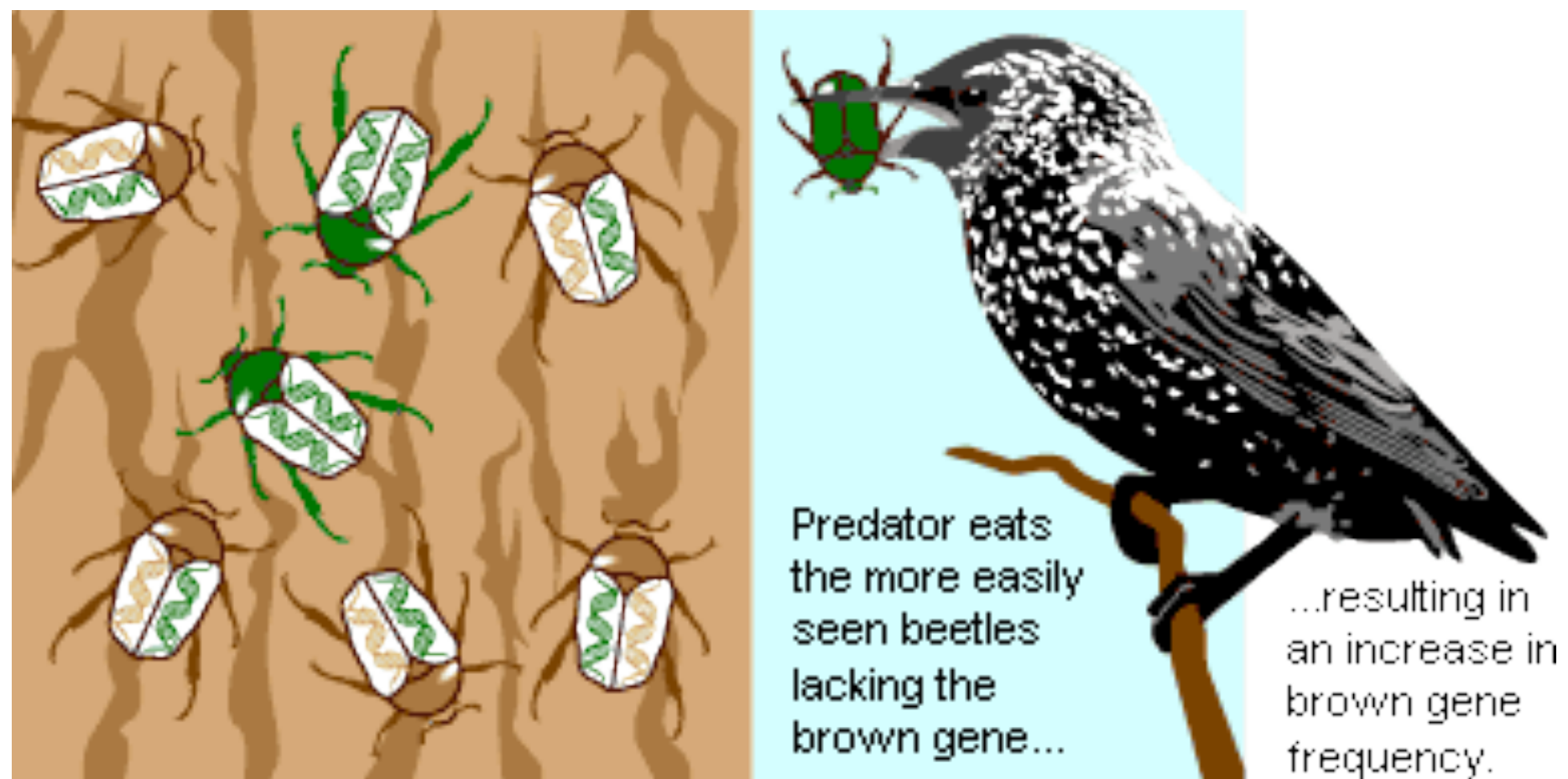


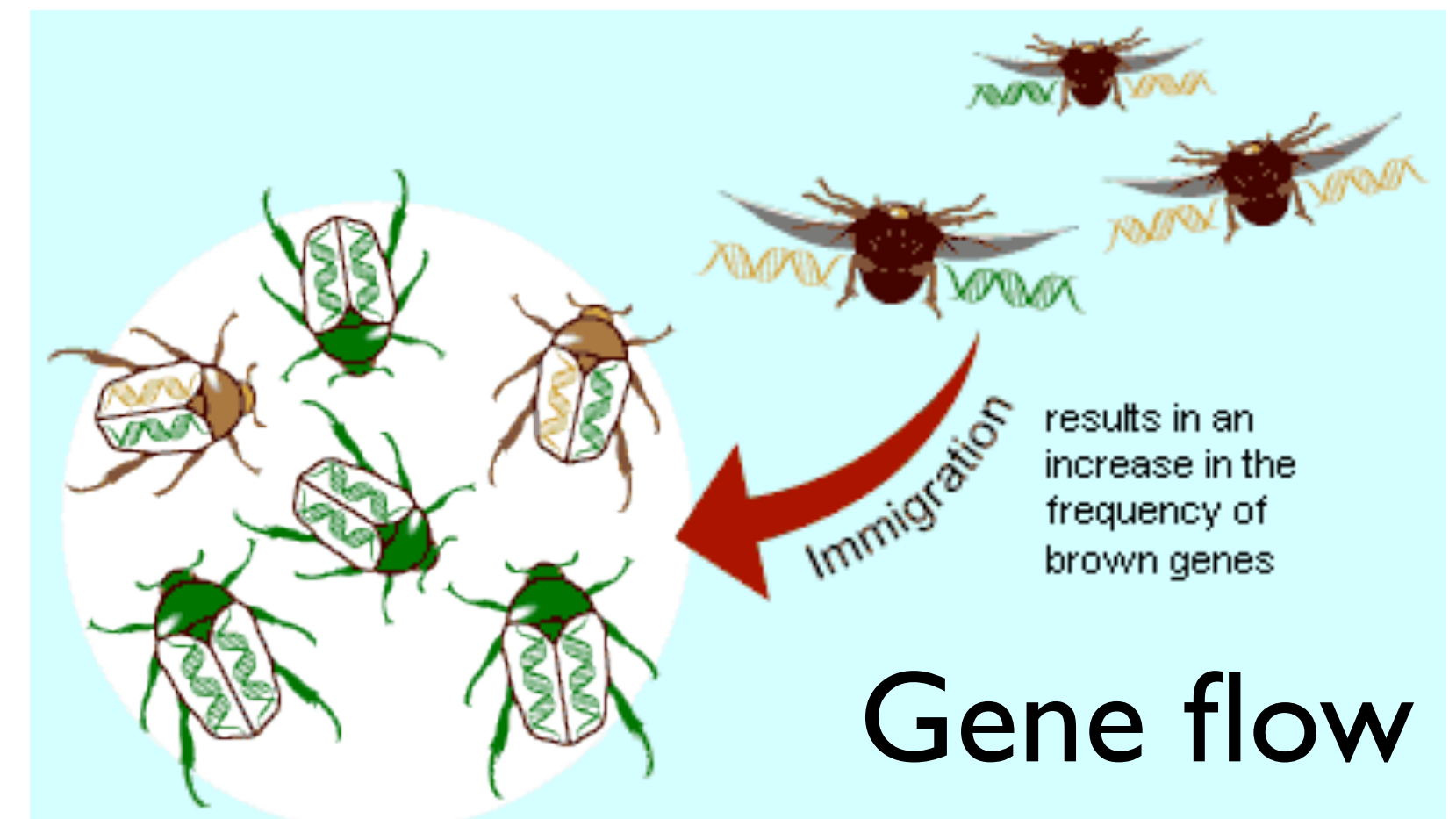
Genetic drift , Gene flow, and the maintenance of genetic diversity

Lecture 4

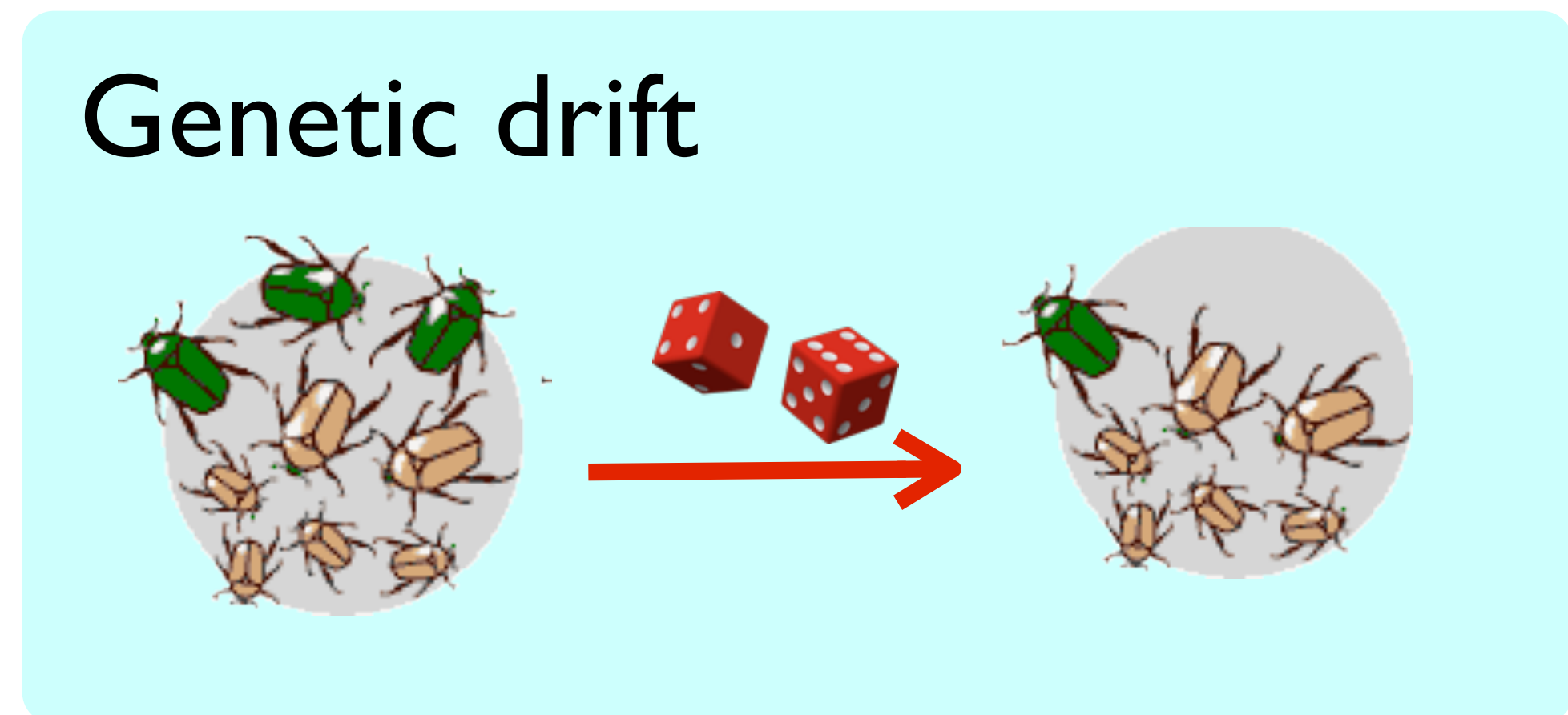
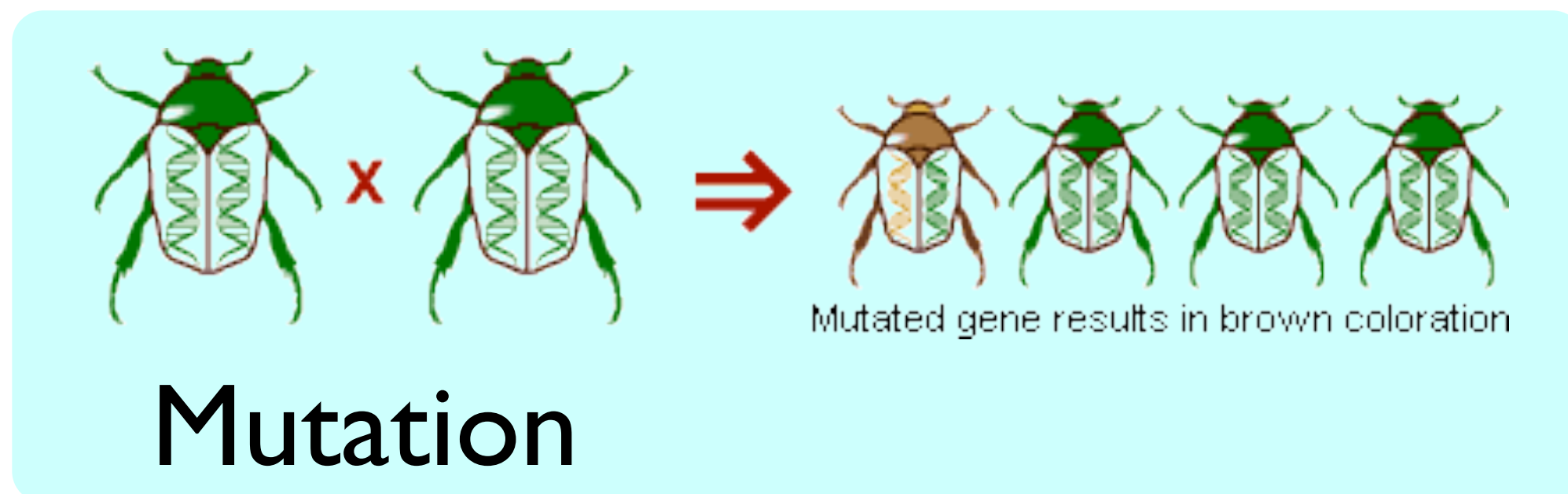
Agents of micro-evolution (i.e. causes for changes in allele frequency)



Selection

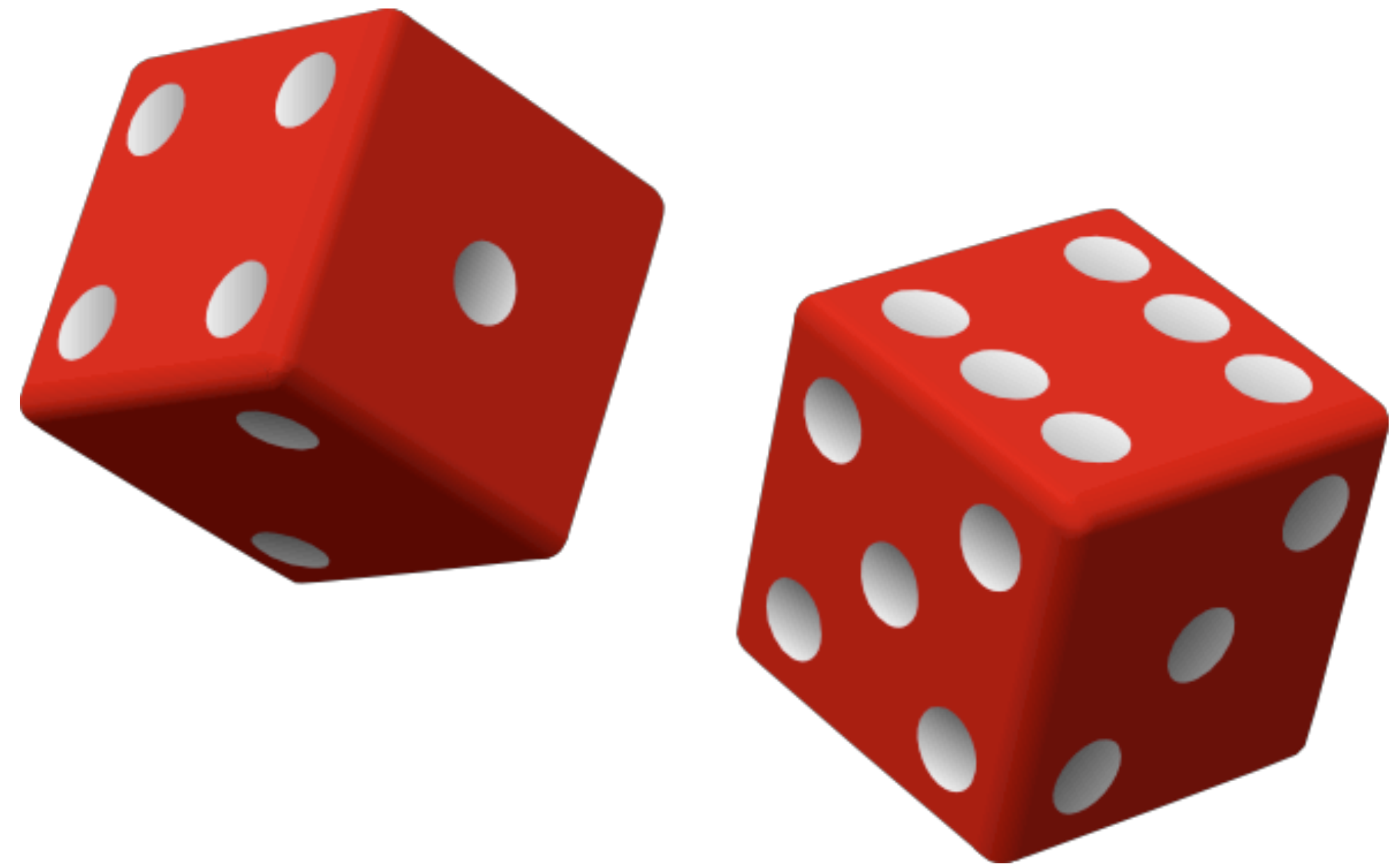


Genetic drift



Genetic drift

- **Genetic drift:** a change in the gene pool of a population due to chance.
- **Gene pool:** All the alleles for all the genes in the population



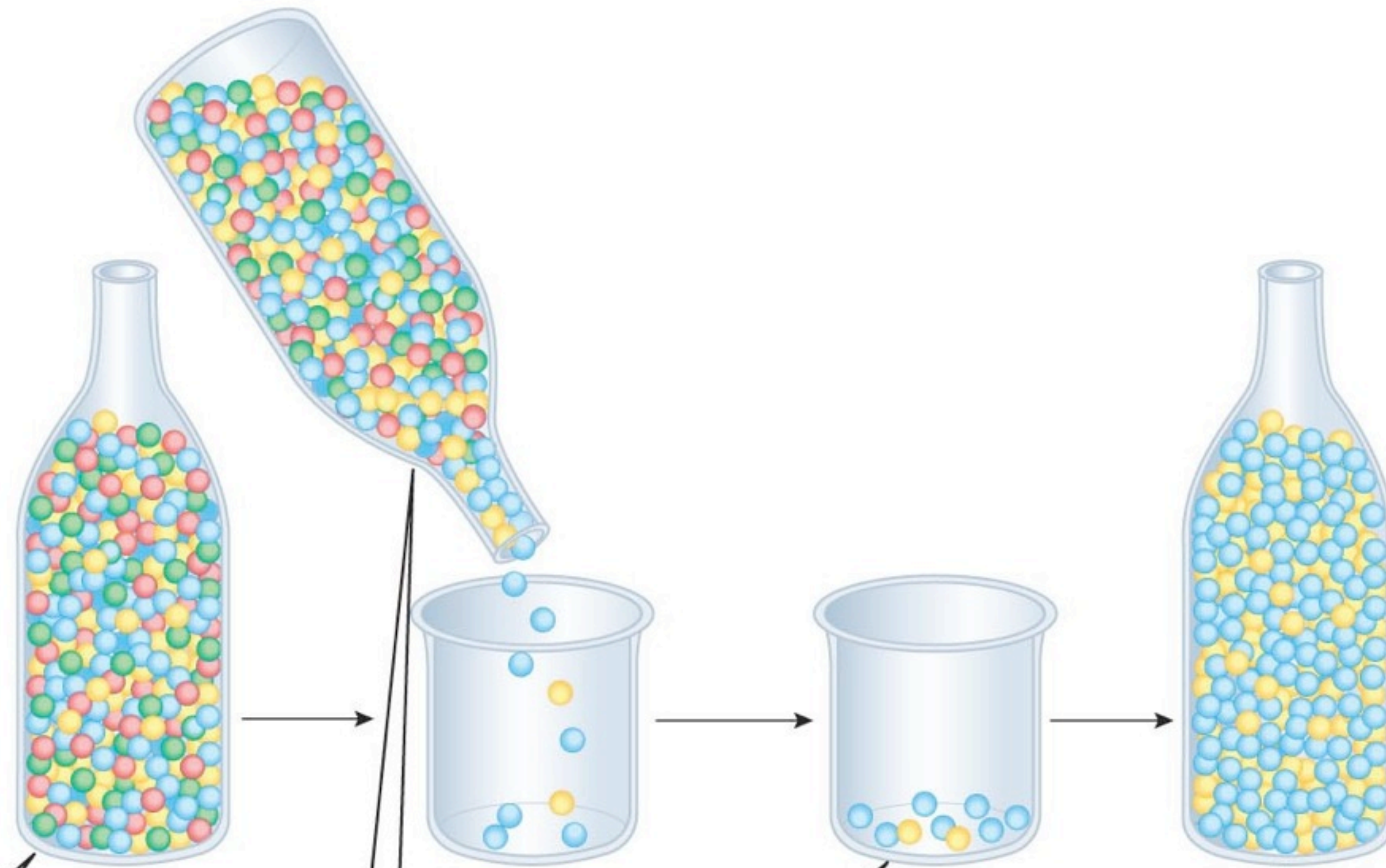
Genetic drift & population size

- The effect of drift on allele frequency is more pronounced in small populations

Simulation with Allele A

<http://faculty.washington.edu/herronjc/SoftwareFolder/AlleleA1.html>

Bottleneck effect



The gene pool of a population contains equal numbers of red, blue, yellow, and green alleles

A bottleneck event drastically reduces the size of the population

By chance, the gene pool of the reduced population contains mostly blue and a few yellow alleles

After the population grows and returns to its original size, blue alleles predominate; red and green alleles have disappeared

Population bottleneck: drastic reduction in population size

Bottleneck effect: Genetic drift resulting from a drastic reduction in population size. Typically the resulting population is no longer genetically representative of the original population.

What can cause a population bottleneck?

(a) Simulation of a population bottleneck



Prairie habitat in Illinois

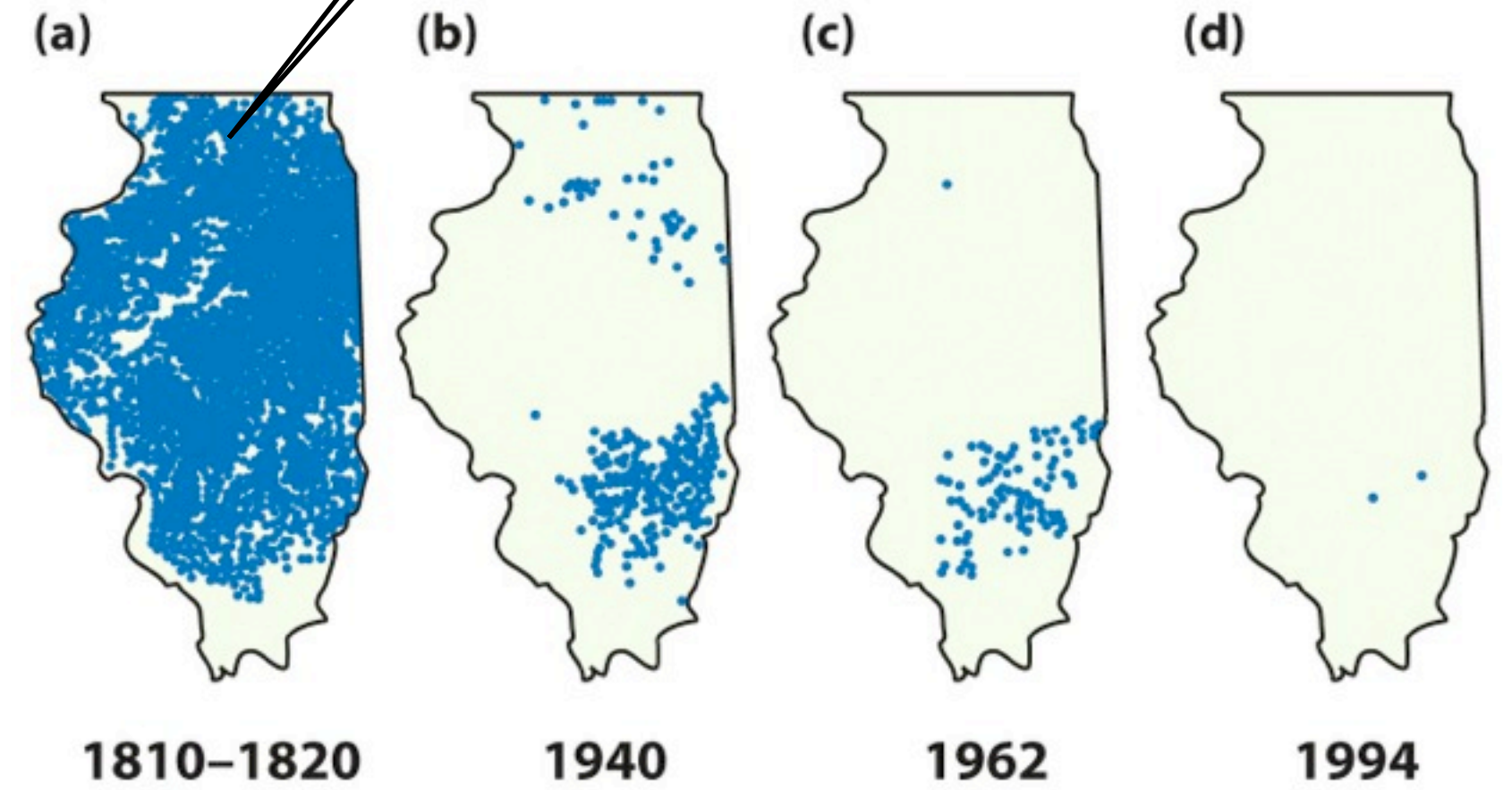
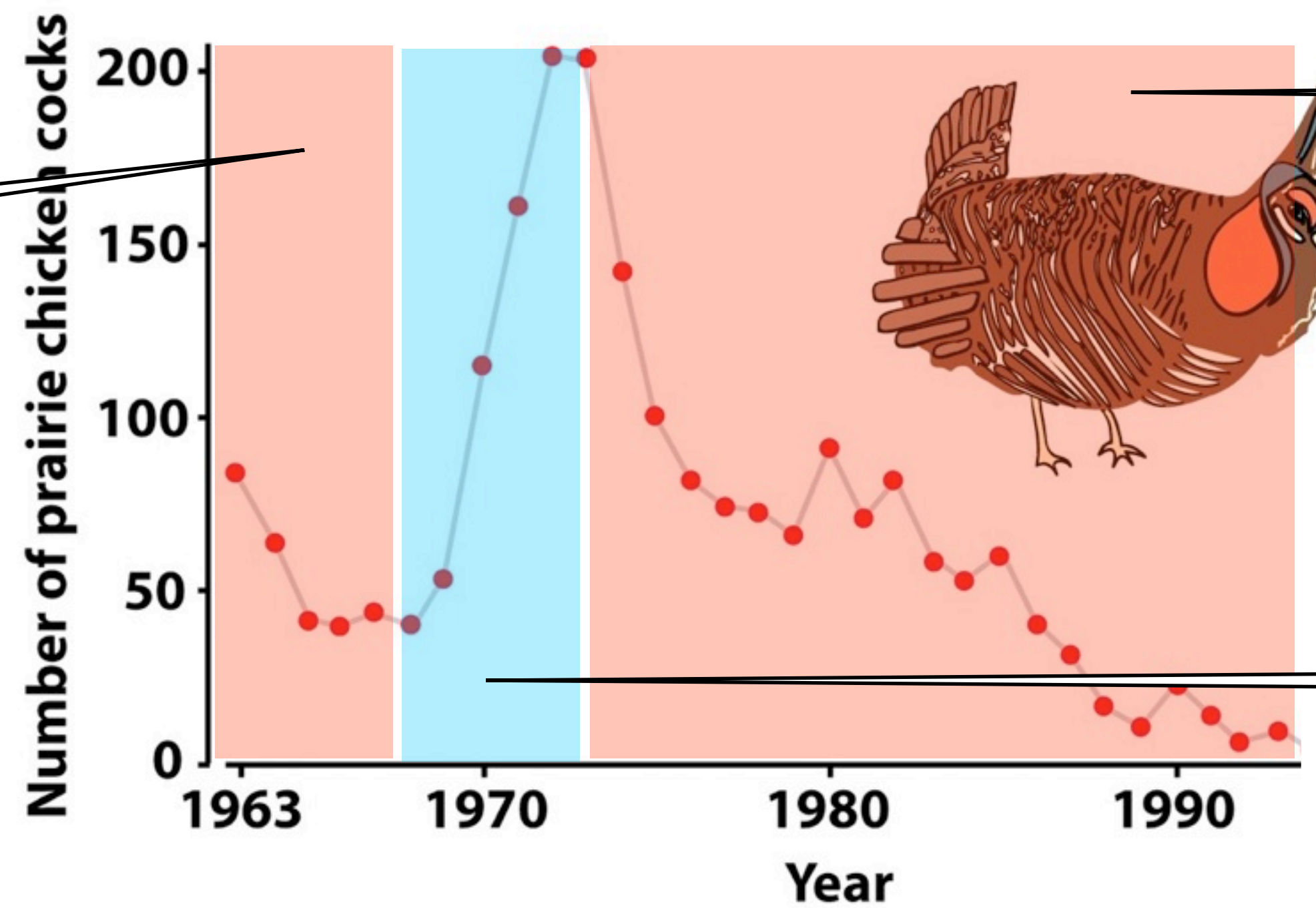


Figure 7-2 Evolutionary Analysis, 4/e
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Population bottleneck due to habitat loss

Decline again?

Recovery due to habitat restoration

Population bottleneck, genetic drift, and species conservation

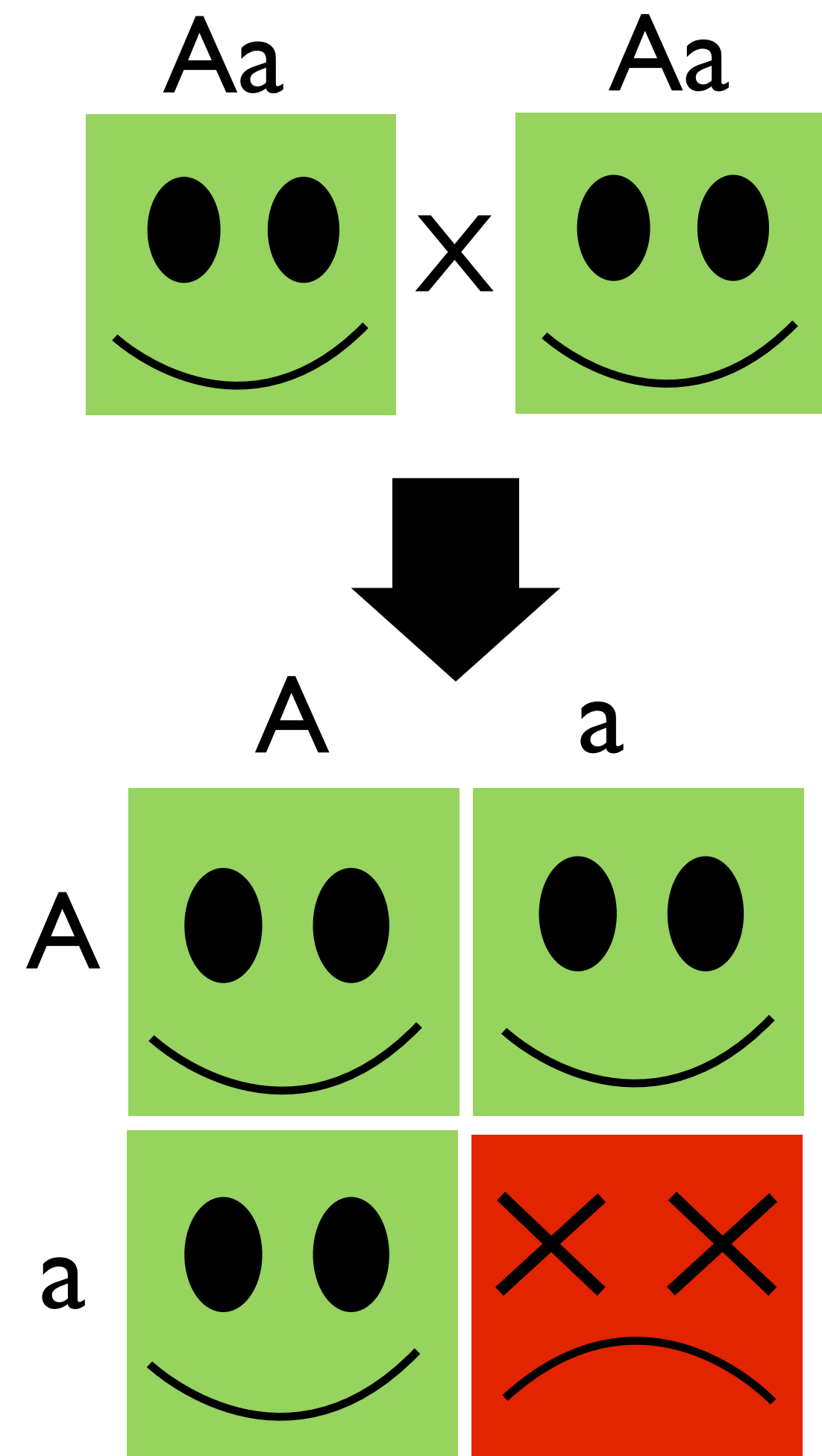
Table 7.6 Number of alleles per locus found in each of the current populations of Illinois, Kansas, Minnesota, and Nebraska and estimated for the Illinois prebottleneck population

Locus	Illinois	Kansas	Minnesota	Nebraska	Illinois prebottleneck*
ADL42	3	4	4	4	3
ADL23	4	5	4	5	5
ADL44	4	7	8	8	4
ADL146	3	5	4	4	4
ADL162	2	5	4	4	6
ADL230	6	9	8	10	9
Mean	3.67	5.83	5.33	5.83	5.12
SE	0.56	0.75	0.84	1.05	0.87
Sample size	32	37	38	20	15

In small populations genetic drift lead to **loss of genetic diversity** (i.e. in the number of allele at one locus)

Reduced genetic diversity and small population size

- **Reduction of genetic variation:** less material for selection to act upon and thus less potential for adaptations to evolve
- **Inbreeding** (reproduction with blood relative) : Blood relatives are more likely to carry the same **deleterious recessive alleles** than unrelated individuals. Inbreeding lead to a higher probability that deleterious recessive alleles will be expressed

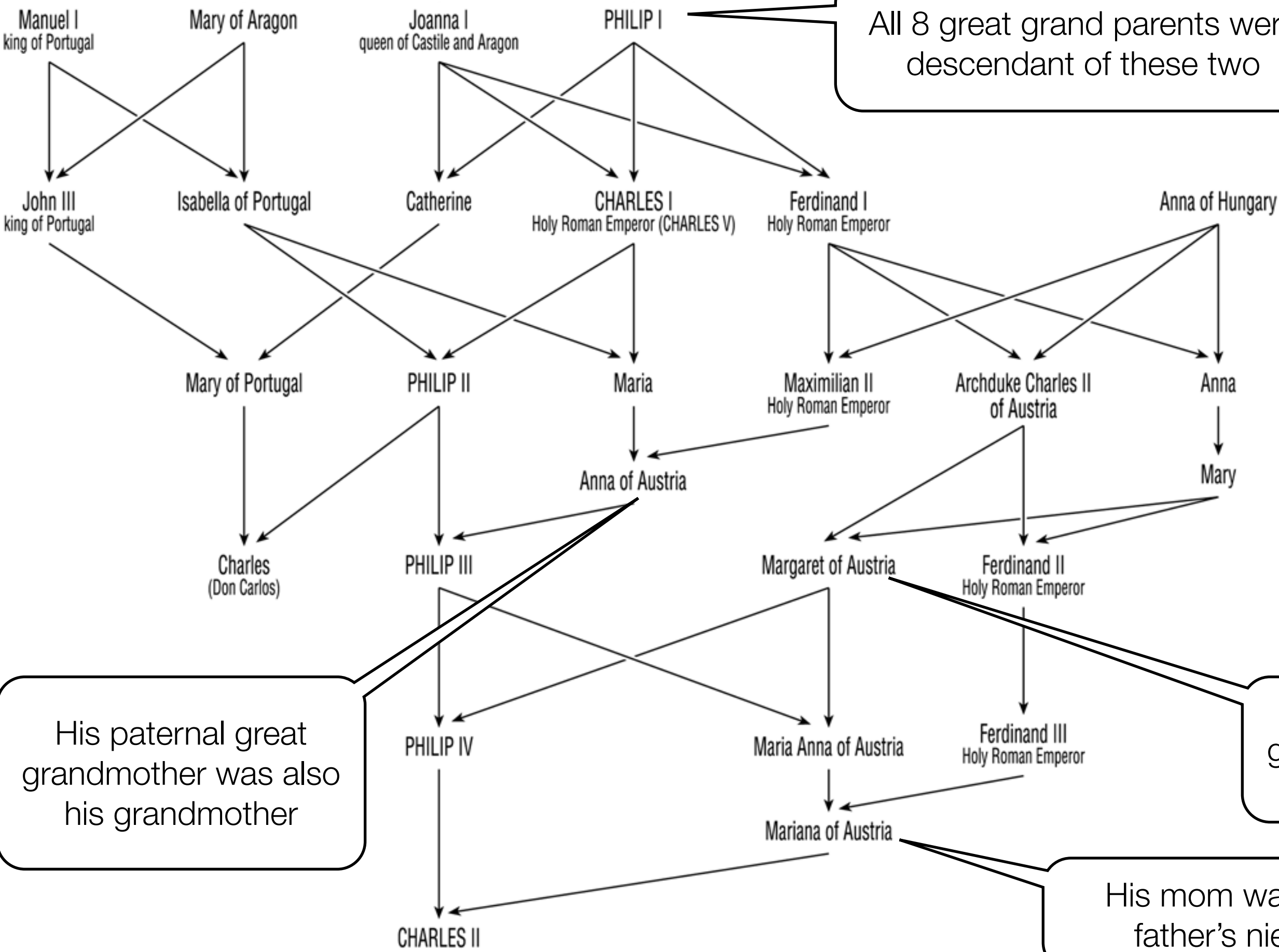


Inbreeding and recessive alleles



Charles II of Spain

All 8 great grand parents were descendant of these two



His paternal great grandmother was also his grandmother

His maternal grandmother was also his aunt

His mom was his father's niece

Homozygote for ~25% of his alleles!

Inbreeding and recessive alleles

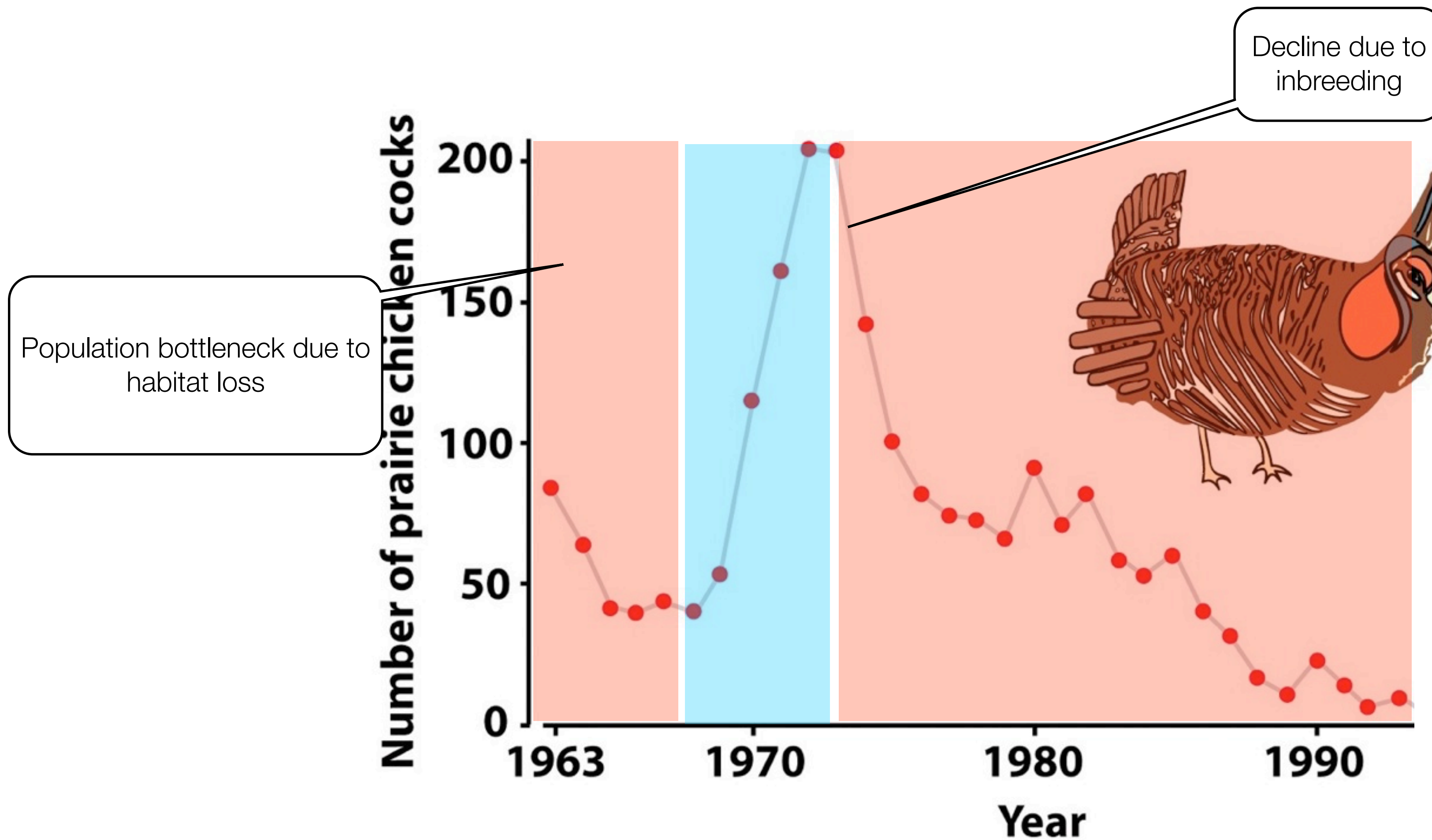
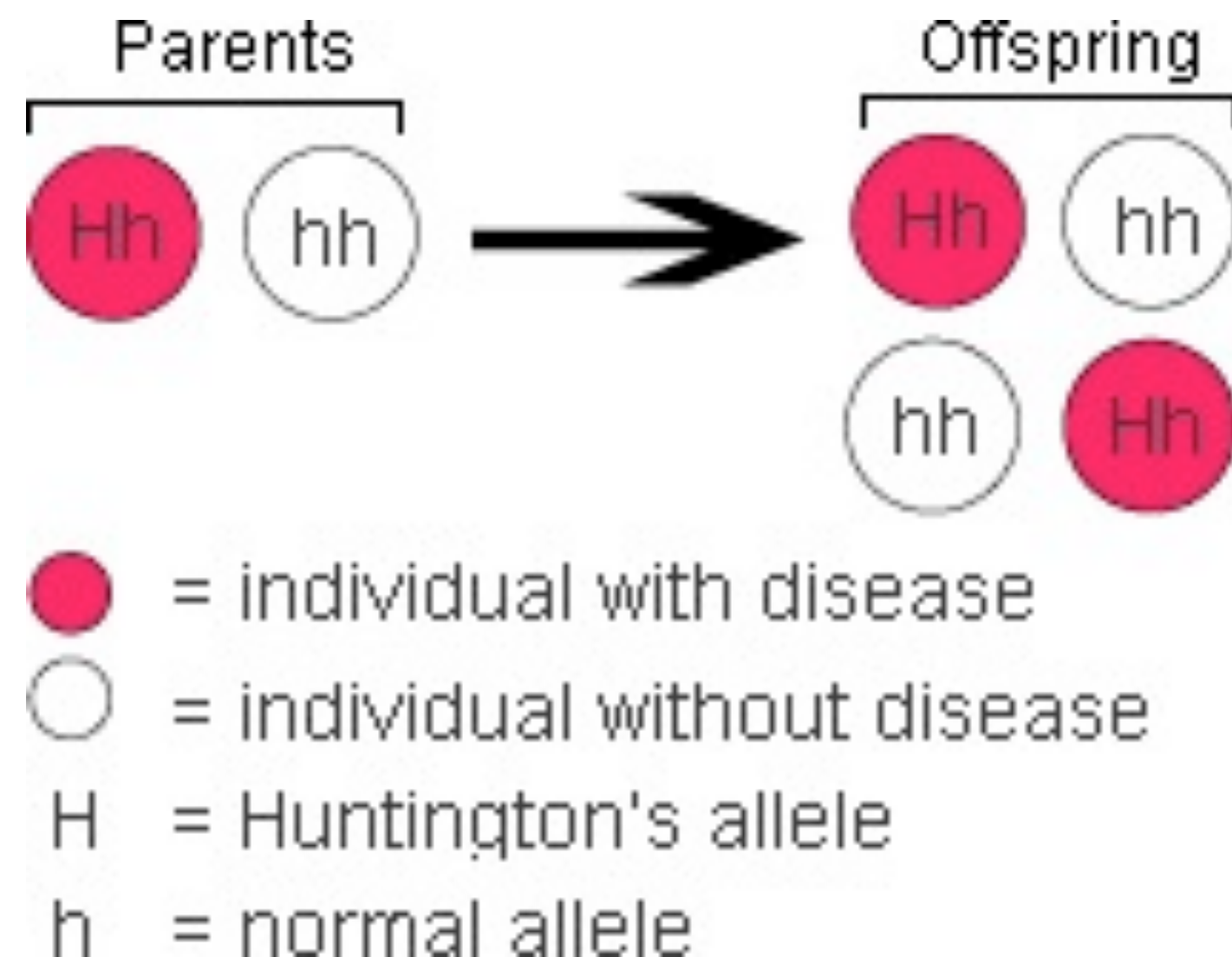


Figure 7-3 Evolutionary Analysis, 4/e
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Founder effect, genetic drift, and genetic disease

- **Huntington chorea**: lethal disease caused by a mutated **dominant allele**
- Normal incidence: 30-70 cases per million person



Founder effect, genetic drift, and genetic disease

- Barranquitas, Venezuela
- Huntington Disease affects close to 50% of the population
- Brought to the area by a single women who had 10 children and drifted to a high frequency
- The **founder effect** can increase the frequency of rare alleles to high frequency (through drift)

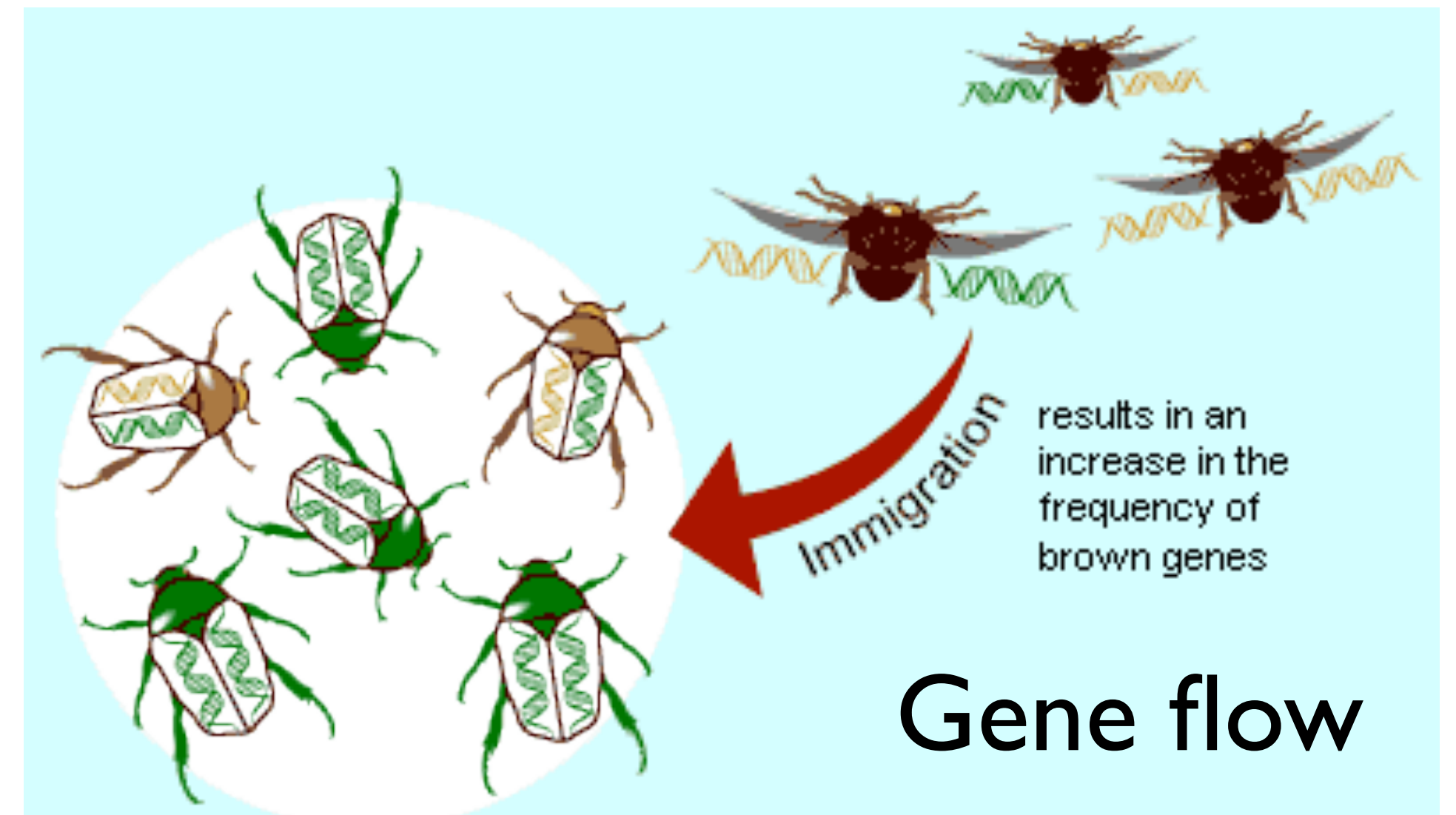


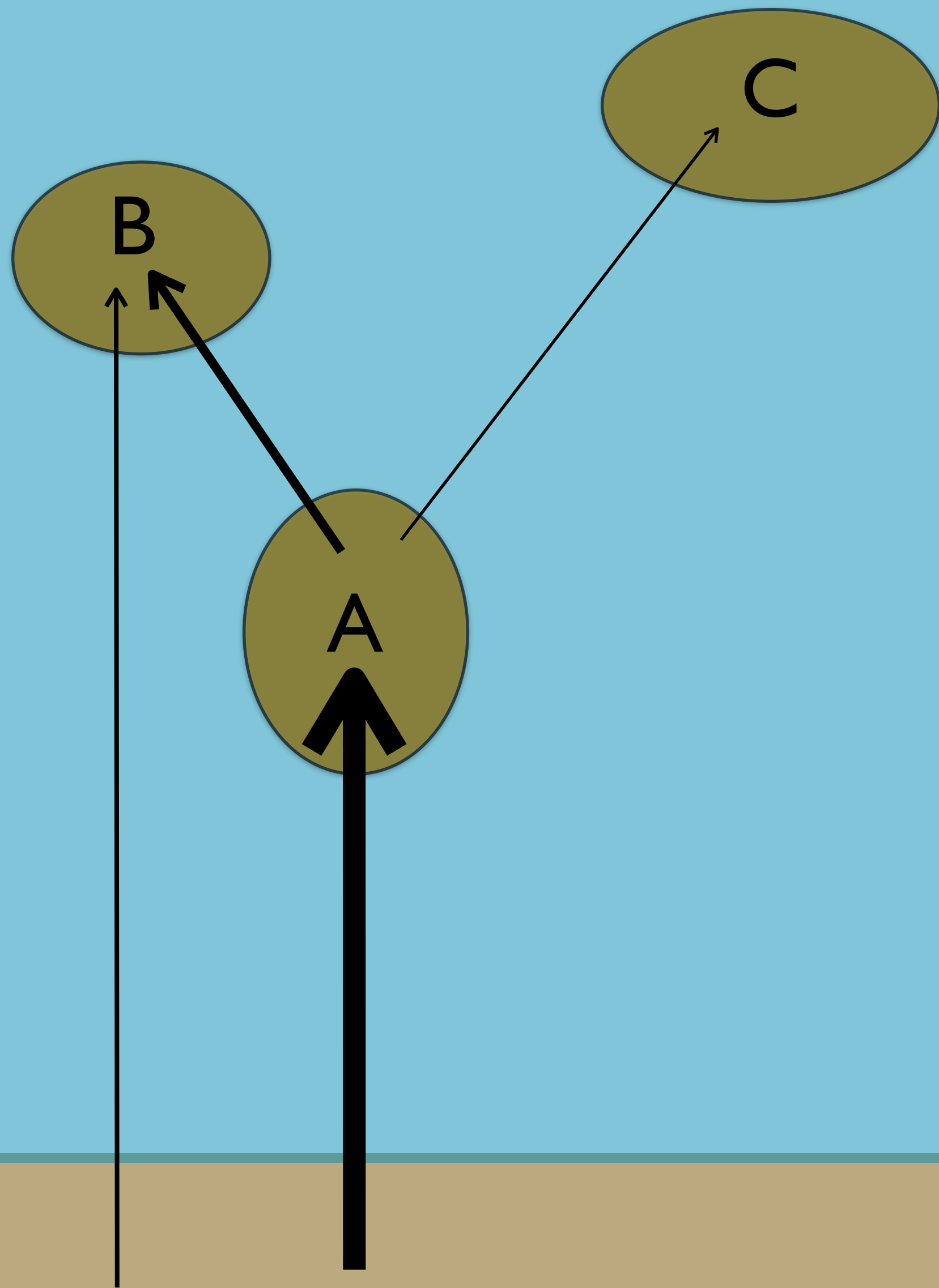
QUESTION

- Huntington disease is an heritable, lethal disease. Why was it not eliminated by selection?

Gene flow

- **Gene flow:** the transfer of alleles among populations as a result of movement of individuals or their gametes
- Gene flow usually increases genetic diversity within populations
- Gene flow decreases genetic differences among populations



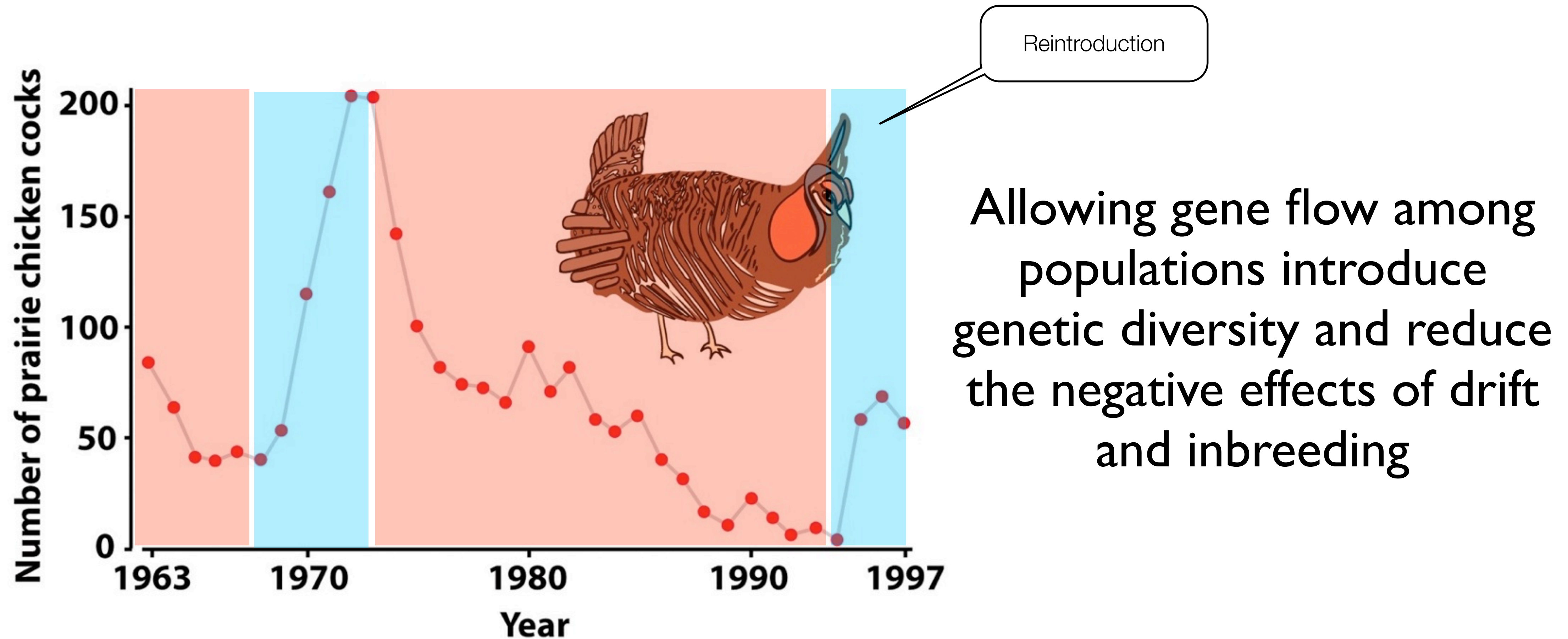


Which population has the highest genetic diversity?

Which population share the greatest number of alleles with population A?

Which population is the most subjected to change through genetic drift?

Gene flow and conservation



Gene flow and conservation



Genetic variation

- **Mutations create new alleles but other mechanisms contribute to the maintenance of existing alleles i.e. the maintenance of genetic variation**

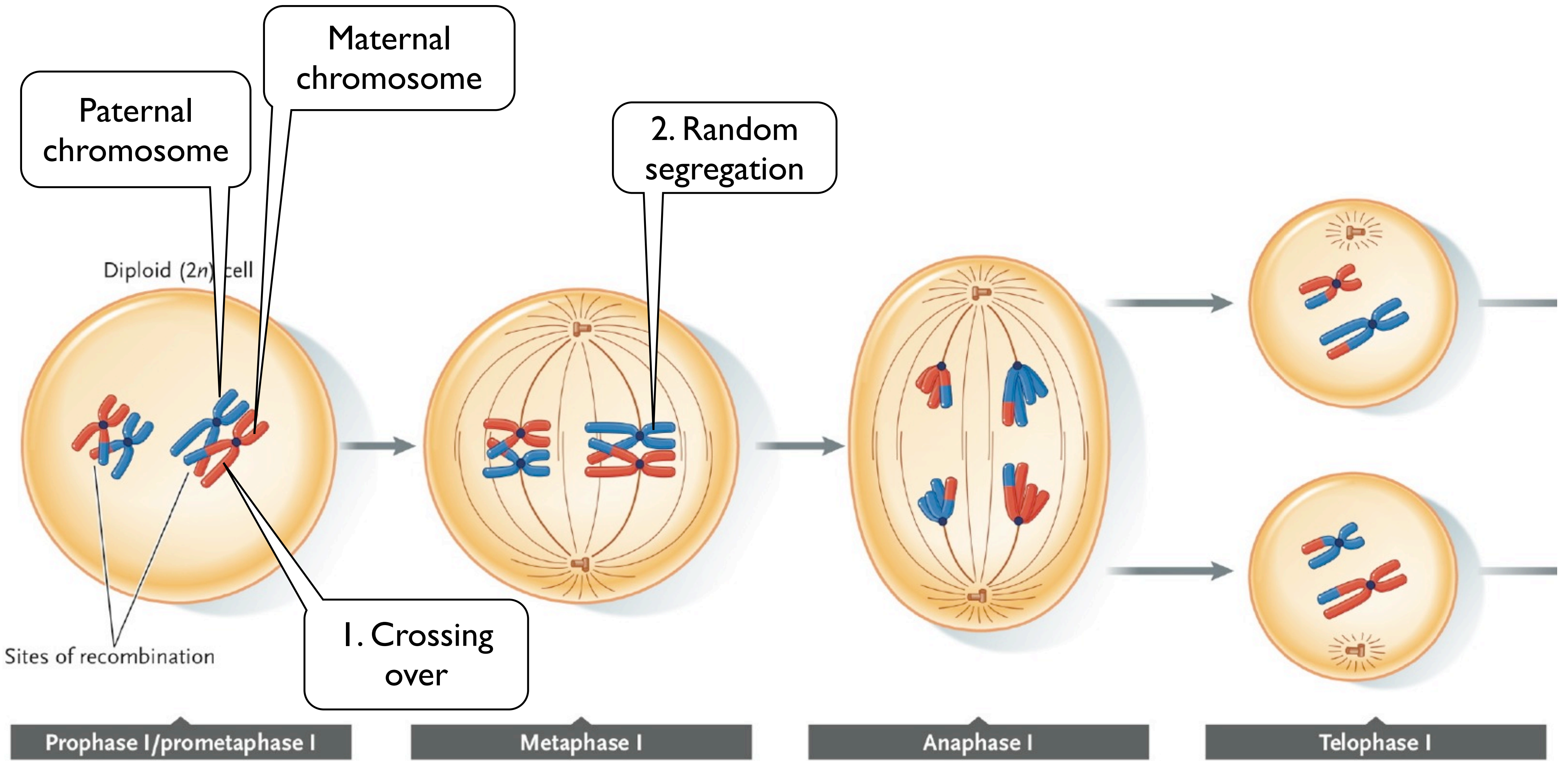
New combinations of alleles: genetic recombination

**Genetic recombination (sexually reproducing organisms)
creates new combinations of alleles**

**1. Independent orientation
of chromosomes** (meiosis)

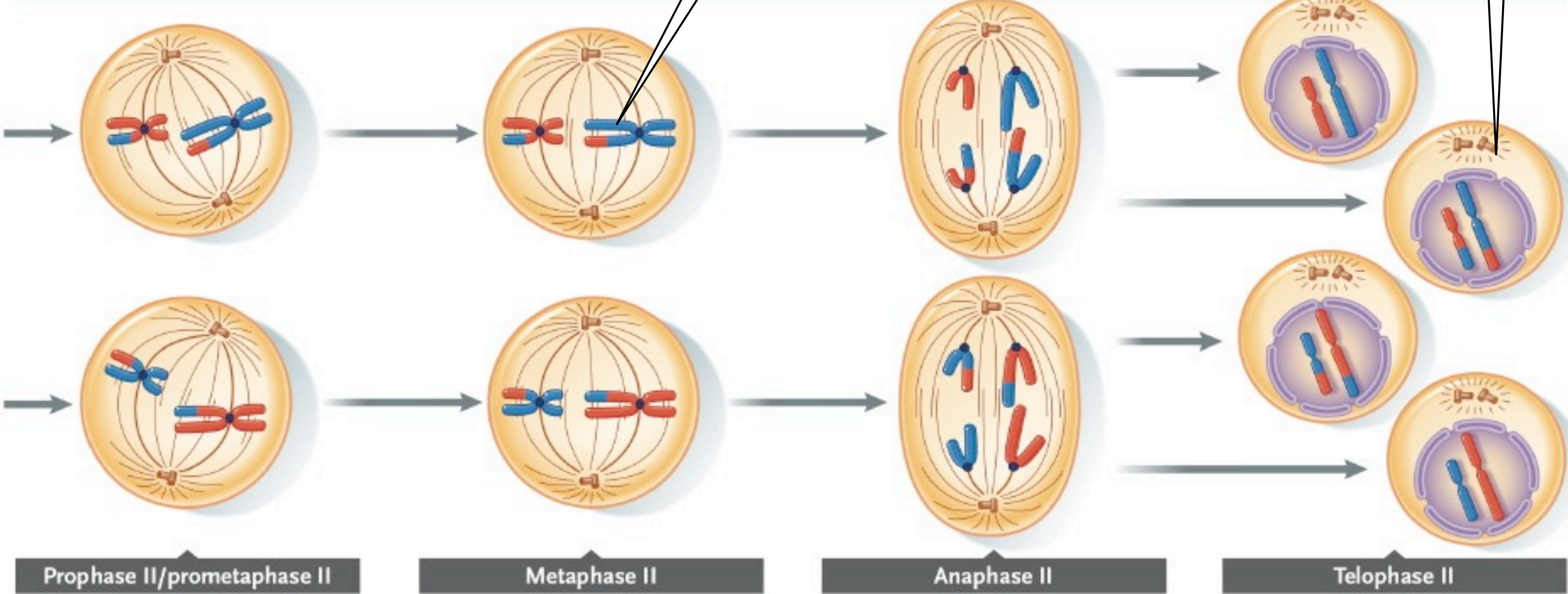
2. Crossing over (meiosis)

3. Random fertilization



3. Alternative combinations

Gametes

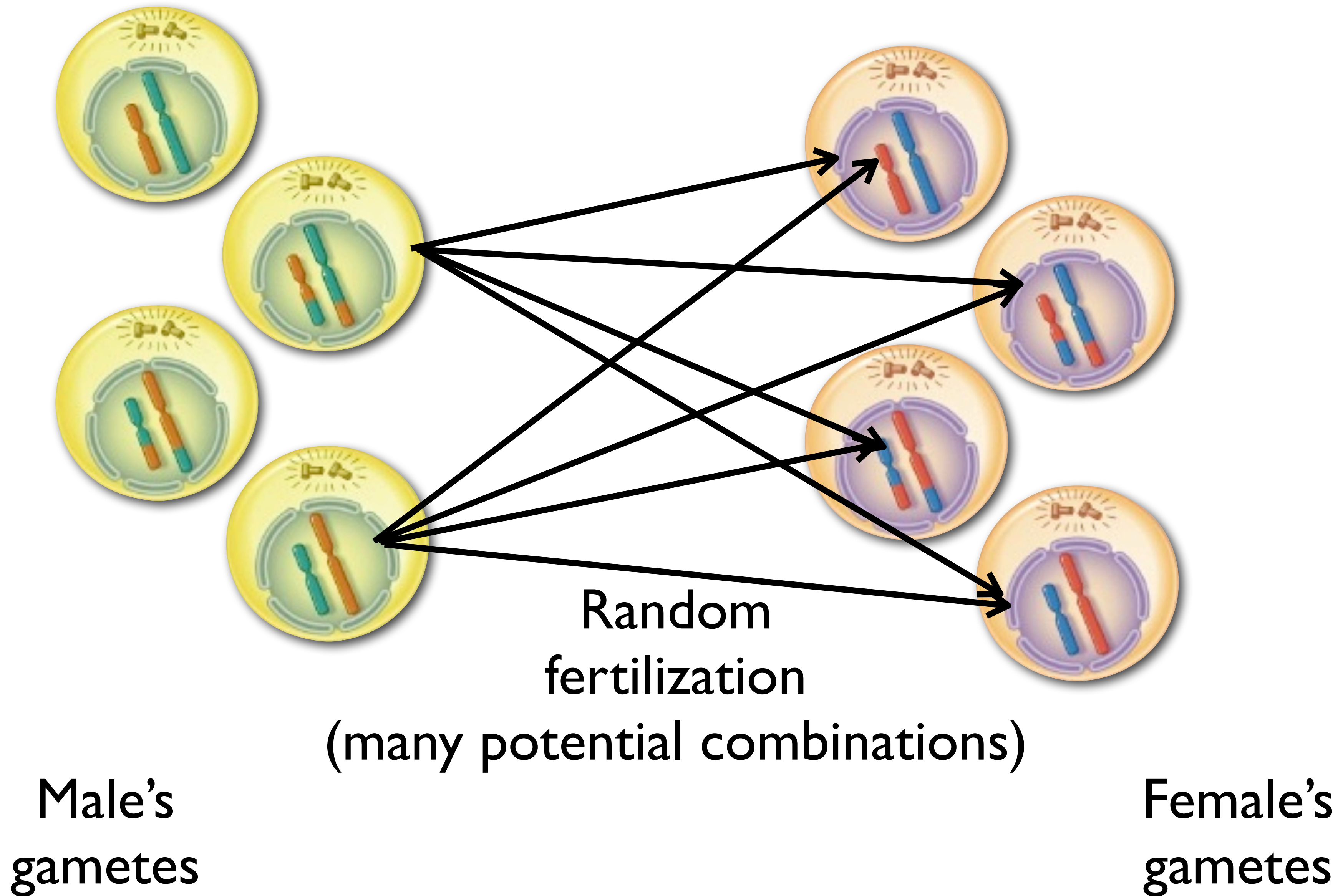


Prophase II/prometaphase II

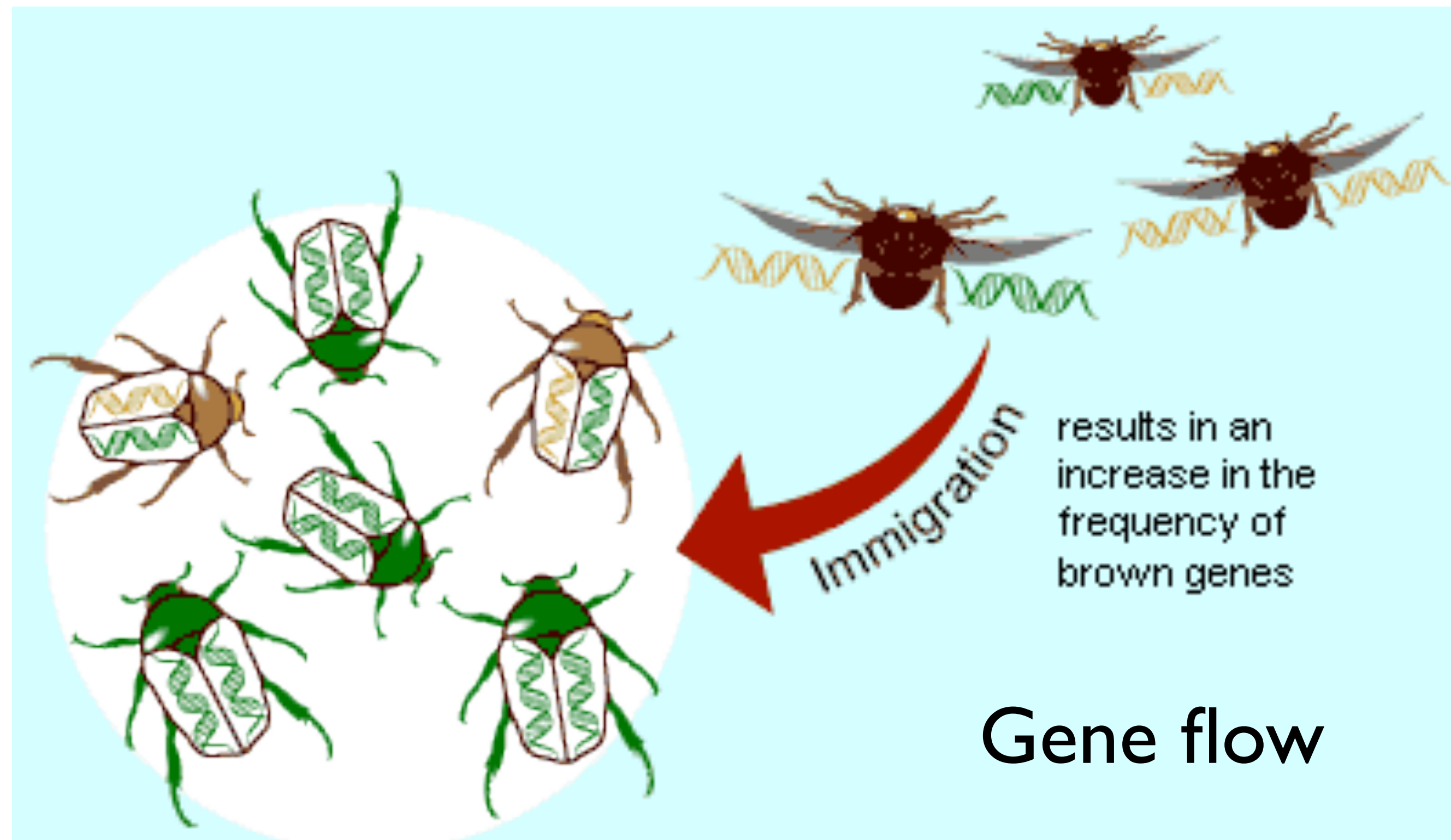
Metaphase II

Anaphase II

Telophase II

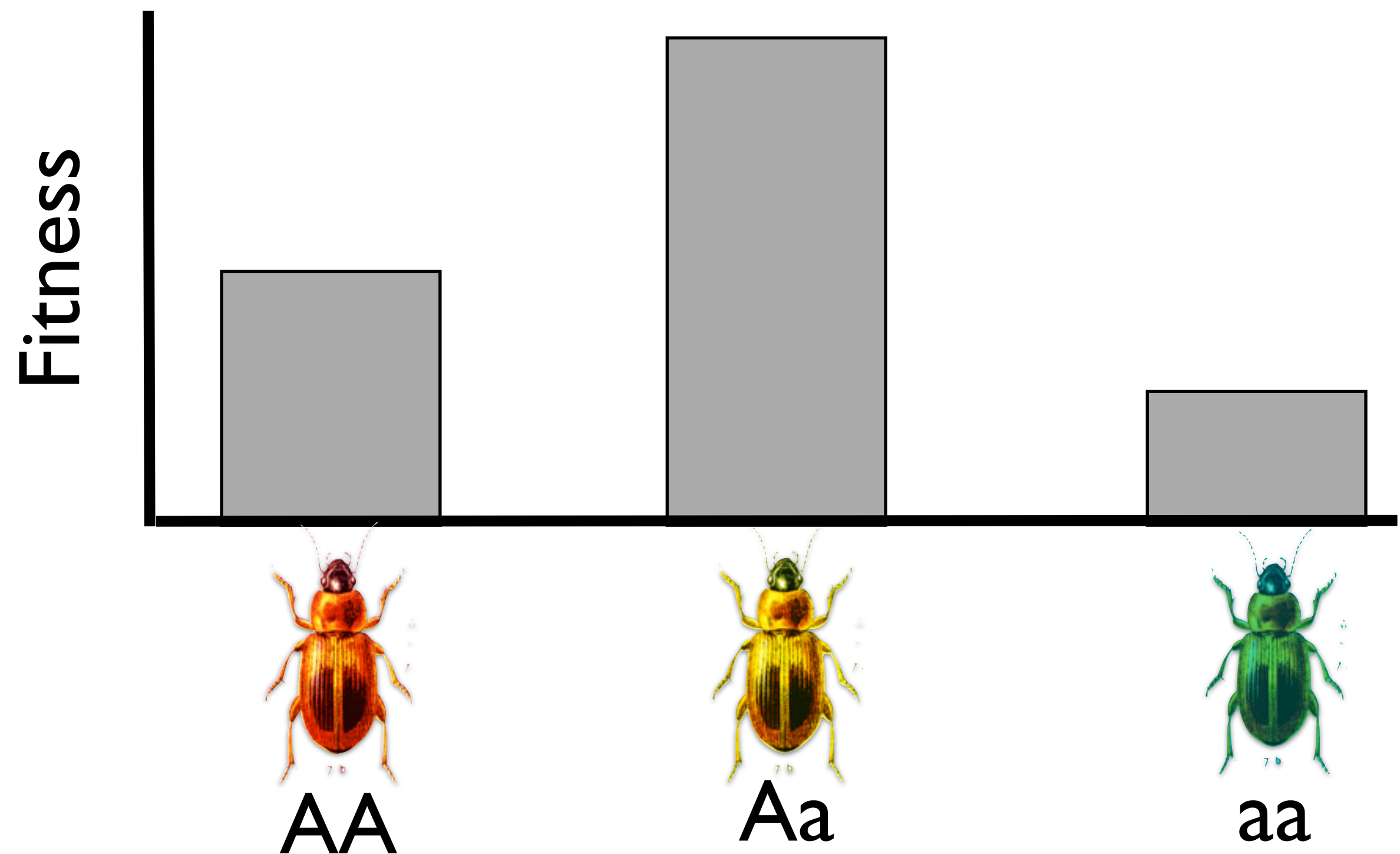


Maintenance of genetic variation: gene flow



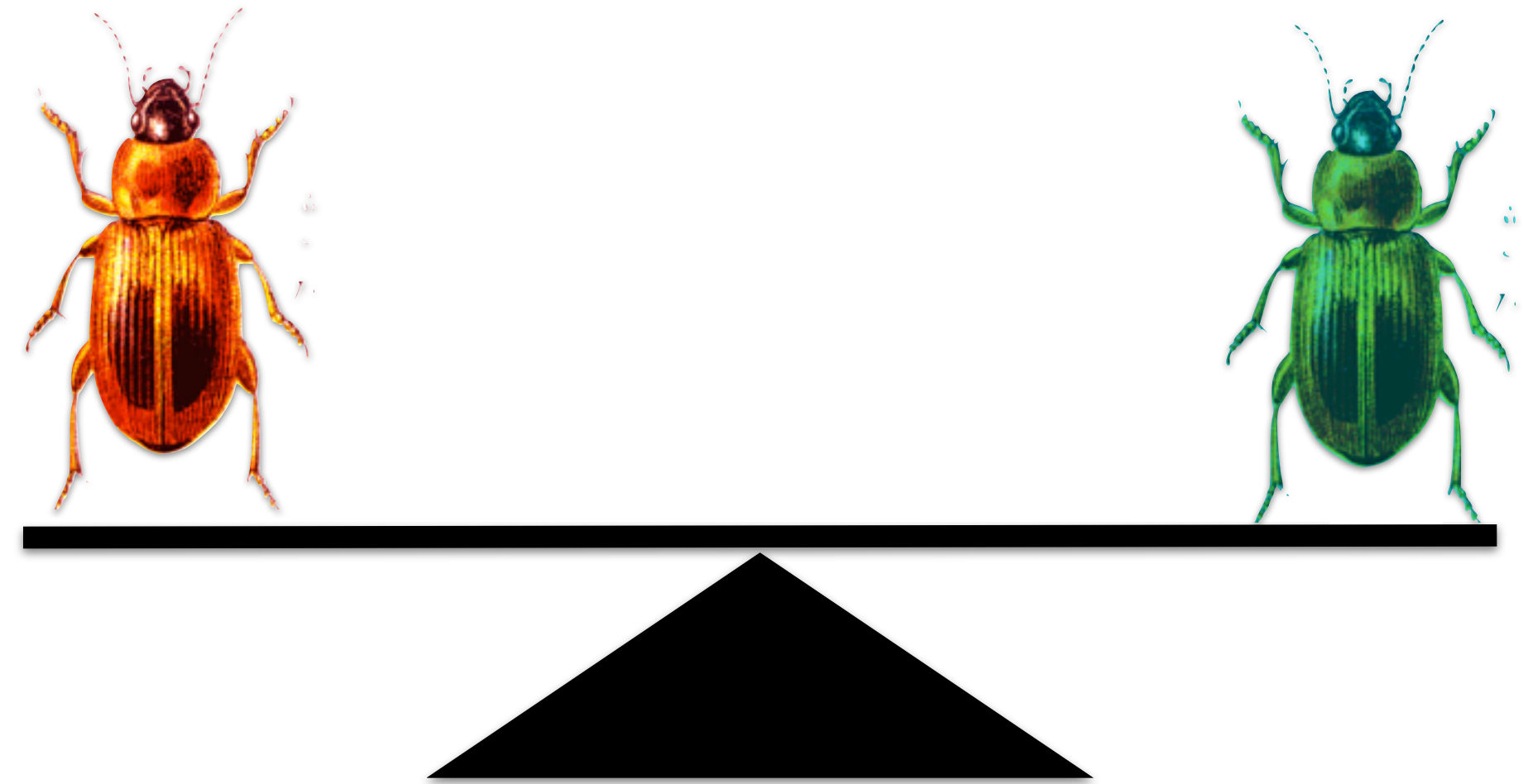
Maintenance of genetic variation: Heterozygote advantage

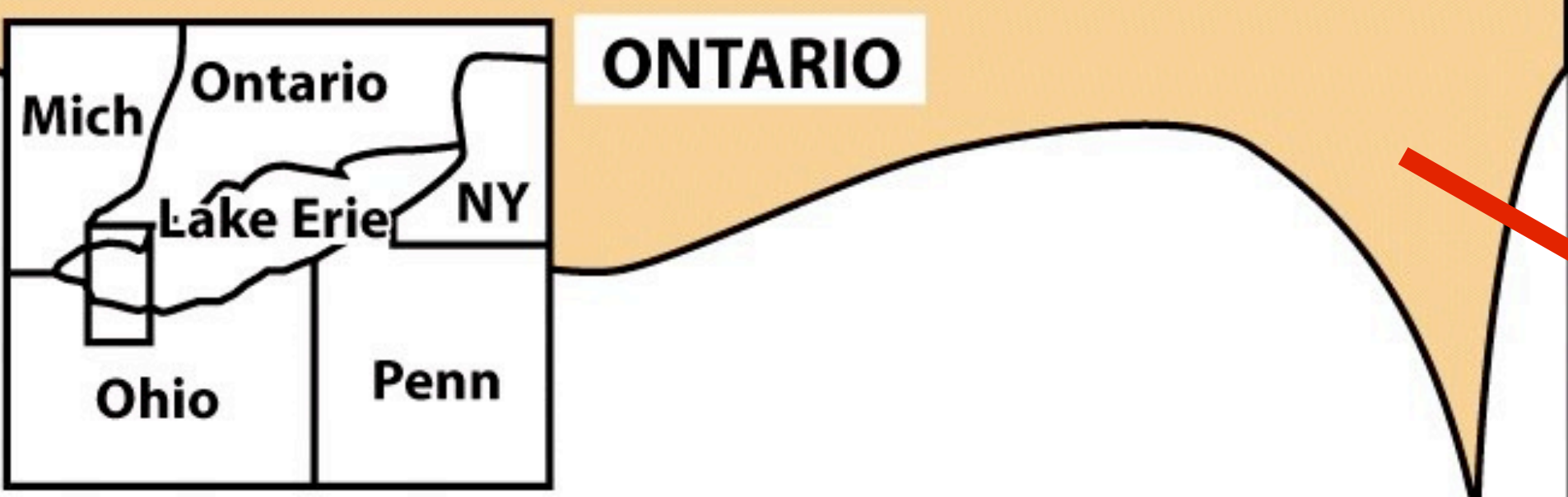
- **Balancing selection**
- If heterozygotes have a higher fitness under some circumstances, both alleles will persist in the population
- Ex: sickle-cell anemia



Maintenance of genetic variation: Balanced polymorphism

- **Balancing selection**
- Two or more phenotypes are maintained in stable proportions because they have the same fitness





ONTARIO

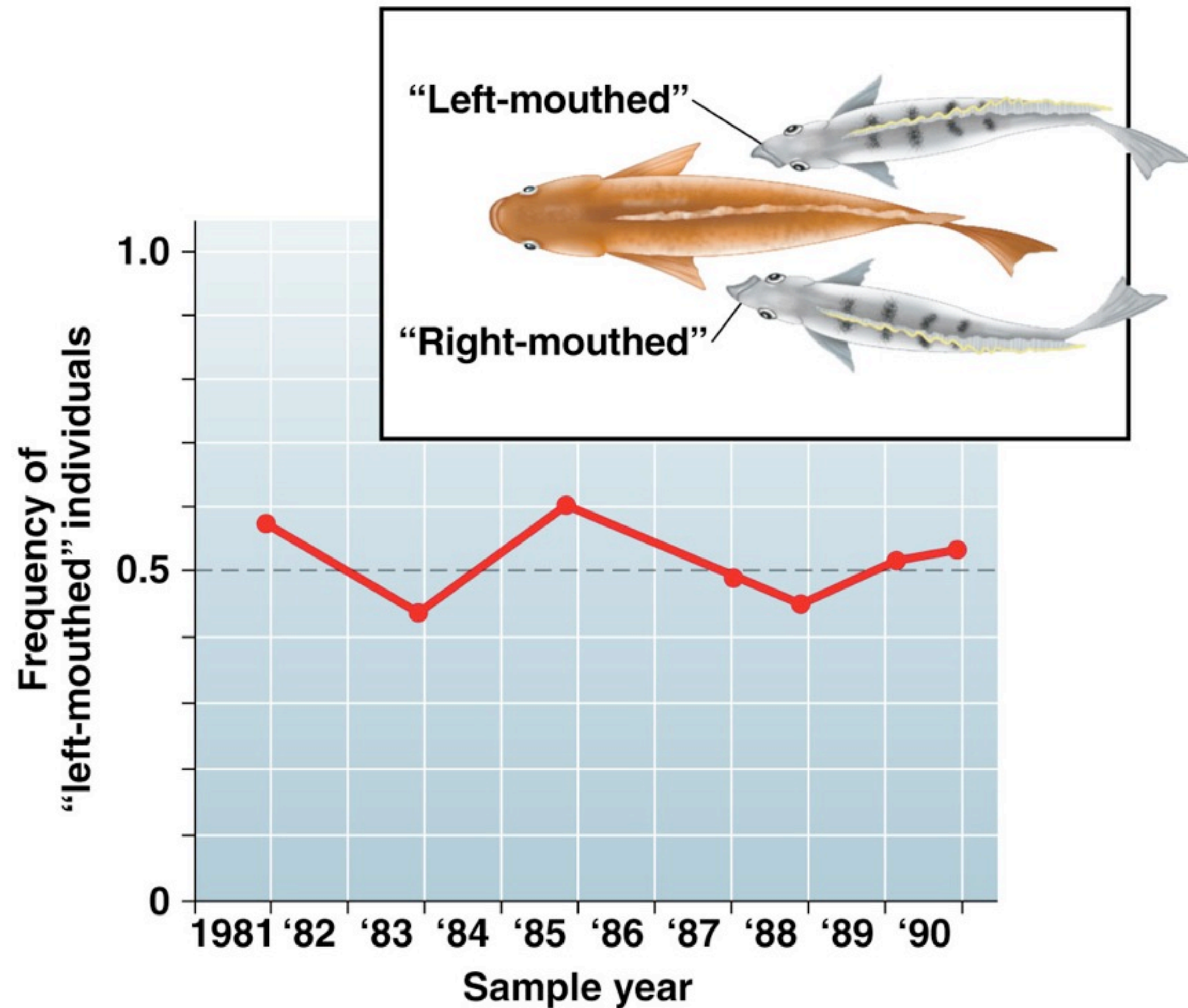


OHIO



Maintenance of genetic variation: Frequency dependent selection

- **Balancing selection**
- Selection acting against the most common phenotype
- Scale eating fish in lake Tanganyika



Genetic variation summary

- **Mutations** create new alleles
- **Genetic recombination** reshuffles alleles and creates new combination of existing alleles
- **Gene flow** and **balancing selection** maintain existing variation
- **Inbreeding** and **genetic drift** reduce genetic variation