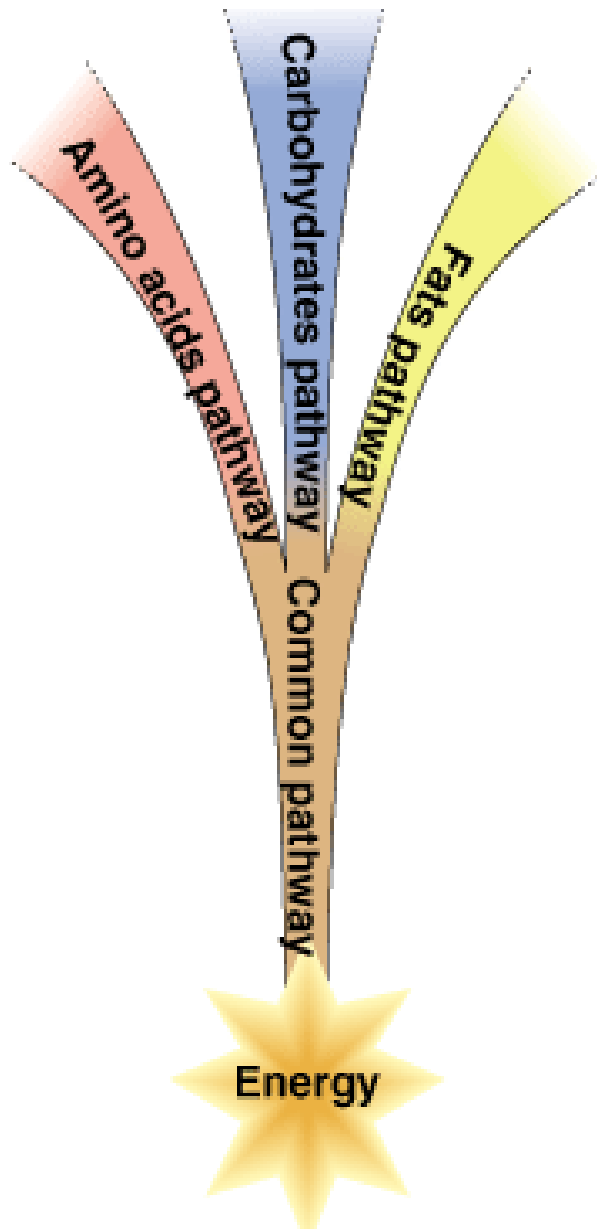


Energy Metabolism

Chapter 7





Simple Overview of Energy Metabolism

The sum of all chemical reactions that go on in living cells

Introduction

- Energy
 - Heat- body temperature
 - Mechanical- moves muscles
 - Electrical- sends nerve impulses
 - Chemical-
 - Stored in food and body
- Metabolism
 - Release of energy, water, and carbon dioxide

Chemical Reactions

- Building Reactions – Anabolism
 - Require energy
- Breakdown Reactions – Catabolism
 - Release energy

A Typical Cell

Inside the cell membrane lies the cytoplasm, a lattice-type structure that supports and controls the movement of the cell's structures. A protein-rich jelly-like fluid called cytosol fills the spaces within the lattice. The cytosol contains the enzymes involved in glycolysis.^a

A separate inner membrane encloses the cell's nucleus.

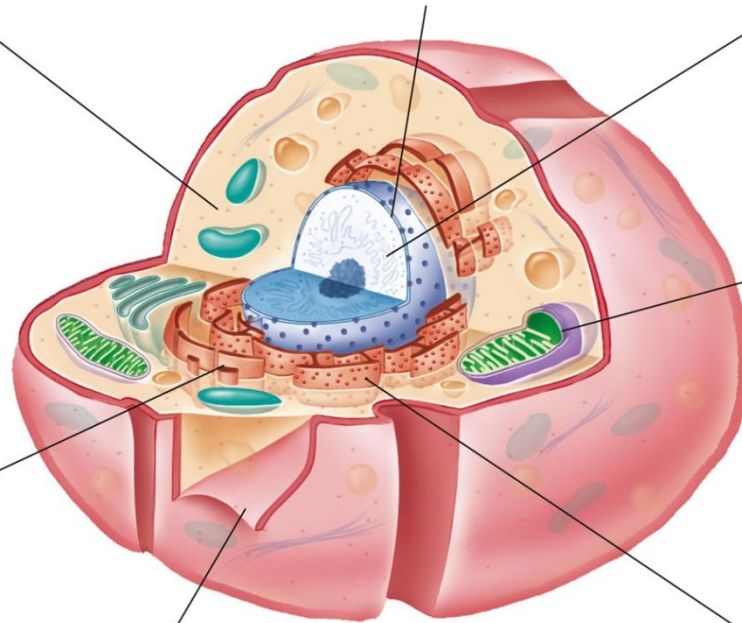
Inside the nucleus are the chromosomes, which contain the genetic material DNA.

Known as the "powerhouses" of the cells, the mitochondria are intricately folded membranes that house all the enzymes involved in the conversion of pyruvate to acetyl CoA, fatty acid oxidation, the TCA cycle, and the electron transport chain.^b

This network of membranes is known as smooth endoplasmic reticulum—the site of lipid synthesis.

A membrane encloses each cell's contents and regulates the passage of molecules in and out of the cell.

Rough endoplasmic reticulum is dotted with ribosomes—the site of protein synthesis.^c



^aGlycolysis is introduced on p. 211.

^bThe conversion of pyruvate to acetyl CoA, fatty acid oxidation, the TCA cycle, and the electron transport chain are described later in the chapter.

^cFigure 6-7 on p. 179 describes protein synthesis.

The Metabolic Work of the Liver

TABLE 7-1 Metabolic Work of the Liver

The liver is the most active processing center in the body. When nutrients enter the body from the digestive tract, the liver receives them first; then it metabolizes, packages, stores, or ships them out for use by other tissues. When alcohol, drugs, or poisons enter the body, they are also sent directly to the liver; here they are detoxified and their by-products shipped out for excretion. An enthusiastic anatomy and physiology professor once remarked that given the many vital activities of the liver, we should express our feelings for others by saying, "I love you with all my liver" instead of "with all my heart." Granted, this declaration lacks romance, but it makes a valid point. Here are just some of the many jobs performed by the liver. To renew your appreciation for this remarkable organ, review Figure 3-11 (p. 81).

Carbohydrates

- Metabolizes fructose, galactose, and glucose
- Makes and stores glycogen
- Breaks down glycogen and releases glucose
- Breaks down glucose for energy when needed
- Makes glucose from some amino acids and glycerol when needed
- Converts excess glucose and fructose to fatty acids

Lipids

- Builds and breaks down triglycerides, phospholipids, and cholesterol as needed
- Breaks down fatty acids for energy when needed
- Packages lipids in lipoproteins for transport to other body tissues
- Manufactures bile to send to the gallbladder for use in fat digestion
- Makes ketone bodies when necessary

Proteins

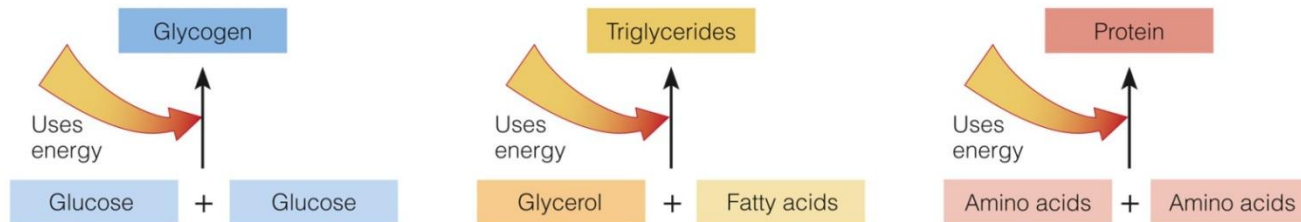
- Manufactures nonessential amino acids that are in short supply
- Removes from circulation amino acids that are present in excess of need and converts them to other amino acids or deaminates them and converts them to glucose or fatty acids
- Removes ammonia from the blood and converts it to urea to be sent to the kidneys for excretion
- Makes other nitrogen-containing compounds the body needs (such as bases used in DNA and RNA)
- Makes many proteins

Other

- Detoxifies alcohol, other drugs, and poisons; prepares waste products for excretion
- Helps dismantle old red blood cells and captures the iron for recycling
- Stores most vitamins and many minerals
- Activates vitamin D

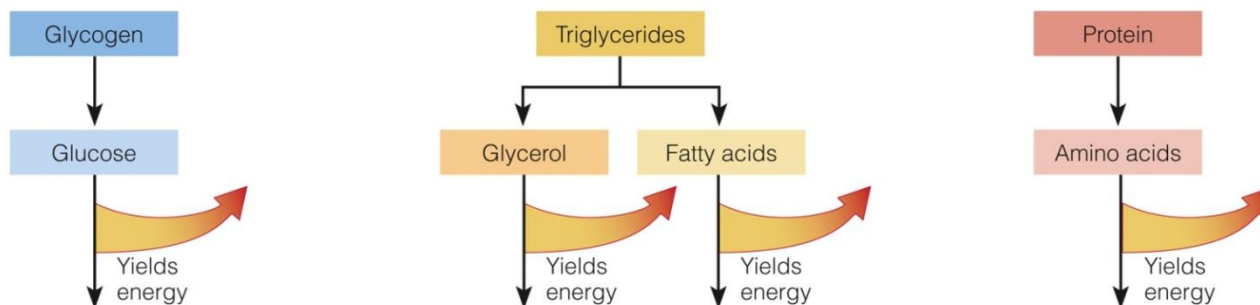
Anabolic and Catabolic Reactions Compared

ANABOLIC REACTIONS



Anabolic reactions include the making of glycogen, triglycerides, and protein; these reactions require differing amounts of energy.

CATABOLIC REACTIONS

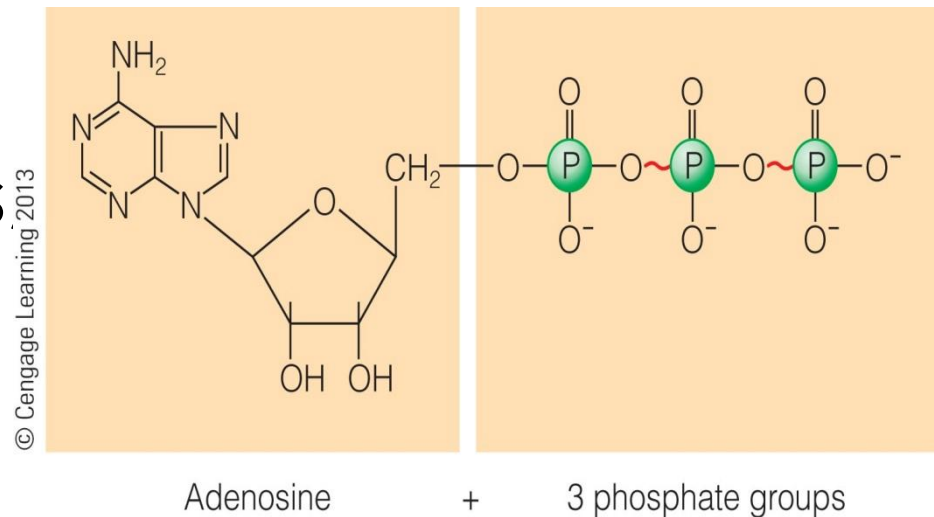


Catabolic reactions include the breakdown of glycogen, triglycerides, and protein; the further catabolism of glucose, glycerol, fatty acids, and amino acids releases differing amounts of energy. Much of the energy released is captured in the bonds of adenosine triphosphate (ATP).

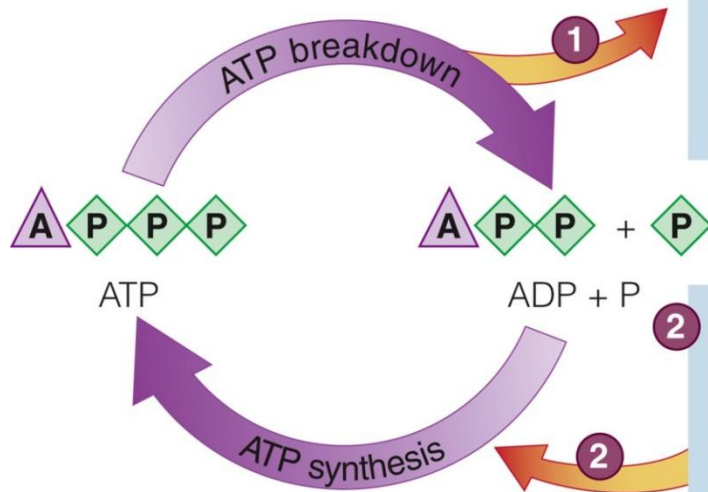
NOTE: You need not memorize a color code to understand the figures in this chapter, but you may find it helpful to know that blue is used for carbohydrates, yellow for fats, and red for proteins.

Chemical Reactions in the Body

Energy released during the breakdown of glucose, fatty acids and amino acids is often captured by ATP- a high energy compound



Capture and Release of Energy by ATP



1 Energy is released when a high-energy phosphate bond in ATP is broken. Just as a battery can be used to provide energy for a variety of uses, the energy from ATP can be used to do most of the body's work—contract muscles, transport compounds, make new molecules, and more. With the loss of a phosphate group, high-energy ATP (charged battery) becomes low-energy ADP (used battery).

2 Energy is required when a phosphate group is attached to ADP, making ATP. Just as a used battery needs energy from an electrical outlet to get recharged, ADP (used battery) needs energy from the breakdown of carbohydrate, fat, and protein to make ATP (recharged battery).

Chemical Reactions in the Body

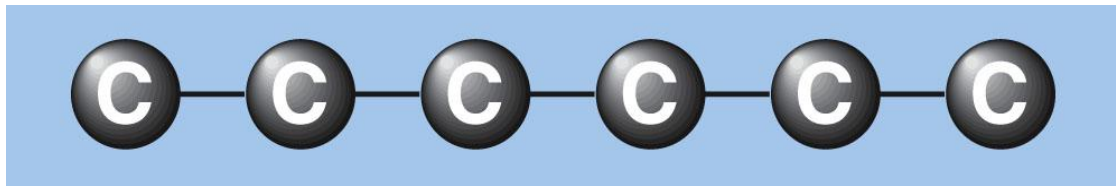
- Enzymes
 - Facilitators of metabolic reactions
- Coenzymes
 - Organic
 - Associate with enzymes
 - Without coenzyme, an enzyme cannot function

Breaking Down Nutrients for Energy

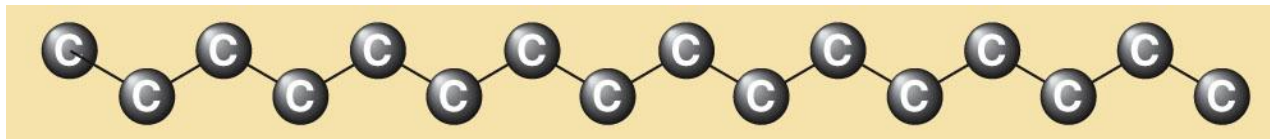
- Digestion
 - Carbohydrates – glucose (& other monosaccharides)
 - Fats (triglycerides) – glycerol and fatty acids
 - Proteins – amino acids
- Molecules of glucose, glycerol, amino acids, and fatty acids
 - Catabolism
 - Carbon, nitrogen, oxygen, hydrogen

Breaking Down Nutrients for Energy

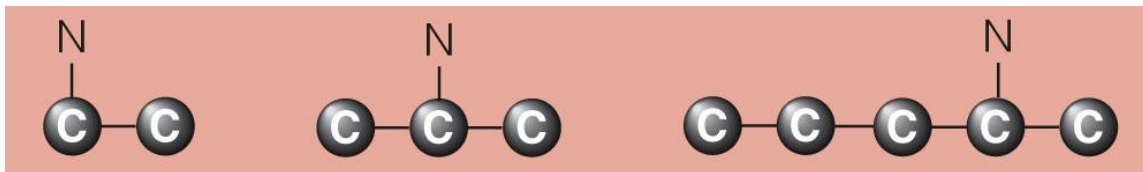
Glucose



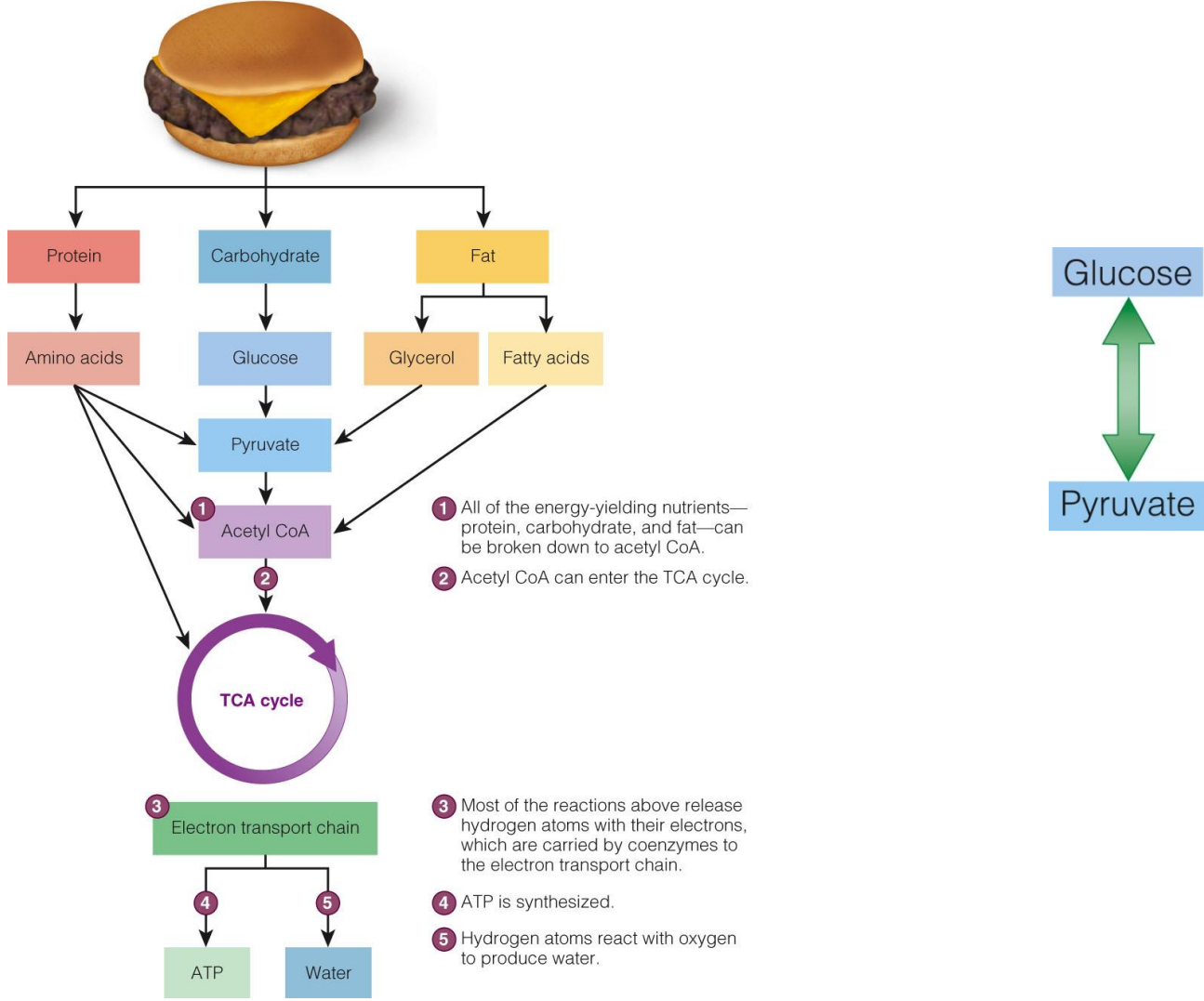
Fatty Acid



Amino Acid



Breaking Down Nutrients for Energy



Breaking Down Nutrients for Energy

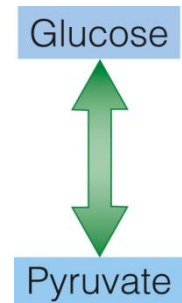
- Two new compounds
 - **Pyruvate**
 - 3-carbon structure
 - Can be used to make glucose
 - **Acetyl CoA**
 - 2-carbon structure
 - Cannot be used to make glucose
- TCA cycle and electron transport chain

Breaking Down Nutrients for Energy

- **Amino acids and glycerol can be converted to pyruvate and therefore glucose**
 - Needed for CNS and red blood cells
 - Without glucose, body will break down lean tissue
 - Adequate carbohydrate prevents this
- **Fatty acids are converted to Actyl CoA**
 - Cannot be used to make glucose
 - Readily can make fat

Breaking Down Nutrients for Energy--Glucose

- Glycolysis (glucose splitting) is the first step for glucose on its pathway to yielding energy.
- Glucose is converted to pyruvate
- Pyruvate can be converted back to glucose
- Glycolysis occurs in the cytoplasm of the cell



Glycolysis

A little ATP is used to start glycolysis.

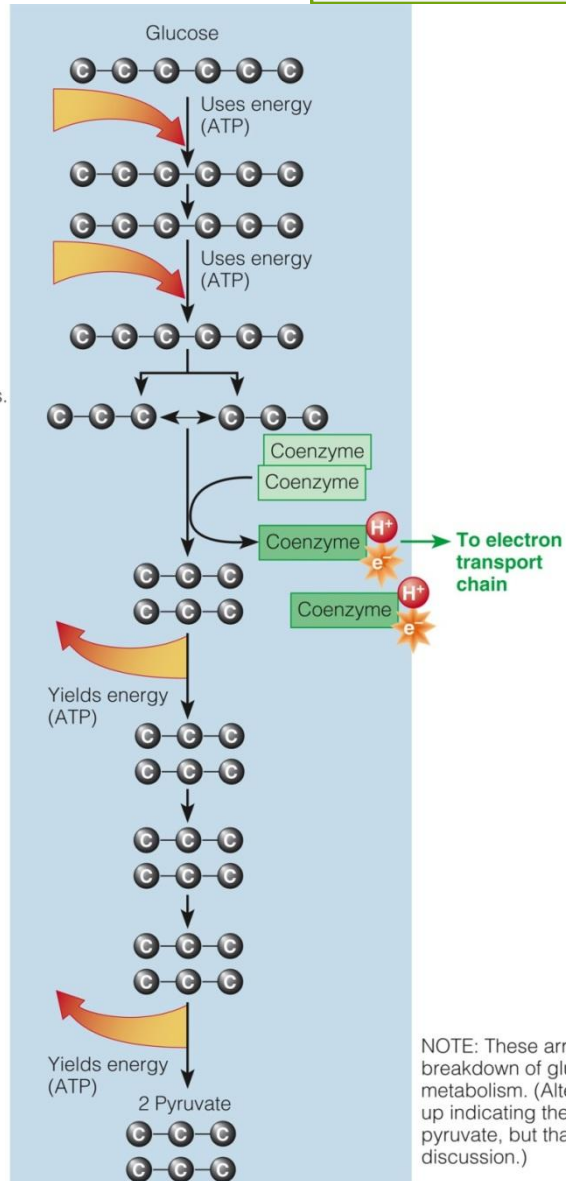
Galactose and fructose enter glycolysis at different places, but all continue on the same pathway.

In a series of reactions, the 6-carbon glucose is converted to other 6-carbon compounds, which eventually split into two interchangeable 3-carbon compounds.

A little ATP is produced, and coenzymes carry the hydrogens and their electrons to the electron transport chain.

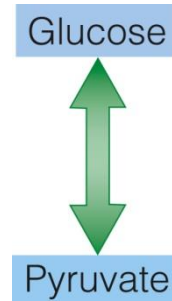
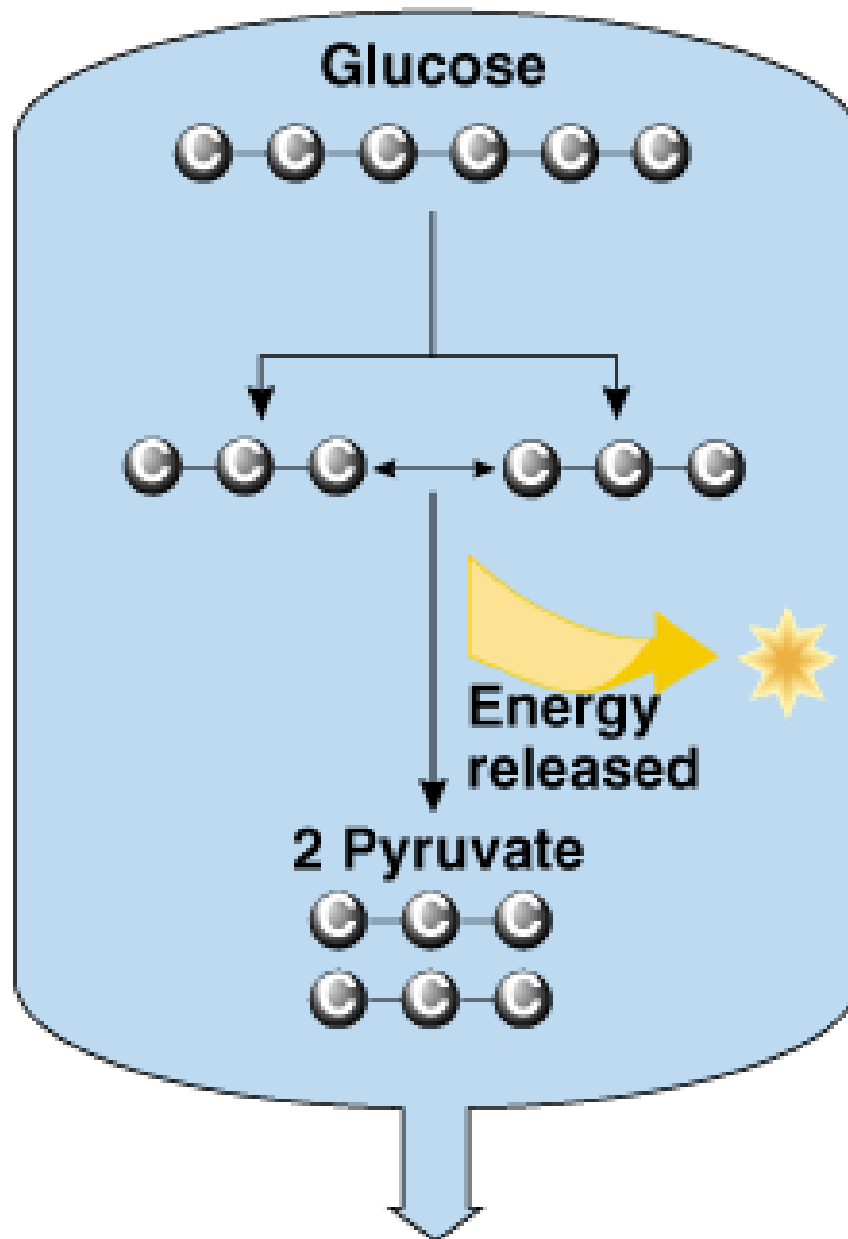
The 3-carbon compounds go through a series of conversions, producing another 3-carbon compound, each slightly different.

Eventually, the 3-carbon compounds are converted to pyruvate. Glycolysis of one molecule of glucose produces two molecules of pyruvate.



NOTE: These arrows point down indicating the breakdown of glucose to pyruvate during energy metabolism. (Alternatively, the arrows could point up indicating the making of glucose from pyruvate, but that is not the focus of this discussion.)

Glycolysis



To be continued . . .

Breaking Down Nutrients for Energy – Glucose

- Pyruvate's options-Anaerobic or Aerobic
 - Quick energy needs –
 - Pyruvate is converted to lactate
 - Does not require oxygen-**anaerobic**
 - Sustained for just a few minutes
 - Slower energy needs –
 - Pyruvate-to-acetyl CoA
 - Oxygen requiring-**aerobic**



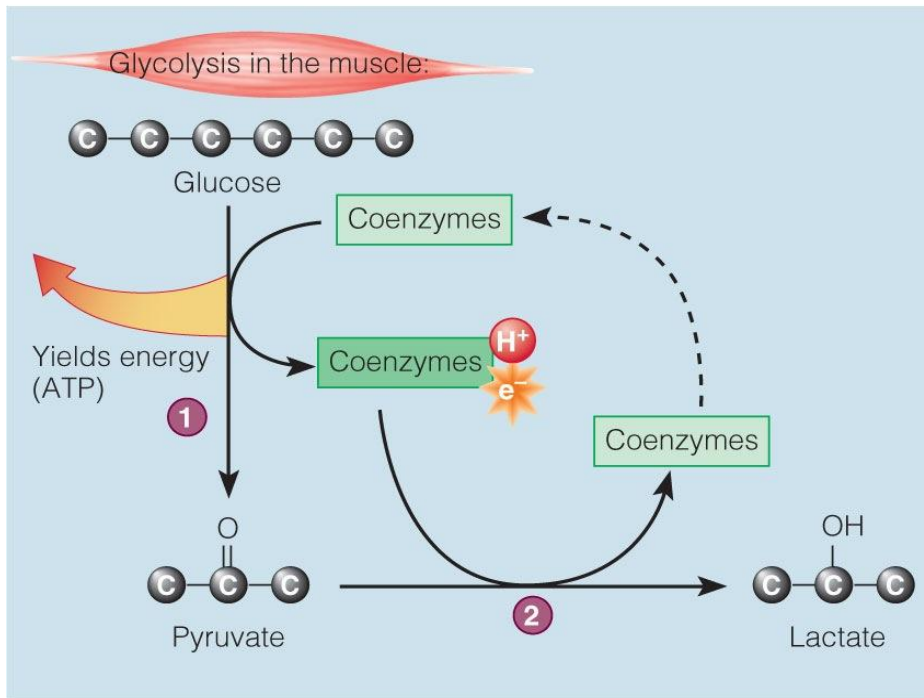
Glucose Retrieval via the Cori Cycle

- When less oxygen is available
 - Pyruvate is converted to lactic acid.
- Occurs during high-intensity exercise
 - exceeds the body's ability to delivery oxygen to the muscles and clear the CO_2 .
- Lactic acid accumulates in muscles
 - may experience burning pain and fatigue.
- Lactic acid travels to the liver
 - The liver converts it back to glucose
 - This is called the **Cori cycle**

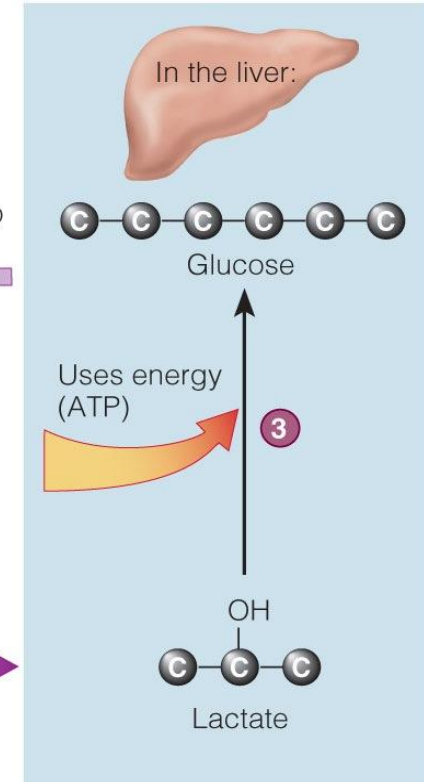


Pyruvate-to-Lactate (Anaerobic)

- 1 Working muscles break down most of their glucose molecules to pyruvate.



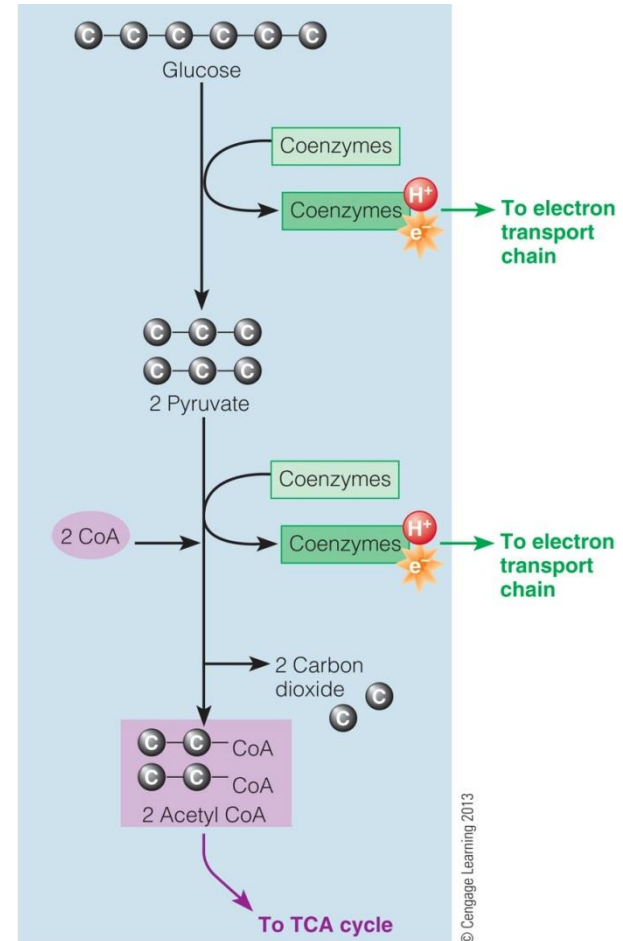
- 2 If the cells lack sufficient mitochondria or in the absence of sufficient oxygen, pyruvate can accept the hydrogens from glucose breakdown and become lactate. This conversion frees the coenzymes so that glycolysis can continue.



- 3 Liver enzymes can convert lactate to glucose, but this reaction requires energy.

Pyruvate-To-Acetyl CoA

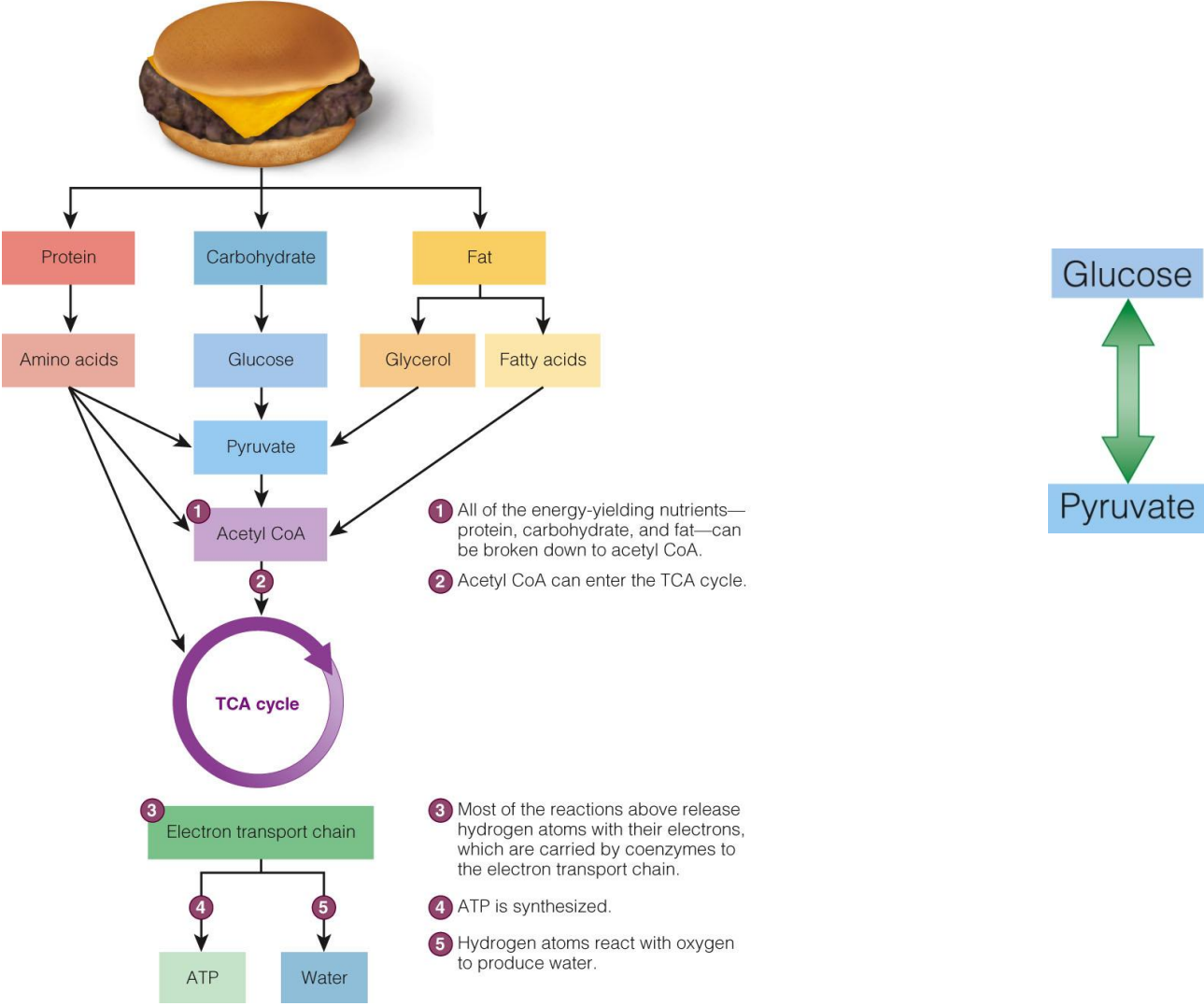
- If the cell needs energy, and oxygen is available
 - pyruvate enters the mitochondria,
 - where a carbon group is removed and the remaining compound combines with Co-enzyme A
 - produce 2 acetyl CoA.
- This is an aerobic reaction (oxygen requiring)



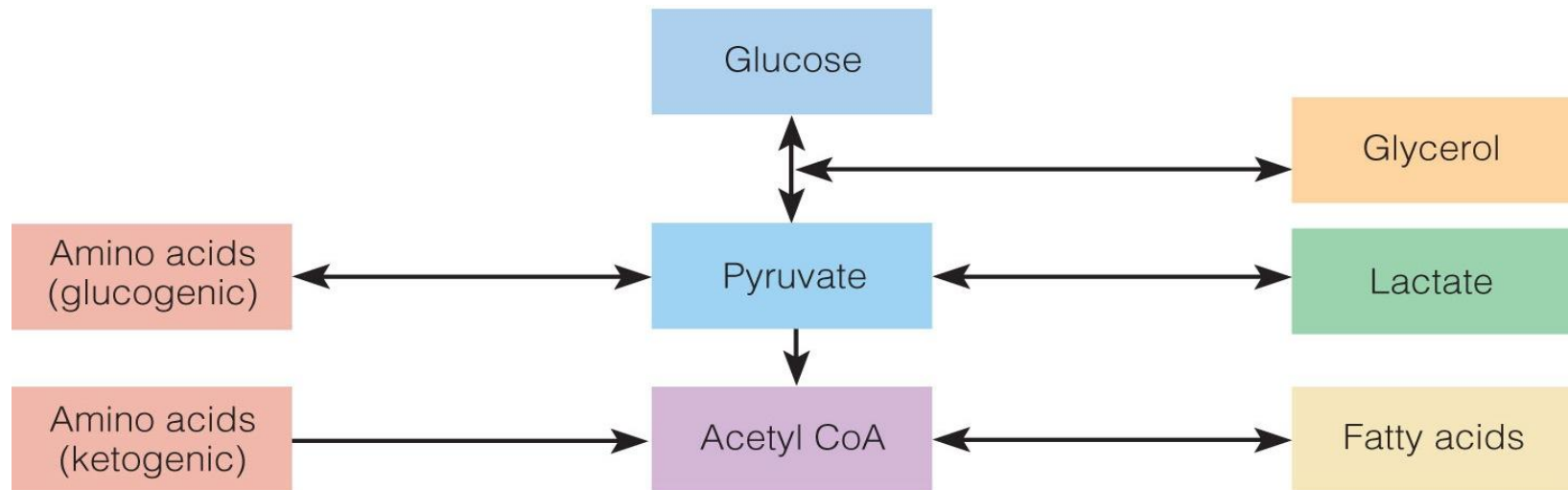
REVIEW IT

1 glucose yields 2 pyruvate, which yield 2 acetyl CoA.

Breaking Down Nutrients for Energy



The Paths of Pyruvate and Acetyl CoA



NOTE: Amino acids that can be used to make glucose are called *glucogenic*; amino acids that are converted to acetyl CoA are called *ketogenic*.

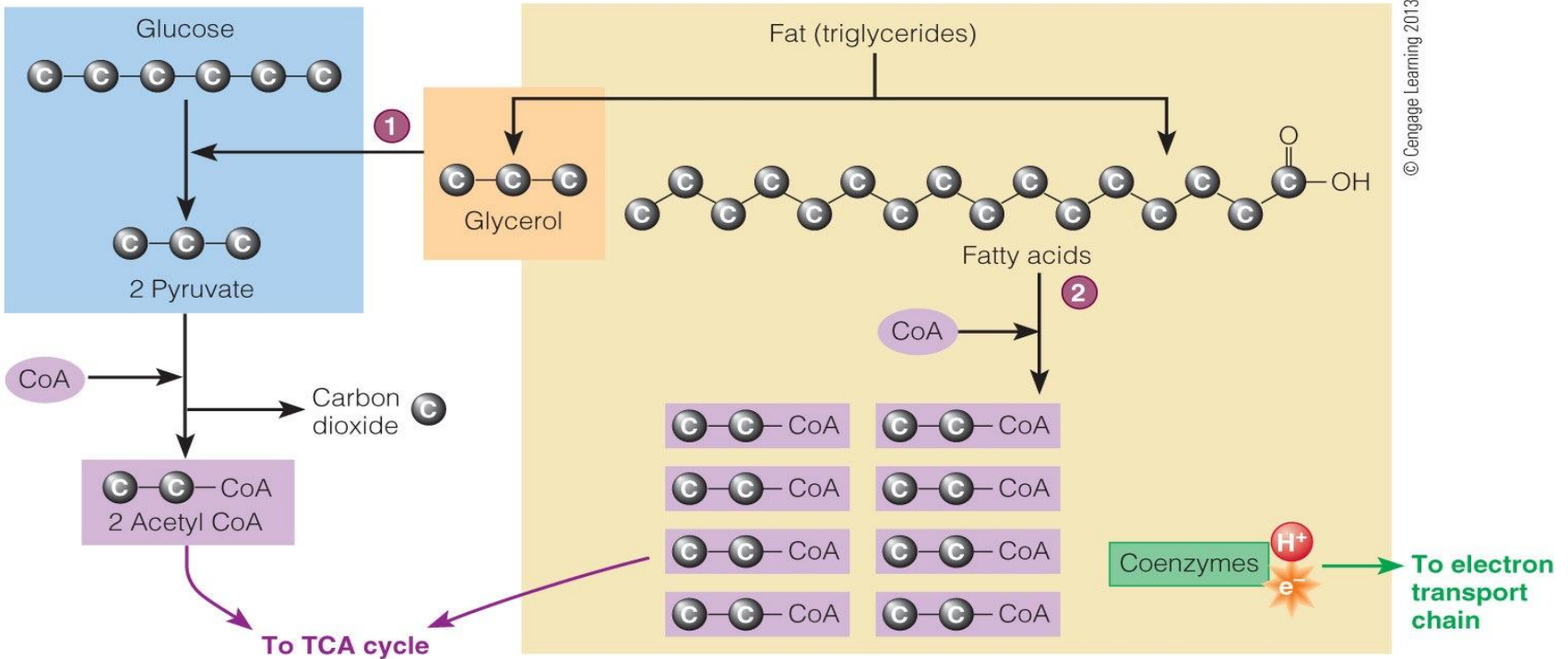
Fats to Energy

- Triglyceride breaks down to glycerol and fatty acids.
- **Glycerol**
 - Can be converted to pyruvate and go down the pathway
 - It can go up the pathway and be converted to glucose.
- **Fatty acids** are broken into 2-carbon units which combine with CoA to make acetyl CoA.
- Fatty Acids cannot be used to make glucose

Fats Enter the Energy Pathway

1 Glycerol enters the glycolysis pathway about midway between glucose and pyruvate.

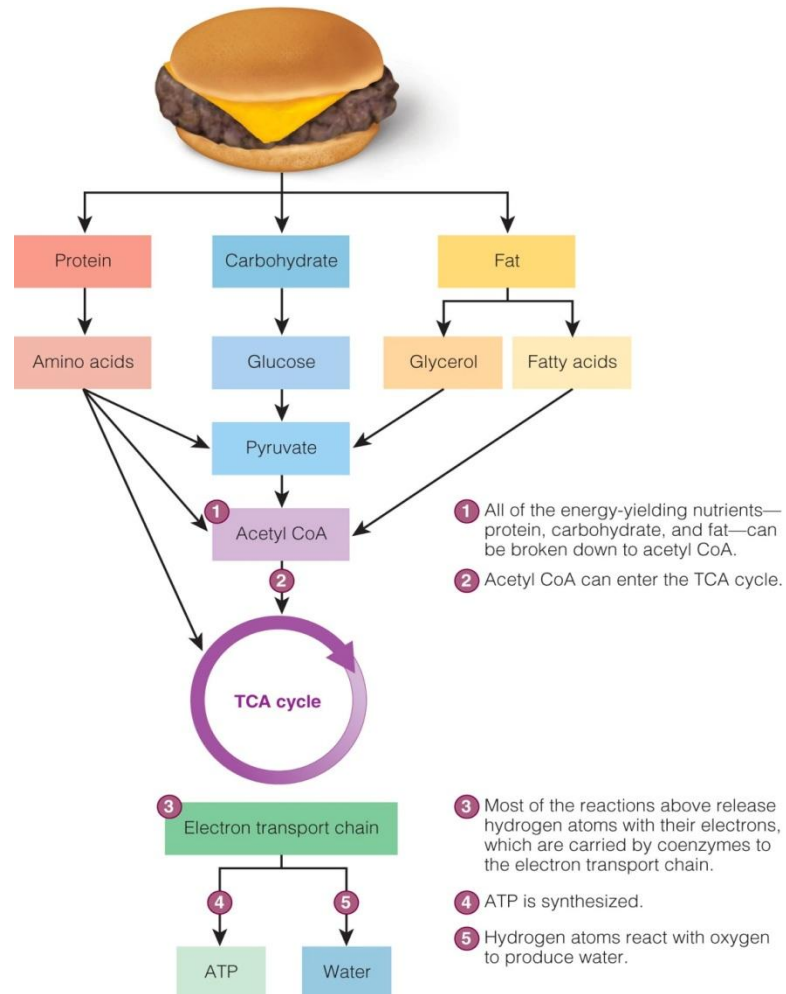
2 Fatty acids are broken down into 2-carbon fragments that combine with CoA to form acetyl CoA (shown in Figure 7-11).



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REVIEW IT 16-carbon fatty acid yields 8 acetyl CoA.

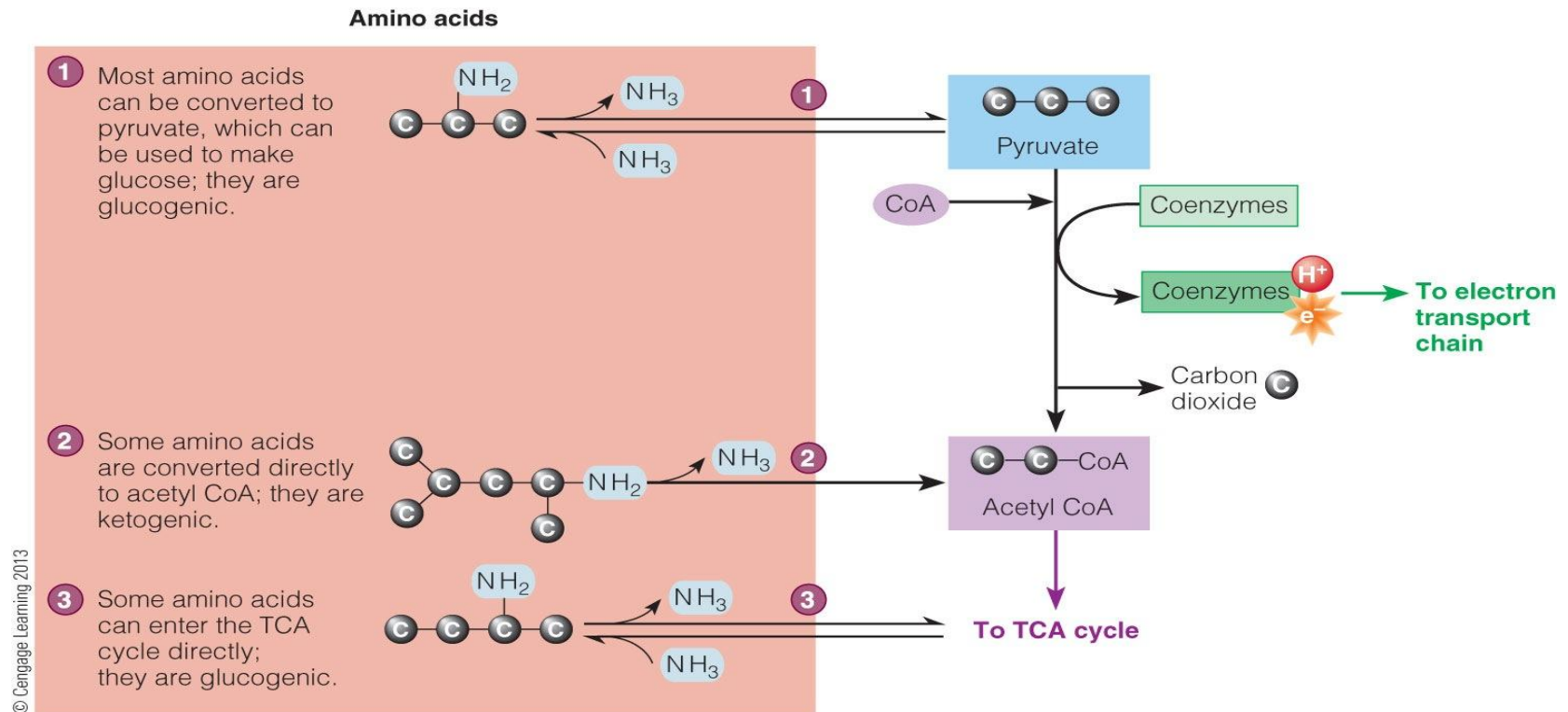
Simplified Overview of Energy-Yielding Pathways



Amino Acids

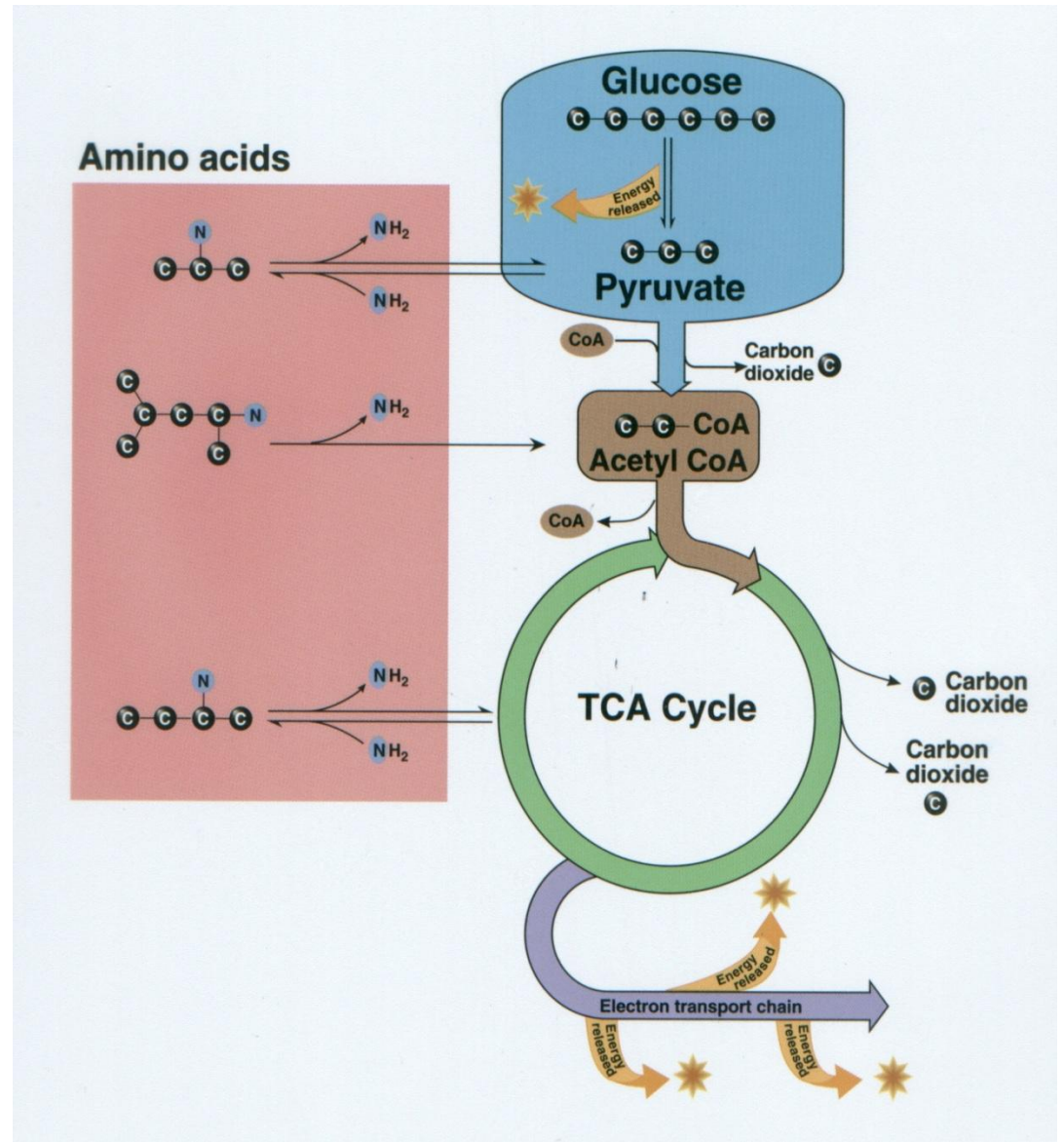
- Amino acids can be converted to glucose
 - Deaminated first (remove the nitrogen amino group).
 - Can be converted to pyruvate – (glucogenic)
 - used for CNS, RBCs
 - Can be converted to acetyl CoA (ketogenic)
 - Can be used for energy **or** converted to fatty acids and stored as triglyceride.
 - Some enter the TCA cycle directly

Amino Acids Enter the Energy Pathway



NOTE: Deamination and the synthesis of urea are discussed and illustrated in Chapter 6, Figure 6-13 (p. 180). The arrows from pyruvate and the TCA cycle to amino acids are possible only for *nonessential* amino acids; remember, the body cannot make essential amino acids.

Amino Acids-to-Energy Pathway



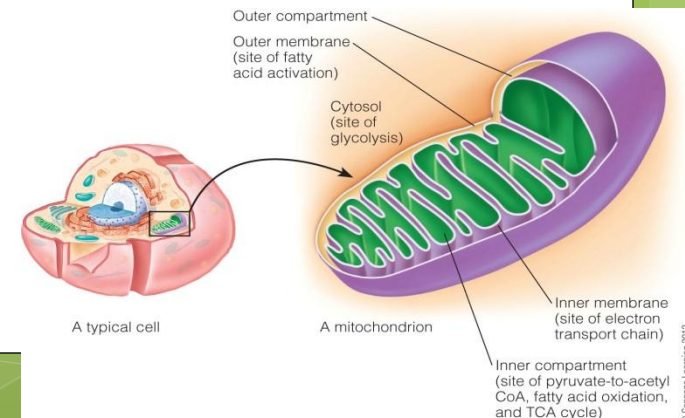
Review of Energy-Yielding Nutrient Endpoints

TABLE 7-2 Review of Energy-Yielding Nutrient Endpoints

Nutrient	Yields energy?	Yields glucose?	Yields amino acids and body proteins?	Yields fat stores?
Carbohydrates (glucose)	Yes	Yes	Yes—when nitrogen is available, can yield <i>nonessential</i> amino acids	Yes
Lipids (fatty acids)	Yes	No	No	Yes
Lipids (glycerol)	Yes	Yes—when carbohydrate is unavailable	Yes—when nitrogen is available, can yield <i>nonessential</i> amino acids	Yes
Proteins (amino acids)	Yes	Yes—when carbohydrate is unavailable	Yes	Yes

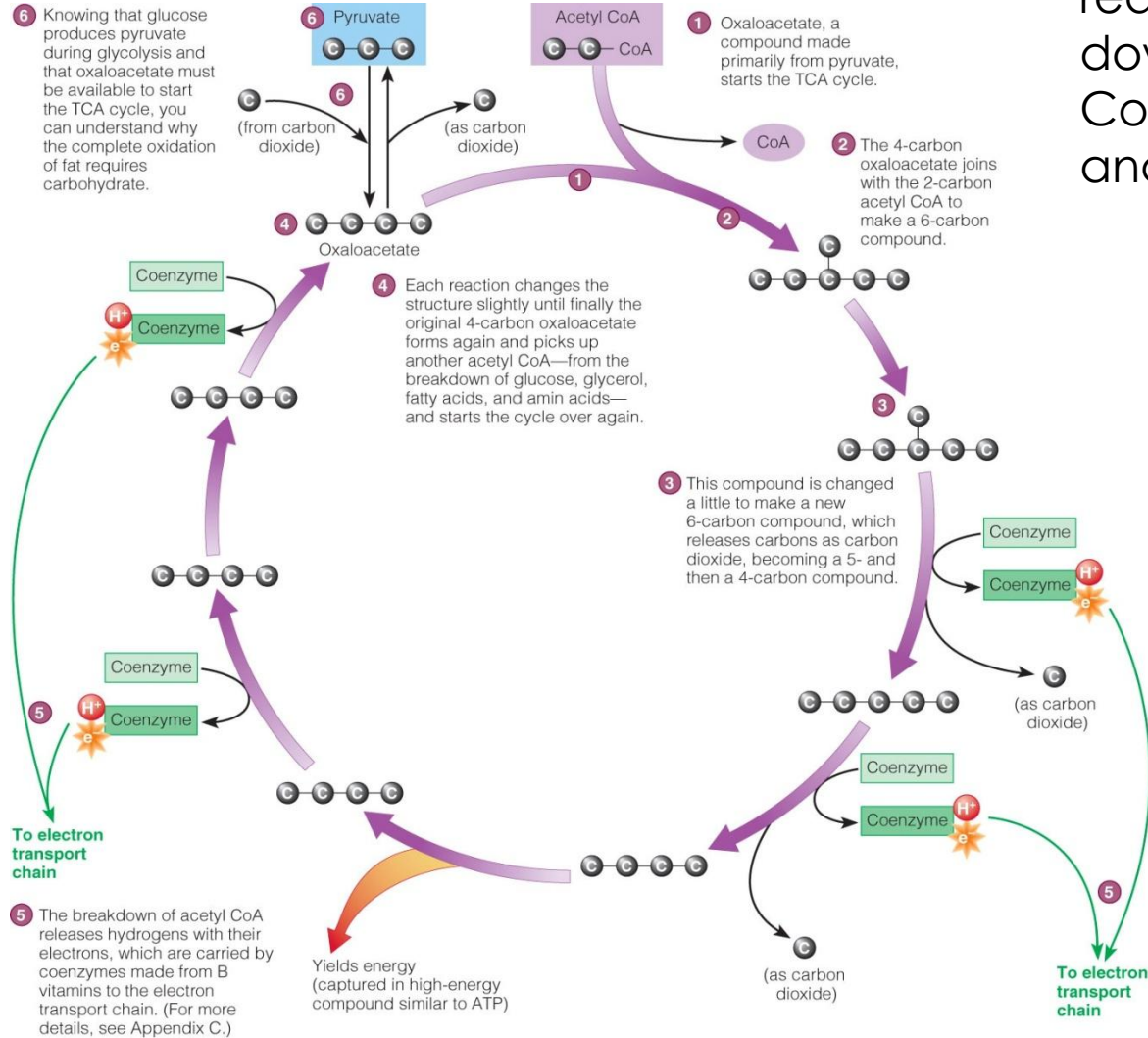
Final Steps of Catabolism

- TCA Cycle
 - Inner compartment of mitochondria
 - Circular path
 - Acetyl CoA
 - Oxaloacetate – made primarily from pyruvate
 - Carbon dioxide release
 - Hydrogen atoms and their electrons
 - Niacin and riboflavin are coenzymes that are essential



The TCA Cycle

A series of metabolic reactions that break down molecules of acetyl CoA to carbon dioxide and hydrogen atoms.



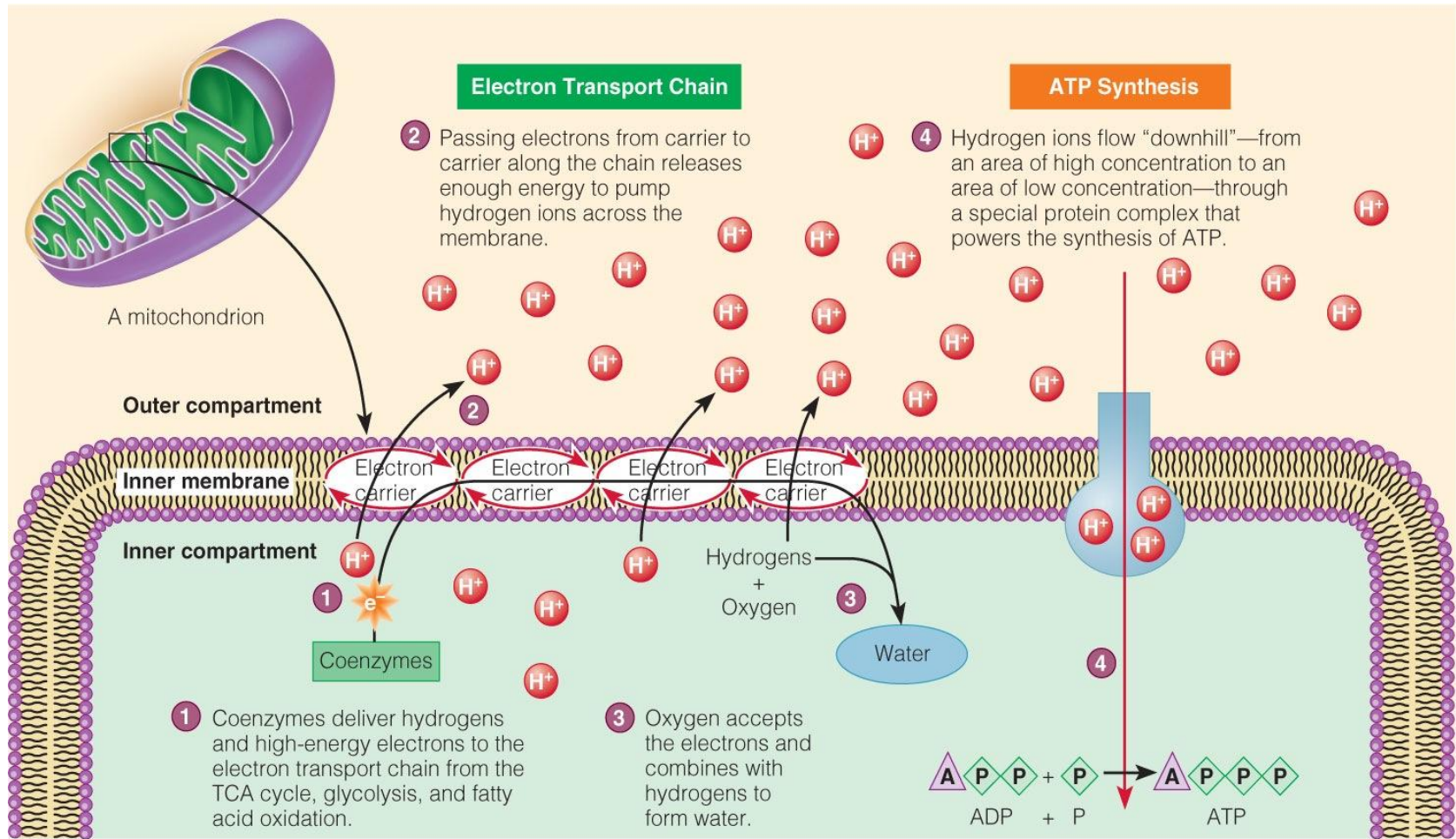
The TCA Cycle reactions take place in the mitochondria of the cell

Final Steps of Energy Metabolism

- **Electron transport chain**

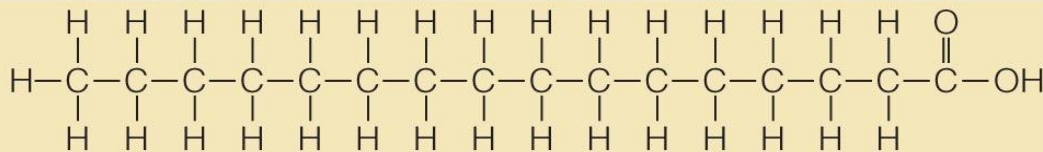
- Captures energy in ATP
- Series of proteins
 - Electron “carriers”
 - Inner membrane of mitochondria
- Electrons passed to next carrier
 - Join oxygen at end of chain – water released
 - ATP synthesis

Electron Transport Chain and ATP Synthesis

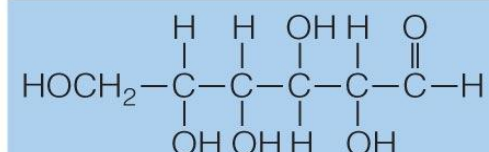


Final Steps of Energy Metabolism

- kCalorie-per-gram secret
 - Fat provides most energy per gram
 - Carbon-hydrogen bonds
 - More ATP = more kcalories

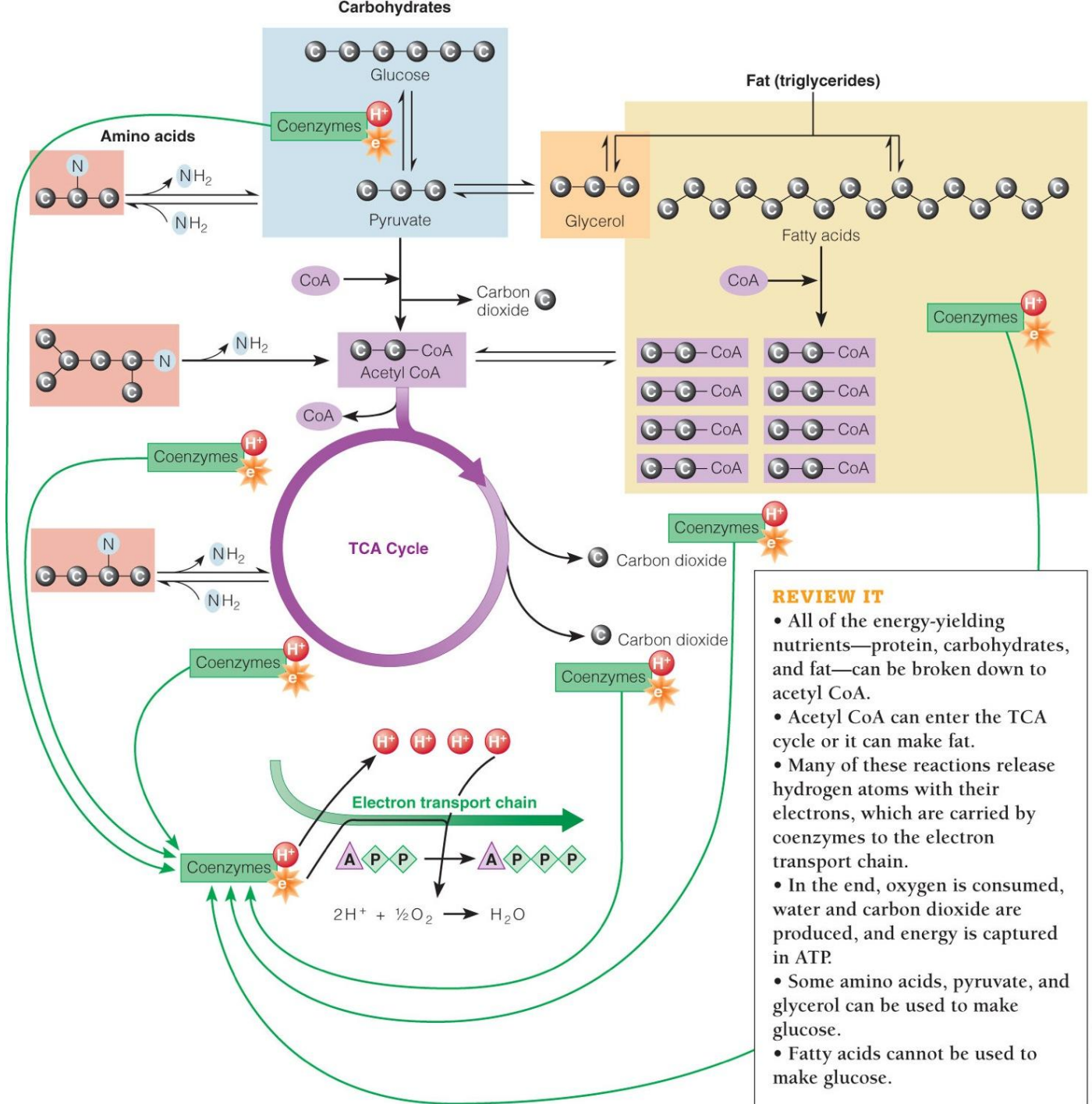


Fatty acid



Glucose

Central Pathways of Energy Metabolism



Feasting – Excess Energy

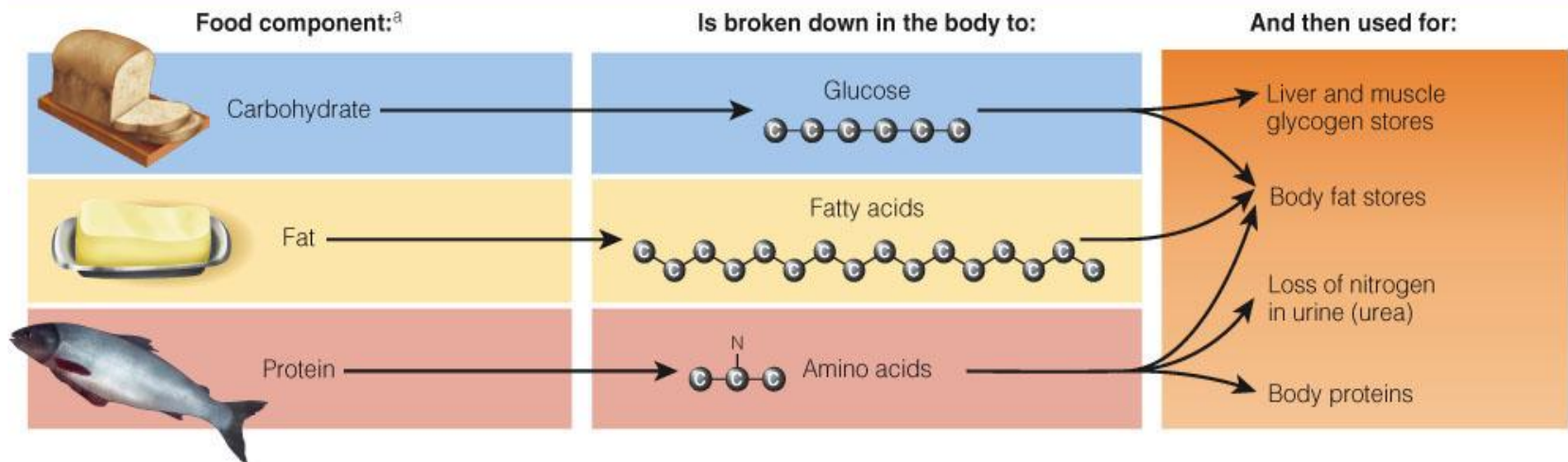
- Metabolism favors fat formation
 - Regardless of excess from protein, fat, or carbohydrates
 - Excess protein
 - Excess carbohydrate
 - Dietary fat to body fat is most direct and efficient conversion
 - Fuel mix



Feasting



A When a person overeats (feasting): When a person eats in excess of energy needs, the body stores a small amount of glycogen and much larger quantities of fat.

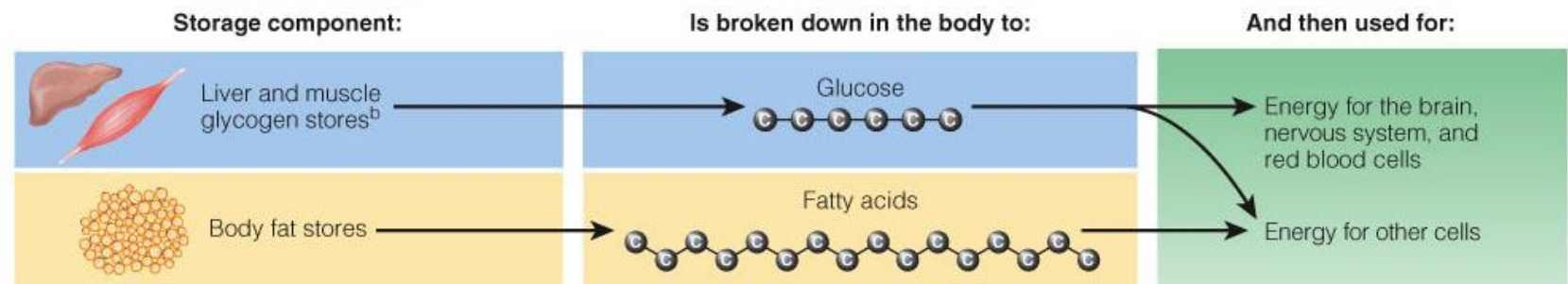


^aAlcohol is not included because it is a toxin and not a nutrient, but it does contribute energy to the body. After detoxifying the alcohol, the body uses the remaining two carbon fragments to build fatty acids and stores them as fat.

Fasting

- Glucose from liver glycogen is released
- Fatty acids from adipose tissue are released

B When a person draws on stores (fasting): When nutrients from a meal are no longer available to provide energy (about 2 to 3 hours after a meal), the body draws on its glycogen and fat stores for energy.

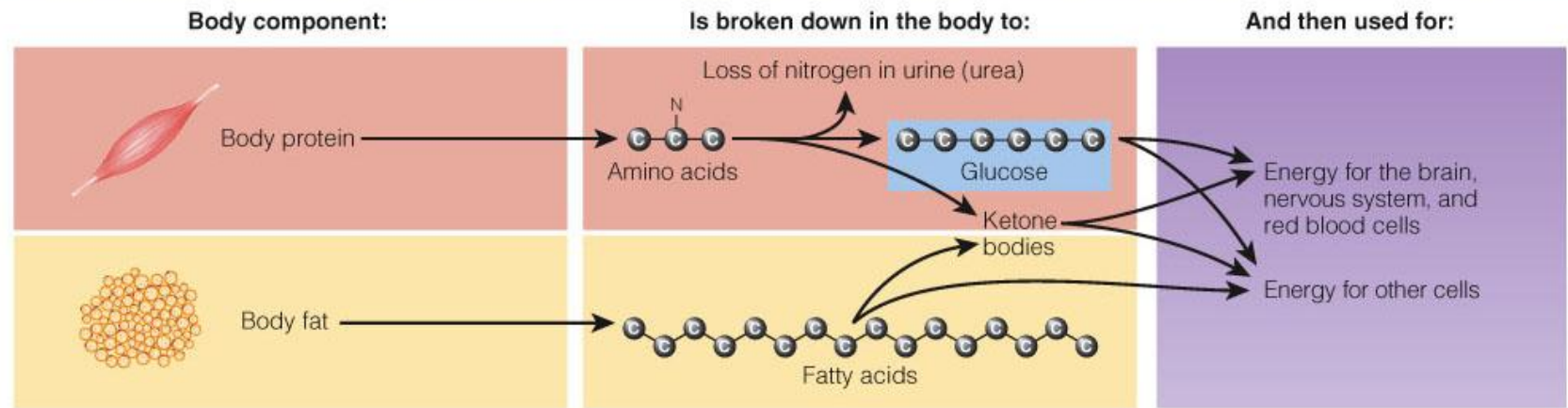


^bThe muscles' stored glycogen provides glucose only for the muscle in which the glycogen is stored.

Extended Fasting

Glucose is needed for the brain RBCs, nervous system
Brain and nerve cells use 1/2 of total glucose used each day

C If the fast continues beyond glycogen depletion: As glycogen stores dwindle (after about 24 hours of starvation), the body begins to break down its protein (muscle and lean tissue) to amino acids to synthesize glucose needed for brain and nervous system energy. In addition, the liver converts fats to ketone bodies, which serve as an alternative energy source for the brain, thus slowing the breakdown of body protein.

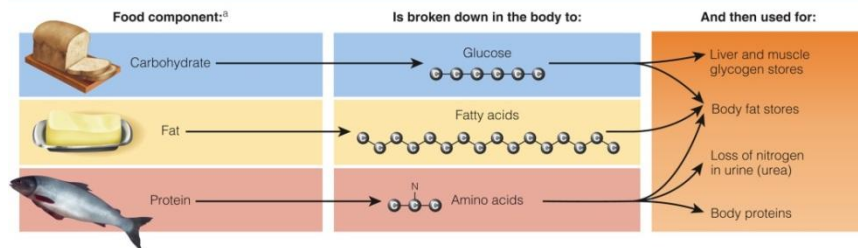


Extended Fasting

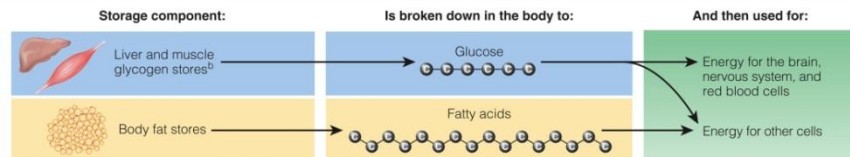
- Adaptation: make glucose
 - Breakdown of body protein meets glucose needs via **gluconeogenesis**
 - Glycerol portion of the triglyceride is used
- Adaptation: Create an alternative fuel
 - Body shifts to using ketone bodies from fat breakdown (ketosis) for brain fuel
 - After about 10 days
 - Appetite suppression

Energy Balance – Transition from Feasting to Fasting

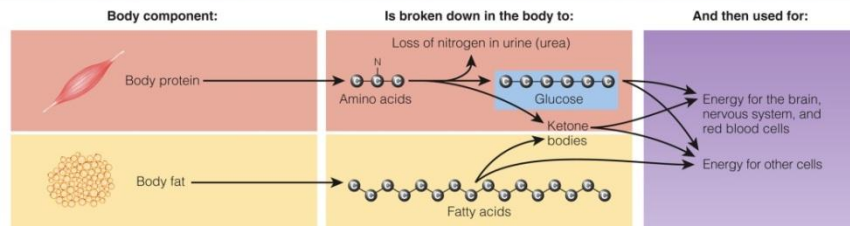
A When a person overeats (feasting): When a person eats in excess of energy needs, the body stores a small amount of glycogen and much larger quantities of fat.



B When a person draws on stores (fasting): When nutrients from a meal are no longer available to provide energy (about 2 to 3 hours after a meal), the body draws on its glycogen and fat stores for energy.



C If the fast continues beyond glycogen depletion: As glycogen stores dwindle (after about 24 hours of starvation), the body begins to break down its protein (muscle and lean tissue) to amino acids to synthesize glucose needed for brain and nervous system energy. In addition, the liver converts fats to ketone bodies, which serve as an alternative energy source for the brain, thus slowing the breakdown of body protein.



^aAlcohol is not included because it is a toxin and not a nutrient, but it does contribute energy to the body. After detoxifying the alcohol, the body uses the remaining two carbon fragments to build fatty acids and stores them as fat.

^bThe muscles' stored glycogen provides glucose only for the muscle in which the glycogen is stored.

Fasting—Inadequate Energy

- Adaptation: Conserving Energy
- Symptoms of Starvation
 - Metabolism slows
 - Muscle wasting
 - Decreased heart rate, respiratory rate, metabolic rate, and body temperature
 - Impaired vision
 - Organ failure
 - Decreased immunity
 - Depression, anxiety, and food-related dreams

Low-Carbohydrate Diets

- Metabolism similar to fasting
 - Uses glycogen stores first
 - Gluconeogenesis when glycogen is depleted
 - Body tissues used somewhat even when protein provided in diet
- Urine monitoring
- Ketosis

Adverse Side Effects of Low-Carbohydrate, Ketogenic Diets

TABLE 7-3 Adverse Side Effects of Low-Carbohydrate, Ketogenic Diets

- Nausea
 - Fatigue (especially if physically active)
 - Constipation
 - Low blood pressure
 - Elevated uric acid (which may exacerbate kidney disease and cause inflammation of the joints in those predisposed to gout)
 - Stale, foul taste in the mouth (bad breath)
 - In pregnant women, fetal harm and stillbirth
-



Alcohol and Nutrition

Highlight 7

Short Term Effects

- 20% of all boating fatalities
- 25% of all emergency-room admissions
- 23% of all suicides
- 47% of all homicides
- 65% of all domestic violence incidents
- 39% of all traffic fatalities
- 40% of all residential fire victim fatalities

Effects of Alcohol

- On an average day alcohol is involved in:
 - Death of 5 college students
 - Sexual assault of 266 college students
 - Injury of 1641 college students
 - Assault of 1907 college students

Alcohol in Beverages

- Beer, wine and distilled liquor (hard liquor)
- Alcohol behaves like a drug, therefore altering body functions.
- Moderation of drinks
 - 1 drink per day for women
 - 2 drinks per day for men
 - 5 ounces of wine
 - 10 ounces of wine cooler
 - 12 ounces of beer
 - 1 ½ ounces distilled liquor (80 proof)

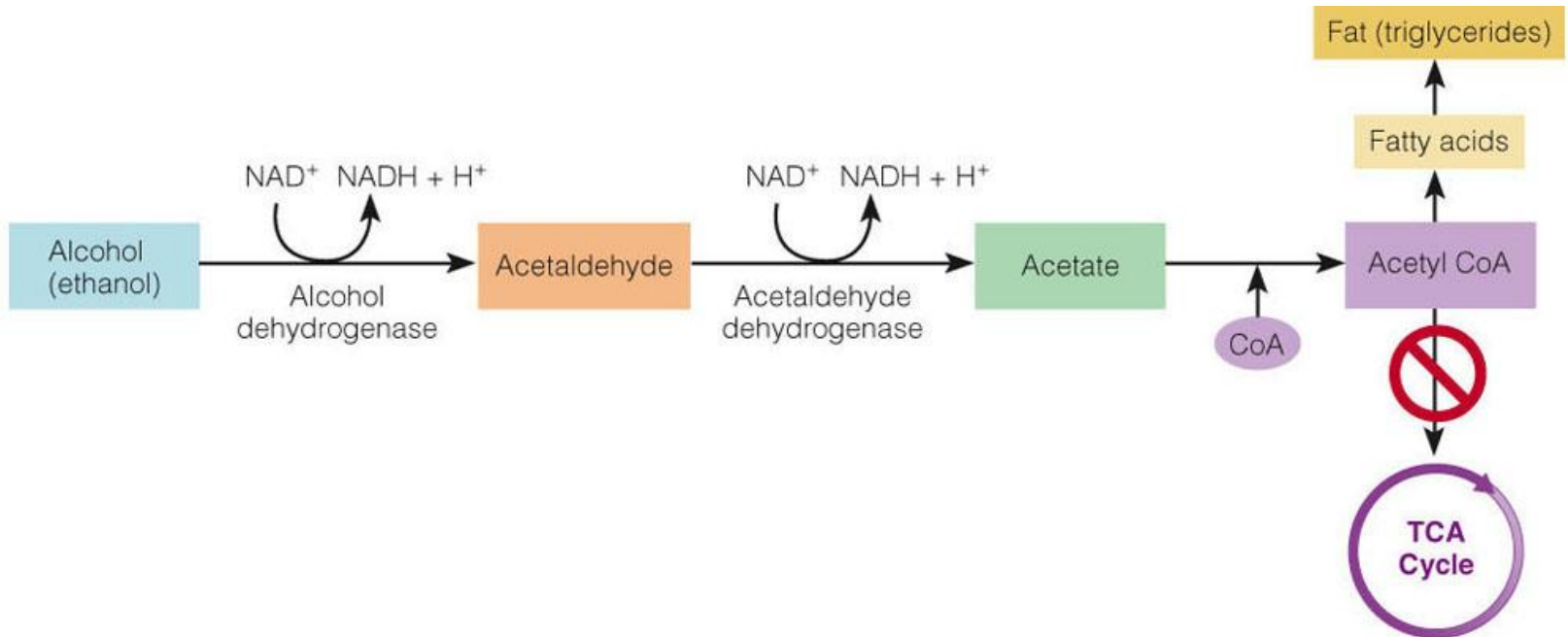


Alcohol in the Body

- Alcohol's special privileges
 - No digestion
 - Quick absorption
- Stomach
 - Alcohol dehydrogenase (women produce less)
 - Food slows absorption
- Small intestine
 - Priority over nutrients

Alcohol Arrives in the Liver

- Liver cells
 - First to receive alcohol-laden blood
- Alcohol dehydrogenase
- Disrupts liver activity
- Fatty acids accumulate
- Uses up Niacin coenzyme
- Can permanently change liver cell structure
- Rate of alcohol metabolism
 - $\frac{1}{2}$ ounce per hour



Acetyl CoA molecules are blocked from getting into the TCA cycle by the high level of NADH. Instead of being used for energy, the acetyl CoA molecules become building blocks for fatty acids.

Alcohol Disrupts the Liver

- Development of a fatty liver is the first stage of liver deterioration.
- Fibrosis is the second stage (scar tissue)
- Cirrhosis is the most advanced stage of liver deterioration.



Metabolic Work of the Liver

TABLE 7-1 Metabolic Work of the Liver

The liver is the most active processing center in the body. When nutrients enter the body from the digestive tract, the liver receives them first; then it metabolizes, packages, stores, or ships them out for use by other tissues. When alcohol, drugs, or poisons enter the body, they are also sent directly to the liver; here they are detoxified and their by-products shipped out for excretion. An enthusiastic anatomy and physiology professor once remarked that given the many vital activities of the liver, we should express our feelings for others by saying, "I love you with all my liver" instead of "with all my heart." Granted, this declaration lacks romance, but it makes a valid point. Here are just some of the many jobs performed by the liver. To renew your appreciation for this remarkable organ, review Figure 3-11 (p. 81).

Carbohydrates

- Metabolizes fructose, galactose, and glucose
- Makes and stores glycogen
- Breaks down glycogen and releases glucose
- Breaks down glucose for energy when needed
- Makes glucose from some amino acids and glycerol when needed
- Converts excess glucose and fructose to fatty acids

Lipids

- Builds and breaks down triglycerides, phospholipids, and cholesterol as needed
- Breaks down fatty acids for energy when needed
- Packages lipids in lipoproteins for transport to other body tissues
- Manufactures bile to send to the gallbladder for use in fat digestion
- Makes ketone bodies when necessary

Proteins

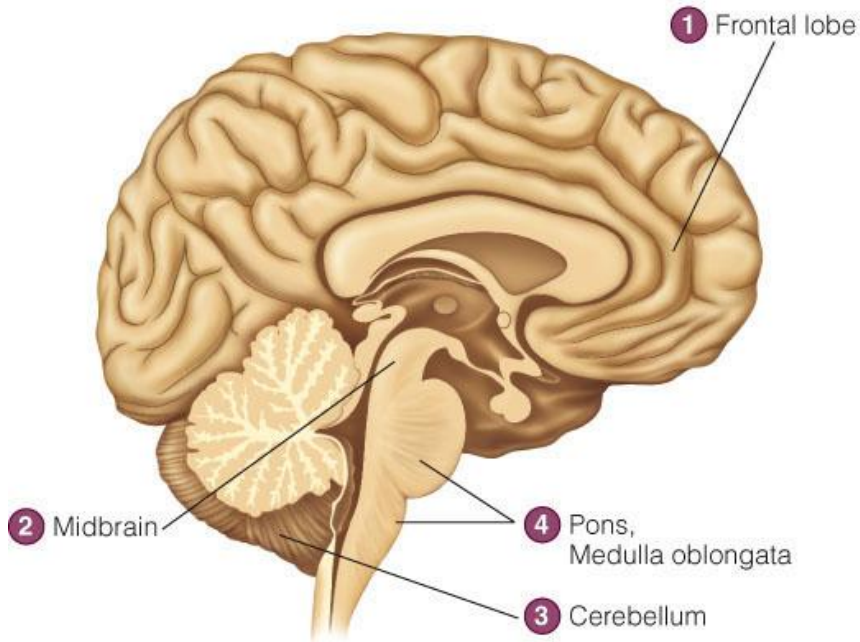
- Manufactures nonessential amino acids that are in short supply
- Removes from circulation amino acids that are present in excess of need and converts them to other amino acids or deaminates them and converts them to glucose or fatty acids
- Removes ammonia from the blood and converts it to urea to be sent to the kidneys for excretion
- Makes other nitrogen-containing compounds the body needs (such as bases used in DNA and RNA)
- Makes many proteins

Other

- Detoxifies alcohol, other drugs, and poisons; prepares waste products for excretion
- Helps dismantle old red blood cells and captures the iron for recycling
- Stores most vitamins and many minerals
- Activates vitamin D

Alcohol Arrives in the Brain

- Alcohol acts as a narcotic, anesthetizes pain
- Sedates inhibitory nerves
- Depressant; affects all nerves
- Alcohol suppresses antidiuretic hormone (ADH) resulting in the loss of body water.
- Brain cells die with excessive alcohol exposure



- 1 Judgment and reasoning centers are most sensitive to alcohol. When alcohol flows to the brain, it first sedates the frontal lobe, the center of all conscious activity. As the alcohol molecules diffuse into the cells of these lobes, they interfere with reasoning and judgment.
- 2 Speech and vision centers in the midbrain are affected next. If the drinker drinks faster than the rate at which the liver can oxidize the alcohol, blood alcohol concentrations rise: the speech and vision centers of the brain become sedated.
- 3 Voluntary muscular control is then affected. At still higher concentrations, the cells in the cerebellum responsible for coordination of voluntary muscles are affected, including those used in speech, eye-hand coordination, and limb movements. At this point people under the influence stagger or weave when they try to walk, or they may slur their speech.
- 4 Respiration and heart action are the last to be affected. Finally, the conscious brain is completely subdued, and the person passes out. Now the person can drink no more; this is fortunate because higher doses would anesthetize the deepest brain centers that control breathing and heartbeat, causing death.

Alcohol Doses & Approximate Blood Level Percentages for Men & Women

TABLE H7-1 Alcohol Doses and Approximate Blood Level Percentages for Men and Women

Drinks ^a	Body Weight in Pounds—Men								ONLY SAFE DRIVING LIMIT	Drinks ^a	Body Weight in Pounds—Women								ONLY SAFE DRIVING LIMIT	
	100	120	140	160	180	200	220	240			90	100	120	140	160	180	200	220		240
1	.04	.03	.03	.02	.02	.02	.02	.02	IMPAIRMENT BEGINS	1	.05	.05	.04	.03	.03	.03	.02	.02	.02	IMPAIRMENT BEGINS
2	.08	.06	.05	.05	.04	.04	.03	.03		2	.10	.09	.08	.07	.06	.05	.05	.04	.04	
3	.11	.09	.08	.07	.06	.06	.05	.05	DRIVING SKILLS SIGNIFICANTLY AFFECTED	3	.15	.14	.11	.10	.09	.08	.07	.06	.06	DRIVING SKILLS SIGNIFICANTLY AFFECTED
4	.15	.12	.11	.09	.08	.08	.07	.06		4	.20	.18	.15	.13	.11	.10	.09	.08	.08	
5	.19	.16	.13	.12	.11	.09	.09	.08	LEGALLY INTOXICATED	5	.25	.23	.19	.16	.14	.13	.11	.10	.09	LEGALLY INTOXICATED
6	.23	.19	.16	.14	.13	.11	.10	.09		6	.30	.27	.23	.19	.17	.15	.14	.12	.11	
7	.26	.22	.19	.16	.15	.13	.12	.11	LEGALLY INTOXICATED	7	.35	.32	.27	.23	.20	.18	.16	.14	.13	LEGALLY INTOXICATED
8	.30	.25	.21	.19	.17	.15	.14	.13		8	.40	.36	.30	.26	.23	.20	.18	.17	.15	
9	.34	.28	.24	.21	.19	.17	.15	.14	LEGALLY INTOXICATED	9	.45	.41	.34	.29	.26	.23	.20	.19	.17	LEGALLY INTOXICATED
10	.38	.31	.27	.23	.21	.19	.17	.16		10	.51	.45	.38	.32	.28	.25	.23	.21	.19	

NOTE: Driving under the influence is proved when an adult's blood contains 0.08 percent alcohol. Many states have adopted a "zero-tolerance" policy for drivers under age 21, using 0.00 to 0.02 percent as the limit.

^aTaken within an hour or so; each drink equivalent to ½ ounce pure ethanol.

SOURCE: National Clearinghouse for Alcohol and Drug Information.

Alcohol Blood Levels and Brain Responses

TABLE H7-2 Alcohol Blood Levels and Brain Responses

Blood Alcohol Concentration	Effect on Brain
0.05	Impaired judgment, relaxed inhibitions, altered mood, increased heart rate
0.10	Impaired coordination, delayed reaction time, exaggerated emotions, impaired peripheral vision, impaired ability to operate a vehicle
0.15	Slurred speech, blurred vision, staggered walk, seriously impaired coordination and judgment
0.20	Double vision, inability to walk
0.30	Uninhibited behavior, stupor, confusion, inability to comprehend
0.40 to 0.60	Unconsciousness, shock, coma, death (cardiac or respiratory failure)

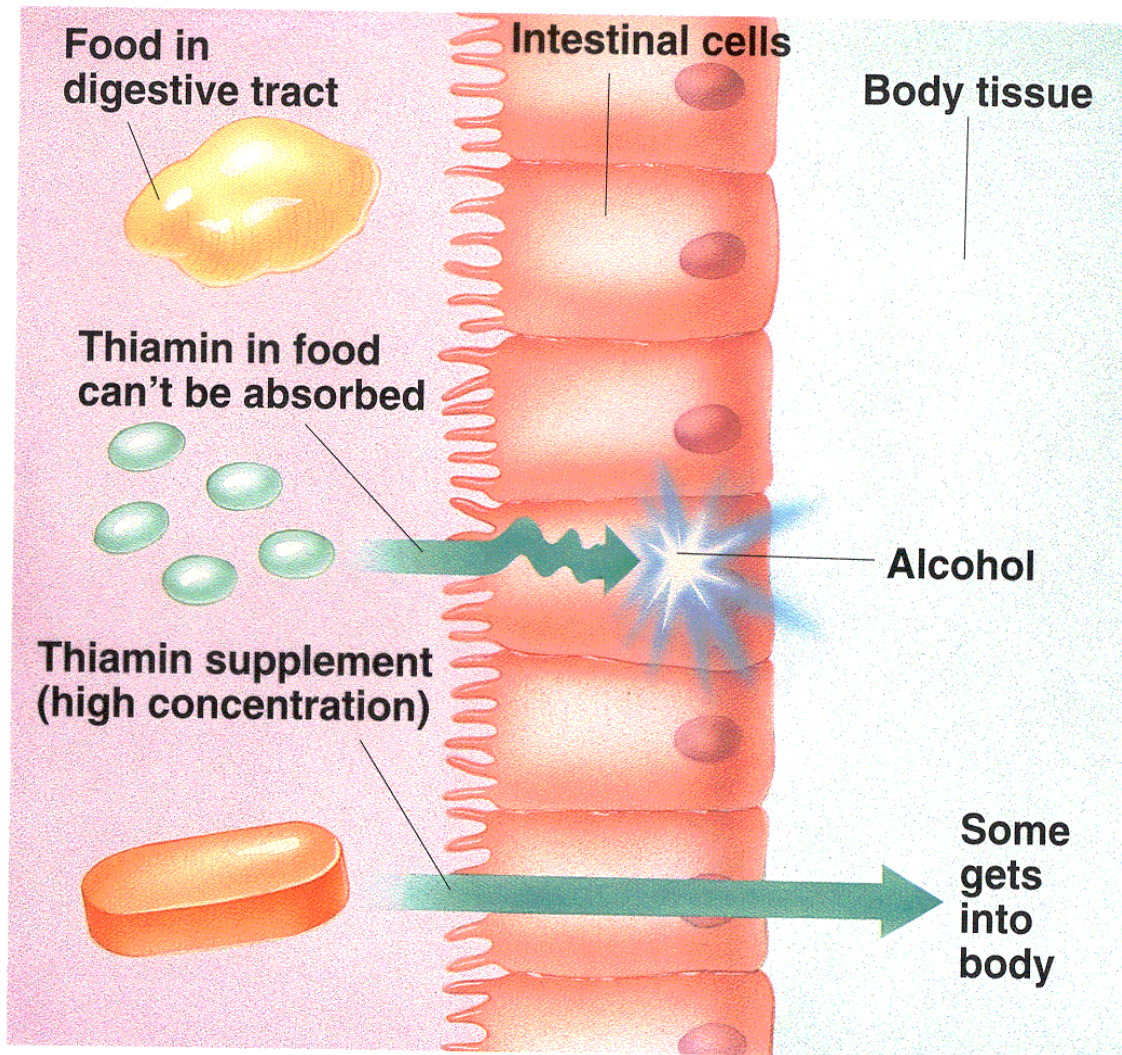
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NOTE: Blood alcohol concentration depends on a number of factors, including alcohol in the beverage, the rate of consumption, the person's gender, and body weight. For example, a 100-pound female can become legally drunk (≥ 0.10 concentration) by drinking three beers in an hour, whereas a 220-pound male consuming that amount at the same rate would have a 0.05 blood alcohol concentration.

Alcohol and Malnutrition

- Heavy drinkers may have inadequate food intake.
- Impaired nutrient metabolism will result from chronic alcohol abuse.
- Vitamin B₆, folate, thiamin deficiencies
- Wernicke-Korsakoff syndrome is seen in chronic alcoholism.

Alcohol's Effect on Vitamin Absorption



Alcohol's Long-Term Effects

- Abuse during pregnancy
- Third leading cause of preventable death

Health Effects of Alcohol Consumption

TABLE H7-5 Health Effects of Heavy Alcohol Consumption

Health Problem	Effects of Alcohol
Arthritis	Increases the risk of inflamed joints.
Cancer	Increases the risk of cancer of the liver, breast, mouth, pharynx, larynx, esophagus, colon, and rectum.
Fetal alcohol syndrome	Causes physical and behavioral abnormalities in the fetus (see Highlight 15).
Heart disease	In heavy drinkers, raises blood pressure, blood lipids, and the risk of stroke and heart disease; when compared with those who abstain, heart disease risk is generally lower in light-to-moderate drinkers.
Hyperglycemia	Raises blood glucose.
Hypoglycemia	Lowers blood glucose, especially in people with diabetes.
Infertility	Increases the risks of menstrual disorders and spontaneous abortions (in women); suppresses luteinizing hormone (in women) and testosterone (in men).
Kidney disease	Enlarges the kidneys, alters hormone functions, and increases the risk of kidney failure.
Liver disease	Causes fatty liver, alcoholic hepatitis, and cirrhosis.
Malnutrition	Increases the risk of malnutrition; low intakes of protein, calcium, iron, vitamin A, vitamin C, thiamin, vitamin B ₆ , and riboflavin; and impaired absorption of calcium, phosphorus, vitamin D, and zinc.
Nerve disorders	Causes neuropathy and dementia; impairs balance and memory.
Obesity	Increases energy intake, but is not a primary cause of obesity.
Psychological disturbances	Causes depression, anxiety, and insomnia.

NOTE: This list is by no means all-inclusive. Alcohol has direct toxic effects on all body systems.

TABLE H7-6 Myths and Truths Concerning Alcohol

Myth:	Liquors such as rum, vodka, and tequila are more harmful than wine and beer.
Truth:	The damage caused by alcohol depends largely on the <i>amount</i> consumed. Compared with liquor, beer and wine have relatively low percentages of alcohol, but they are often consumed in larger quantities.
Myth:	Consuming alcohol with raw seafood diminishes the likelihood of getting hepatitis.
Truth:	People have eaten contaminated oysters while drinking alcoholic beverages and not gotten as sick as those who were not drinking. But do not be misled: hepatitis is too serious an illness for anyone to depend on alcohol for protection.
Myth:	Alcohol stimulates the appetite.
Truth:	For some people, alcohol may stimulate appetite, but it seems to have the opposite effect in heavy drinkers. Heavy drinkers tend to eat poorly and suffer malnutrition.
Myth:	Drinking alcohol is healthy.
Truth:	Moderate alcohol consumption is associated with a lower risk for heart disease. Higher intakes, however, raise the risks for high blood pressure, stroke, heart disease, some cancers, accidents, violence, suicide, birth defects, and deaths in general. Furthermore, excessive alcohol consumption damages the liver, pancreas, brain, and heart. No authority recommends that nondrinkers begin drinking alcoholic beverages to obtain health benefits.
Myth:	Wine increases the body's absorption of minerals.
Truth:	Wine may increase the body's absorption of potassium, calcium, phosphorus, magnesium, and zinc, but the alcohol in wine also promotes the body's excretion of these minerals, so no benefit is gained.
Myth:	Alcohol is legal and, therefore, not a drug.
Truth:	Alcohol is legal for adults 21 years old and older, but it is also a drug—a substance that alters one or more of the body's functions.
Myth:	A shot of alcohol warms you up.
Truth:	Alcohol diverts blood flow to the skin making you <i>feel</i> warmer, but it actually cools the body.
Myth:	Wine and beer are mild; they do not lead to alcoholism.
Truth:	Alcoholism is not related to the kind of beverage, but rather to the quantity and frequency of consumption.
Myth:	Mixing different types of drinks gives you a hangover.
Truth:	Too much alcohol in any form produces a hangover.
Myth:	Alcohol is a stimulant.
Truth:	People think alcohol is a stimulant because it seems to relieve inhibitions, but it does so by depressing the activity of the brain. Alcohol is medically defined as a depressant drug.
Myth:	Beer is a great source of carbohydrate, vitamins, minerals, and fluids.
Truth:	Beer does provide some carbohydrate, but most of its calories come from alcohol. The few vitamins and minerals in beer cannot compete with rich food sources. And the diuretic effect of alcohol causes the body to lose more fluid in urine than is provided by the beer.

TABLE H7-3 kCalories in Alcoholic Beverages and Mixers

Beverage	Amount (oz)	Energy (kcal)	Alcohol (g)
Beer			
Regular	12	153	14
Light	12	103	11
Nonalcoholic	12	32	0
Cocktails			
Daiquiri, canned	6.8	259	20
Daiquiri, from recipe	4.5	223	28
Piña colada, canned	6.8	526	20
Piña colada, from recipe	4.5	245	14
Tequila sunrise, canned	6.8	232	20
Whiskey sour, canned	6.8	249	20
Liquor (gin, rum, vodka, whiskey)			
80 proof	1.5	97	14
86 proof	1.5	105	15
90 proof	1.5	110	16
94 proof	1.5	116	17
100 proof	1.5	124	18
Sake	1.5	58	7
Liqueurs			
Coffee and cream liqueur, 34 proof	1.5	154	7
Coffee liqueur, 53 proof	1.5	170	11
Coffee liqueur, 63 proof	1.5	160	14
Crème de menthe, 72 proof	1.5	186	15
Mixers			
Club soda	12	0	0
Cola	12	136	0
Cranberry juice cocktail	4	72	0
Ginger ale or tonic water	12	124	0
Grapefruit juice	4	48	0
Orange juice	4	56	0
Tomato or vegetable juice	4	21	0
Wine			
Champagne	5	105	13
Cooking	5	72	5
Dessert, dry	5	224	23
Dessert, sweet	5	236	23
Red or rosé	5	125	16
White	5	121	15
Wine cooler	10	150	11

Personal Strategies

- Serve and consume nonalcoholic beverages.
- Drink slowly
- Consume alcohol moderately
- Accompanied by food and water
- Do not drive
- Driving coordination is still impaired the morning after



End of Chapter 7

Metabolism