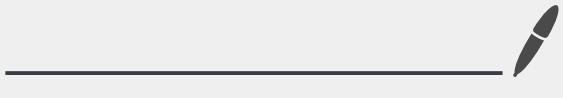


1.1 (2-3) ATLAS IA p 28-29
1.3 (p 6-9)
1.5, 1.6, 1.7 (p 11-21)

CHAPTER 1

1.1 Scope of Anatomy + Physiology

Anatomy = study of structure > complementary
Physiology = study of function

anatomy + dissection mean "cutting apart"

Ways to study anatomy
- inspection = looking at
- palpating = feeling with fingers (hands)
- Auscultation = listening
- percussion = tapping, feeling for abnormal resistance
- dissection = cutting / separating tissues

comparative anatomy
↳ examine multiple species for similarities and evolutionary trends

medical imaging has replaced exploratory surgery
↳ radiology

gross anatomy = can be seen w/ naked eye, imaging, dissection

histology * microscopic anatomy
↓
tissues

Ultrastructure = fine detail (molecular level) revealed by electron light microscope

cytology → cells

Comparitive physiology → study of how different species have solved problems of life, how develop new drugs + medical procedures

Before you go on: ⚠ question

- difference b/w anatomy + physiology
- name the method that would be used:
  - listening to heart murmur — ascultation
  - studying microscopic structure of the liver
  - microscopically examining liver for signs of hepatitis — inspection
  - learning the blood vessels of a cadaver — dissection
  - performing a breast self-exam — palpation

1.3 Scientific Method

Francis Bacon + René Descartes = philosophers
↳ outlined systematic way of thinking

Scientific method
↳ habits of creativity, observation, logical thinking, analysis of conclusions

credited on putting science on the path to modern Scientific thought

Inductive method → making numerous observations until you make a generalization or prediction

* Anatomy is the result of the inductive method we can never prove a claim beyond all possible refutation. we can consider a statement proven beyond reasonable doubt through reliable methods of observation, tested and confirmed repeatedly, and not falsified.

hypothetico-deductive method - asks a question, forms hypothesis, specify what could prove it wrong

hypothesis operated in cycles of conjecture and disproof until one is found that is supported by evidence.

Experimental Design

↳ Sample size (bigger = better) # of subjects used in a study
* an adequate sample size controls for chance of individual variations

Controls → allows for comparison

treatment group → group getting treated on
control group → like treatment group, sans treatment

psychosomatic effects → effects of the subject's state of mind that can have undesireable effect on results

placebo → given to control group to account for ↗

experimenter bias → interpretation of data affected by unconscious bias
↳ double-blind method = person reporting nor control groups know if they're control or treatment groups.

statistical testing - statements of probability of how confident conclusion is effective
T-test, chi squeare test, analysis of variance

peer-review - critical evaluation by experts in that field

fact - verifiable information.

Law of nature - a generalization about the predictable ways matter & energy behave
result of inductive reasoning

theory - explanatory statement derived from facts, laws, or confirmed hypothesis
purpose is to suggest direction for further study & summarize what we already know

Before You Go ON

- Describe process of inductive method
- Describe some sources of potential bias in research what are ways of minimizing bias?
- Is there more information in a fact or theory?

1.5 Human Structure

organism → organ system → organ → tissues → cells → organelles → macromolecules → molecules → atoms

organism = single complete individual

11 organ systems

endocrine, respiratory, circulatory, reproductive, endocrine, nervous, skeletal, muscular, urinary, lymphatic, integumentary

organ = structure composed of two or more types that work together to carry out a particular function

tissue = mass of similar cells that performs a particular function
epithelial, connective, muscular, nervous
Histology = study of cells

Cells = basic unit of life
cytology = study of cells to organelles

molecule = two or more atoms
macromolecule = protein, fat, DNA, carbohydrates

reductionism = view that you can understand large thing by studying its smaller parts (Aristotle)

Holism → complementary theory that thing is more than the sum of its parts

Anatomical variation common structure = 70% or more of people

Before YOU GO ON

12. Hierarchy of human organization
13. How are tissues relevant to definition of an organ?
14. Why is reductionism necessary but not sufficient point of view?

1.6 Human Function

8 characteristics of life:

organization
cellular composition
metabolism take in things from environment
reproduction
development differentiation + growth
evolution
responsiveness + movement excitability
homeostasis internal stability

*physiological variation differs with age, sex, weight, diet, physical activity, genetics, environment

negative feedback → process of activating mechanisms that oppose change to achieve homeostasis ←

can stay in a range dynamic equilibrium

tendency to maintain internal stability

vasoconstriction → meant to hold onto heat
vasodialation → meant to release heat

receptor → integrating center → effector

Senseory organ brain muscle/organ

positive feedback - self amplifying (childbirth)
blood clotting, protein digestion, generation of nerve signals

gradient = difference in chemical concentration, physical pressure, temp, electrical charge

moves from higher to lower concentration
"down gradient"

going up concentration gradient spends energy.

1.7 The Language of Medicine

Terminological Anatomica = international names, codified in 1998

eponyms = names coined from names of people

hypo natr emia

prefix: under
root: sodium
suffix: blood disorder

table 1.1

Singular ending	plural ending	
-a	-ae	axilla → axillae
-en	-ina	lumen → lumina
-ex	-ices	cortex → cortices
-is	-es	diagnosis → diagnoses
-is	-ides	epididymis → epididymides
-ix	-ices	appendix → appendices
-ma	-mata	carcinoma → carcinomata
-on	-a	ganglion → ganglia
-um	-a	septum → septa
-us	-era	viscus → viscera
-us	-i	villus → villi
-us	-ora	corpus → corpora
-x	-ges	phalanx → phalanges
-y	-ies	ovary → ovaries
-yx	-yces	calyx → calyces

memory tricks

a → ae ageec...

en → ina pen ina pen

ex → ices ices ex bf

is → es ingles → español

ma → mata ma → motha

on → a on a table

um → a when in doubt... a

us → i united states is individualistic

us → era us is an era

us → ora us is an aura

x → ges less used to word here

y → ies normal ending

yx → yces like regular ending but with a y

ides?

PICTURES & DIAGRAMS

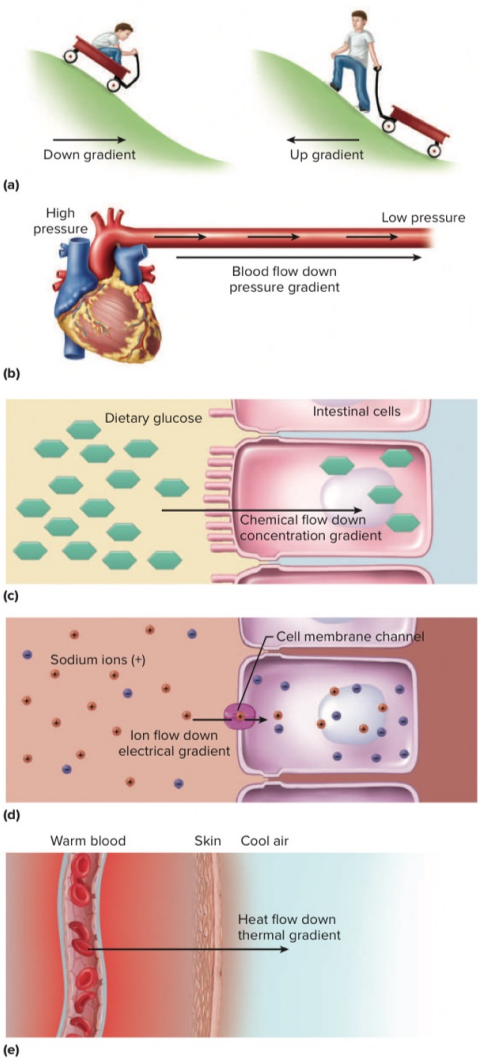


FIGURE 1.10 Flow Down Gradients. (a) A wagon rolling downhill (down a gradient) (left) is a useful analogy to spontaneous, gradient-driven physiological processes. Moving up a gradient (right) requires an energy input. (b) Blood flowing down a pressure gradient. (c) Dietary sugars flowing down a concentration gradient into an intestinal cell. (d) Sodium ions flowing down an electrical gradient into a cell. (e) Heat flowing down a thermal gradient to leave the body through the skin.

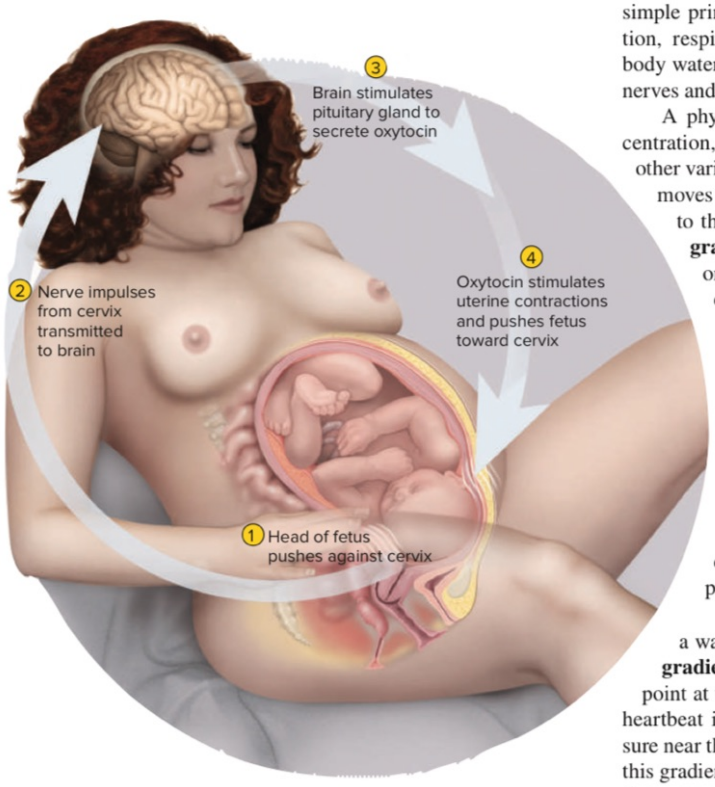


FIGURE 1.9 Positive Feedback in Childbirth.

Could childbirth as a whole be considered a negative feedback event? Discuss.

simple principle
tion, respiratory
body water distr
nerves and musc
A physiolo
centration, elect
other variable
moves from
to the poi
gradien
or a pla
conce
the g

slop
cal
top
wit
Sin
ousl
of m
quire
push o
Co
a water ta
gradient; v
point at the ta
heartbeat is like
sure near the hea
this gradient awa
flows down a pr
to pulmonary ai
gradient also dr
and waste produ

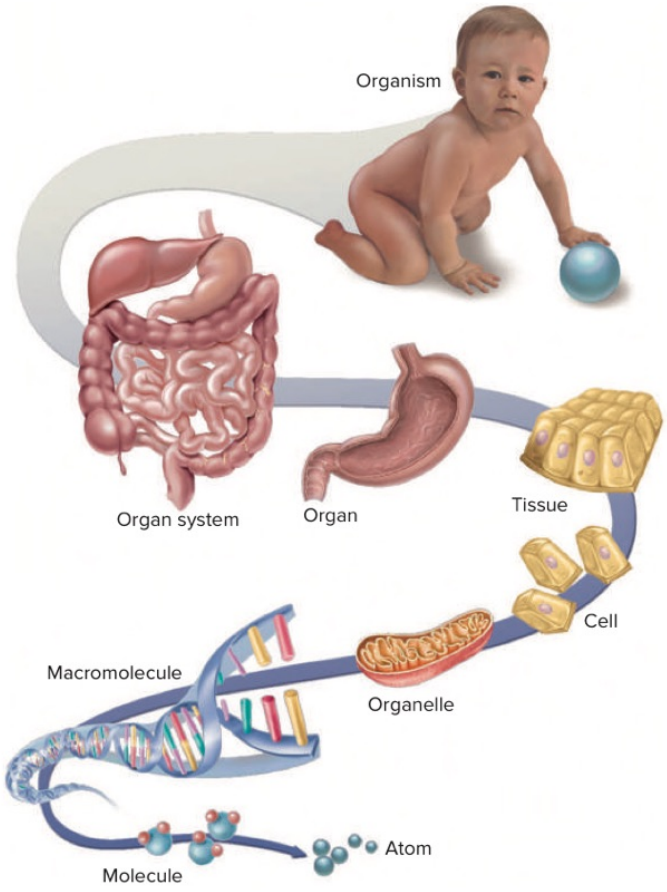


FIGURE 1.5 The Body's Structural Hierarchy.

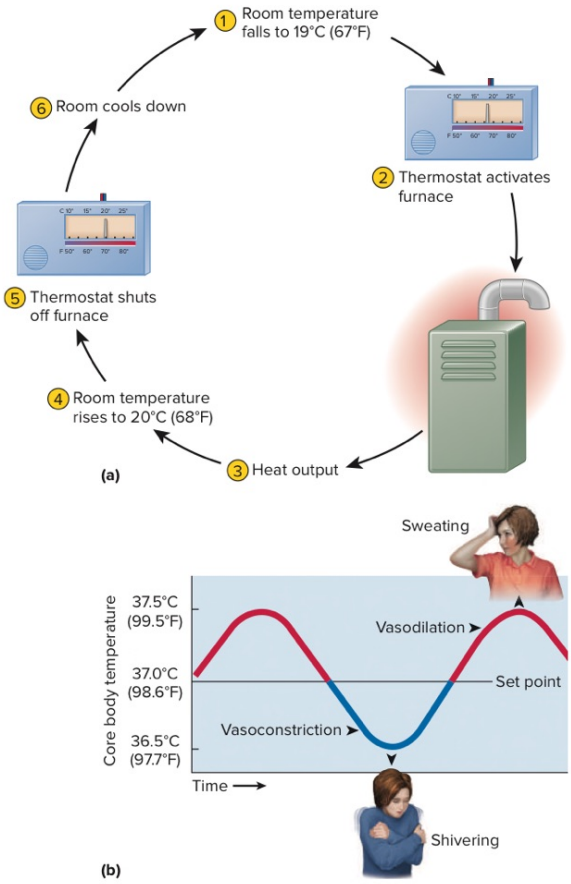


FIGURE 1.7 Negative Feedback in Thermoregulation.
(a) The negative feedback loop that maintains room temperature. (b) Negative feedback usually keeps the human body temperature within about 0.5°C of a 37°C set point. Cutaneous vasoconstriction and shivering set in when the body temperature falls too low, and soon raise it. Cutaneous vasodilation and sweating set in when body temperature rises too high, and soon lower it.

How does vasodilation reduce the body temperature?

your head and upper torso, resulting in falling blood pressure in this region—a local imbalance in your homeostasis **(fig. 1.8).** This is detected by sensory nerve endings called *baroreceptors* in large arteries near the heart. They transmit nerve signals to the brainstem, where we have a *cardiac center* that regulates the heart rate. The cardiac center responds by transmitting nerve signals to the heart, which speed it up. The faster heart rate quickly raises the blood pressure and restores normal homeostasis. In elderly people, this feedback loop is sometimes insufficiently responsive, and they may feel dizzy as they rise from a reclining

DEEPER INSIGHT 1.3
MEDICAL HISTORY

Men in the Oven

English physician Charles Blagden (1748–1820) staged a rather theatrical demonstration of homeostasis long before Cannon coined the word. In 1775, Blagden spent 45 minutes in a chamber heated to 127°C (260°F)—along with a dog, a beefsteak, and some research associates. Being dead and unable to maintain homeostasis, the steak was cooked. But being alive and capable of evaporative cooling, the dog panted, the men sweated, and all of them survived. History does not record whether the men ate the steak in celebration or shared it with the dog.

position and their cerebral blood pressure falls. This sometimes causes fainting.

This reflexive correction of blood pressure *(baroreflex)* illustrates three common, although not universal, components of a feedback loop: a receptor, an integrating center, and an effector. The **receptor** is a structure that senses a change in the body, such as the stretch receptors that monitor blood pressure. The **integrating (control) center,** such as the cardiac center of the

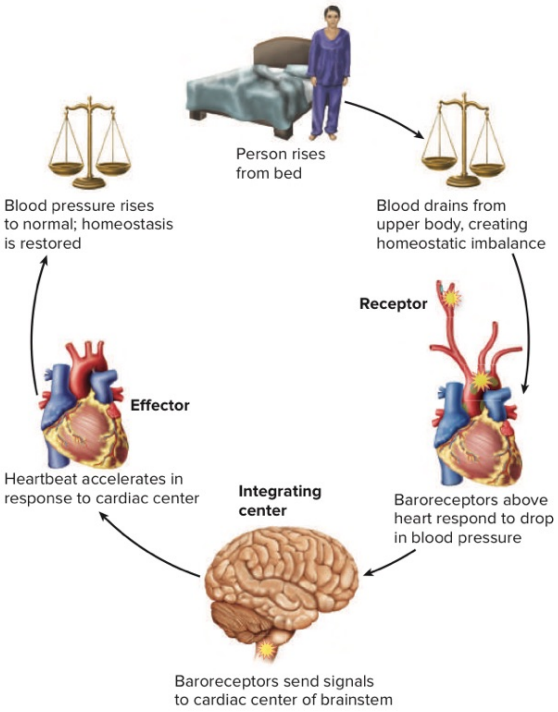


FIGURE 1.8 Homeostatic Compensation for a Postural Change in Blood Pressure.

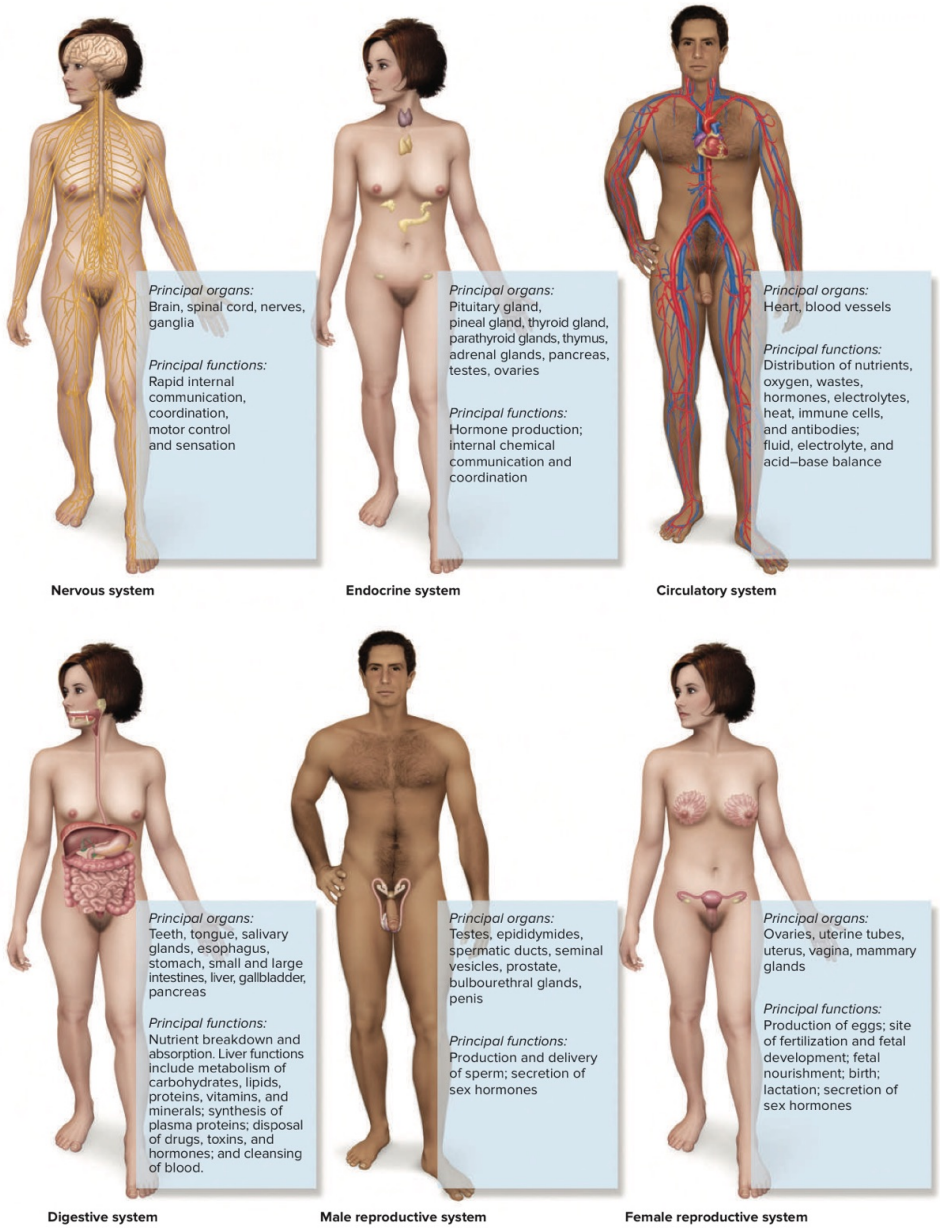
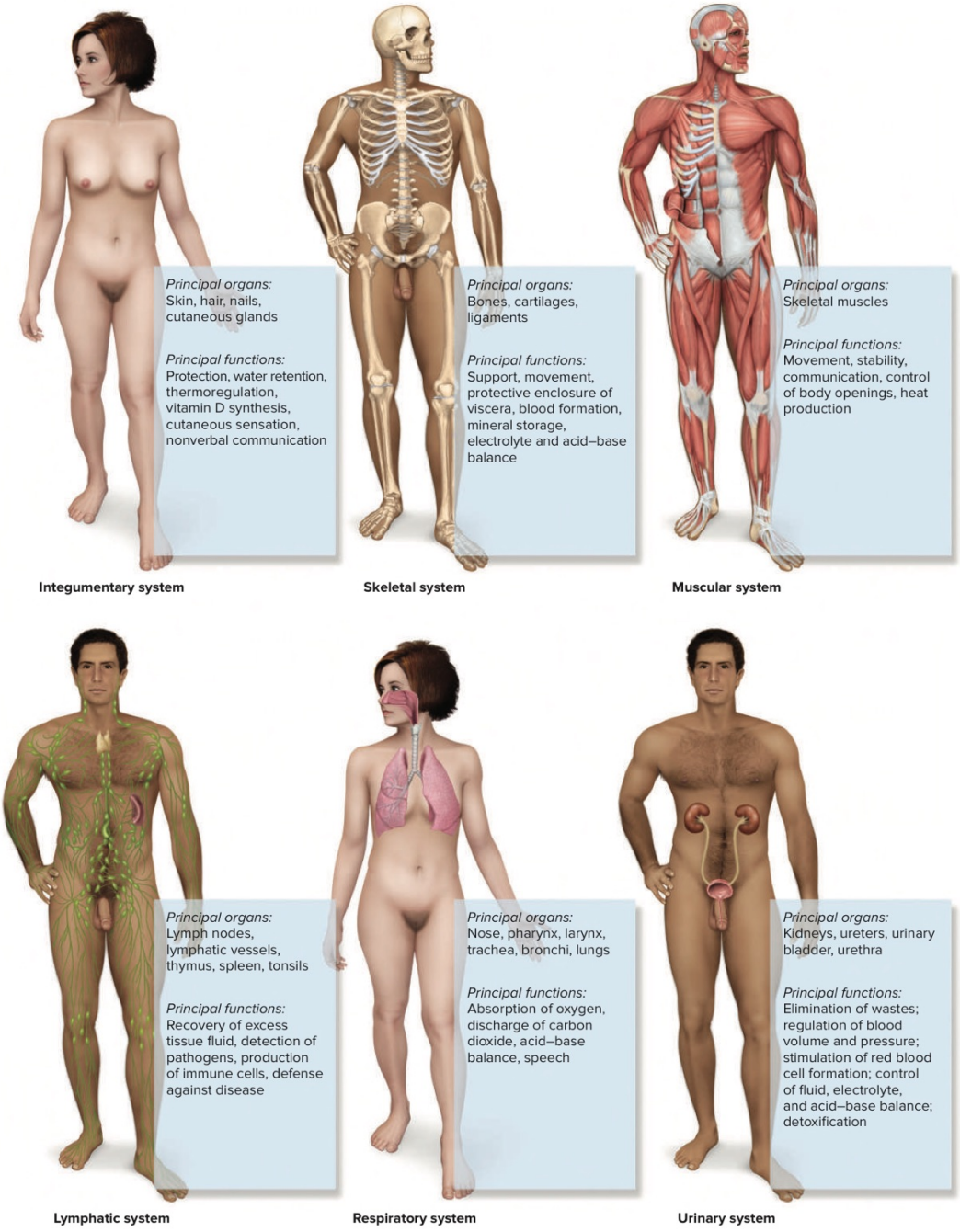
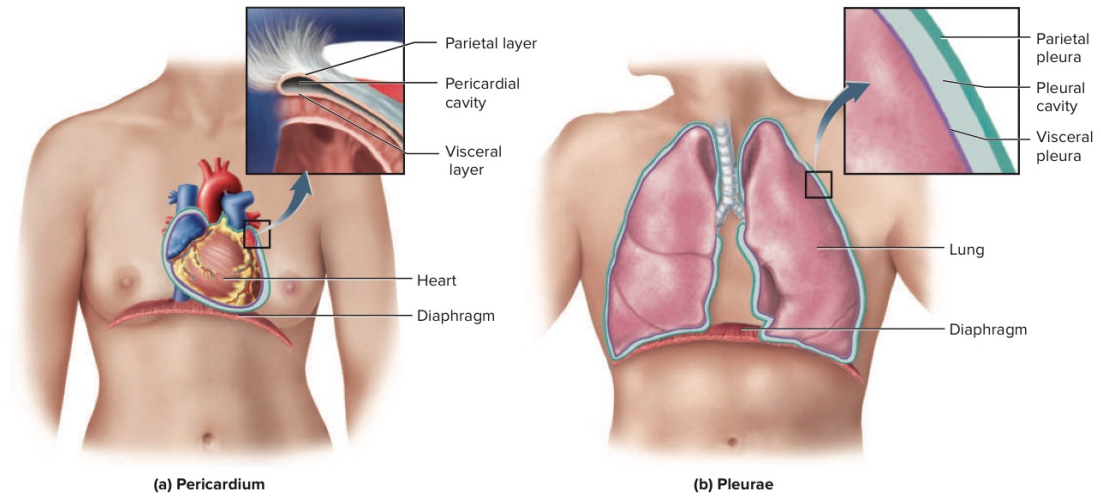


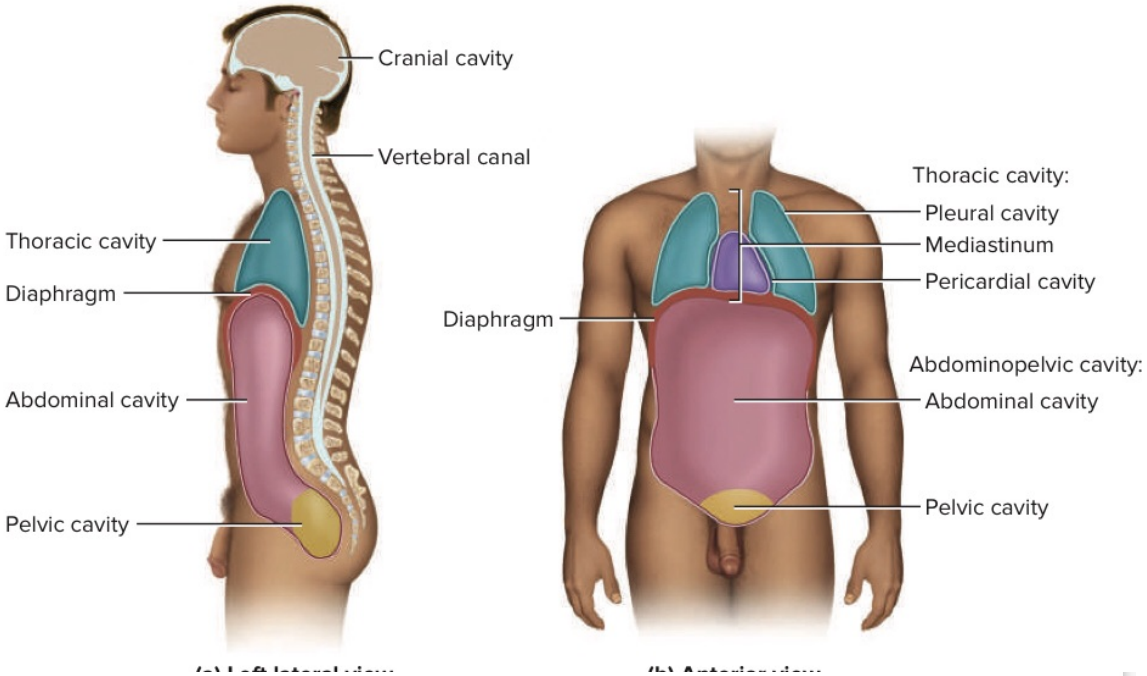
FIGURE A.9 The Human Organ Systems (continued).

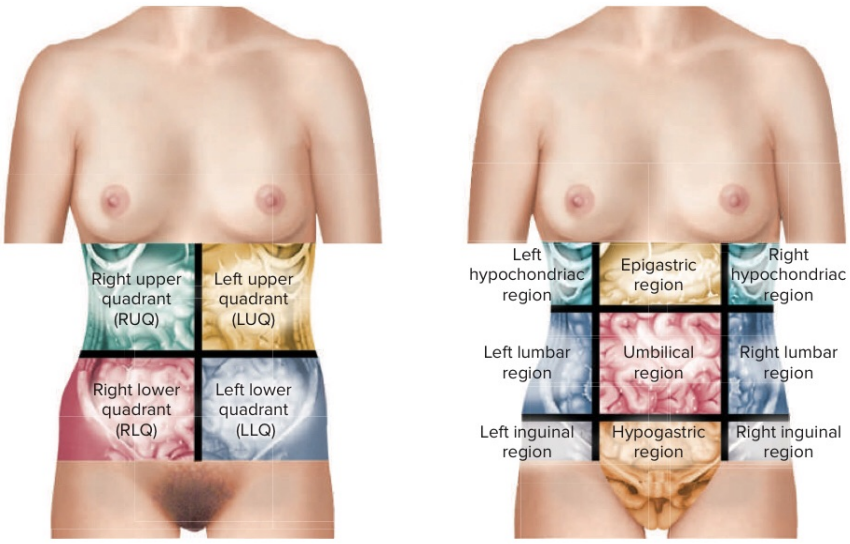


The Human Organ Systems.



(a) Pericardium (b) Pleurae





(a) Abdominopelvic quadrants (b) Abdominopelvic regions

FIGURE A.4 The Four Quadrants and Nine Regions of the Abdomen. (a) External division into four quadrants. (b) External division into nine regions. APR

? *In what quadrant would the pain of appendicitis usually be felt?*

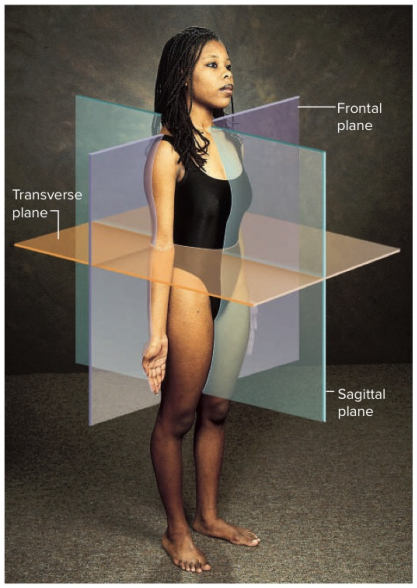


FIGURE A.1 Anatomical Position and the Three Primary Anatomical Planes.

[1]*sagitta* = arrow
[2]*para* = next to

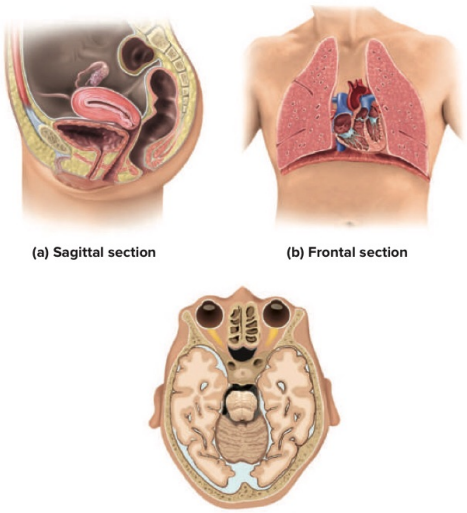


FIGURE A.2 Body Sections Cut Along the Three Primary Anatomical Planes. (a) Sagittal section of the pelvic region. (b) Frontal section of the thoracic region. (c) Transverse section of the head at the level of the eyes.

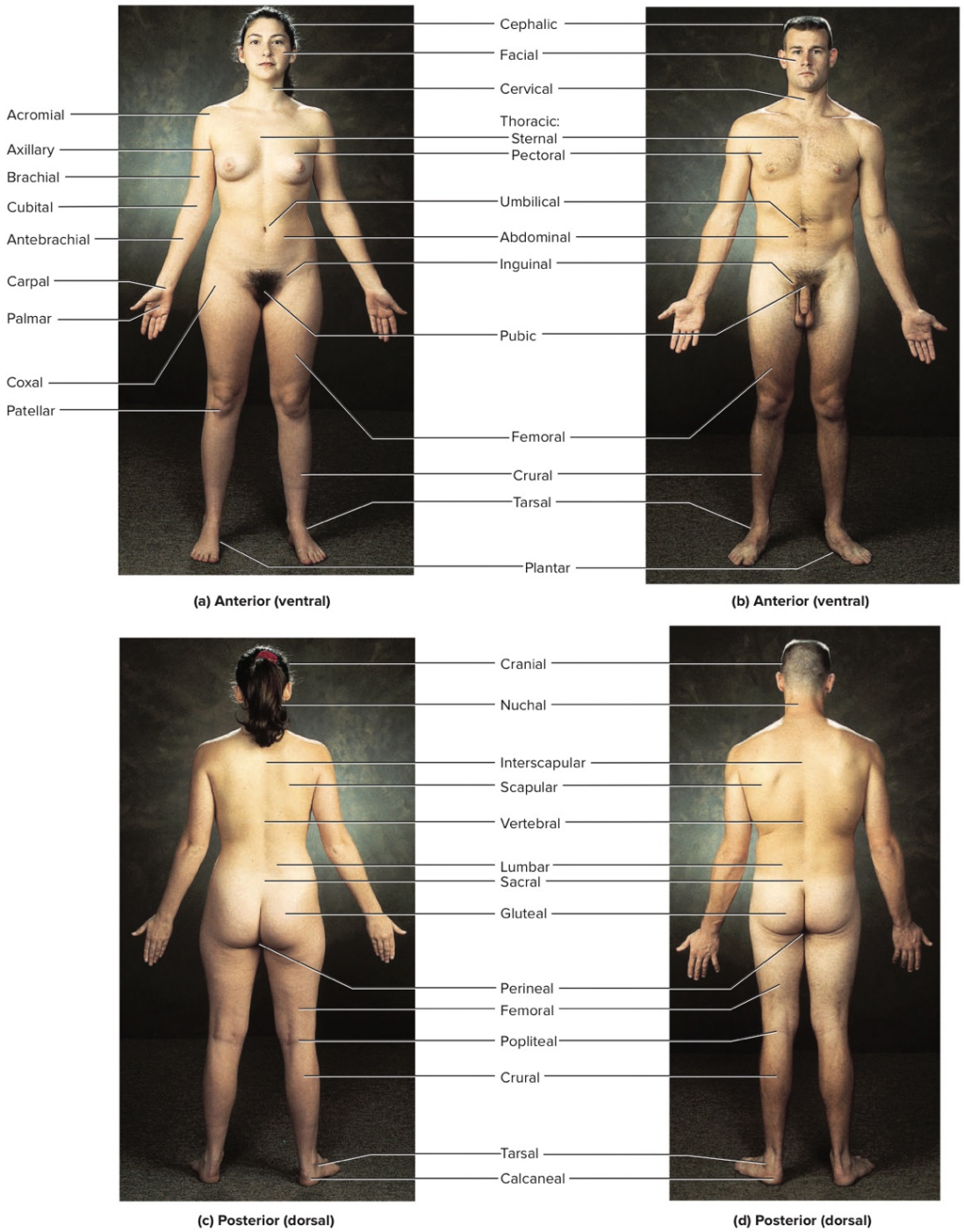
TABLE A.1 Directional Terms in Human Anatomy APR

Term	Meaning	Examples of Usage
Ventral Dorsal	Toward the front* or belly Toward the back or spine	The aorta is ventral to the vertebral column. The vertebral column is dorsal to the aorta.
Anterior Posterior	Toward the ventral side* Toward the dorsal side*	The sternum is anterior to the heart. The esophagus is posterior to the trachea.
Cephalic Rostral Caudal	Toward the head or superior end Toward the forehead or nose Toward the tail or inferior end	The brain develops from the cephalic end of the neural tube. The forebrain is rostral to the brainstem. The spinal cord is caudal to the brain.
Superior Inferior	Above Below	The heart is superior to the diaphragm. The liver is inferior to the diaphragm.
Medial Lateral	Toward the median plane Away from the median plane	The heart is medial to the lungs. The eyes are lateral to the nose.
Proximal Distal	Closer to the point of attachment or origin Farther from the point of attachment or origin	The elbow is proximal to the wrist. The fingernails are at the distal ends of the fingers.
Ipsilateral Contralateral	On the same side of the body (right or left) On opposite sides of the body (right and left)	The liver is ipsilateral to the appendix. The spleen is contralateral to the liver.
Superficial Deep	Closer to the body surface Farther from the body surface	The skin is superficial to the muscles. The bones are deep to the muscles.

*In humans only; definition differs for other animals.

TABLE 2.2 Major Electrolytes and the Ions Released by their Dissociation

Electrolyte		Cations and Anions
Calcium chloride ($CaCl_2$)	→	$Ca^{2+} + 2\ Cl^-$
Disodium phosphate (Na_2HPO_4)	→	$2\ Na^+ + HPO_4^{2-}$
Magnesium chloride ($MgCl_2$)	→	$Mg^{2+} + 2\ Cl^-$
Potassium chloride (KCl)	→	$K^+ + Cl^-$
Sodium bicarbonate ($NaHCO_3$)	→	$Na^+ + HCO_3^-$
Sodium chloride (NaCl)	→	$Na^+ + Cl^-$



The Adult Female and Male Body Regions. (a) Female, anterior. (b) Male, anterior. (c) Female, posterior. (d) Male, posterior.

a–d: Joe DeGrandis/McGraw-Hill Education

Chapter 2

p 42-54
p 55-73

Ions, electrolytes and Free Radicals
table 2.1 (p41)
p 44-45

TABLE 2.1 Elements of the Human Body

Name and Symbol	Percentage of Body Weight	Name and Symbol	Percentage of Body Weight
Major Elements (Total 98.5%)			
Oxygen (O)	65.0	Nitrogen (N)	3.0
Carbon (C)	18.0	Calcium (Ca)	1.5
Hydrogen (H)	10.0	Phosphorus (P)	1.0
Lesser Elements (Total 0.8%)			
Sulfur (S)	0.25	Chlorine (Cl)	0.15
Potassium (K)	0.20	Magnesium (Mg)	0.05
Sodium (Na)	0.15	Iron (Fe)	0.006
Trace Elements (Total 0.7%) (Names and symbols only)			
Chromium (Cr)	Fluorine (F)	Molybdenum (Mo)	Tin (Sn)
Cobalt (Co)	Iodine (I)	Selenium (Se)	Vanadium (V)
Copper (Cu)	Manganese (Mn)	Silicon (Si)	Zinc (Zn)

element = simplest form of matter to have unique chemical properties

made of proton, electrons, and neutron.

identified by # of protons (atomic number)

91 naturally occuring elements, 24 play normal physiological roles in humans.

↳ other elements w/o natural physiological roles can contaminate the body and/or disrupt physiological processes

mineral = inorganic elements extracted from soil by plants that are passed up the food chain to humans + other animals.

↳ 4 % of human body weight, mainly Ca & P, the rest Cl, Mg, K, Na, S.

enable enzymes to function.

Bones & teeth = calcium, phosphorus? (phosphate), magnesium, flouride, sulfate ions

many proteins contain sulfur,

phosphorus = major component of nucleic acids, ATP, and cell membranes.

Iodine = component of thyroid hormone

Some enzymes only function when bound to manganese, zinc, copper, etc

Atomic Structure

John Dalton developed atomic theory in 1803

nucleus = protons (+) + neutrons (0)

~1 amu ~1 amu

electrons (−) → no mass

determines chemical properties of an atom

electrons of the outermost shell = valence electrons, *bonding activity

Isotopes = a variety of an element, has different # of neutrons (atomic mass)

radioisotopes = unstable isotopes that decay (break down)

radioactivity

high energy radiation that ejects electrons from atoms (converts atoms to ions = ionizing radiation

↳ it destroys molecules and produces dangerous free radicals in human tissues.

mutagenic = mutation in DNA
carcinogenic = mutation results in cancer

Uranium + plutonium emit gamma rays

physical half-life = time it takes for a radioactive isotope to decay 50% of its atoms to a more stable isotope.

biological half-life = time it takes for half to disappear from body.

Ions, electrolytes, and Free Radicals

Ions = charged particles w/ unequal amount of protons and electrons.

anion = negative charge - gains electron
cation = positive charge - loses electron

* charge of ion = valence

Electrolytes = substances that ionize in water (acids, bases, salts).
↳ important for electrical conduction/effects, chemical reactivity, osmotic effects (influence on water content + distribution).
* essential for nerve and muscle function, one of the most important considerations in patient care

Free Radical = unstable, highly reactive chemical particles w/ an odd number of electrons

- produced by: some normal metabolic reactions (ATP-producing oxidation reactions in mitochondria, or reaction in white blood cells to kill bacteria)
- radiation (UV or x-rays)
- chemicals (nitrites - preservatives used in wine, meat, etc)

* short-lived but combine quickly with other molecules (DNA, fats, proteins)
↳ whatever they combine with is converted into a free radical → chain reaction of molecular destruction
↳ cancer + myocardial infarction (death of heart tissue)

antioxidant = chemical that neutralizes free radicals

Molecules + Chemical Bonds

conjugated = covalently bonded

molecules = two or more atoms

compound = molecules composed of two or more elements

all compounds are molecules, but not the other way around

molecular weight = sum of the atomic weights

ionic bond = electron transfer
* weak and dissociate easily in water

covalent bond = share electrons *strongest bonding

nonpolar = no partial charge
polar = partial charge region present

hydrogen bond = attraction to regions of polar covalent molecules (hydrogen side of one to oxygen of another)

Water and Mixtures

mixture = substances that are physically blended but not chemically combined

water = 50-70% of body weight,

most mixtures in our bodies are chemically or physically suspended in water

adhesion = tendency for one substance to cling to another

cohesion = tendency for molecules of the same substance to cling to each other

water is thermally stable + chemical reactive

* basic unit of heat = calorie
1 cal = heat needed to raise temp of 1g H_2O 1°C

Solutions, Colloids, Suspensions

H_2O NaCl

Solution = solvent + solute

thing that solute is mixed into (normally solvent is a liquid)

particles of matter (usually a solid) mixed into solute

Solutions are defined by the following properties:
- ~~solute particles are under 1nm in size~~
- solute + solvent can not be distinguishably, even with microscope.
- small solute particles don't scatter light noticeably
  - ↳ solutions are usually transparent
- solute particles can pass through selectively permeable membrane
  ex: dialysis tube, cell membranes
- solute does not separate from the solvent when the solution is allowed to stand.

colloid = aqueous mixture of particles that are too large to fit through selectively permeable membranes, but small enough to remain evenly dispersed through the solvent by the thermal motion of solvent particles
  ex: protein in blood plasma
  - ↳ particles scatter light, so colloids are usually cloudy.

emulsion = suspension of one liquid into another

suspension = large particles that are too large to fit through selectively permeable membranes and too heavy to remain evenly dispersed in solvent if allowed to stand.
  ex: red blood cells in plasma

Acids, Bases, pH

acid = donates H^+ ion (has H^+)

base = accepts H^+ ion (has OH^-) * amonium (NH_3) is a base

pure water is neutral (pH 7)

pH 0 - 6.9 = acidic ← less pH = more H^+ ions

pH 7.1 - 14 = basic

buffers = chemical solutions that resist changes in pH

Energy & Work

energy is the capacity to do work

work = to move something

potential energy = energy contained in an object because of its position or internal state (not doing work)

kinetic energy = energy in motion, energy doing work

chemical energy = potential energy stored in molecular bonds.
heat is kinetic energy of molecular motion

electrical energy has both kinetic + potential forms

electrical current — charged battery

free energy = potential energy stored to do useful work

p55

factors that affect rate of chemical reactions:

↑ ↑ - concentration
↑ ↑ - temperature
↑ ↑ - enzyme activity (catalysts)

← pH?

metabolism, oxidation, reduction

all chemical reactions in body = metabolism
catabolism = energy releasing decomposition reactions
↳ exergonic
anabolism = energy absorbing synthesis reactions
↳ endogonic
↳ driven by the energy that catabolism releases

Oxidation = any chemical reaction that gives up electrons and releases energy
↳ whatever molecule takes electron = oxidizing agent
molecule that gives up electron = oxidized
often oxygen is involved as electron acceptor

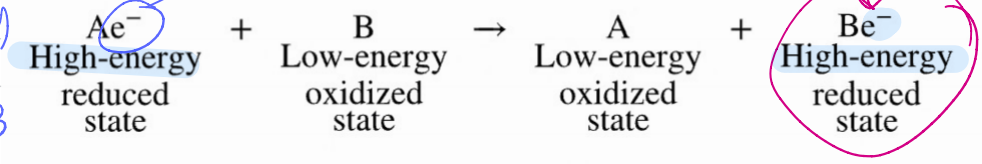
reduction = a chemical reaction where molecule gains electron and gains energy
↳ when molecule gains electron, it is reduced,
molecule that donates electron = reducing agent

redox reactions
↳ electrons are often transferred in the form of hydrogen atoms

$$\underset{\substack{\text{High-energy}\\\text{reduced}\\\text{state}}}{Ae^-} + \underset{\substack{\text{Low-energy}\\\text{oxidized}\\\text{state}}}{B} \rightarrow \underset{\substack{\text{Low-energy}\\\text{oxidized}\\\text{state}}}{A} + \underset{\substack{\text{High-energy}\\\text{reduced}\\\text{state}}}{Be^-}$$

Ae^- is in reduced state because it has energy and 2 electron. It gave to B

B molecule took electron, oxidizing agent



why is Ae^- reducing agent & B oxidizing agent?

the oxidizing agent is reduced.
the reducing agent is oxidized.

↓

B took electron and energy

to be reduced is to gain energy and electron, so B gained A's electron and energy. This would make Ae^- the reducing agent because it gave B its energy and electron.

to be oxidized is to lose an electron and energy. Since B took Ae^-'s electron and energy, B is the oxidizing agent.

A gave up its electron + energy, so it ends up oxidized.

B gains energy + electron, so it ends up reduced.

TABLE 2.5 Energy-Transfer Reactions in the Human Body

Exergonic Reactions	Reactions in which there is a net release of energy. The products have less total free energy than the reactants did.
Oxidation	An exergonic reaction in which electrons are removed from a reactant. Electrons may be removed one or two at a time and may be removed in the form of hydrogen atoms (H or H_2). The product is then said to be oxidized.
Decomposition	A reaction such as digestion and cell respiration, in which larger molecules are broken down into smaller ones.
Catabolism	The sum of all decomposition reactions in the body.
Endergonic Reactions	Reactions in which there is a net input of energy. The products have more total free energy than the reactants did.
Reduction	An endergonic reaction in which electrons are donated to a reactant. The product is then said to be reduced.
Synthesis	A reaction such as protein and glycogen synthesis, in which two or more smaller molecules are combined into a larger one.
Anabolism	The sum of all synthesis reactions in the body.

BEFORE YOU GO ON

Answer the following questions to test your understanding of the preceding section:

12. Define *energy.* Distinguish potential energy from kinetic energy.

Na^+Cl^-

13. Define *metabolism, catabolism,* and *anabolism.*

14. What does *oxidation* mean? What does *reduction* mean? Which of them is endergonic and which is exergonic?

15. When sodium chloride forms, which element—sodium or chlorine—is oxidized? Which one is reduced?

Organic Compounds

organic chemistry – the study of compounds of carbons

Large organic compounds (macromolecules)
1. Lipids
2. Nucleic Acids
3. Carbohydrates
4. Proteins

*Carbon has 4 valence electrons

carbon backbones = long chains, branches, or rings of carbons covalently bonded to each other
↳ forms functional groups – clusters of atoms that determine many of the chemical properties of an organic molecules
ex: methyl, amino, phosphate, carboxyl group

monomers = subunits of polymers (amino acid)
polymer = macromolecule (protein)

polymerization – the joining of monomers to form a polymer – formed by dehydration synthesis (condensation)
↳ removes -OH from one monomer and a hydrogen from another, bonds monomers, forms water as byproduct

hydrolysis = breaking up water to break up polymers into monomers.

Carbohydrate = hydrophillic macromolecule, $C_N H_{2N} O_N$ $(CH_2O)_N$

monosaccharide = carb monomer – glucose, fructose, galactose
↳ RNA + DNA
disaccharide = carb dimer
↳ sucrose, lactose, maltose
Oligosaccharide = short (10-20)
polysaccharide = long chain of carb monomers

glycogen = energy storage, liver maintains glucose
Starch = plant energy storage, only digestable polysaccharide
Cellulose = plant cell wall structure, dietary fiber

glycoprotein = major component of mucus

proteoglycans - macromolecules with a dominant carb component and a smaller amount being formed by protein

moiety = part (reference to each chemically different component

Lipid → hydrophobic organic molecule usually composed of hydrogen, oxygen, carbon w/ high ratio of hydrogen to oxygen
* less oxidized than carbs

fatty acid - a chain of 4-24 carbon atoms w/ carboxyl group at one end and methyl group at the other.

Saturated - no room for hydrogens, unkinked
unsaturated - double C=C bond, kinked

triglyceride — molecule of 3-carbon alcohol (glycerol) and 3 fatty acid tails
↳ each bond is formed by dehydration synthesis
"neutral fats"
broken down w/ hydrolysis reactions

liquid fat @ room temp = oil
primary function = fat storage

phospholipids - like triglycerides but have glycerol, two fatty acid tails + phosphate group
phosphate head = hydrophillic → amphipathic
fatty acid tails = hydrophobic

Eicosanoid - 20-carbon compounds derived from fatty acid called arachidonic acid. They function as hormone like chemical signal b/w cells.
prostaglandins - signaling roles in inflammation, blood clotting, hormone action, labor contractions, control of blood vessel diameter.

Steroid: a lipid w/ 17 of its carbons arranged in 4 rings.
* Cholesterol: parent steroid
↳ all other steroids are made from cholesterol.
estrogen, testosterone, progesterone, bile acids, cortisol

Avg. adult contains 1/2 pound (200g) of cholesterol.
85% is internally synthesized, 15% is eaten

Protein - polymer of amino acids. proteins = of first importance

amino acid - central carbon w/ amino, carboxly, r group
↳ often amphipatic peptide = 2 or more amino acid

oligopeptides = 10-15 amino acids (oxytocin)
oxytocin-composed of 9 amino acids

confirmation = protein shape (change in confirmation = denaturization)

primary structure - chain of amino acids

secondary structure - a-helix, b sheet formed by hydrogen bonding
spring-like ↗ ribbon-like ↙

tertiary structure - folding and coiling due to interactions b/w R groups and/or surrounding water

quarternary structure - association of two or more polypeptide chains with each other into globular or fibrous shapes.

disulfide bridges hold two polypeptide chains together

Protein functions

1. Structure - gives strength to hair, nails, skin, bones, cartilage
2. Communication
ligand = anything that binds to a protein
membrane transport

4. Catalysts
5. Recognition + protection (glycoproteins in immune system) antibodies, clotting protein
6. movement (motor proteins)
7. cell adhesion (cell binding)

enzyme - protein that function as biological catalyst.
substrate = what enzyme acts on

activation energy = energy needed to start a reaction

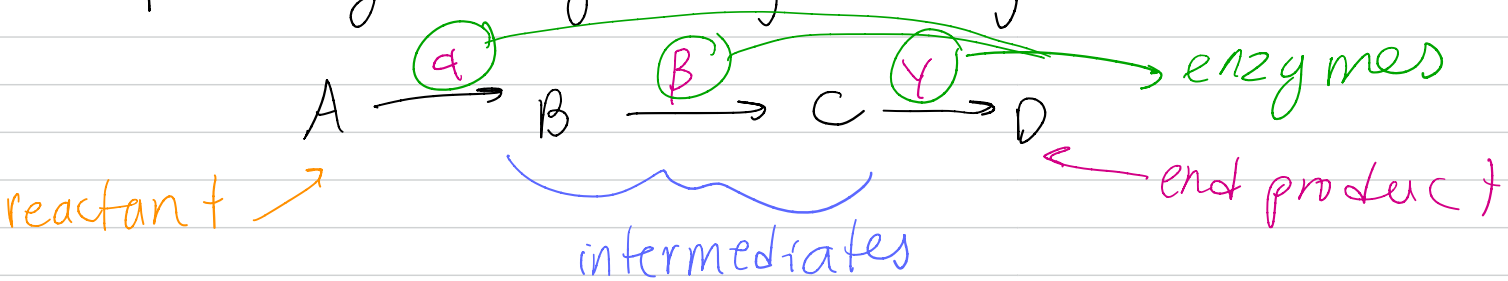
Enzyme action
1. substrate molecule approaches pocket on enzyme (active site)
2. substrate binds to enzyme, forming an enzyme-substrate complex.
*specificity
3. reaction → enzyme remains unchanged, it is not consumed by the reaction

factors that change shape of enzyme
1. temperature
2. pH

cofactor - a non-protein partner of an enzyme (iron, copper, zinc, magnesium, copper, calcium ions) that the enzyme needs to function

coenzyme - a small organic molecule (usually derived from a vitamin, that is needed to make an enzyme catalytically active
↳ acts by accepting electrons from an enzymatic reaction and transferring them to a different reaction chain

metabolic pathway = a chain of reactions, with each step usually catalyzed by an enzyme



nucleotides - monomer of nucleic acids

1. nitrogenous base (double ringed carbon)
2. monosacchanide
3. one or more phosphate groups

ex: ATP → body's most important energy-transfer molecule

phosphorylation - switch that turns metabolic pathways on/off
↳ activated by enzymes called kinases.

much of energy from ATP synthesis is glucose oxidation

glycolysis produces pyruvate and net gain of two ATPs.

Anaerobic fermentation converts pyruvate to lactate and permits glycolysis to continue producing ATP w/o O_2.
Aerobic respiration makes much more ATP but requires O_2.

guanosine triphosphate (GTP)
↳ donates phosphate to ADP to yield ATP

cyclic AMP - atp w/ only one phosphate, acts as messenger to activate metabolic effects w/in cell.

nucleic acids - polymers of nucleotides. DNA constitutes genes, instructions for protein synthesis. RNA = makes protein

Cellular Respiration

turning glucose → energy

reduction
OIL ← loss of electrons
RIG ← gain electrons
oxidation

$C_6H_{12}O_6 + 6O_2 \xrightarrow{\text{cellular respir.}} 6CO_2 + 6H_2O + \text{energy}$

glucose | oxygen | carbon dioxide | water | heat | 38 ATP (~29 more accurately)

begins in cytoplasm

1. Glycolysis = breaking up glucose
   - breaks down carbon backbone
   - generates 4 ATP > net 2 ATPs
   - needs 2 ATPs (anaerobic respiration)
   - produces 2 NADH
   - → fermentation
     - lactic acid when there isn't enough oxygen
     - yeast does alcoholic fermentation
2. Krebs Cycle
   - requires oxygen
   - generates 2 ATP
3. Electron transport chain ★
   - produces 34 ATP
   - aerobic (requires oxygen)

$NAD^+ + H_2O \rightarrow NADH$

drives electron transport chain

mitochondria

glucose converted to pyruvate

undergoes further oxidation
decarboxylation (loses carboxyl group)
forms 2 carbon dioxide
2 NADH
2 acetate

Acetyl co-A is split ↴
into Acetate & co-enzyme A
oxaloacetate receives 2 carbon molecule
makes citric acid
(results in $2CO_2$, 3 NADH, 1 ATP, 1 $FADH_2$) × 2
ETC

$FAD \rightarrow FADH$

electron carrier

NADH from glycolysis, pyruvate oxidation, and krebs cycle continue to electron transport chain

NADH carries electrons to be pulled through membrane in mitochondria to create water and NAD^+. Hydrogen ions in the intermembrane space creates a hydrogen ion gradient. Hydrogen ions leave the gradient through ATP synthase, which generates ATP.

1. Oxidation of NADH + $FADH_2$
2. electrons are gained & lost, creating ATP, water.
3. Oxidized NAD^+ + FAD return to be reduced again.
4. Electrons bind to oxygen to form water, hydrogen accumulates in intermembrane space, electrochemical gradient is established
5. Hydrogen ions re-enter matrix by ATP synthase

Chloroplast = mitochondria

Tables • Pictures

TABLE 2.3 Types of Chemical Bonds

Bond Type	Definition and Remarks
Ionic Bond	Relatively weak attraction between an anion and a cation. Easily disrupted in water, as when salt dissolves.
Covalent Bond	Sharing of one or more pairs of electrons between nuclei.
Single covalent	Sharing of one electron pair.
Double covalent	Sharing of two electron pairs. Often occurs between carbon atoms, between carbon and oxygen, and between carbon and nitrogen.
Nonpolar covalent	Covalent bond in which electrons are equally attracted to both nuclei. May be single or double. Strongest type of chemical bond.
Polar covalent	Covalent bond in which electrons are more attracted to one nucleus than to the other, resulting in slightly positive and negative regions in one molecule. May be single or double.
Hydrogen Bond	Weak attraction between polarized molecules or between polarized regions of the same molecule. Important in the three-dimensional folding and coiling of large molecules. Easily disrupted by temperature and pH changes.
Van der Waals Force	Weak, brief attraction due to random disturbances in the electron clouds of adjacent atoms. Weakest of all bonds individually, but can have strong effects collectively.

TABLE 2.4 Types of Mixtures

	Solution	Colloid	Suspension
Particle size	<1 nm	1–100 nm	>100 nm
Appearance	Clear	Often cloudy	Cloudy-opaque
Will particles settle out?	No	No	Yes
Will particles pass through a selectively permeable membrane?	Yes	No	No
Examples	Glucose in blood O_2 in water Saline solutions Sugar in coffee	Proteins in blood Intracellular fluid Milk protein Gelatin	Blood cells Cornstarch in water Fats in blood Kaopectate

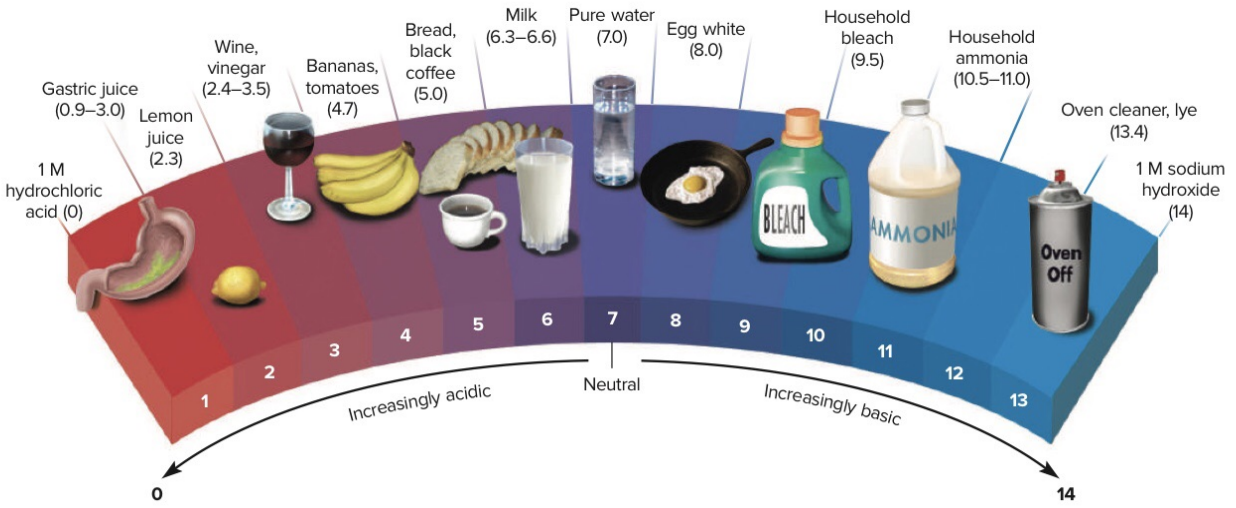


FIGURE 2.11 The pH Scale and Approximate pH of Some Familiar Household Substances. The pH is shown within the colored bar. H^+ molarity increases 10-fold for every step down the scale.

TABLE 2.5 Energy-Transfer Reactions in the Human Body

Exergonic Reactions	Reactions in which there is a net release of energy. The products have less total free energy than the reactants did.
Oxidation	An exergonic reaction in which electrons are removed from a reactant. Electrons may be removed one or two at a time and may be removed in the form of hydrogen atoms (H or H_2). The product is then said to be oxidized.
Decomposition	A reaction such as digestion and cell respiration, in which larger molecules are broken down into smaller ones.
Catabolism	The sum of all decomposition reactions in the body.
Endergonic Reactions	Reactions in which there is a net input of energy. The products have more total free energy than the reactants did.
Reduction	An endergonic reaction in which electrons are donated to a reactant. The product is then said to be reduced.
Synthesis	A reaction such as protein and glycogen synthesis, in which two or more smaller molecules are combined into a larger one.
Anabolism	The sum of all synthesis reactions in the body.

TABLE 2.6 Carbohydrate Functions

Type	Function
Monosaccharides	
Glucose	Blood sugar—energy source for most cells
Galactose	Converted to glucose and metabolized
Fructose	Fruit sugar—converted to glucose and metabolized
Disaccharides	
Sucrose	Cane sugar—digested to glucose and fructose
Lactose	Milk sugar—digested to glucose and galactose; important in infant nutrition
Maltose	Malt sugar—product of starch digestion, further digested to glucose
Polysaccharides	
Cellulose	Structural polysaccharide of plants; dietary fiber
Starch	Energy storage in plant cells; energy source in human diet
Glycogen	Energy storage in animal cells (liver, muscle, brain, uterus, vagina)
Conjugated Carbohydrates	
Glycoprotein	Component of the cell surface coat and mucus, among other roles
Glycolipid	Component of the cell surface coat
Proteoglycan	Cell adhesion; lubrication; supportive filler of some tissues and organs

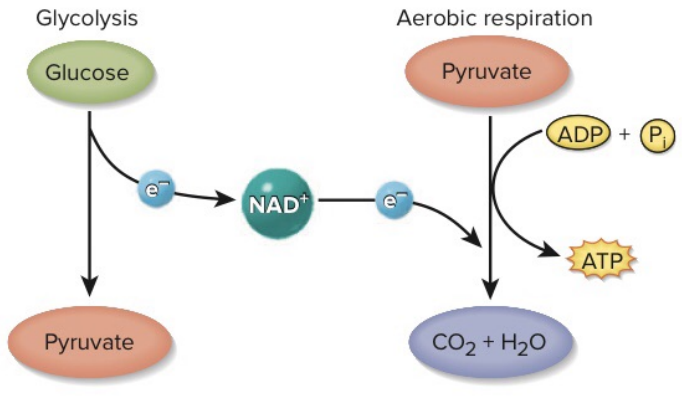
every oxygen. Lipids are less oxidized than carbohydrates, and thus have more calories per gram. Beyond these criteria, it is difficult to generalize about lipids; they are much more variable in structure than the other macromolecules we are considering. We consider here the five primary types of lipids in humans—*fatty acids, triglycerides, phospholipids, eicosanoids,* and *steroids* **(table 2.7).**

[20] *moiet* = half

TABLE 2.7 Lipid Functions

Type	Function
Bile acids	Steroids that aid in fat digestion and nutrient absorption
Cholesterol	Component of cell membranes; precursor of other steroids
Eicosanoids	Chemical messengers between cells
Fat-soluble vitamins (A, D, E, and K)	Involved in a variety of functions including blood clotting, wound healing, vision, and calcium absorption
Fatty acids	Precursor of triglycerides; source of energy
Phospholipids	Major component of cell membranes; aid in fat digestion
Steroid hormones	Chemical messengers between cells
Triglycerides	Energy storage; thermal insulation; filling space; binding organs together; cushioning organs

[18] nicotinamide adenine dinucleotide



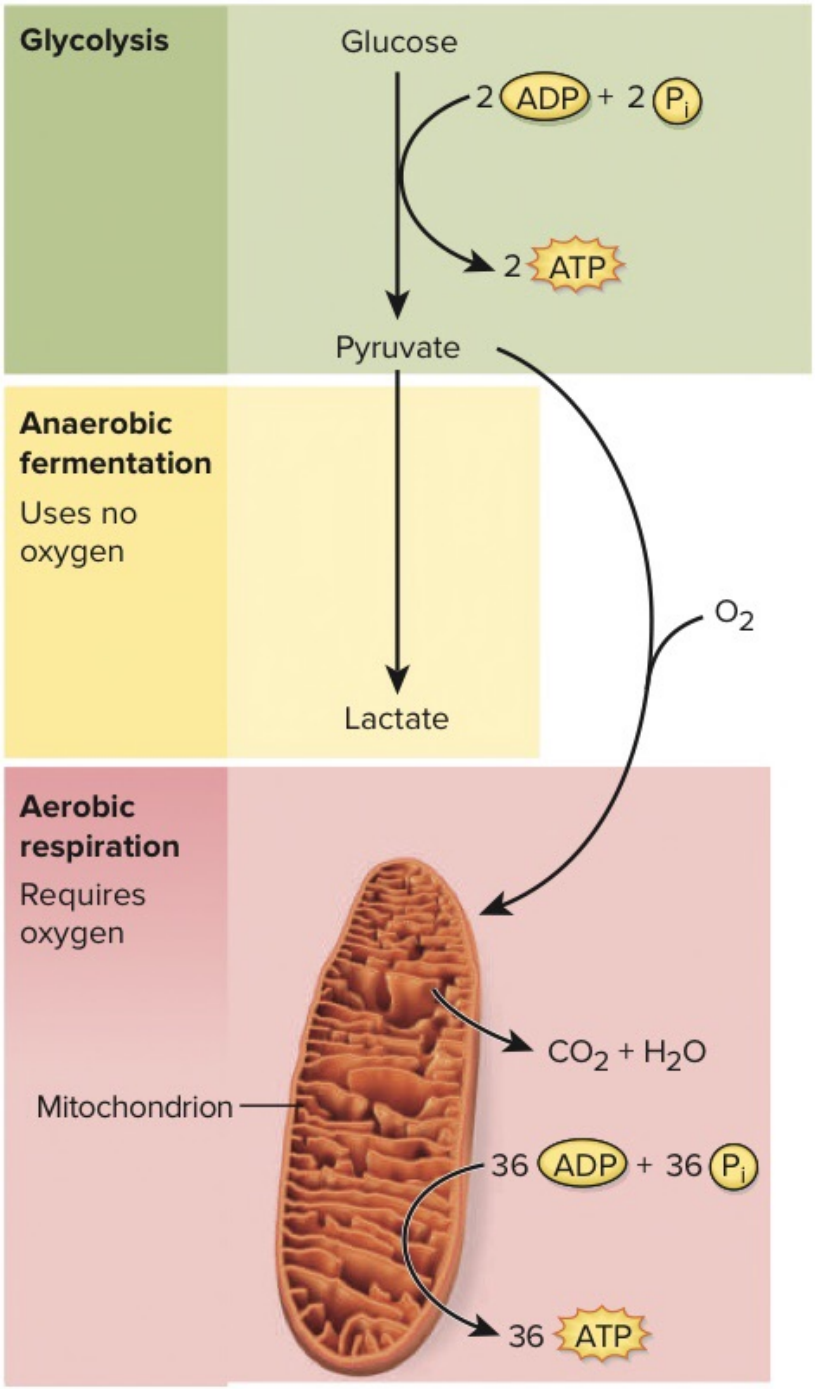


FIGURE 2.31 ATP Production. Glycolysis produces pyruvate and a net gain of two ATPs. Anaerobic fermentation converts pyruvate to lactate and permits glycolysis to continue producing ATP in the absence of oxygen. Aerobic respiration produces a much greater ATP yield but requires oxygen.