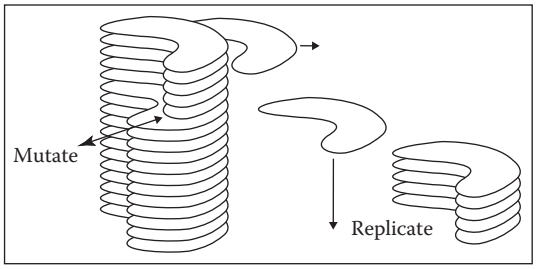
FIGURE 2.1

ALH84001. A rock from Mars retrieved on Earth.

FIGURE 2.2

Replication and reproduction. (a) Replication and reproduction in a stack of clay platelets. (b) Electron micrographs of the structure of kaolinite clay.

(a)



(b)

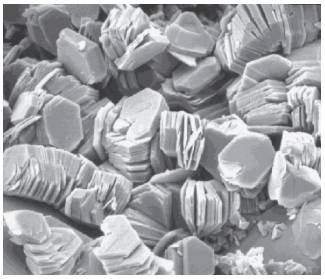


FIGURE 2.3

The tree of life.

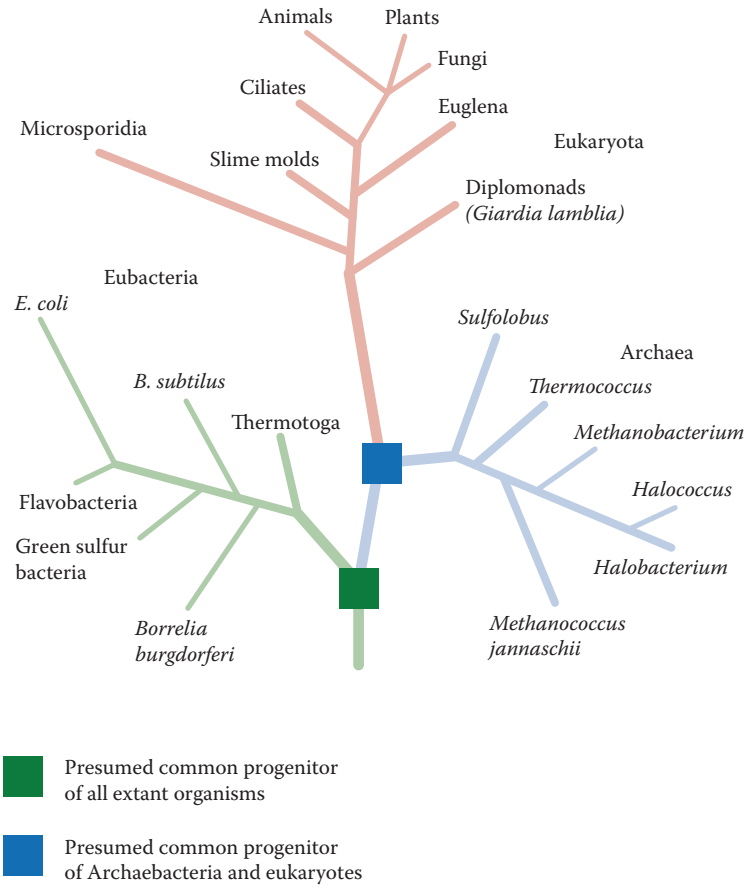


FIGURE 2.4

(a) Single-stranded RNA. (b) Double-stranded DNA.

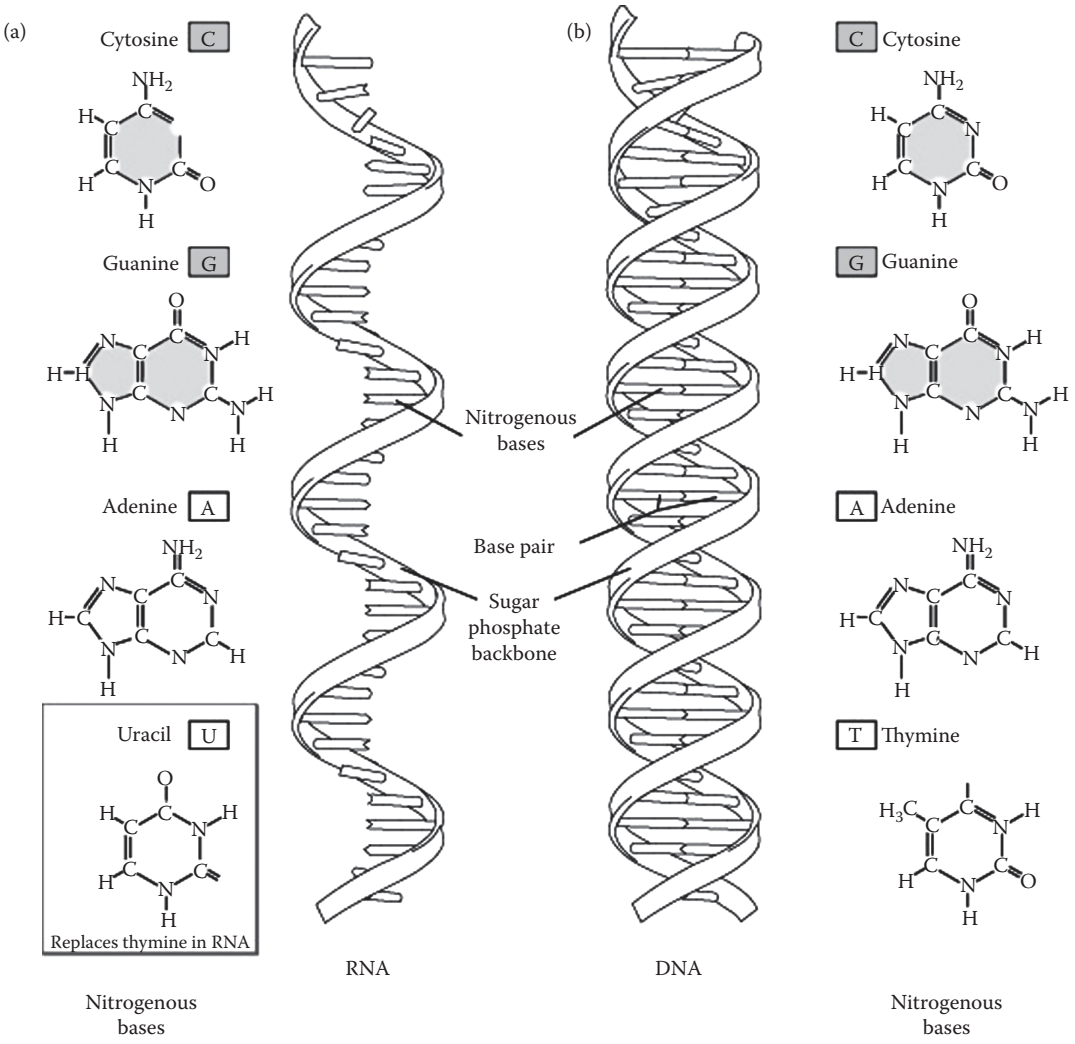


FIGURE 2.5

Rosalind Franklin.

FIGURE 2.6

Base pairing in DNA.

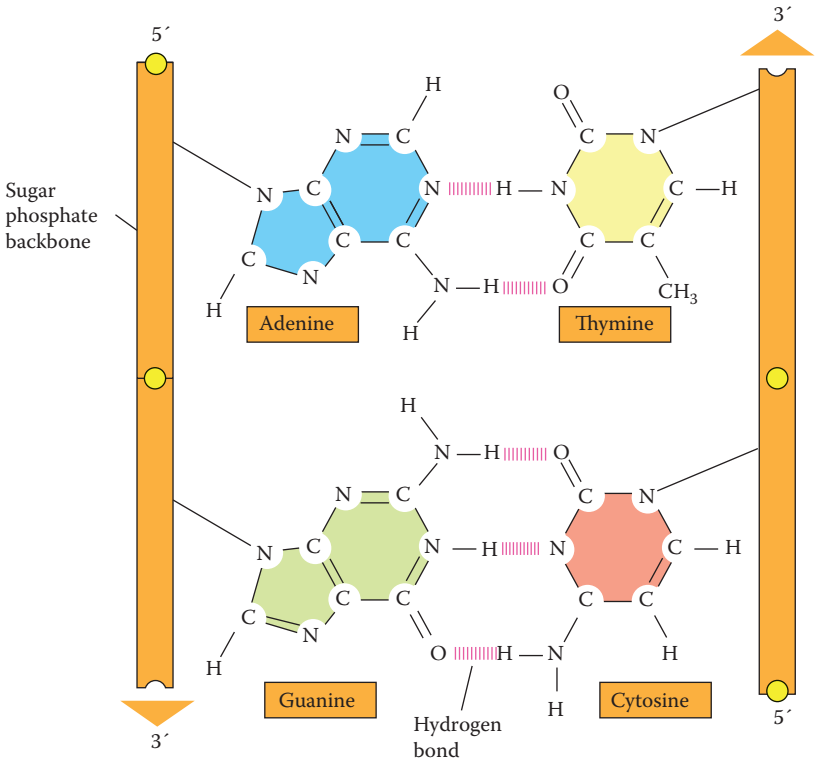


FIGURE 2.7

The DNA replication process.

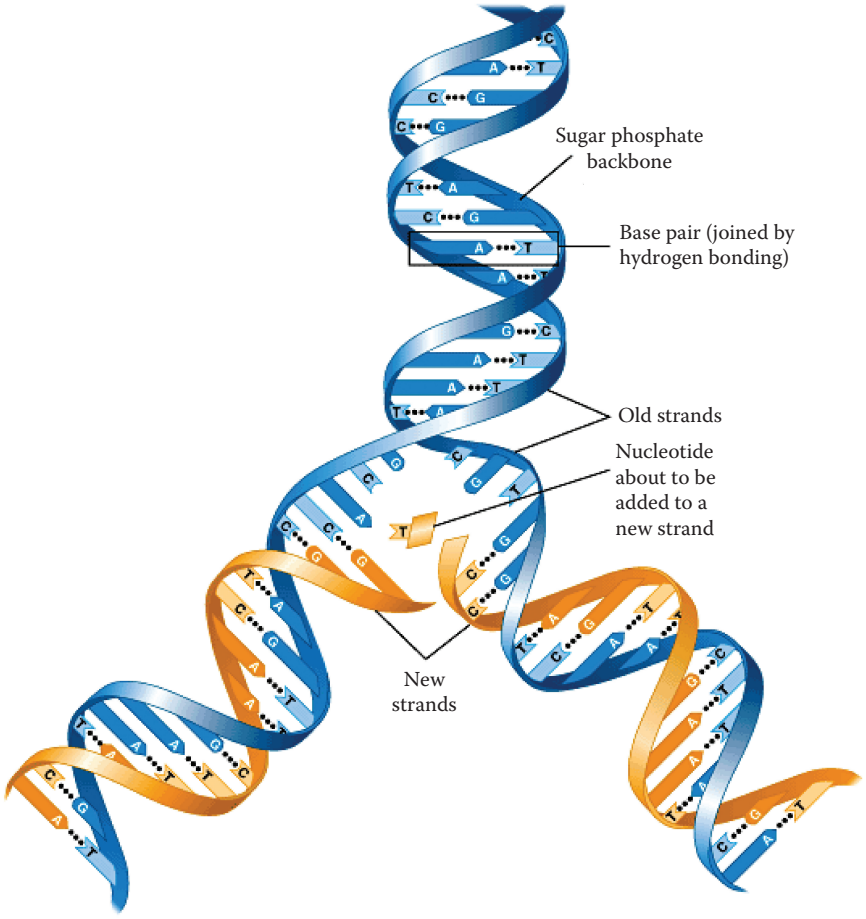


FIGURE 2.8

Right- and left-handed bromochlorofluoromethane. The left-handed form of a chiral molecule rotates a beam of polarized light to the left, while the right-handed form rotates it to the right. The example shown in this figure is the CHFClBr molecule.

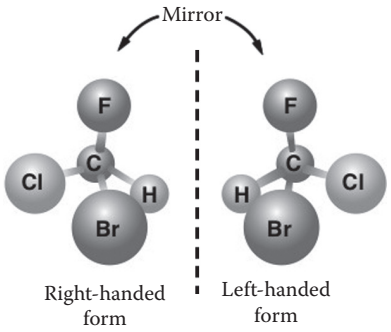


FIGURE 2.9

Water release in protein formation: proteins consist of a polypeptide backbone with attached side chains.

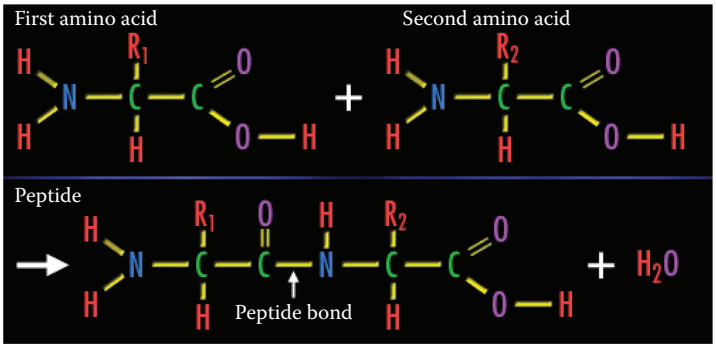


FIGURE 2.10

A protein emerges from a ribosome.

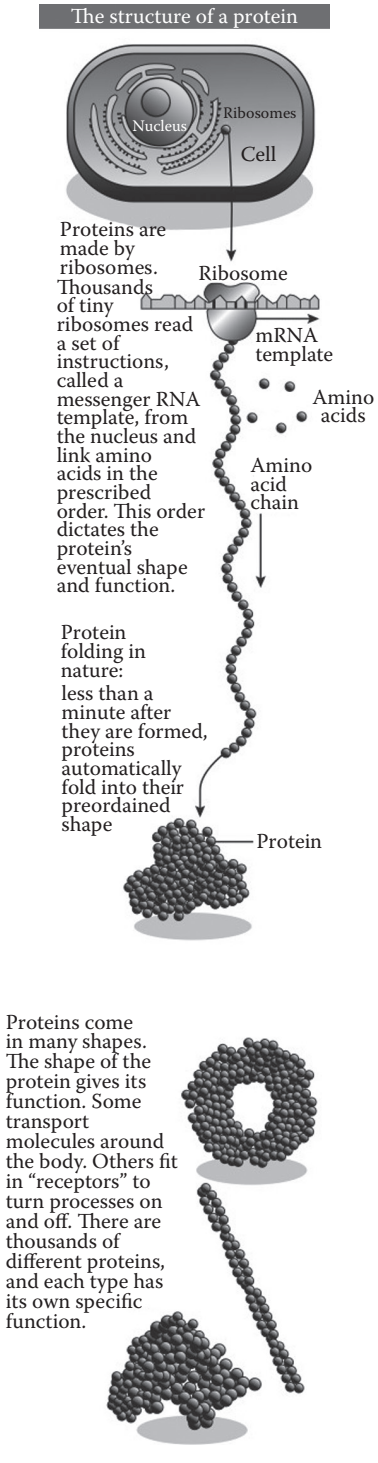


FIGURE 2.11

The various protein structural organizational levels.

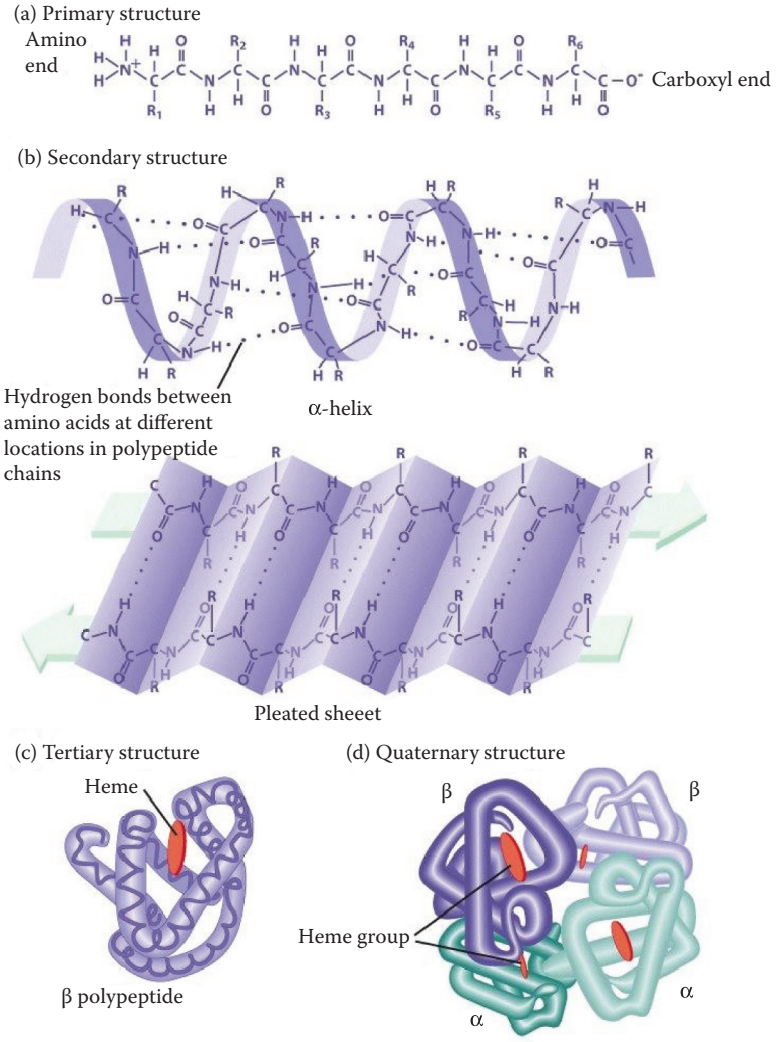


FIGURE 2.12

Protein manufacture: transcription and translation.

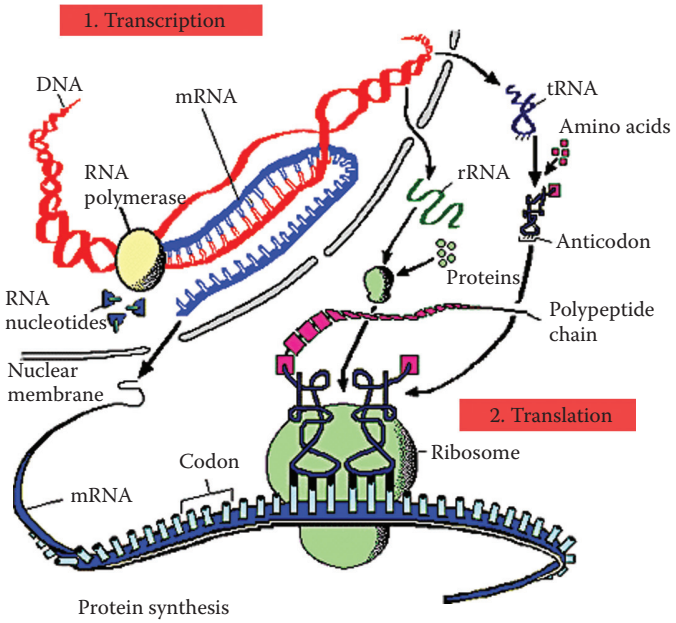


FIGURE 2.13

In the expanded gene, only the exons actually code for the protein corresponding to the gene.

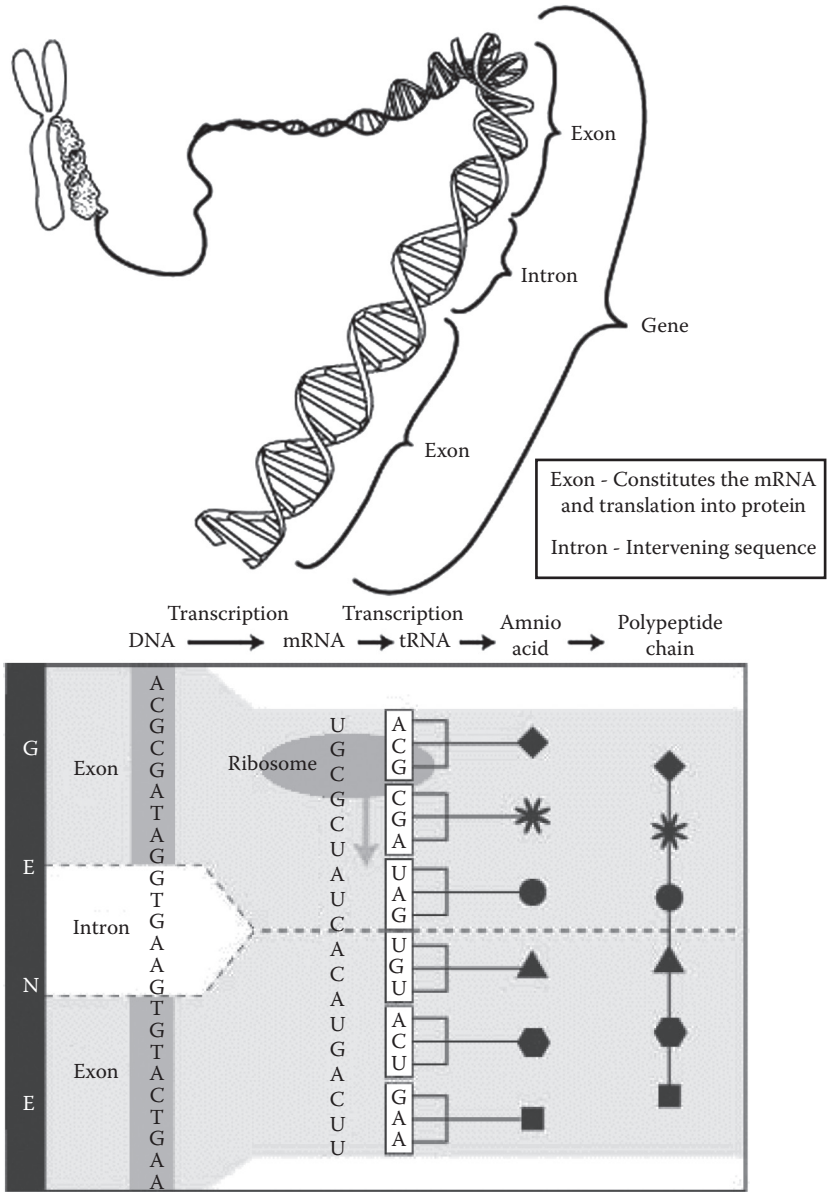
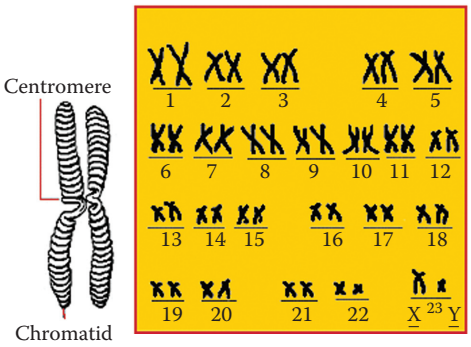


FIGURE 2.14

Human chromosomes and genome size (bases) and estimated number of genes for some different organisms.



Organism	Genome Size (Bases)	Estimated Genes
Human (*Homo sapiens*)	3 billion	30,000
Laboratory mouse (*M. musculus*)	2.6 billion	30,000
Mustard weed (*A. thaliana*)	100 million	25,000
Roundworm (*C. elegans*)	97 million	19,000
Fruit fly (*D. melanogaster*)	137 million	13,000
Yeast (*S. cerevisiae*)	12.1 million	6,000
Bacterium (*E. coli*)	4.6 million	3,200
Human immunodeficiency virus (HIV)	9,700	9

FIGURE 2.15

From chromosome in the nucleus to DNA.

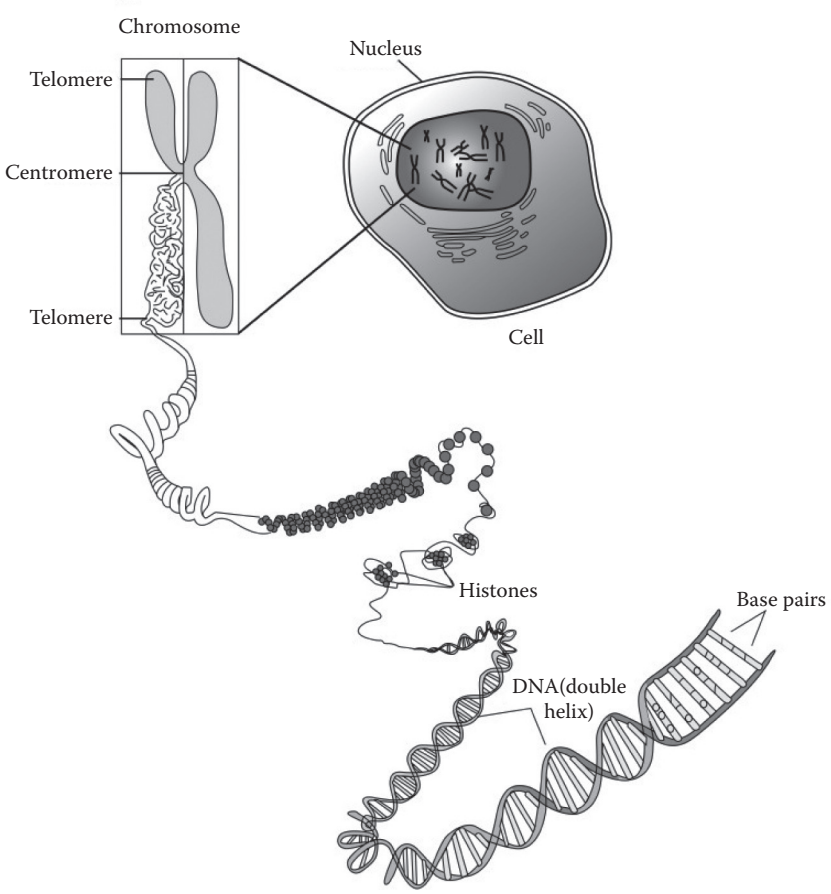


FIGURE 2.16

A generic cloning procedure performed in bacteria.

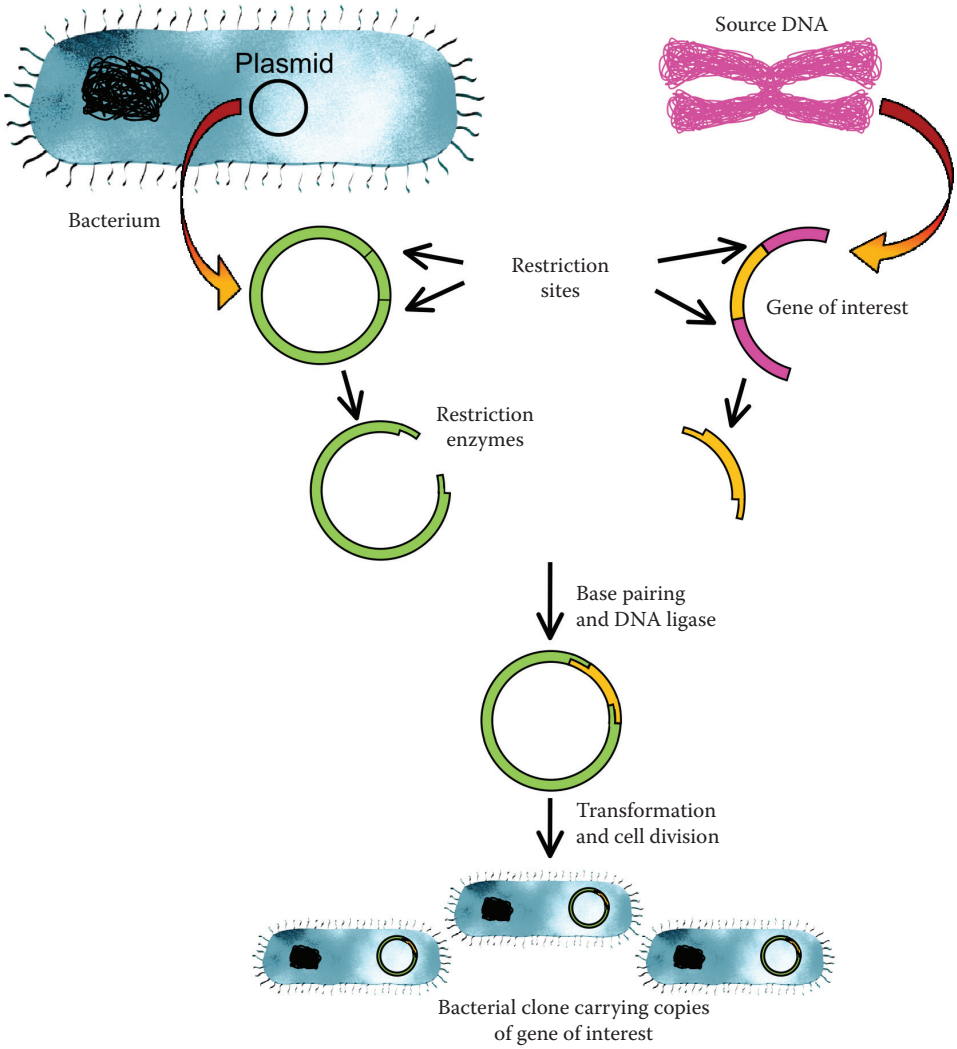


FIGURE 2.17

Reproductive cloning.

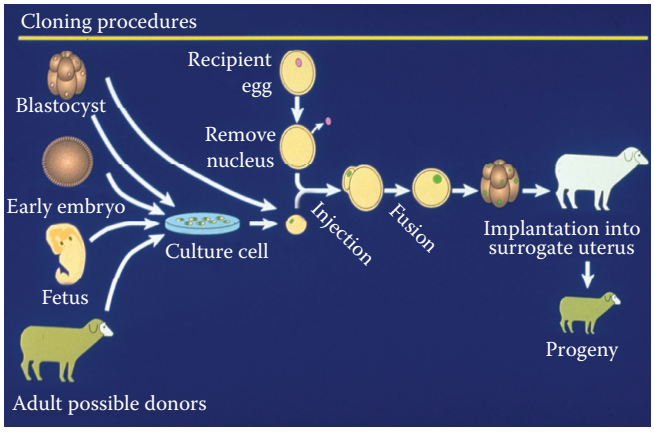


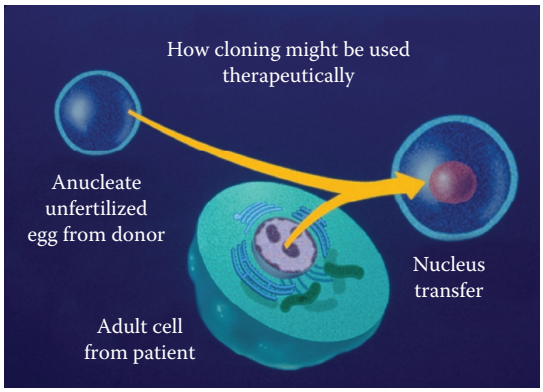
FIGURE 2.18

Dolly with her firstborn lamb, Bonnie. All of Dolly's offspring were bred the old-fashioned way. (Roslin Institute Image Library, http://www.roslin.ac.uk.)

FIGURE 2.19

Therapeutic cloning.

(a)



(b)

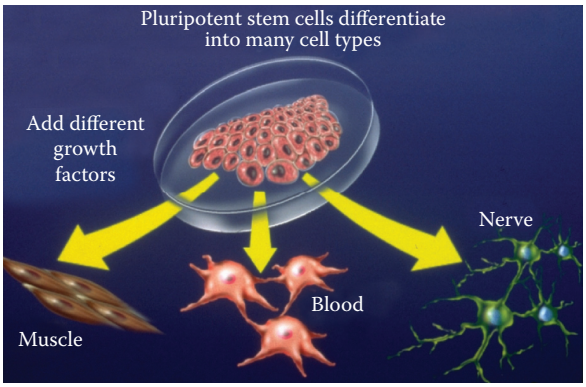
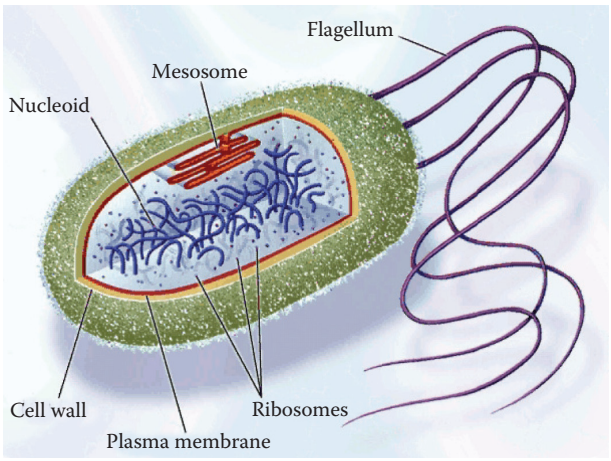


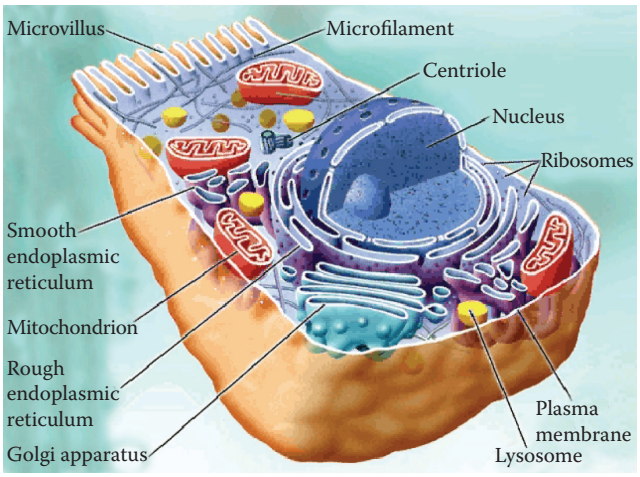
FIGURE 2.20

Comparison of a prokaryotic cell (a) and an eukaryotic cell (b).

(a)



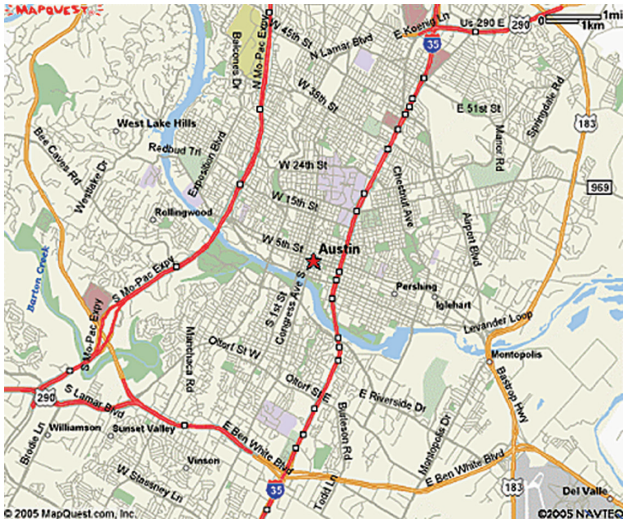
(b)

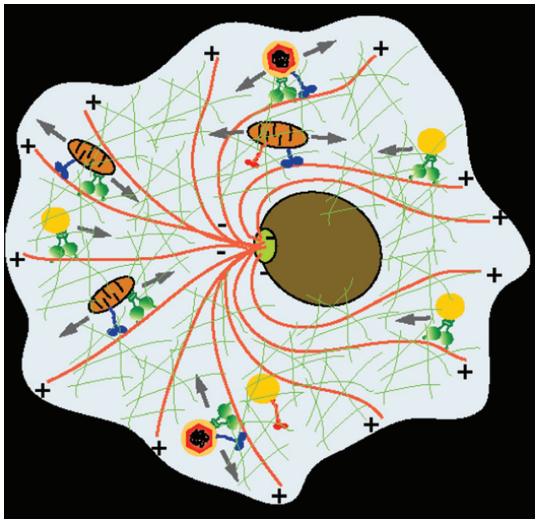


Prokaryotes	Eukaryotes
No nucleus—have a nuclear "area"	Nucleus present
No membrane-bound organelles	Have membrane-bound organelles
DNA present usually as 1 large chromosome	DNA in nucleus
Primitive cells usually quite small	"Modern" cells, can be quite large
Archebacteria, Eubacteria	Plants, Animals, Fungi, Protists

FIGURE 2.21

The cell is like a city.





Workers/machines	Proteins
Roads	Actin filaments
Highways	Microtubules
Trucks	Molecular motors
Power plants	Mitochondria
Factories	Ribosomes
Library	Nucleus with DNA
Post office	Golgi apparatus
Police	Chaperones
Gates, keys, passes	Ion channels
Electric fences	Membranes
Train tracks	Actin filament network
Motors, generators	ATP synthases
Vehicles	Hemoglobin
Train control center	Centrosome
Copy machines	Polymerases
Chain couplers	Ligases
Bulldozers, destroyers	Proteases, proteasomes
Internet nodes	Neuron synapses
Mail sorting machines	Protein sorting machines

FIGURE 2.22

Evolutionary trees or phylogenies can be reconstructed by comparing mitochondrial DNA.

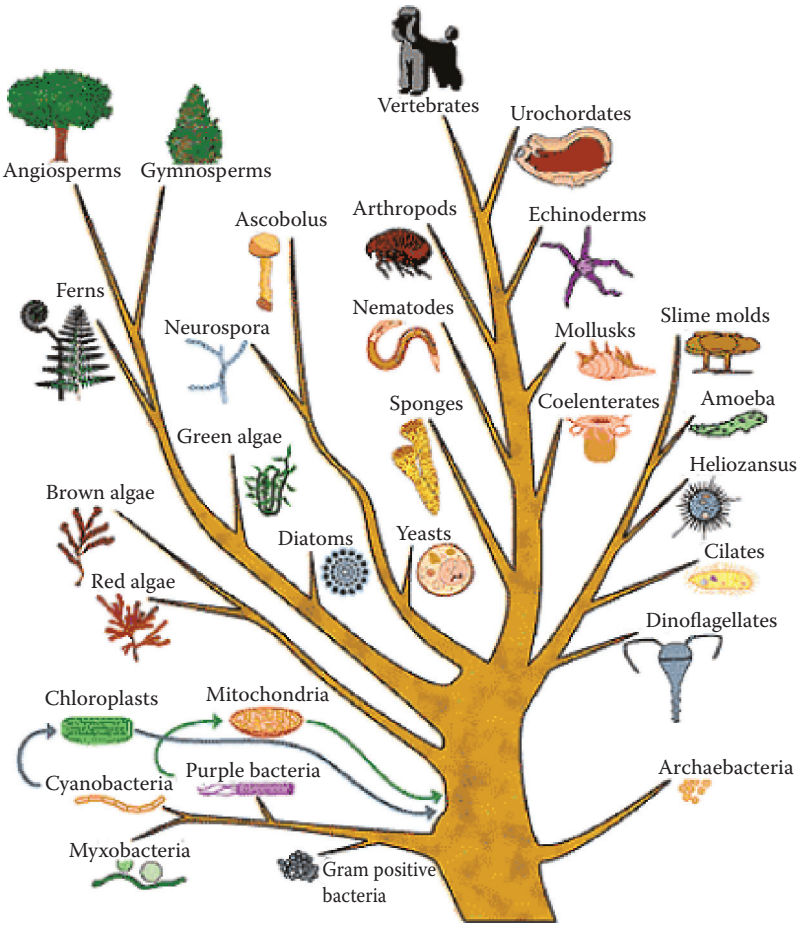


FIGURE 2.23

Mitochondria.

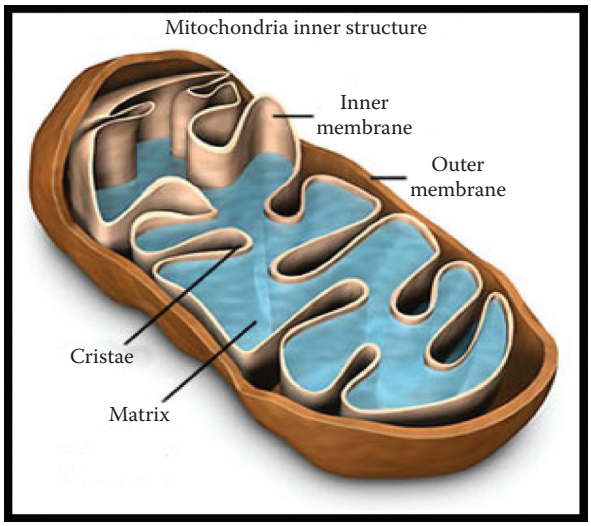
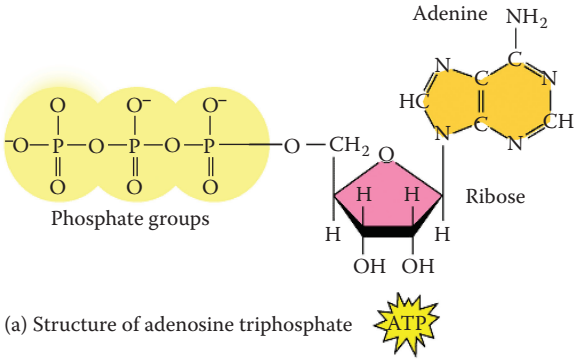
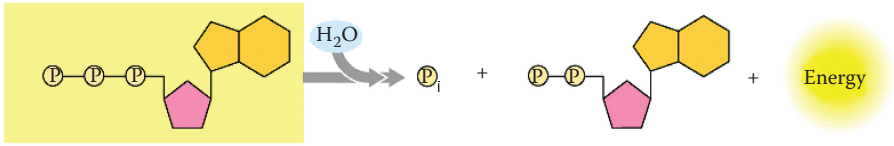


FIGURE 2.24

(a) Molecular structure of adenosine triphosphate (ATP). (b) Hydrolysis of ATP to ADP.



(a) Structure of adenosine triphosphate



Adenosine triphosphate (ATP) | Inorganic phosphate | Adenosine diphosphate (ADP)

(b) Hydrolysis of ATP

FIGURE 2.25

Photosynthesis in plants: from trees to pigment molecules in the thylakoids in chloroplasts.

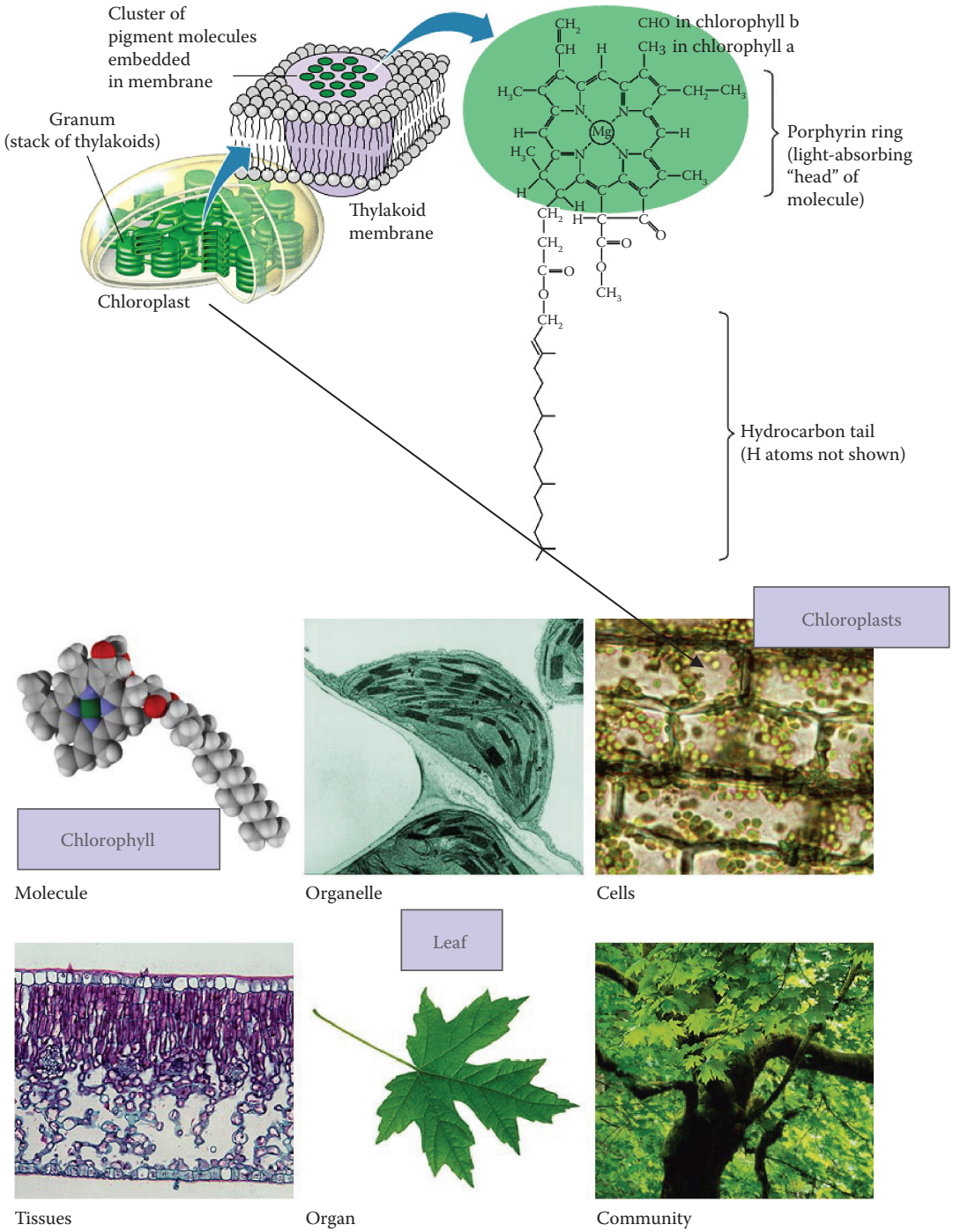


FIGURE 2.26

(a) Anabolic process: use of energy to conduct unfavorable/uphill reactions (from small to large molecules). (b) Catabolic processes: fuel breakdown to deliver energy (from large molecules to small).

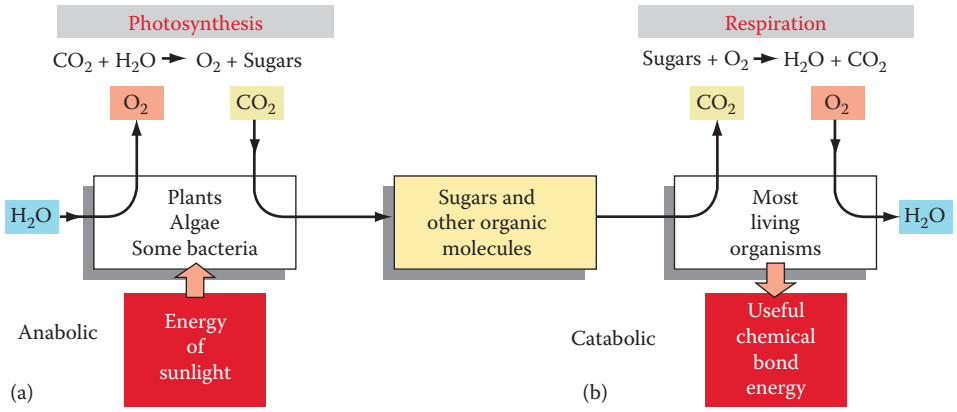


FIGURE 2.27

Various pathways to making of pyruvate, the food source for mitochondria.

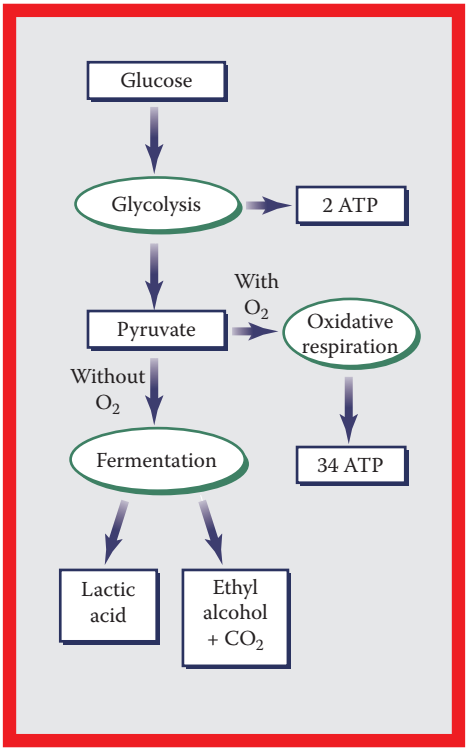


FIGURE 2.28

The various processes that ATP energizes: ATP at work.

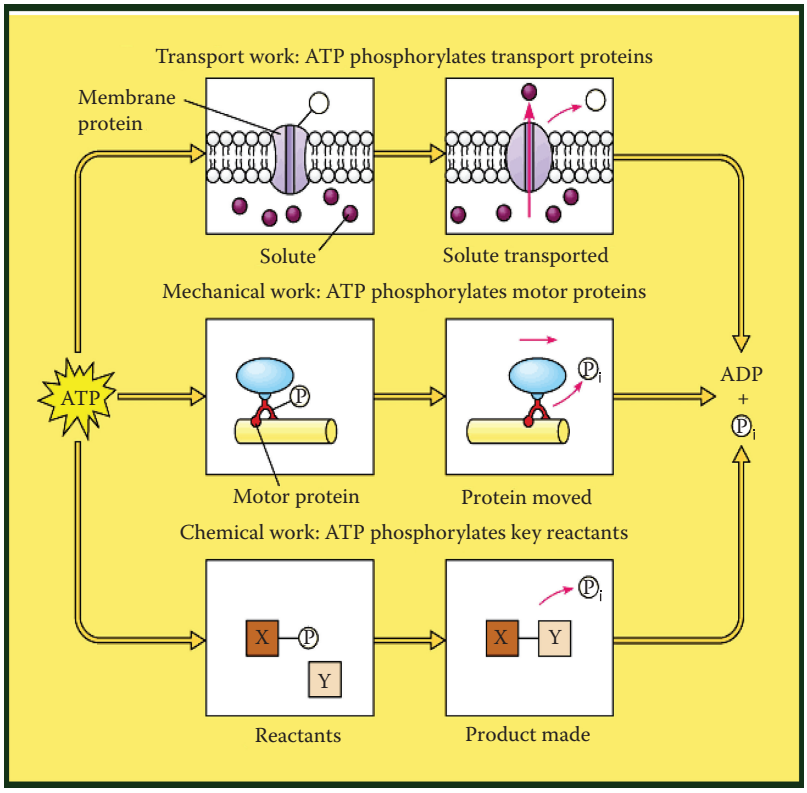


FIGURE 2.29

From light to photosynthesis to cellular respiration and heat energy.

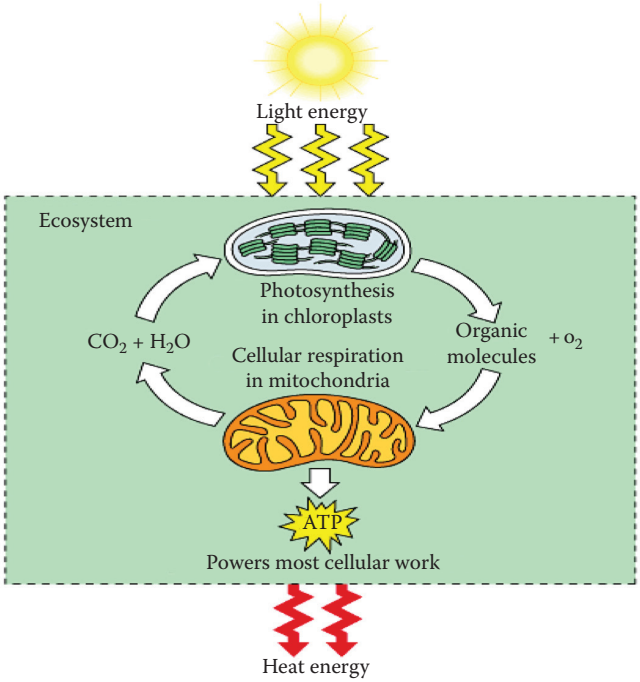


FIGURE 2.30

Stomata and veins in a green leaf.

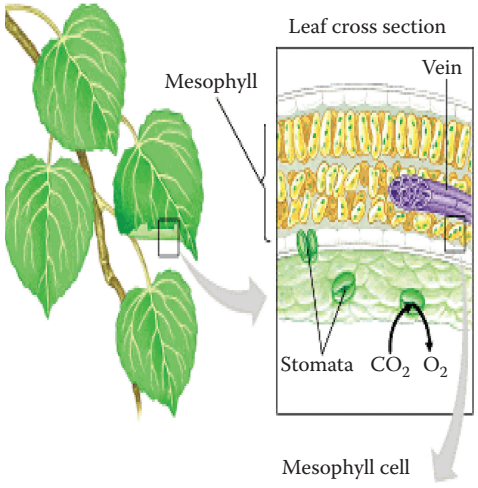


FIGURE 2.31

Photosynthesis with light reaction and dark reaction in the Calvin-Benson cycle.

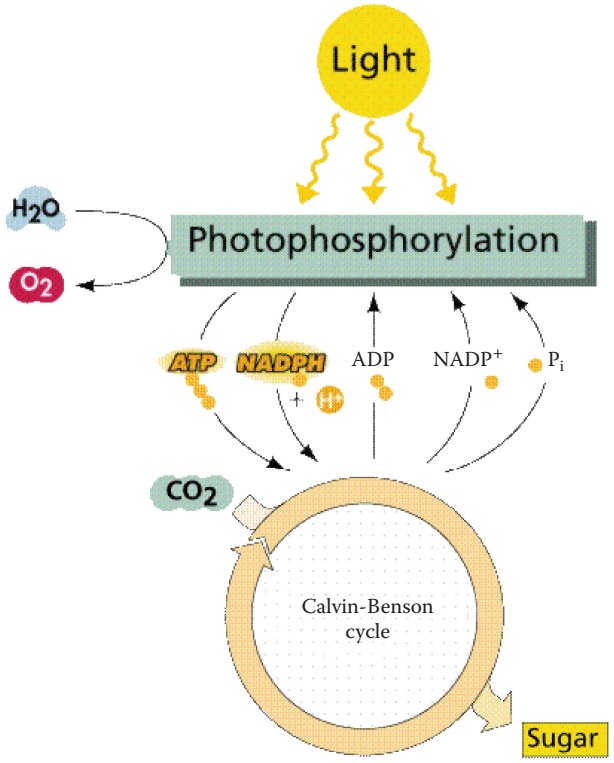


FIGURE 2.32

Kinesin motor. Schematic diagram showing movements mediated by kinesin, an ATP-driven motor, on microtubule tracks. Vesicles and beads containing kinesin molecules on their surface move toward the plus end of microtubules. Microtubules can also move themselves along a glass slide containing bound kinesin.[48]

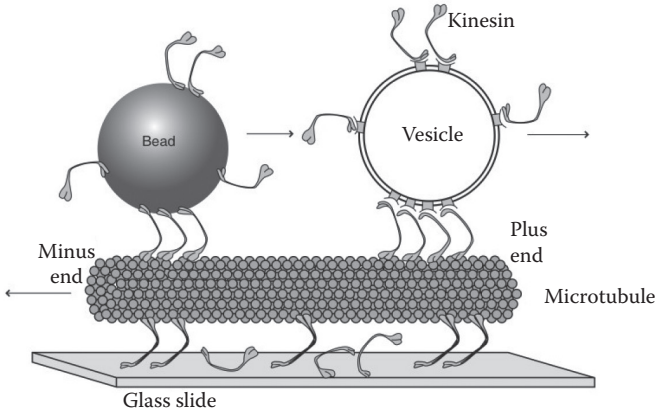


FIGURE 2.33

Laser tweezers were used to study kinesin motors with the kinesin molecule attached to a bead traveling over a microtubule. (From http://www.stanford.edu/group/blocklab.)

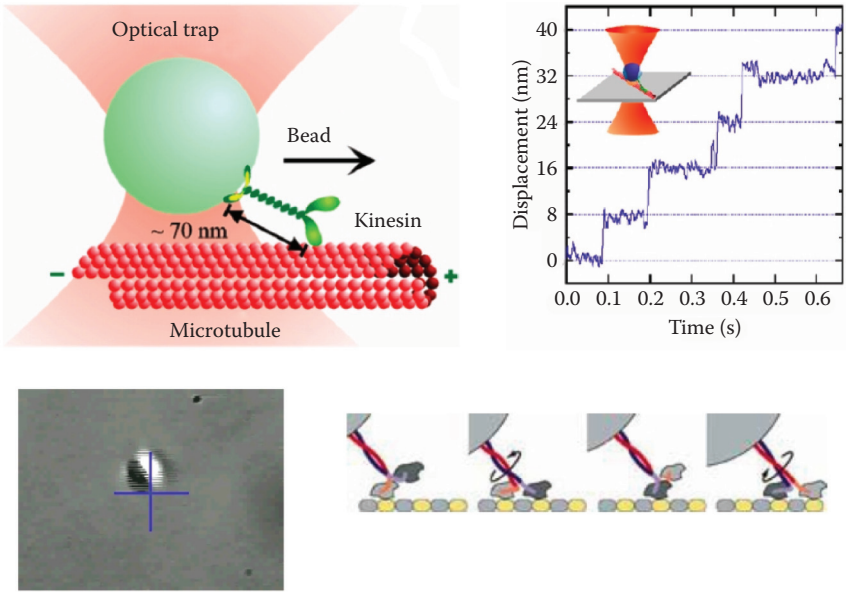


FIGURE 2.34

ATPase motors. A single molecule of F_0 F_1-ATPase acts as a rotary motor—the smallest known. A central rotor of radius ~1 nm, formed by its γ-subunit, turns in a stator barrel of radius ~5 nm formed by three α- and three β-subunits.

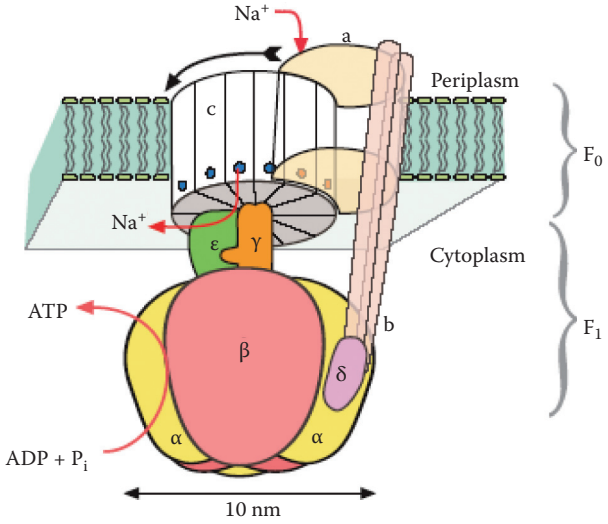


FIGURE 2.35

Bacteria swim in viscous liquid environments by rotating helical propellers called flagella.

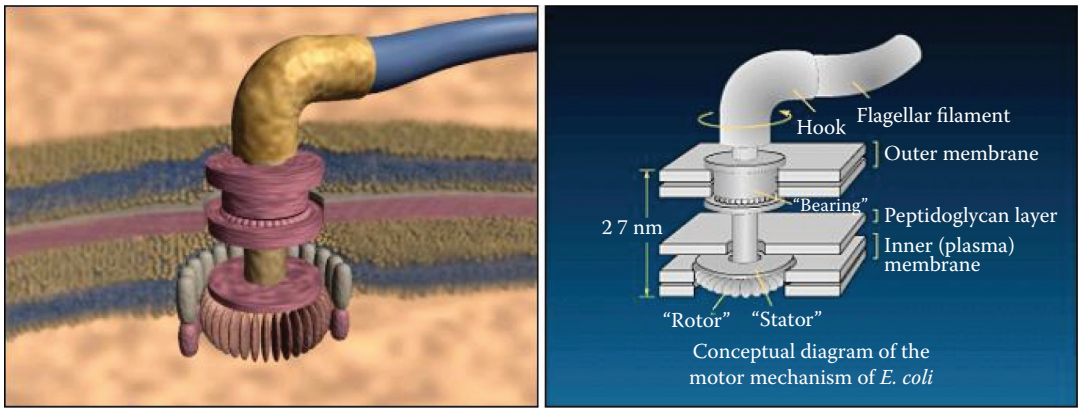


FIGURE 2.36

Muscle cells: the linear motion of muscles, which results in muscle contraction, is driven by chemical energy as ATP is hydrolyzed.

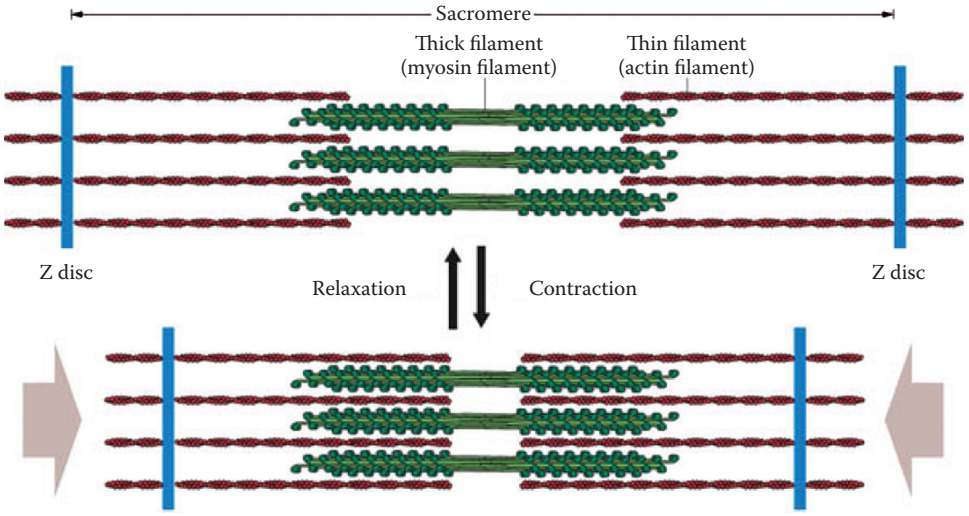


FIGURE 2.37

The linear motion is effected by the myosin head, which is attached to the thick filament via a flexible hinge, and binds to the actin filament.

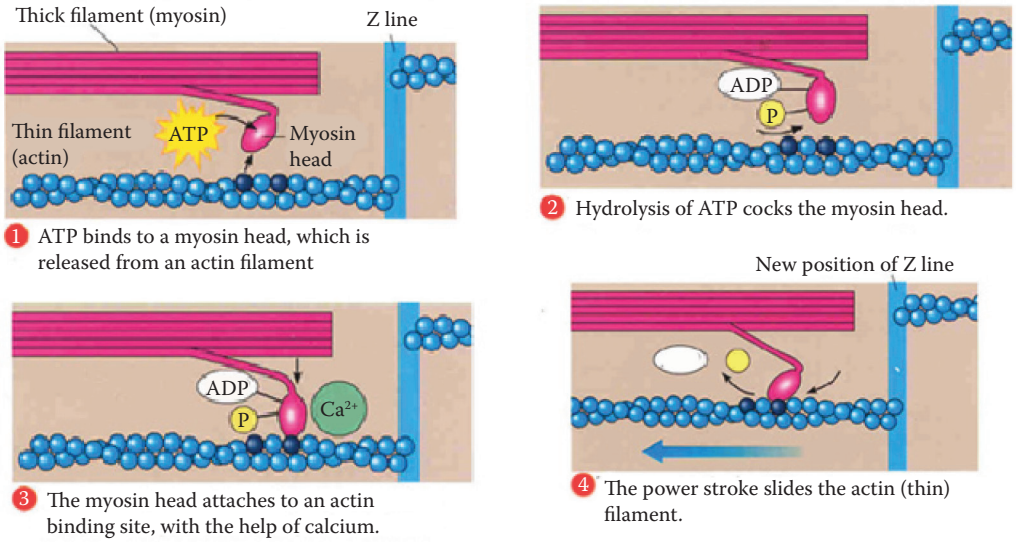


FIGURE 2.38

Dynein, found in cilia and flagella, causes a beating motion.

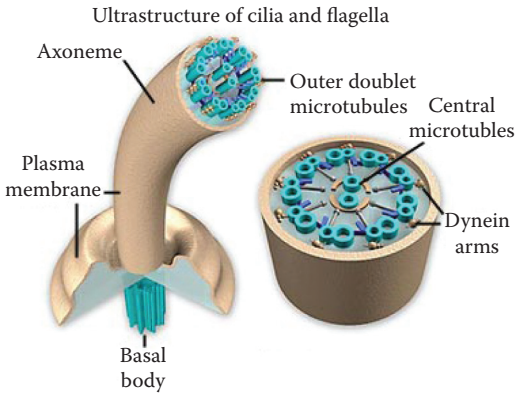


FIGURE 2.39

Aggregation reduces the hydrophobic surface area that requires ordering of water molecules for optimized solvation.

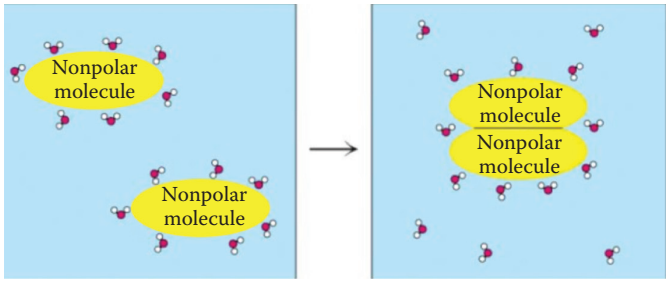


FIGURE 2.40

A water "cage" around another molecule or a clathrate.

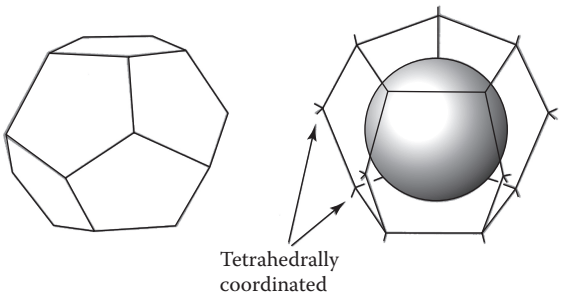


FIGURE 2.41

Steps involved in making a micelle. See text for explanation. (a) The water molecules around one amphiphilic molecule reduce the entropy of the water through ordering (forming of a clathrate). (b) Dispersion of lipid molecules, where each molecule forces surrounding water molecules to become highly ordered. (c) Only lipids at the edge of the cluster force the ordering of water. Fewer water molecules are ordered, and the entropy is thus increased. (d) All hydrophobic groups are sequestered from water; the ordered shell of water is minimized, the entropy is further increased, and a micelle is formed.

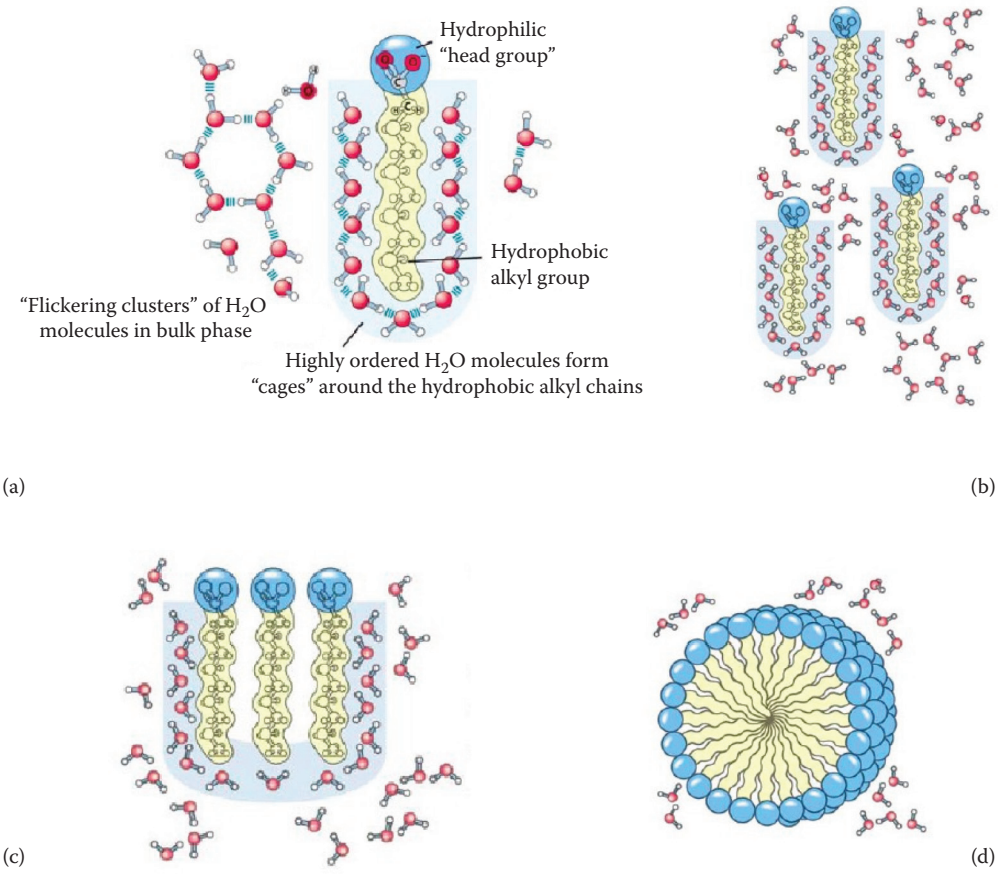


FIGURE 2.42

Surfactants can assemble into spherical micelles, cylindrical micelles, bilayers (membranes), or saddle surfaces in bicontinuous structures. (From I. W. Hamley. 2000. *Introduction to soft matter.* (2nd edition), J. Wiley, Chichester. With permission.)

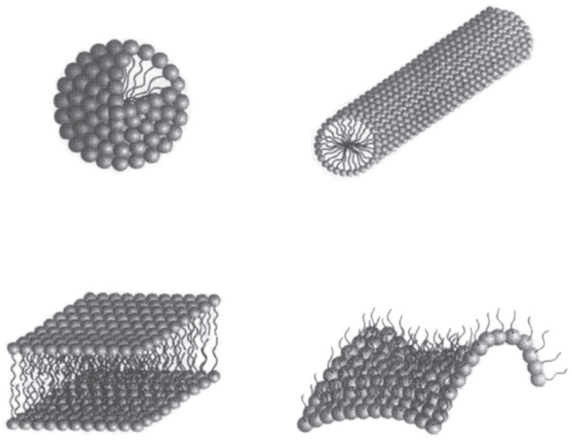


FIGURE 2.43

Surfactants can create a bicontinuous surface to separate an oil phase and a water phase. (From R. A. L. Jones. 2002. *Soft condensed matter.* Oxford University Press, Oxford. With permission.)

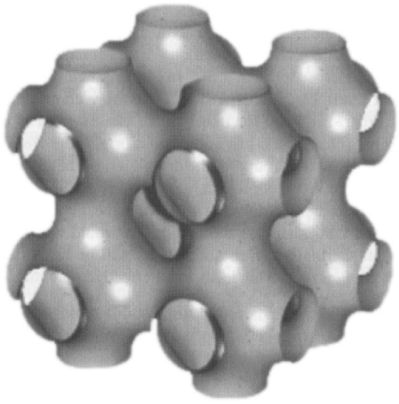


FIGURE 2.44

(A) Example of an amphiphilic molecule (phosphatidylcholine). (B) Amphiphilic molecules forming micelle (a), lipid membranes (b), and unilamellar liposome (c).

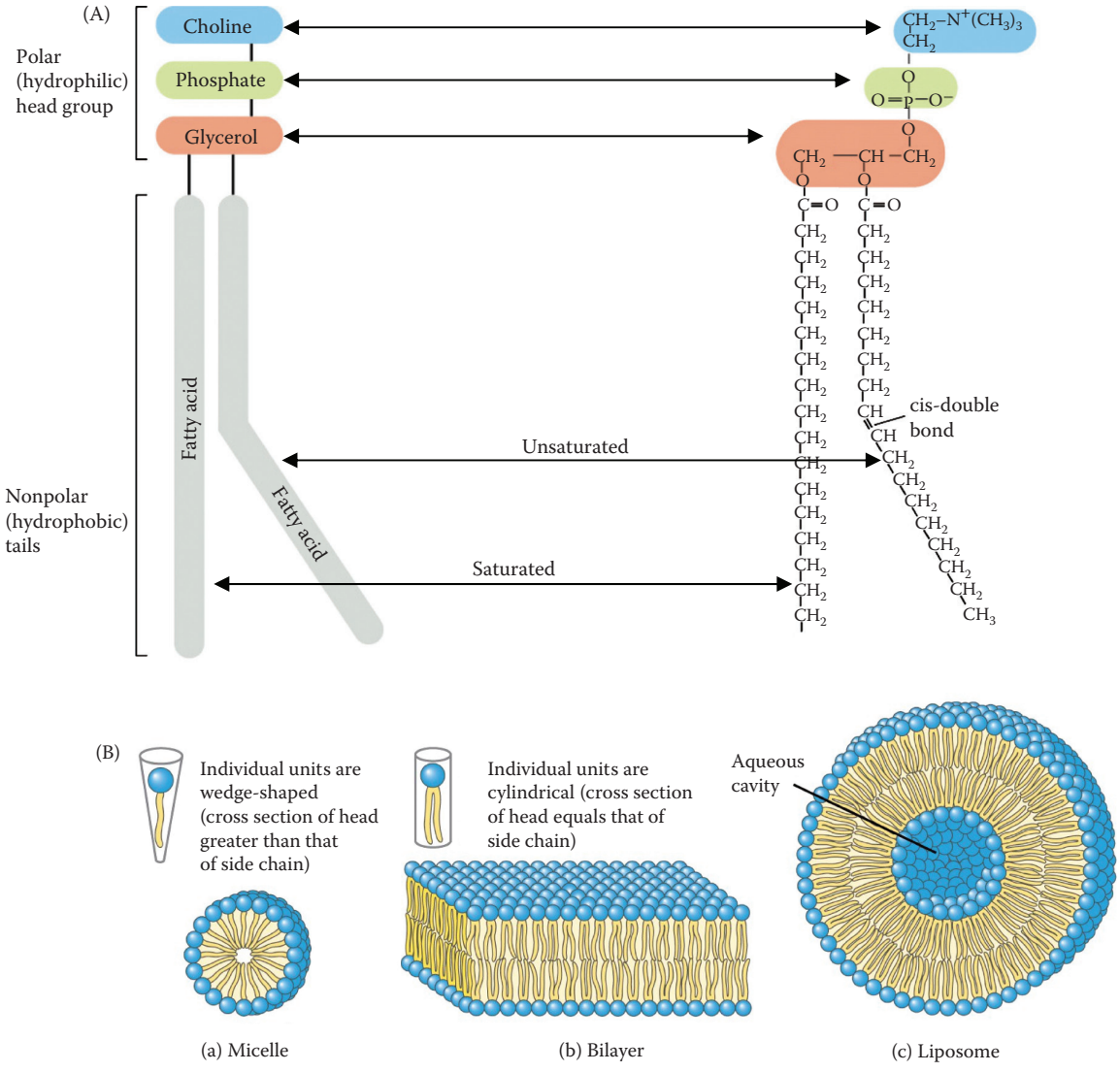


FIGURE 2.45

The cell wall of an animal cell is a phospholipid bilayer with embedded proteins regulating a series of functions, e.g., transport, recognition.

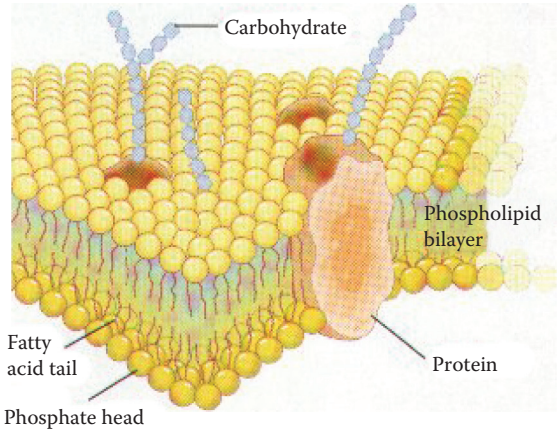


FIGURE 2.46

DNA: a question of entropy of coiling versus enthalpy of the hydrogen bonds (two between adenine and thymine and three between cytosine and guanine).

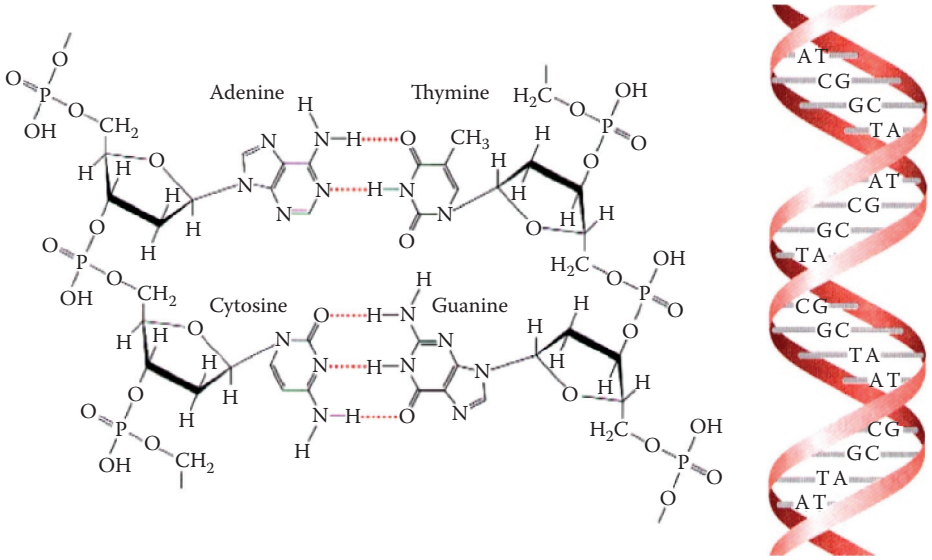


FIGURE 2.47

Melting temperature or critical temperature of DNA is reached at the moment that the entropy wins out. The higher the CG content, the higher the melting temperature.

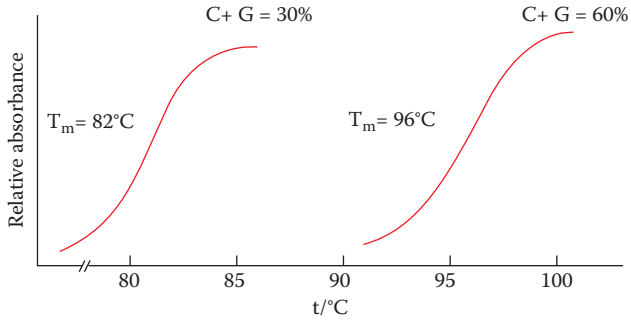
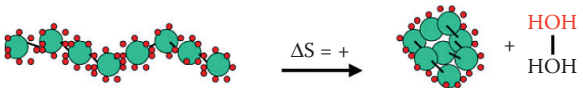


FIGURE 2.48

Protein folding and unfolding (denaturing).



Unfolded

More hydrocarbon-water interfacial area, more water ordered

Folded

Less hydrocarbon-water interfacial area, less water ordered

FIGURE 2.49

Model showing the exposure of drug binding site in calmodulin following binding of Ca^{2+}. Upon binding to calcium, calmodulin undergoes a change in conformation, which exposes two hydrophobic pockets located in the N- and C-domains. Certain hydrophobic peptides and the antipsychotic phenothiazine class of drugs interact with these exposed hydrophobic pockets.

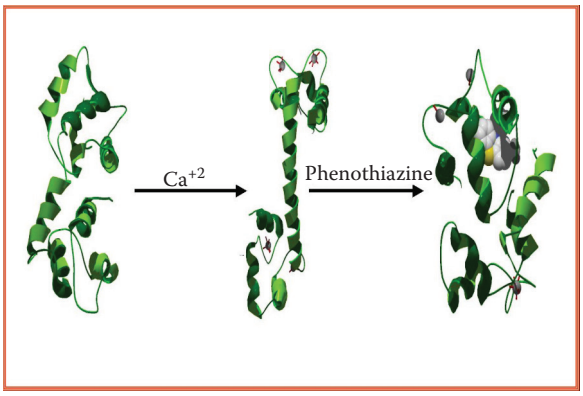


FIGURE 2.50

Calibration plot for calcium obtained with the MDCC [N-[2-(1-maleimidyl)ethyl]- 7-(diethylamino)coumarin-3-carboxamide]-labeled calmodulin (CaM) mutant. The *x*-axis denotes the concentrations of free calcium.[56]

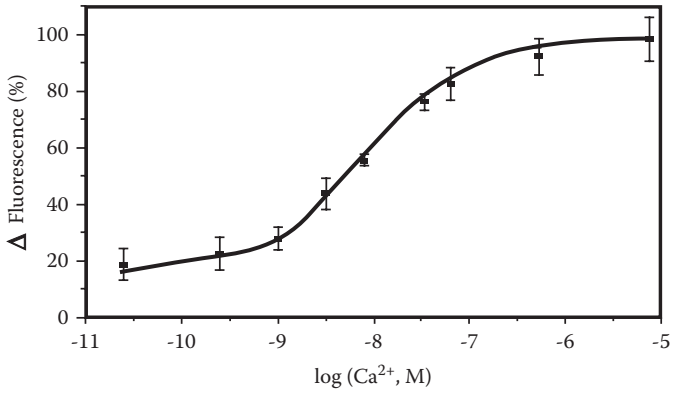


FIGURE 2.51

Kary Mullis, inventor of polymerase chain reaction.

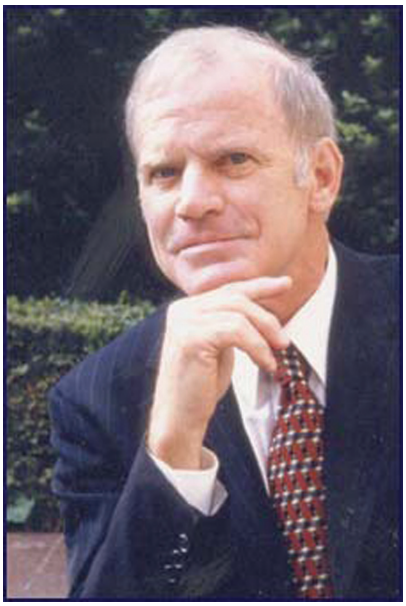


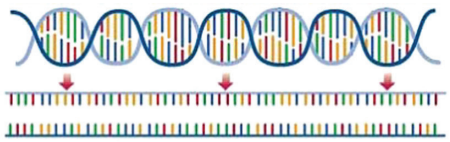
FIGURE 2.52

The bacterium *Thermus aquaticus* was first discovered in several springs in the Great Fountain area of the Lower Geyser Basin at Yellowstone National Park.

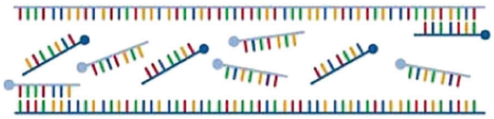
FIGURE 2.53

Polymerase chain reaction (PCR). (a) How PCR cycle doubles DNA. (b) A typical PCR temperature profile (1, denature; 2, anneal primers; 3, extend primers; see text). (c) Commercial PCR instrument from Cepheid: the SmartCycler II System.

(a)



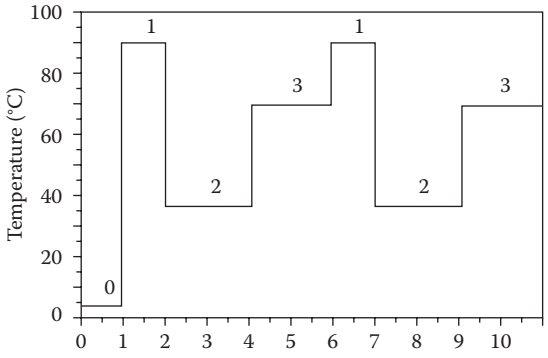
Step 1 – Denaturation (optimal temperature is 94°C). By heating the DNA, the double strand melts and opens to single-stranded DNA.



Step 2 – Annealing (optimal temperature is 60°C). The single-stranded primers bind to their complementary single-stranded bases on the denaturated DNA.

Step 3 – Extension: 72°C is the ideal temperature for the *Taq* polymerase to attach and start copying the template. The result is two new helixes in place of the first.

Step 4 – By applying this cycle several times, the quantity of DNA obtained is quickly enough to perform any analysis. Starting with one DNA molecule, after just 20 cycles there will be a million copies, and after 30 cycles there will be a billion copies.

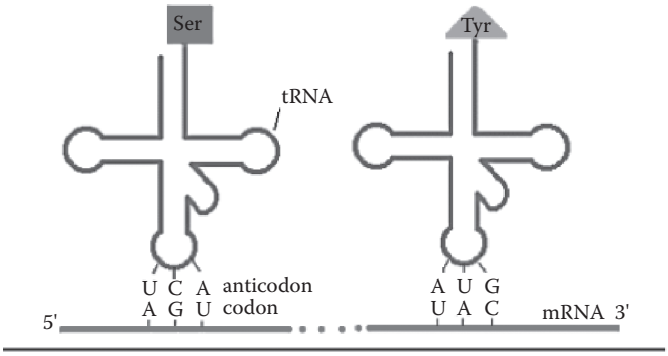


(b)

(c)

FIGURE A2C.1

The genetic code.



2nd base in codon

1st base in codon	U		A	G		3rd base in codon
U	Phe	Ser	Tyr	Cys	U	
	Phe	Ser	Tyr	Cys	C	
	Leu	Ser	STOP	STOP	A	
	Leu	Ser	STOP	Trp	G	
C	Leu	Pro	His	Arg	U	
	Leu	Pro	His	Arg	C	
	Leu	Pro	Gln	Arg	A	
	Leu	Pro	Gln	Arg	G	
A	Ile	Thr	Asn	Ser	U	
	Ile	Thr	Asn	Ser	C	
	Ile	Thr	Lys	Arg	A	
	Met	Thr	Lys	Arg	G	
G	Val	Ala	Asp	Gly	U	
	Val	Ala	Asp	Gly	C	
	Val	Ala	Glu	Gly	A	
	Val	Ala	Glu	Gly	G	