OUTLINE 21

POPULATION GENETICS

I. The New Synthesis

A. Challenge

1. Bracydactyly

2. The Hardy-Weinberg rule

B. Populations and Gene Pools

1. Definitions

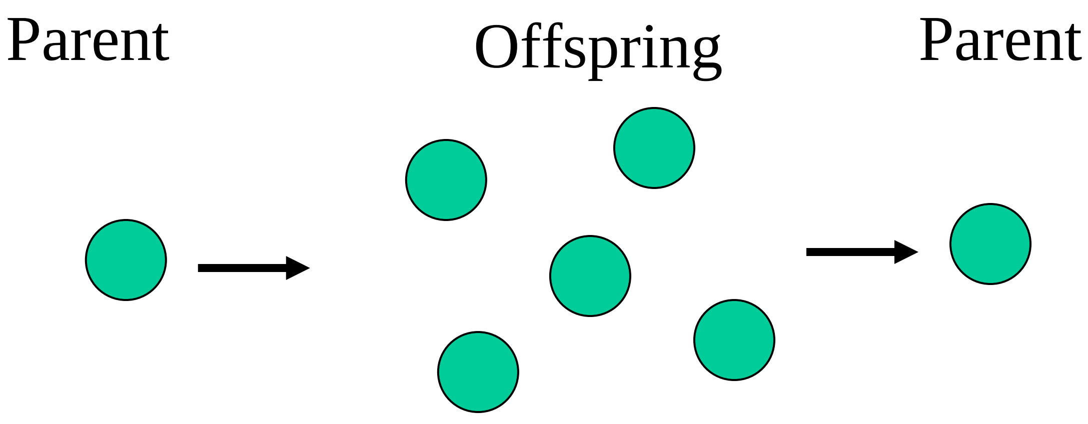
2. Illustration of Hardy-Weinberg Equilibrium

C. Conditions for Hardy-Weinberg equilibrium

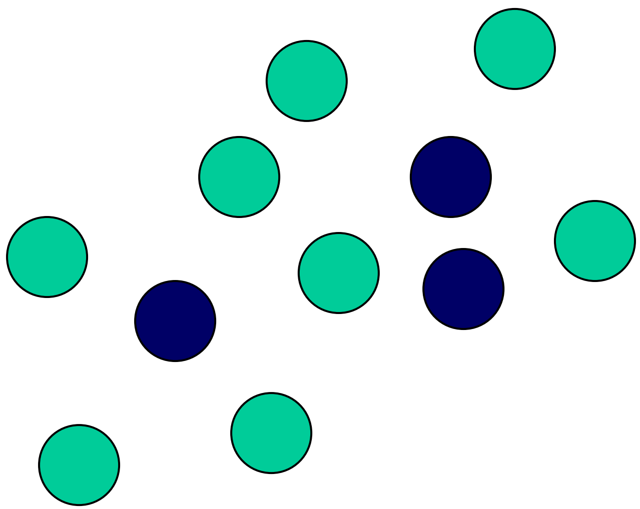
D. Significance of Hardy-Weinberg for the study of Evolution

E. How to recognize Hardy-Weinberg equilibrium

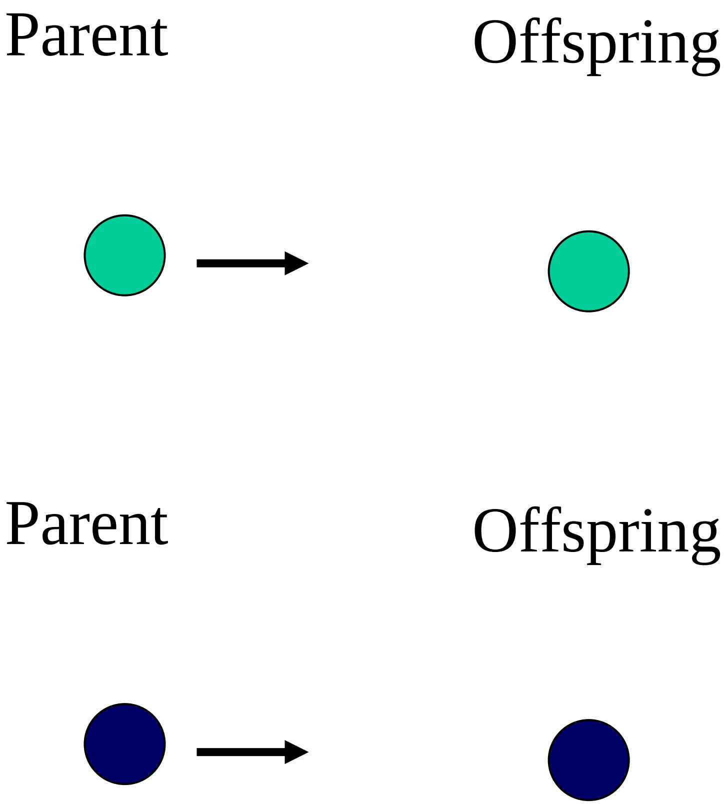
More offspring are born than can survive to reproduce



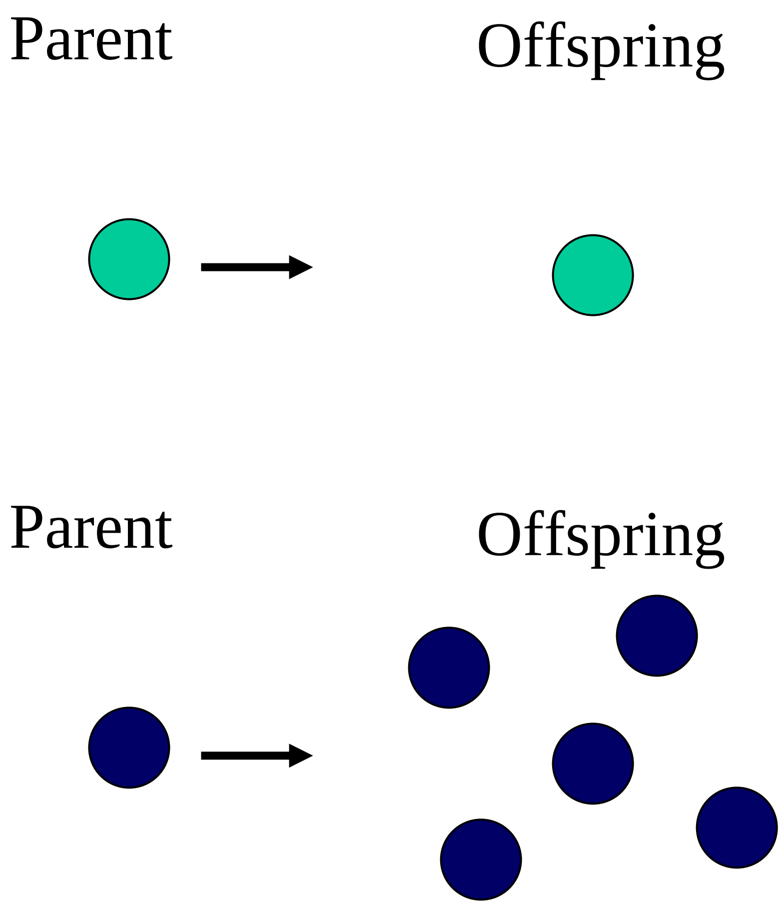
Individuals within a species vary



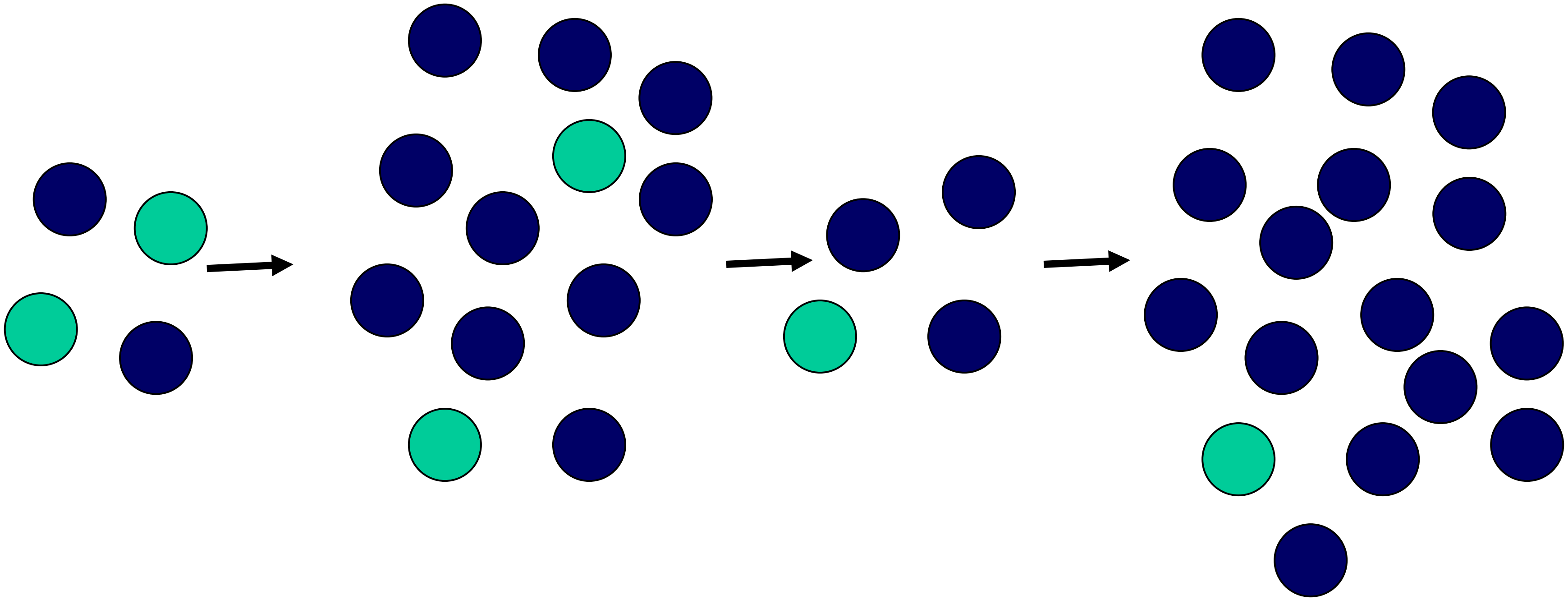
Traits are heritable



Individuals with some traits reproduce more than others



Traits that enhance reproduction become more common each generation



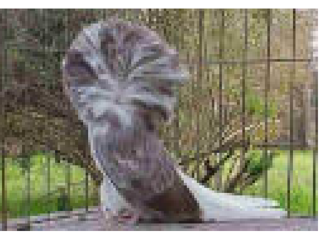
parents generation 1

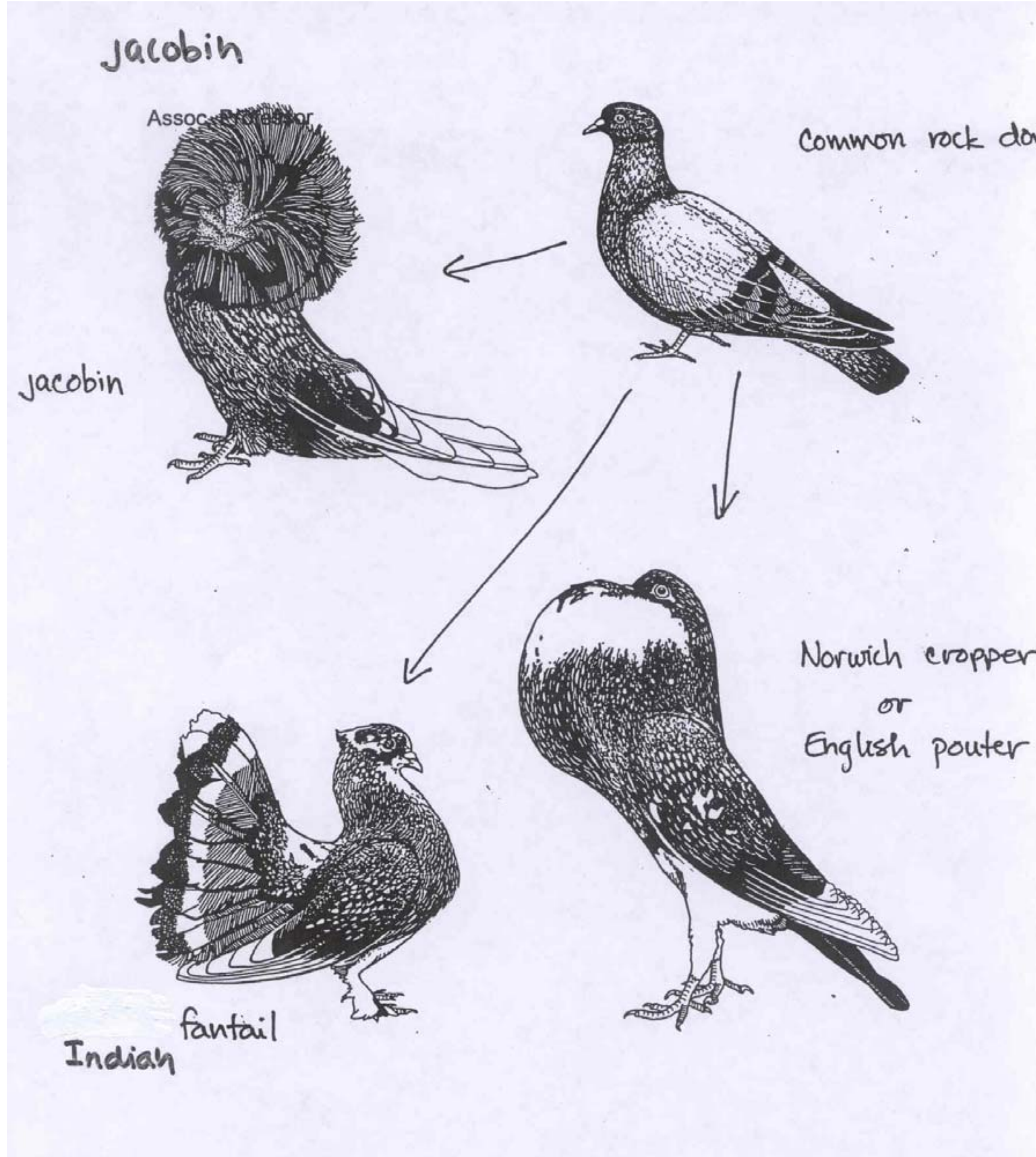
offspring generation 1

parents generation 2

offspring generation 2

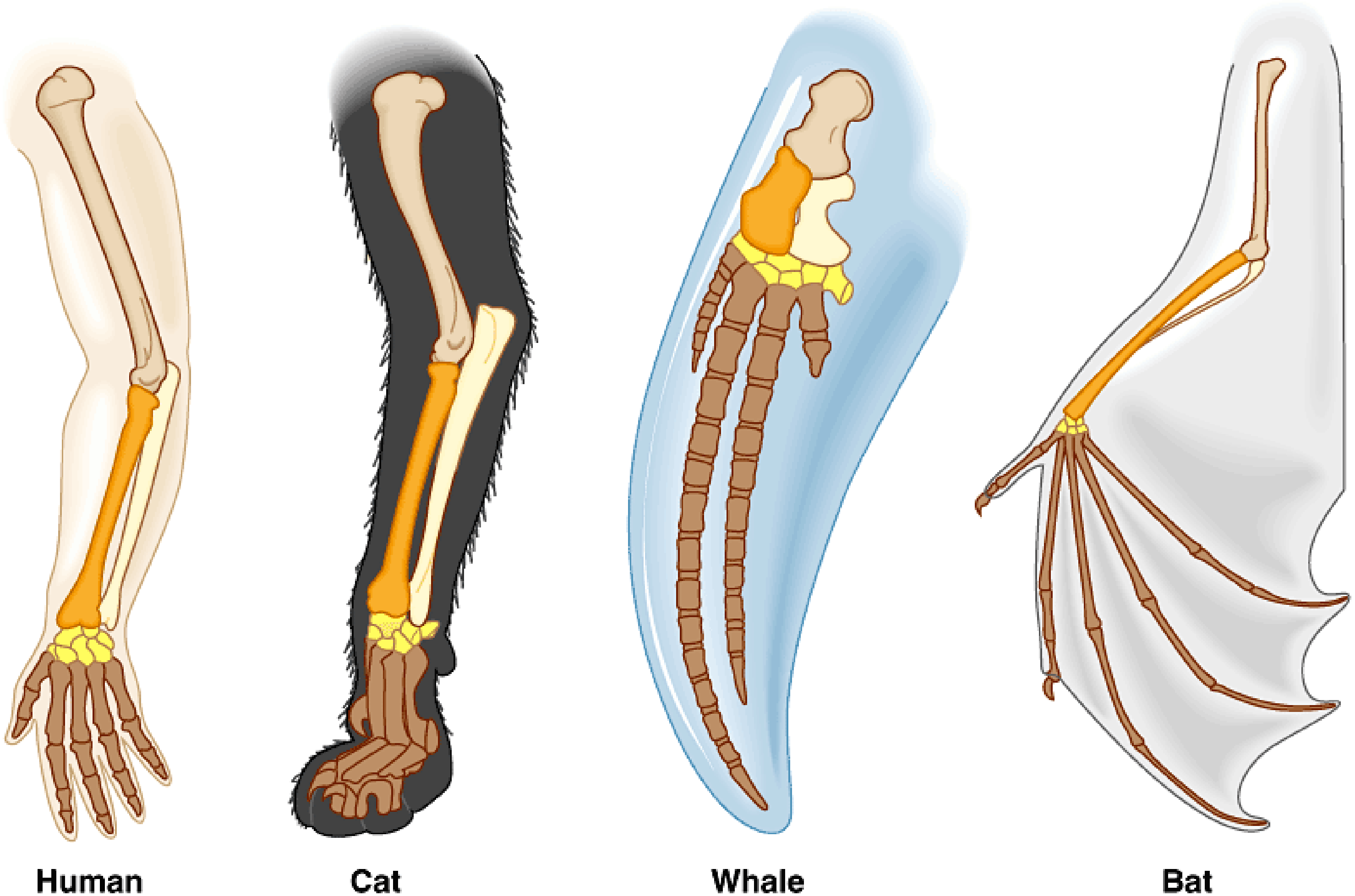
Artificial selection has produced different, true-breeding varieties of “fancy” pigeons from a single ancestral form



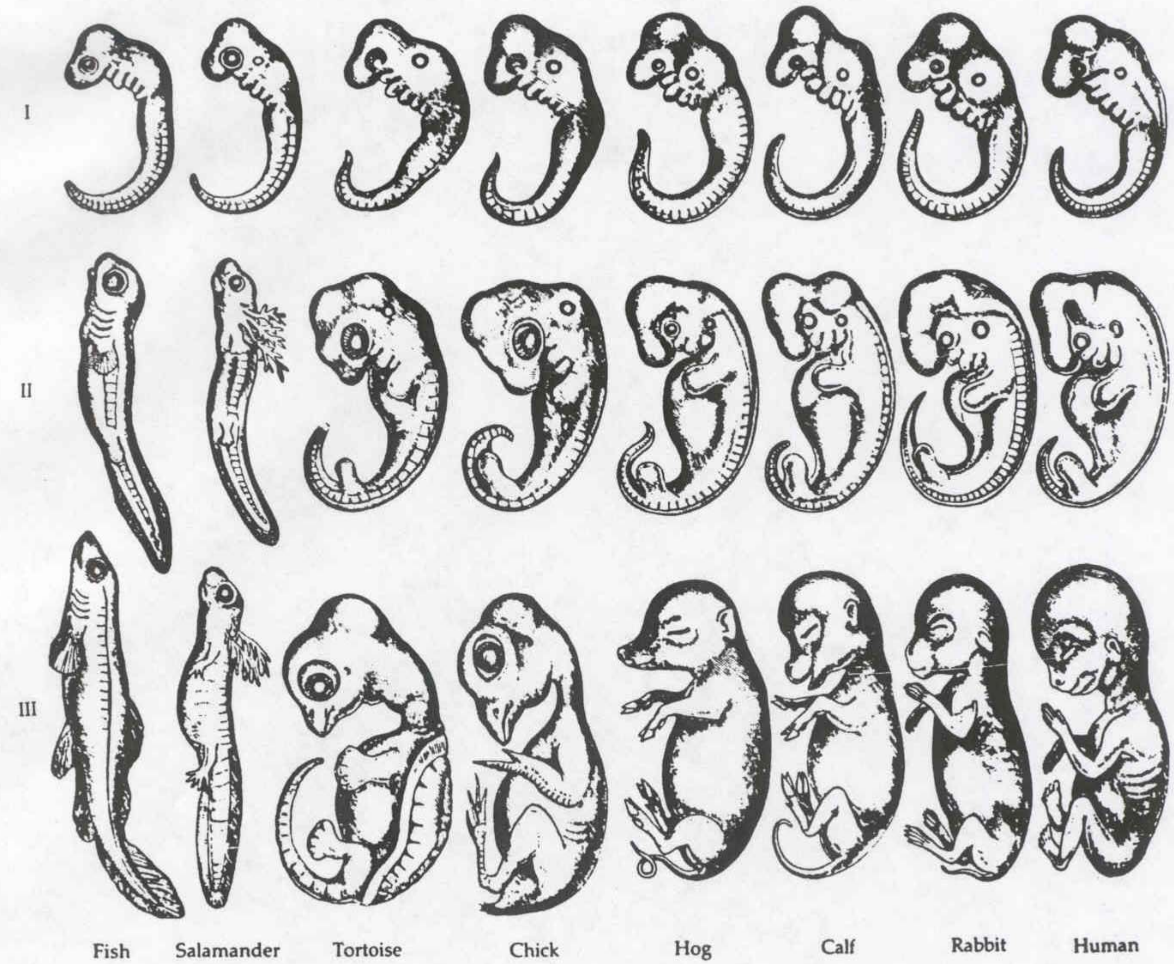


Fossils - preserved evidence of previously living things

Homology - similarity caused by common ancestry



Homology in early embryonic form



Early embryos of diverse groups share many features. As development proceeds, embryonic forms diverge and become more similar to adults of their own species (von Baer’s law)

The Paradox of Variation:

Evolution requires natural selection, but natural selection eliminates variation.

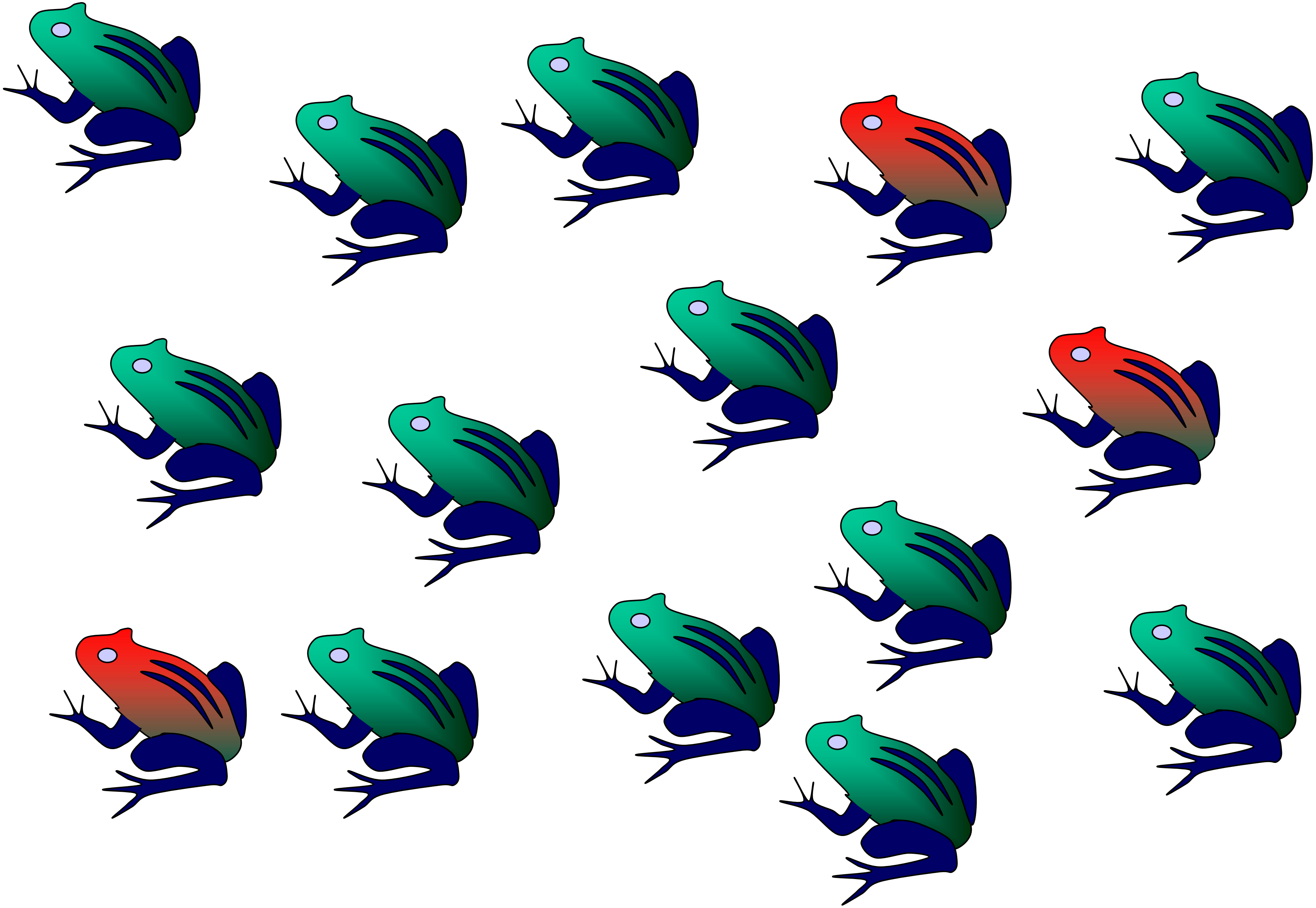
The Hardy-Weinberg equilibrium

"A fundamental principle in population genetics stating that the genotype frequencies and gene frequencies of a large, randomly mating population remain constant provided immigration, mutation, and selection do not take place." *American Heritage Dictionary*

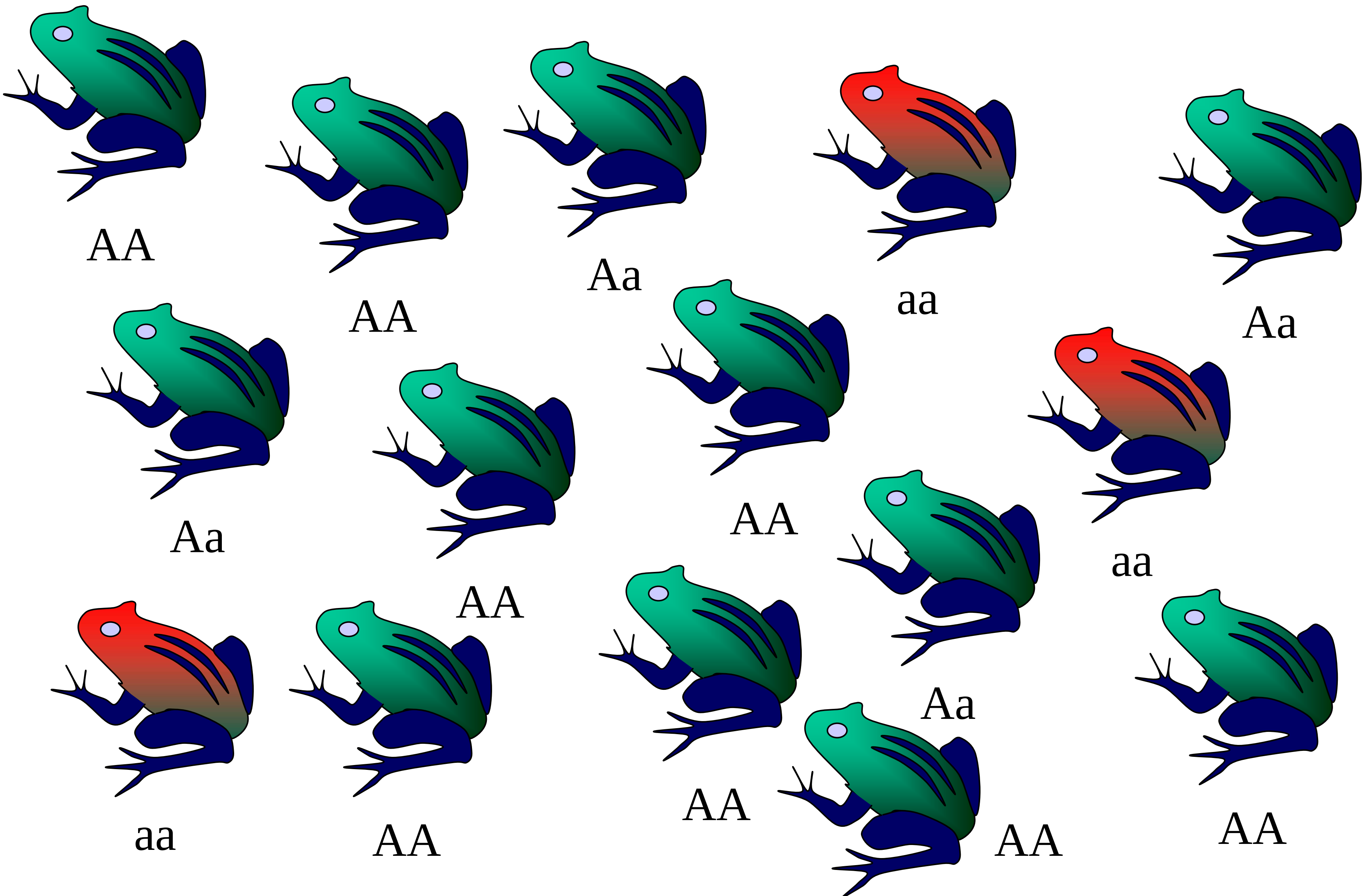
Godfrey Harold Hardy
1877-1947

Wilhelm Weinberg
1862-1937

A population: Phenotype frequencies 1/3 red and 2/3 green



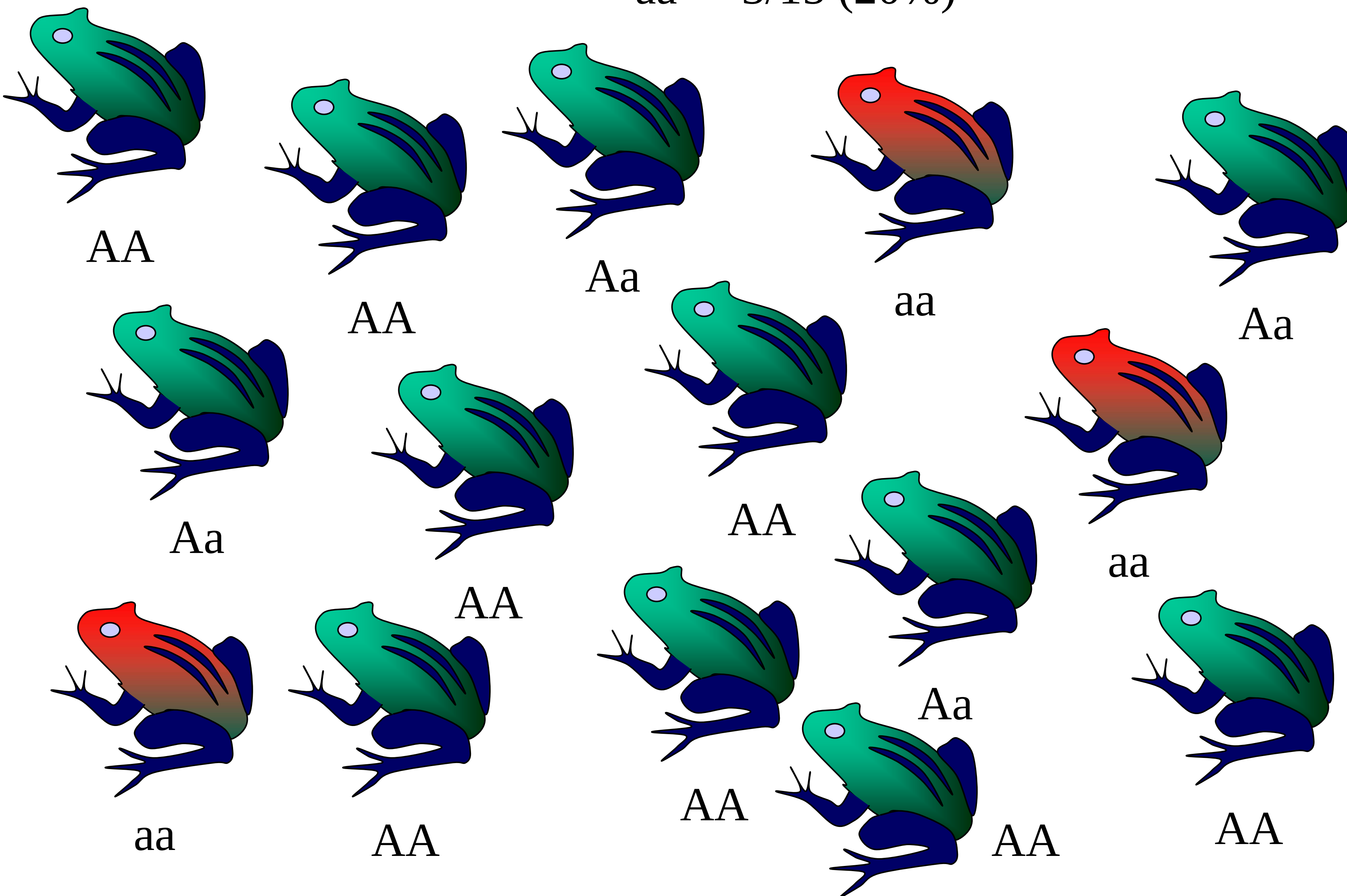
A population has a frequency of genotypes



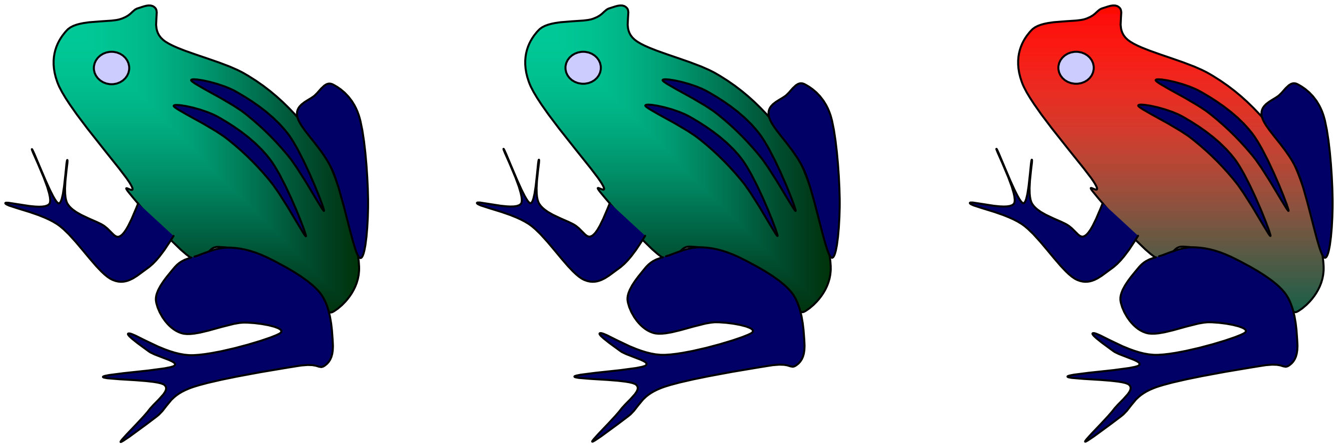
Total number = 15, frequency of AA = 8/15 (53%)

Aa = 4/15 (27%)

aa = 3/15 (20%)



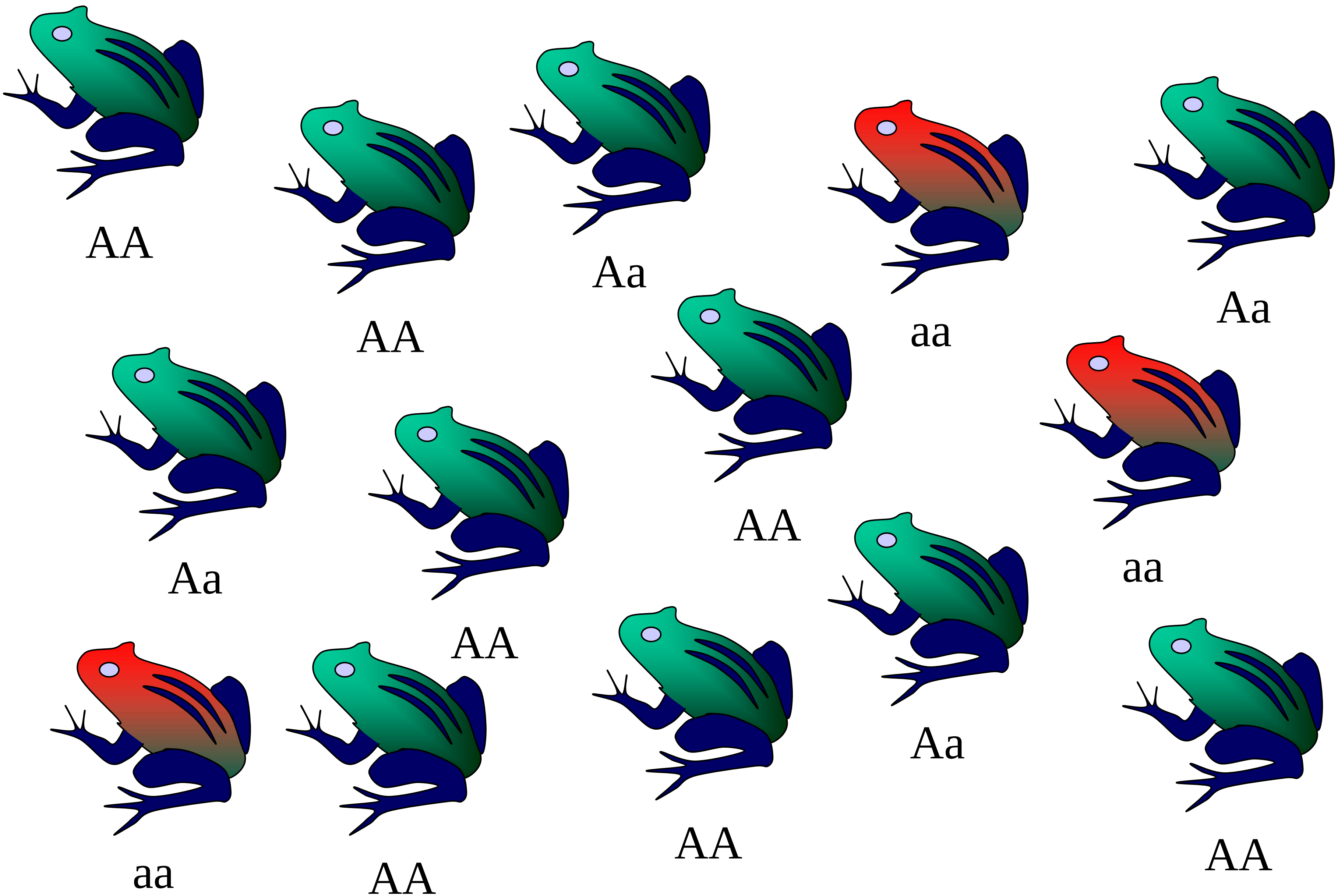
Individuals have 2 alleles for each gene



AA Aa aa

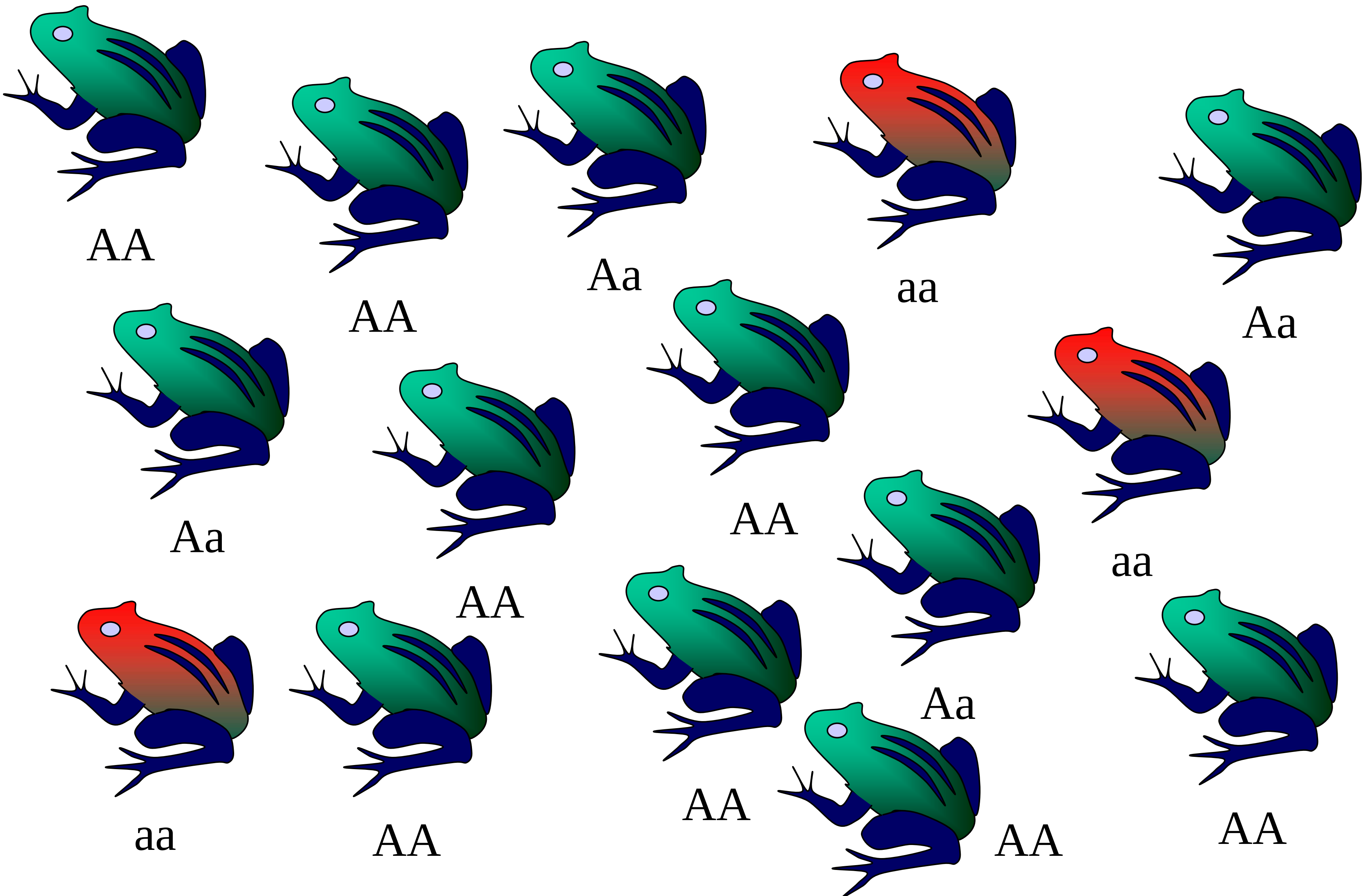
Total number of alleles in the gene pool = 2 x # individuals

A population has a frequency of alleles

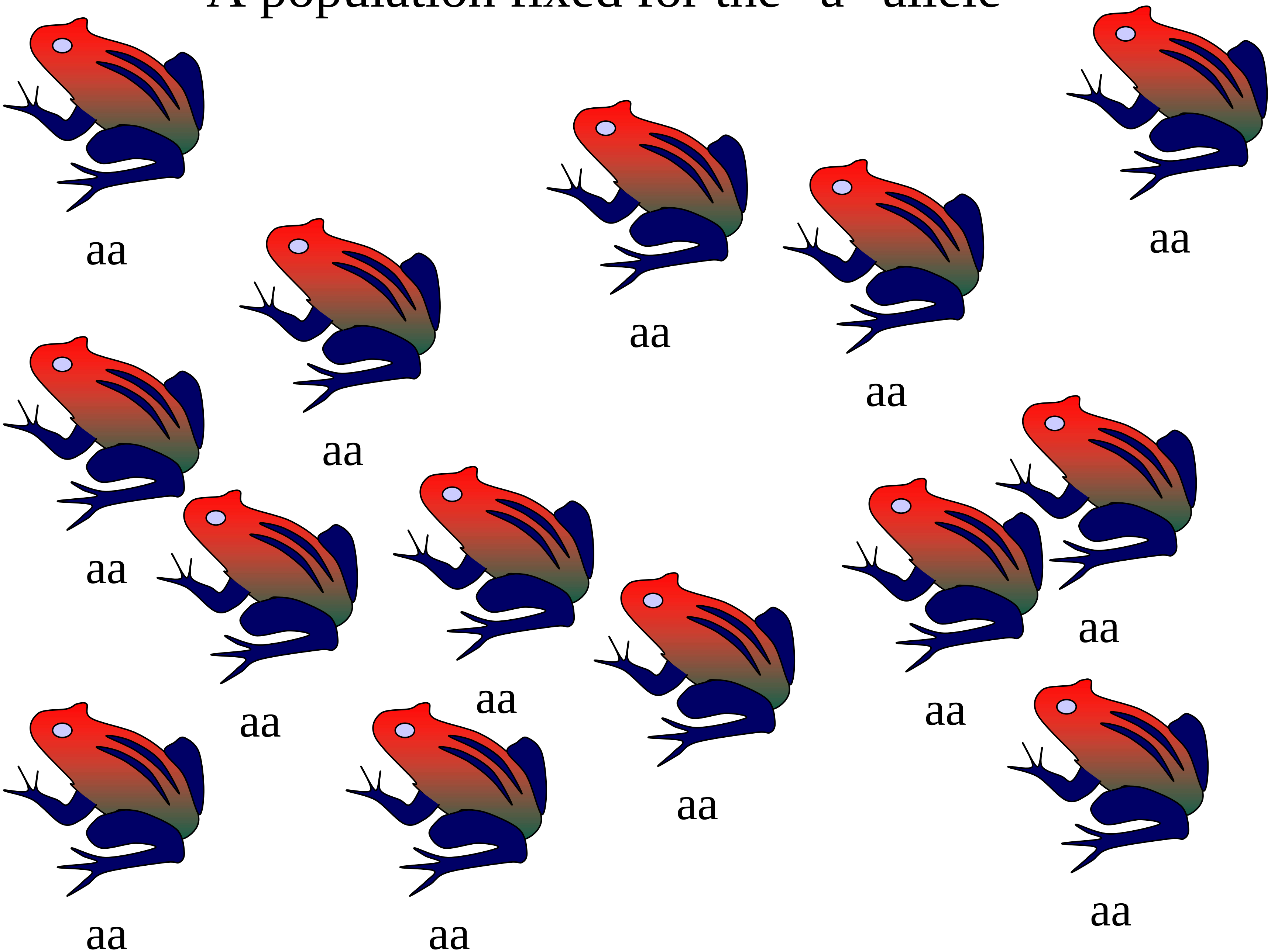


Total number of alleles = 30, frequency of A = 20/30 (67%)

a = 10/30 (33%)



A population fixed for the “a” allele



A population with genetic variation

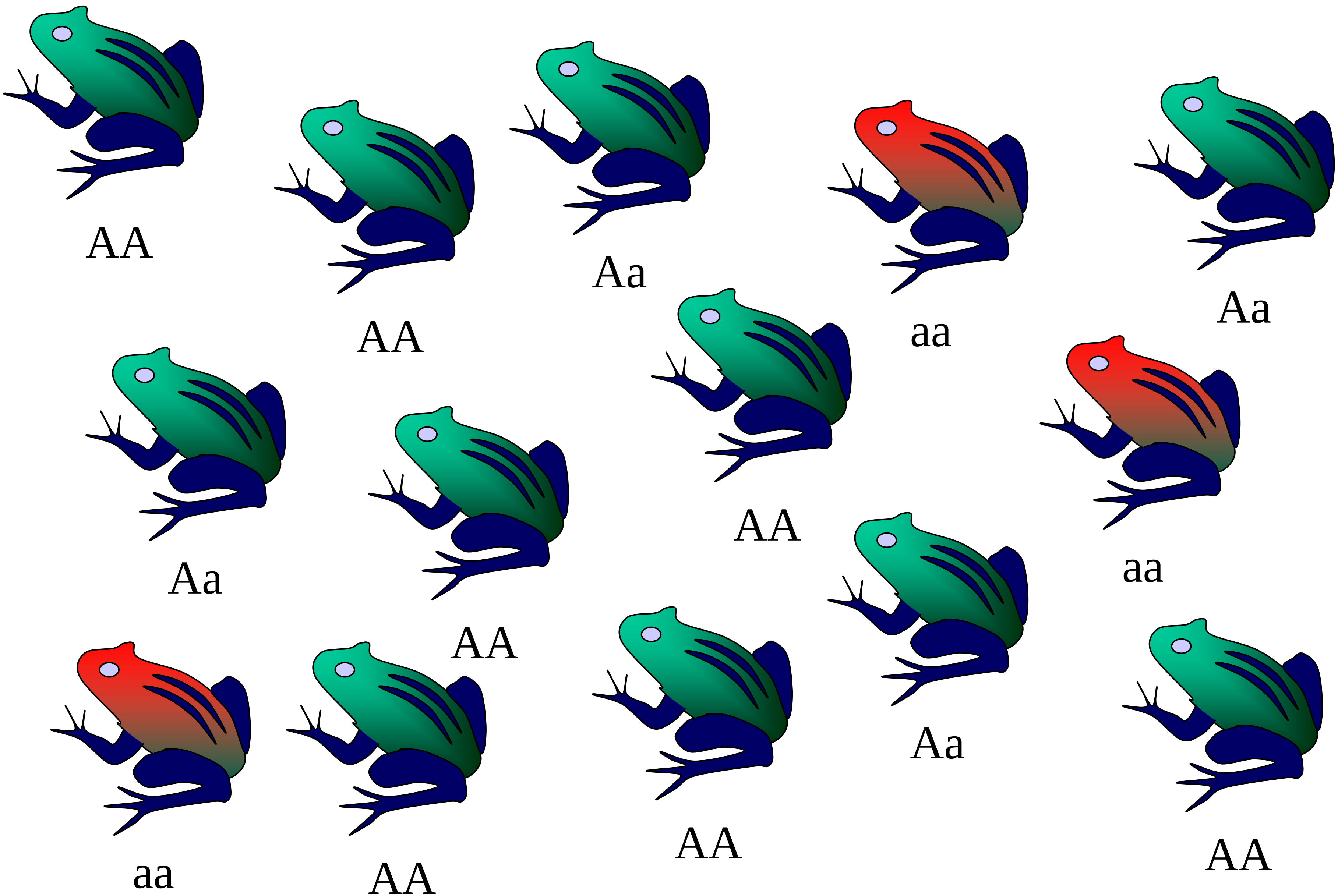


Fig 23.3a

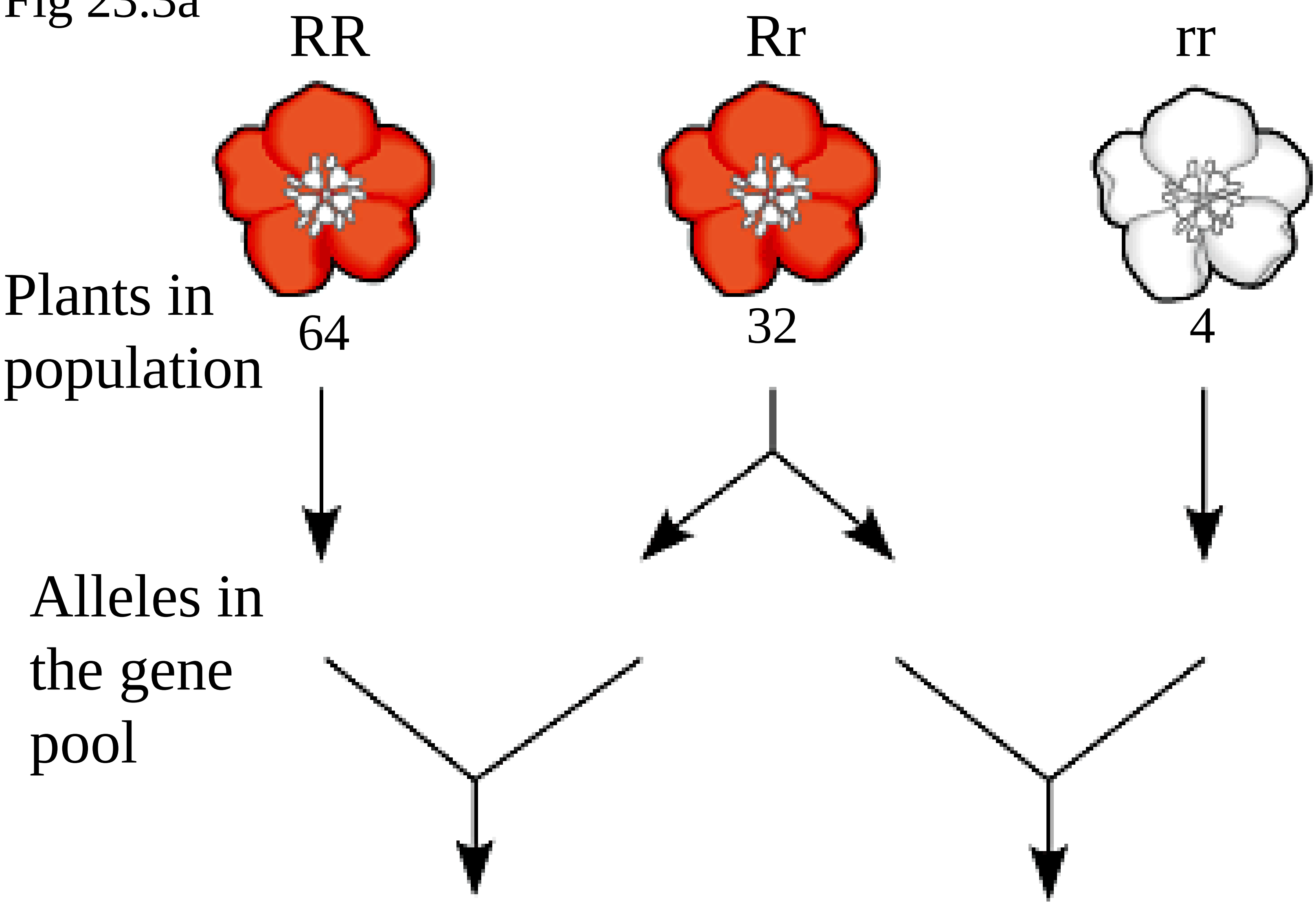
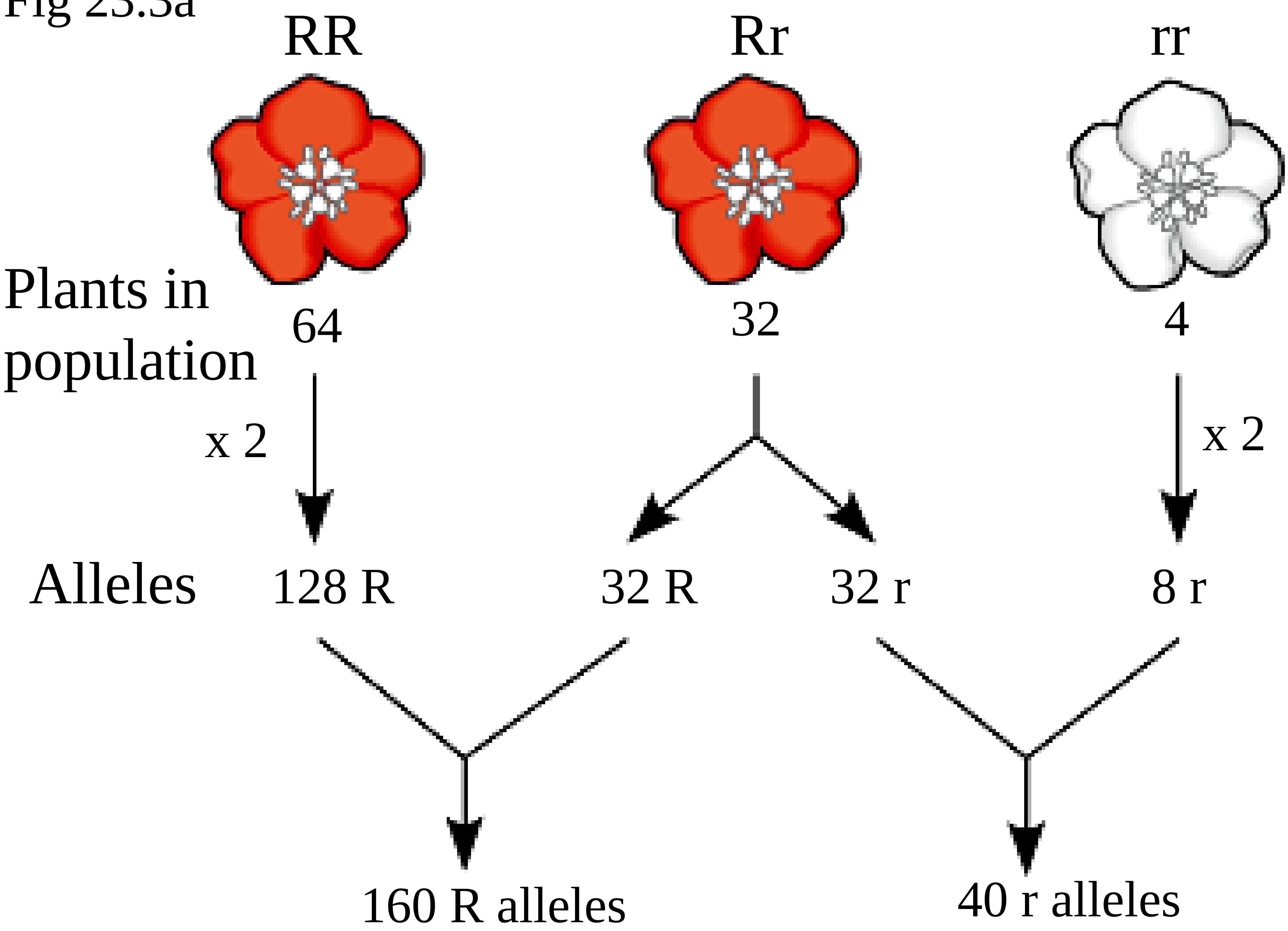
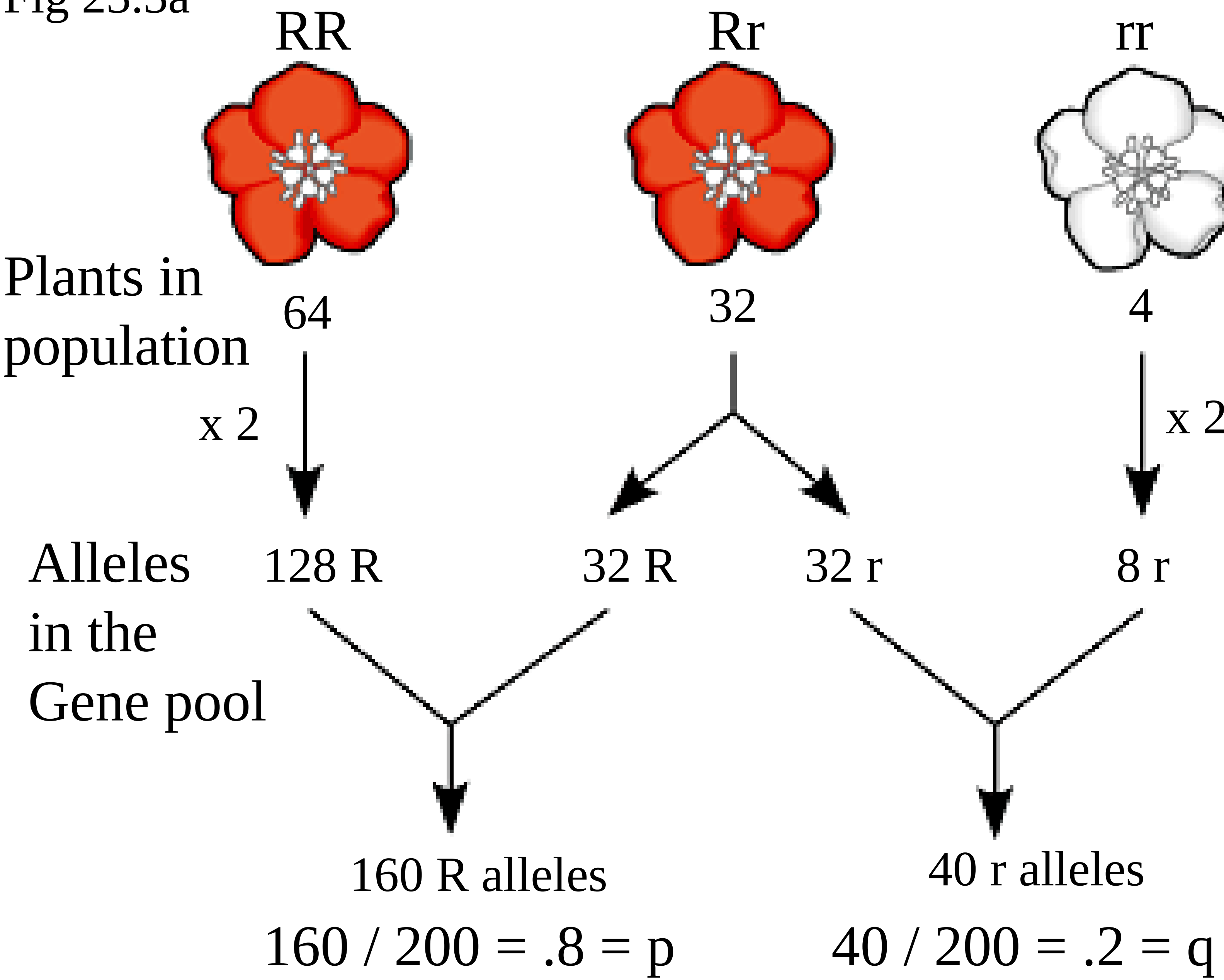


Fig 23.3a



RR
Rr
rr
Plants in population
64
32
4
x 2
x 2
Alleles
128 R
32 R
32 r
8 r
160 R alleles
40 r alleles

Fig 23.3a


RR
Rr
rr
Plants in population
64
32
4
x 2
x 2
Alleles in the Gene pool
128 R
32 R
32 r
8 r
160 R alleles
40 r alleles
160 / 200 = .8 = p
40 / 200 = .2 = q

What is the probability of an offspring with the genotype RR
In the next generation?

Probability of observing event 1 AND event 2 =
the product of their probabilities.

$$160 / 200 = .8 = p$$

$$40 / 200 = .2 = q$$

P[2 R alleles from 2 gametes]?

Probability of each R = .8
Probability of RR = .8 x .8 = .64

$$= p \times p = \mathbf{p^2}$$

What is the probability of an offspring with the genotype rr
In the next generation?

Probability of observing event 1 AND event 2 =
the product of their probabilities.

$160 / 200 = .8 = p$

$40 / 200 = .2 = q$

Pr: 2 r alleles from 2 gametes?

Probability of each r = .2
Probability of rr = .2 x .2 = .04
= q x q = $\mathbf{q^2}$

What is the probability of an offspring with the genotype Rr
In the next generation?

$$160 / 200 = .8 = p$$

$$40 / 200 = .2 = q$$

Pr: one r and one R from 2 gametes?

P[r and R] or P[R and r]
= (.2 x .8) + (.8 x .2) = .32
= (p x q) + (p x q) = **2pq**

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

Frequency of RR

Frequency of Rr

Frequency of rr

Fig 23.3b

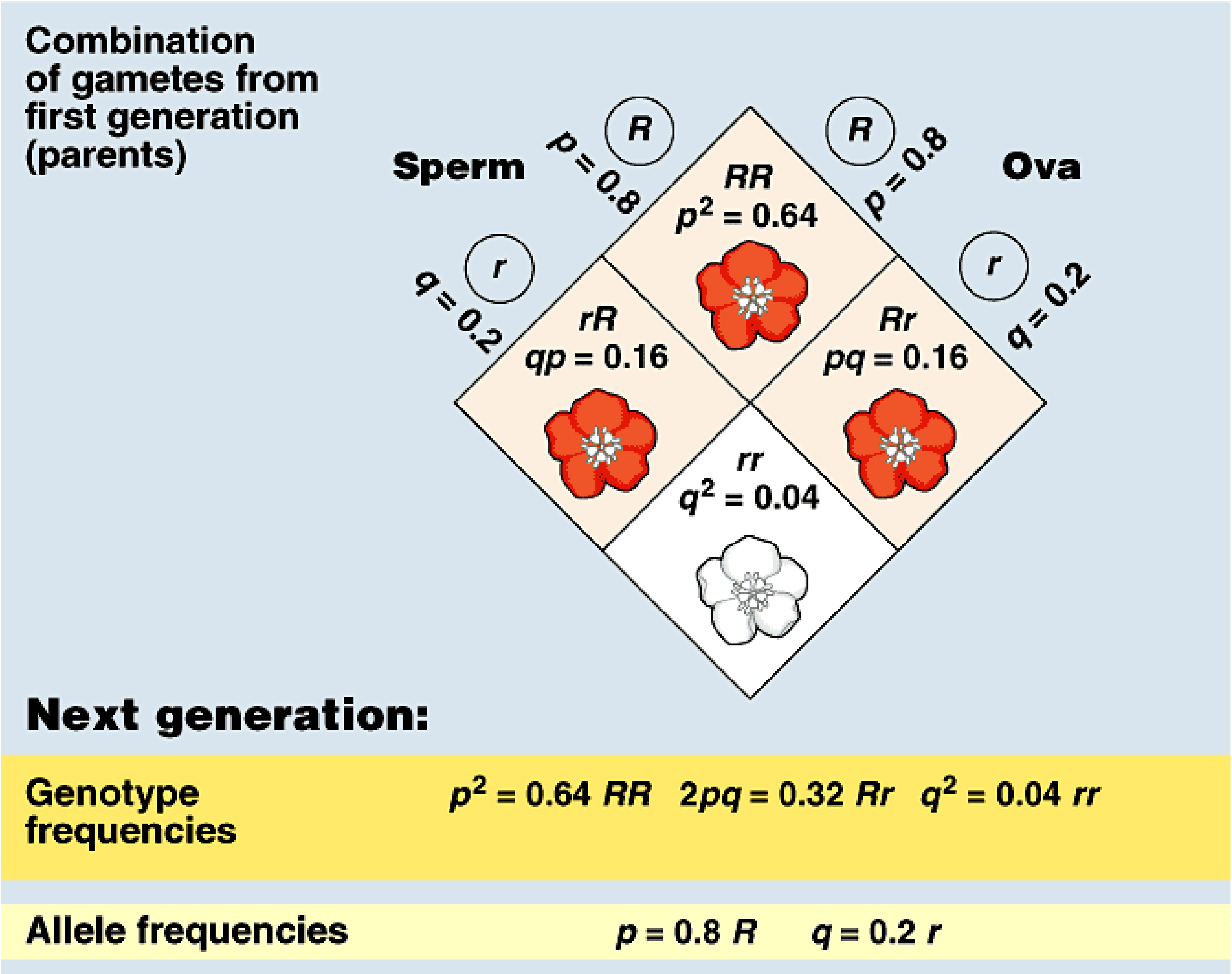
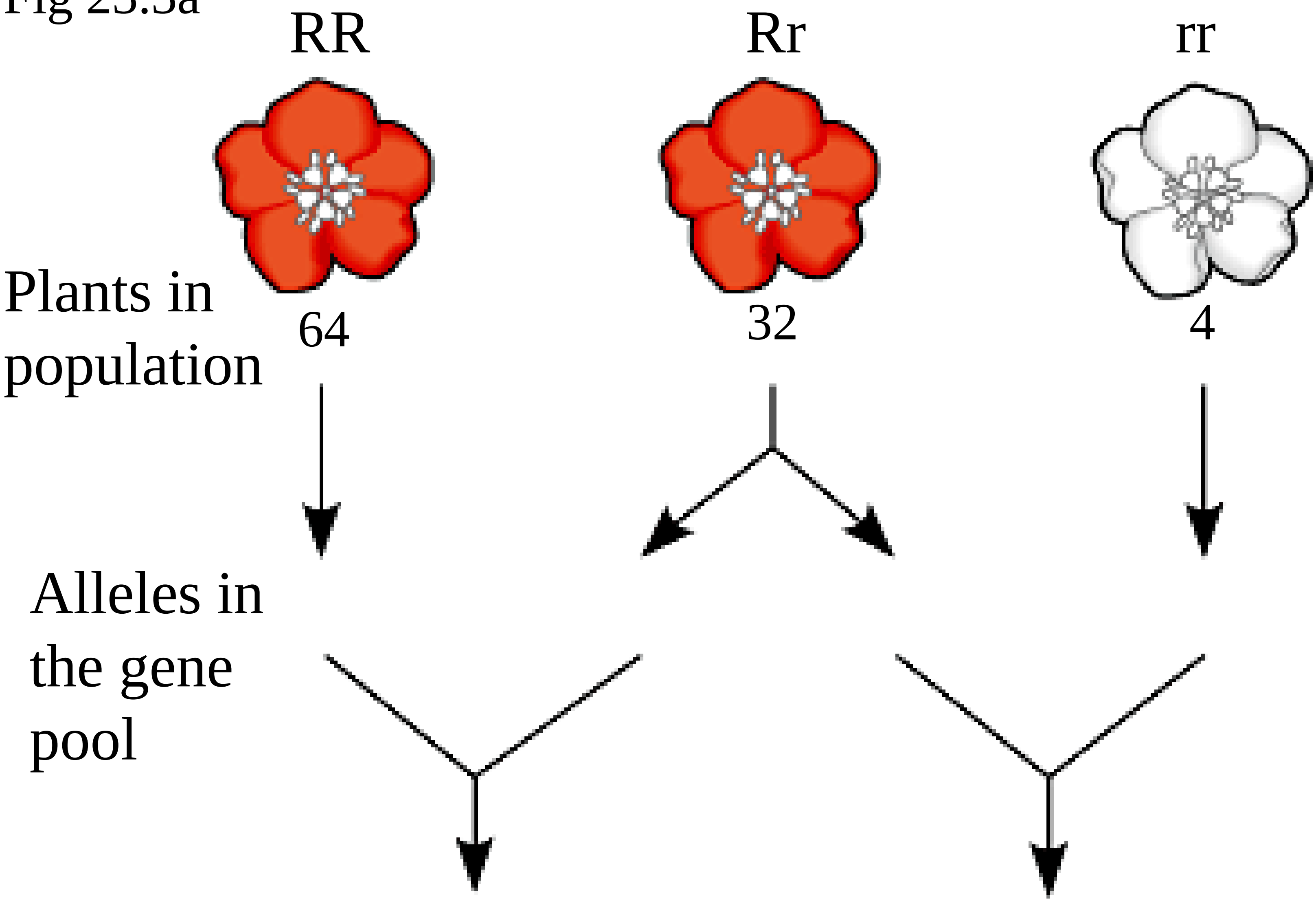

Combination of gametes from first generation (parents)
Sperm
Ova
R
$p = 0.8$
r
$q = 0.2$
R
$p = 0.8$
r
$q = 0.2$
RR
$p^2 = 0.64$
rR
$qp = 0.16$
Rr
$pq = 0.16$
rr
$q^2 = 0.04$
Next generation:
Genotype frequencies
$p^2 = 0.64$ RR $2pq = 0.32$ Rr $q^2 = 0.04$ rr
Allele frequencies
$p = 0.8$ R $q = 0.2$ r

Fig 23.3a



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