Module 13

Brad Ashburn, PhD

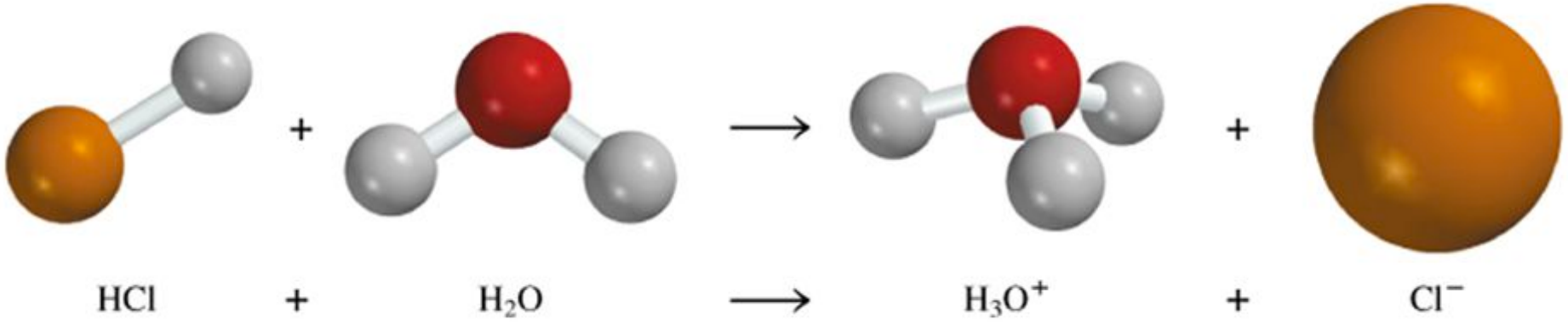
BIOC 141

Acids and Bases


ORIGINAL
Rolaids
ANTACID / CALCIUM SUPPLEMENT
Relieves:
• Heartburn
• Acid Indigestion
PEPPERMINT
150 TABLETS
CHEWABLE
Maalox
MAXIMUM STRENGTH
MULTI
SYMPTOM
Antacid/Anti-gas
Fast Relief of
Heartburn
Pressure
Bloating
Acid Indigestion
65
Chewable
Tablets
Mylanta
ULTIMATE
STRENGTH
Relief of Heartburn even
when it Breaks Through
Can be used while on
a Rx strength
heartburn
medicine
Cherry
Fast Acting
35 Tablets
99¢
Aspirin
Pain Reliever-Fever Reducer
300 TABLETS

Arrhenius Definition (Section 10.1)

An acid contains a hydrogen atom and dissolves in water to form H^+/H_3O^+ cations.



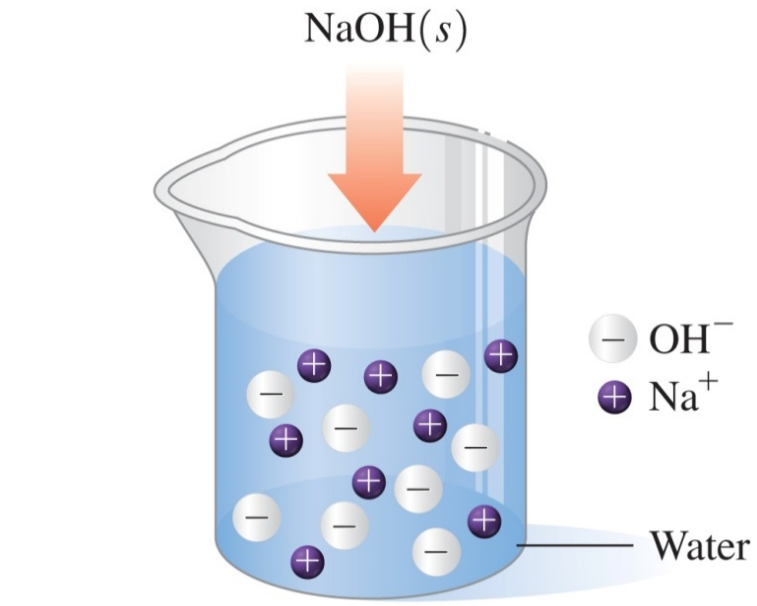
Common Acids

TABLE 10.1 Names of Common Acids and Their Anions

Acid	Name of Acid	Anion	Name of Anion
HCl	**Hydrochloric acid**	Cl^-	Chlor**ide**
HBr	**Hydrobromic acid**	Br^-	Brom**ide**
HI	**Hydroiodic acid**	I^-	Iod**ide**
HCN	**Hydrocyanic acid**	CN^-	Cyan**ide**
HNO_3	Nitr**ic acid**	NO_3^-	Nitr**ate**
HNO_2	Nitr**ous acid**	NO_2^-	Nitr**ite**
H_2SO_4	Sulfur**ic acid**	SO_4^{2-}	Sulf**ate**
H_2SO_3	Sulfur**ous acid**	SO_3^{2-}	Sulf**ite**
H_2CO_3	Carbon**ic acid**	CO_3^{2-}	Carbon**ate**
$HC_2H_3O_2$	Acet**ic acid**	$C_2H_3O_2^-$	Acet**ate**
H_3PO_4	Phosphor**ic acid**	PO_4^{3-}	Phosph**ate**
H_3PO_3	Phosphor**ous acid**	PO_3^{3-}	Phosph**ite**
$HClO_3$	Chlor**ic acid**	ClO_3^-	Chlor**ate**
$HClO_2$	Chlor**ous acid**	ClO_2^-	Chlor**ite**

Arrhenius Definition

A base contains a hydroxide ion and dissolves in water to form OH^- anions.



$$NaOH(s) \xrightarrow{H_2O} Na^+(aq) + OH^-(aq)$$

Ionic compound — Dissociation — Hydroxide ion

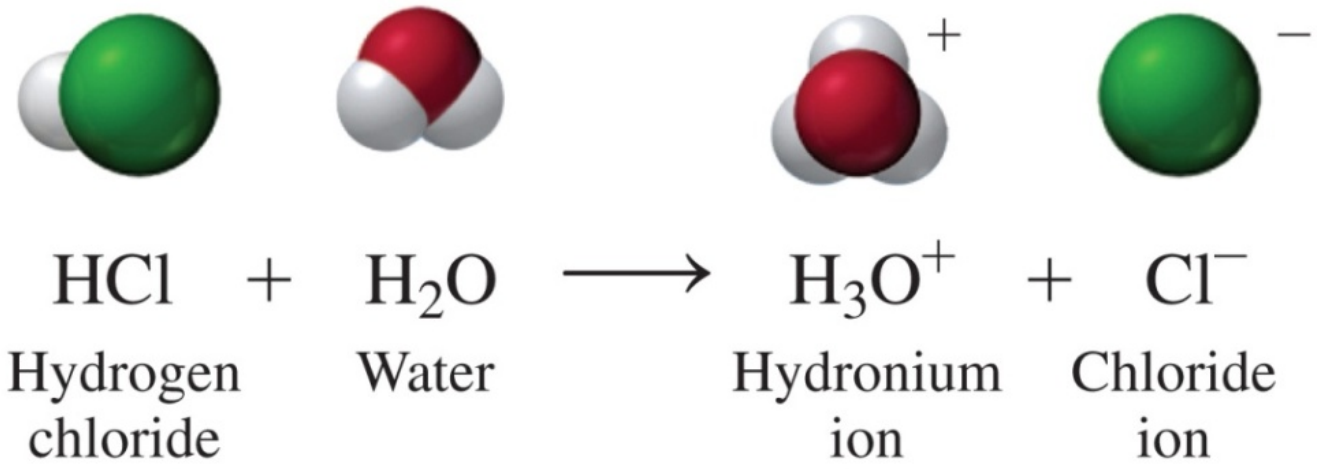
Antacid Active Ingredients

TABLE 10.7 Basic Compounds in Some Antacids

Antacid	Base(s)
Amphojel	$Al(OH)_3$
Milk of magnesia	$Mg(OH)_2$
Mylanta, Maalox, Di-Gel, Gelusil, Riopan	$Mg(OH)_2$, $Al(OH)_3$
Bisodol, Rolaids	$CaCO_3$, $Mg(OH)_2$
Titralac, Tums, Pepto-Bismol	$CaCO_3$
Alka-Seltzer	$NaHCO_3$, $KHCO_3$

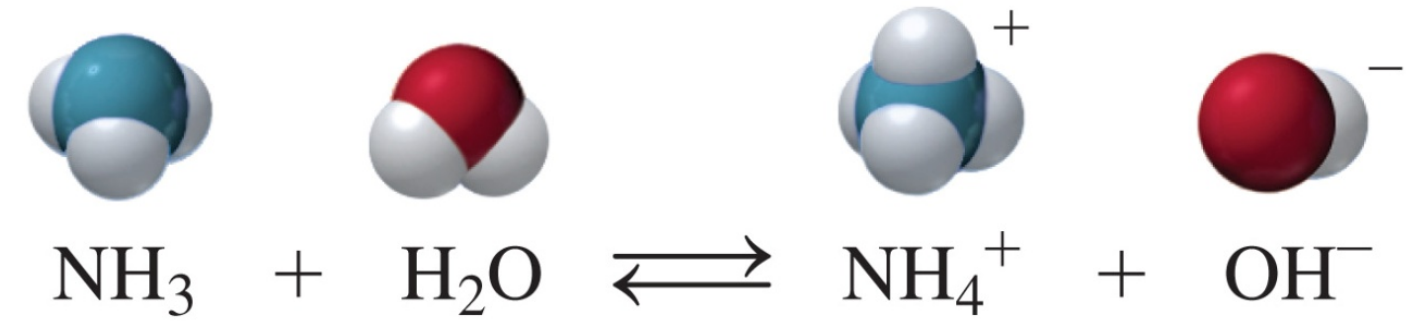
Bronsted-Lowry Definition (10.2)

A Bronsted-Lowry acid is a proton (H^+) donor

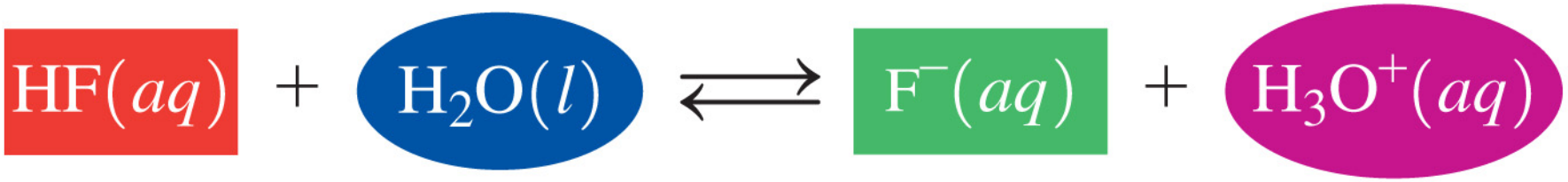


Bronsted-Lowry Definition

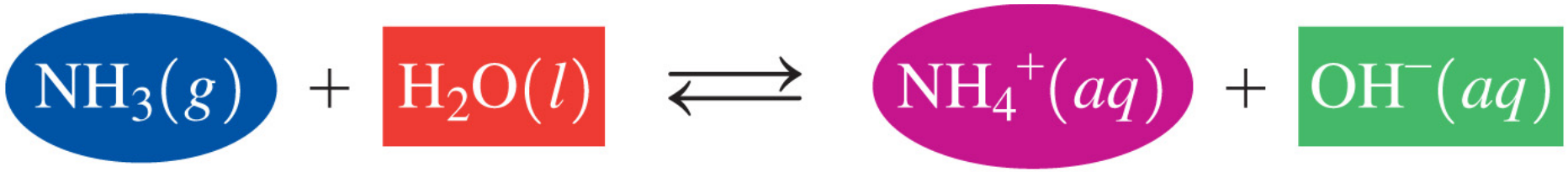
A Bronsted-Lowry base is a proton (H^+) acceptor



Conjugate Acid/Base Pairs



Conjugate Acid/Base Pairs



Concept Check 1

Write the conjugate base for each of the following acids:

A. HBr
B. H_2S
C. H_2CO_3

Write the conjugate acid for each of the following bases:

A. NO_2^-
B. NH_3
C. OH^-

Concept Check 2

$$HNO_3(aq) + NH_3(aq) \longrightarrow NO_3^-(aq) + NH_4^+(aq)$$

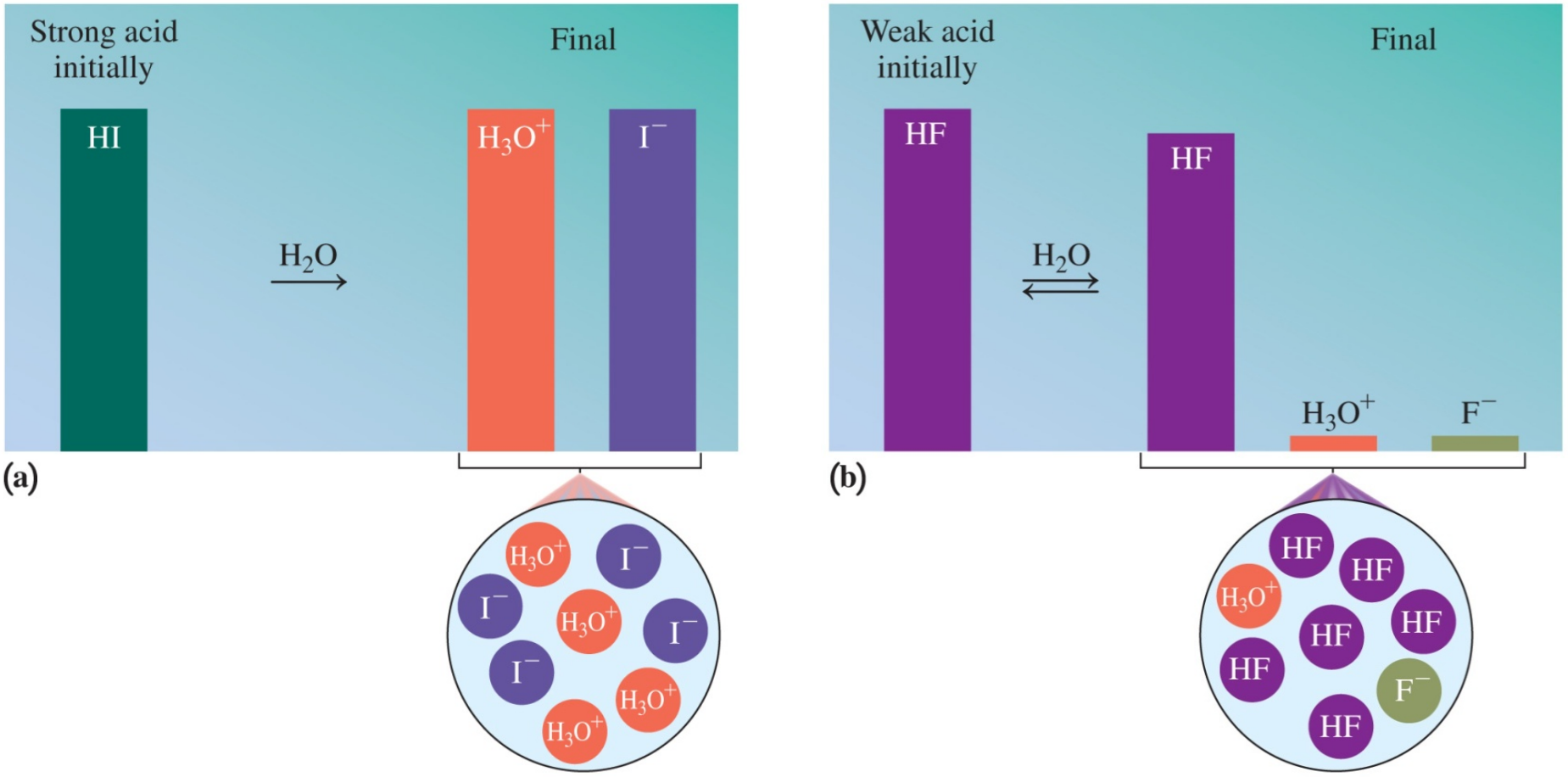
Concept Review (Section 10.2)

CONCEPT REVIEW EXERCISE

1. Give the definitions of a Brønsted-Lowry acid and a Brønsted-Lowry base.

Practice Problems: 1-10

The Strengths of Acids and Bases (Section 10.4)



Strong vs Weak

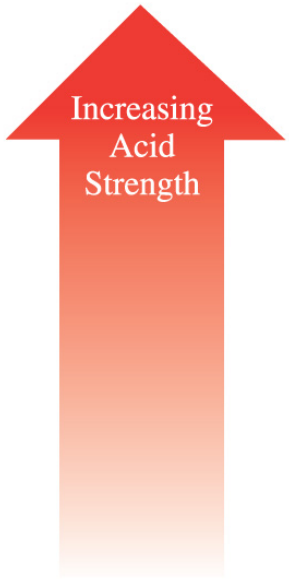
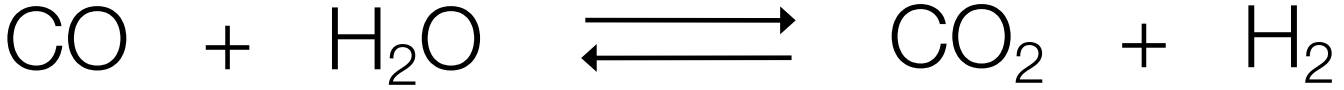


TABLE 10.3 Common Strong and Weak Acids

Strong Acids	
Hydroiodic acid	HI
Hydrobromic acid	HBr
Perchloric acid	$HClO_4$
Hydrochloric acid	HCl
Sulfuric acid	H_2SO_4
Nitric acid	HNO_3
Weak Acids	
Hydronium ion	H_3O^+
Hydrogen sulfate ion	HSO_4^-
Phosphoric acid	H_3PO_4
Hydrofluoric acid	HF
Nitrous acid	HNO_2
Acetic acid	$HC_2H_3O_2$
Carbonic acid	H_2CO_3
Hydrosulfuric acid	H_2S
Dihydrogen phosphate	$H_2PO_4^{2-}$
Ammonium ion	NH_4^+
Hydrocyanic acid	HCN
Bicarbonate ion	HCO_3^-
Hydrogen sulfide ion	HS^-
Water	H_2O

Chemical Equilibrium

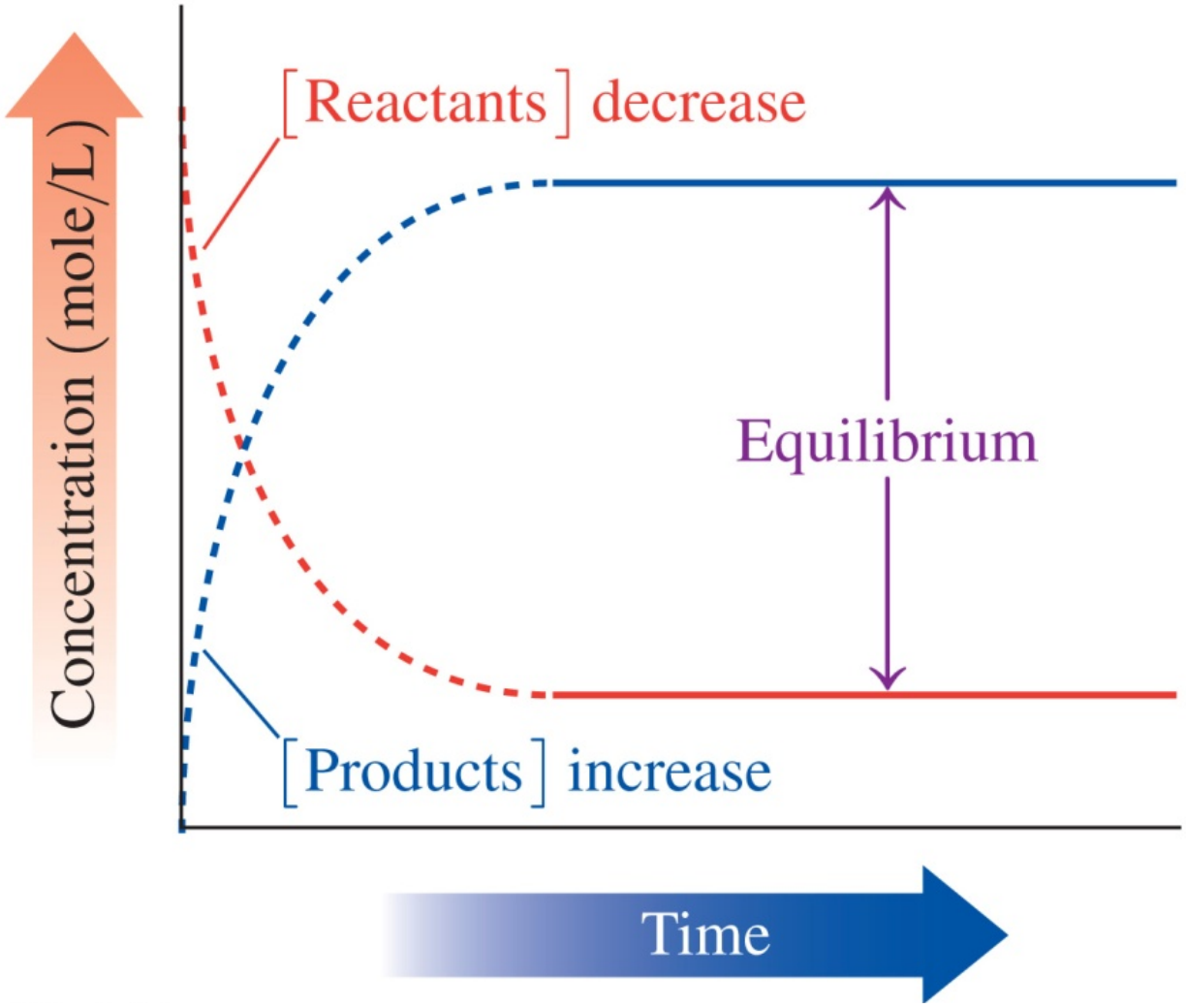
The forward reaction
proceeds to the right.



The reverse reaction
proceeds to the left.

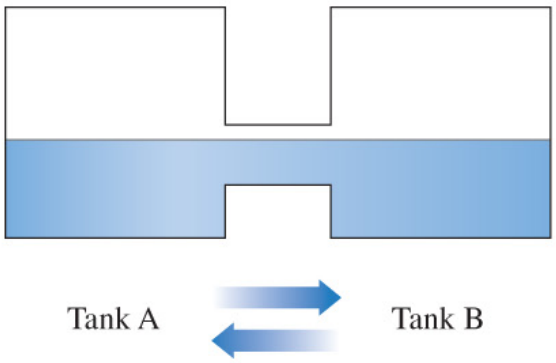
The reaction is occurring in *both directions*
simultaneously (equilibrium).

Chemical Equilibrium




Le Chatelier's Principle
The system will shift to oppose any change.

Le Chatelier's Principles



Concentration Change

$$2CO + O_2 \rightleftharpoons 2CO_2$$

If we increase the CO concentration

The system will shift to oppose any change.

The equilibrium will shift to the right

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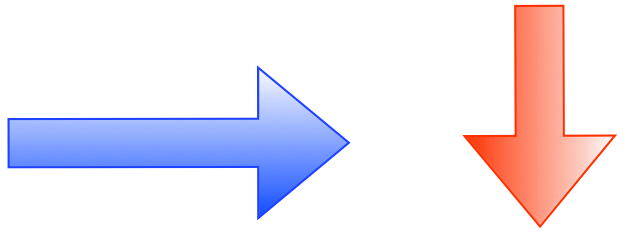
Concentration Change



$$2CO + O_2 \rightleftharpoons 2CO_2$$

If we decrease the CO_2 concentration

The system will shift to oppose any change.

The equilibrium will shift to the right

Concept Check

Predict the direction of equilibrium when the

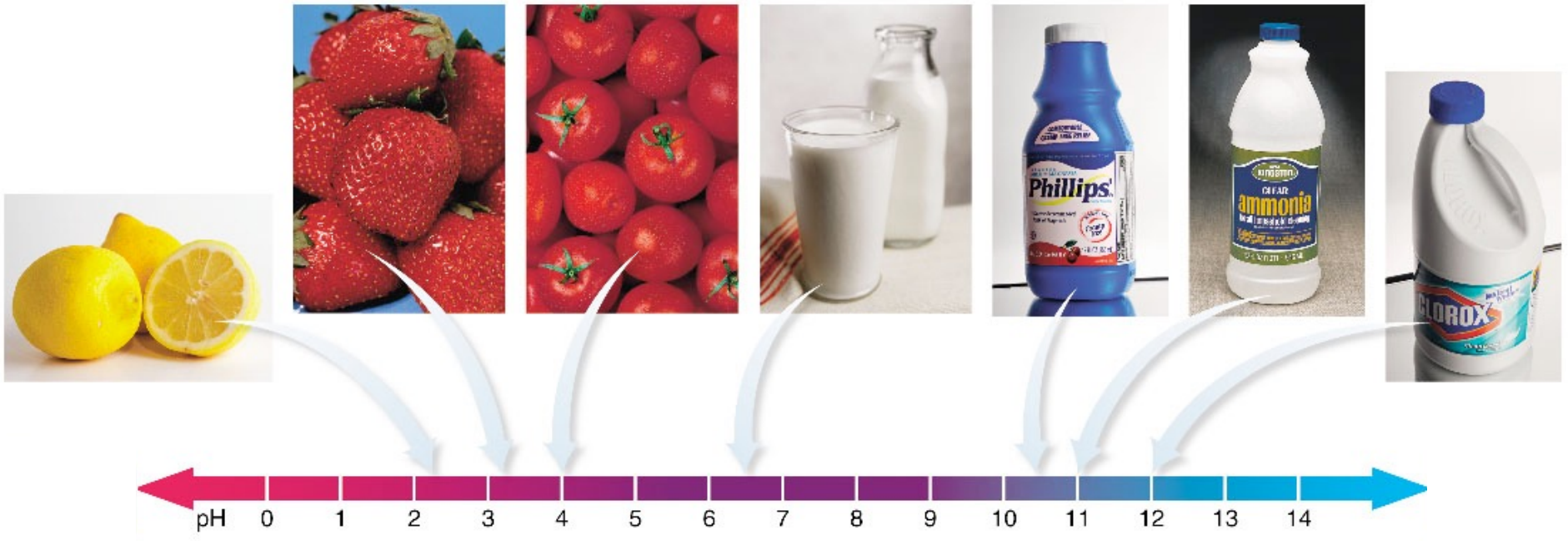
[H_2O] decreases

[Cl_2] increases

[HCl] increases

[O_2] decreases

pH Scale

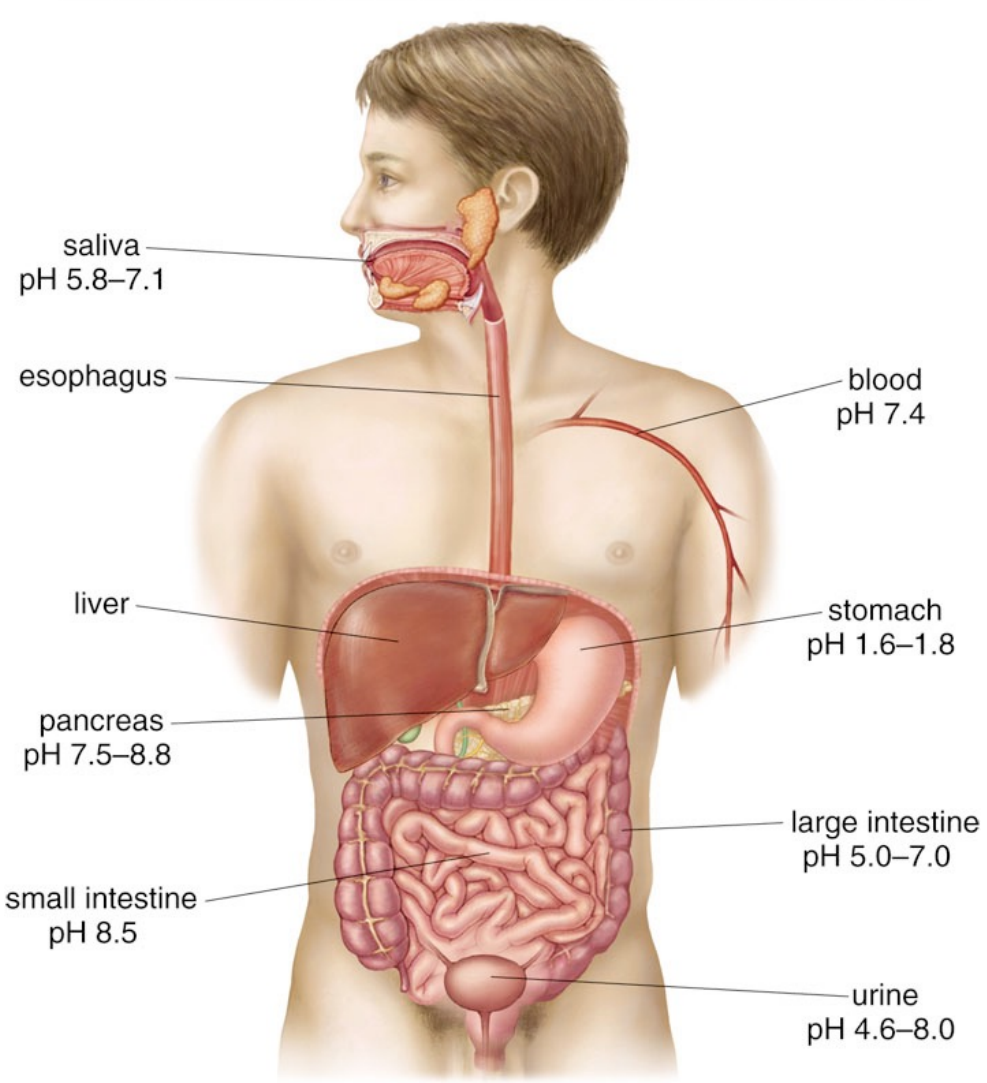


acidic neutral basic

Lower pH

Higher pH

The pH of Body Fluids



Concept Review (Section 10.4)

CONCEPT REVIEW EXERCISES

1. Explain the difference between a strong acid or base and a weak acid or base.

2. Explain what is occurring when a chemical reaction reaches equilibrium.

3. Define *pH*.

Practice Problems: Worksheet

Buffers (Section 10.5)

A buffer is a solution whose pH changes very little when acid or base is added.

Resists change in pH because:

- added acid reacts with base
- added base reacts with acid

Human Blood Buffer

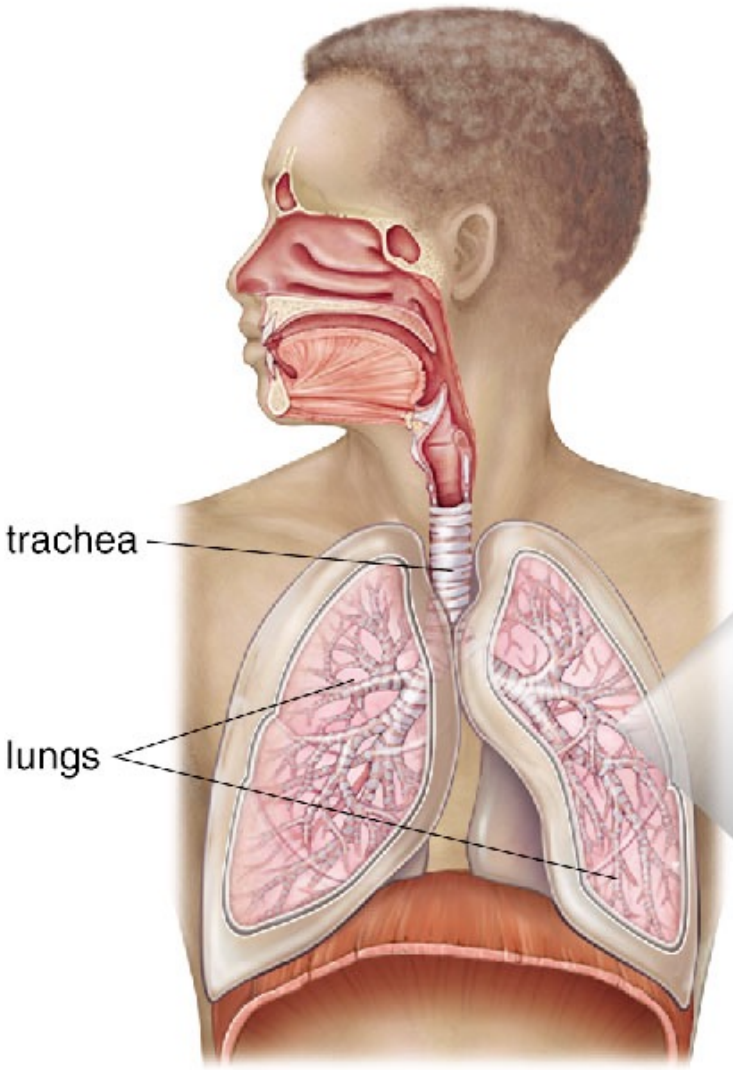
Normal blood pH is between 7.35-7.45

CO_2 is constantly produced by metabolism of food

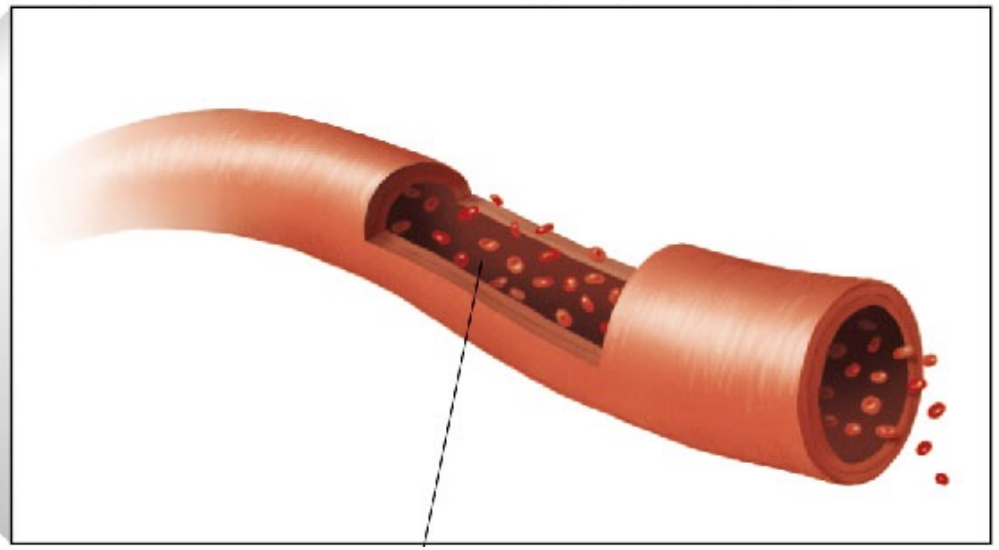
$$CO_2 + H_2O \rightleftharpoons H_2CO_3 + H_2O \rightleftharpoons H_3O^+ + HCO_3^-$$

The [CO_2] is directly related to the pH of the blood

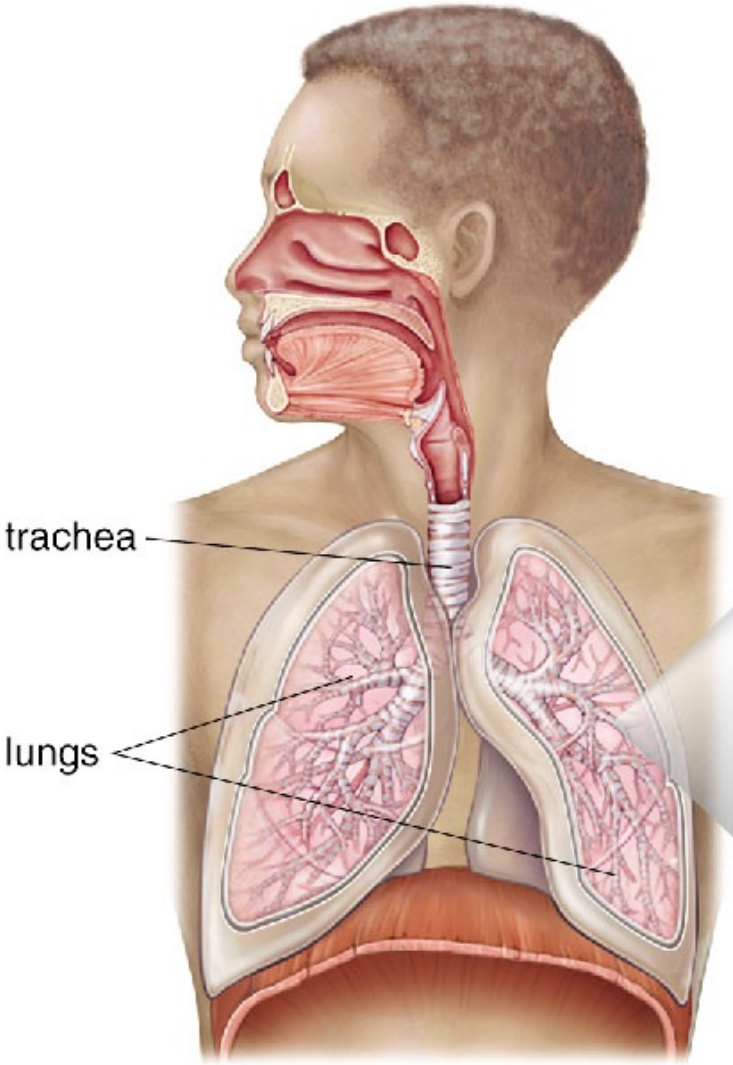
Respiratory Acidosis



$$CO_2(g) + 2\,H_2O(g) \rightleftharpoons H_3O^+(aq) + HCO_3^-(aq)$$



Respiratory Alkalosis



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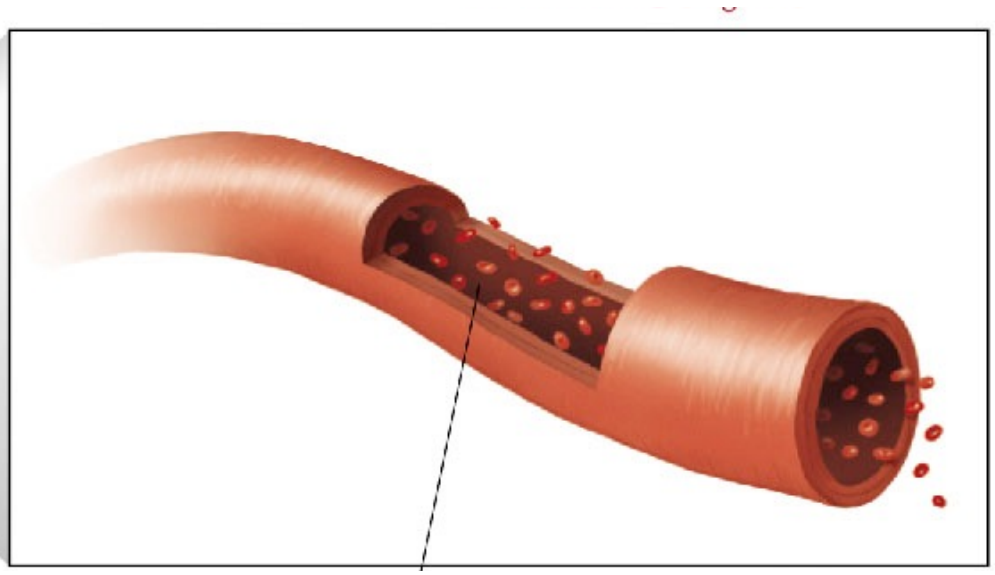

Concept Review (Section 10.5)

CONCEPT REVIEW EXERCISE

1. Explain how a buffer prevents large changes in pH.

Practice Problems: Worksheet