

Population genetics 族群遺傳

Population genetics is the study of how genetic principles apply to interbreeding groups (populations).



Phenotype表現型：一個生物體可觀測的性狀。

Genotype基因型：特定組織中相關的一個或幾個基因組成。

Gene基因：遺傳的基本單位。

Gene pool基因庫：一個群體的基因總和。

Population genetics族群（群體）遺傳學：在群體的水平上對基因頻率、基因型、表現型和交配系統的研究。



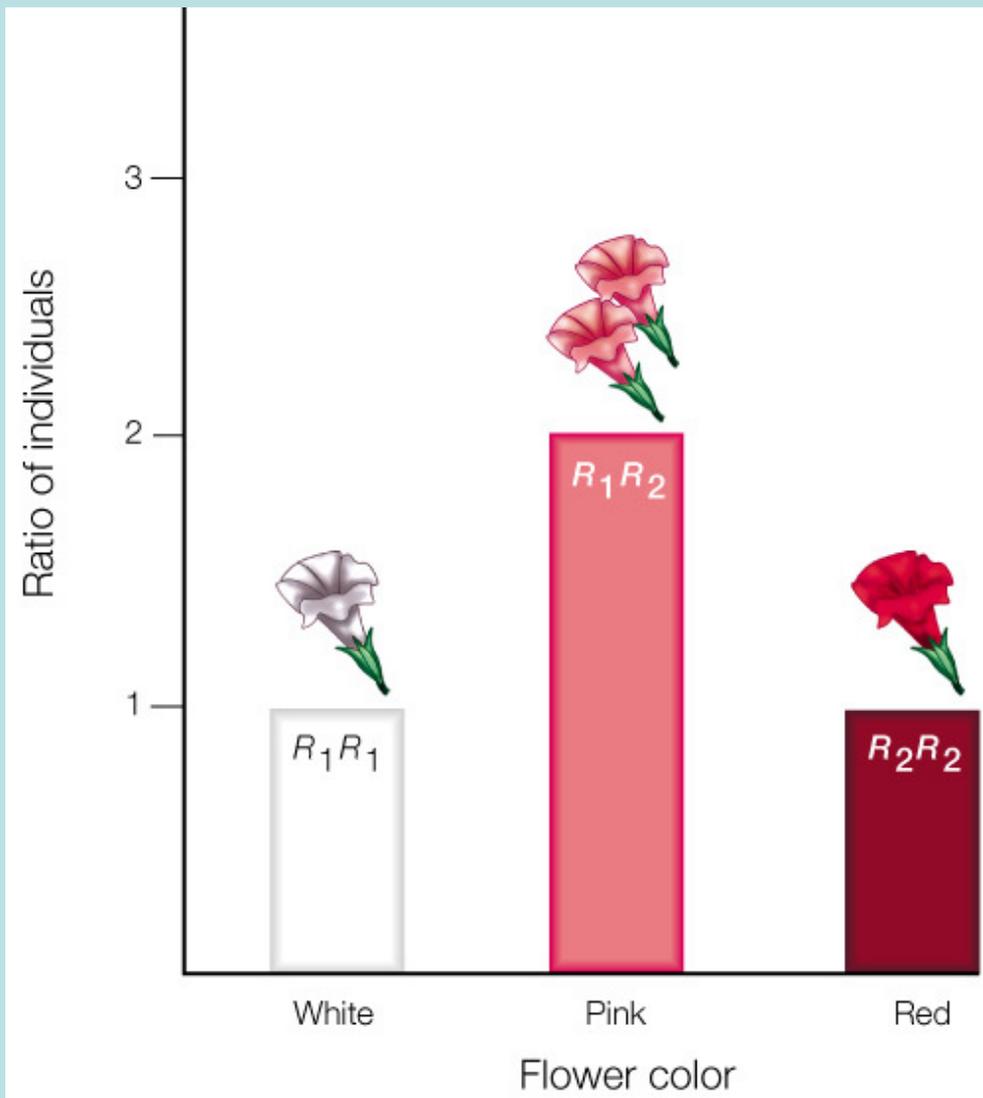


Figure 8-2

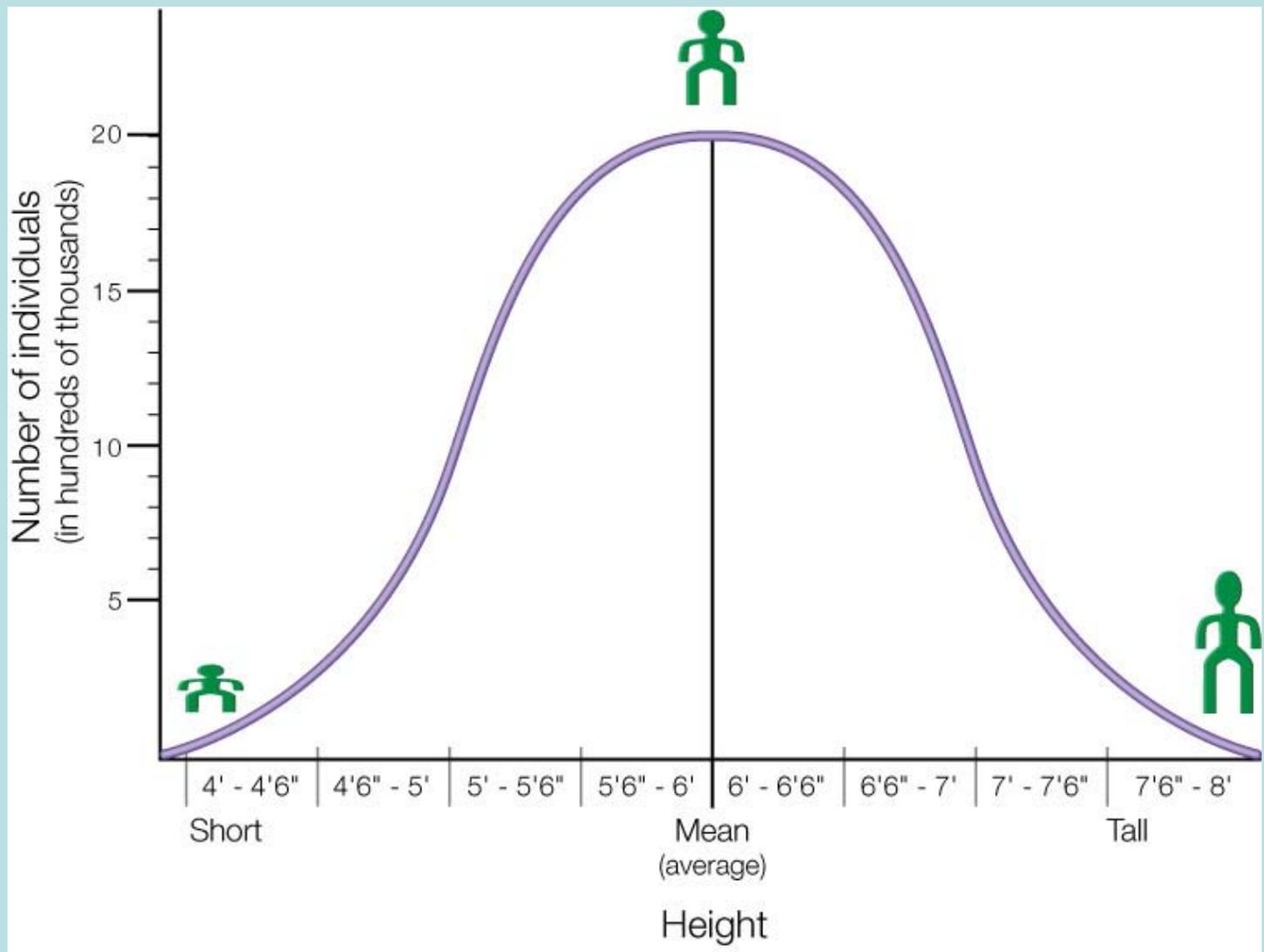


Figure 8-3

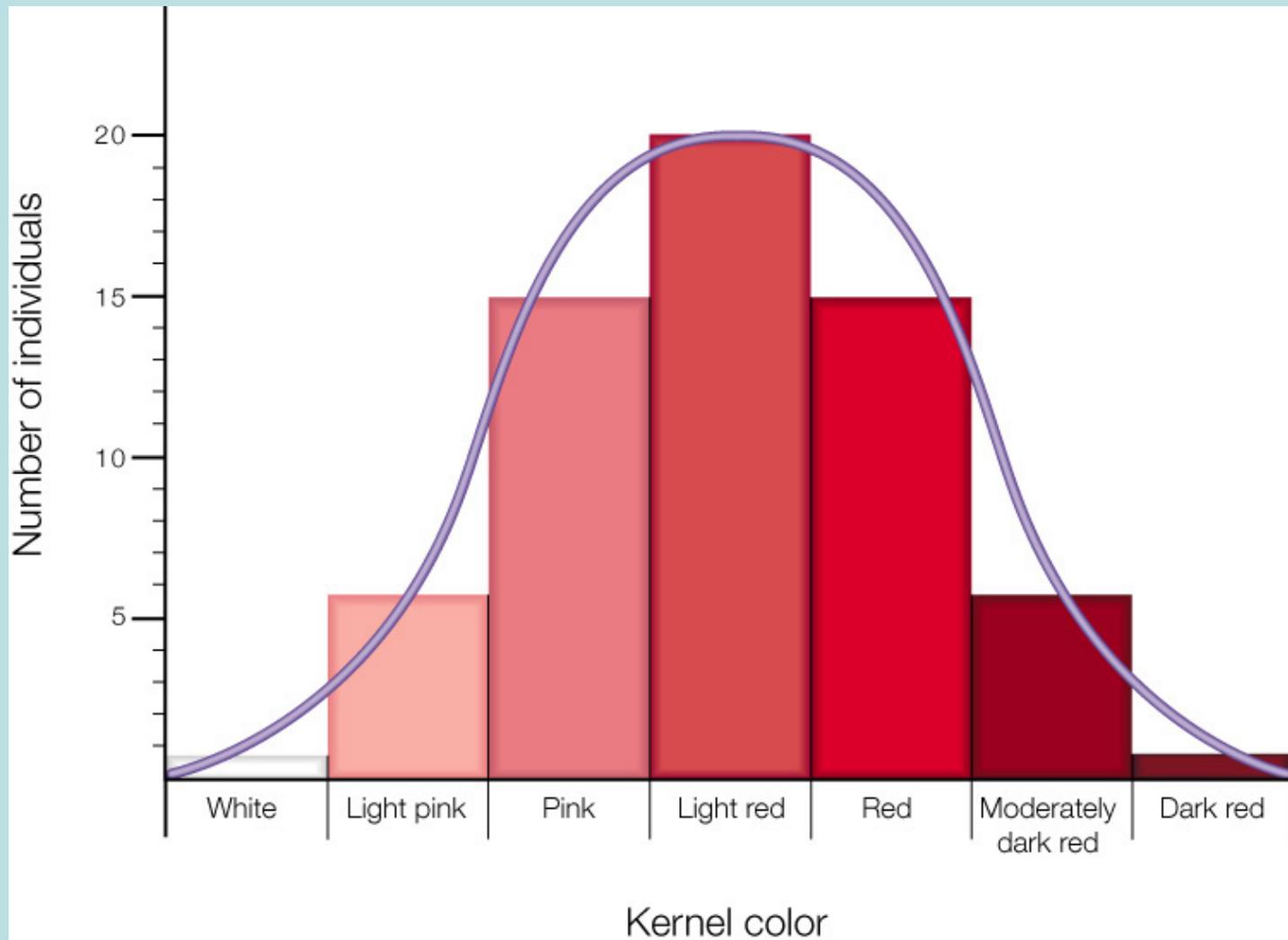


Figure 8-4

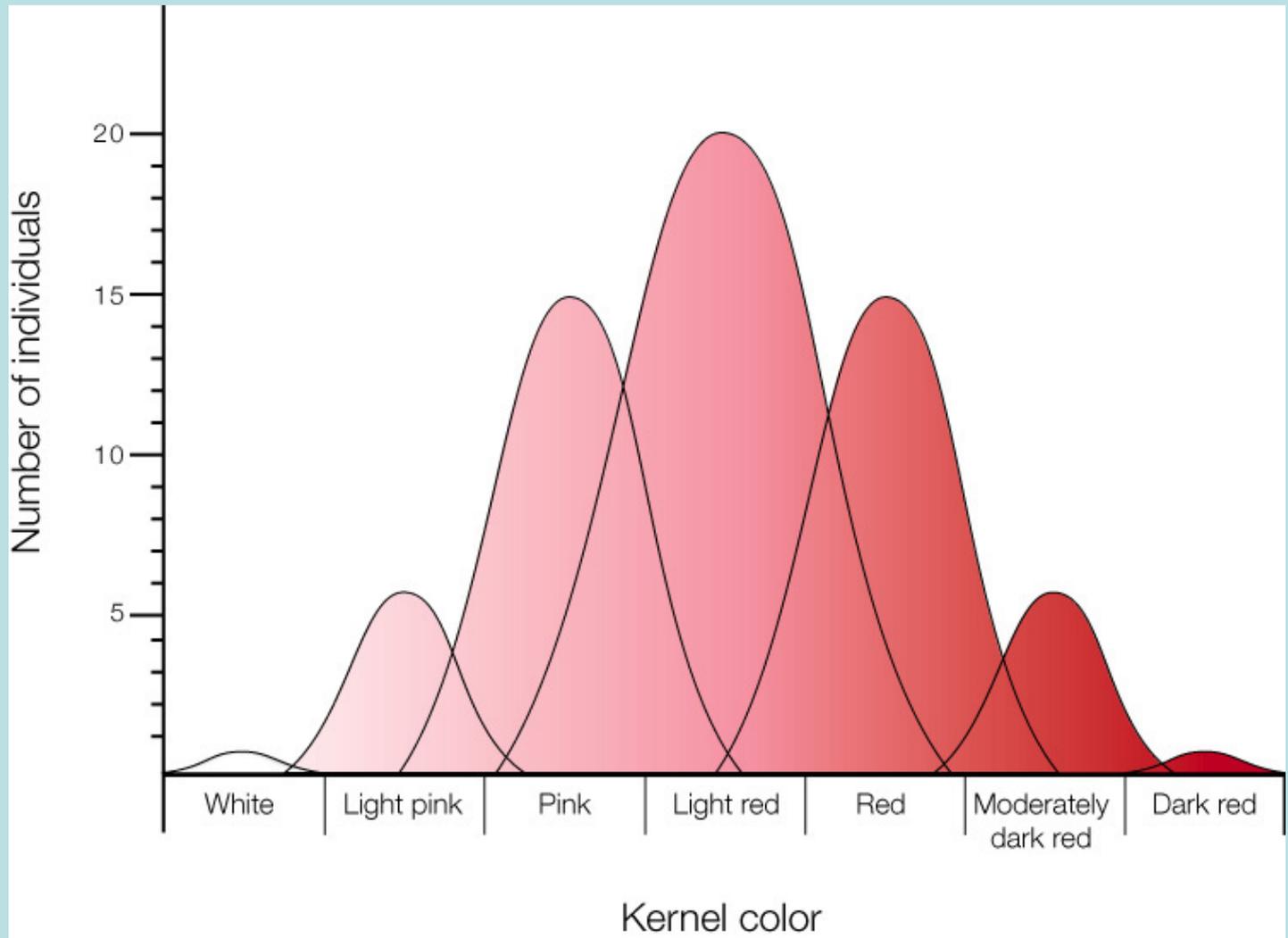


Figure 8-5

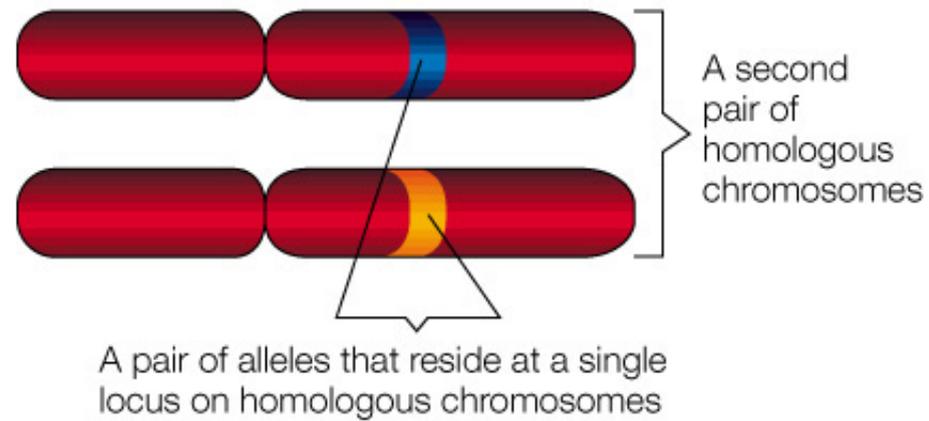
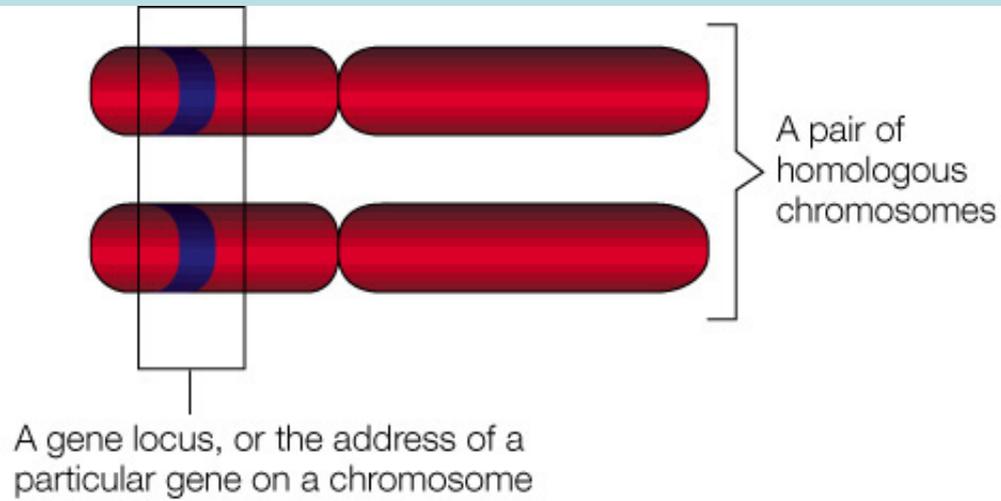


Figure 8-6

Allele等位基因：位於同源染色體的同一位點上的一對基因中的一個，或一個基因的多種形式中的一個，又稱為**allelomorph**

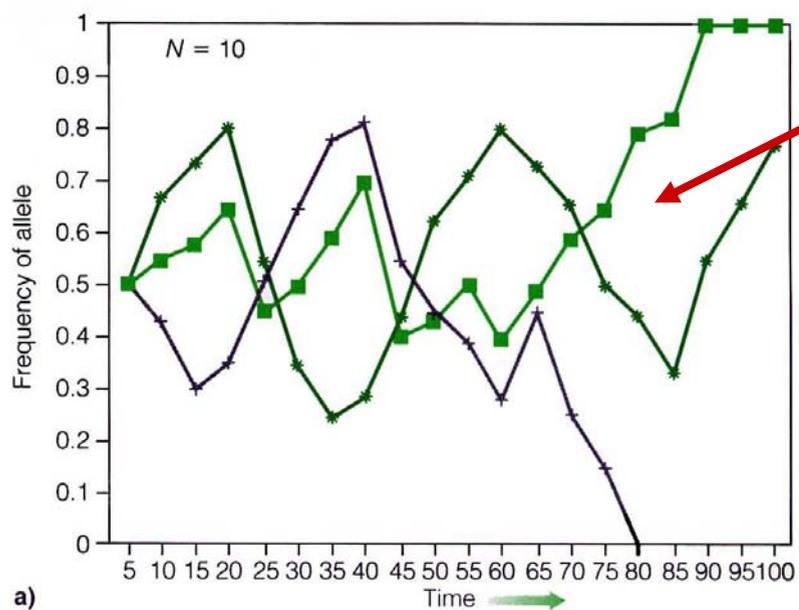
Locus座位：一個基因在一條染色體上的固定位置。

TABLE 2.1**Conditions and Violations of the Hardy–Weinberg Equation**

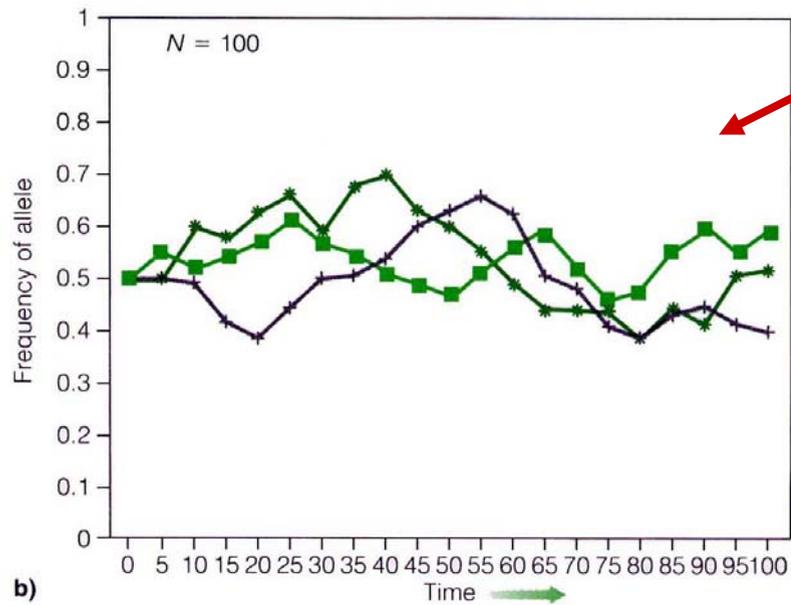
Condition for Hardy–Weinberg Equilibrium	Corresponding Mechanism of Evolution If Violated
Infinitely large population	Genetic drift
No net immigration or emigration of alleles	Gene flow
No differential mortality or survival by genotype	Natural selection
No new mutations	Mutation pressure

The mechanism of evolution

1. Genetic drift 遺傳漂變
2. Gene flow 基因流動
3. Mutation 突變
4. Nonrandom mating 非隨機配對
5. Natural selection 自然選擇

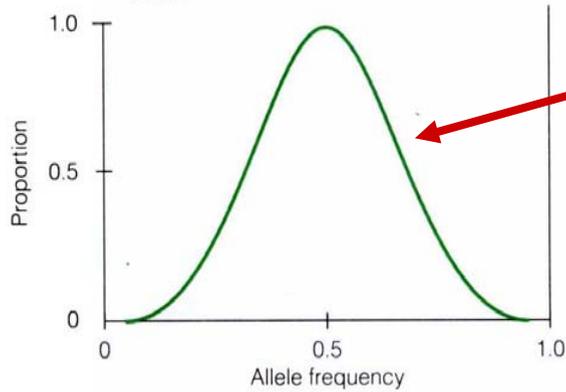


Small population



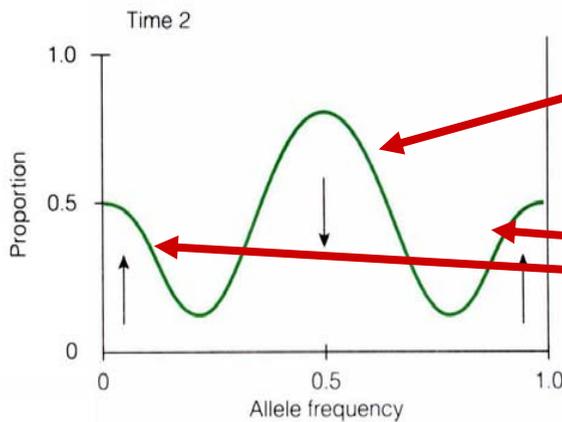
large population

FIGURE 2.2 Examples of changes over time in allele frequency resulting from genetic drift. Each line plots allele frequency for a different population of the same species. (a) Populations containing 10 individuals; (b) populations containing 100 individuals. Note that the fluctuations in allele frequencies are more extreme in the smaller populations than in the larger populations.



Allele frequencies

a)



Allele frequencies lost

Allele frequencies increase

b)

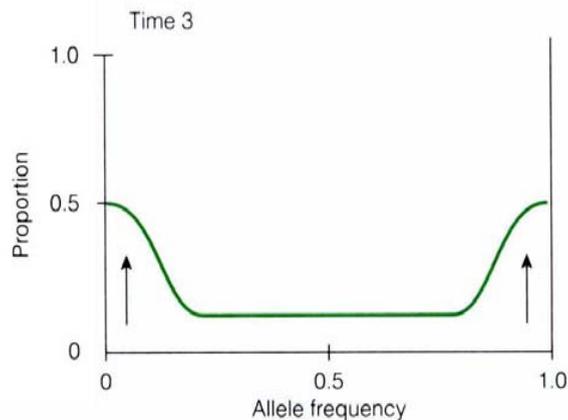


FIGURE 2.3 Changes over time in allele frequency distributions as a result of genetic drift. Each graph represents several populations simultaneously undergoing drift. (a) At time 1, the populations have a normal distribution of allele frequencies. (b) As time passes, drift causes loss or increase of alleles, (c) eventually resulting in a bimodal distribution in which populations with allele frequencies of either 1.0 or 0 predominate.

1. Genetic drift 遺傳漂變:

在一個小群體內，基因頻率從一個世代到下一個世代的隨機變動。

- . Bottleneck effect (瓶頸效應)
- . Founder effect (創造者效應)

2. Gene flow 基因流動:

通過雜交(hybridization)或回交(back cross)，將一個群體的遺傳特性傳遞給另一個群體基因組。

Backcross回交：

一種F1雜合體與一種P1基因型個體間的雜交。

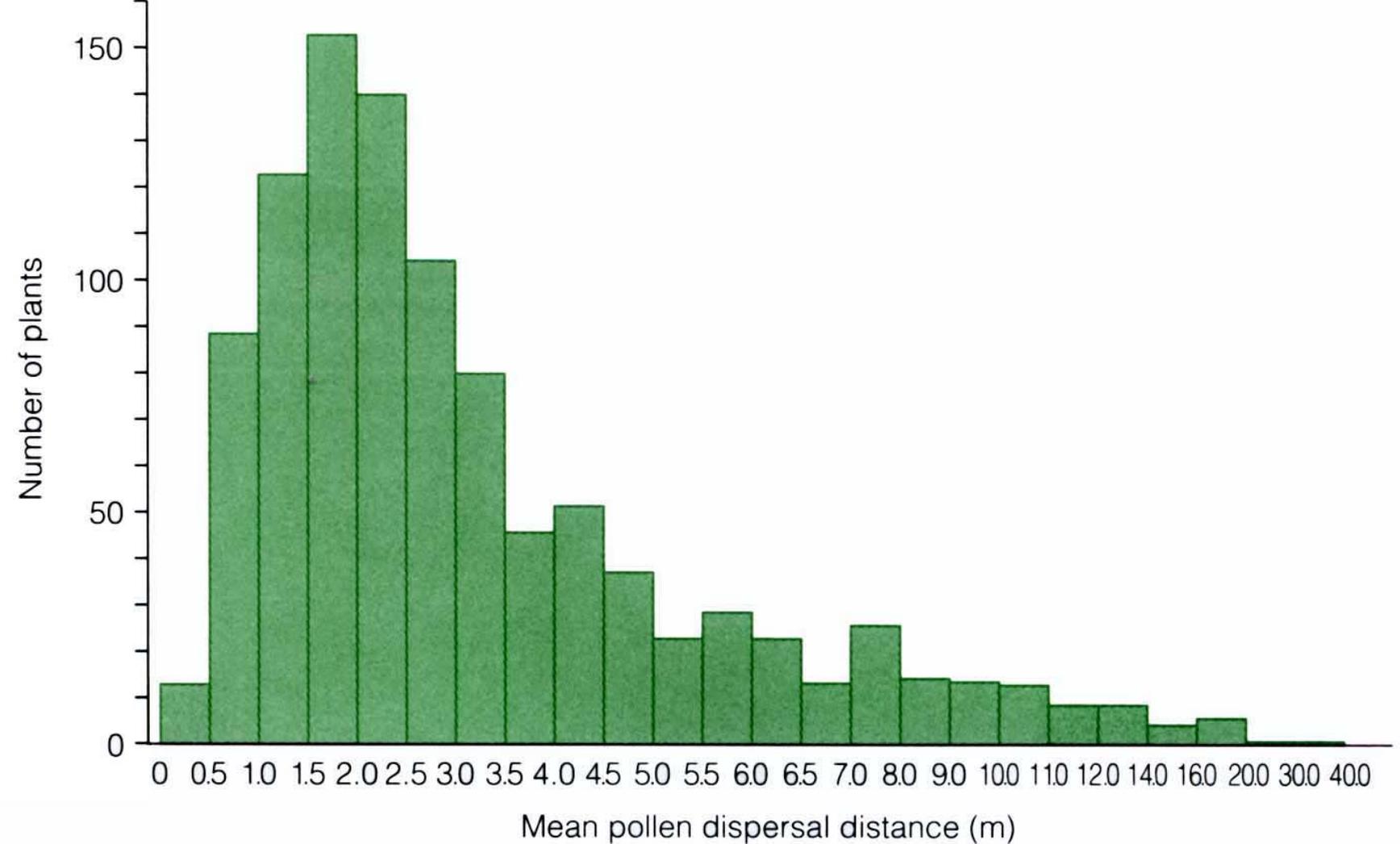


FIGURE 2.4 Mean distances over which bees disperse pollen in the yellow fawn lily, *Erythronium grandiflorum*. Note that the intervals on the horizontal axis are unequal. (From Thomson and Thomson 1989)

3. Mutation突變：

突變比例通常每十萬到一百萬個配子之中只有一個基因座突變的機率。

Random changes：隨機變異。

4. Nonrandom mating 非隨機配對：

個子高矮，膚色，財富

5. Natural selection 自然選擇：

只有那些具有有利變異的後代可以在生存競爭中生存下來，通過以後各代有利變異得到累積，使這樣的後代漸漸與其親代不同。

5. Natural selection 自然選擇：

(1). Stabilizing selection 穩定選擇：

(2). Direction selection 定向選擇：

(3). Disruptive selection 分裂選擇：

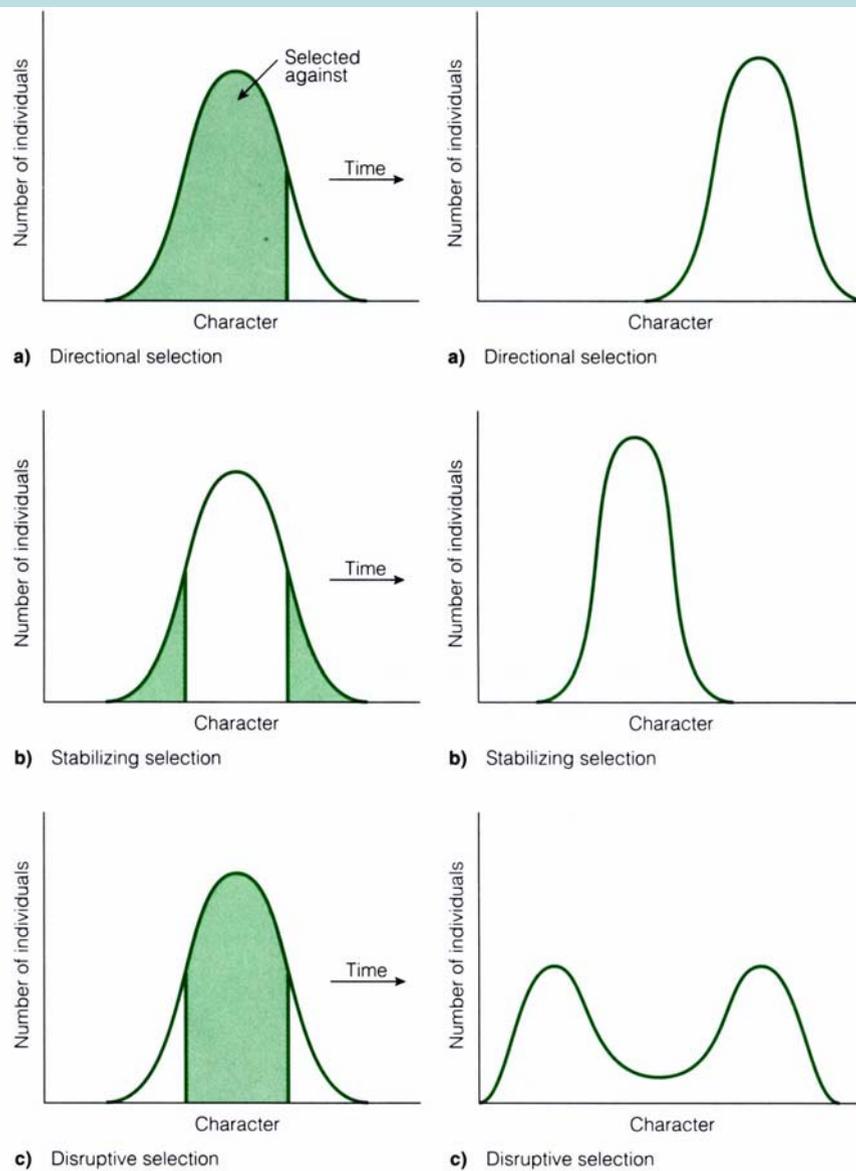


FIGURE 2.7 Changes in phenotypes under three modes of selection. The shaded regions represent phenotypes selected *against*.

(1). Stabilizing selection 穩定選擇：

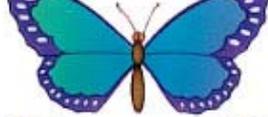
環境條件有利於族群的表現型性狀常態分布線的平均值附近時，對於兩側的極端個體有較高的淘汰率。例如人的出生死亡率和出生重的關係。

(2). Direction selection 定向選擇:

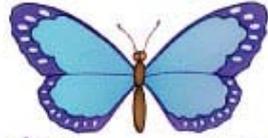
選擇對於一側極端的個體有利，從而使族群的平均值向這一側移動。例如大部分的人工選擇。

(3). Disruptive selection 分裂選擇:

選擇對兩側極端的個體有利，而不利於中間的個體，從而使族群分成兩個部份。



490 AA butterflies
(dark-blue wings)

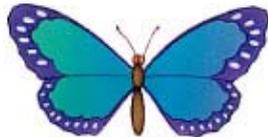


420 Aa butterflies
(medium-blue wings)

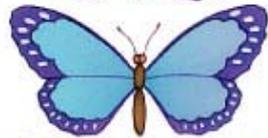


90 aa butterflies
(white wings)

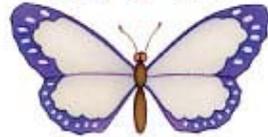
The next generation:



490 AA butterflies



420 Aa butterflies



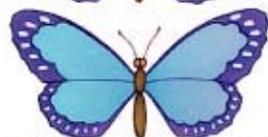
90 aa butterflies

(NO CHANGE)

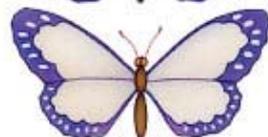
The next generation:



490 AA butterflies

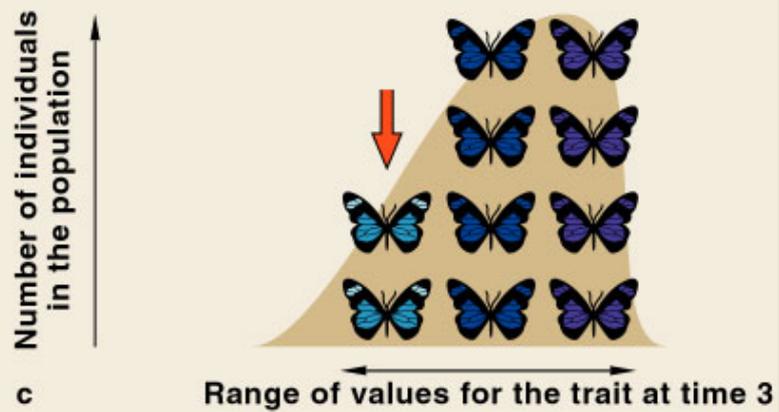
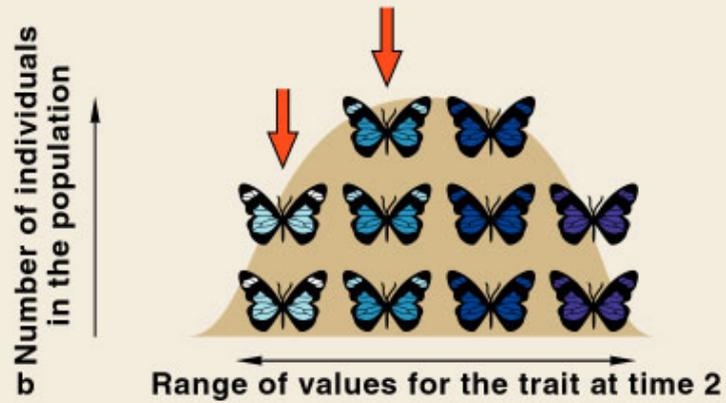
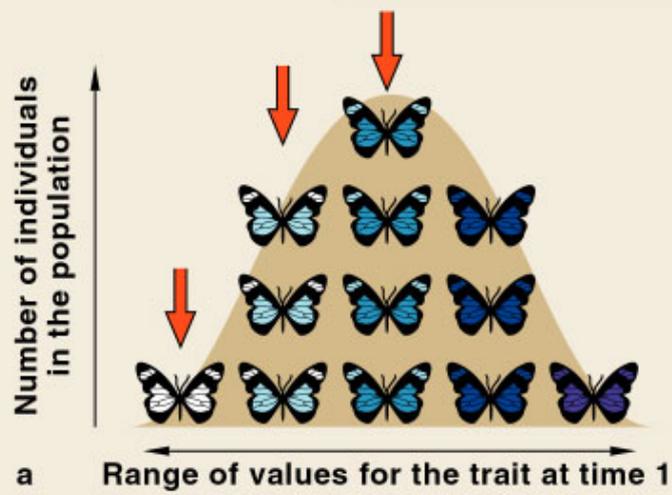


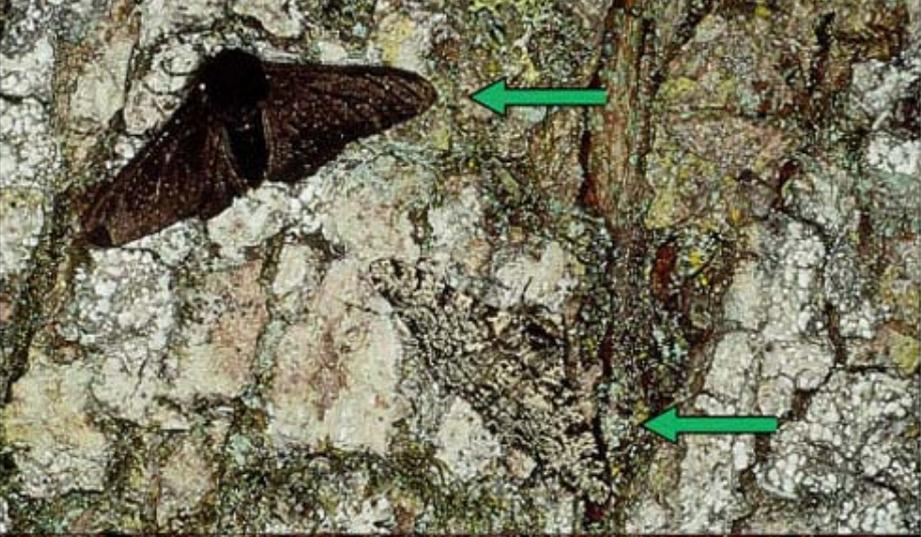
420 Aa butterflies



90 aa butterflies

(NO CHANGE)





a



b



Figure 8-16

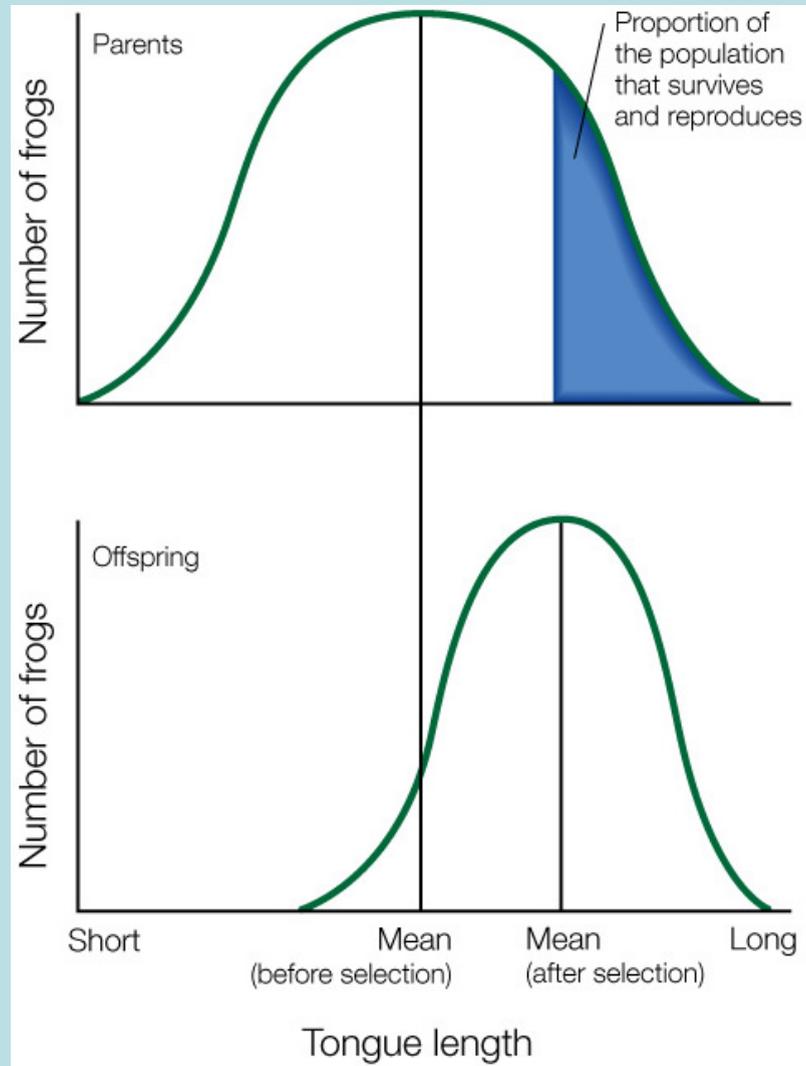
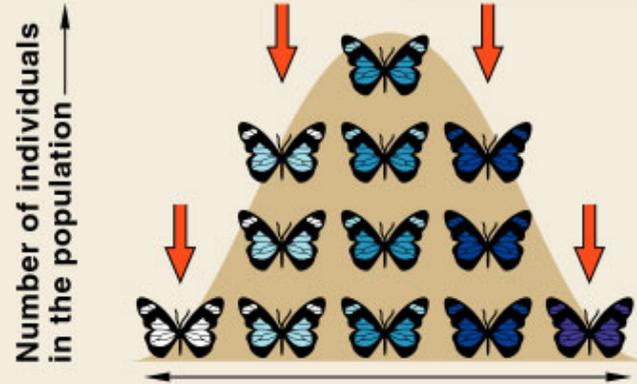
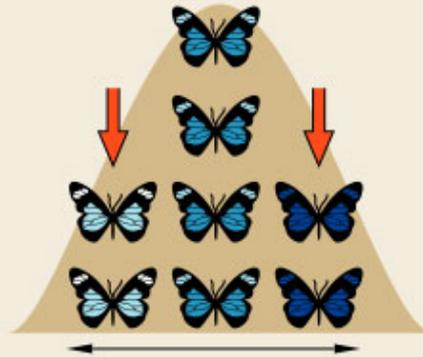


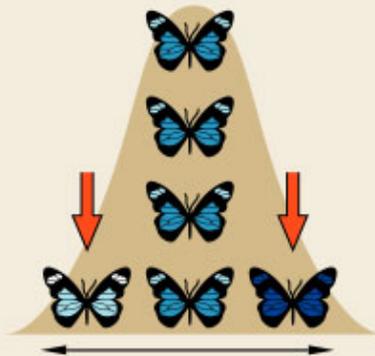
Figure 8-11



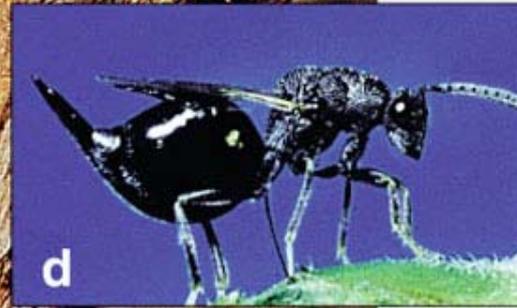
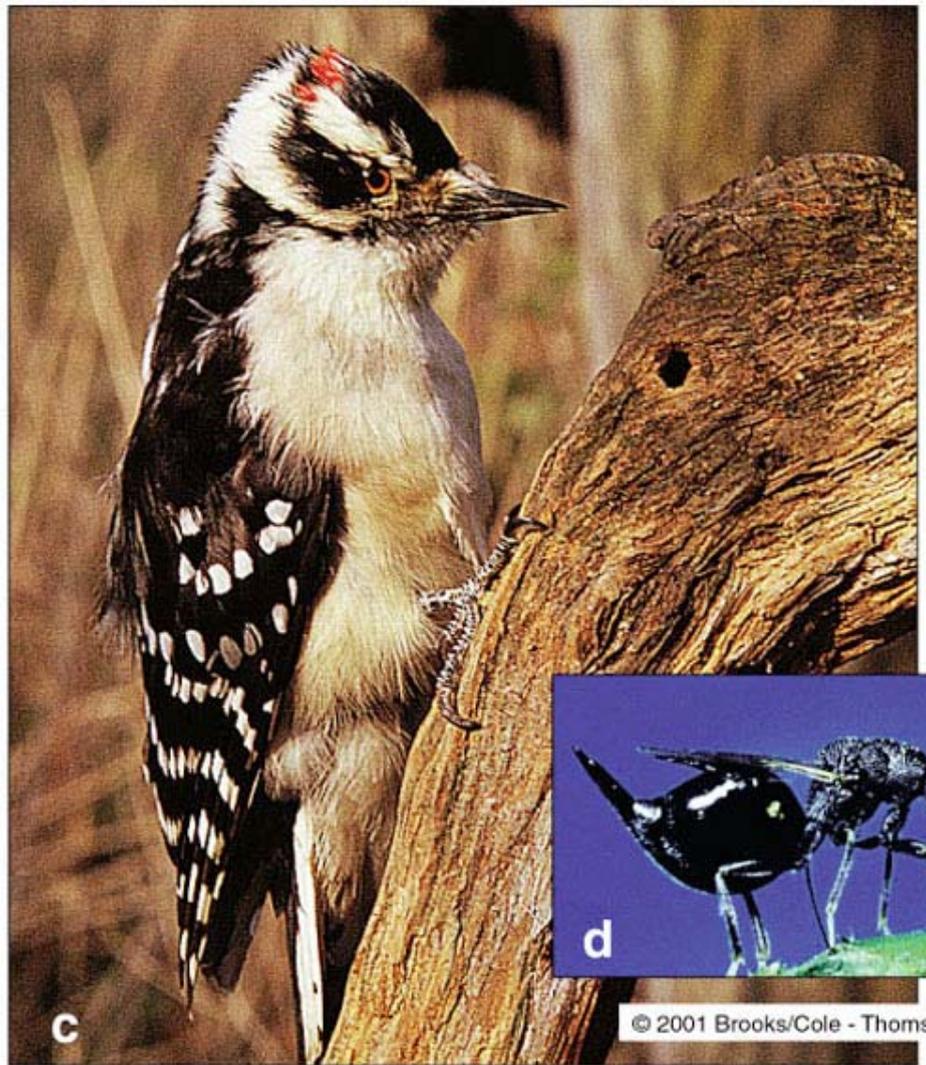
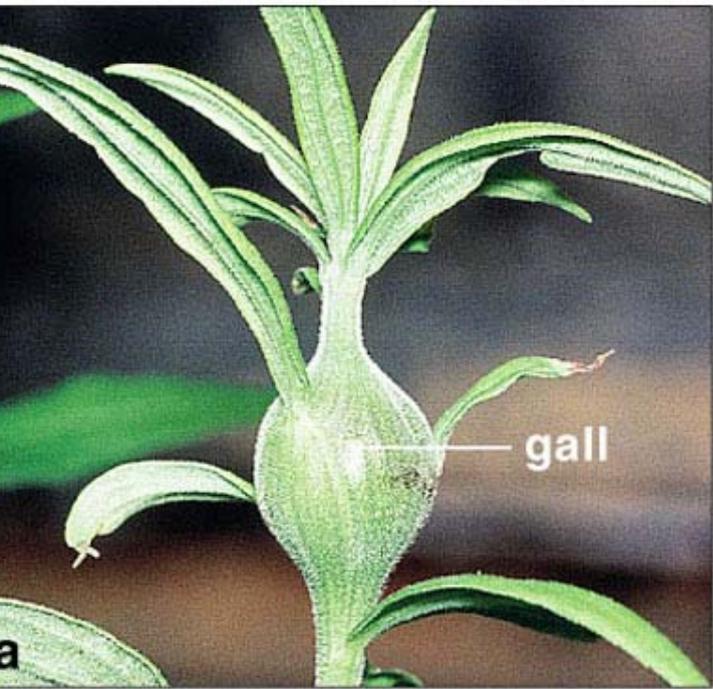
a Range of values for the wing-color trait at time 1



b Range of values for the trait at time 2



c Range of values for the trait at time 3



© 2001 Brooks/Cole - Thomson Learning

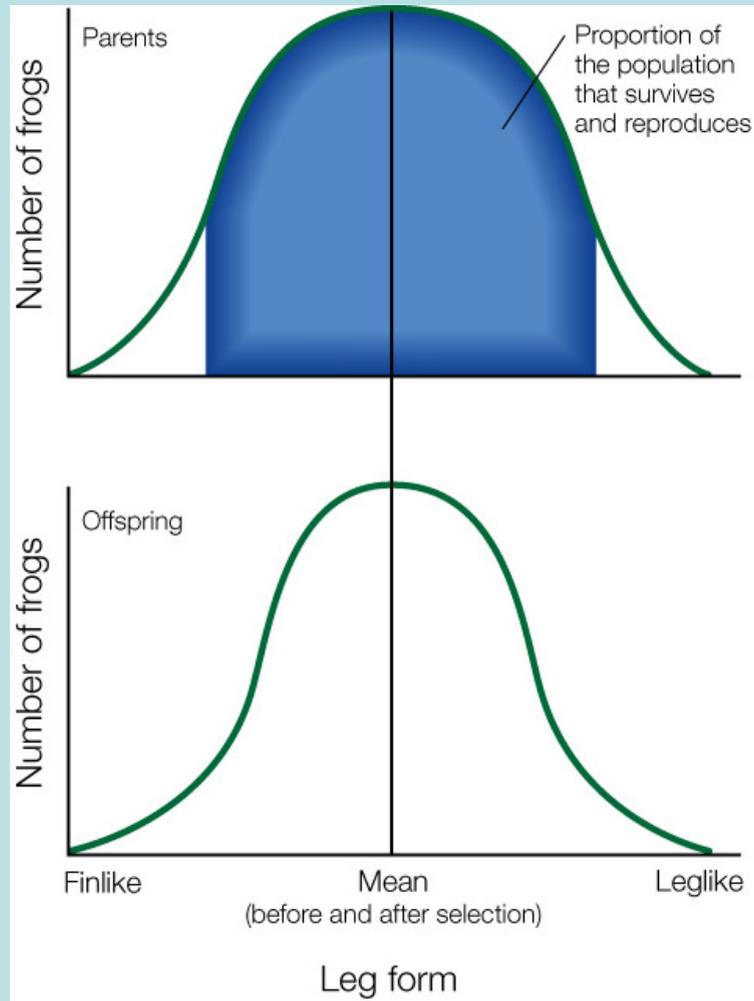
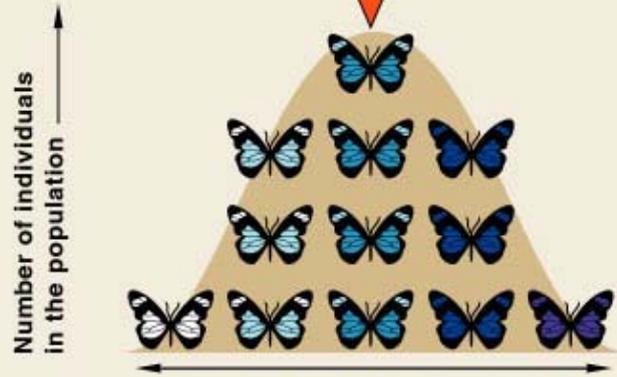
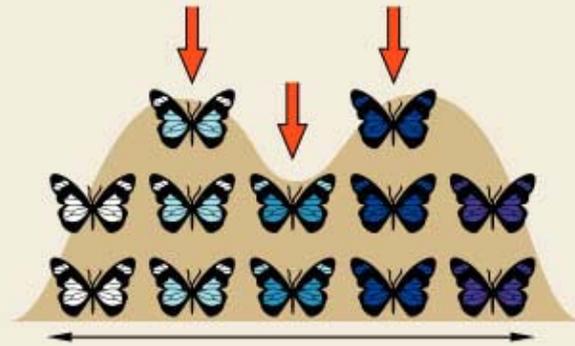


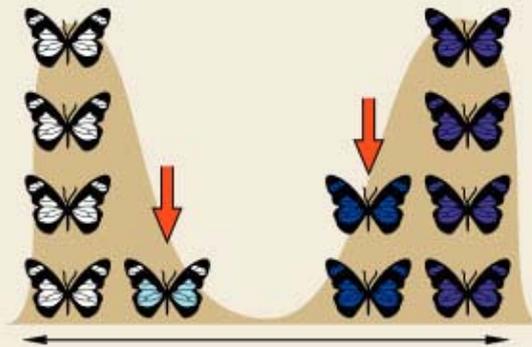
Figure 8-12



a Range of values for the wing-color trait at time 1



b Range of values for the trait at time 2



c Range of values for the trait at time 3

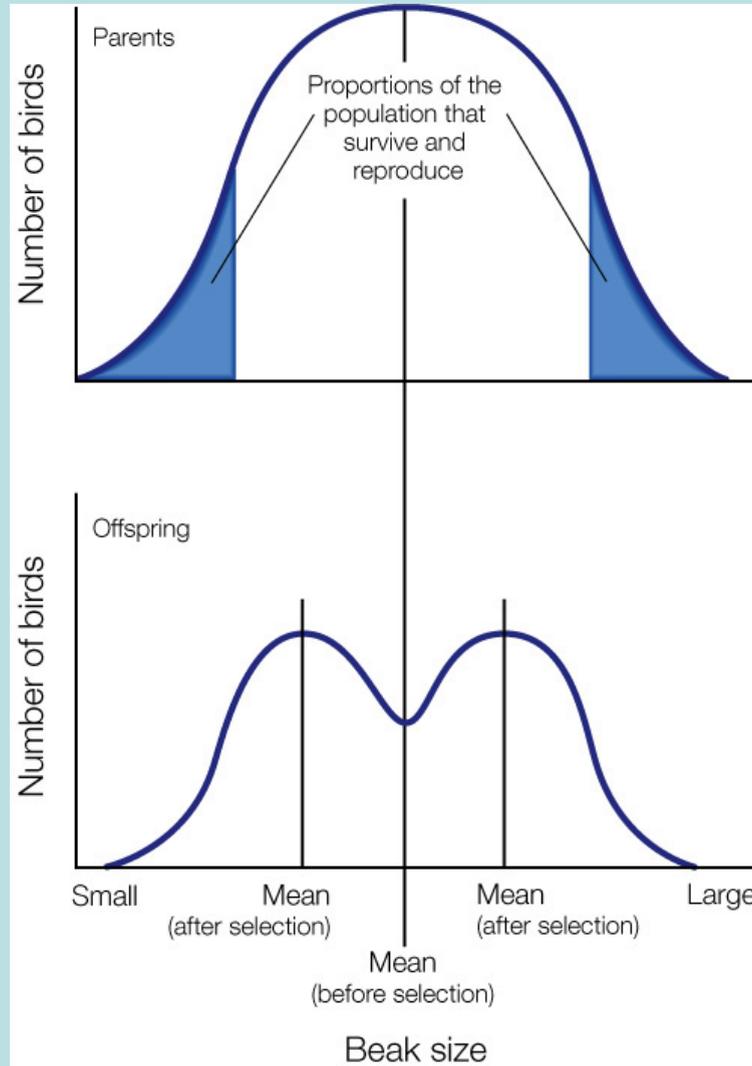
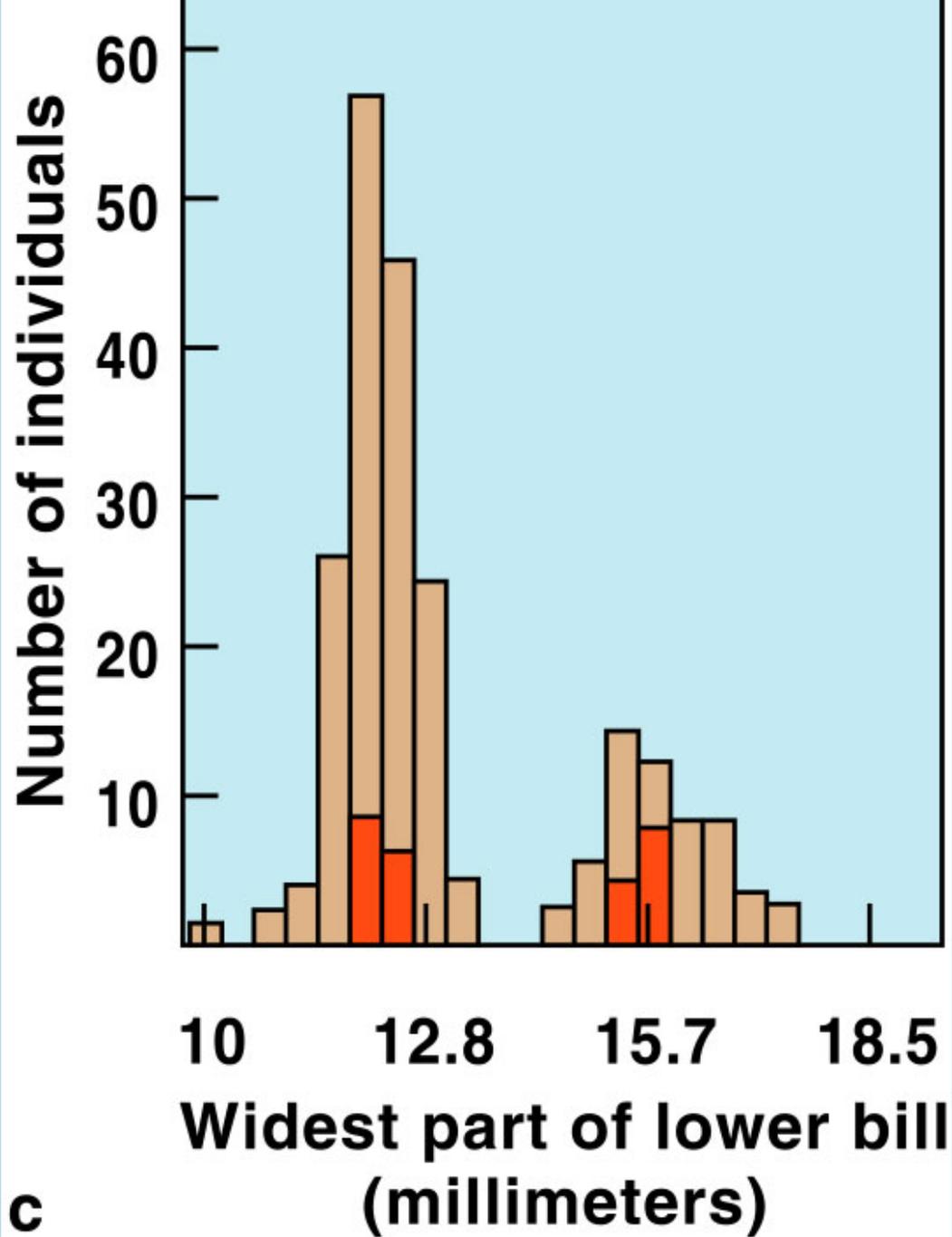


Figure 8-13



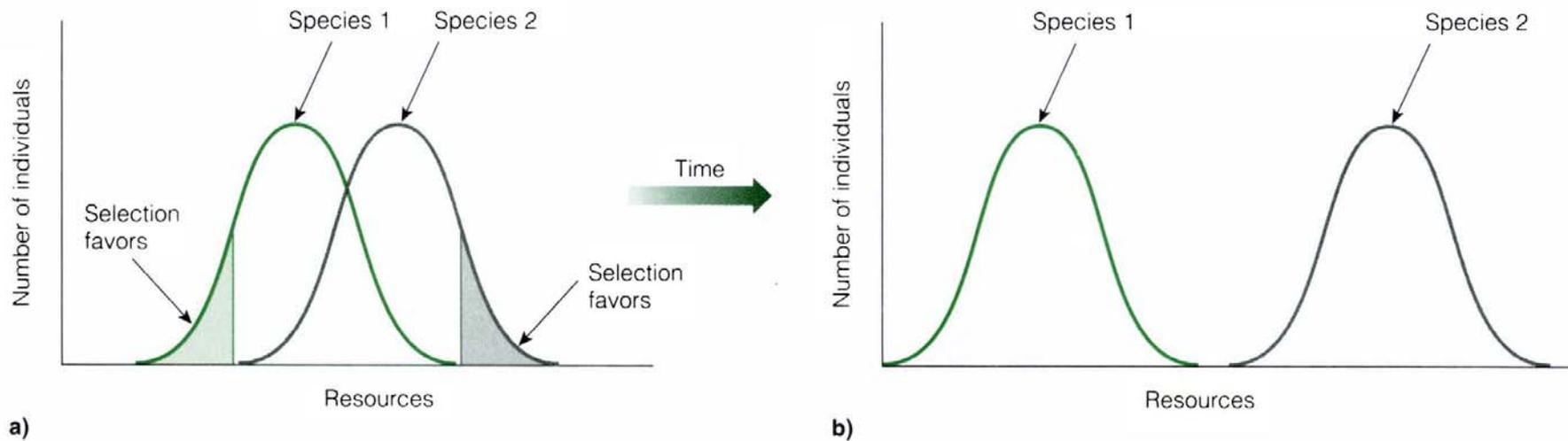


FIGURE 2.21 Diagram of the process of character displacement. In (a), the resource utilization curves for two species overlap. Selection favors those individuals in each species that do not use resources used by the other species. Over time, the resource utilization curves may separate (b).

自然選擇的條件：

- 1.** 任何生物單位具有複製自身（繁殖）的能力。
- 2.** 子代的數目超過其替代的需要。
- 3.** 子代的存活決定於某些特徵（外表型或是基因型）。
- 4.** 這些特徵具有遺傳傳遞的機制。

Soft selection:

特定基因型的個體比族群內的其他個體，具有更強取得資源的競爭力，因此可以有較高的活存機率。

Hard selection:

一個個體的適應度（**Fitness**:存活率、死亡率等量化差異）和其他基因型無關，一種突發的外界環境因素可能導致高死亡率的發生。

Gamete selection 配子選擇：

選擇對基因頻率的影響，可以發生在配子上，例如精子的活動力差異可以受物理的或化學的狀況所影響。

Kin selection 親屬選擇：

相關個體間（親屬間）利他行為所產生的總適應度提高的一種選擇。例如土撥鼠發出警告叫聲的土撥鼠可以使其他親屬有較高的活存率，但是本身較易受攻擊而死亡。

Sexual selection 性別選擇：

最強壯或最活躍的個體具有較高的交配機率，因此這種個體的特徵在後代中會不斷的強化發展。例如孔雀的尾羽、鬥魚的鰭、雄鹿的角。

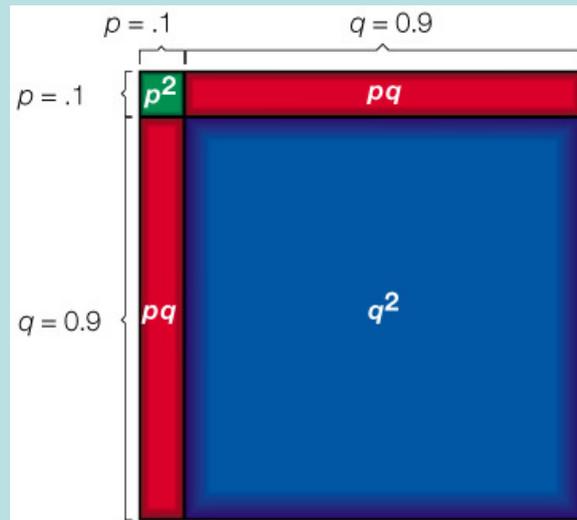


Frequency-dependent selection 頻度相關的選擇：

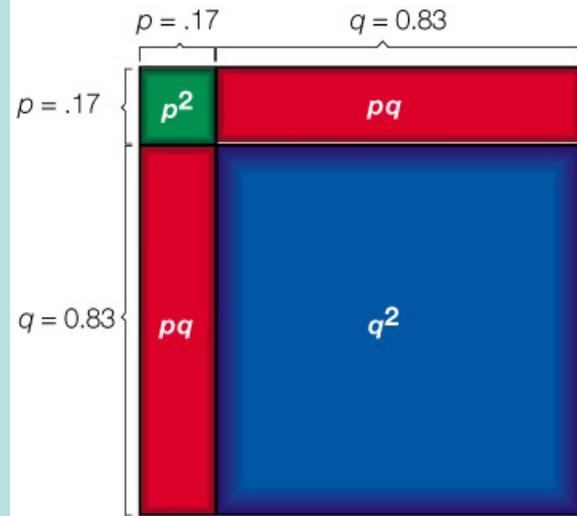
自然選擇作用在出現頻度最多的外表型個體上較高，其結果將造成其生殖程度下降，如此可以使一個群維持平衡式的多形態性。如果選擇對於某種頻度的個體最有利，則將提高這種有
個體的適應度。



Figure 8-8

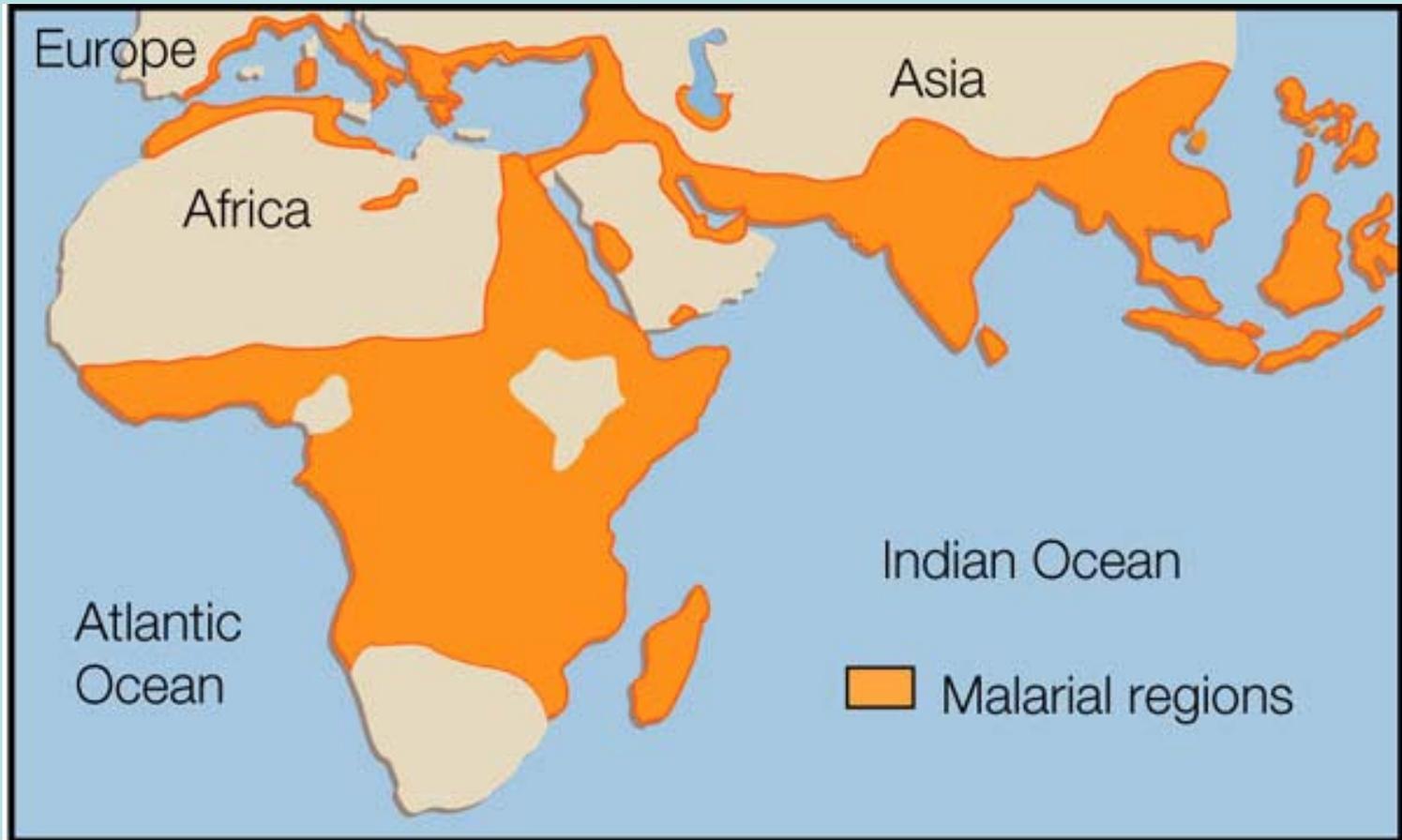


(a) Before industrial melanism



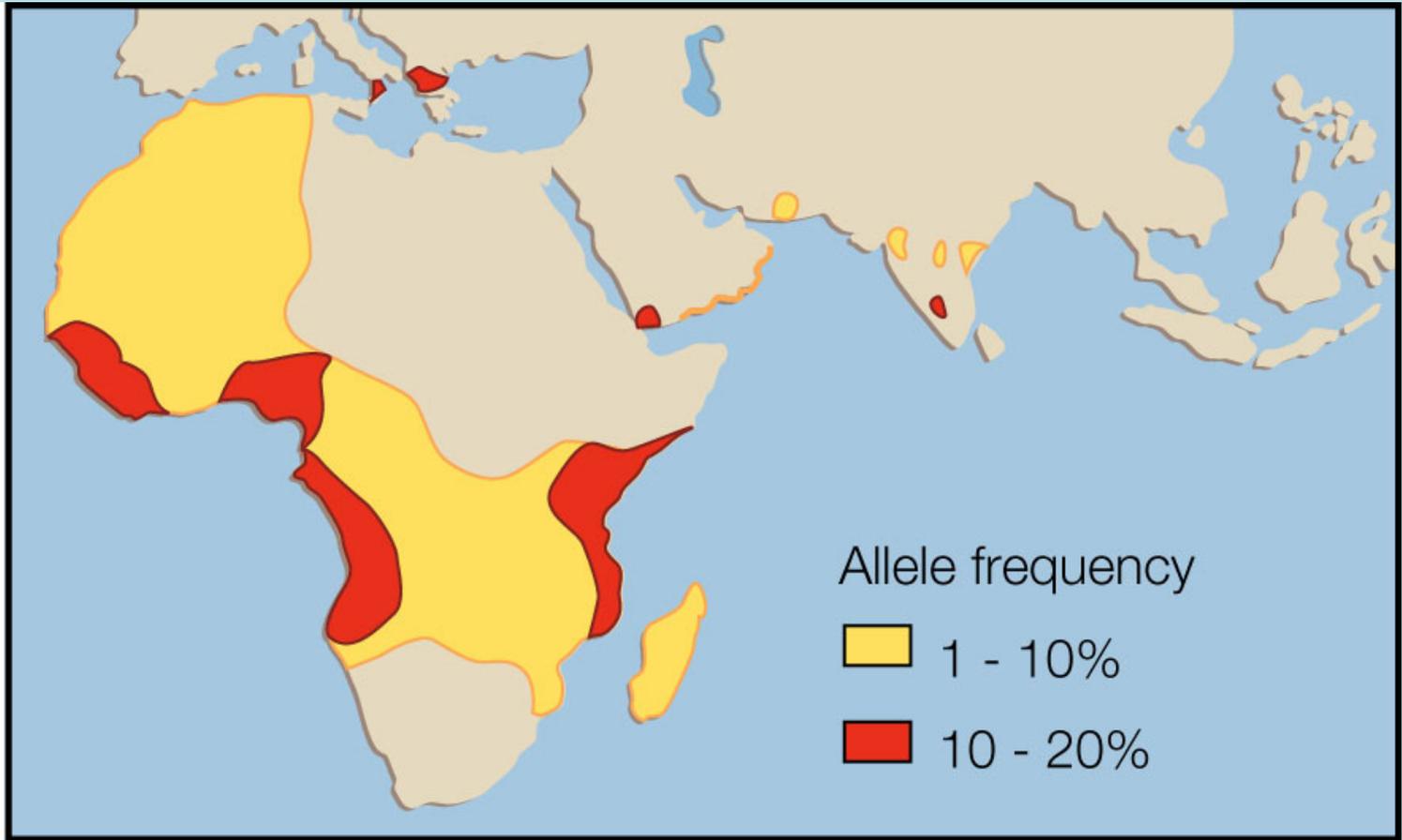
(b) After industrial melanism

Figure 8-9



(a) Distribution of malaria

Figure 8-10a



(b) Distribution of sickle-cell anemia allele (HbS)

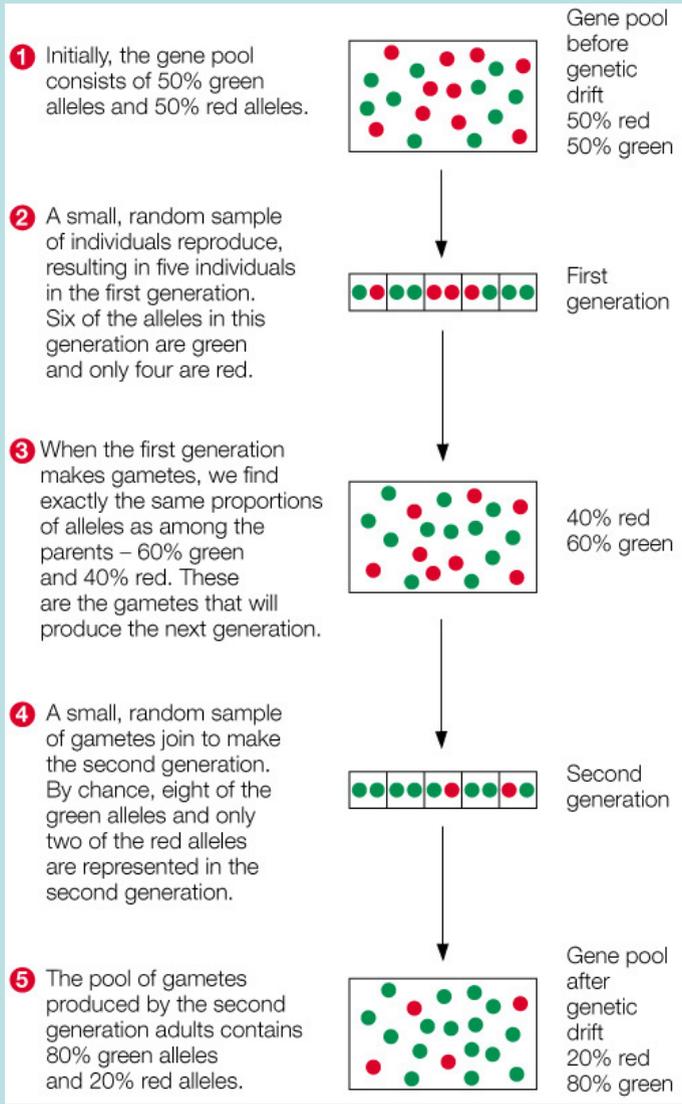


Figure 8-14

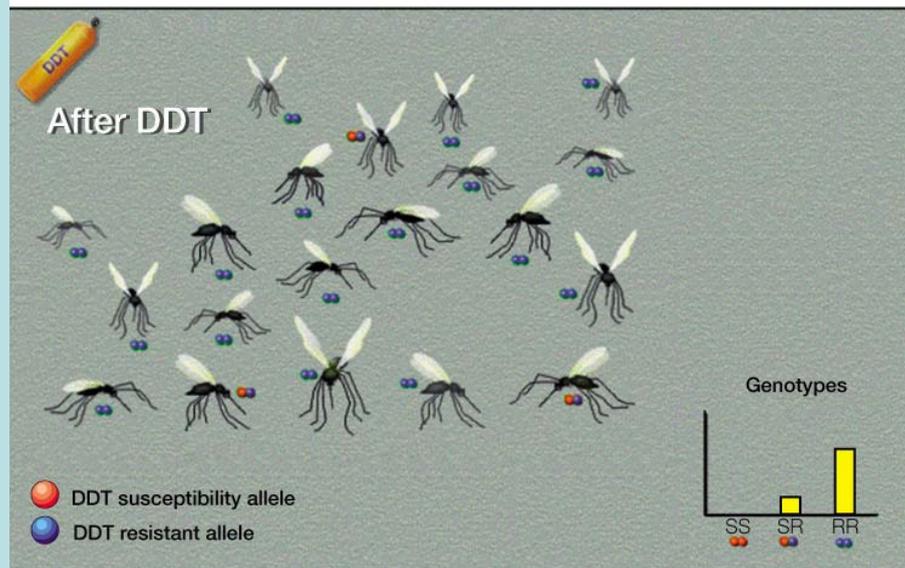
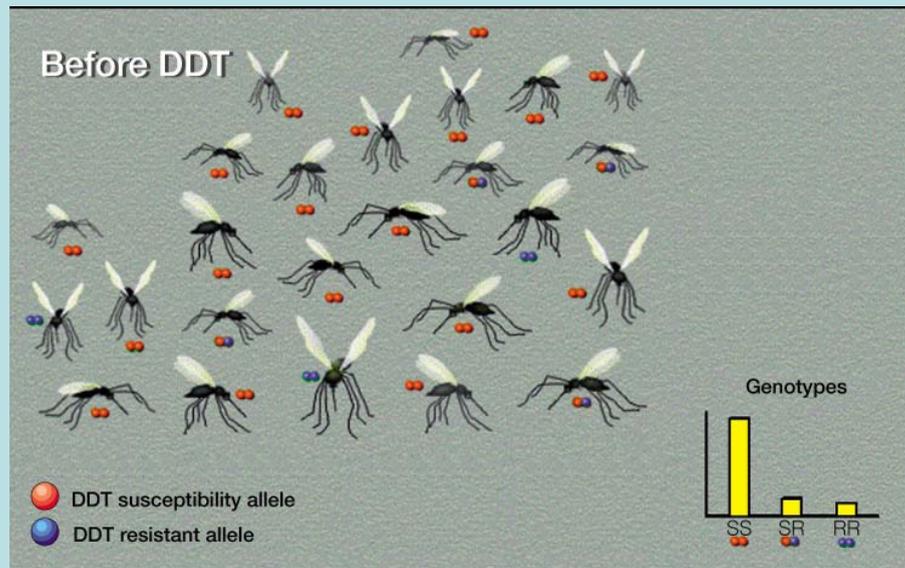


Figure 8-17

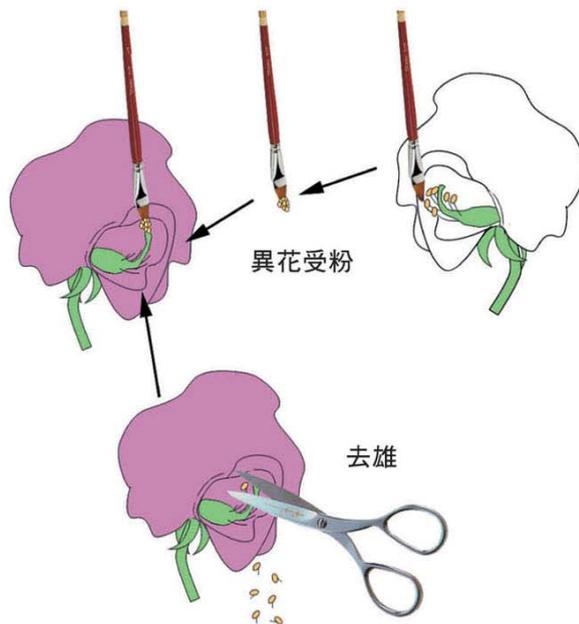


圖 8-13 Mendel 在修道院花園裡進行豌豆的遺傳育種研究



豌豆花瓣閉合，
外界花粉很難
進入

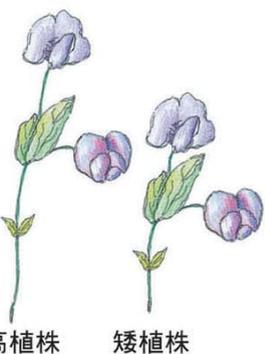
豌豆是嚴格的自花受粉植物



異花受粉

去雄

2 豌豆花大，便於人工除去雄蕊花藥



高植株 矮植株

1 植株高矮



紫色 白色

2 花的顏色



腋生 頂生

3 花的位置



飽滿

皺縮

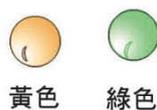
4 豆莢形狀



綠色

黃色

5 豆莢顏色



黃色

綠色

6 種子顏色



圓形

皺縮

7 種子形狀

圖 8-14 豌豆作為實驗材料有許多 (至少 7 種) 優點

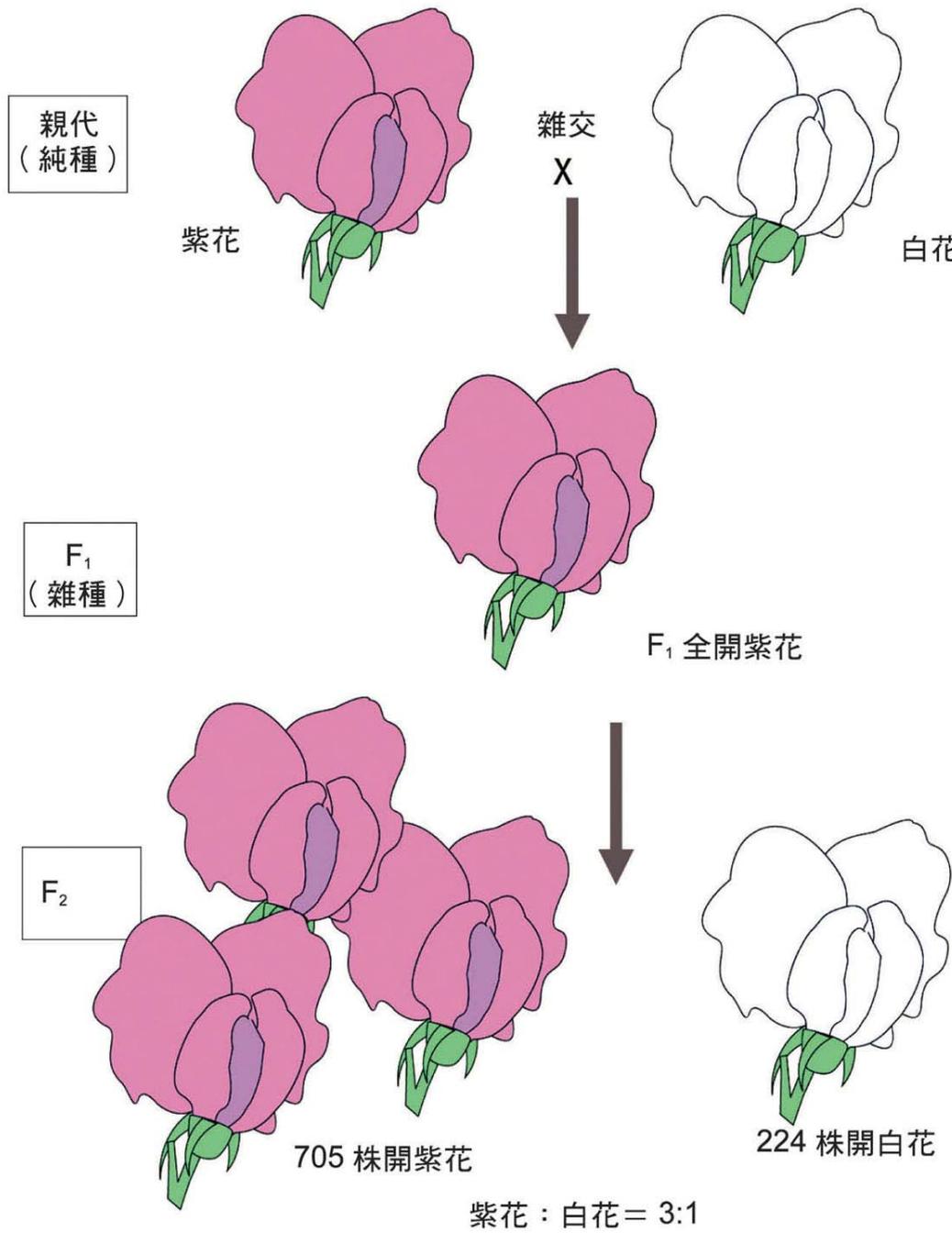


圖 8-15 豌豆單因子雜交實驗與遺傳學分離律

性狀	顯性性狀 X 隱性性狀	F ₂ 顯性：隱性	比例
花的顏色	 紫色  白色	705:224	3.15:1
花的位置	 腋生  頂生	651:207	3.14:1
植株高度	 高植株  矮植株	787:277	2.84:1
豆莢形狀	 飽滿  皺縮	882:299	2.95:1
豆莢顏色	 綠色  黃色	428:152	2.82:1
豌豆顏色	 黃色  綠色	6022:2001	3.01:1
豌豆形狀	 圓形  皺縮	5474:1850	2.96:1

圖 8-16 豌豆 7 組相對性狀分別雜交實驗結果

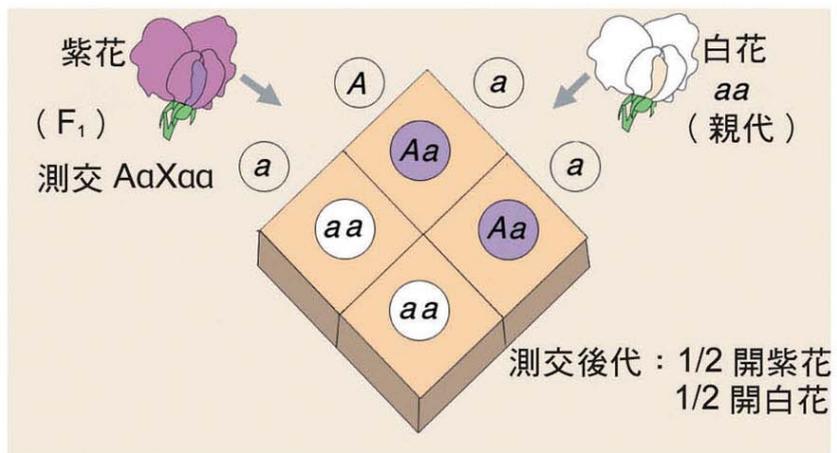
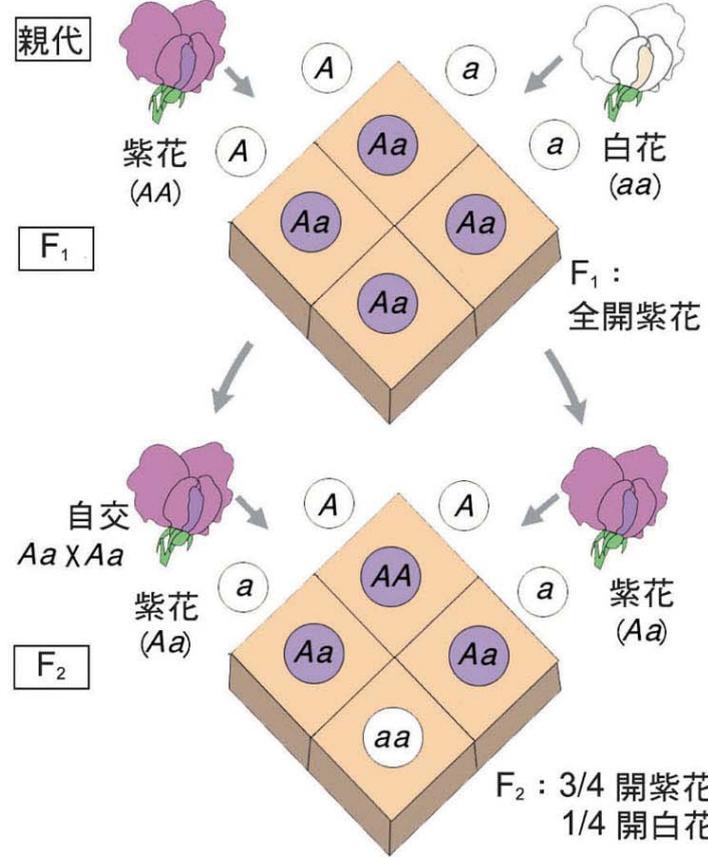


圖 8-17 遺傳學第一法則

兩對因子雜交

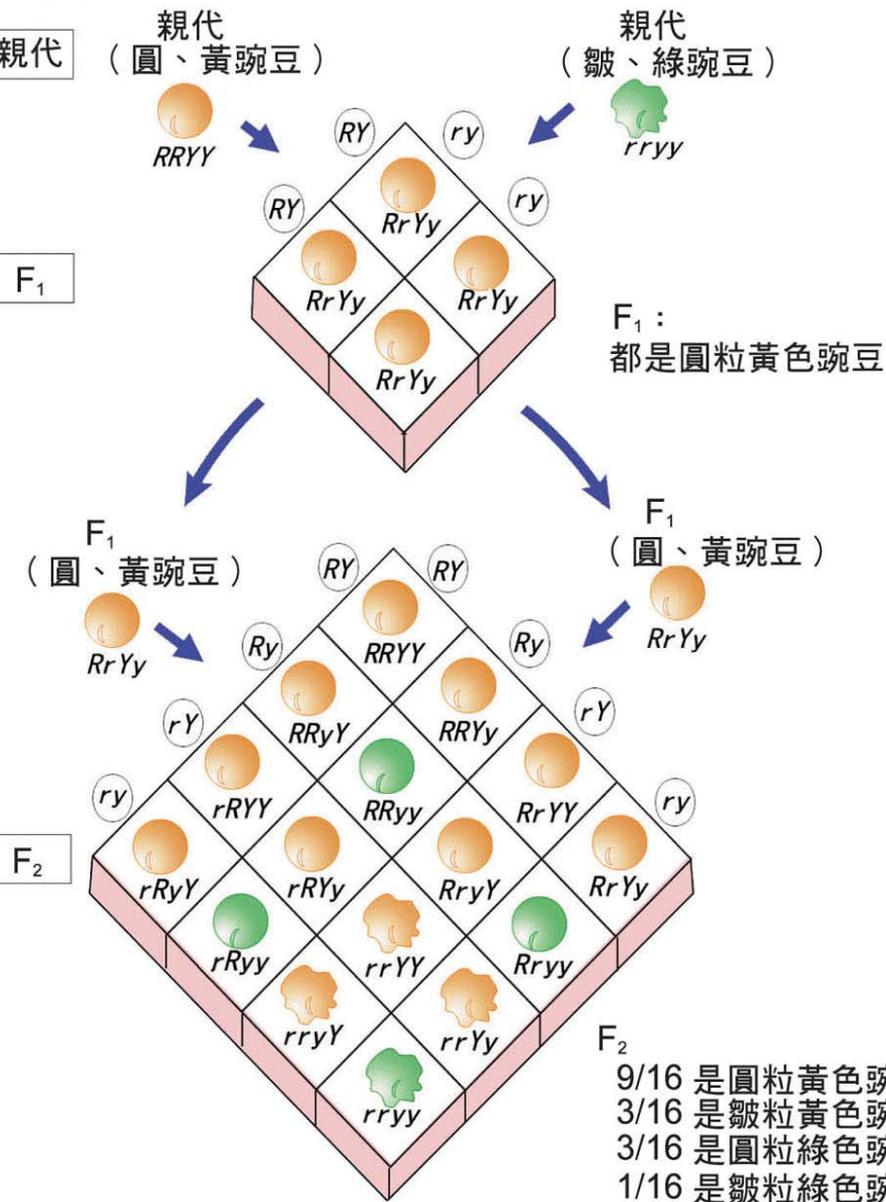
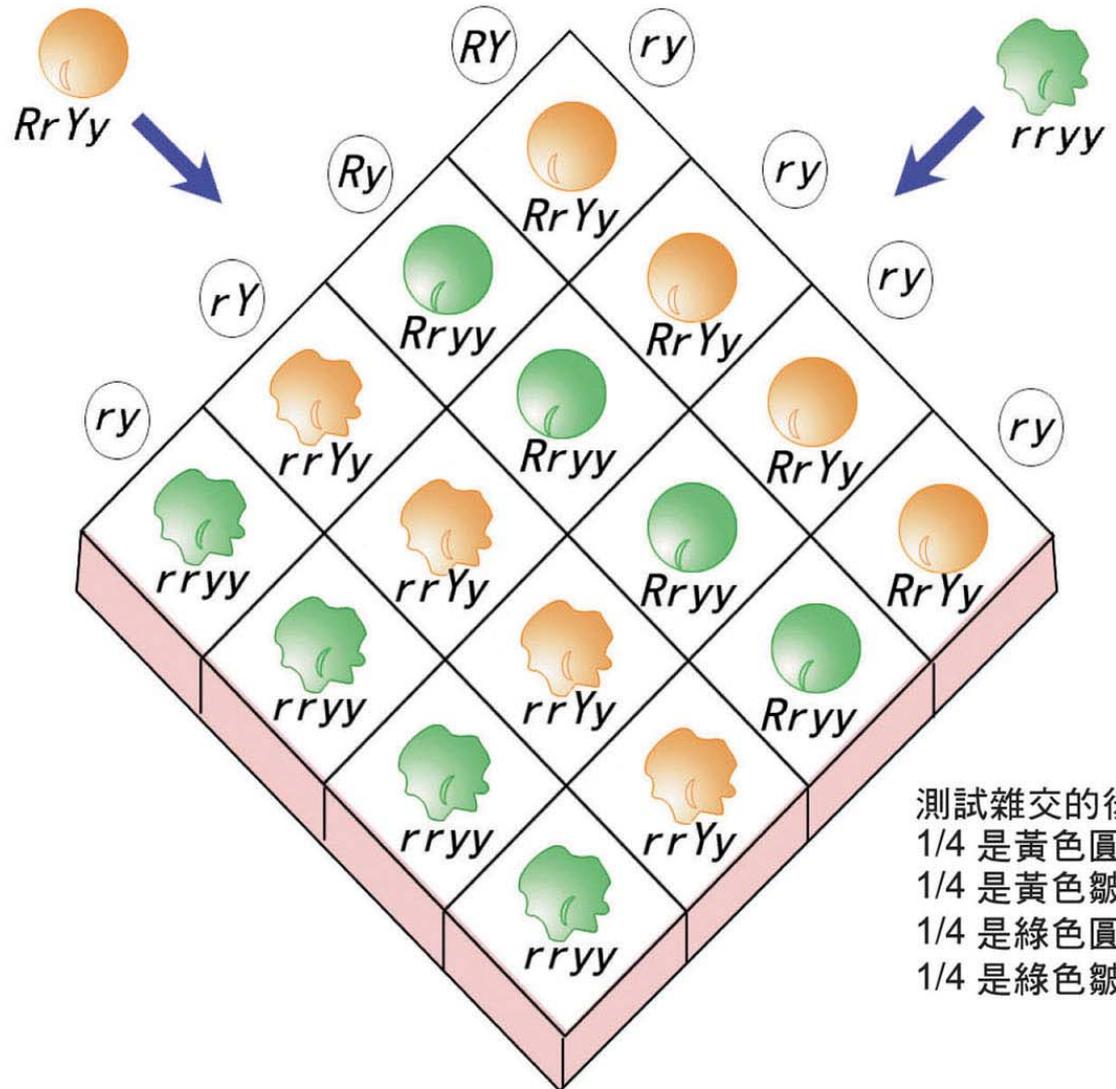


圖 8-18 多對基因的獨立分配和自由分配現象

F₁
(圓、黃豌豆)

親代
(皺、綠豌豆)



測試雜交的後代：
 1/4 是黃色圓形豌豆
 1/4 是黃色皺縮豌豆
 1/4 是綠色圓形豌豆
 1/4 是綠色皺縮豌豆

圖 8-19 測交試雜實驗

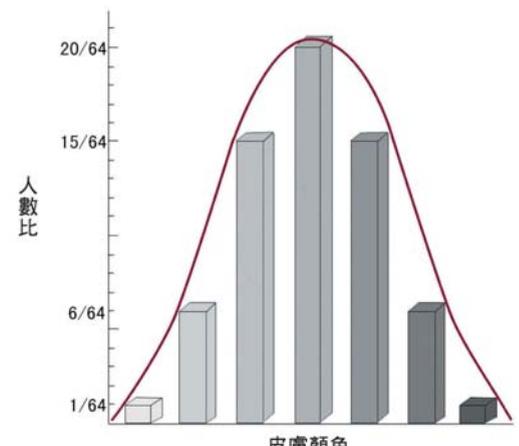
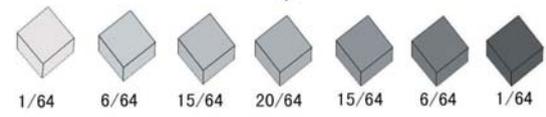
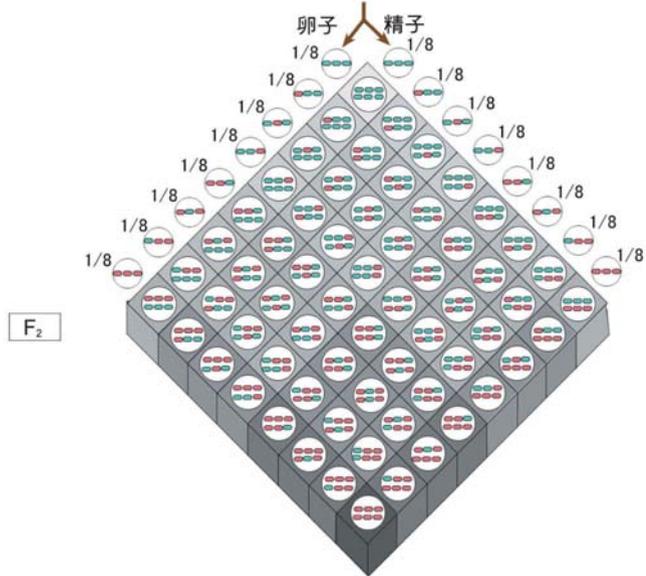
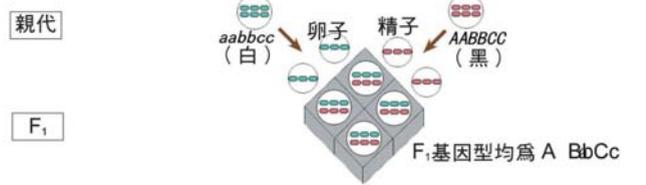


圖 8-20 人類皮膚色素的連續性變化