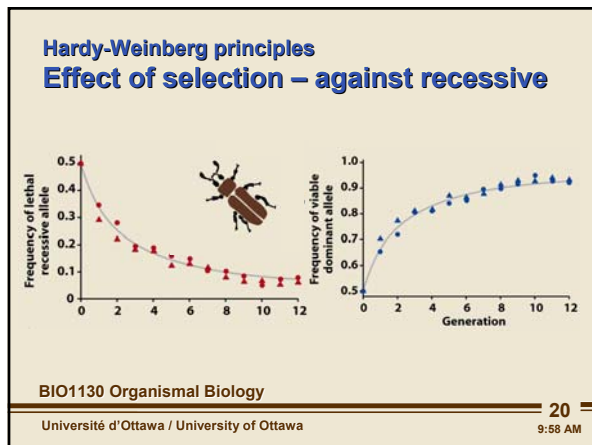
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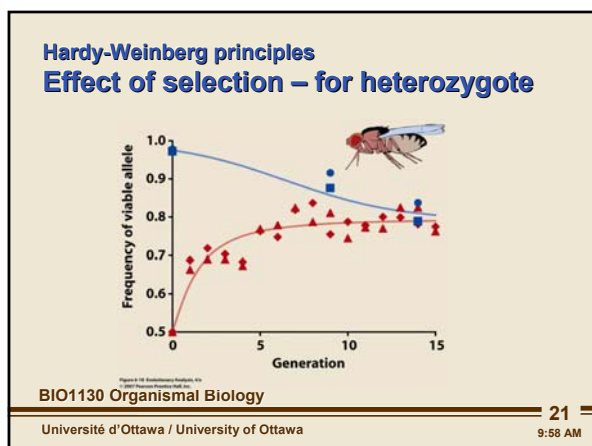
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# Microevolution

### Hardy-Weinberg principles

### Effect of selection – for heterozygote

**KEY**

**Allele frequencies of HbS allele**

>0.14	0.11-0.12	0.06-0.08	0.02-0.04
0.12-0.14	0.08-0.10	0.04-0.06	0.00-0.02

**Regions with malaria**

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Figure 17.14

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### Selection with multiple loci traits

- Directional selection
- Stabilizing selection
- Disruptive selection

Figure 17.1a Evolutionary Analysis, 6/e  
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Figure 17.1a

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### Selection with multiple loci traits

### Directional selection

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Figure 17.9a

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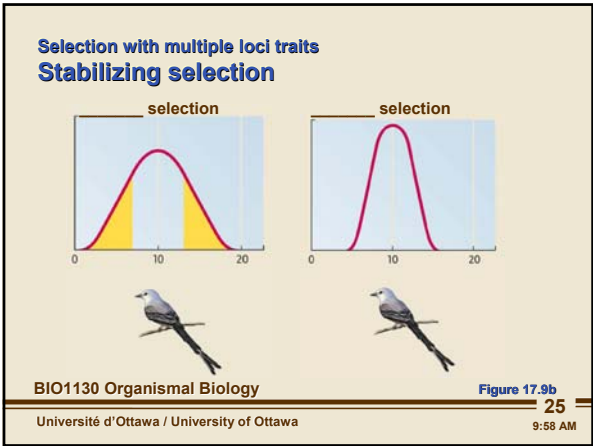
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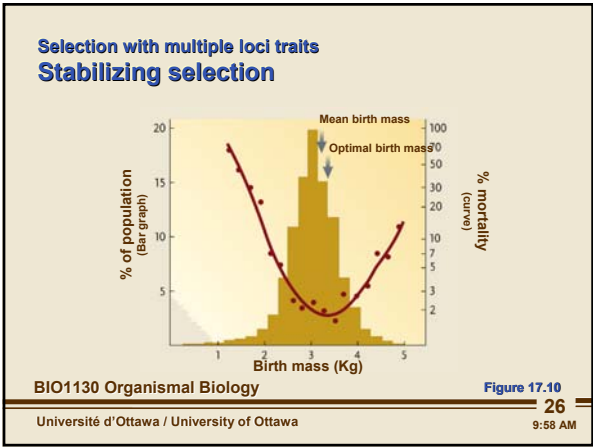
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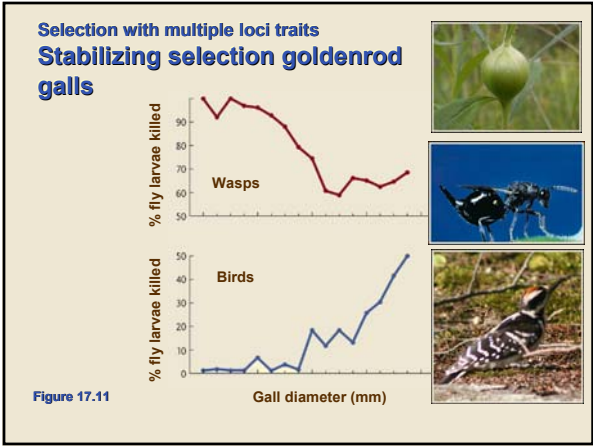
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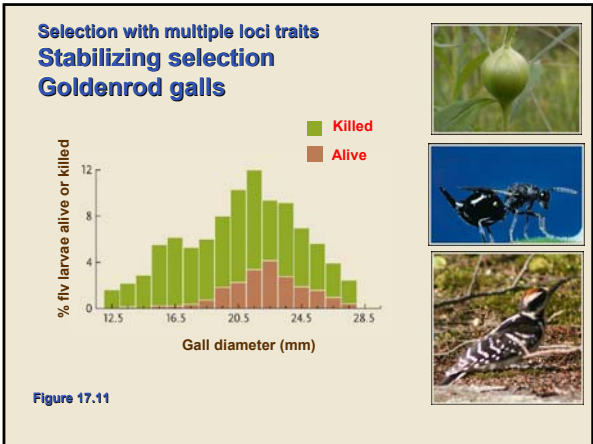
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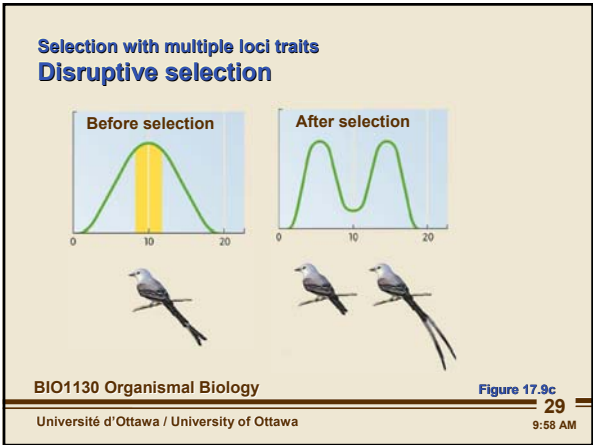
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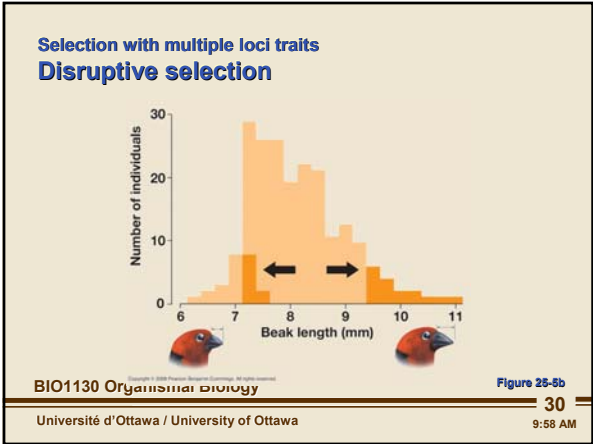
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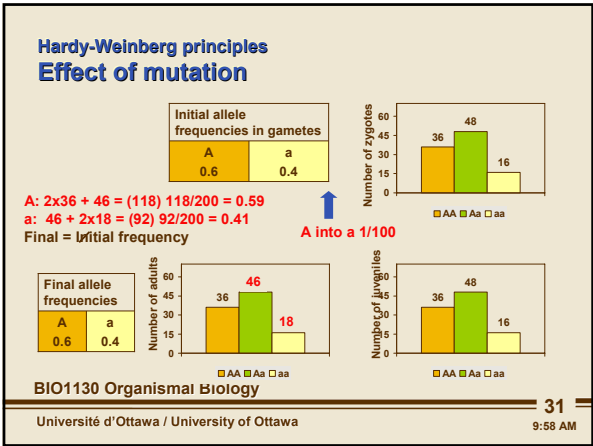
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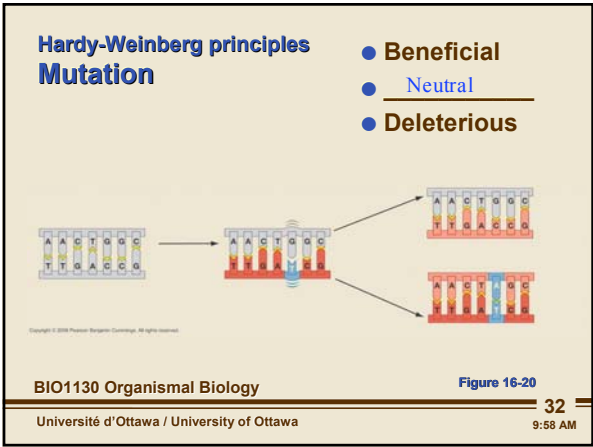
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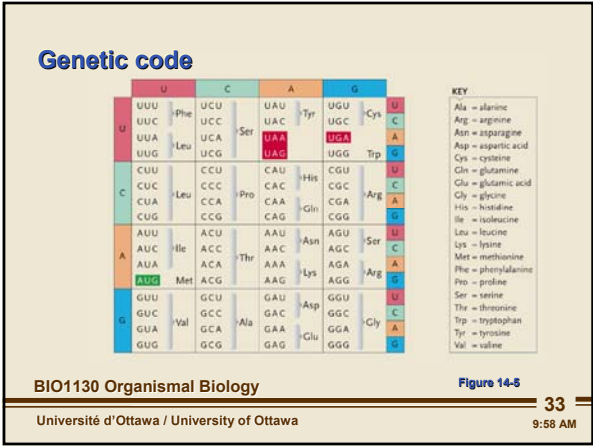
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Hardy-Weinberg principles

Mutation

● Point mutations

– Silent

– Missense

– Nonsense

– Frame shift

● Chromosomal mutations

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Missense

5'...CAAATGACCGGTTCAATGCTTA...3'

3'...GTTTACTGGCCAAGTACGAAT...5'

5'...CAA AUGACCGGUUCAUGCUUA...3'

Met Thr Gly Ser Cys Leu

5'...CAAATGACCGGTTCAATGCTTA...3'

3'...GTTTACTGGCCAAGTACGAAT...5'

5'...CAA AUGACCGGUUCAUGCUUA...3'

Met Thr Gly Pro Cys Leu

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Nonsense

5'...CAAATGACCGGTTCAATGCTTA...3'

3'...GTTTACTGGCCAAGTACGAAT...5'

5'...CAA AUGACCGGUUCAUGCUUA...3'

Met Thr Gly Ser Cys Leu

5'...CAAATGACCGGTTCAATGCTTA...3'

3'...GTTTACTGGCCAAGTACGAAT...5'

5'...CAA AUGACCGGUUCAUGCUUA...3'

Met Thr Gly Ser

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**Silent**

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**Frame shift**

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

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Figure 14-21

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## Hardy-Weinberg principles Point mutation

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

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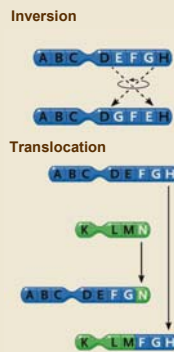
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## Hardy-Weinberg principles Mutation

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

Figure 12-11



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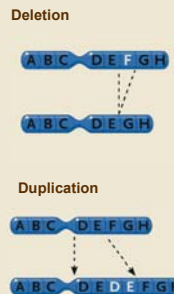
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## Hardy-Weinberg principles Mutation

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

Figure 12-11



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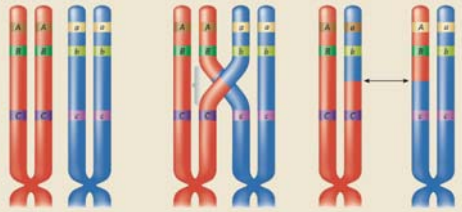
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Hardy-Weinberg principles

Chromosomal mutations – crossing over



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Figure 10-14

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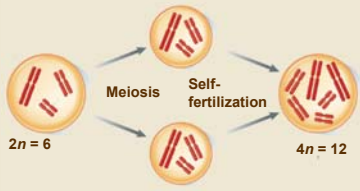
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Hardy-Weinberg principles

Chromosomal mutations – polyploidy



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Figure 18-24

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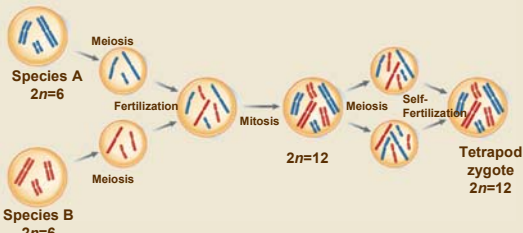
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Hardy-Weinberg principles

Chromosomal mutations – polyploidy



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Figure 18-25

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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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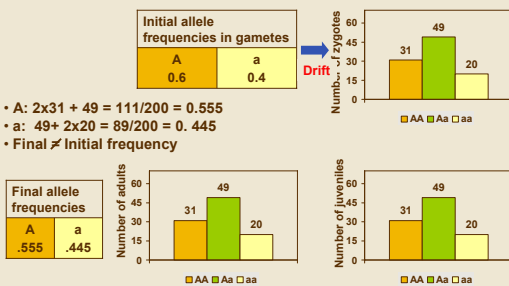
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## Hardy-Weinberg principles Genetic drift



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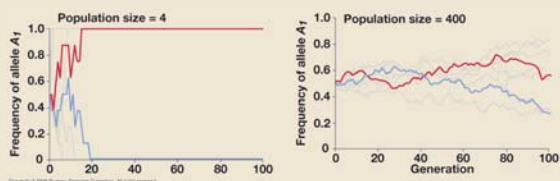
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## Hardy-Weinberg principles Genetic drift



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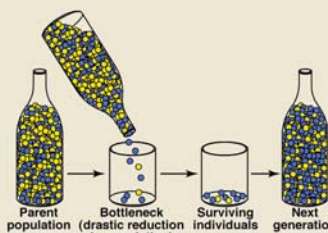
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Hardy-Weinberg principles

Genetic drift – bottle neck affect



Parent population

Bottleneck (drastic reduction in population)

Surviving individuals

Next generation

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Hardy-Weinberg principles

Genetic drift – Founder affect



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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

Number of adults

Number of zygotes

Number of juveniles

25 aa individuals

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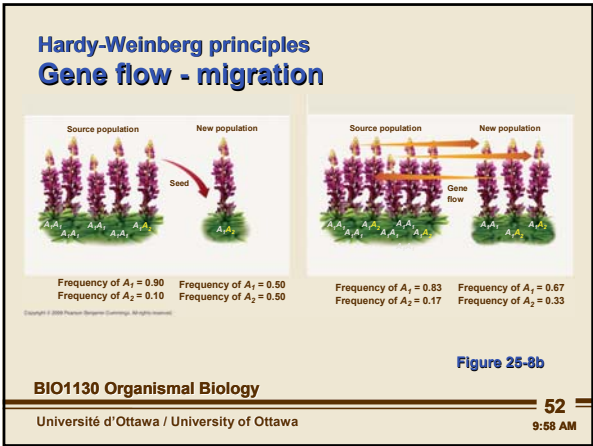
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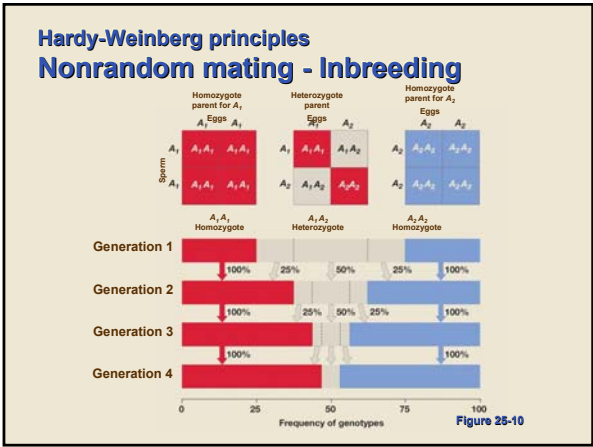
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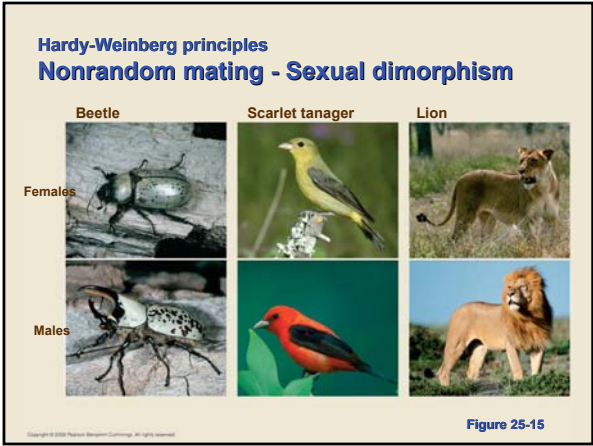
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# Microevolution

## Hardy-Weinberg principles Nonrandom mating - sexual selection

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

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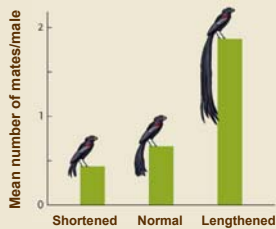
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## Hardy-Weinberg principles Sexual selection female choice



riflebird  
Tail feathers



Figure 17.13

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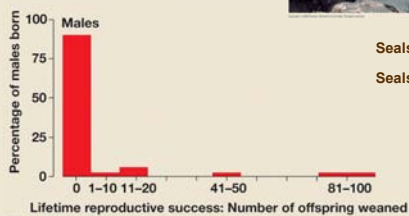
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## Hardy-Weinberg principles Sexual selection Male competition - combat



Seals V1  
Seals V2

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Figure 25-14

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Hardy-Weinberg principles

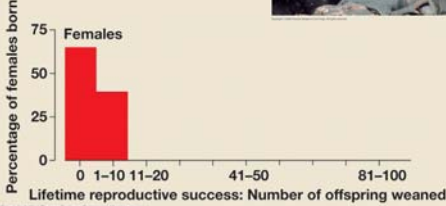
Sexual selection

Male competition - combat



Percentage of females born

Females



Lifetime reproductive success: Number of offspring weaned	Percentage of females born
0	~65
1-10	~40
11-20	0
41-50	0
81-100	0

Lifetime reproductive success: Number of offspring weaned

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Figure 25-14a

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Hardy-Weinberg principles

Sexual selection

Male competition – sperm competition



Copulatory wheel

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Hardy-Weinberg principles

Sexual selection

Male competition – infanticide



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# Microevolution



**Speciation**

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**Species concepts**

- 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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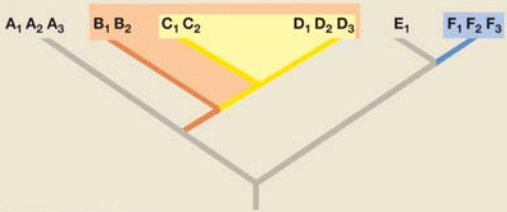
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**Species concepts**

**Phylogenetic species**



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# Microevolution

Species concepts

Morphospecies



Yellow throated warbler      Yellow rumped warbler

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Species concepts

- Biological species
- Phylogenetic species
- Ecological species
- Morphospecies

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Species concepts

Ring species – *Elaphe obsoleta*

Figure 18.14



Black rat snake  
*E. o. obsoleta*

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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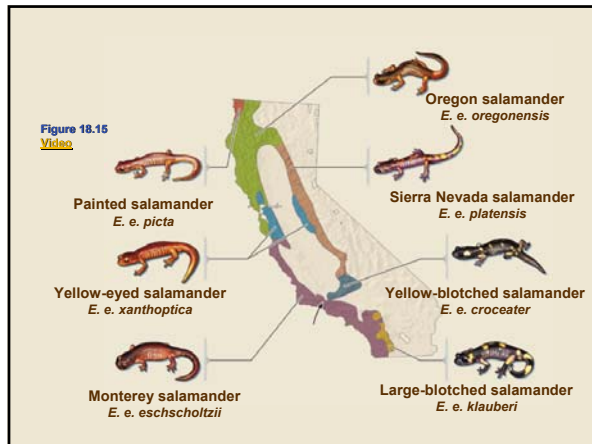
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# Microevolution




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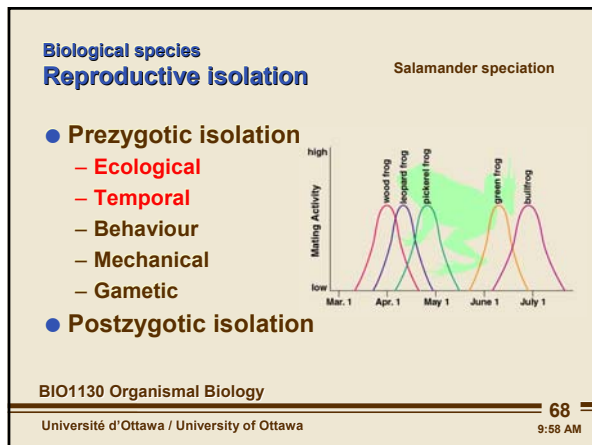
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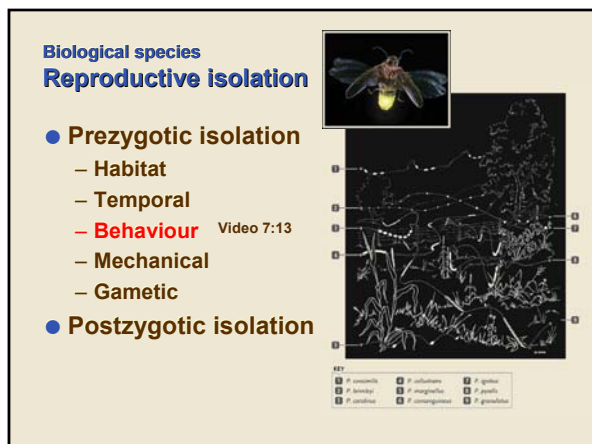
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# Microevolution

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

- **Prezygotic isolation**
  - Habitat
  - Temporal
  - Behaviour
  - **Mechanical** [comit orchid](#)
  - Gametic
- **Postzygotic isolation**



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

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



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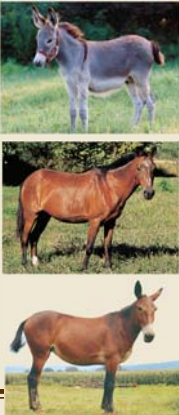
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**Biological species**  
**Reproductive isolation**

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



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Microevolution

**Allopatric Speciation - Vicariance**



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Figure 18.18

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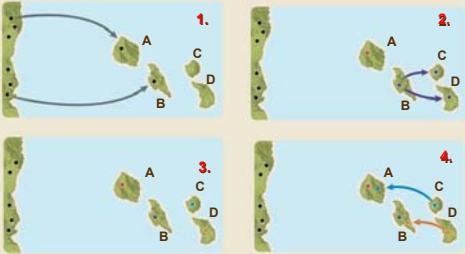
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**Allopatric Speciation - Dispersal**



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Figure 18.18

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**Grylloblattid – Ice age vicariance**



Video

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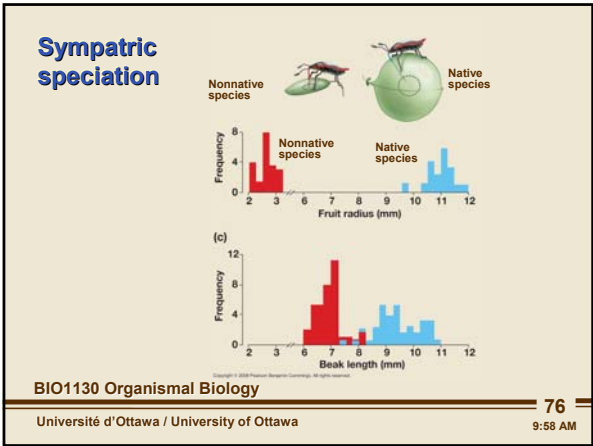
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Microevolution



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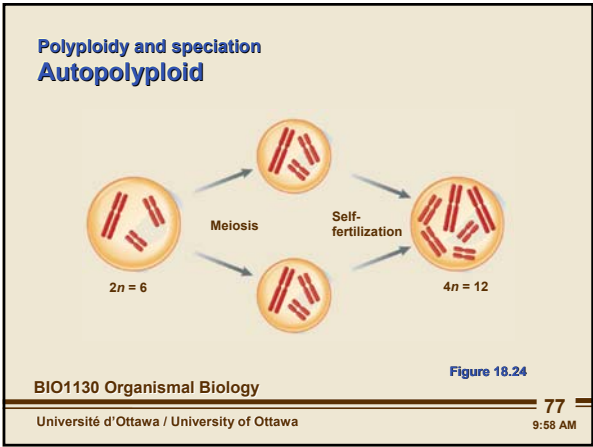
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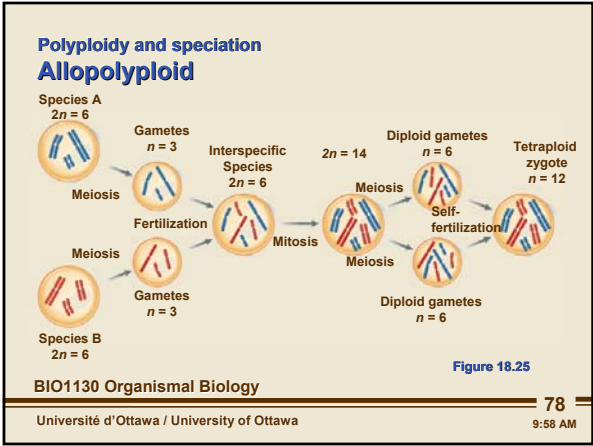
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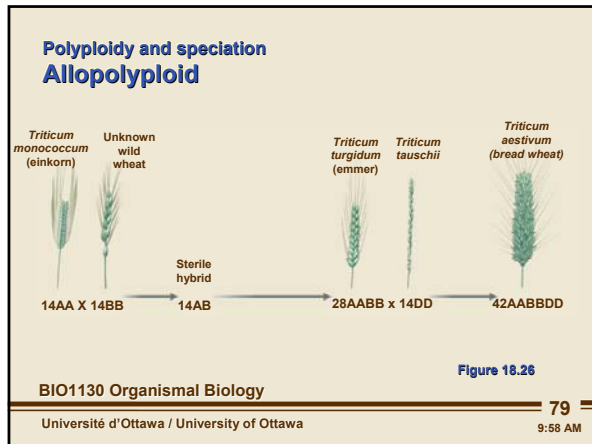
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# Microevolution



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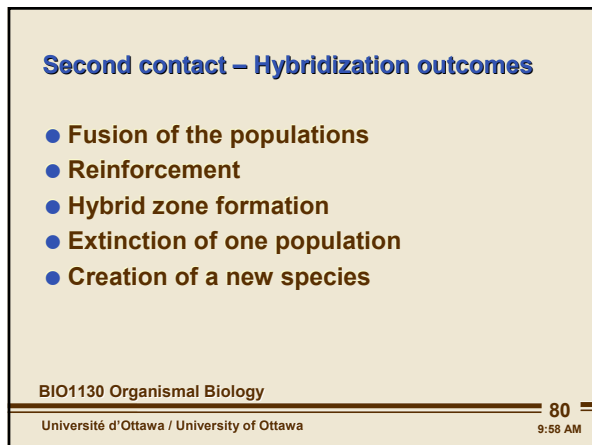
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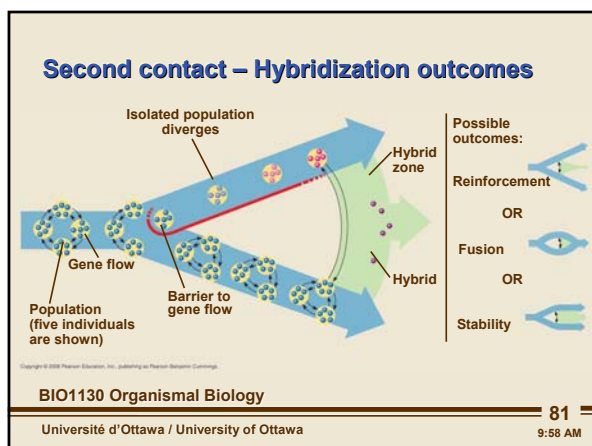
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