基因體結構與遺傳原理
Genome Structure & Genetic Principles

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演講綱要

- 孟德爾單基因遺傳學
- 染色體遺傳學說與與細胞減數分裂之染色體行爲
- 染色體結構，基因體組成，基因結構與功能
- 多基因遺傳模式
- 遺傳疾病種類與再發率

孟德爾(Gregor Mendel)創立了遺傳學(Genetics)

- 在1865年,孟德爾發表了兩篇關於碗豆育種的研究論文。
- 這些研究論文包含了今日遺傳學最基礎的原理。

Freeman et al., Introduction to Genetic Analysis,2001, 5th ed.
Vogel & Mutolsky Human Genetics 1997, 2nd ed.

孟德爾的實驗
Mendel's Experiments

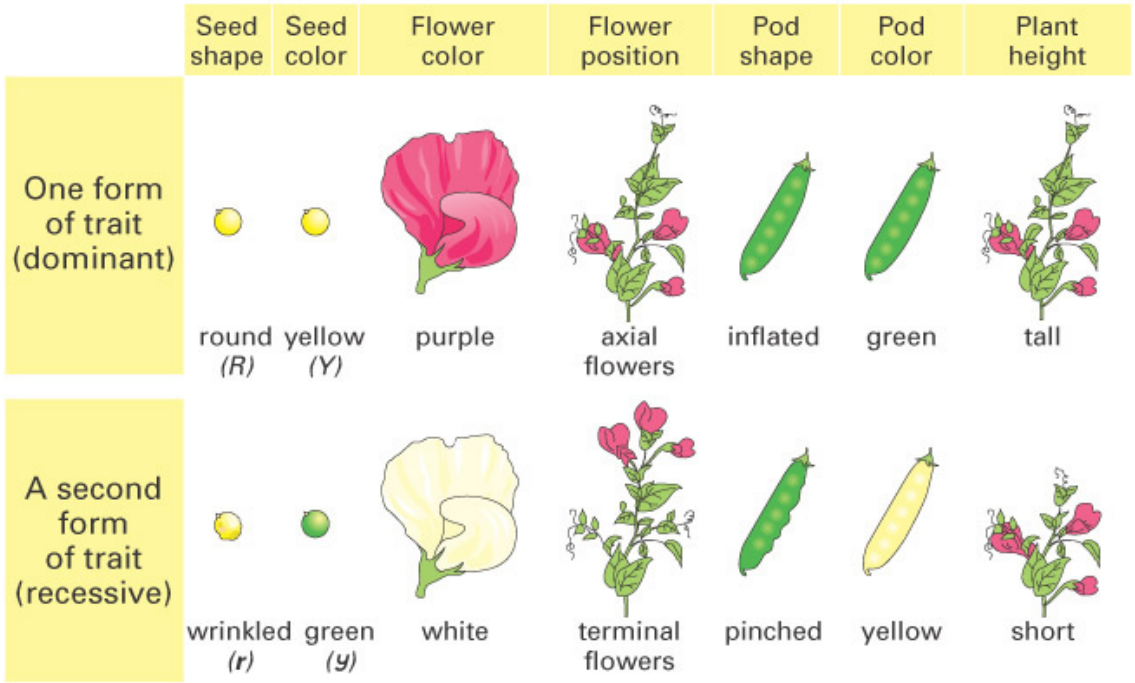


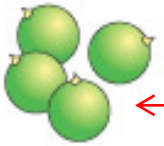
Figure 20-15 Essential Cell Biology, 2/e. (© 2004 Garland Science)

表現型
Phenotype

基因型
Genotype

純種品系
Pure line

yellow-seeded pea plants



green-seeded pea plants

自體授粉
Self-fertilization

CROSS-FERTILIZATION

交叉授粉

單型律
Law of uniformity

F1 GENERATION

100% yellow-seeded pea plants

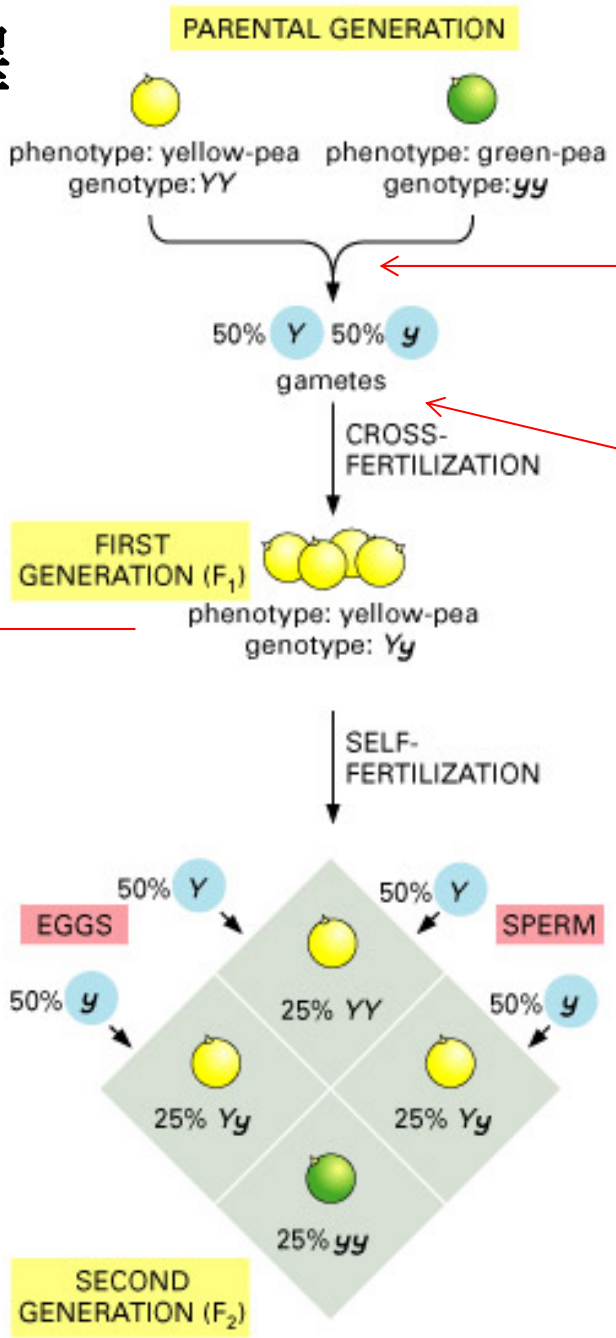
CROSSED TO THEMSELVES

75% yellow-seeded pea plants

25% green-seeded pea plants

Figure 20-16 Essential Cell Biology, 2/e. (© 2004 Garland Science)

孟德爾如何解釋他的實驗結果



分離律
Law of segregation

配子
Gamete
如: 卵子或精子

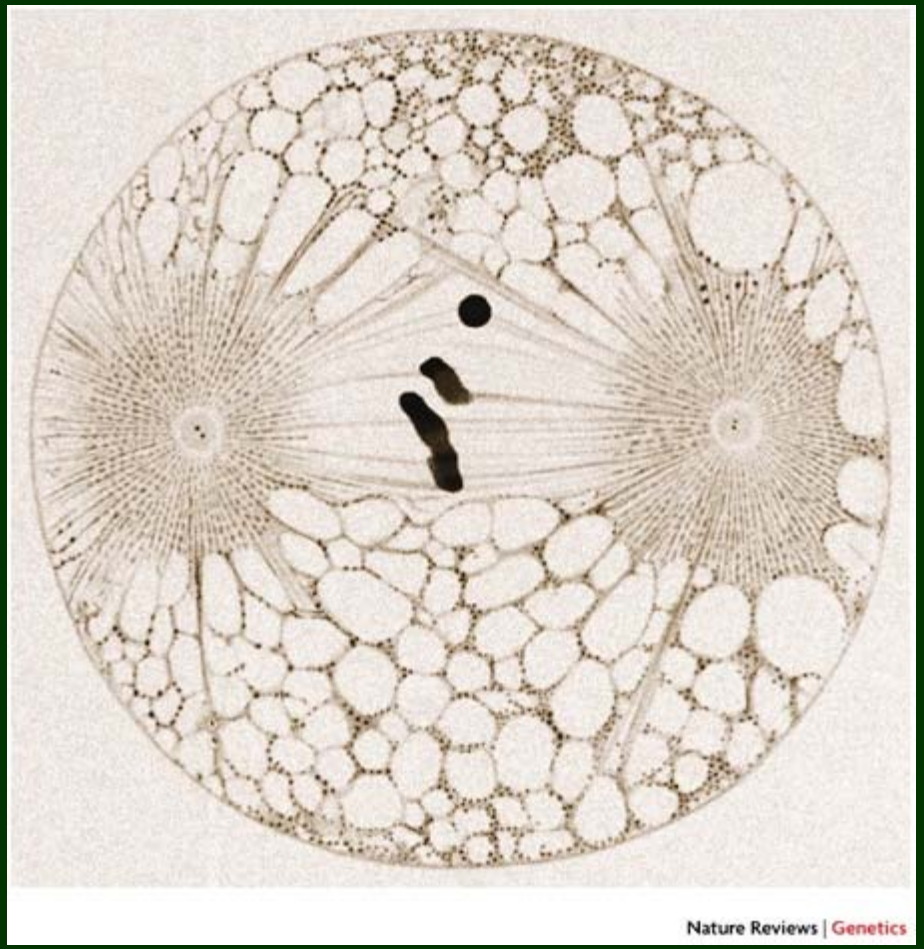
對偶基因
allele
顯性(的)
dominant
隱性(的)
recessive

表現型
Phenotype
基因型
Genotype

基因型與表現型的關係
(genotype-phenotype relationship)-
遺傳學的主題

Figure 20-17 Essential Cell Biology, 2/e. (© 2004 Garland Science)

手繪顯微鏡下細胞分裂(cell division)時的染色體(chromosomes)



Adopted from Nature Review Genetics

生殖母細胞分裂產生配子過程中染色體的分配

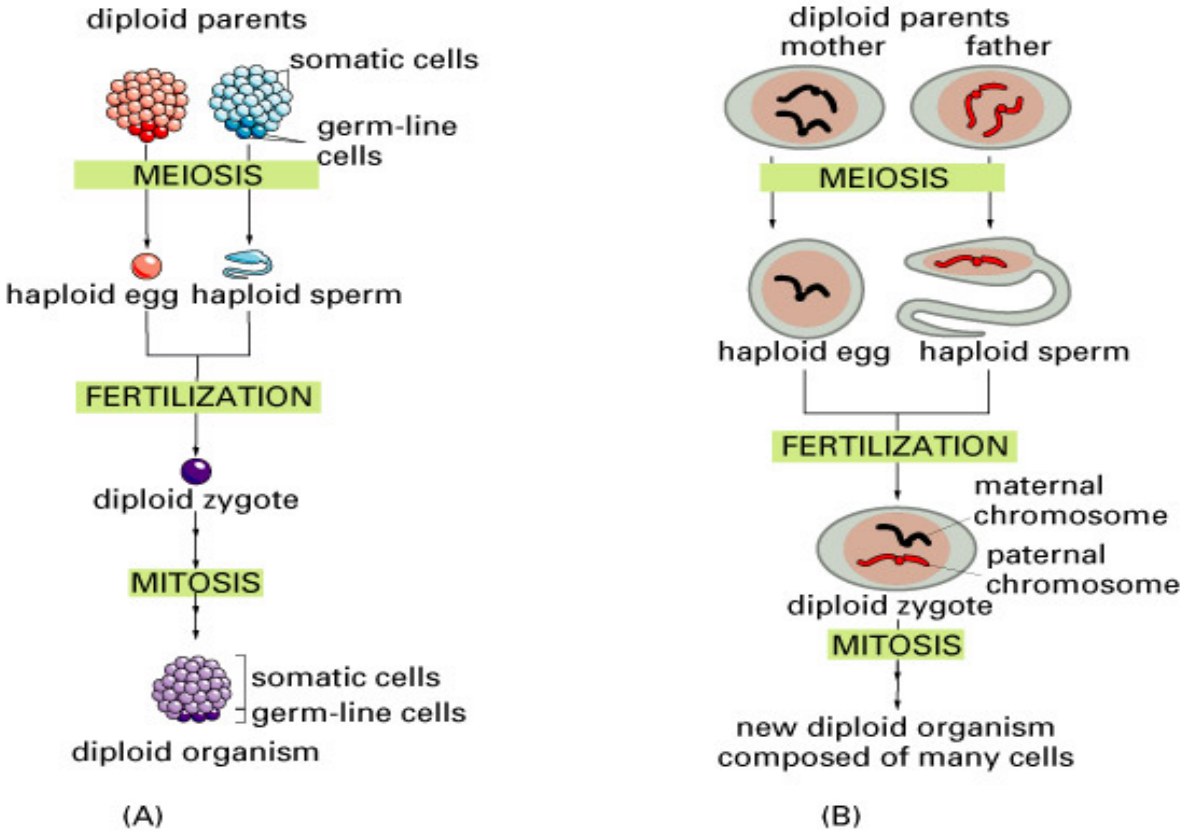
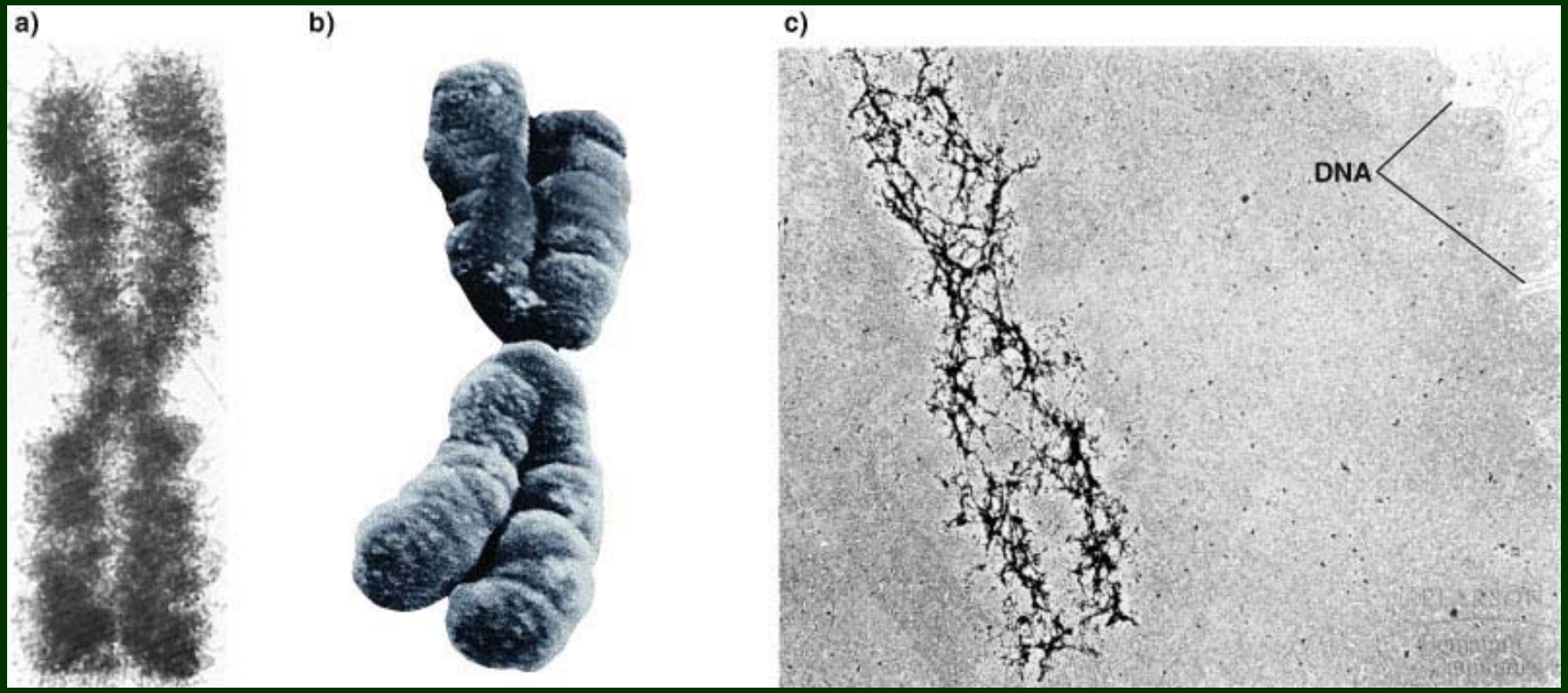


Figure 20-4 Essential Cell Biology, 2/e. (© 2004 Garland Science)

電子顯微鏡(electron microscope)下的染色體(chromosome)



Essential cell biology 2nd ed. 2004

DNA 雙螺旋 (DNA double helix)結構

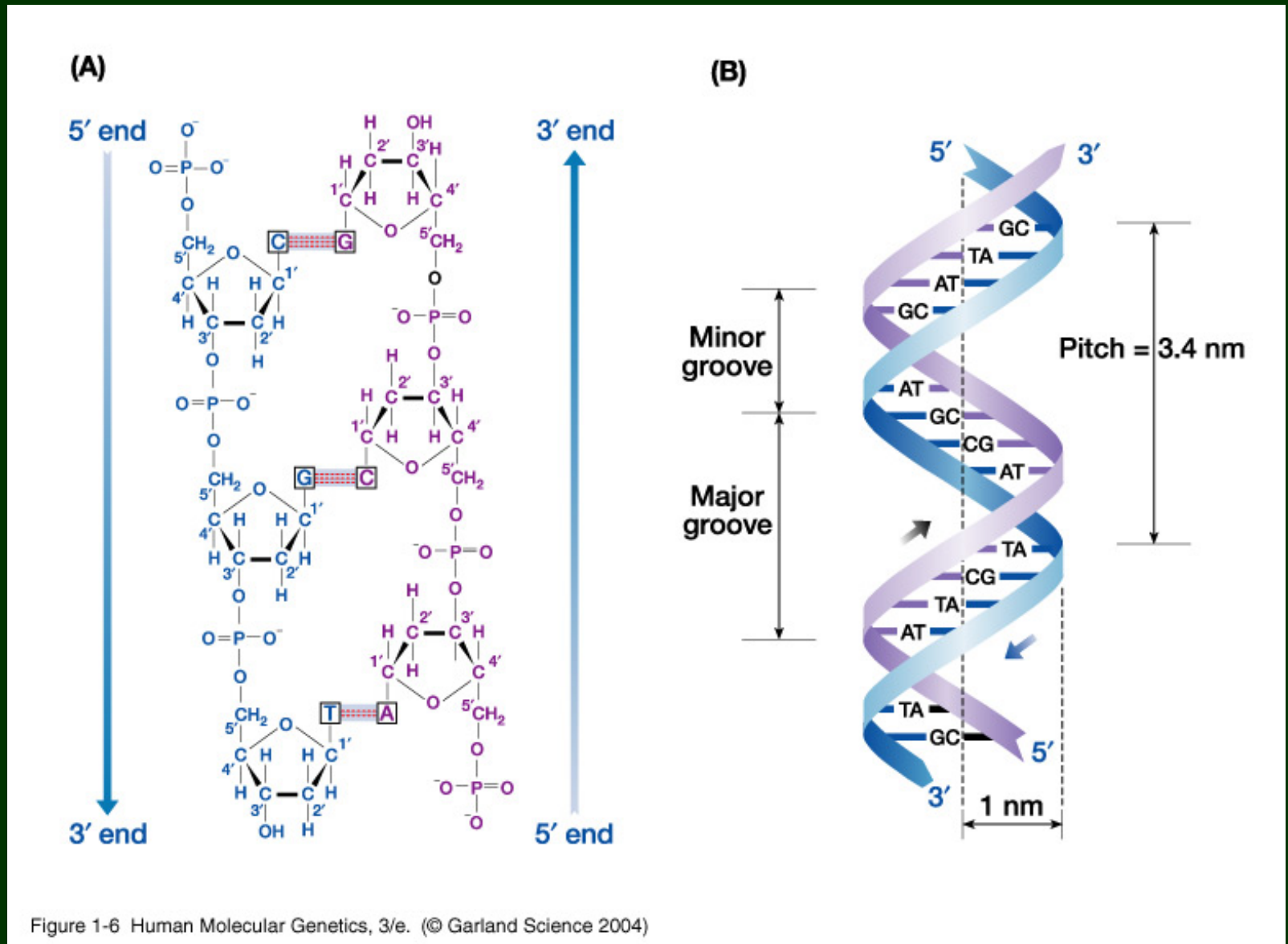


Figure 1-6 Human Molecular Genetics, 3/e. (© Garland Science 2004)

DNA被逐步包裝成染色絲(chromatin)及染色體(chromosome)

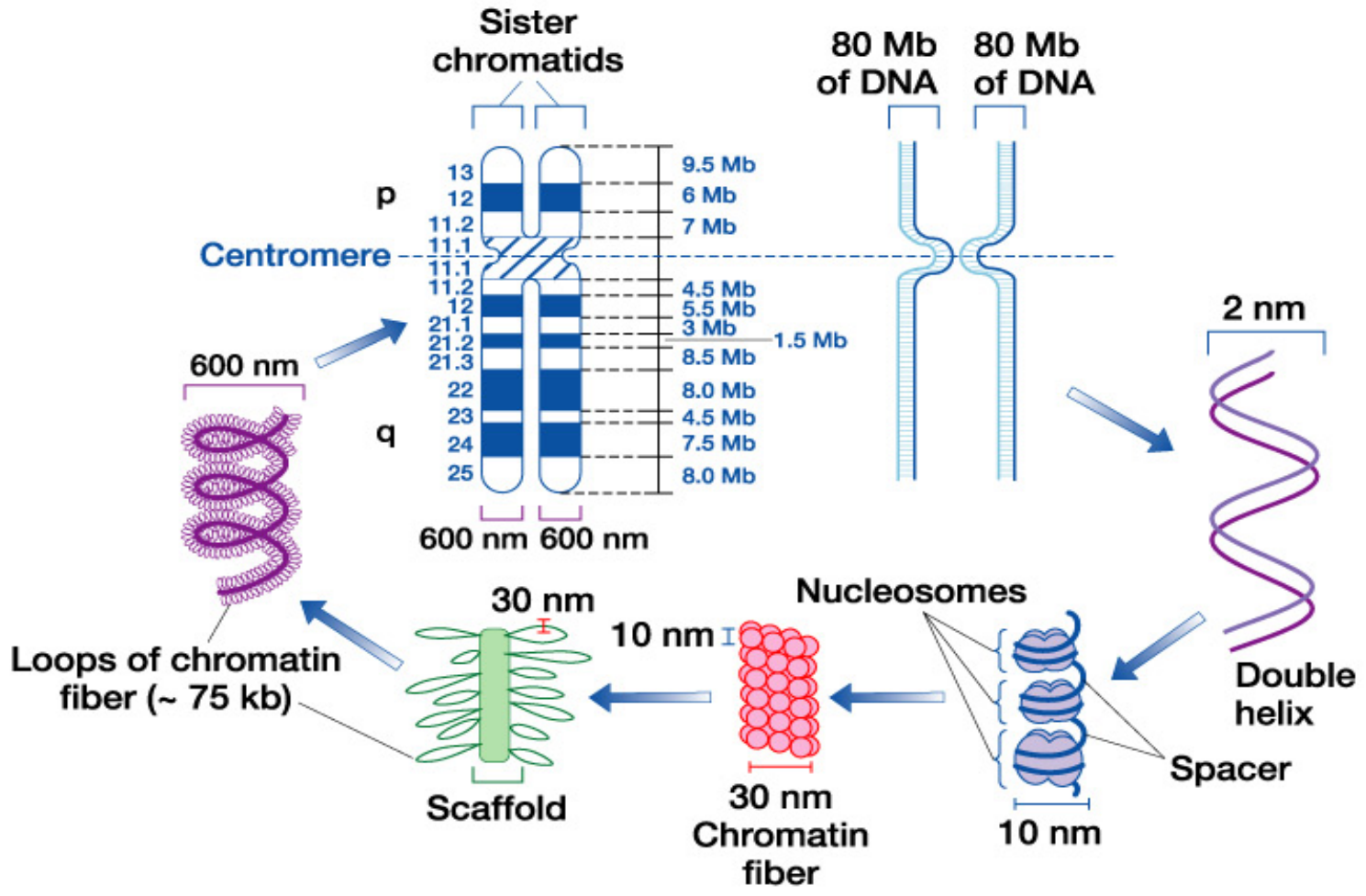
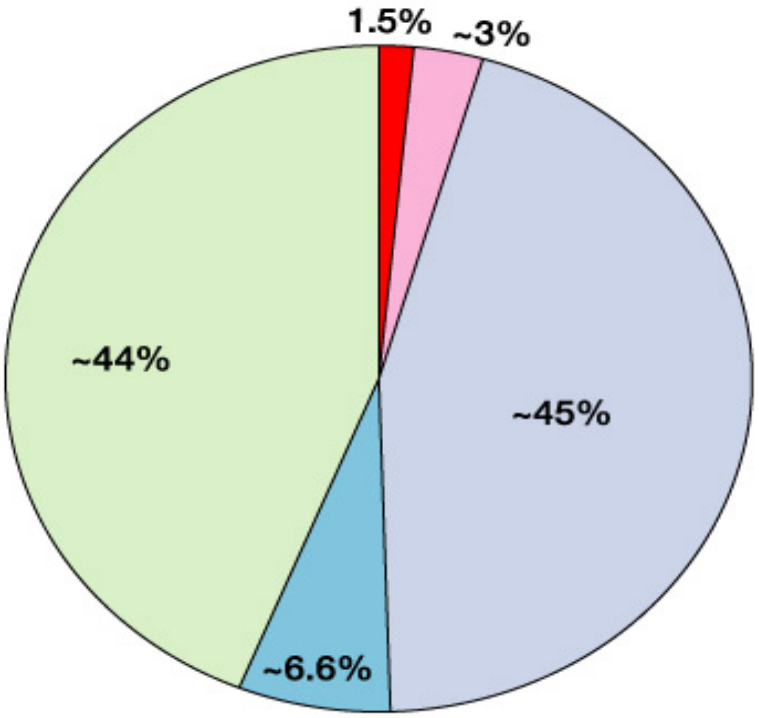


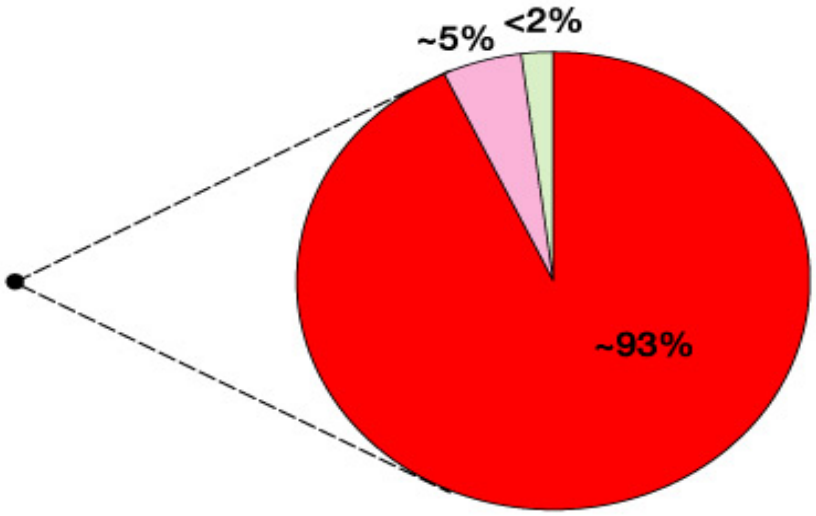
Figure 2-3 Human Molecular Genetics, 3/e. (© Garland Science 2004)

人類基因體的組成
(Organization of human genome)



Nuclear genome
(24 linear double-stranded DNA molecules – 3200 Mb; ~30 000 genes)

細胞核
基因體



Mitochondrial genome
(1 circular double-stranded DNA 16.6 kb; 37 genes)

粒線體
基因體

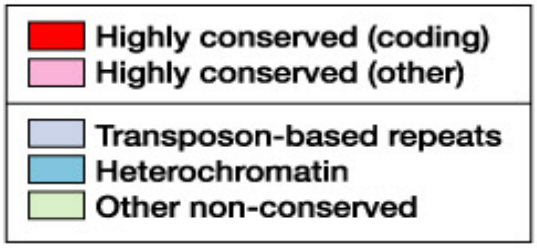


Figure 9-1 Human Molecular Genetics, 3/e. (© Garland Science 2004)

基因的結構與表現

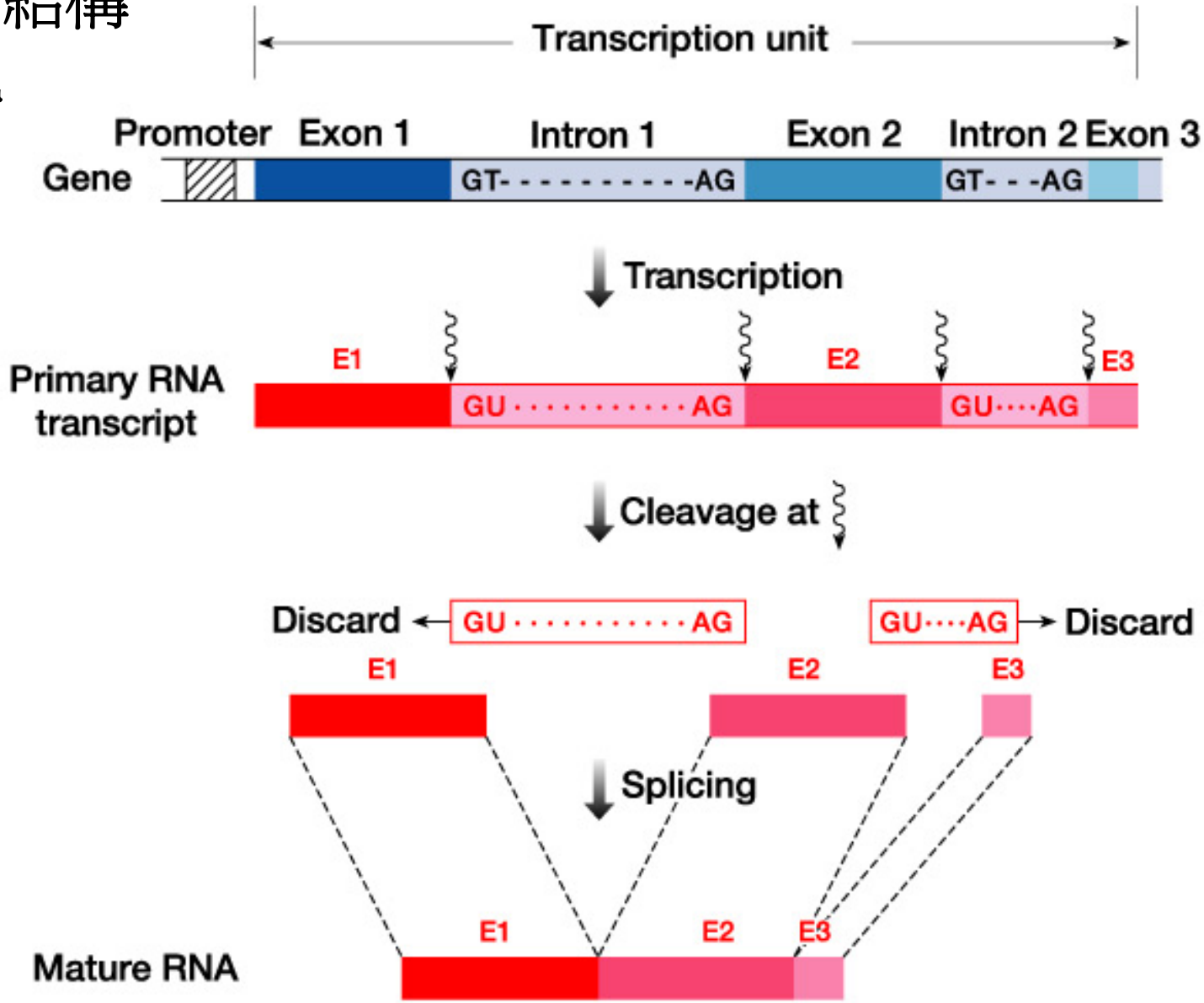


Figure 1-14 Human Molecular Genetics, 3/e. (© Garland Science 2004)

分子生物學(molecular biology)的中心理論(central theory)

DNA

↓

RNA

↓

蛋白質

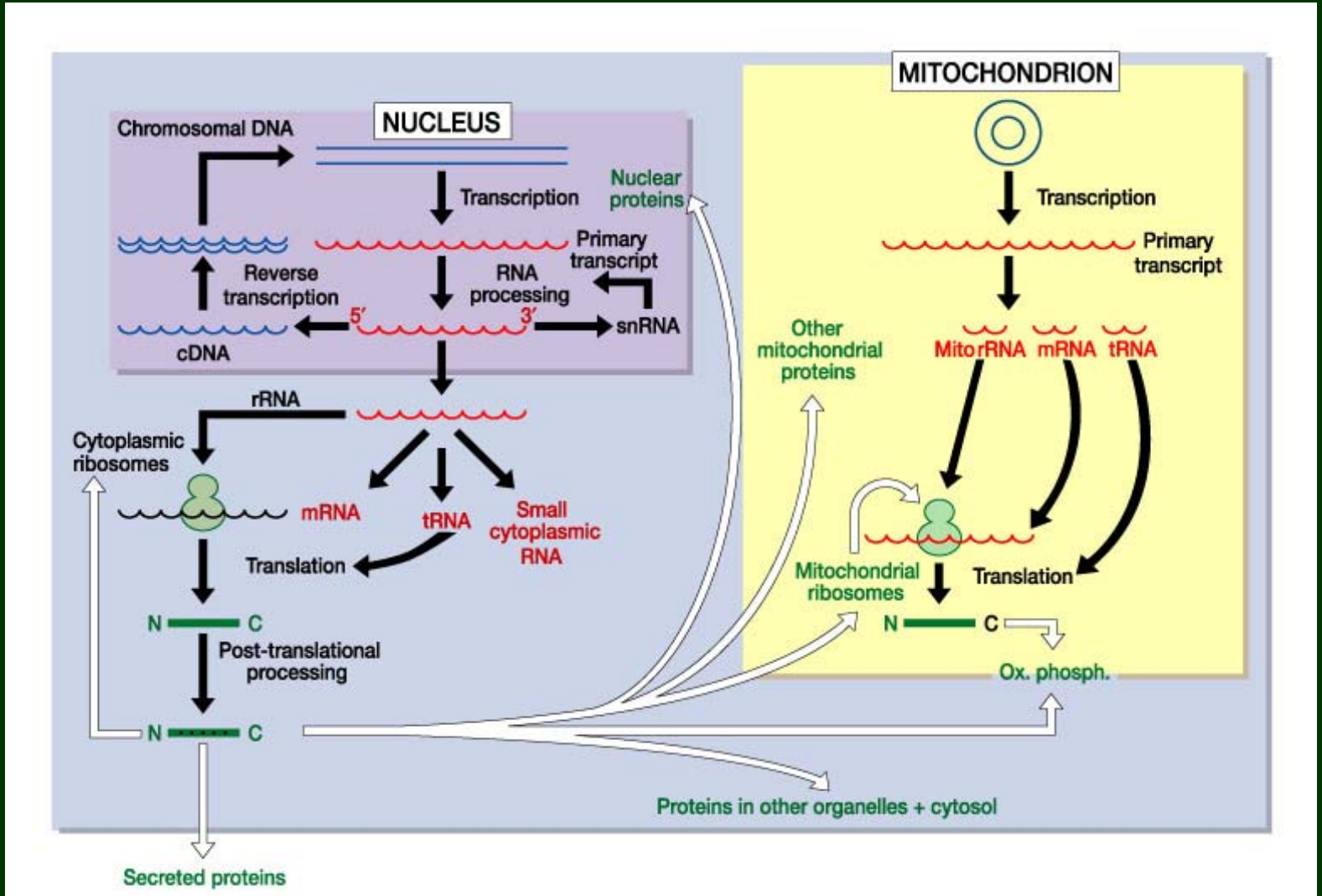
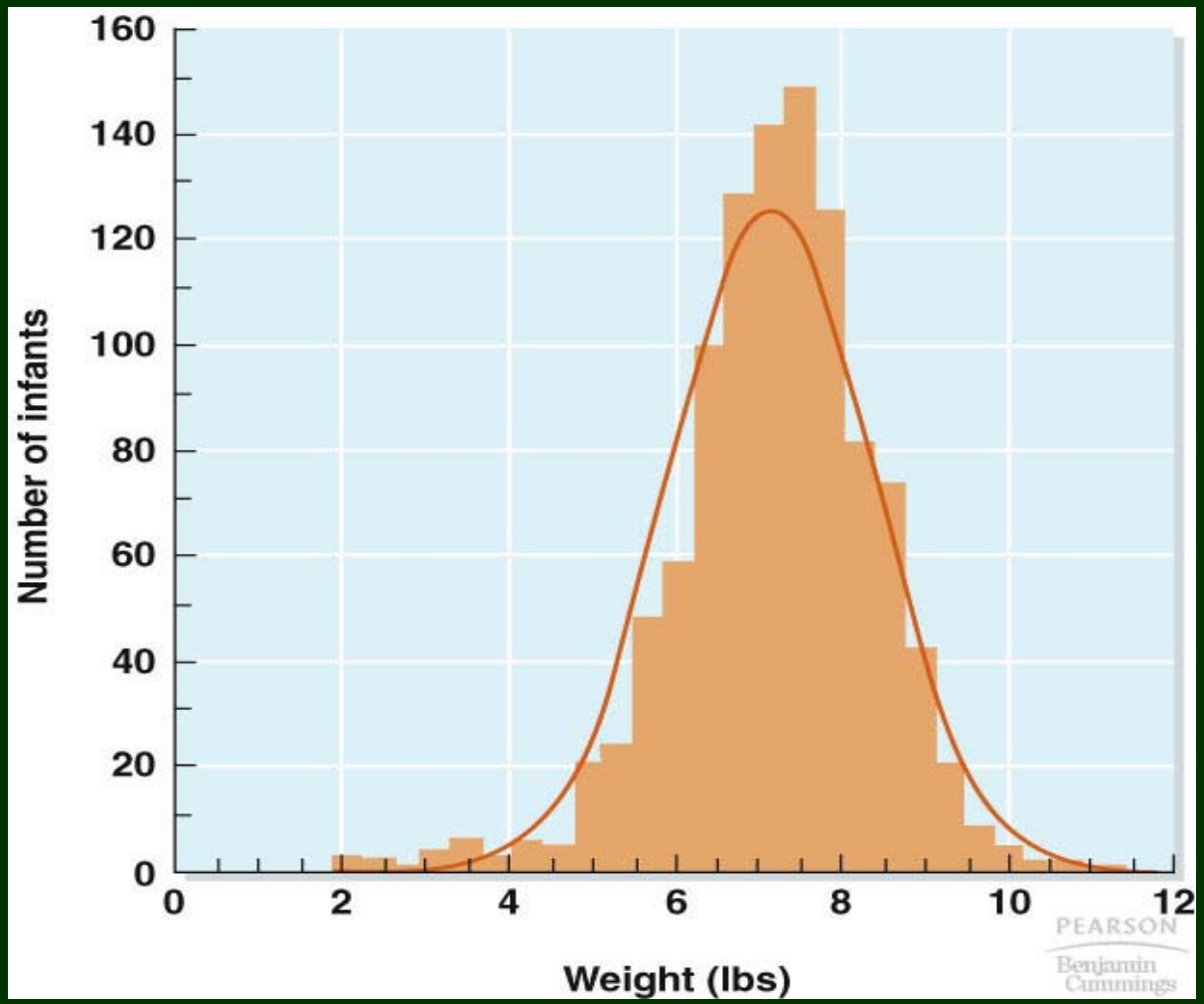


Figure 1-11 Human Molecular Genetics, 3/e. (© Garland Science 2004)

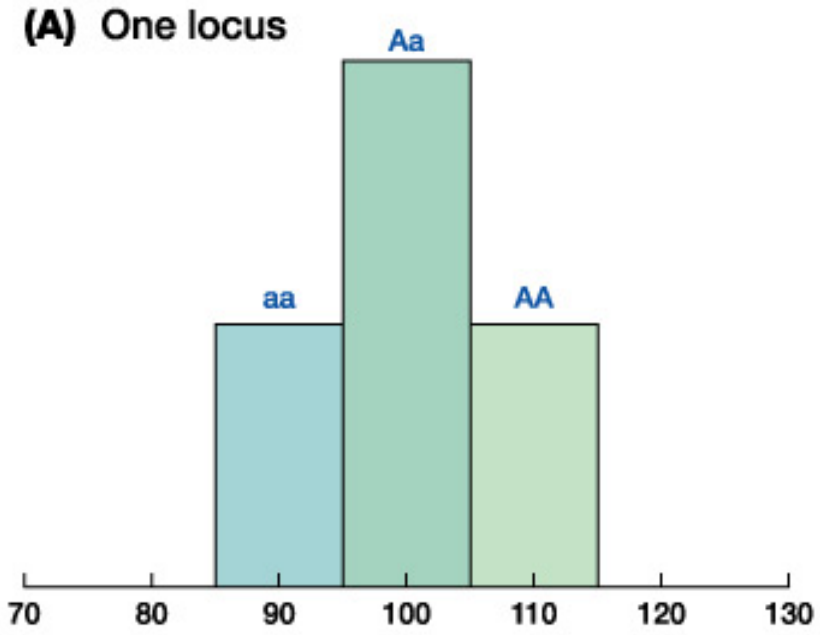
人類嬰兒出生體重分佈之直方圖(histogram)

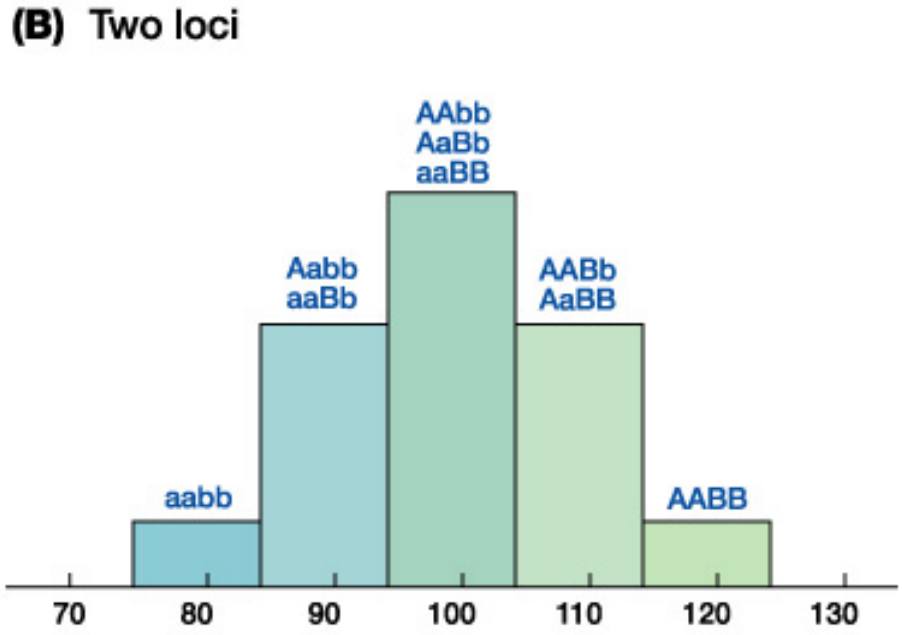


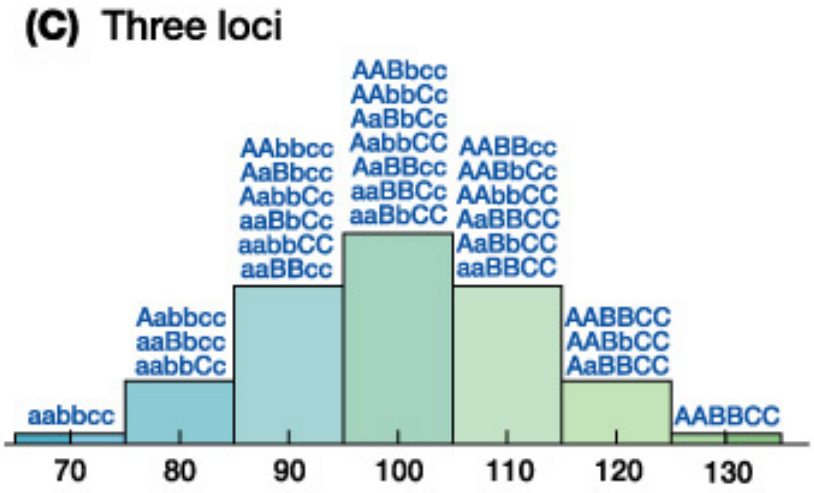
表現型是
連續性的特徵
(continuous trait)

而不是孟德爾遺傳
學所研究之
二分法的特徵
(dichotomous trait)

Peter J. Russell iGenetics 2006, 2nd ed.







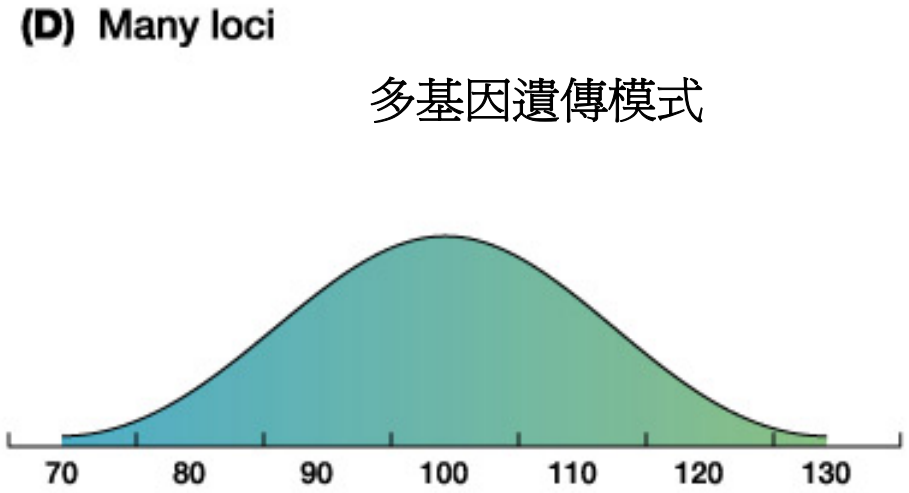


Figure 4-11 Human Molecular Genetics, 3/e. (© Garland Science 2004)

人類疾病與特徵受到遺傳與環境因素共同影響

多基因
Polygenic

單基因
Monogenic

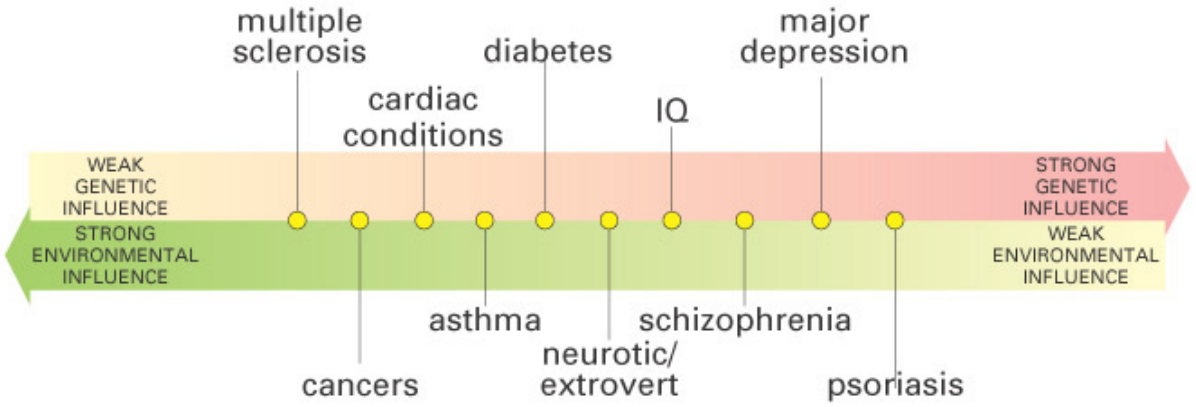
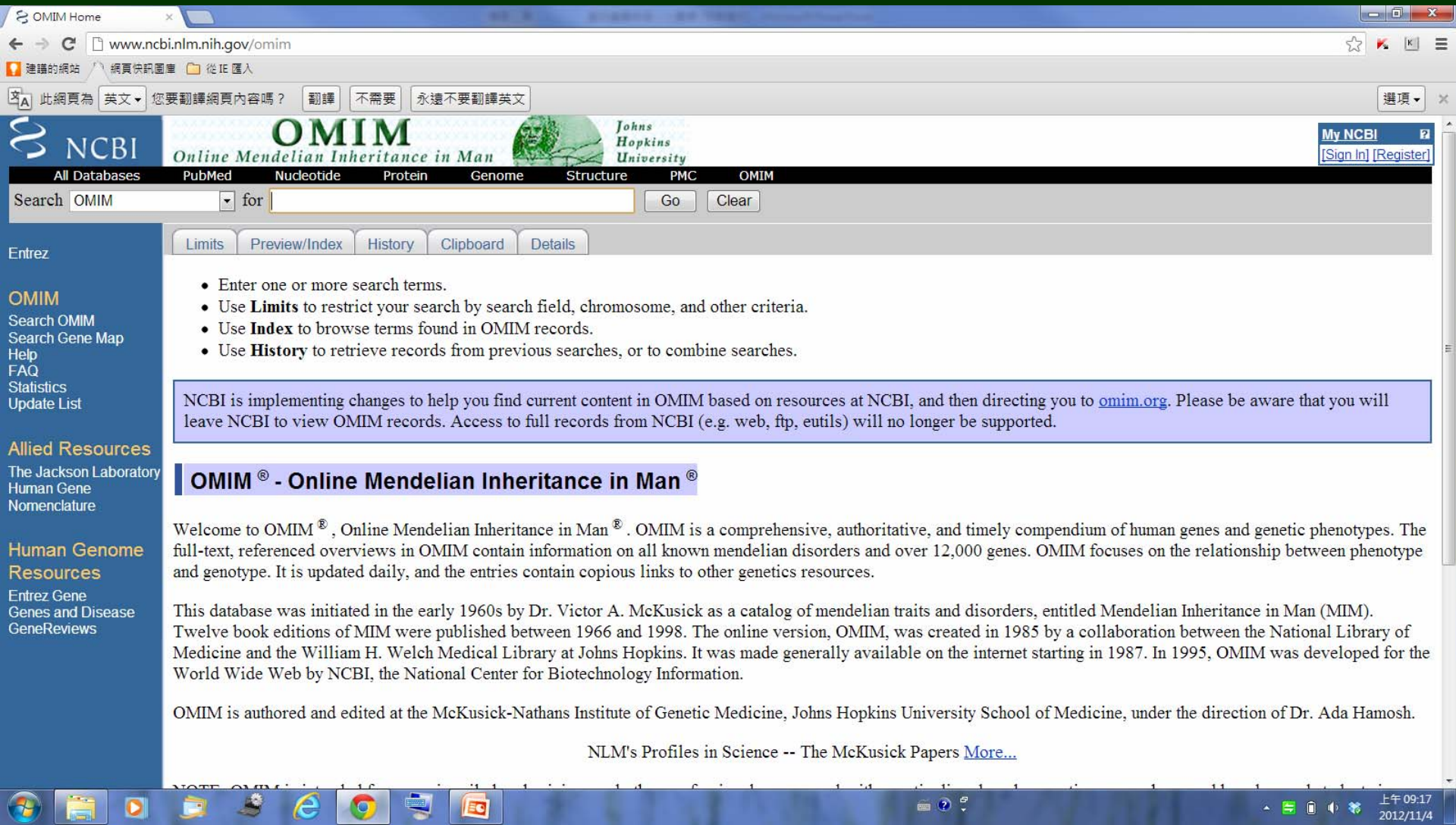


Figure 20-32 Essential Cell Biology, 2/e. (© 2004 Garland Science)

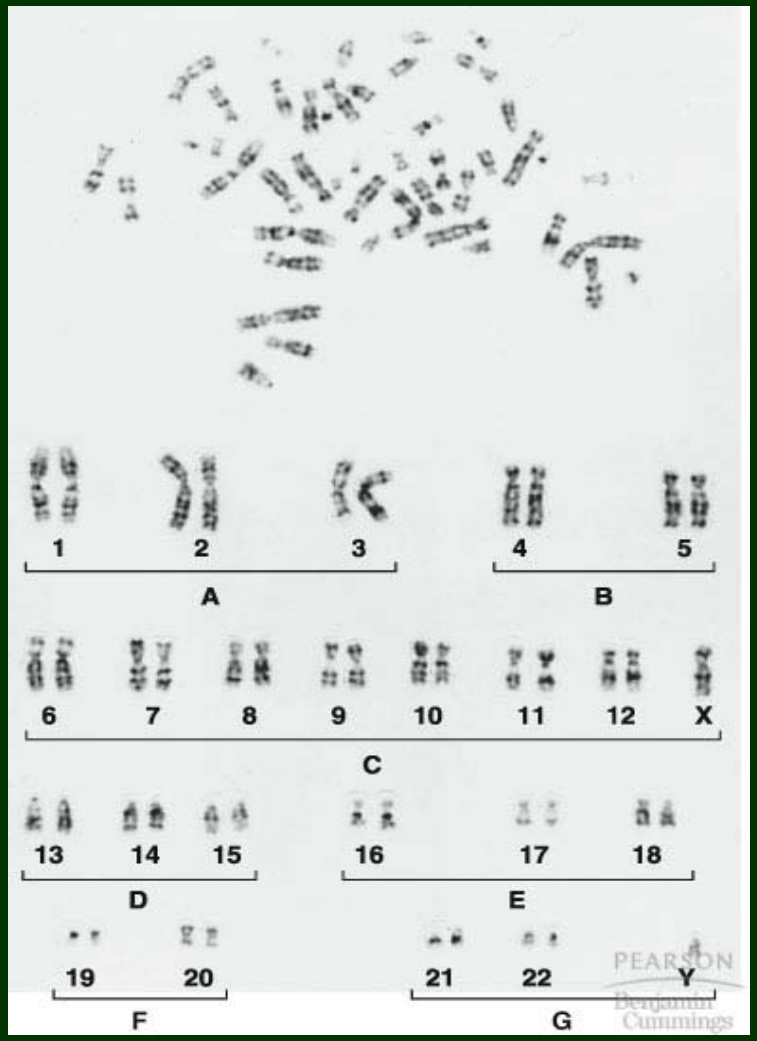
遺傳疾病與再發風險(Recurrence Risk)

- 染色體異常(Chromosomal disorders)
- 粒線體基因突變(Mitochondrial mutations)
- 單基因突變(Monogenic disorders)
- 多基因遺傳模式疾病(Multifactorial or polygenic or complex diseases)
- 體細胞遺傳(Somatic cell genetics)

Online Mendelian Inheritance in Men (http://www.ncbi.nlm.nih.gov/omim)



染色體核型 (karyotyping)



Thymidine

Clocemid

Staining

← **Karyotype**

Karyogram

染色體不分離

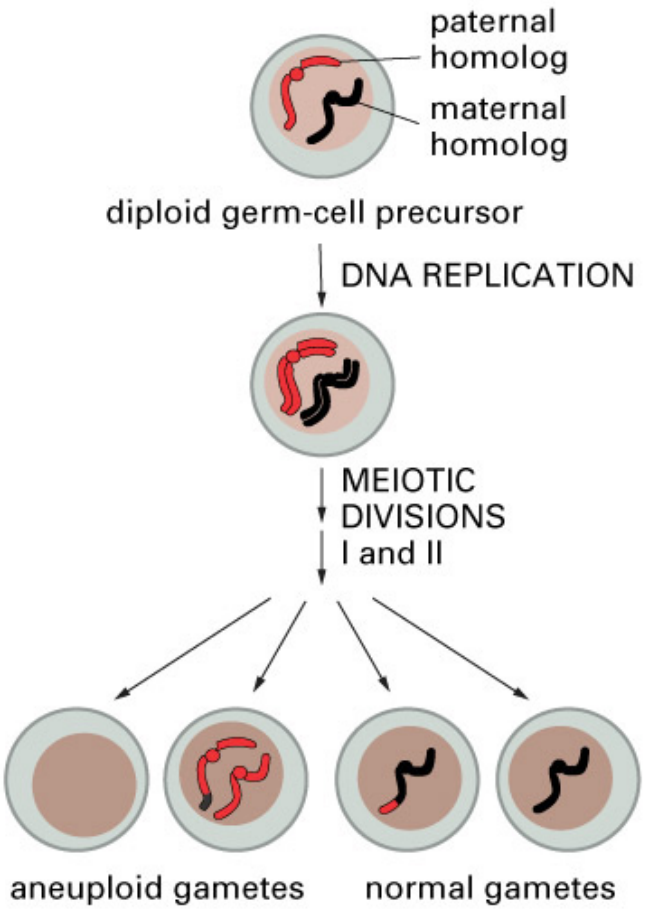


Figure 20-12 Essential Cell Biology, 2/e. (© 2004 Garland Science)

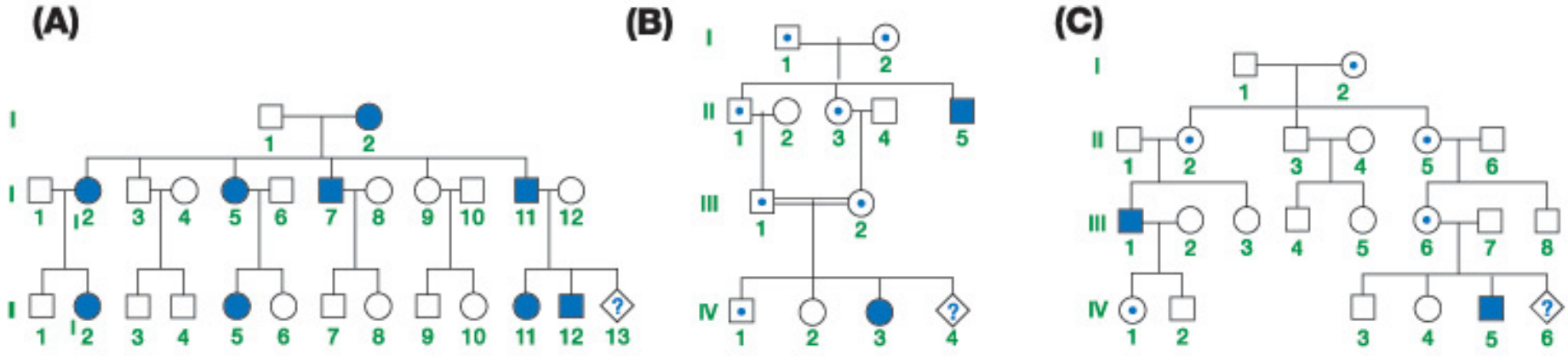
五種孟德爾單基因遺傳族譜型態 (Mendelian Pedigree Patterns)

- 體染色體顯性(autosomal dominant)
- 體染色體隱性(autosomal recessive)
- X體染色體性聯隱性(X-linked recessive)
- X體染色體性聯顯性(X-linked dominant)
- X體染色體性聯(Y-linked)

AD

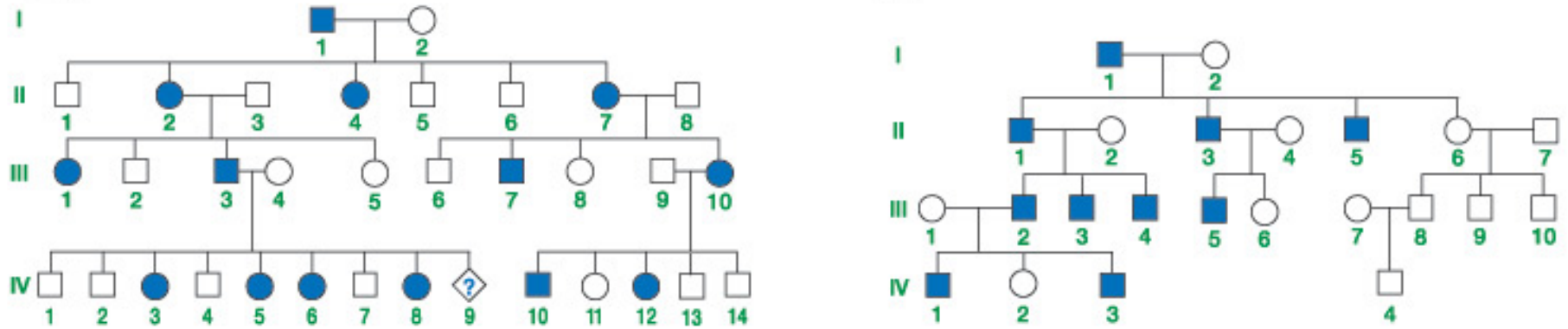
AR

XR



XD

Y



家族譜

Figure 4-2 Human Molecular Genetics, 3/e. (© Garland Science 2004)

粒線體基因遺傳

(Mitochondrial Inheritance)

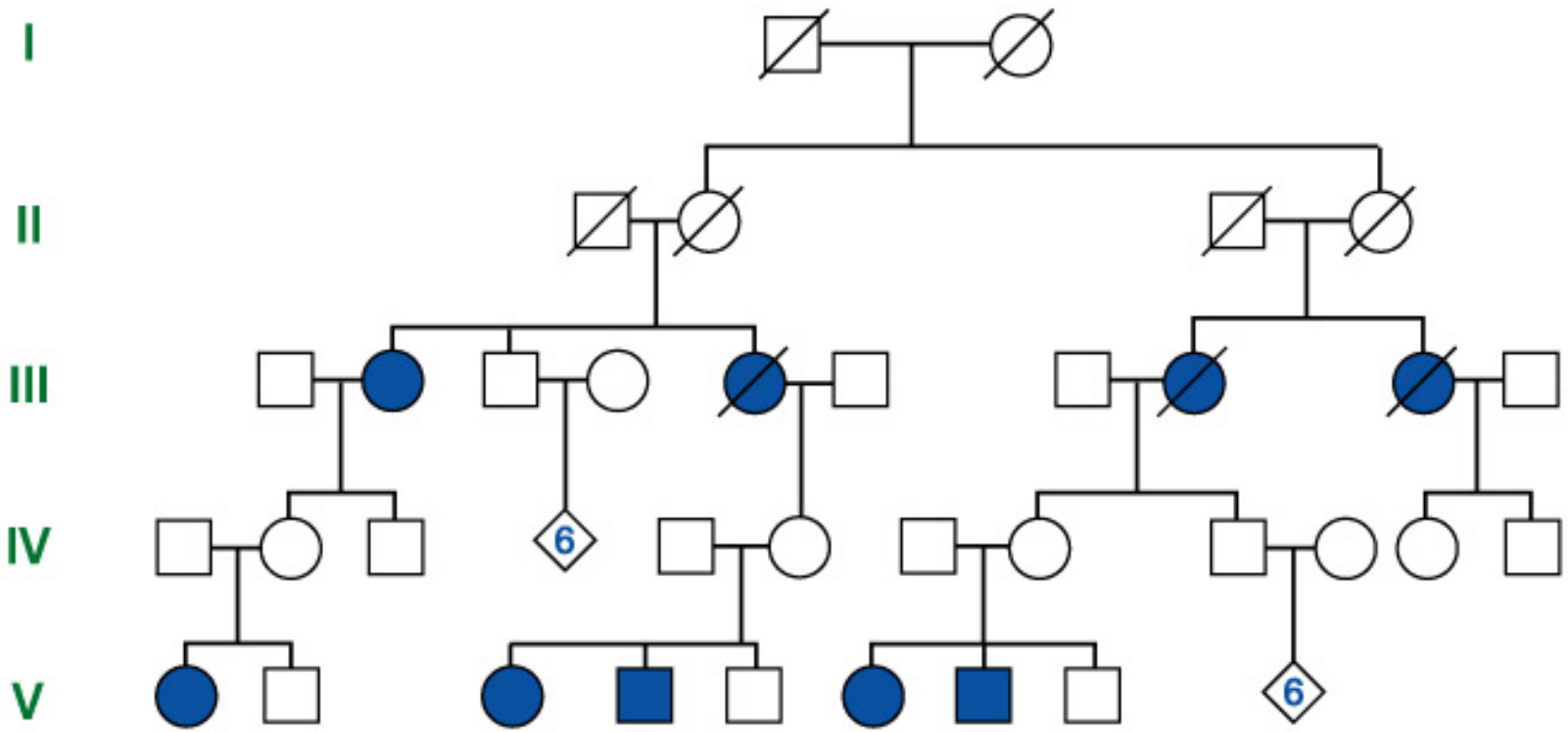


Figure 4-4 Human Molecular Genetics, 3/e. (© Garland Science 2004)

多基因遺傳模式

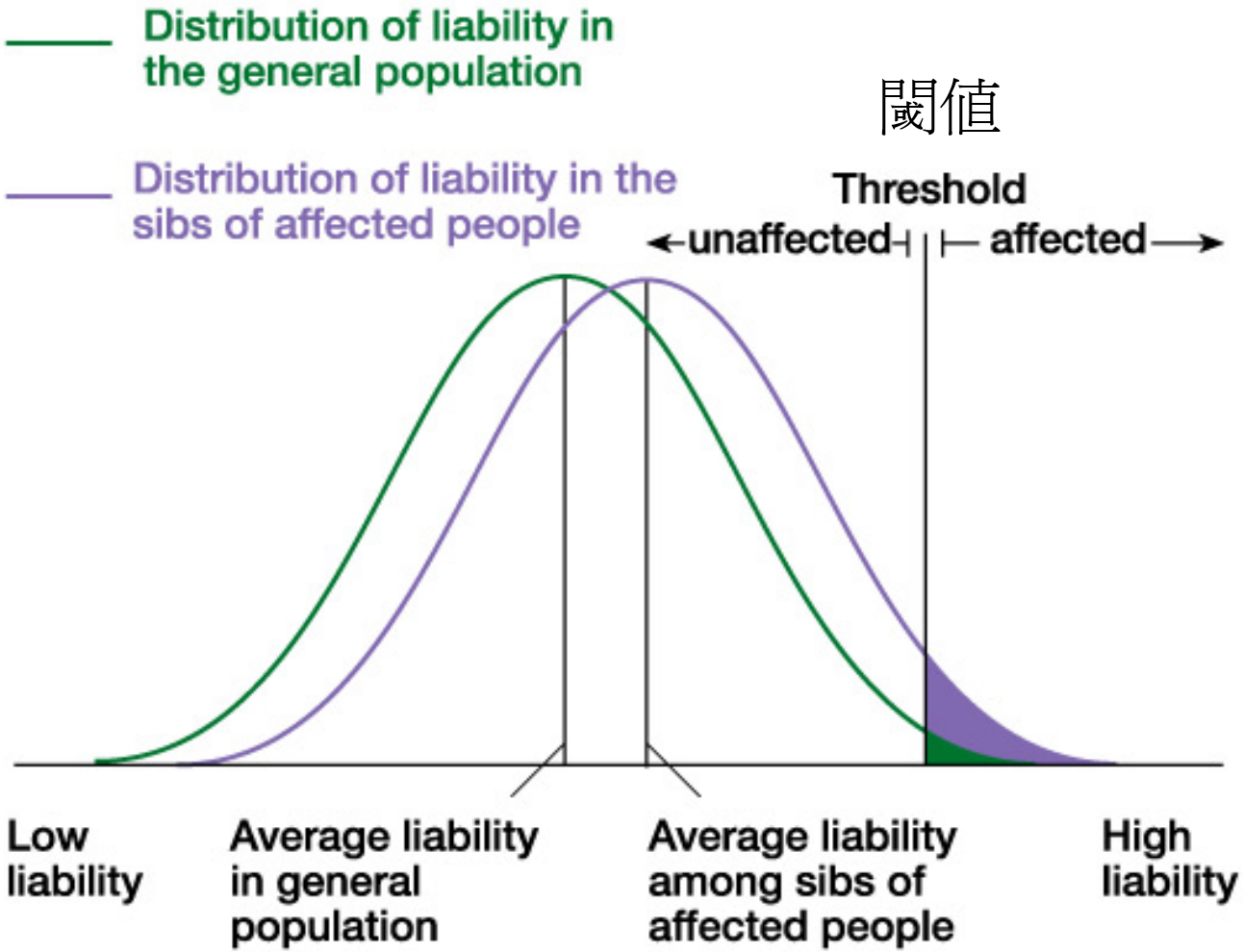


Figure 4-14 Human Molecular Genetics, 3/e. (© Garland Science 2004)

結論

- 孟德爾遺傳學是現代基因醫學的中心理論.
- DNA是遺傳的物質物質基礎.
- DNA數量與組成的變異是遺傳疾病主要來源.
- 幾乎大多數疾病都是基因與環境的交互作用所致.

attention!

Ayers Rock, Central Australia,

Balance of Life!