Chapter 3

The Only Diet You Will Ever Need: Nutrients, Enzymes and Metabolism, and Transport Across Membranes

1

3.1 Nutrients

- _____: needed in large amounts
- _____: needed in small amounts

2

Macronutrients

- _____
- _____
- _____
- _____

3

Water and Nutrition

- Water helps:
  - to disperse nutrients
  - to eliminate waste
  - to maintain blood pressure
  - with many cellular activities

4

Water and Nutrition

- _____ can cause:
  - muscle cramps, fatigue, headache, dizziness, nausea, confusion, increase in heart rate
- Large water deficit can lead to:
  - hallucinations, heat stroke, death

5

Water and Nutrition

- Water in the circulatory system helps deliver oxygen and other nutrients to all parts of the body, including the brain
- Water helps with thermoregulation; sweating is an important mechanism for keeping the body cool

6

Water and Nutrition

- Humans lose 3 liters of water every day through sweat and elimination
- We must replace the water by drinking or eating food with high water content to avoid the negative health impacts of dehydration

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Carbohydrates as Nutrients

- The major source of energy for the body
- Found in foods such as:
  - bread, cereal, rice, pasta, fruit, vegetables

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Carbohydrates as Nutrients

- Plants store carbohydrates as starch
- Animals store carbohydrates as glycogen
- Both starch and glycogen are polymers of glucose

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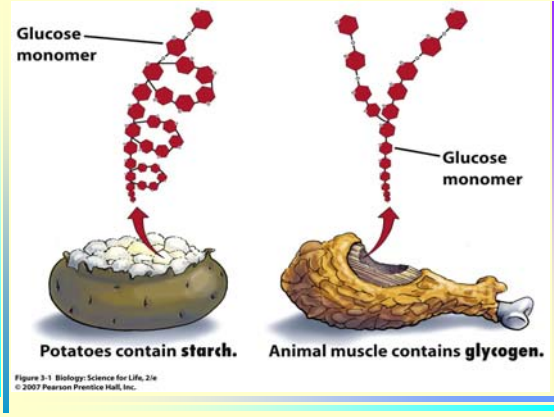

Complex Carbohydrates

- Takes longer to digest complex carbohydrates because there are chemical more bonds to break

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Complex Carbohydrates: Fiber

- Humans cannot digest these complex carbohydrates into monomers, so fiber is passed into the large intestine
- Bacteria digest some of the fiber and the rest gives bulk to the feces

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Complex Carbohydrates: Fiber

- Even though fiber is not digested by humans, it has an important role in nutrition
- Fiber helps lower the amount of the membrane lipid, **cholesterol**
- Fiber may have a role in cancer prevention

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Proteins as Nutrients

- Found in food such as:
  - _____
  - _____
  - _____
  - _____
  - _____
  - _____

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Proteins as Nutrients

- Amino acids are the building blocks of proteins
- _____ – cannot be made by the human body and must be supplied through food

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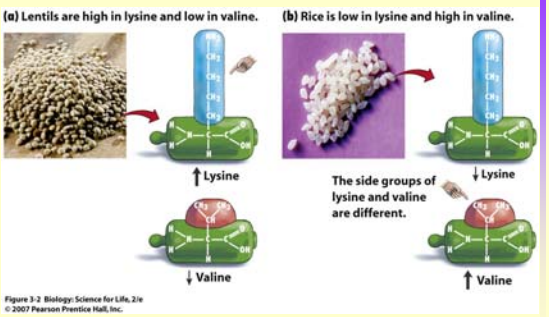
Proteins as Nutrients



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Proteins as Nutrients

- _____ contain all the essential amino acids
- Meat usually is complete
- Plant material more often lacks some essential amino acids

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Proteins as Nutrients

- Vegetarians need to be sure to eat a varied diet to get an adequate supply of essential amino acids

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Fats as Nutrients

- Fats contain more energy than carbohydrates or proteins
- Fats are found in foods such as:
  - _____
  - _____
  - _____
  - _____

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Fats as Nutrients

- Fat can be found in meat
  - Mixed in with muscle - beef
  - On surface of muscle - chicken

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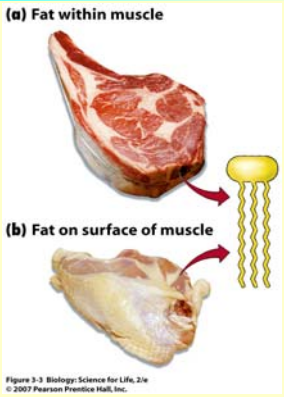

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Fats as Nutrients

- Fat helps insulate bodies
- Fat is stored against possible famine
- Fat cushions vital organs

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Fats as Nutrients

Fatty Acids:

- One of the building blocks of fat
- _____ – cannot be made by the body and must be acquired through food

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Fats and Hydrogen Saturation

- _____ – the carbons of the fatty acid are all bound to hydrogen molecules – no double bonded carbons
- _____ – double carbon to carbon bonds exist – carbons are not saturated with hydrogen molecules

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Fats and Hydrogen Saturation

- The more double bonds in the fatty acid, the more unsaturated it is:
  - **Monounsaturated** – _____
  - **Polyunsaturated** – _____

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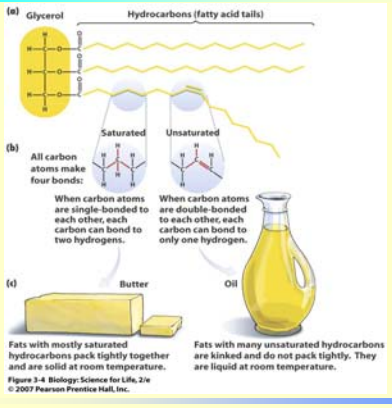

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Fats and Hydrogen Saturation

- Adding hydrogen atoms to unsaturated fats is called _____
  - retards spoilage
  - but also increases saturation

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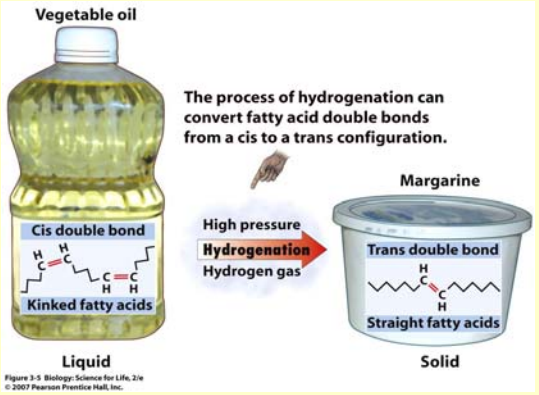

Micronutrients

- _____
- _____

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Vitamins

- Function as _____, molecules that help enzymes speed up the body's chemical reactions
- Contain carbon – so they are organic molecules
- Most cannot be made by the human body

30

Vitamins

- Vitamins can help the body absorb other nutrients
- We can have vitamin deficiencies

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Vitamin D

- The only vitamin made by the human body
- Process requires sunlight
- In cold climates, some people have vitamin D deficiencies

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Vitamins

- All other vitamins are supplied in our food
- Eating raw vegetables and fruit is the best way to get vitamins

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Water-Soluble Vitamins

- Do not stay in body long
- Boiling can cause these water soluble vitamins to leave the food, so steaming vegetables is a better way to preserve the vitamins

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Water-soluble vitamins

- Small organic molecules (containing carbon)
- Will dissolve in water
- Cannot be synthesized by body
- Supplements packaged as pressed tablets
- Excesses usually not a problem since water-soluble vitamins are excreted in urine, not stored

Vitamin	Sources	Functions	Effects of Deficiency
Thiamin (B_1)	Pork, whole grains, leafy green vegetables	Required component of many enzymes	Water retention and heart failure
Riboflavin (B_2)	Milk, whole grains, leafy green vegetables	Required component of many enzymes	Skin lesions
Folic acid	Dark green vegetables, nuts, legumes (dried beans, peas, and lentils), whole grains	Required component of many enzymes	Neural-tube defects, anemia, and gastrointestinal problems
B_{12}	Chicken, fish, red meat, dairy	Required component of many enzymes	Anemia and impaired nerve function
B_6	Red meat, poultry, fish, spinach, potatoes, and tomatoes	Required component of many enzymes	Anemia, nerve disorders, and muscular disorders
Pantothenic acid	Meat, vegetables, grains	Required component of many enzymes	Fatigue, numbness, headaches, and nausea
Biotin	Legumes, egg yolk	Required component of many enzymes	Dermatitis, sore tongue, and anemia
C	Citrus fruits, strawberries, tomatoes, broccoli, cabbage, green pepper	Collagen synthesis; improves iron absorption	Scurvy and poor wound healing
Niacin (B_3)	Nuts, leafy green vegetables, potatoes	Required component of many enzymes	Skin and nervous system damage

Table 3-1 part 1 Biology: Science for Life, 2/e

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Fat-Soluble Vitamins

- Stored in fat and can remain in the body for a long time
- Excess vitamin storage in fat can be toxic

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Fat-soluble vitamins

- Small organic molecules (containing carbon)
- Will not dissolve in water
- Cannot be synthesized by body (except vitamin D)
- Supplements packaged as oily gel caps
- Excesses can cause problems since fat-soluble vitamins are not excreted readily

Vitamin	Sources	Functions	Effects of Deficiency	Effects of Excess
A	Leafy green and yellow vegetables, liver, egg yolk	Component of eye pigment	Night blindness, scaly skin, skin sores, and blindness	Drowsiness, headache, hair loss, abdominal pain, and bone pain
D	Milk, egg yolk	Helps calcium be absorbed and increases bone growth	Bone deformities	Kidney damage, diarrhea, and vomiting
E	Dark green vegetables, nuts, legumes, whole grains	Required component of many enzymes	Neural-tube defects, anemia, and gastrointestinal problems	Fatigue, weakness, nausea, headache, blurred vision, and diarrhea
K	Leafy green vegetables, cabbage, cauliflower	Helps blood clot	Bruising, abnormal clotting, and severe bleeding	Liver damage and anemia

Table 3-1 part 2 Biology: Science for Life, 2/e

Minerals

- Inorganic – do not contain carbon
- Essential for:
  - _____
  - _____
  - _____
  - _____

Minerals

- Some common minerals:
  - _____
  - _____
  - _____
  - _____
  - _____

Minerals

- Some minerals are water soluble – so boiling is not the preferred way of cooking
- Minerals are not made in the body – and must be consumed in food

Minerals

- Will dissolve in water
- Inorganic elements (do not contain carbon)
- Cannot be synthesized by body
- Supplements packaged as pressed tablets

Mineral	Sources	Functions	Effects of Deficiency	Effects of Excess
Calcium	Milk, cheese, dark green vegetables, legumes	Bone strength, blood clotting	Stunted growth, osteoporosis	Kidney stones
Chloride	Table salt, processed foods	Formation of HCl acid in stomach	Muscle cramps, reduced appetite, poor growth	High blood pressure
Magnesium	Whole grains, leafy green vegetables, legumes, dairy, nuts	Required component of many enzymes	Muscle cramps	Neurological disturbances
Phosphorus	Dairy, red meat, poultry, grains	Bone and tooth formation	Weakness, bone damage	Impaired ability to absorb nutrients
Potassium	Meats, fruits, vegetables, whole grains	Water balance, muscle function	Muscle weakness	Muscle weakness, paralysis, and heart failure
Sodium	Table salt, processed foods	Water balance, nerve function	Muscle cramps, reduced appetite	High blood pressure
Sulfur	Meat, legumes, milk, eggs	Components of many proteins	None known	None known

Table 3-2 Biology: Science for Life, 2/e

Processed Versus Whole Foods

- Processing foods reduces nutritive value:
  - refined flour is stripped of nutrients
  - sweets provide to no real nutrition
- A variety of **whole foods** = a healthy diet
  - rich in antioxidants, which may prevent diseases, slow aging, and protect cells from harmful **free radicals** molecules
  - fruits, vegetables, nuts, grains, some meats

Antioxidants

- Present in whole foods
- Protect cells from damage caused by free radicals
- Thought to have a role in disease prevention

Antioxidant	Source
Beta-carotene	Foods rich in beta-carotene are orange in color; they include carrots, cantaloupe, squash, mangoes, pumpkin, and apricots. Beta-carotene is also found in some leafy green vegetables such as collard greens, kale, and spinach.
Lutein	Lutein, which is known to help keep eyes healthy, is also found in leafy green vegetables such as collard greens, kale, and spinach.
Lycopene	Lycopene is a powerful antioxidant found in watermelon, papaya, apricots, guava, and tomatoes.
Selenium	Selenium is a mineral (not an antioxidant) that serves as a cofactor for many antioxidant enzymes, thereby increasing their effectiveness. Rice, wheat, meats, bread, and Brazil nuts are major sources of dietary selenium.
Vitamin A	Foods rich in vitamin A include sweet potatoes, liver, milk, carrots, egg yolks, and mozzarella cheese.
Vitamin C	Foods rich in vitamin C include most fruits, vegetables, and meats.
Vitamin E	Vitamin E is found in almonds, many cooking oils, mangoes, broccoli, and nuts.

Table 3-3 Biology: Science for Life, 2/e

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3.2 Enzymes and Metabolism

- _____ – all of the chemical reactions that happen in the cells of the body
- _____ – proteins that regulate metabolic reactions

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Enzymes

- Enzymes speed up, or _____, the rate of reaction in cells
  - heat can do this, too, but heat can kill cells
- Enzymes help the body break down food and free energy stored in chemical bonds

45

Enzymes

- _____ – the energy required for a reaction to occur
- Enzymes decrease activation energy requirements – allow reactions to occur
- _____ – molecule (or molecules) being metabolized
- The enzyme region where the substrate binds is called its _____

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Enzymes

- The enzyme binds the substrate and changes shape slightly
- This shape is called **induced fit**
- When the enzyme's shape changes, the bonds of the substrate are stressed, which makes them easy to break

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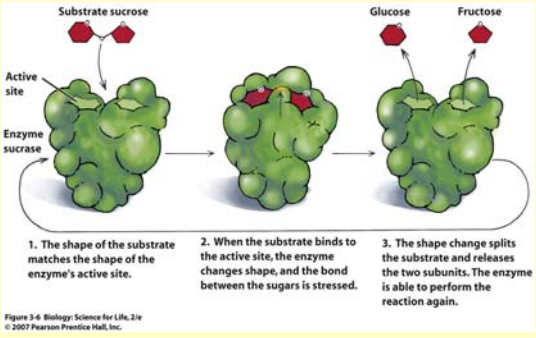

Figure 3-6 Biology: Science for Life, 2/e

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Enzymes

- _____ – each enzyme catalyzes a specific reaction
- Enzymes are usually named for the reaction they catalyze and end in *–ase*
- Example: the enzyme sucrase breaks down the sugar sucrose

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Enzymes

- Specificity is due to shape of the enzyme
- The place where the substrate fits is called the active site
- Only substrates of the proper shape will fit into the active site and cause a reaction

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Lactose Intolerance

- People are missing or low on the enzyme **lactase** – which breaks down the milk sugar lactose – suffer from **lactose intolerance**
- This causes a buildup of lactic acid in the intestines – causing the symptoms of bloating, cramps and diarrhea associated with lactose intolerance

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Lactose Intolerance

- Treatment for lactose intolerance:
  - take supplements of lactase

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Calories and Metabolic Rate

- _____ – energy unit of food
- Need to balance the intake of calories with the metabolic rate – how fast calories are used

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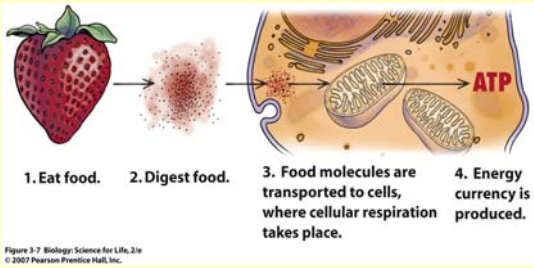

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Calories and Metabolic Rate

- The energy from food needs to be converted to **ATP** (_____), the type of energy that cells can use
- Any calories not converted to ATP are stored as fat

55

Calories and Metabolic Rate

- _____ is a measurement of energy use
- _____ is the resting state – how much energy is used when the person is awake but not exercising
- Average basal metabolic rate is 70 Cal/hr (1680 Cal / day)

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Calories and Metabolic Rate

- Metabolic rate varies depending on:
  - _____
  - _____
  - _____
  - _____
  - _____
  - _____

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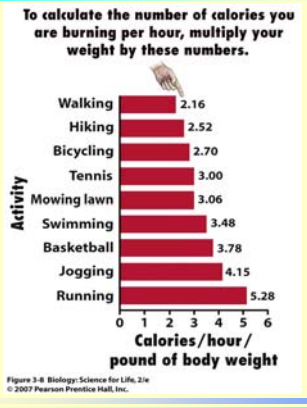

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Calories and Metabolic Rate

- Food is broken down first by the digestive system
- The particles are transported to the cells by the bloodstream
- The particles then are transported into the cell through the membrane surrounding the cell – **the plasma membrane**

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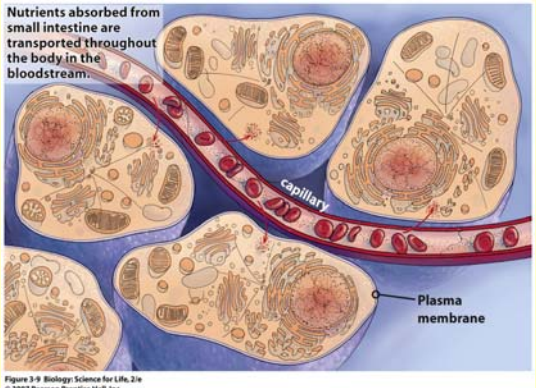

3.3 Transport Across Membranes

- Nutrients must pass from the bloodstream into the cells
- The plasma membrane, the outer layer of cells in the body, is made of a double layer of phospholipids called the **lipid bilayer**

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Transport Across Membranes

The nature of the lipid bilayer:

- The interior of the bilayer – where the fatty acid tails of the phospholipids are – is hydrophobic
- The hydrophilic heads of the phospholipids point outward, toward the water

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Transport Across Membranes

- The bilayer controls what enters and leaves the cell – semipermeable
- Hydrophobic material can pass directly through the membrane
- Hydrophilic material is more difficult to move across

63

Diffusion

- _____ – movement of molecules from where they are highly concentrated to where they are less concentrated
- Requires no energy – spontaneous

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Diffusion

- Diffusion across a membrane – _____
- This is how small hydrophobic molecules cross the membrane
- Gas molecules, such as carbon dioxide and oxygen, cross this way

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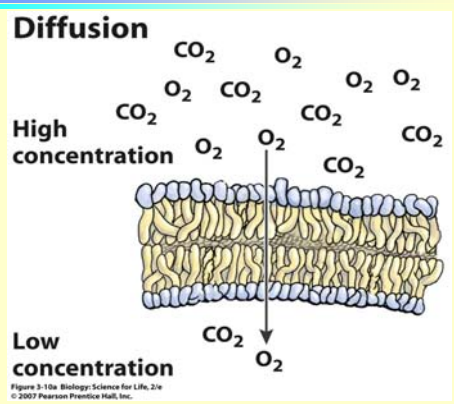

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Facilitated Diffusion

- Hydrophilic and charged molecules cannot pass directly through the membrane
- There are proteins in the membrane for this
- Proteins in the membrane allow molecules to cross the membrane passively in this _____
- The membranes facilitate the diffusion

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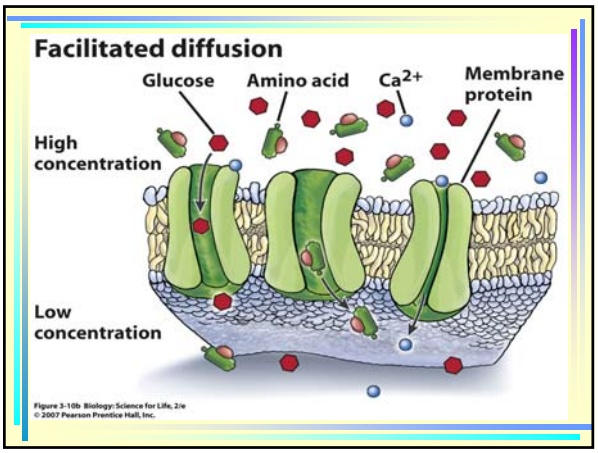

Osmosis

- **Osmosis** is _____ _____
- Water can leave the cell – cell _____
- Water can enter the cell – cell _____

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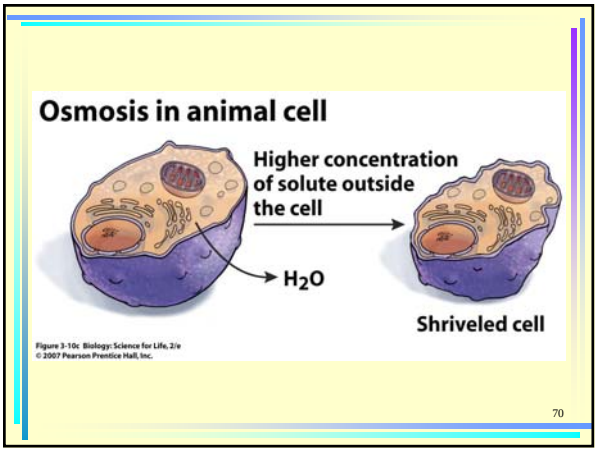

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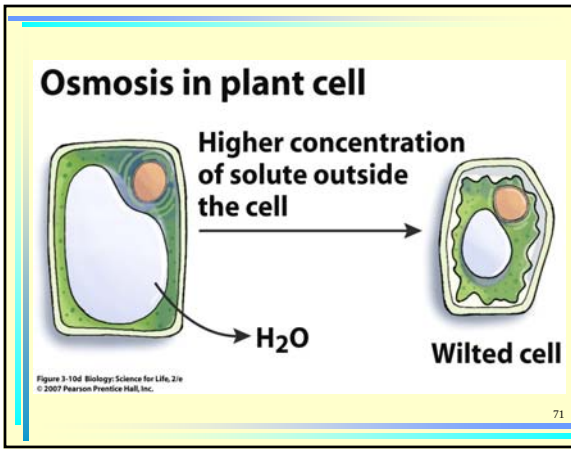

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Active Transport

- Sometimes cells need to maintain high levels of material and still transport more inside
- This requires energy output in a process type called **active transport**

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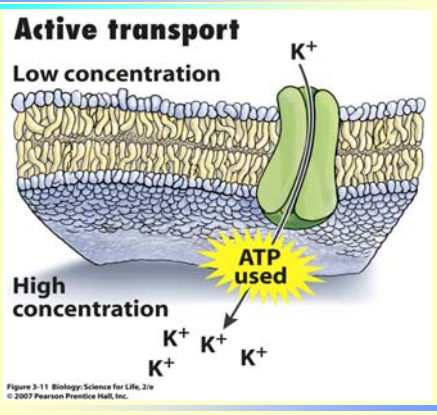

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Movement of Large Molecules

- Sometimes molecules are too large to pass through a membrane
- They need vesicles to carry them
- Vesicles are made of membrane, so they can fuse with the plasma membrane
- This requires energy output

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Exocytosis

- In **exocytosis**, a vesicle inside a cell _____
- The contents are emptied outside the cell

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Endocytosis

- In **endocytosis**, the membrane folds in and captures something on the outside
- The vesicle is _____ _____

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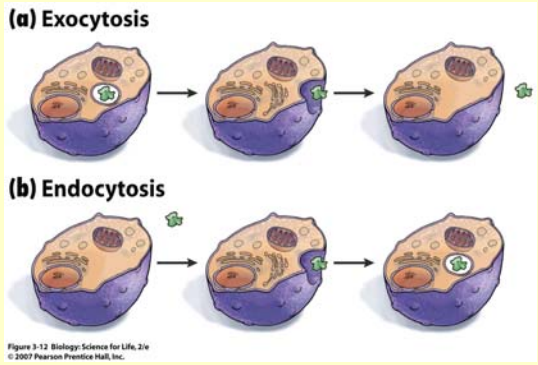

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3.4 Body Fat and Health

You are what you eat:

- All of the nutrients from the food you eat must be broken down and get into your cells to be used for energy and building blocks for other molecules

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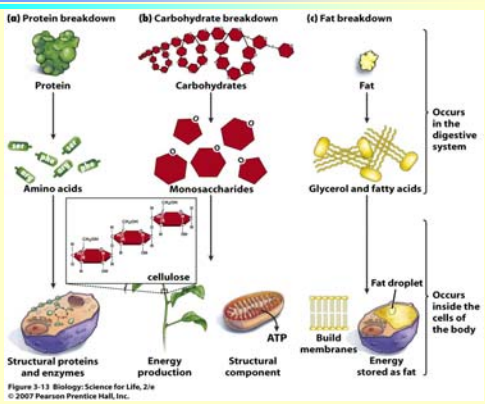

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Body Fat and Health

- What is "overweight"?
- Standards have changed from the 1960s and 1970s

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Evaluating How Much Body Fat Is Healthful

- Average women have 22% body fat
  - healthy range 12% - 32%
- Average men have 14% body fat
  - healthy range 3% - 29%

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Determining Ideal Weight

- Determining ideal weight is complicated
- The **body mass index** (**BMI**) is a newer system…

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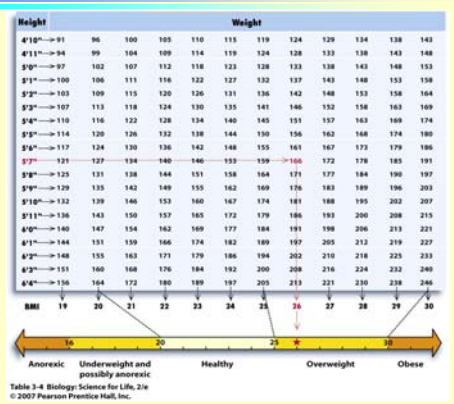

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Determining Ideal Weight

- BMI is not perfect because it doesn't account for differences in:
  - _____
  - _____
  - _____

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Obesity

- BMI of 30 or greater is classified as **obesity**
- 25% of Americans fall into this category
- Probably due to the availability of inexpensive, high fat food and lack of exercise

87

Diabetes

- The disorder called **diabetes** is when the body has difficulty with _____ response and/or production
- Insulin is a hormone that triggers cells to take in glucose for energy conversion
- Diabetics have cells that don't take up much glucose – so there is a lot of glucose in the blood

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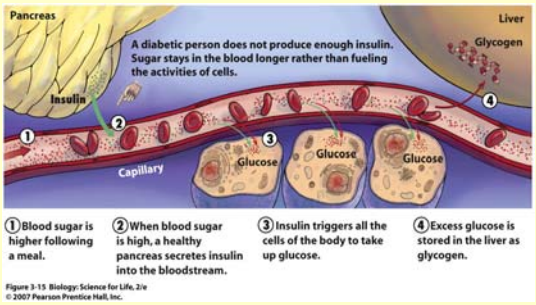

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Types of Diabetes

- Type I – _____ (IDDM)
  - Usually begins in childhood
  - Cannot make insulin
  - Need injections of insulin

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Types of Diabetes

- Type II – _____ (NIDDM)
  - Usually begins after 40 years of age
  - More common in obese people
  - Reduced insulin secretion or reduced response to insulin
  - Controlled through diet, exercise and sometimes insulin injections

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Hypertension

- Clinically, high blood pressure is often called **hypertension**
- Blood pressure is the force from the beating of the heart on the blood vessel walls
- Hypertension stresses circulatory system which means the heart must work harder

92

Hypertension

- _____ – higher number – pressure from heartbeat on vessel walls
- _____ – lower number – pressure when heart is relaxed
- Normal blood pressure:
  - Typically 120 systolic and 80 diastolic
  - Written as 120/80

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Hypertension

- Hypertension can result from weight gain because there is more fat in the body
- Fat uses more oxygen, so the demand on the circulatory system goes up
- Blood volume increases to compensate
- This puts more pressure on the vessels

94

Heart Attack and Stroke

- _____ – sudden interruption of blood supply to heart
- _____ – sudden loss of brain function because of blocked or ruptured blood vessels

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Heart Attack and Stroke

- Heart attack and stroke are more likely in obese people because they commonly have high blood pressure, which damages vessels
- This causes an increases risk in the vessels failing and having cholesterol deposits formed

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Lipoproteins: LDL & HDL

- Cholesterol is carried in the blood by **lipoproteins**
- **LDL** – _____
- **HDL** – _____

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LDL

- Low protein amount
- High cholesterol amount
- Carry cholesterol to cells – for placement in plasma membrane

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HDL

- High amount of protein
- Low amount of cholesterol
- Return excess cholesterol to liver; used to make bile which is sent to the small intestine and released as feces

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Cholesterol Levels

Desired levels:

- Total cholesterol – below 200
- LDL – below 100
- Treatment for high cholesterol level can be medication or a change in diet

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Cholesterol Levels

- Some cholesterol is necessary
- It makes up part of membranes
- It is a building block for some hormones

101

Anorexia and Bulimia

- _____ – self-starvation eating disorder
- _____ – eating and purging eating disorder
- Serious health consequences…

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Health problems resulting from OBESITY	Health problems resulting from ANOREXIA and BULIMIA
• Adult-onset diabetes	• Altered heart rhythms
• Hypertension (high blood pressure)	• Amenorrhea (cessation of menstruation)
• Heart attack	• Osteoporosis (weakened bones)
• Stroke	• Dental/gum problems
• Joint problems	• Ruptured stomach
	• Dehydration

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USDA Food Guide Pyramid

- There is a new food guide pyramid
- Healthy eating and good fitness are important

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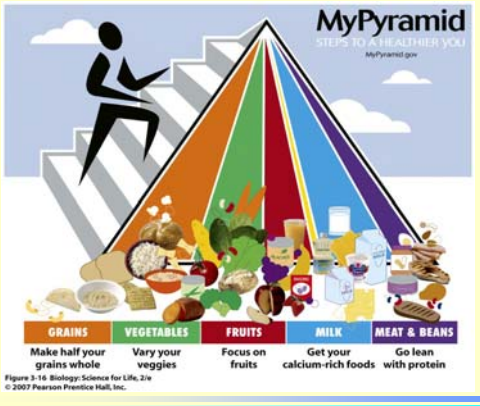

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