Sodium + **Chlorine** → **Sodium chloride**
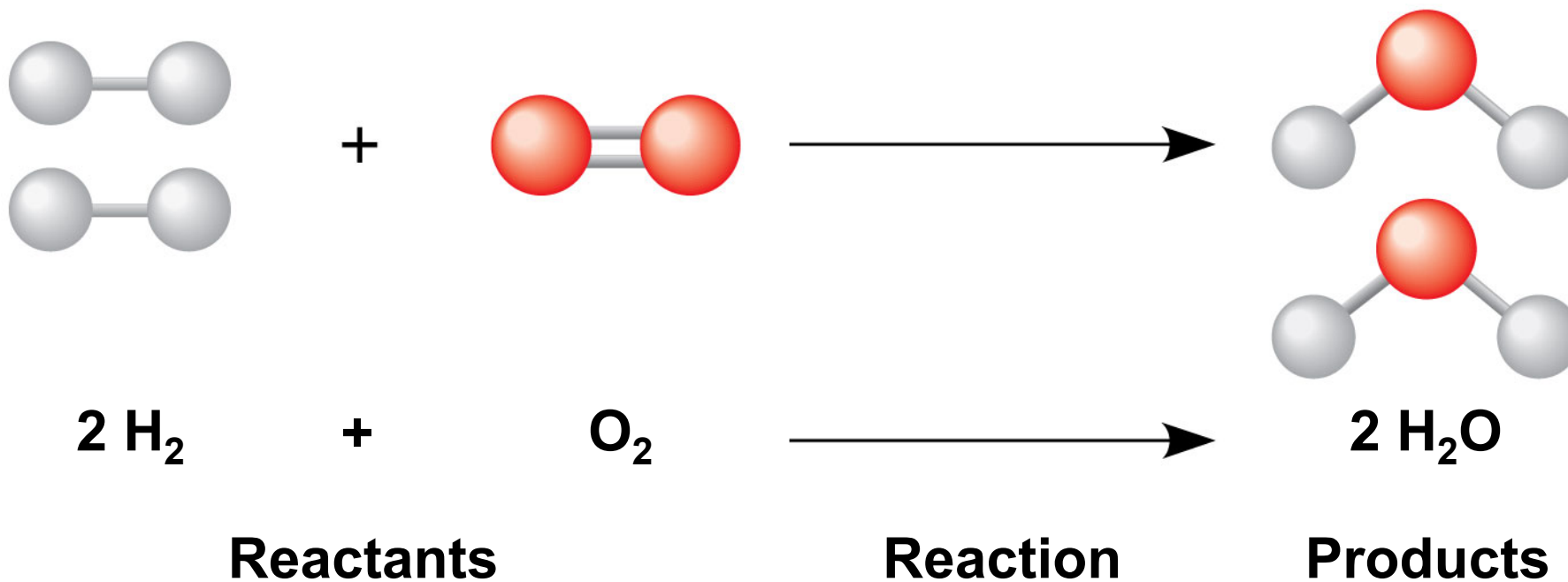
© 2011 Pearson Education, Inc.

1

$2\ H_2$ + O_2 ⟶ $2\ H_2O$

Reactants   **Reaction**   **Products**

Table 2.1 Elements in the Human Body

Element	Symbol	Percentage of Body Mass (including water)	
Oxygen	O	65.0%	
Carbon	C	18.5%	
Hydrogen	H	9.5%	96.3%
Nitrogen	N	3.3%	
Calcium	Ca	1.5%	
Phosphorus	P	1.0%	
Potassium	K	0.4%	
Sulfur	S	0.3%	3.7%
Sodium	Na	0.2%	
Chlorine	Cl	0.2%	
Magnesium	Mg	0.1%	

Trace elements (less than 0.01% of mass): Boron (B), chromium (Cr), cobalt (Co), copper (Cu), fluorine (F), iodine (I), iron (Fe), manganese (Mn), molybdenum (Mo), selenium (Se), silicon (Si), tin (Sn), vanadium (V), zinc (Zn)
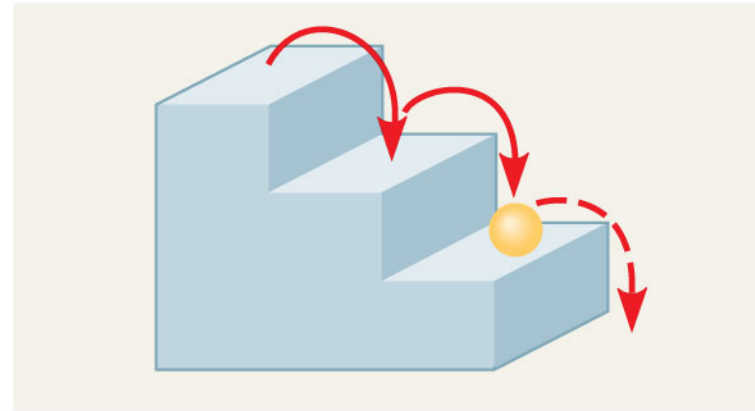
3

Nucleus

**Protons (+ charge)
determine element**

**Neutrons (no charge)
determine isotope**

**Electrons (– charge)
form negative cloud
and determine
chemical behavior**

Atom

4

Cloud of negative charge (2 electrons)

Electrons

Nucleus

+

+

+

+

−

−

(a)

(b)

5
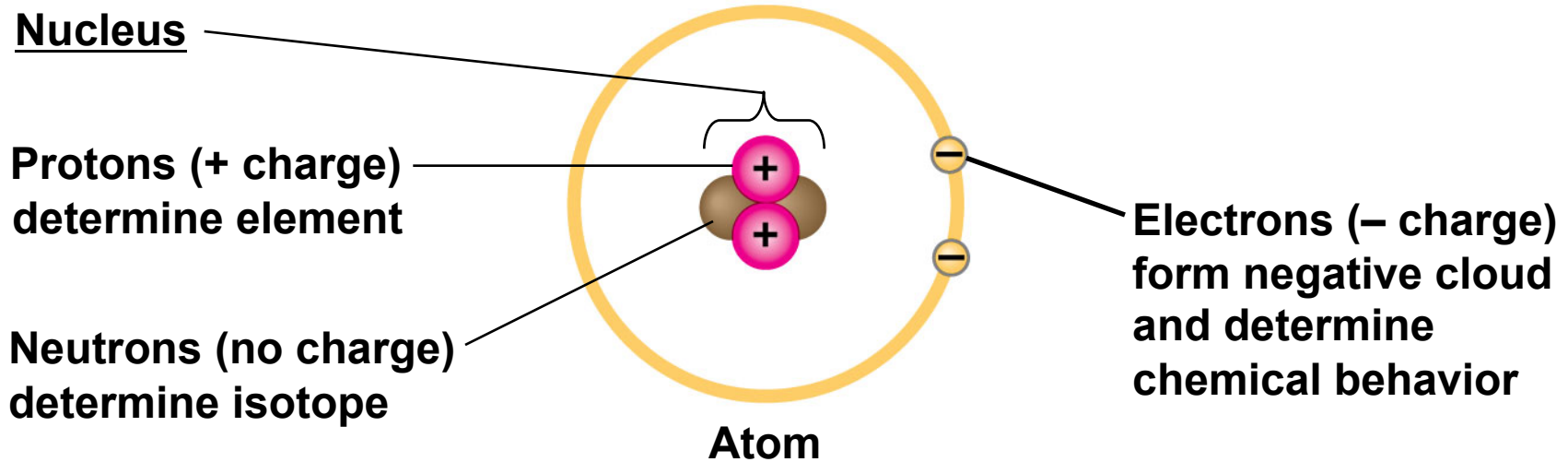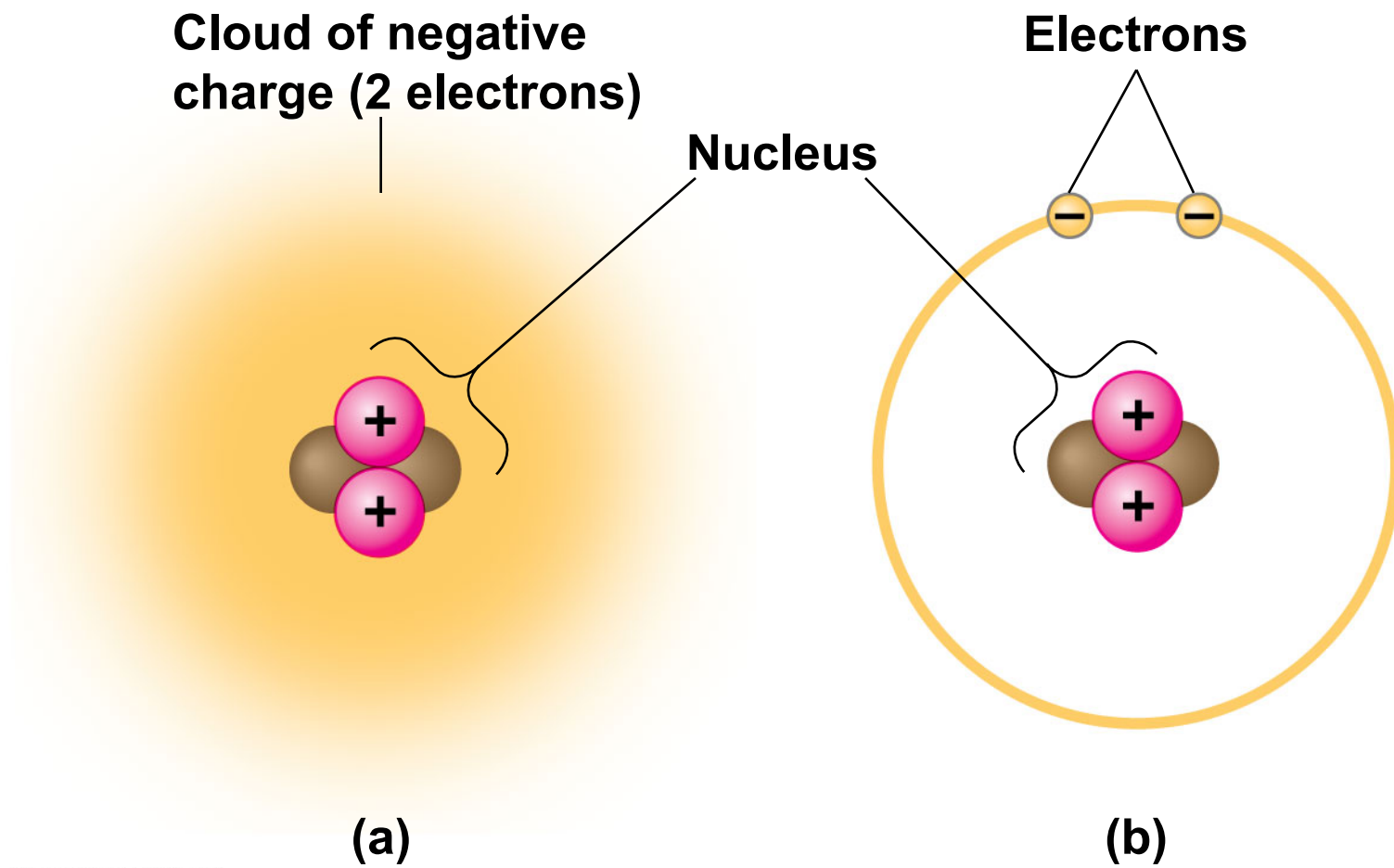
(a) A ball bouncing down a flight of stairs provides an analogy for energy levels of electrons.

Third shell (highest energy level in this model)

Second shell (higher energy level)

Energy absorbed

First shell (lowest energy level)

Energy lost

Atomic nucleus

(b)

6
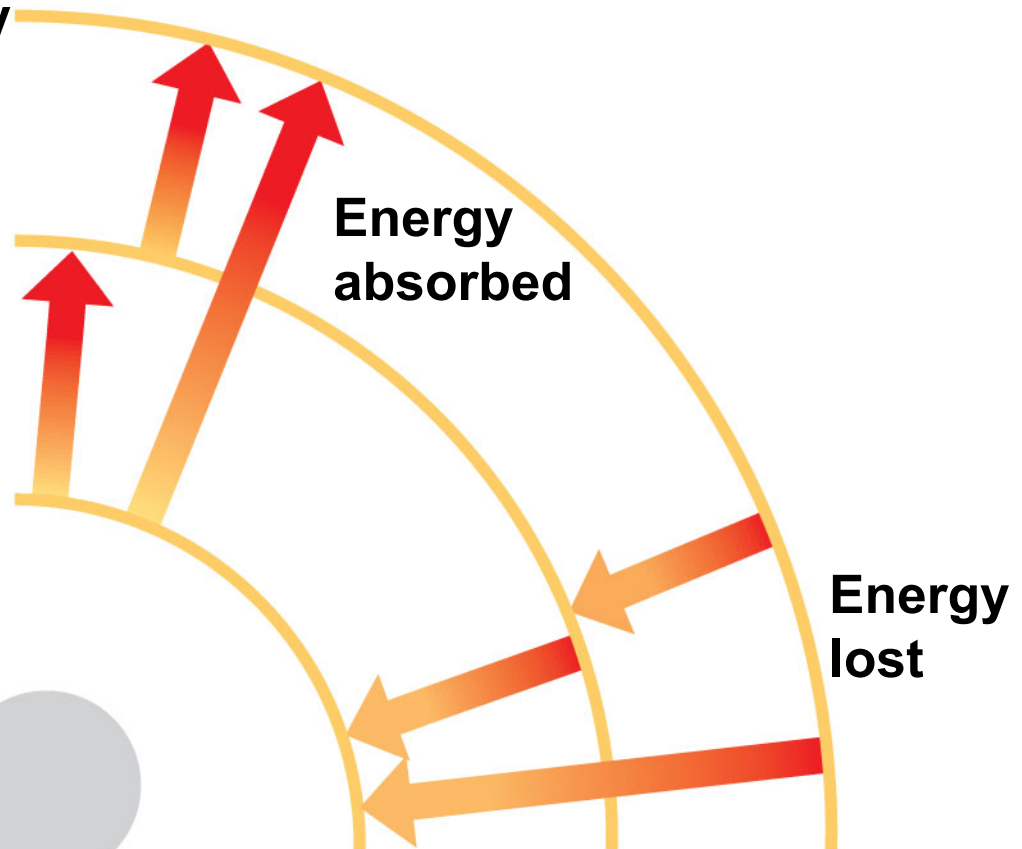
Electron orbitals

© 2011 Pearson Education, Inc.

Neon, with two filled
Shells (10 electrons)

First shell

Second shell

(a) Electron distribution diagram

First shell

Second shell

x

y

z

1*s* orbital

2*s* orbital

Three 2*p* orbitals
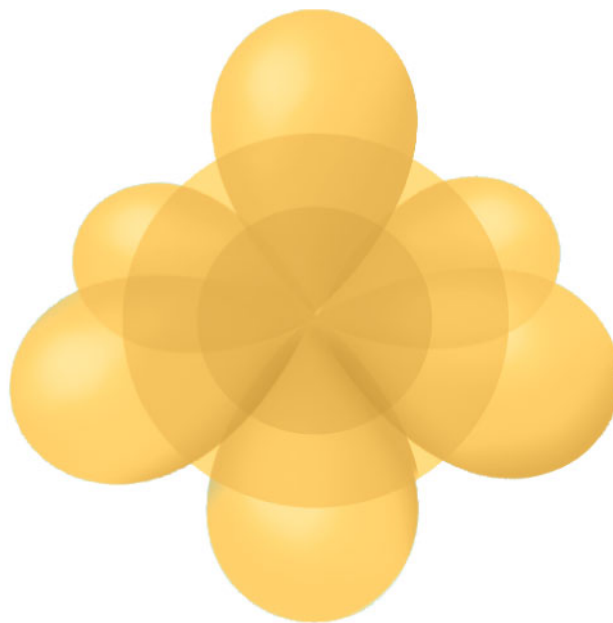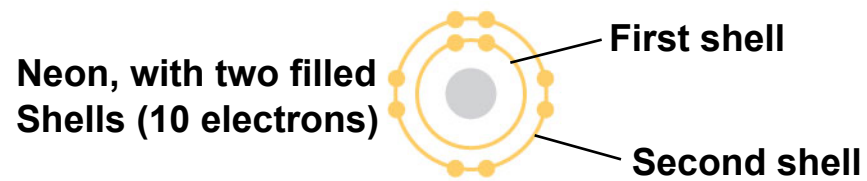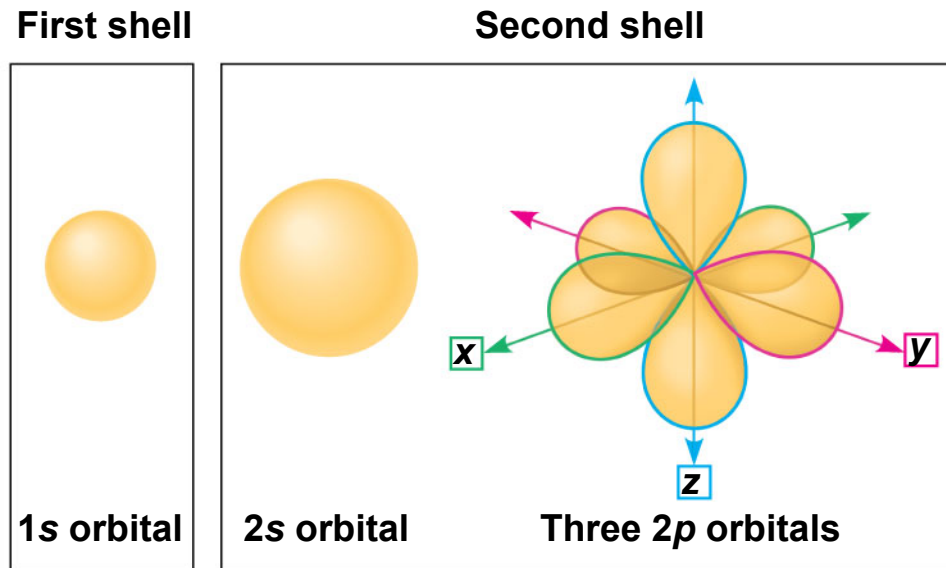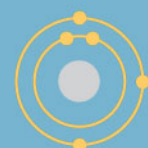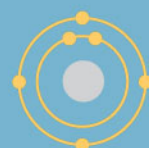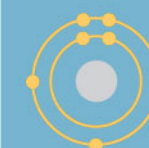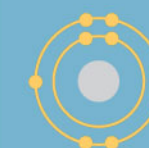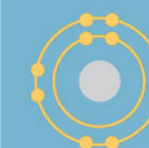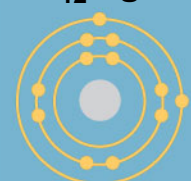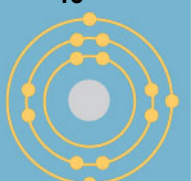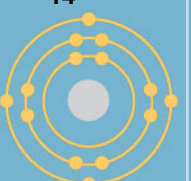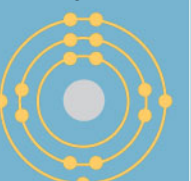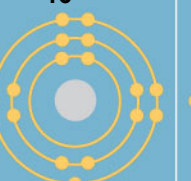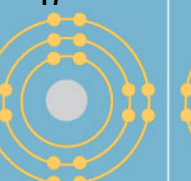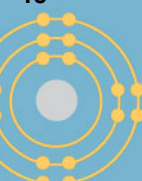
(b) Separate electron orbitals

1*s*, 2*s*, and
2*p* orbitals
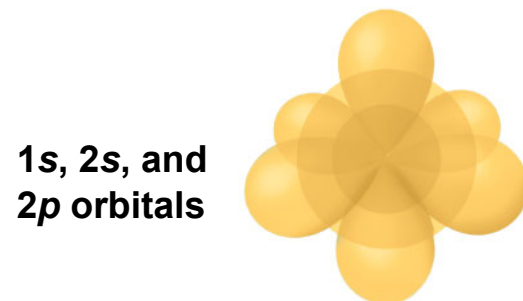
(c) Superimposed electron orbitals

8

First shell	**Hydrogen** $_1$H							**Helium** $_2$He
Second shell	**Lithium** $_3$Li	**Beryllium** $_4$Be	**Boron** $_5$B	**Carbon** $_6$C	**Nitrogen** $_7$N	**Oxygen** $_8$O	**Fluorine** $_9$F	**Neon** $_{10}$Ne
Third shell	**Sodium** $_{11}$Na	**Magnesium** $_{12}$Mg	**Aluminum** $_{13}$Al	**Silicon** $_{14}$Si	**Phosphorus** $_{15}$P	**Sulfur** $_{16}$S	**Chlorine** $_{17}$Cl	**Argon** $_{18}$Ar

2
He
4.00

Atomic number
Element symbol
Mass number
Electron distribution diagram

9

Ionic bond

+ −

Electronic transfer forms ions →

Na
Sodium atom

Cl
Chlorine atom

Na⁺
Sodium ion
(a cation)

Cl⁻
Chloride ion
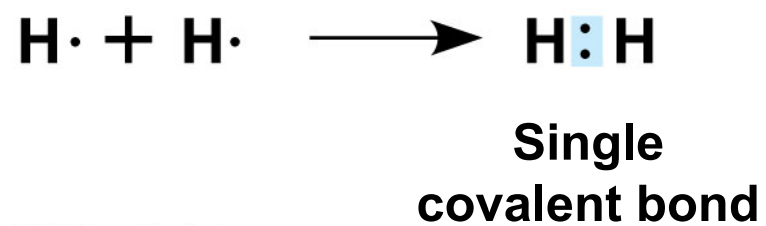(an anion)

10

Na+

Cl−

© 2011 Pearson Education, Inc.

11

Hydrogen atoms (2 H)
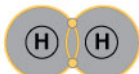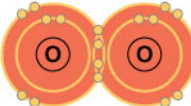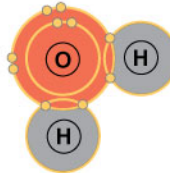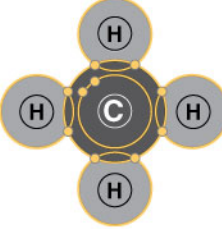
Hydrogen molecule (H$_2$)

12

Single covalent bond

Double covalent bond

© 2011 Pearson Education, Inc.

13
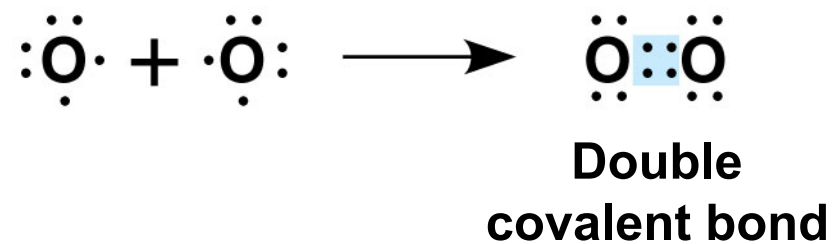
Name and Molecular Formula	Electron Distribution Diagram	Lewis Dot Structure and Structural Formula	Space-Filling Model
(a) Hydrogen (H_2)		$H:H$ $H-H$	
(b) Oxygen (O_2)		$\ddot{O}::\ddot{O}$ $O=O$	
(c) Water (H_2O)		$:\ddot{O}:H$ $\dot{H}$ $O-H$ $\vert$ H	
(d) Methane (CH_4)		H $H:\ddot{C}:H$ H H $\vert$ $H-C-H$ $\vert$ H	

14

δ−

O

H   H

δ+   H₂O   δ+
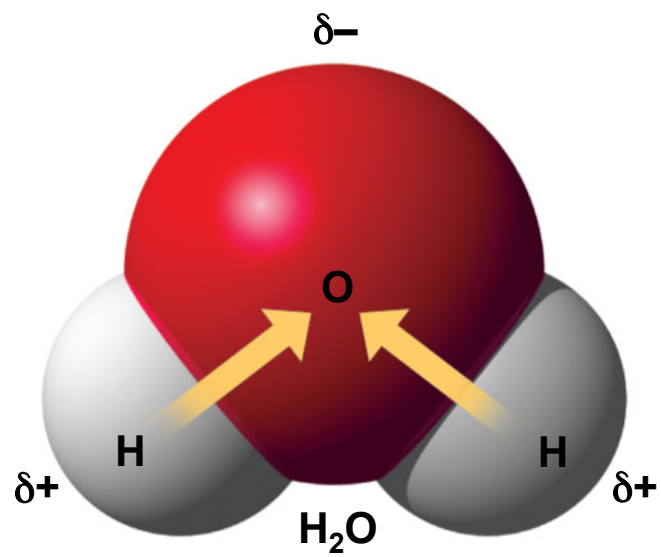
© 2011 Pearson Education, Inc.

Water (H₂O)

Ammonia (NH₃)

Hydrogen bond

16

s orbital

z

Three p orbitals

Four hybrid orbitals

x

y

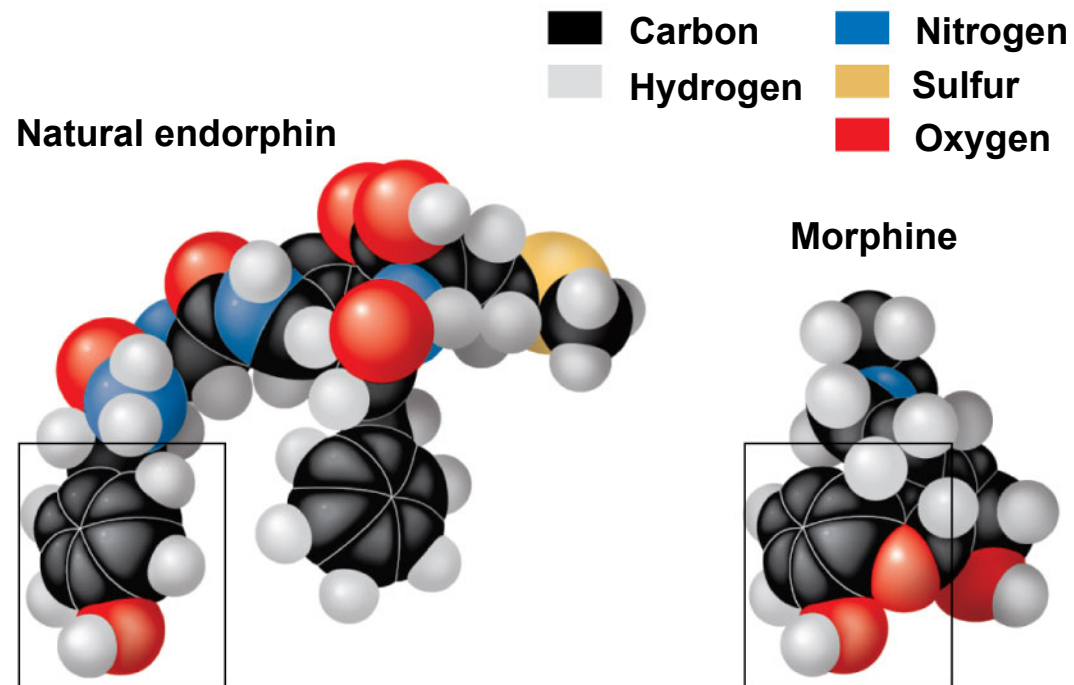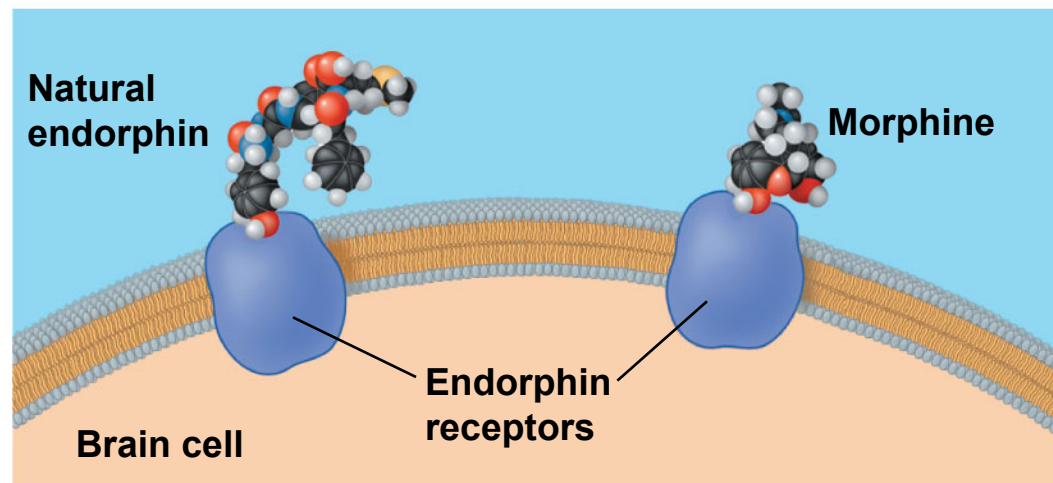**Tetrahedron**
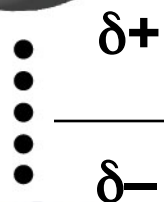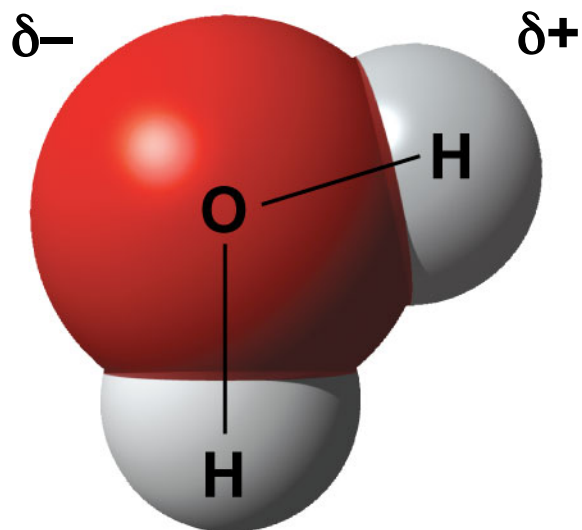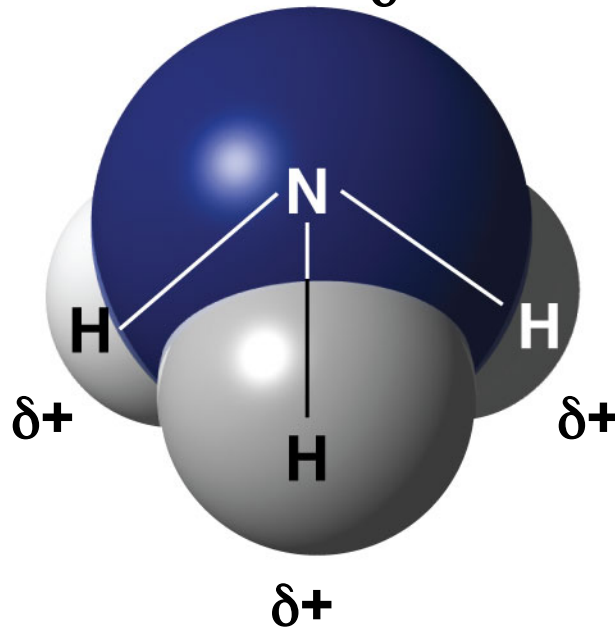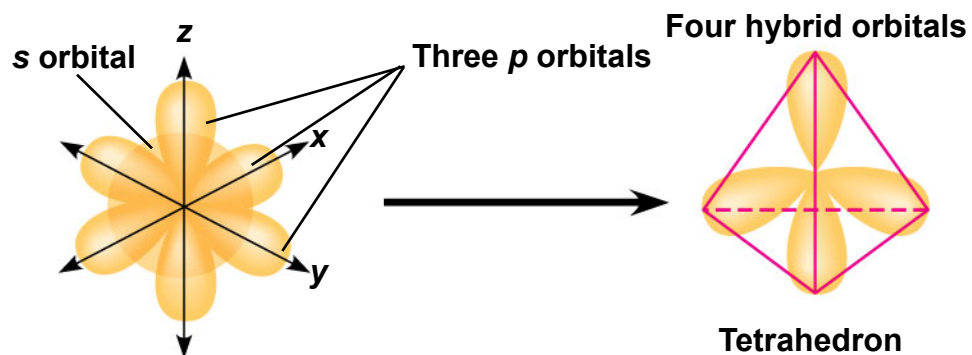
(a) Hybridization of orbitals

Space-Filling Model	Ball-and-Stick Model	Hybrid-Orbital Model (with ball-and-stick model superimposed)
		Unbonded Electron pair
Water (H_2O)	O / H H	O / H H
Methane (CH_4)	H C H H	H C H H

(b) Molecular-shape models

© 2011 Pearson Education, Inc.

Carbon   Nitrogen
Hydrogen   Sulfur
Oxygen

Natural endorphin

Morphine

(a) Structures of endorphin and morphine

Natural endorphin

Morphine

Endorphin receptors

Brain cell

(b) Binding to endorphin receptors

© 2011 Pearson Education, Inc.

18