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1 Genes and Chromosomes

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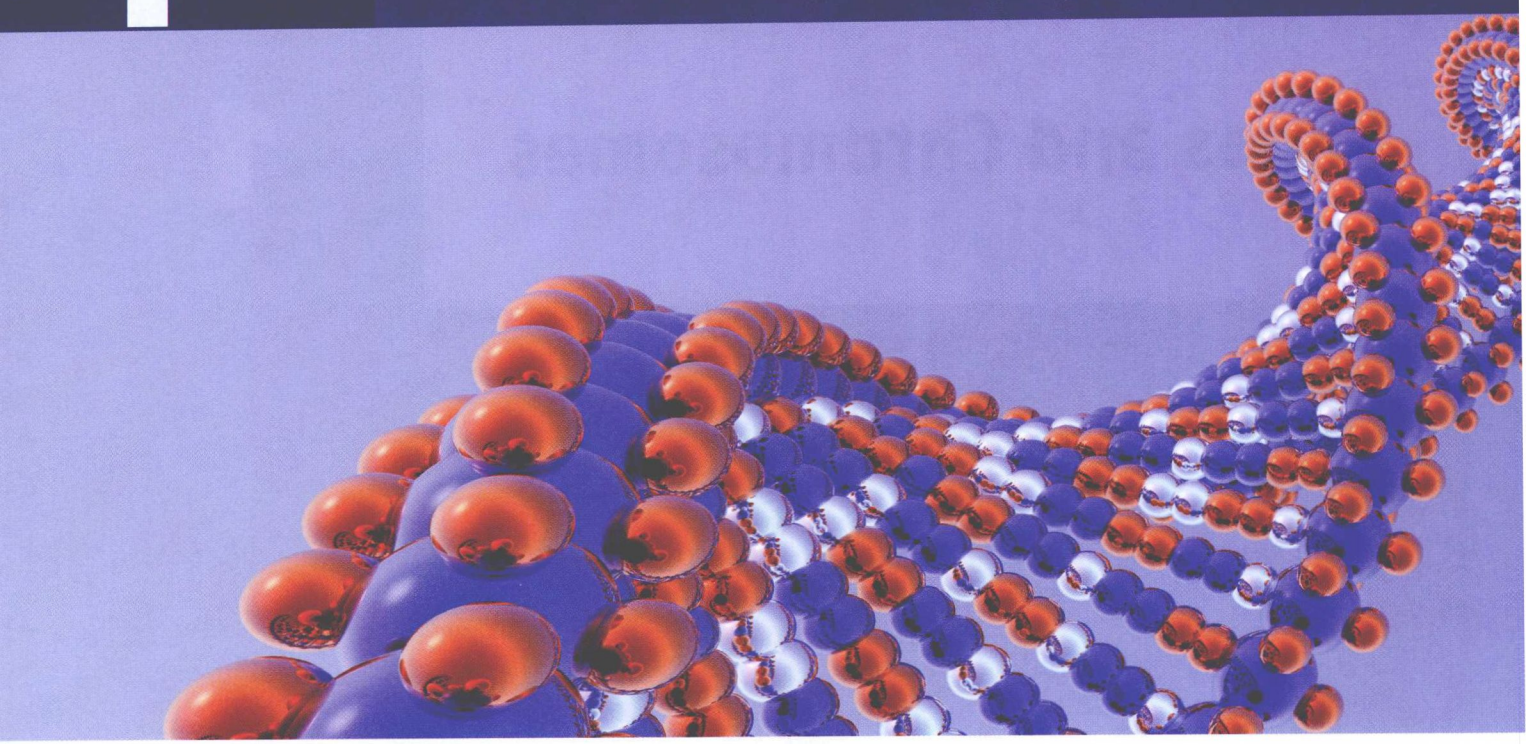

Genes Are DNA

CHAPTER OUTLINE

- The nitrogenous bases of each chain are flat purine or pyrimidine rings that face inward and pair with one another by hydrogen bonding to form only A-T or G-C pairs.
- The diameter of the double helix is 20 Å, and there is a complete turn every 34 Å, with 10 base pairs per turn (~10.4 base pairs per turn in solution).
- The double helix has a major (wide) groove and a minor (narrow) groove.

1.7 DNA Replication Is Semiconservative

- The Meselson–Stahl experiment used "heavy" isotope labeling to show that the single polynucleotide strand is the unit of DNA that is conserved during replication.
- Each strand of a DNA duplex acts as a template for synthesis of a daughter strand.
- The sequences of the daughter strands are determined by complementary base pairing with the separated parental strands.

1.8 Polymerases Act on Separated DNA Strands at the Replication Fork

- Replication of DNA is undertaken by a complex of enzymes that separate the parental strands and synthesize the daughter strands.
- The replication fork is the point at which the parental strands are separated.
- The enzymes that synthesize DNA are called DNA polymerases.
- Nucleases are enzymes that degrade nucleic acids; they include DNases and RNases and can be categorized as endonucleases or exonucleases.

1.9 Genetic Information Can Be Provided by DNA or RNA

- Cellular genes are DNA, but viruses may have genomes of RNA.
- DNA is converted into RNA by transcription, and RNA may be converted into DNA by reverse transcription.
- The translation of RNA into protein is unidirectional.

1.10 Nucleic Acids Hybridize by Base Pairing

- Heating causes the two strands of a DNA duplex to separate.
- The T_m is the midpoint of the temperature range for denaturation.
- Complementary single strands can renature when the temperature is reduced.
- Denaturation and renaturation/hybridization can occur with DNA–DNA, DNA–RNA, or RNA–RNA combinations and can be intermolecular or intramolecular.
- The ability of two single-stranded nucleic acids to hybridize is a measure of their complementarity.

1.11 Mutations Change the Sequence of DNA

- All mutations are changes in the sequence of DNA.
- Mutations may occur spontaneously or may be induced by mutagens.

1.12 Mutations May Affect Single Base Pairs or Longer Sequences

- A point mutation changes a single base pair.
- Point mutations can be caused by the chemical conversion of one base into another or by errors that occur during replication.
- A transition replaces a G-C base pair with an A-T base pair or vice versa.
- A transversion replaces a purine with a pyrimidine, such as changing A-T to T-A.
- Insertions and/or deletions can result from the movement of transposable elements.

1.13 The Effects of Mutations Can Be Reversed

- Forward mutations alter the function of a gene, and back mutations (or revertants) reverse their effects.
- Insertions can revert by deletion of the inserted material, but deletions cannot revert.
- Suppression occurs when a mutation in a second gene bypasses the effect of mutation in the first gene.

1.14 Mutations Are Concentrated at Hotspots

- The frequency of mutation at any particular base pair is statistically equivalent, except for hotspots, where the frequency is increased by at least an order of magnitude.

1.15 Many Hotspots Result from Modified Bases

- A common cause of hotspots is the modified base 5-methylcytosine, which is spontaneously deaminated to thymine.
- A hotspot can result from the high frequency of change in copy number of a short, tandemly repeated sequence.

1.16 Some Hereditary Agents Are Extremely Small

- Some very small hereditary agents do not encode polypeptide, but consist of RNA or protein with heritable properties.

1.17 Summary

1.1 Introduction

The hereditary basis of every living organism is its **genome**, a long sequence of deoxyribonucleic acid (DNA) that provides the complete set of hereditary information carried by the organism as well as its individual cells. The genome includes chromosomal DNA as well as DNA in plasmids and (in eukaryotes) organellar DNA, as found in mitochondria and chloroplasts. We use the term *information* because the genome does not itself perform an active role in the development of