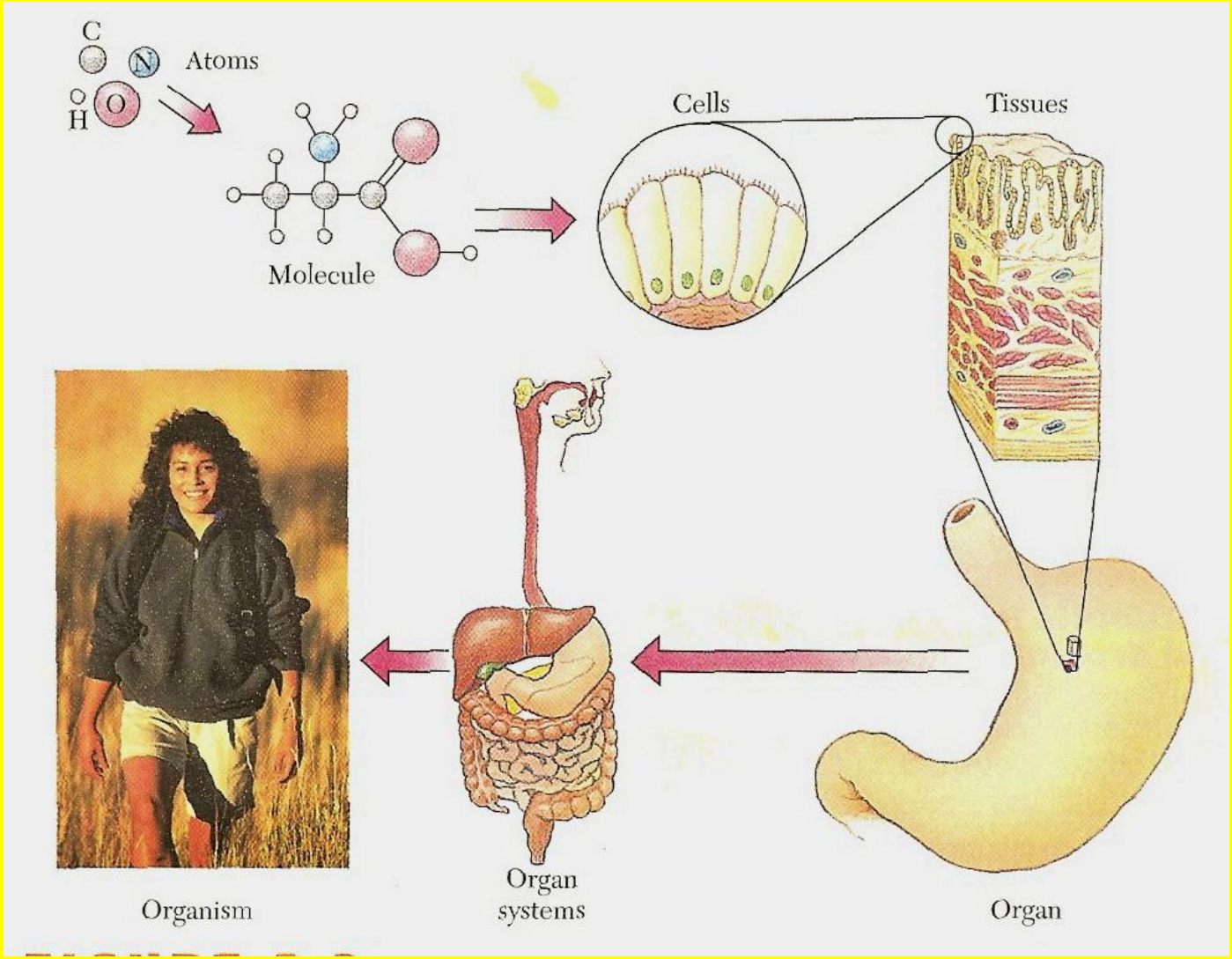
Your Body Chemistry

Your body: built from smaller parts: held together by chemical bonds

ATOMS: 99% Hydrogen
Oxygen
Carbon
Nitrogen

From Atoms ⟶ You



Calories: amount of **energy** in chemical bonds of food

Fats:	9 calories/gram
Carbohydrates:	4 calories/gram
Protein:	4 calories/gram
Alcohol:	7 calories/gram

Most of your energy:

- from carbohydrates & fats
- energy **stored** in carbohydrates & fats
- **protein**: **not** stored for energy

Metabolism: all chemical reactions in body

Anabolism: building up processes

Example:

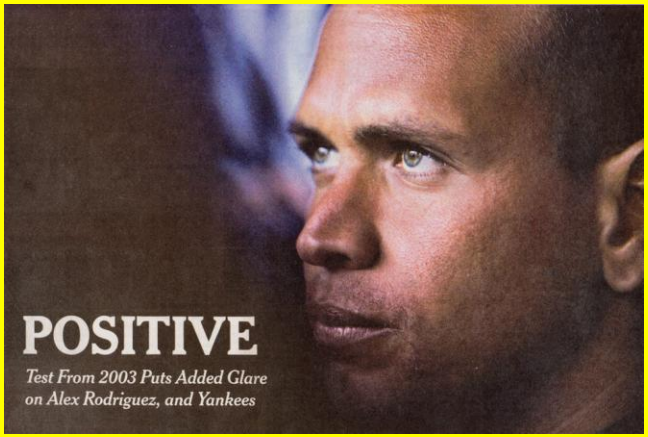
Making **new cell protein**

Anabolic steroids- mimic testosterone

↑ muscle strength, mass

Food & Drug Administration warning July 2009

- Body-building nutritional supplements
- May contain **steroids**
- Code words: “anabolic”, “tren”, “blocks estrogen”, “minimizes gyno”



Anabolic steroids: side effects

- Jaundice, liver failure
- Liver tumors
- Hypertension
- ↓ HDL (good cholesterol)
- Heart damage, kidney failure
- **↓ Sperm production, ↓ size testes**
- **↓ Testosterone, ↑ breasts**
- **↓ Sex drive, feminization**
- **Acne**

Metabolism:

Catabolism- breaking down processes

Example: energy release from glucose

Nutrients: 6 types

- Carbohydrates
- Fats
- Protein
- Water

macronutrients

- Vitamins
- Minerals

micronutrients

Nutrients: what they do

- Build body structures- cells, tissues
- Repair damage- injury/disease
- Energy: ~~all a~~ctivities: thinking running

What is a carbohydrate?

- Contain **C, H, O**
- Name origin: **carb**= carbon
  hydrate= water

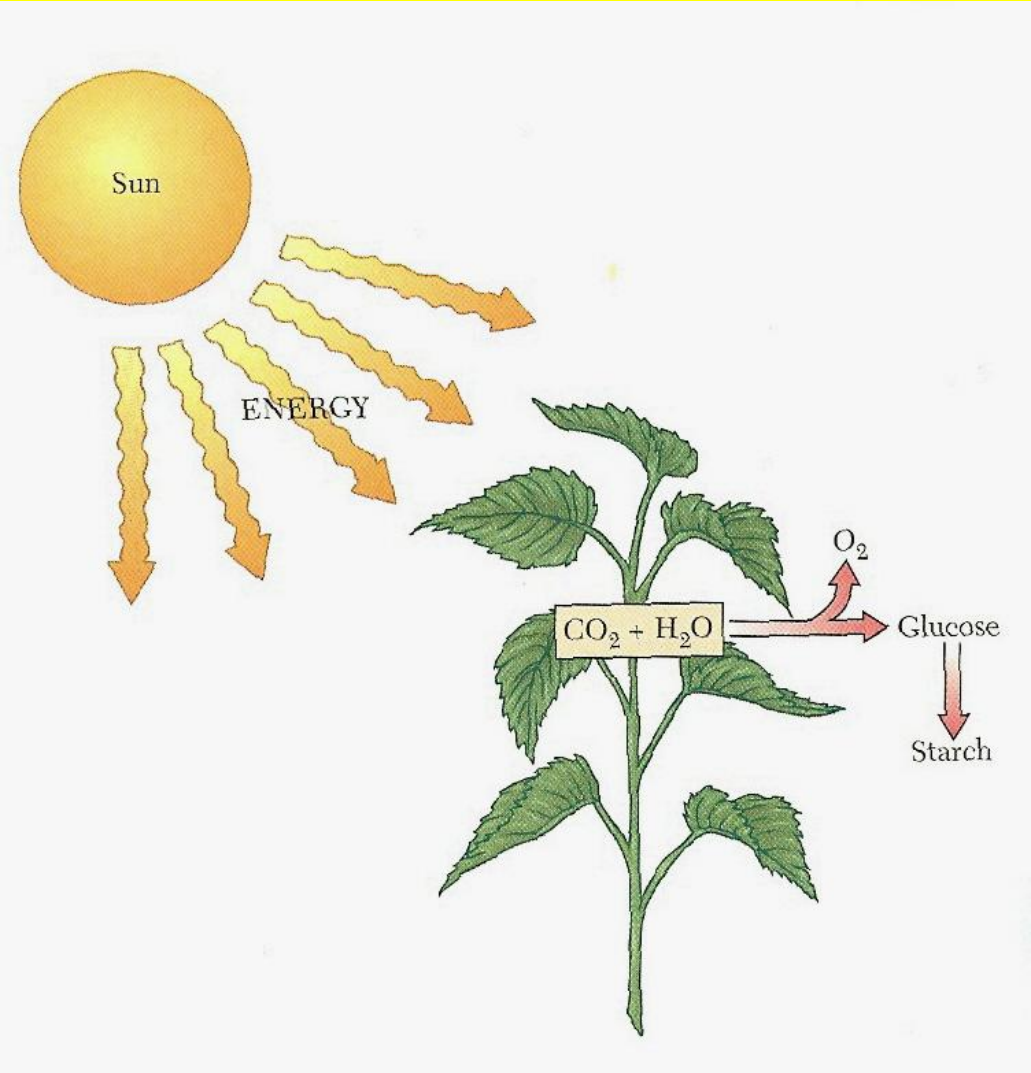
All carbons and oxygen- same proportion as **H_2O** 2H's 1 O

What do carbohydrates do?

Main function: give you **energy**

Main carbohydrate for your energy: **glucose**

Where do carbohydrates come from?



Carbohydrates

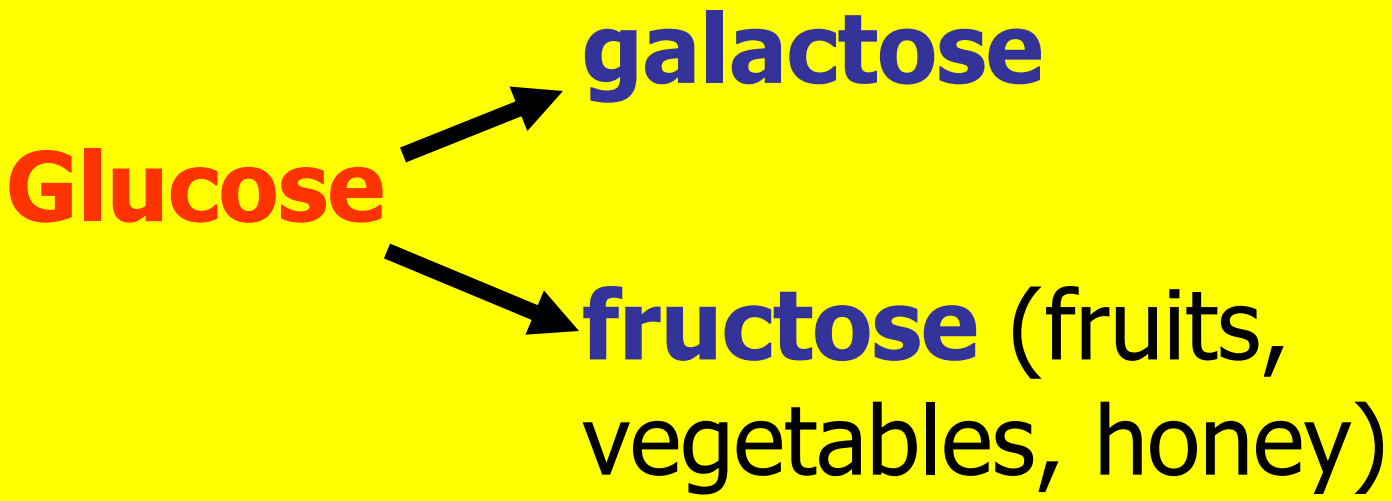
1) **Sugars**

2) **Complex Carbohydrates**
(starch, glycogen, fibers)

Sugars

- **Monosaccharides**:

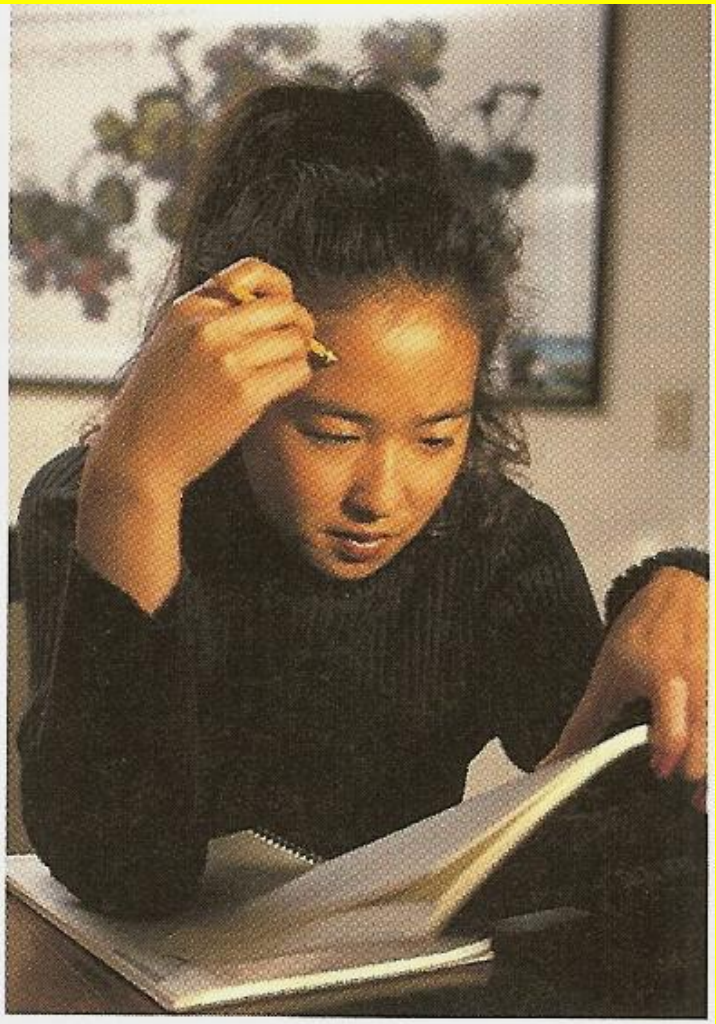
  Example: **glucose** (blood sugar)



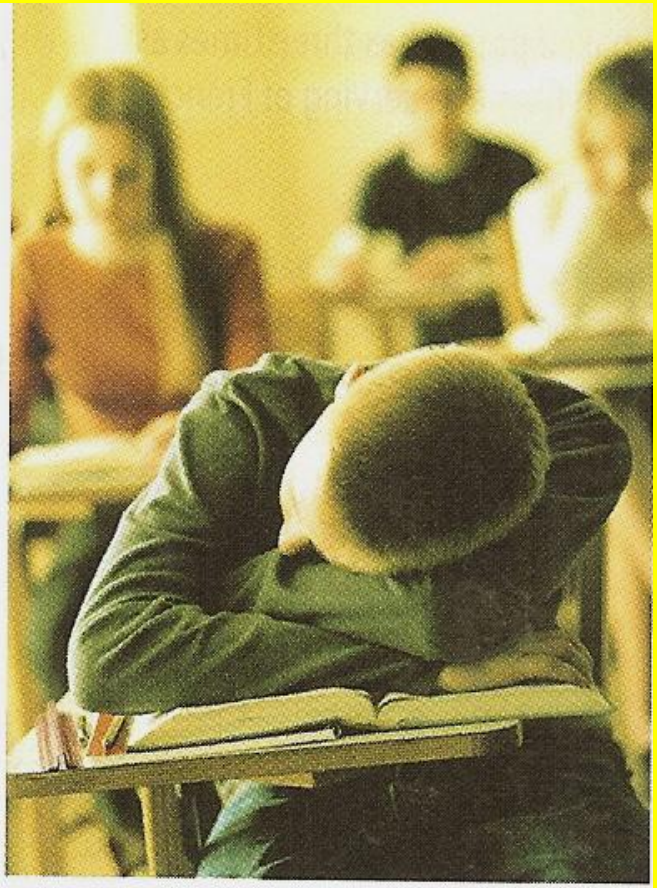
Glucose: very important

Only source energy- red blood cells;

Preferred energy: brain, nervous system, placenta, fetus



In our bodies, glucose is the preferred source of energy for the brain.



Our red blood cells, brain, and nerve cells primarily rely on glucose. This is why you get tired, irritable, and shaky when you have not eaten for a prolonged period of time.

Tufts University Study 2009

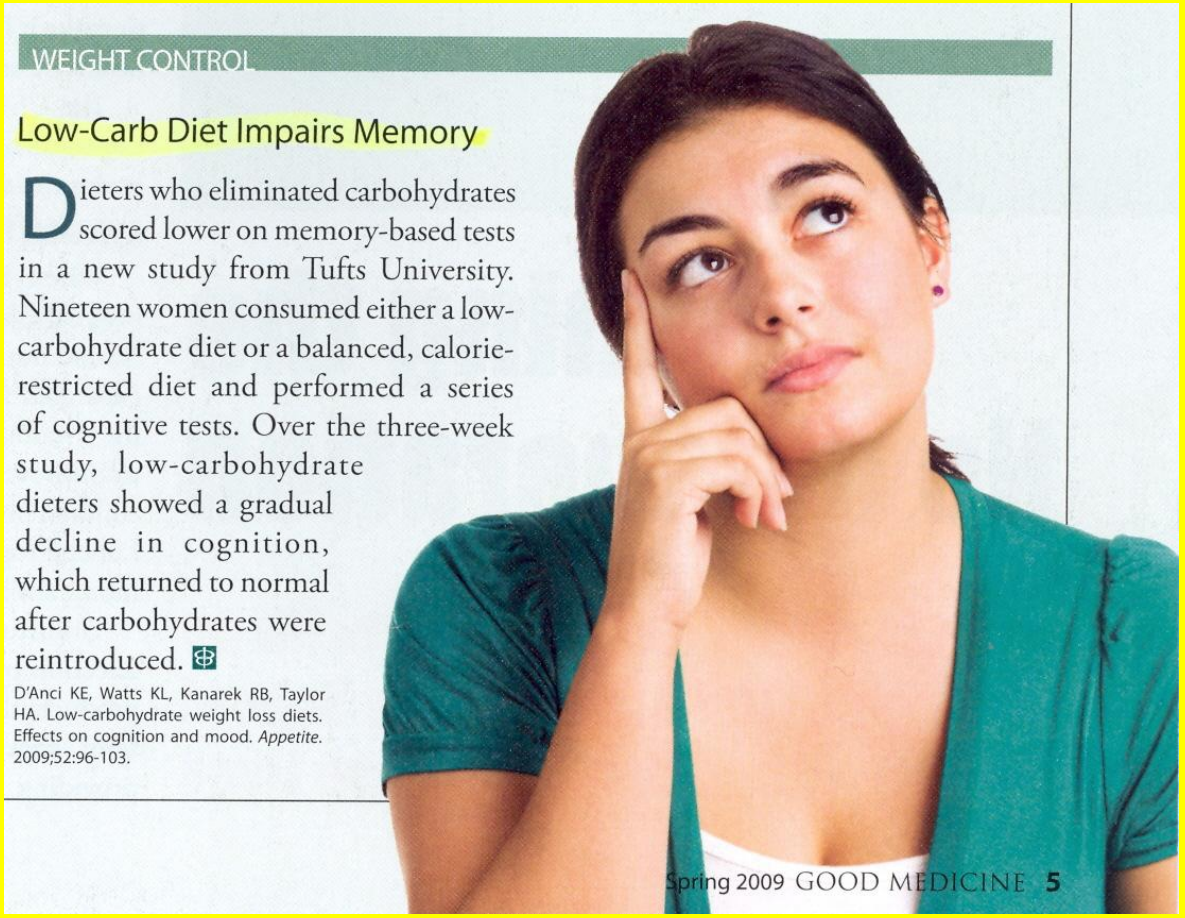
Dieters:

Eliminate Carbs

Score

Lower:

Memory tests

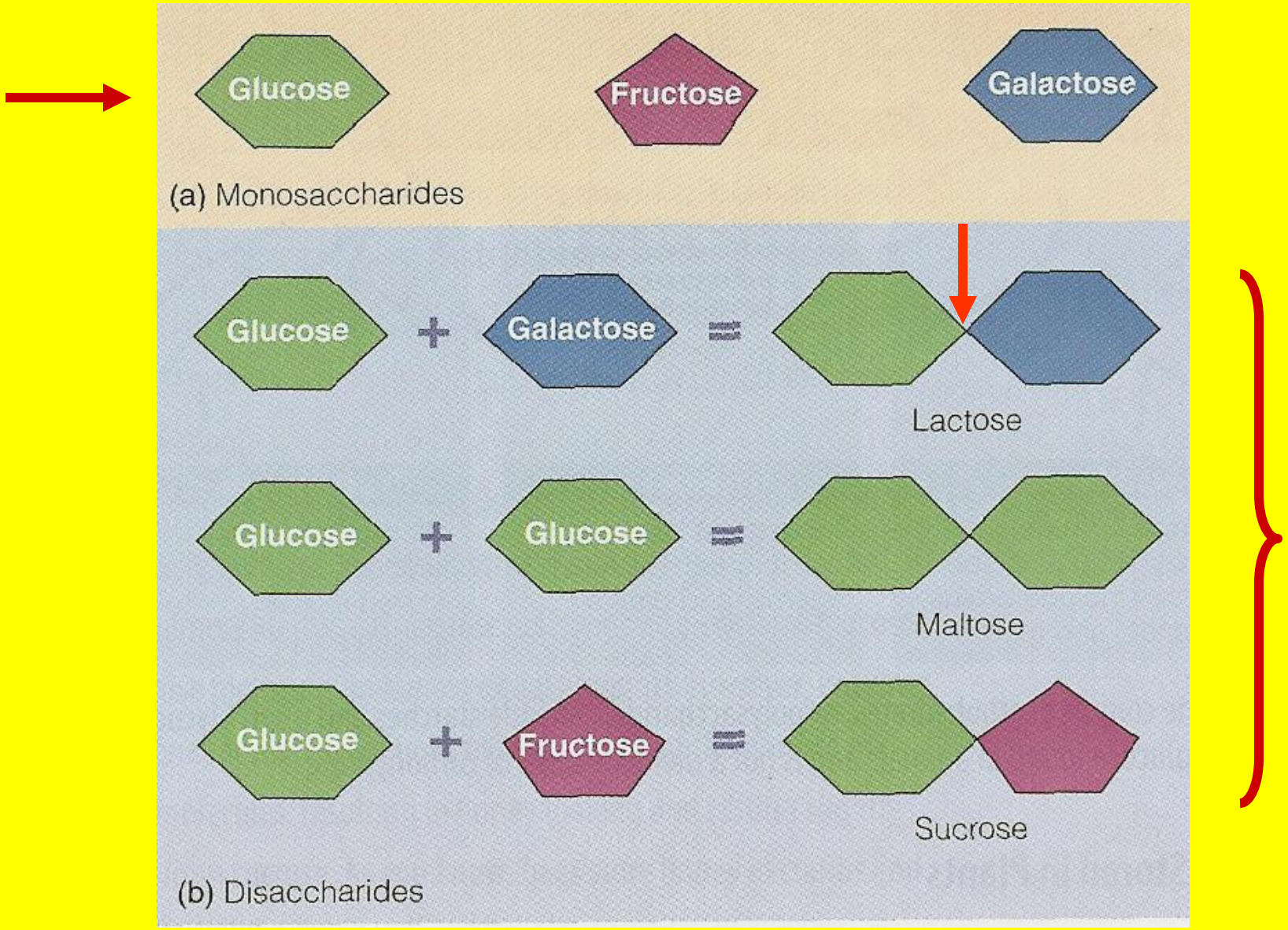


WEIGHT CONTROL

Low-Carb Diet Impairs Memory

Dieters who eliminated carbohydrates scored lower on memory-based tests in a new study from Tufts University. Nineteen women consumed either a low-carbohydrate diet or a balanced, calorie-restricted diet and performed a series of cognitive tests. Over the three-week study, low-carbohydrate dieters showed a gradual decline in cognition, which returned to normal after carbohydrates were reintroduced.

D'Anci KE, Watts KL, Kanarek RB, Taylor HA. Low-carbohydrate weight loss diets. Effects on cognition and mood. *Appetite.* 2009;52:96-103.


Glucose
Fructose
Galactose
(a) Monosaccharides
Glucose
+
Galactose
=
Lactose
Glucose
+
Glucose
=
Maltose
Glucose
+
Fructose
=
Sucrose
(b) Disaccharides

Sugars

- **Disaccharides**

Maltose: malt products (brewing, distilling, yeast making)

Sucrose: table sugar (sugar cane, maple syrup, honey)

Lactose: milk sugar (human & cow's milk)

Lactose Intolerance

- Babies digest milk (lactase)
- ↓ Lact**ase** with age
- Some people ↓ ↓ lactase: can't digest milk
- Lactose → large intestine

  bacteria: acids + gas
- Bloating, gas, cramps, diarrhea

Lactose Intolerant Adults

- 5% people Northwestern Europe descent
- **75%:** African Americans
- **90%:** Asian Americans

Problem: ↓ Milk/milk products

↓ Calcium intake

Solutions:

- **Small intake** dairy products throughout day
- **Yogurt/cheese**- during processing lactose digested
- **Lactase** tablet- before drinking milk
- **Lactose-free** milk
- Other **calcium** foods w/o lactose (vegetables, tofu, fish)
- Calcium **fortified** food

Figure 4.18 There are many products available on the market today that contain the lactase enzyme or are low in lactose. These products are developed for people with lactose intolerance.

Sugar Substitutes

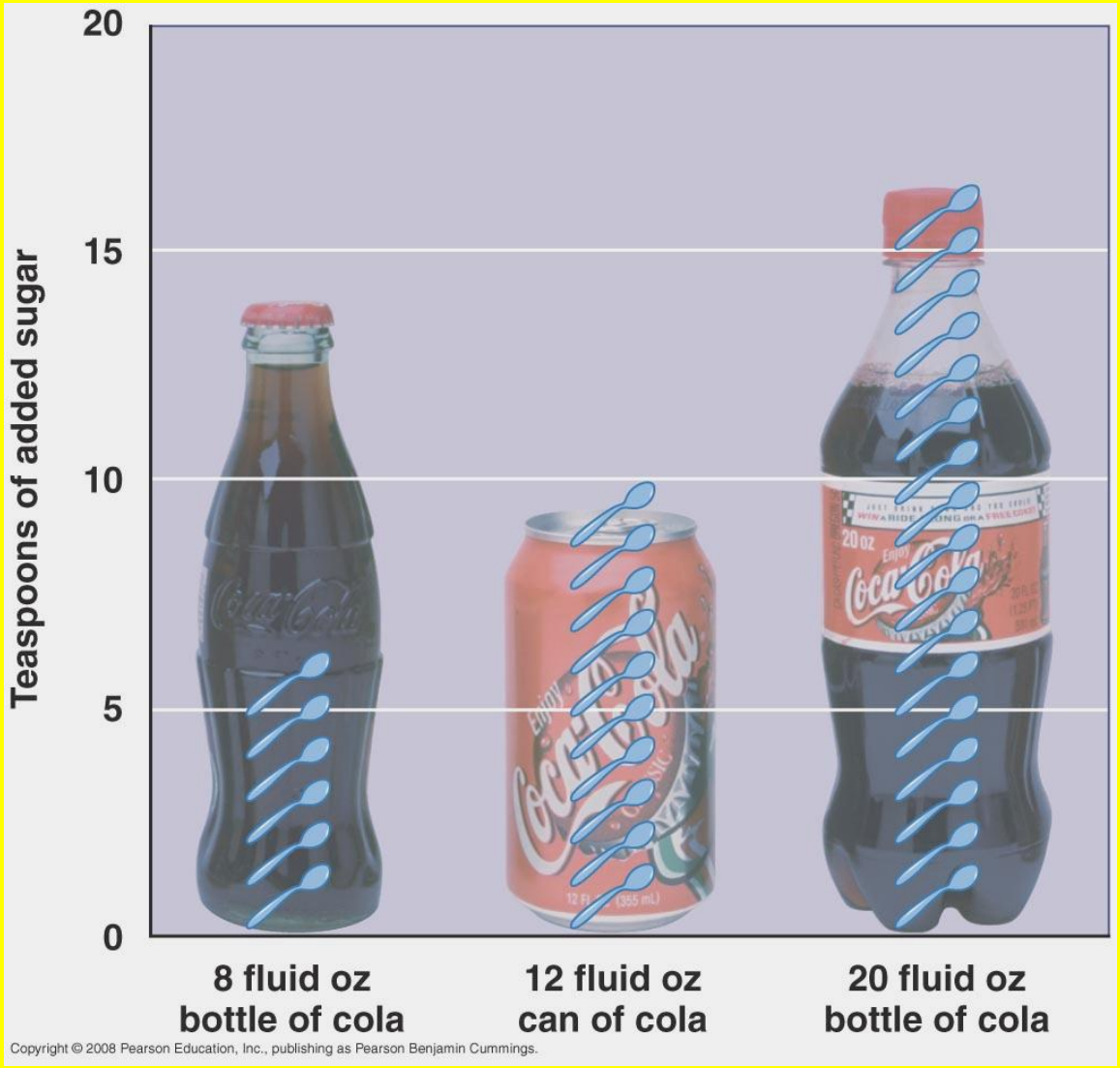
- Provide little/no calories
- Added to sugar-free, low-calorie, "light" foods
- Alternative to simple sugars
- Generally safe

Artificial Sweeteners

Sugar Substitutes

- Don't make food "healthy"
- Benefits: **diabetic**- control blood sugar & ↓ dental cavities
- Weight control? Maybe if part of weight control program
- **??** ↑ American obesity epidemic with ↑ sugar substitutes

Added sugars are everywhere



High Fructose Corn Syrup (HFCS)

Corn starch → processed → high fructose corn syrup

HFCS vs. Sugar (sucrose), both:

- **~ 50% glucose**
- **~ 50% fructose**
- Similar sweetness & taste

HFCS FDA approved **1983**

1983 ⟶ today ↑ HFCS

Today: "universal" calorie sweetener

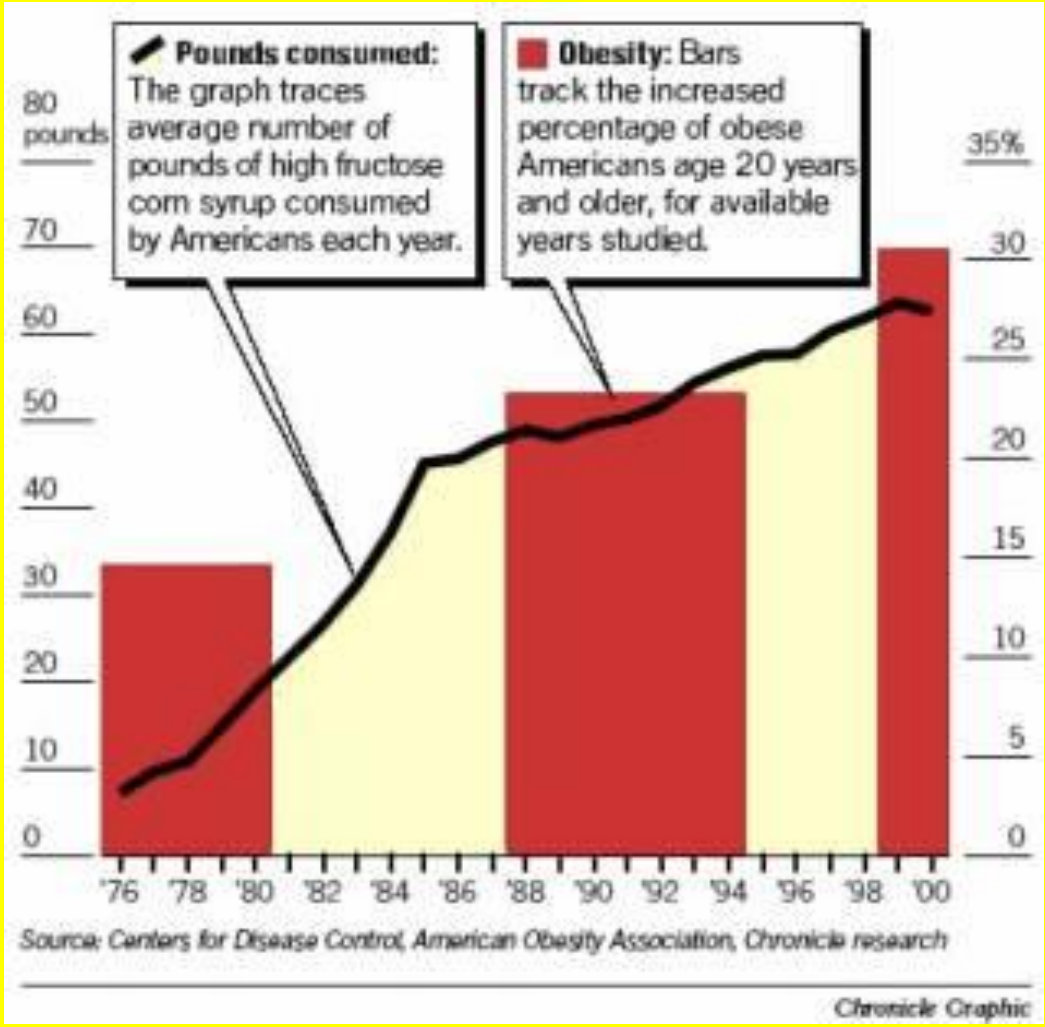
- **40%** of all sweeteners
- Found everywhere
- Average American: **132** calories/day from HFCS

High Fructose Corn Syrup (HFCS)

Why use it?

1. Safe
2. Cheaper than sugar
3. Liquid: easier to mix with drinks and food

1980's ↑ HFCS and ↑ Obesity



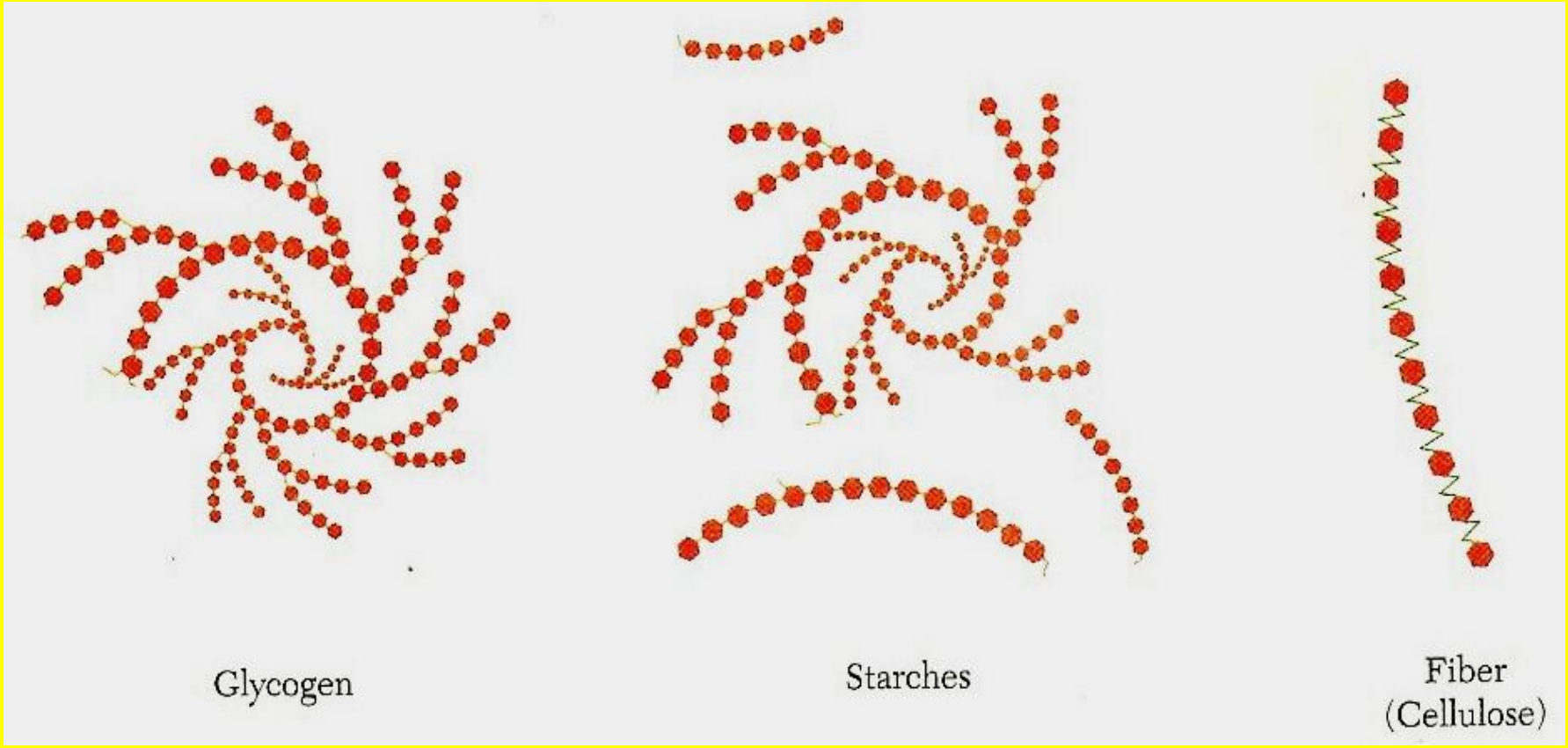
? Relationship: HFCS and Obesity

- Some studies: yes
- Other research: University of Maryland: HFCS **"not uniquely fattening"**
- More important: drinking **too** much sweetened soft drinks: ↑ obesity
- Regardless if HFCS or sugar used
- 1 12 ounce soft drink/day = "added" sugar allowance (USDA)

Complex Carbohydrates

Many glucose molecules linked: chemical bonds

Differ in structure (straight vs. branched) and type of chemical bonds


Glycogen
Starches
Fiber
(Cellulose)

Animals	Plants
Glycogen- stored glucose: liver, muscles	Starch-stored glucose & **Fibers**

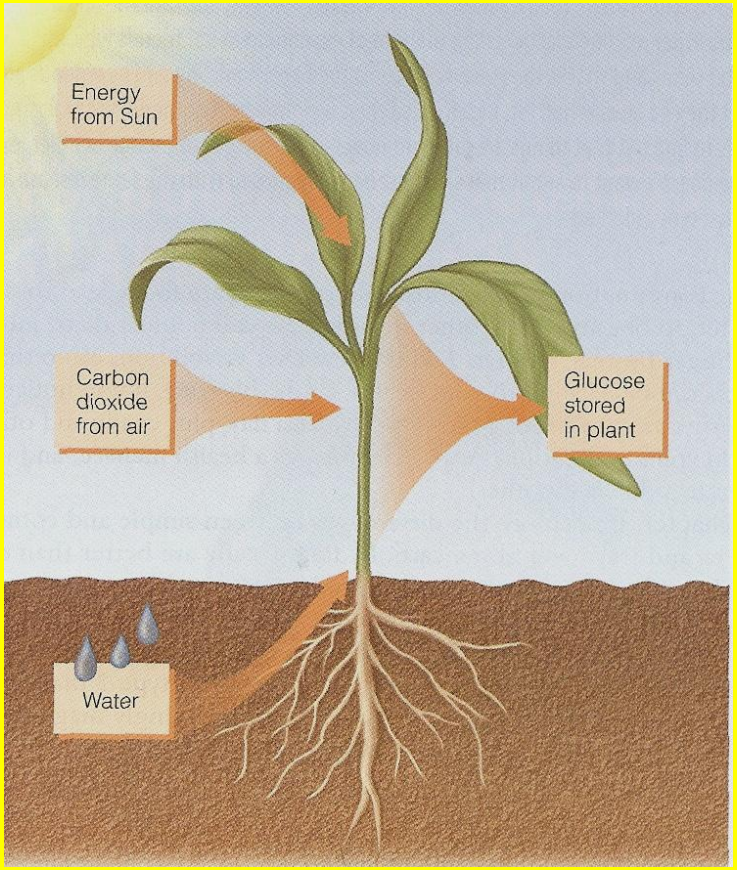
Glycogen

Branched glucose chains

Glycogen: broken down in animal slaughterhouse; not eaten in foods

Starch

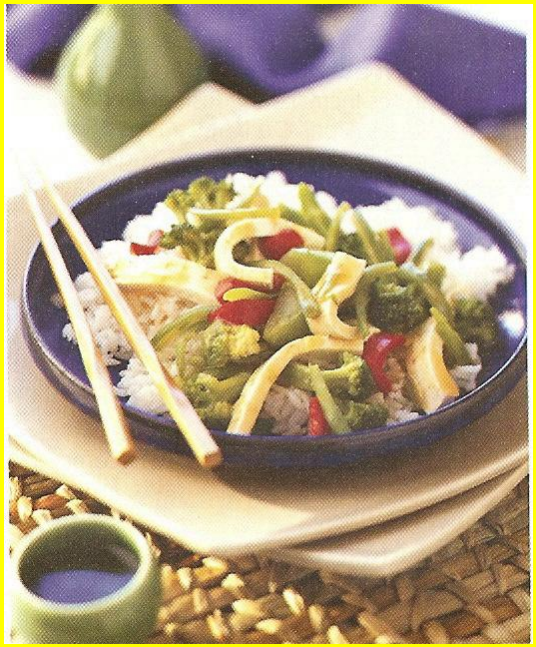
Found in: plant seeds, roots, stems, leaves



Starch examples

Corn, cereals, potatoes, sweet potatoes, apples, bananas, peas, beans wheat flour, rice, oats, peanuts, soybeans, breads

Major source of carbohydrate: American diet



starch A polysaccharide stored in plants; the storage form of glucose in plants.

Tubers, such as these sweet potatoes, are excellent food sources of starch.

Starch → **Glucose** → Glycogen

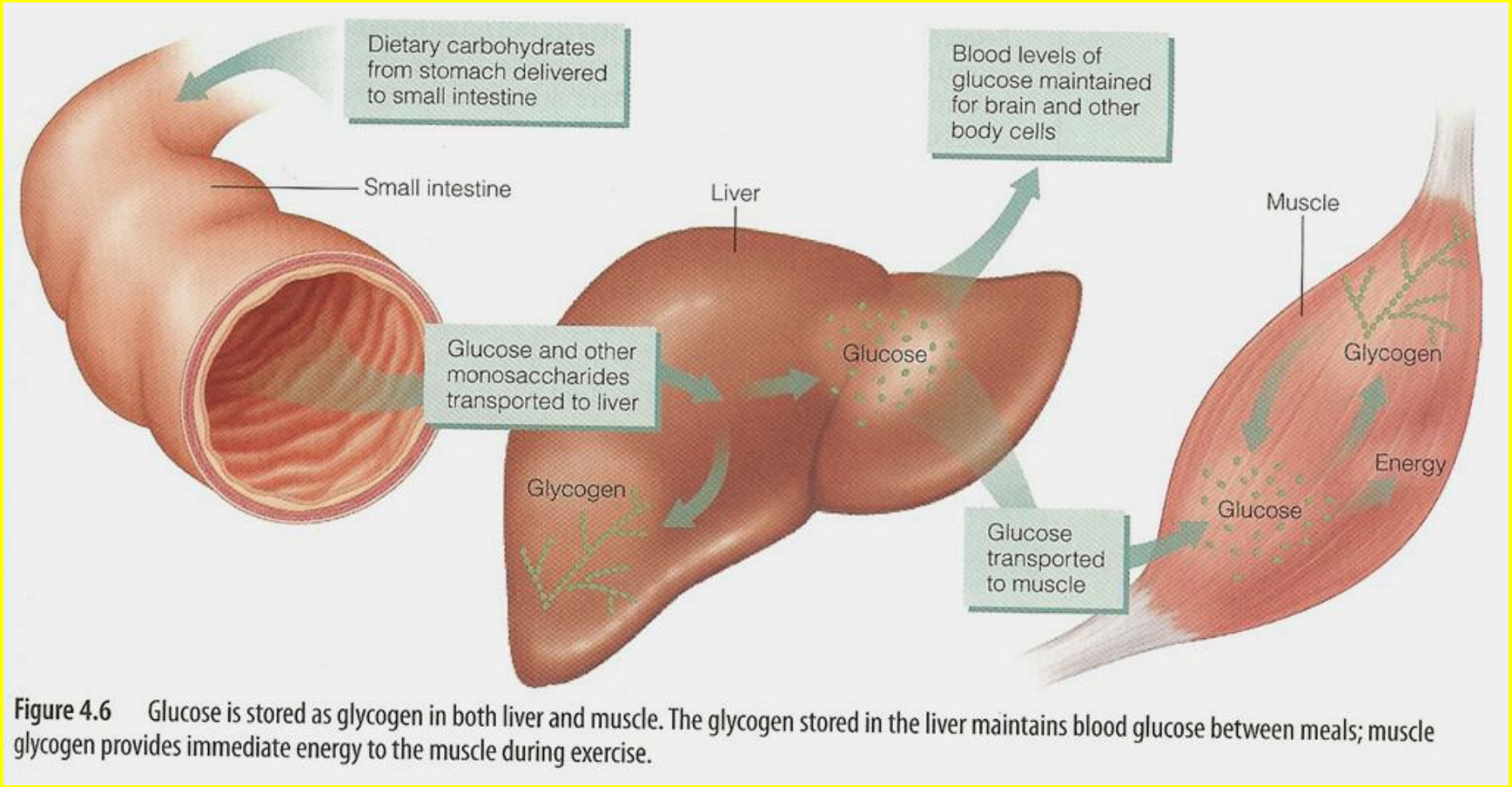
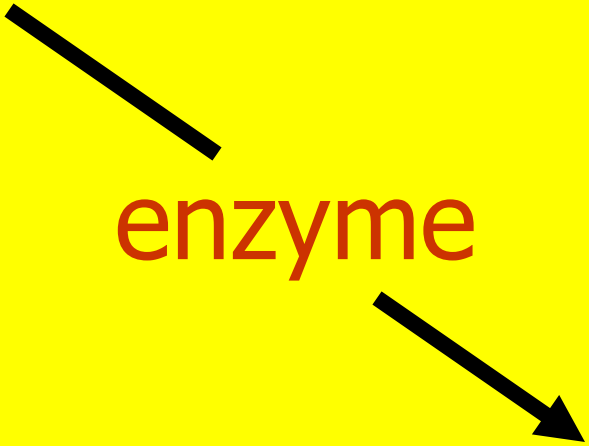


Figure 4.6 Glucose is stored as glycogen in both liver and muscle. The glycogen stored in the liver maintains blood glucose between meals; muscle glycogen provides immediate energy to the muscle during exercise.

Chewing Assignment

Bread (starch)



enzyme

maltose

(sweet)

Fiber(s)

- Mostly many glucose molecules
- Example: **cellulose-** plant cell walls
- Nondigestible carbohydrate
- Fiber breakdown: ~~human enzymes/chemical~~ bonds

Fibers

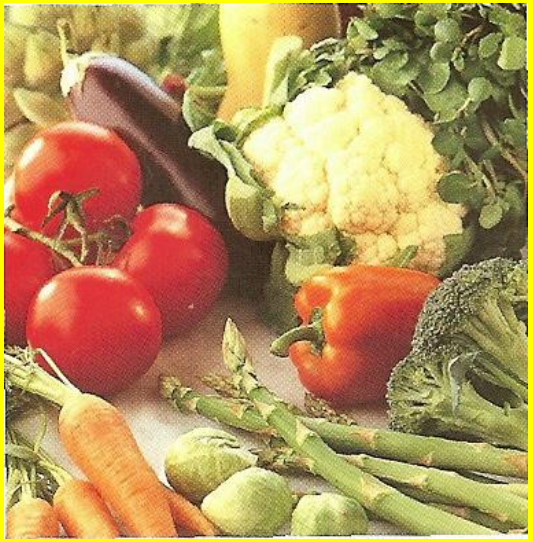
2 types

Soluble

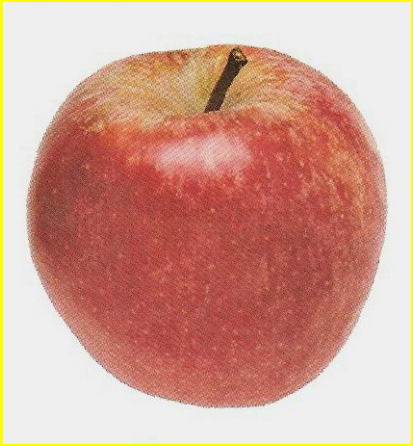
Insoluble

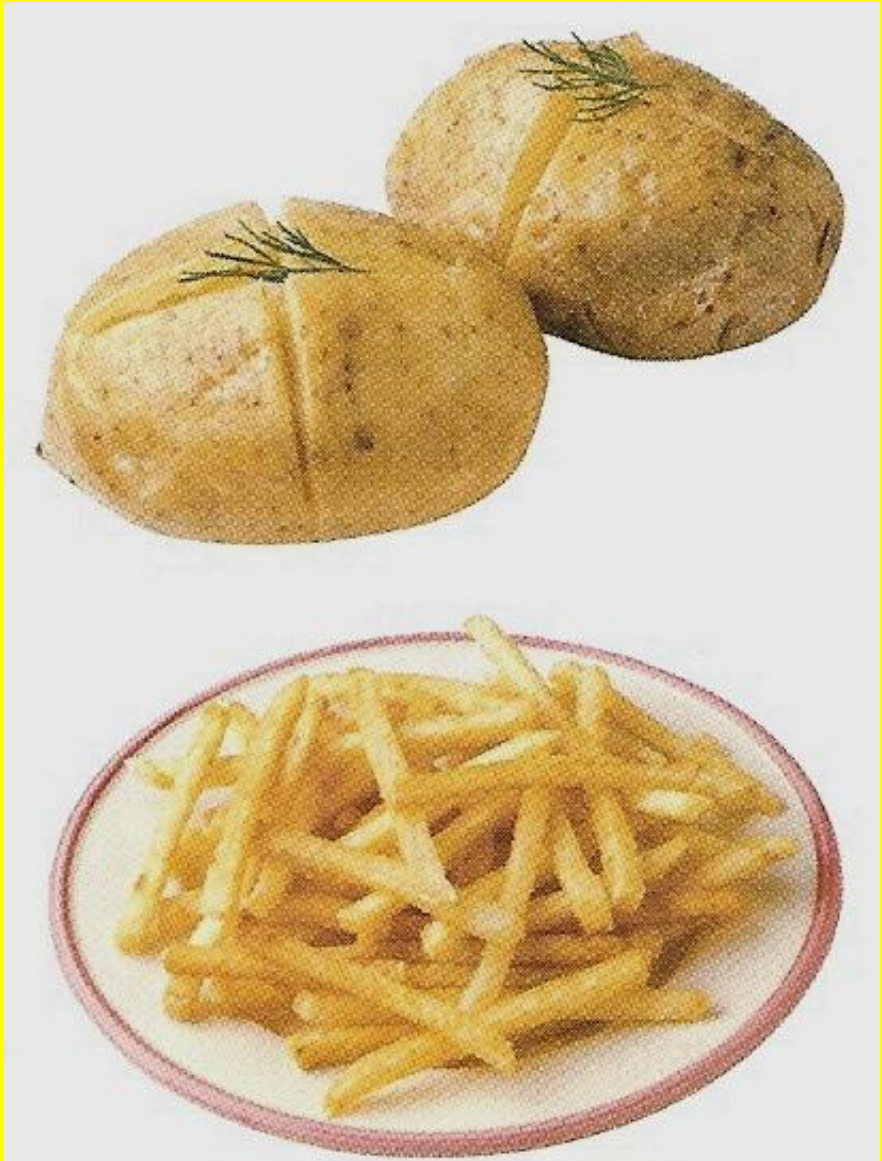
Most fiber rich foods: both types

Whole-grain foods provide more nutrients and fiber than foods made with enriched flour.



Brown rice is a good food source of dietary fiber.





A baked potato has three times as much fiber as a serving of French fries.

Soluble Fiber

- Holds (dissolves in) **H_2O**
- Forms **gel-like mass** in intestine
- ↑ **Weight of feces**
- Partially digested bacteria

gas fatty acids (absorbed)

Soluble Fiber Examples

- **Apples (pectin) (Kaopectate)**
- **Grains (oats, barley, rye)**
- **Fruits**
- **Vegetables**
- **Oatmeal**
- **Legumes (peas, chickpeas, beans, lima beans, soybeans, peanuts, lentils)**

Fiber Supplements

Psyllium (vegetable fiber):
Metamucil, psyllium enriched cereals & breads

Stool softeners/bulk formers

Help with constipation & diarrhea

Insoluble Fiber

- Doesn't dissolve in H_2O
- Not digested by intestinal bacteria
- Adds **bulk** to feces
- Not changed during passage through intestine

Insoluble Fiber Examples

- Wheat, rye bran (covering-seed)
- Brown rice
- Whole wheat breads & cereals
- Seeds
- Legumes
- Skins of fruits and vegetables
- Broccoli
- Celery

Why should you eat fiber?

Soluble Fiber

- Slows breakdown starch → glucose
- Slows absorption glucose
- Slows increase in blood glucose
- Binds to cholesterol in feces
- Lowers blood cholesterol
- Promotes **fullness, reduces hunger feelings**

Why should you eat fiber?

Insoluble Fiber

- Keeps GI tract **clean/healthy**
- **Exercises** your **colon** muscles
- Regular/easier **bowel movements**
- **Softer stools**: ↑ H_2O absorption (soluble) + bulk (insoluble)
- Prevents: constipation, hemorrhoids, diverticulitis
- Stimulates **peristalsis**
- ↓ **Transit time**

Transit Time and Fiber

African Countries		U.S.
	Fiber/day	
40-150	(grams)	**15**
	Transit time	
	(hours)	
36 or less		up to **96**

Constipation

- Common in U.S./Western countries
- Infrequent/difficult passage stools
- Fiber-rich diet: normal **laxation** (bowel movements)
- Children: **10% chronic constipation; 20%- adults**

Think about these issues: friends & family

How to help with this problem:

Whole grain foods, fruits, vegetables

Adequate fluids

Fiber and Fluid

↑ Fiber need ↑ Fluid

Without fluid **(H_2O):** stools hard/difficult bowel movements

Adding fiber to your diet

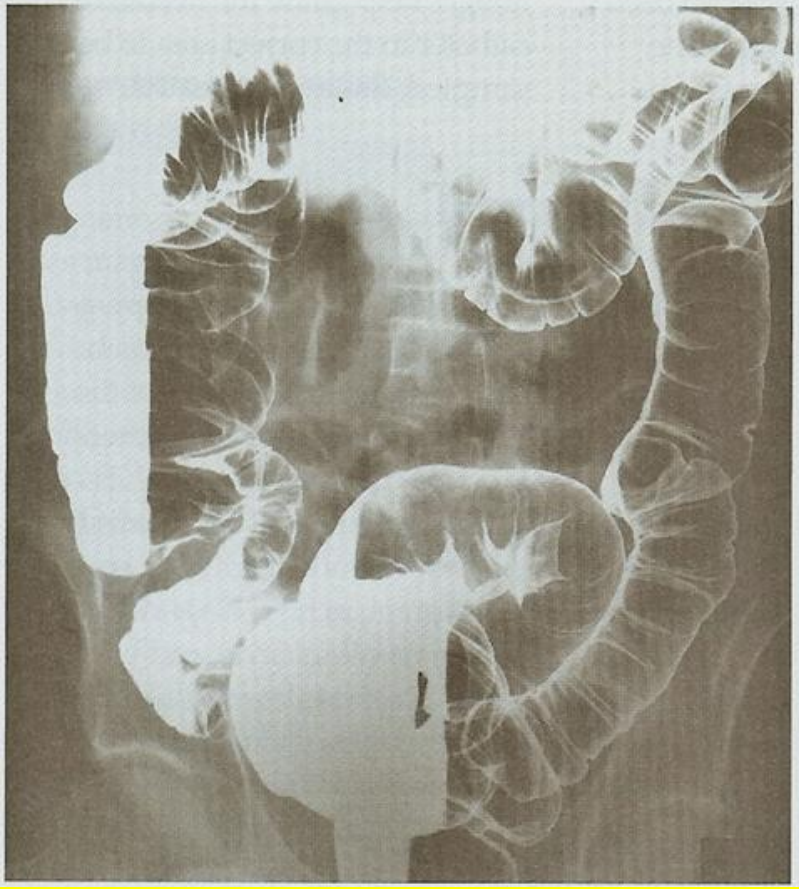
Sudden ↑ fiber in diet

- **Gas**
- **Diarrhea**

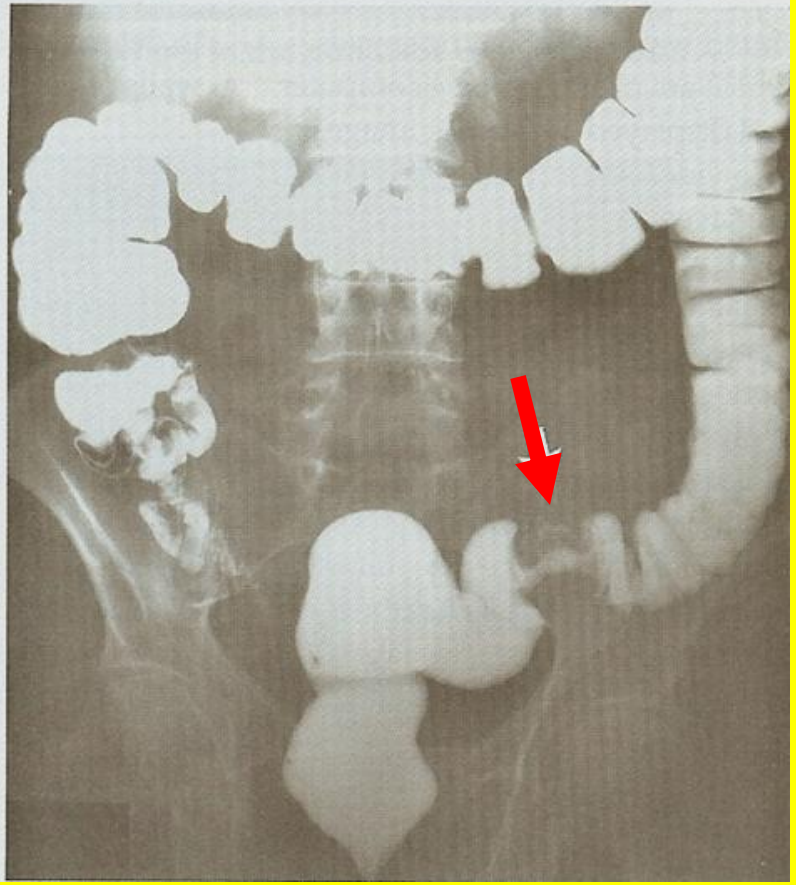
Therefore: ↑ fiber in diet gradually & drink enough **fluid**

Fiber and Colon Cancer?

Normal Colon



Colon Cancer (see arrow)



Fiber and Colon Cancer?

Fiber ↓ contact: intestine cells & carcinogens due to ↑ feces bulk

Population studies ↑ fiber ↓ colon cancer

Intervention studies: no benefit

? Amount of fiber ? Study duration

Test for Fecal Blood Screening

Directions:

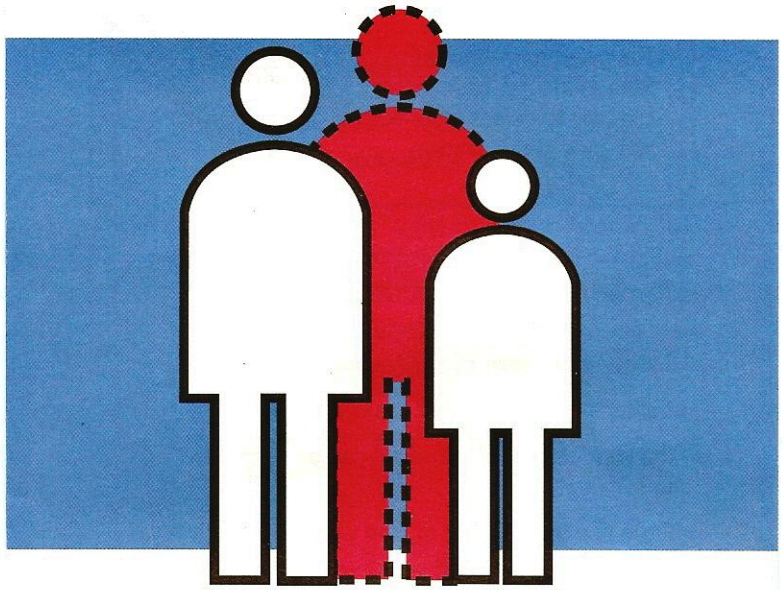
2 days before test:

↓ Red meat ↓ Aspirin

↑ Vegetables, fruits, bran cereals, high fiber foods WHY?

Colorectal Cancer

is **90% CURABLE** when caught early,
but **ONLY 8%** when detected late.



Control your health. GET TESTED.

Screening Saves LIVES

Hemoccult BRAND **SENSA**

ColoScreen

A test for fecal occult blood

Name: _____ Age: ___

Street: _____

City: _____

State: _____ Zip: _____

Phone No.: _____

Date of collection: _____

Helena Laboratories
Beaumont, Texas 77704-0752

A	B

1. Collect small stool specimen on applicator. Apply thin smear in **box A.**
2. Reuse applicator to obtain another sample from a different part of the stool. Apply thin smear in **box B.**
3. Close cover. Place slide away from heat and light. **Return slide to physician.**

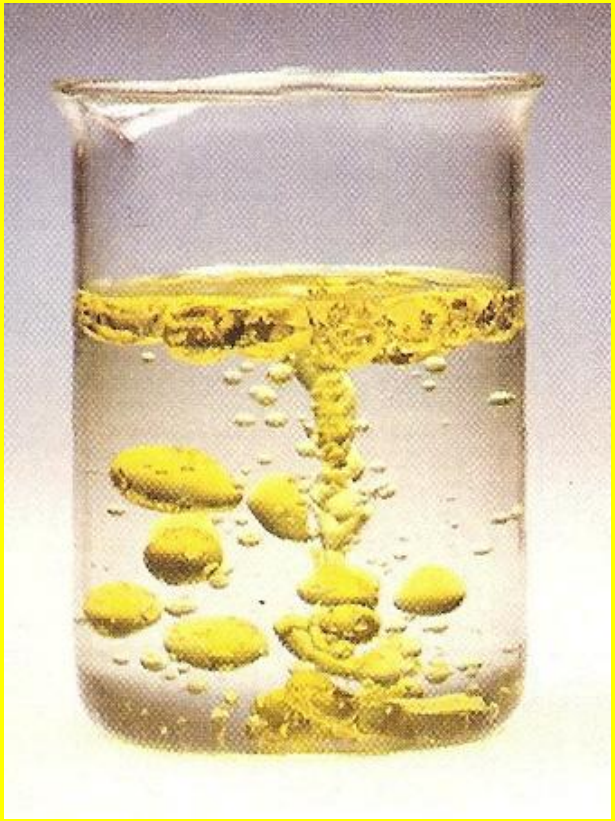
FATS

Fats = Lipids

- Organic compounds- mostly carbon
- Found in animals & plants
- Don't dissolve well in H_2O
- Dissolve in organic solvents: ether, chloroform, toluene, methanol

Assignment

Oil and Water



Fats = Lipids

- Solids: butter, lard
- Semi-solids: margarine (tub)
- Liquids: vegetable oils

Some fats, such as olive oil, are liquid at room temperature.

Types of Fat

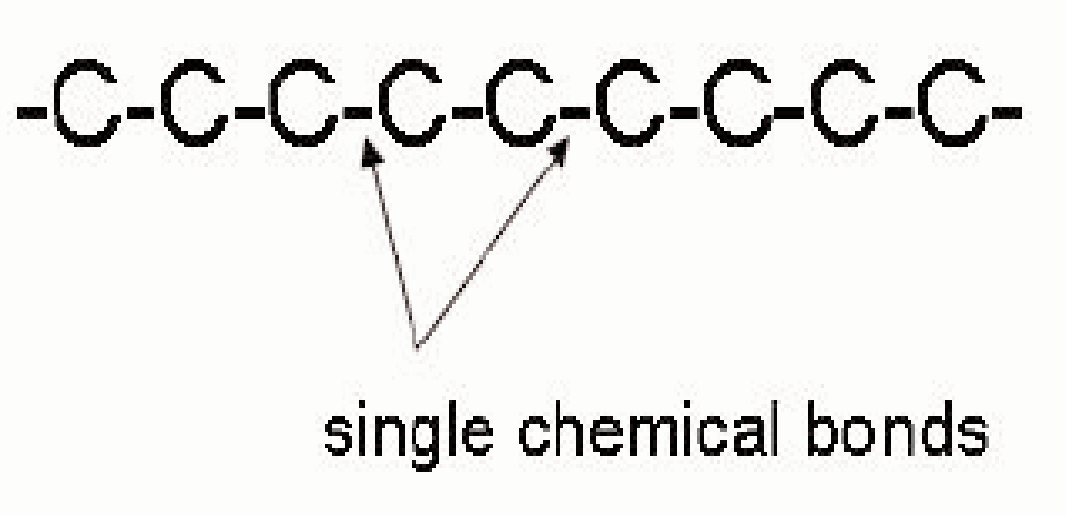
1. **Fatty acids**: long chain of carbon atoms held together by chemical bonds

   3 types: A) **saturated**

   B) **monounsaturated**

   C) **polyunsaturated**

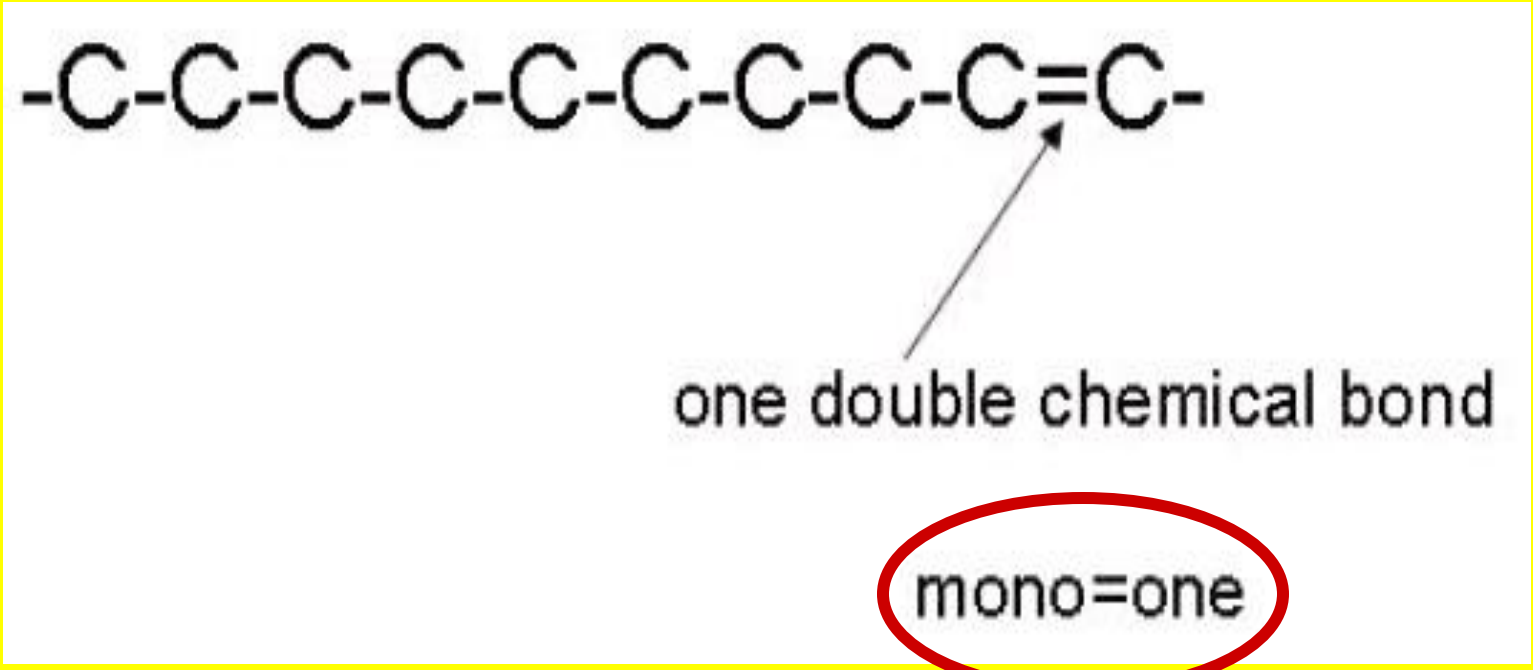
Saturated Fatty Acid



Saturated Fat

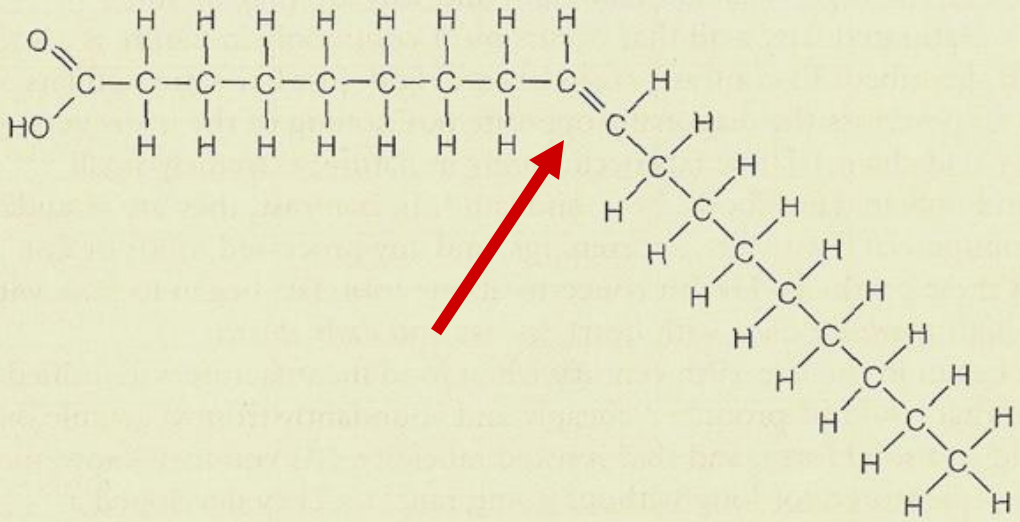
- Found in: meats, whole milk, cheese, ice cream, prepared foods
- ↓ **Plants** except ↑ **palm/coconut oils**
- Chains packed together **tightly**
- **Solid** at room temperature

Monounsaturated fatty acid



- Double bonds → **bends** (kinks) in carbon chains
- Pack together loosely
- Liquid at room temperature
- Found in: canola, olive, peanuts oils, some safflower and sunflower oils, nuts

Monounsaturated fatty acids

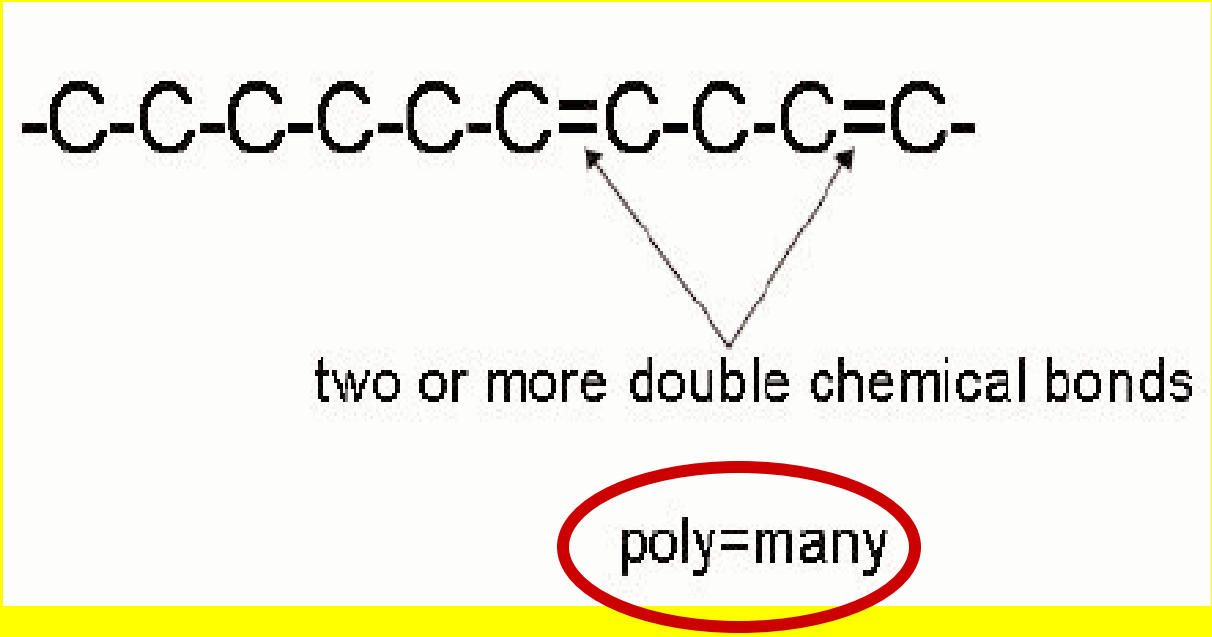


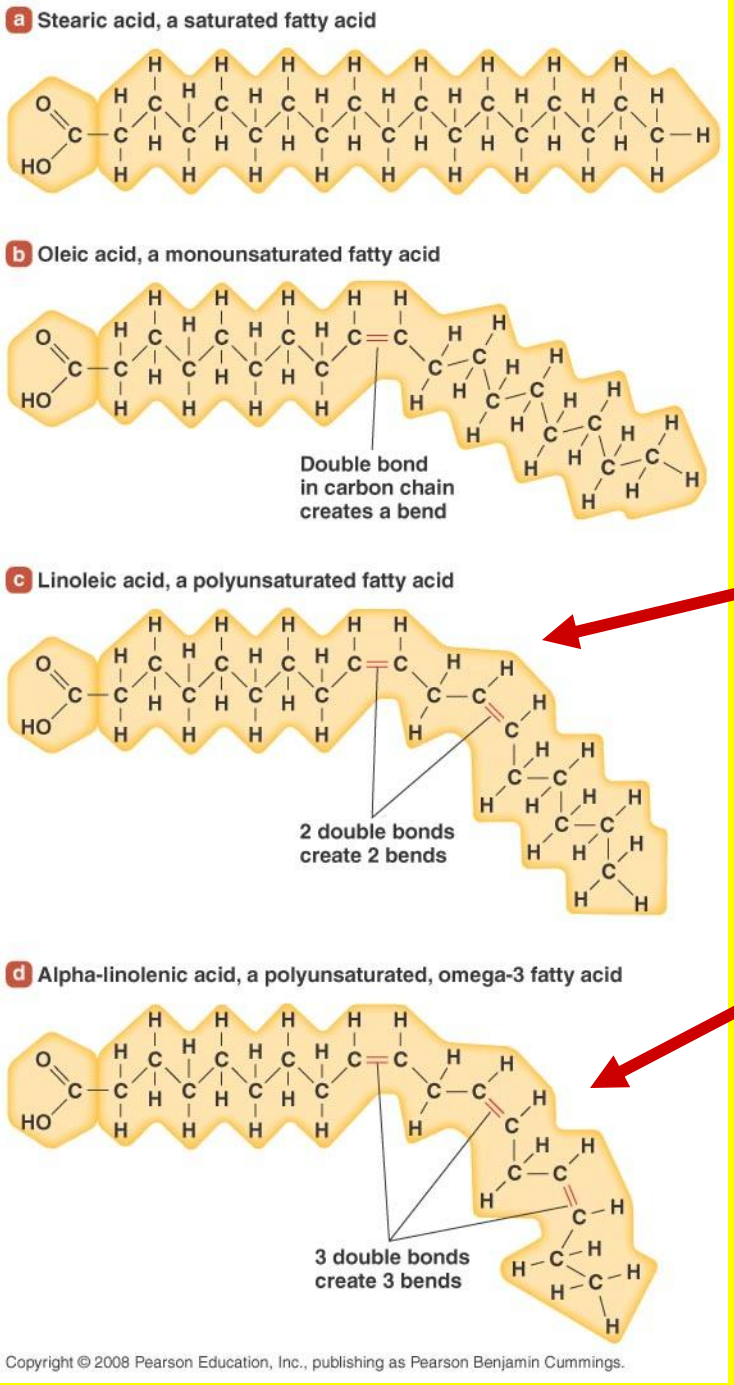
(c)

Monounsaturated and polyunsaturated fatty acids do not stack well together because they are bent. These fatty acids are liquid at room temperature.

(d)

Polyunsaturated fatty acid





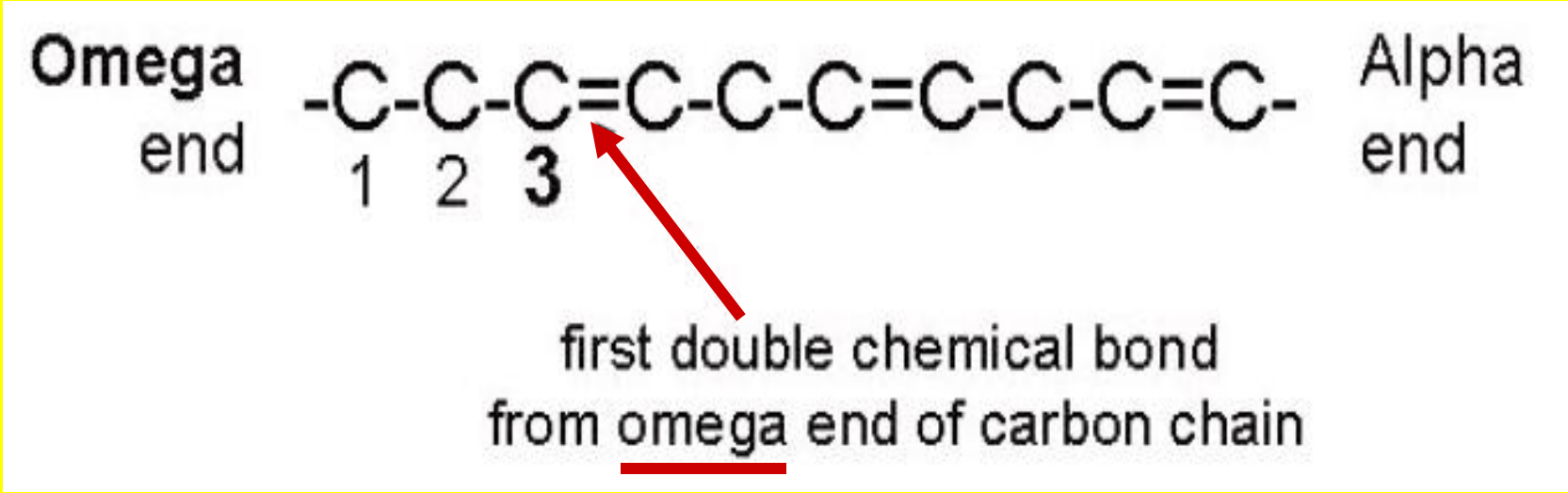
Double Bond Bends

Polyunsaturated Fatty Acid

- Also **liquid** at room temperature

- Found in: vegetable oils (soybean, corn, safflower, sunflower) and margarines (liquid, tub)

Omega 3 fatty acids

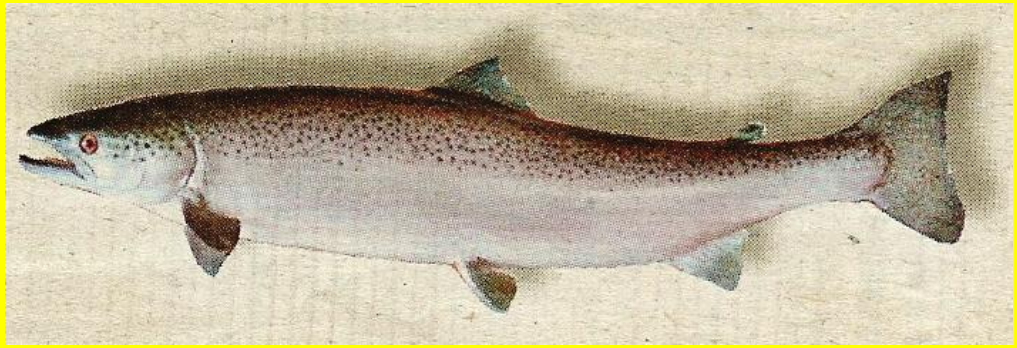


Omega 3 fatty acids

- Special type of polyunsaturated fatty acid
- Important: cell membranes of retina & nervous system; normal brain development in infants
- Found: vegetable oils (soybean, canola), nuts (walnuts), seeds (flaxseed), fish (salmon, tuna, trout), shellfish

Omega 3 fatty acids

Shrimp are high in omega-3 fatty acid content.



Omega 3 capsules

Essential Fatty Acids

- Most fatty acids: you make from starting materials in cells
- Essential fatty acids: special type of **polyunsaturated fatty acid**
- You **can't** make them
- Must consume in diet
- **"Essential"**

Not enough: Essential fatty acid deficiency

- Dry scaly skin
- Liver problems
- ↓ Fertility
- Poor **wound** healing
- **Children**: poor growth, abnormal development of brain and nervous system

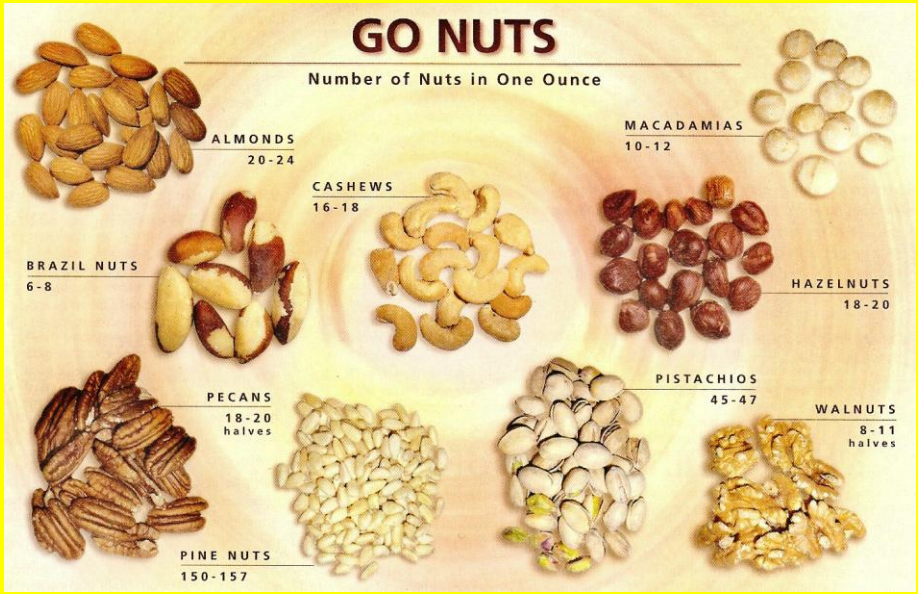
"Essential" Fatty Acids

(a)

(b)

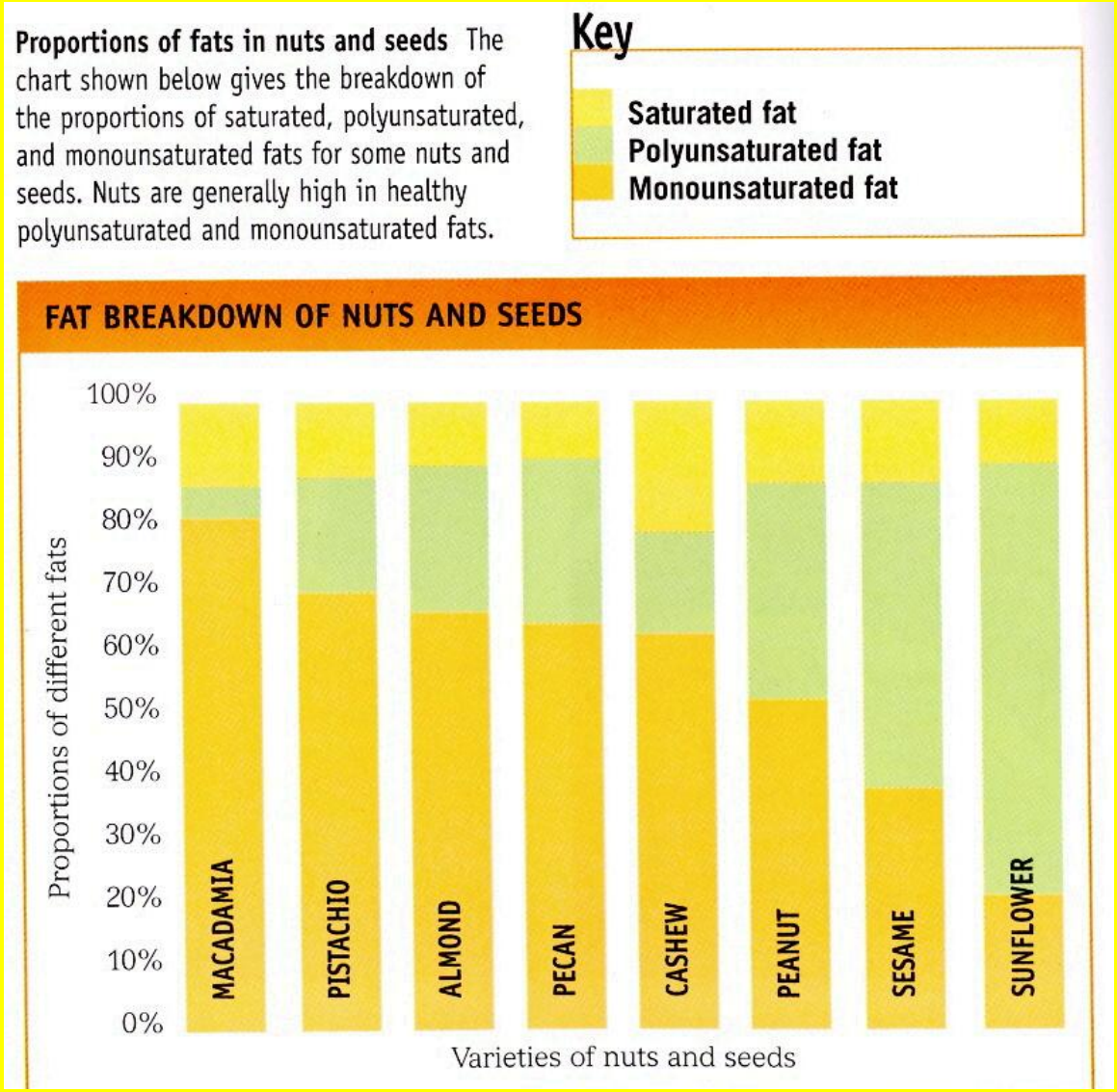
Figure 4.6 Sources of the two essential fatty acids: (a) sources of linoleic acid (omega-6 fatty acid) and (b) sources of alpha-linolenic acid (omega-3 fatty acid).

Soybean oil, corn, safflower, canola oils, walnuts, flaxseed



Nuts: Mono's and Poly's

Proportions of fats in nuts and seeds The chart shown below gives the breakdown of the proportions of saturated, polyunsaturated, and monounsaturated fats for some nuts and seeds. Nuts are generally high in healthy polyunsaturated and monounsaturated fats.

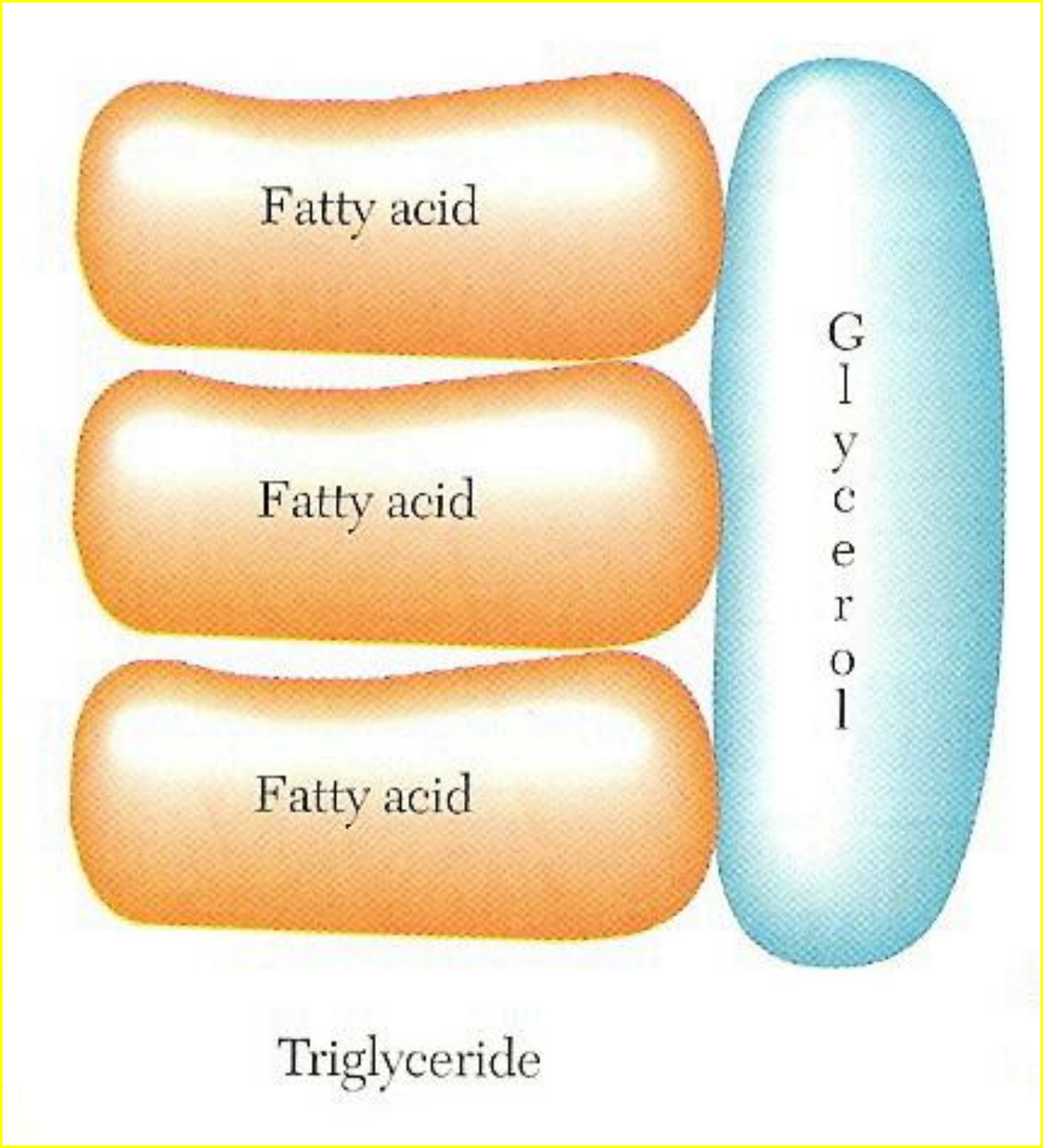


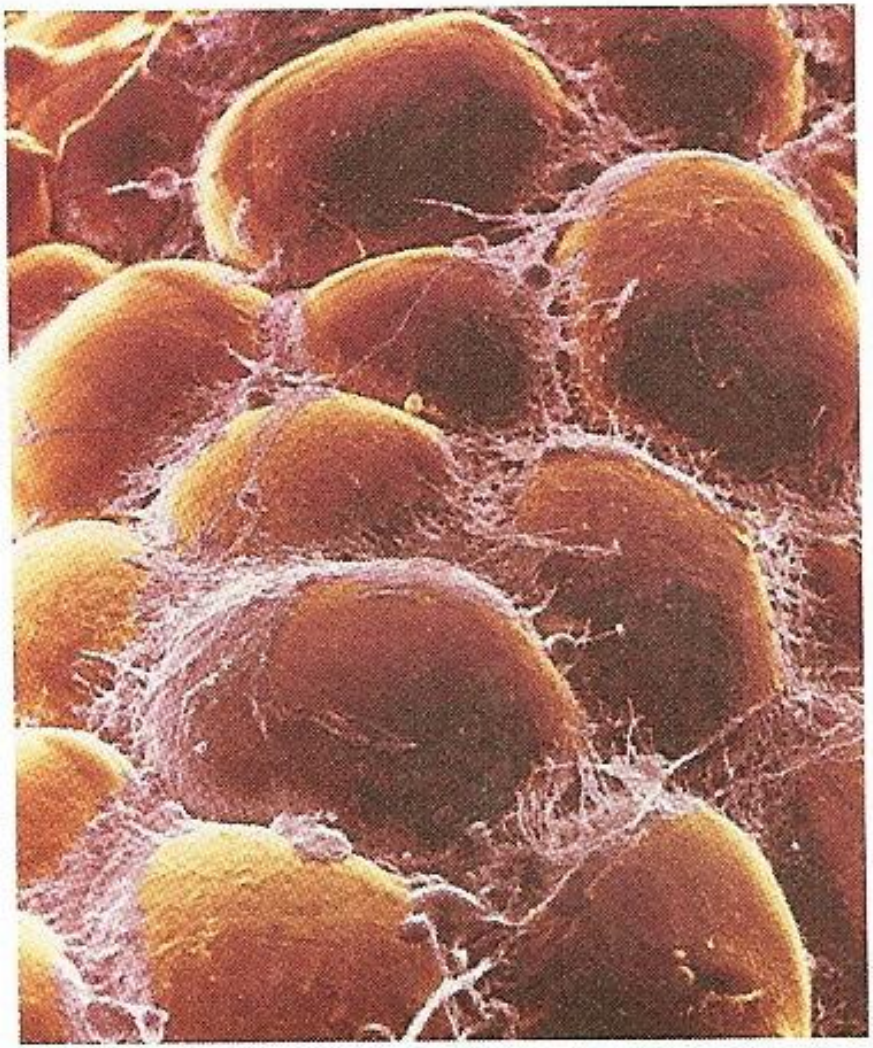
Types of Fat

2) Triglyceride

Most of **fat** in your **foods**

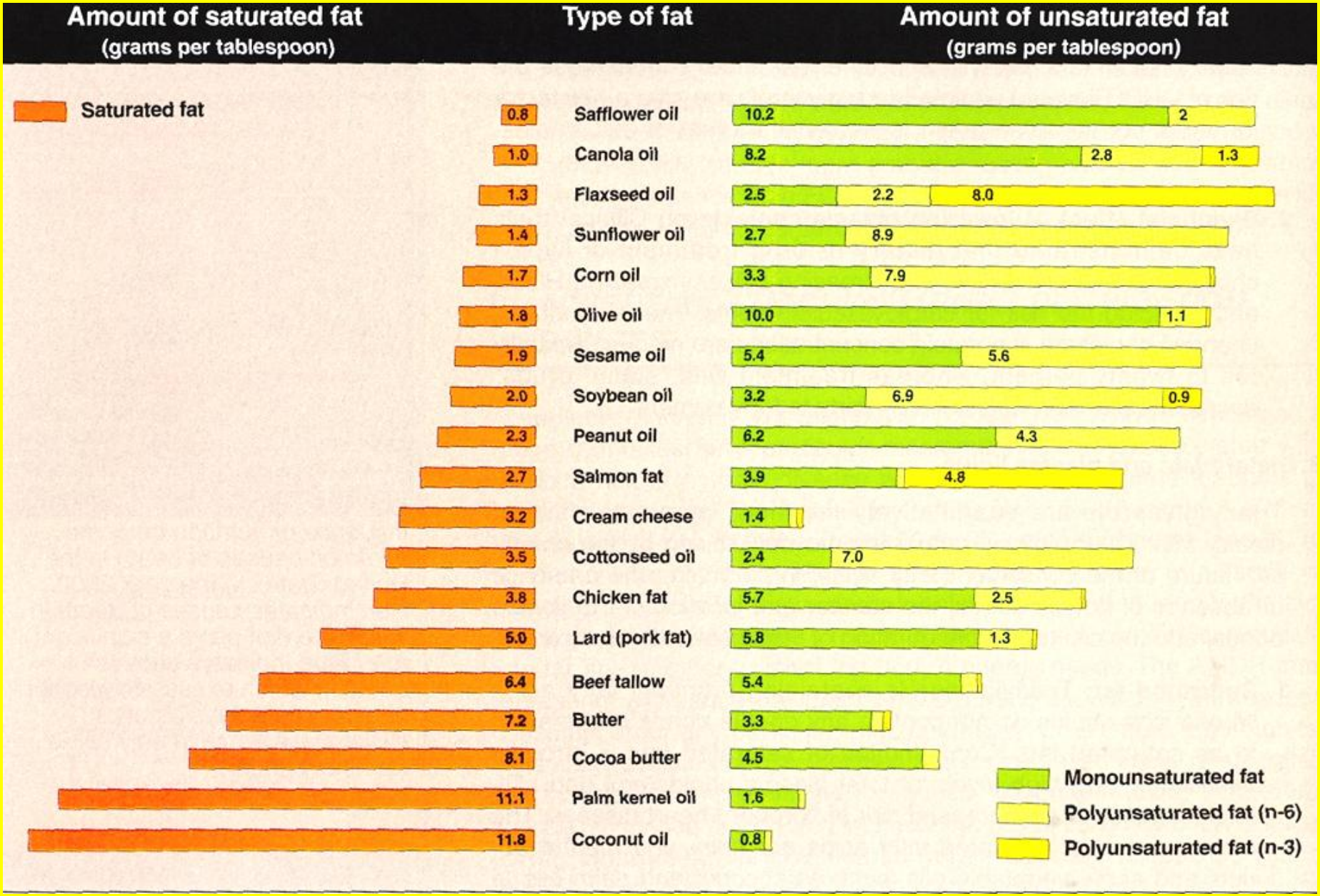
Major fat stored in fat **(adipose)** & muscle tissue


Fatty acid
Fatty acid
Fatty acid
Glycerol
Triglyceride



Adipose tissue. During times of weight gain, excess fat consumed in the diet is stored in the adipose tissue.

You Are What You Eat


Amount of saturated fat
(grams per tablespoon)
Type of fat
Amount of unsaturated fat
(grams per tablespoon)
Saturated fat
0.8 Safflower oil 10.2 2
1.0 Canola oil 8.2 2.8 1.3
1.3 Flaxseed oil 2.5 2.2 8.0
1.4 Sunflower oil 2.7 8.9
1.7 Corn oil 3.3 7.9
1.8 Olive oil 10.0 1.1
1.9 Sesame oil 5.4 5.6
2.0 Soybean oil 3.2 6.9 0.9
2.3 Peanut oil 6.2 4.3
2.7 Salmon fat 3.9 4.8
3.2 Cream cheese 1.4
3.5 Cottonseed oil 2.4 7.0
3.8 Chicken fat 5.7 2.5
5.0 Lard (pork fat) 5.8 1.3
6.4 Beef tallow 5.4
7.2 Butter 3.3
8.1 Cocoa butter 4.5
11.1 Palm kernel oil 1.6
11.8 Coconut oil 0.8
Monounsaturated fat
Polyunsaturated fat (n-6)
Polyunsaturated fat (n-3)

8g Poly

4g Mono

2g Poly

10g Mono

Types of Fat

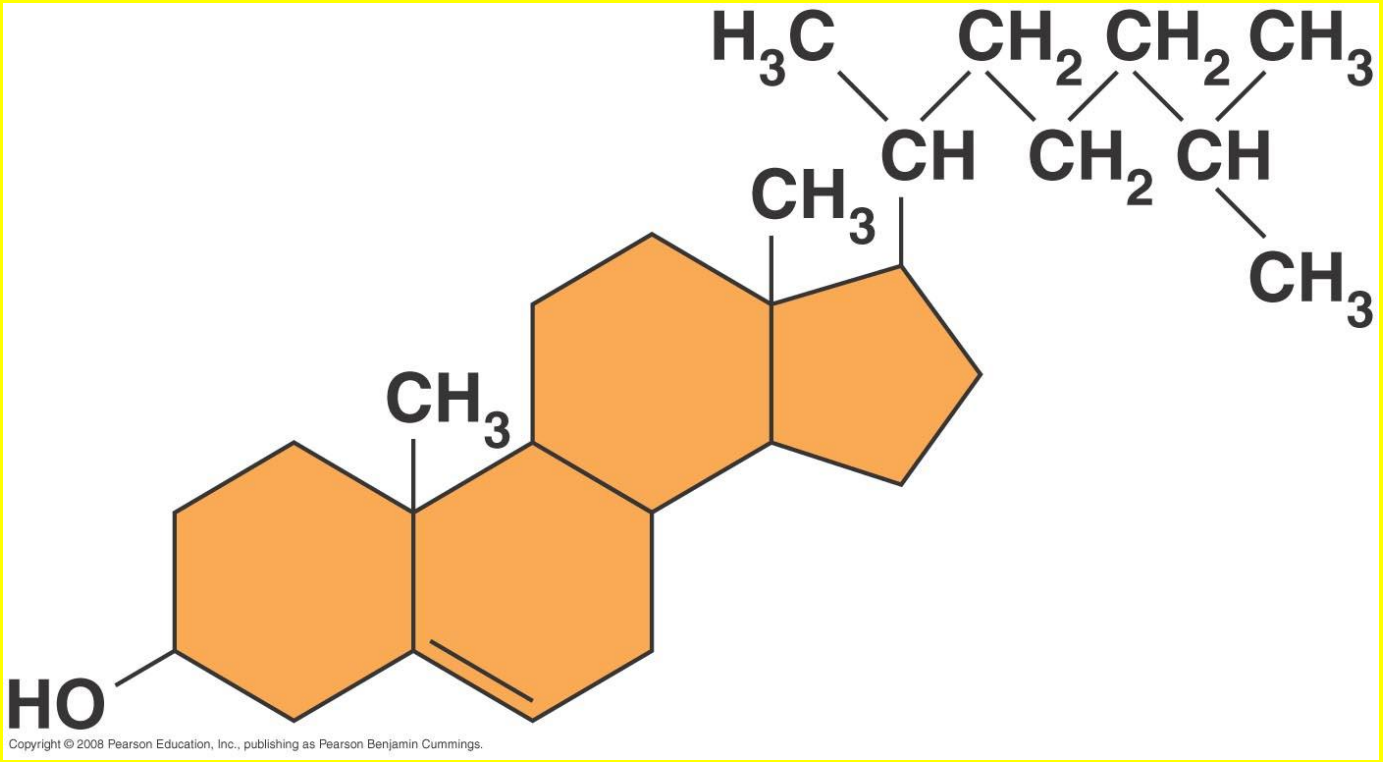
3) **Sterols**

4 Interconnected rings

"chicken wire"

Cholesterol: 1 type of sterol

Important: cell membranes, steroid and bile acid synthesis



Sterols: Examples

- **Plants: Phytosterols-** help lower your blood cholesterol

- **Animals: Cholesterol**

  Made in your liver (2/3's)

  Don't need to eat in foods

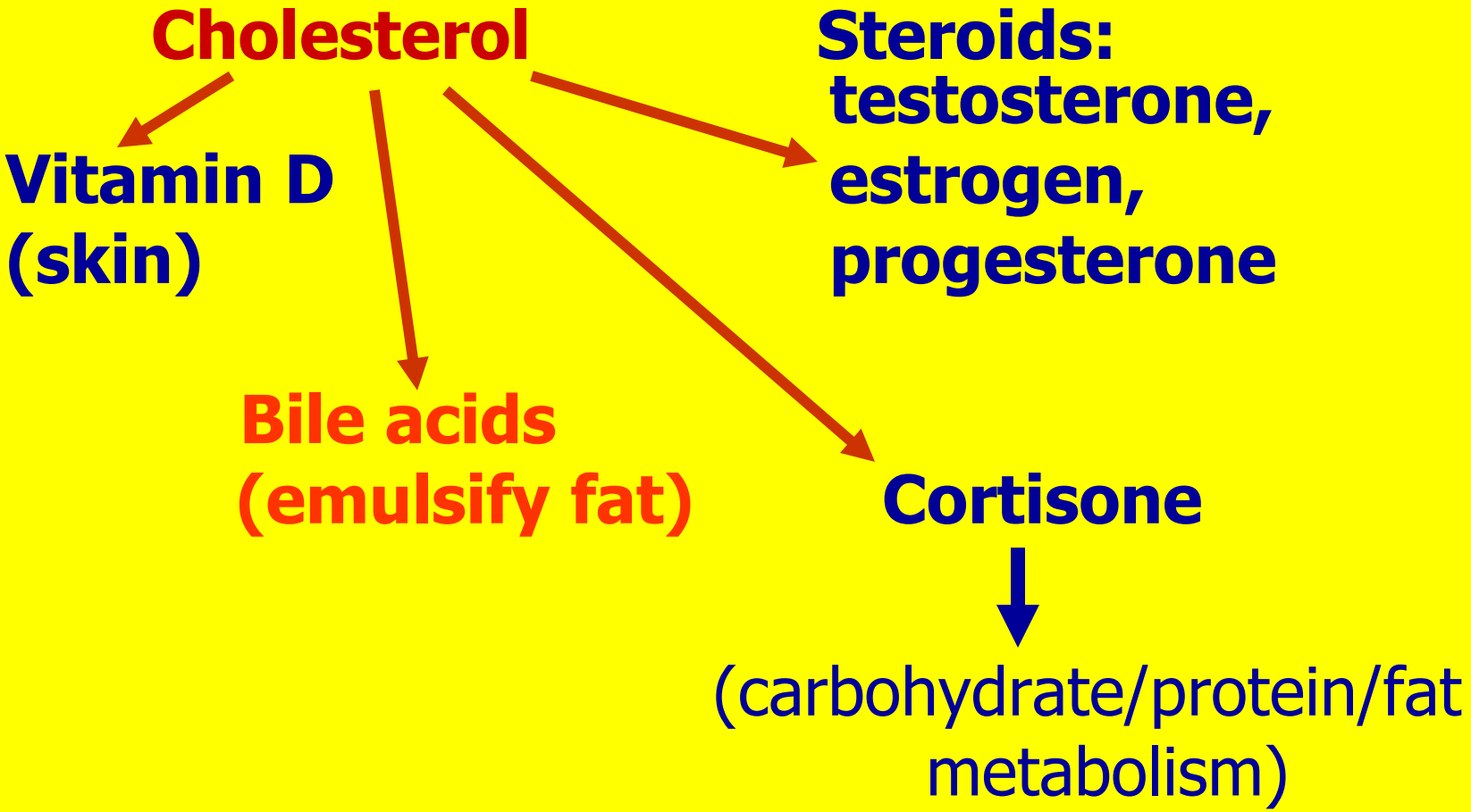
  ↑ egg yolk, liver, kidney, some prepared foods

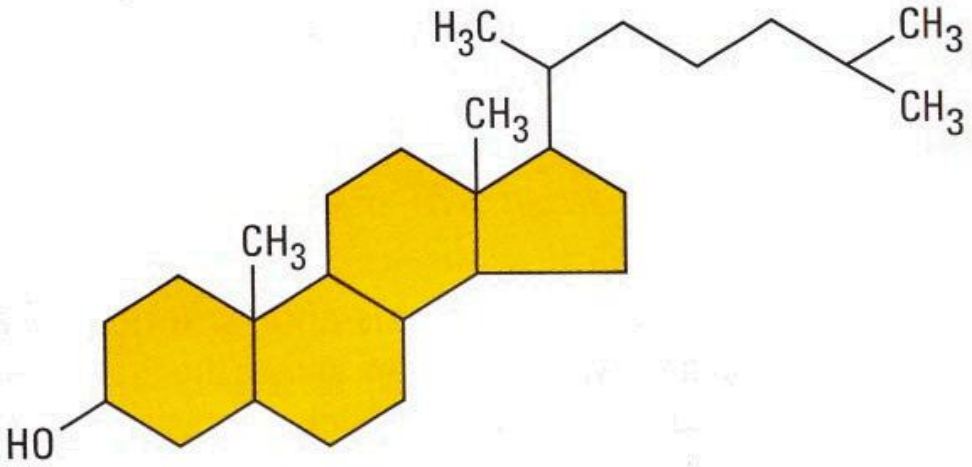
  ↓ fish

No cholesterol in plants

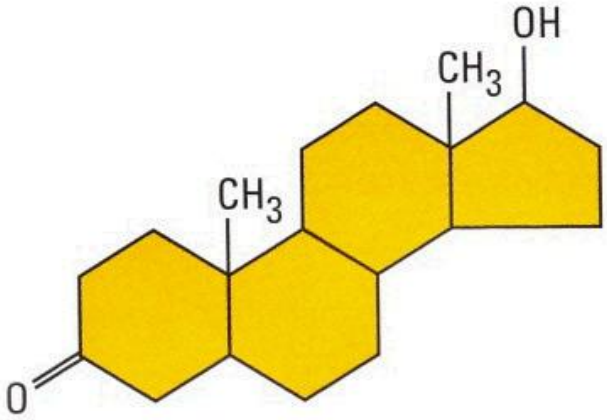
Cholesterol

- Most cholesterol: your cell membranes, coating nerve cells **(nerve impulses)**

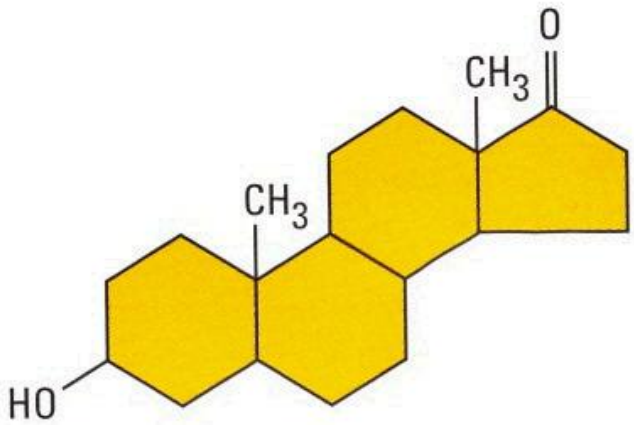




Cholesterol

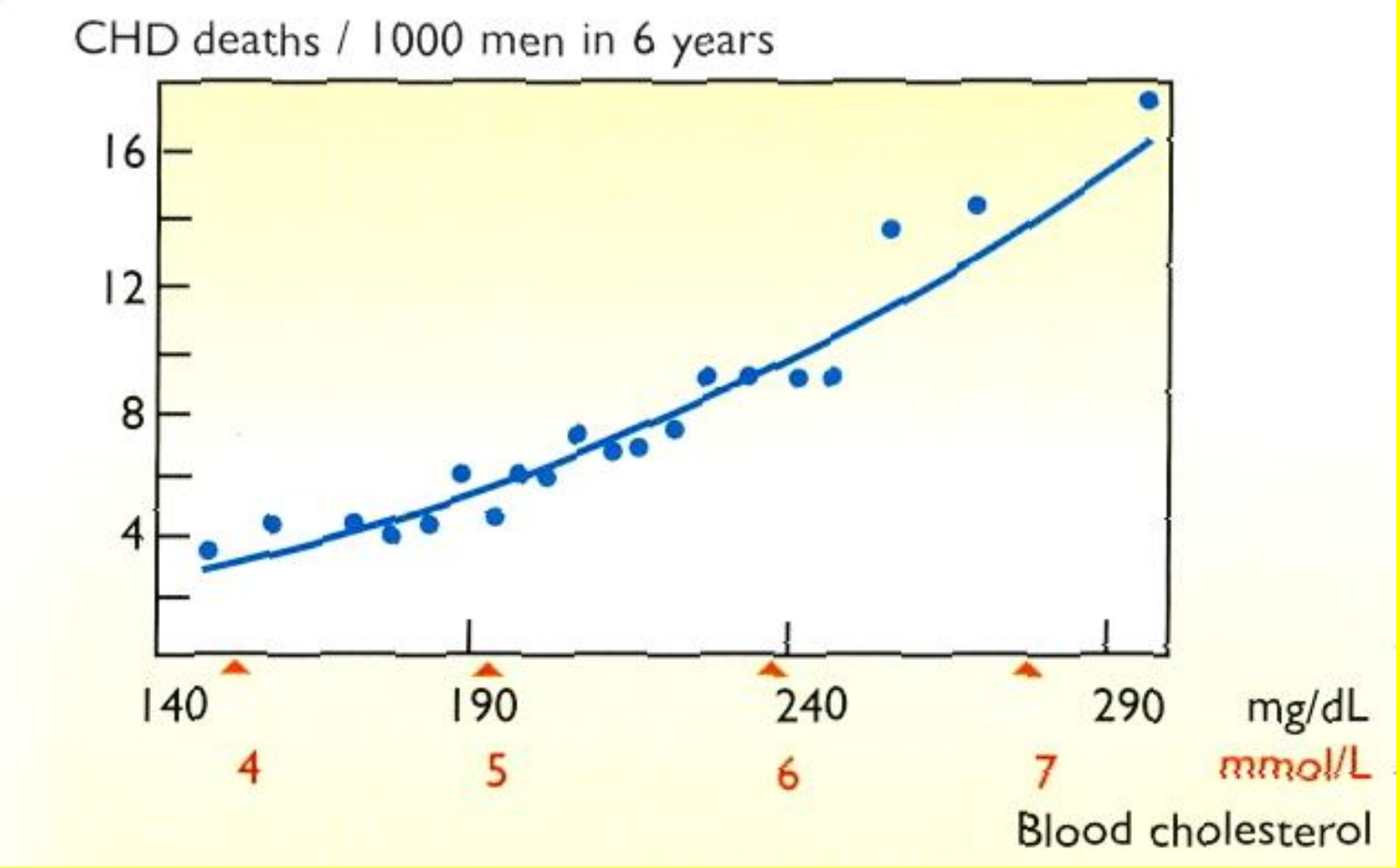


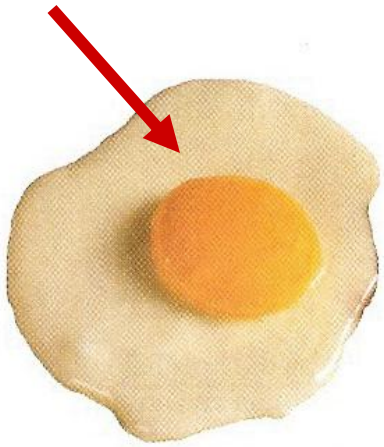
Testosterone



A type of estrogen

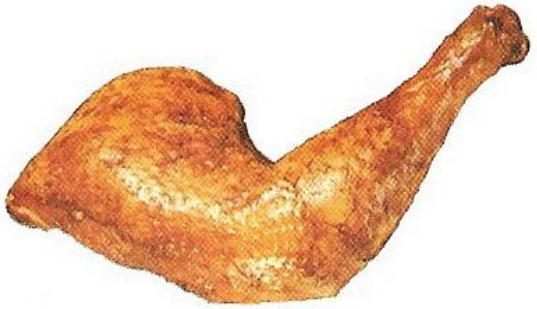
Blood Cholesterol & Heart Disease Risk



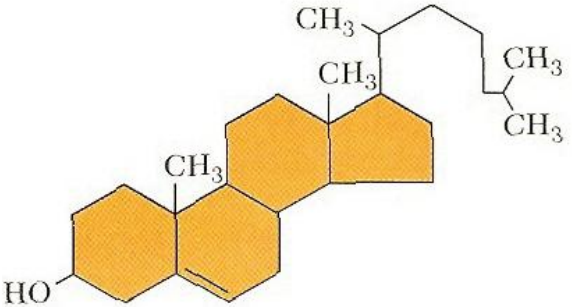


212 mg cholesterol

0 mg cholesterol



138 mg cholesterol



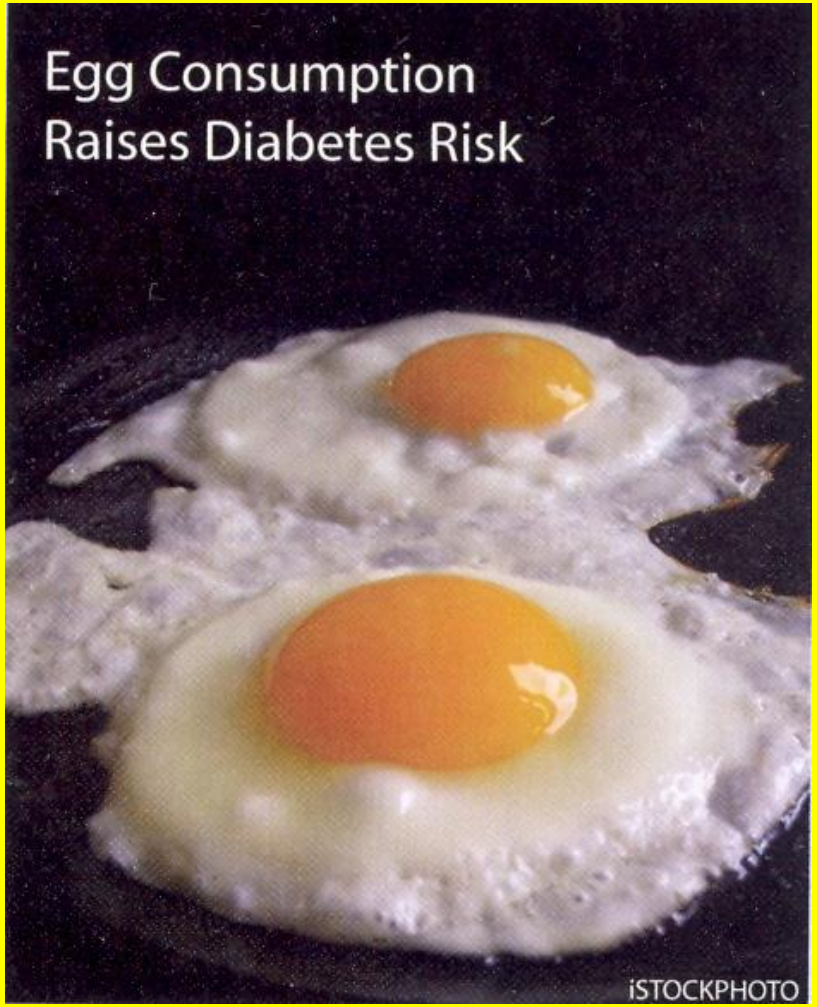
Cholesterol

0 mg cholesterol

130 mg cholesterol

33 mg cholesterol

2009 study: eating eggs daily ↑ risk: Type 2 diabetes

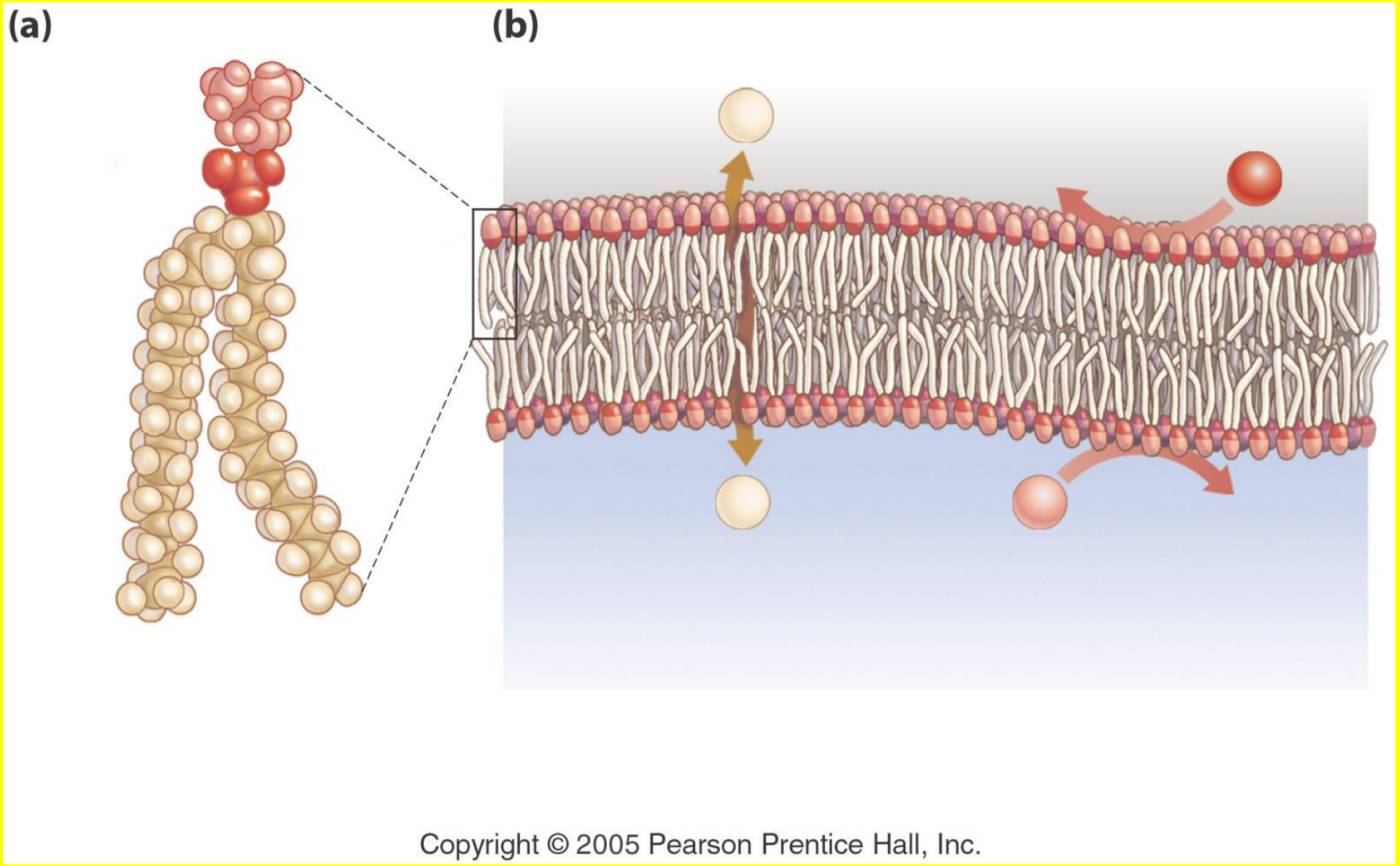



"At last.
I've created
a healthier egg."
99% REAL EGGS. 100% GREAT TASTE.
ORDINARY EGGS
egg beaters
FAT 5g 0g
CHOLESTEROL 210mg 0mg
CALORIES 75 30
PROTEIN 6g 6g
egg beaters
99% real egg
The egg perfected.™

Types of Fat

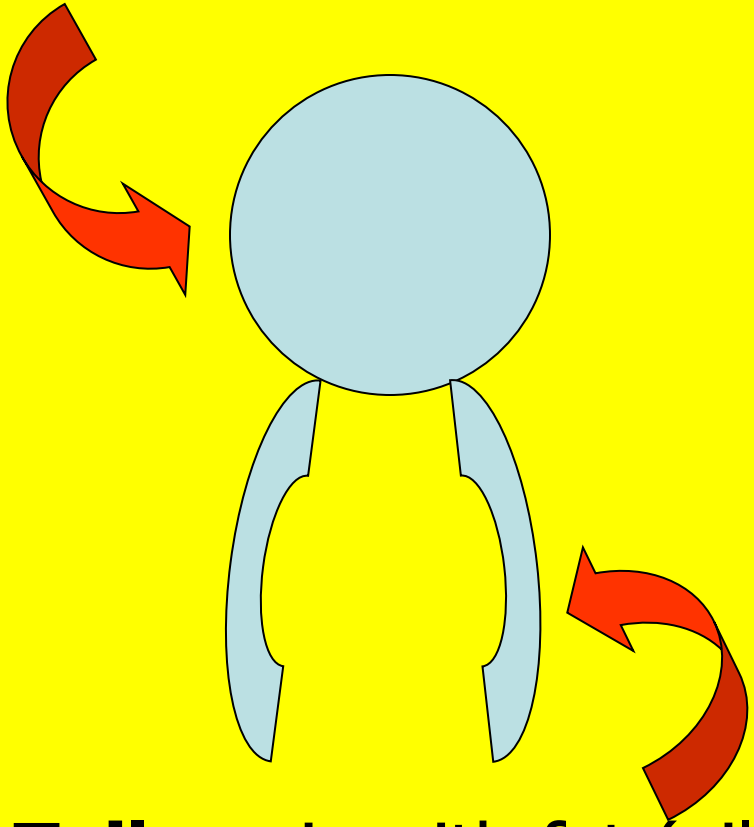
4) Phospholipids

- Contain phosphorus
- Emulsifiers (**emulsification**): break other fats → small droplets, helps fat **mix** with water
- Found in **bile** (gallbladder)- **emulsifies** fat in intestine
- Found: all your **cell membranes**



PHOSPHOLIPID

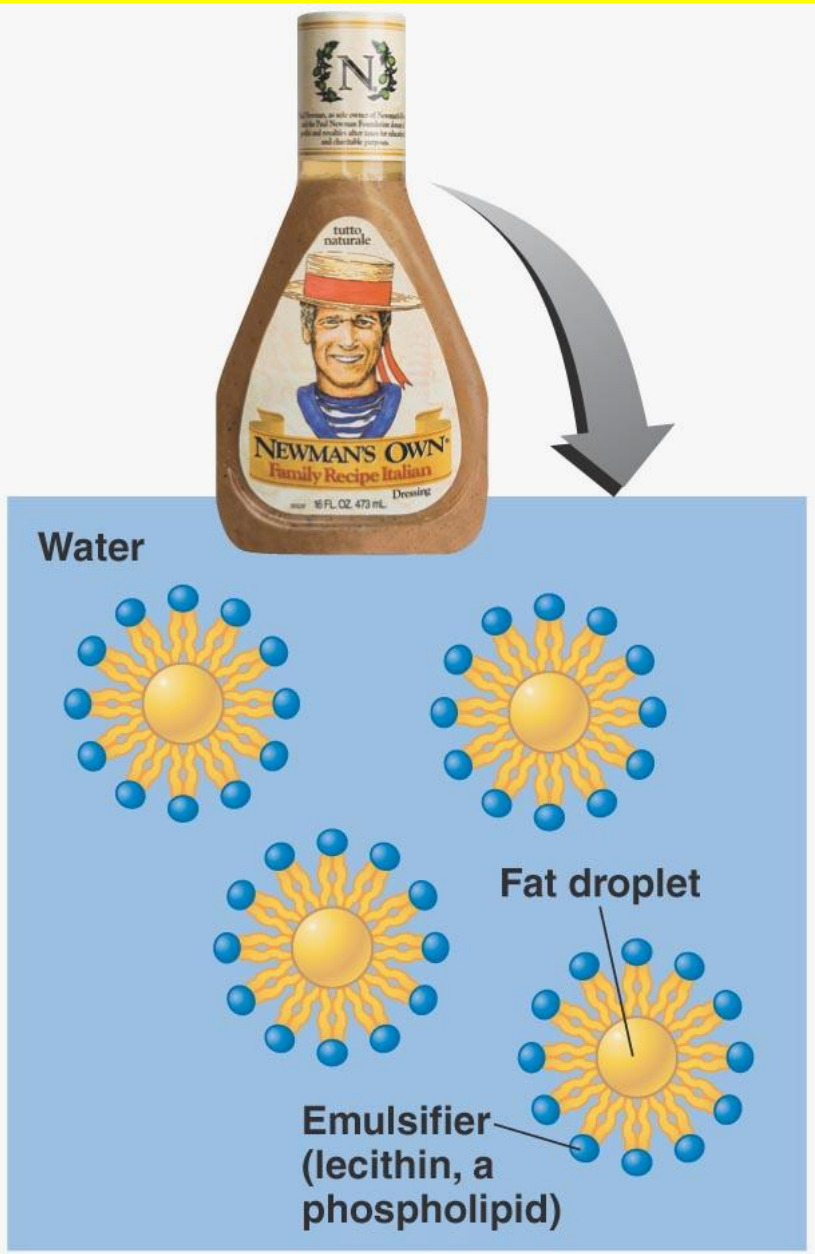
Head part: mixes with H_2O



Tails: mix with fat (oil)

Example: **Lecithin**

- In **eggs** and **soybeans**
- Used in: mayonnaise, margarine, salad dressings, chocolate, frozen desserts, baked foods
- Keeps oil **mixed** with other ingredients



It's lecithin.

That's right. Lecithin. Direct from nature's soybean. It took the makers of PAM to discover the way to put lecithin's unique characteristics to work in the pan.

The result?

Great no-stick cooking and easier clean-up.

Health conscious cooks all over America are turning to PAM for another reason, too.

Cooking with PAM drastically reduces fat, calories and cholesterol. PAM adds no salt, either. Use it to fry, braise, bake... for broiling, too. Read the chart for important facts.

COMPARE PAM® TO BUTTER, MARGARINE, OIL AND SHORTENING.

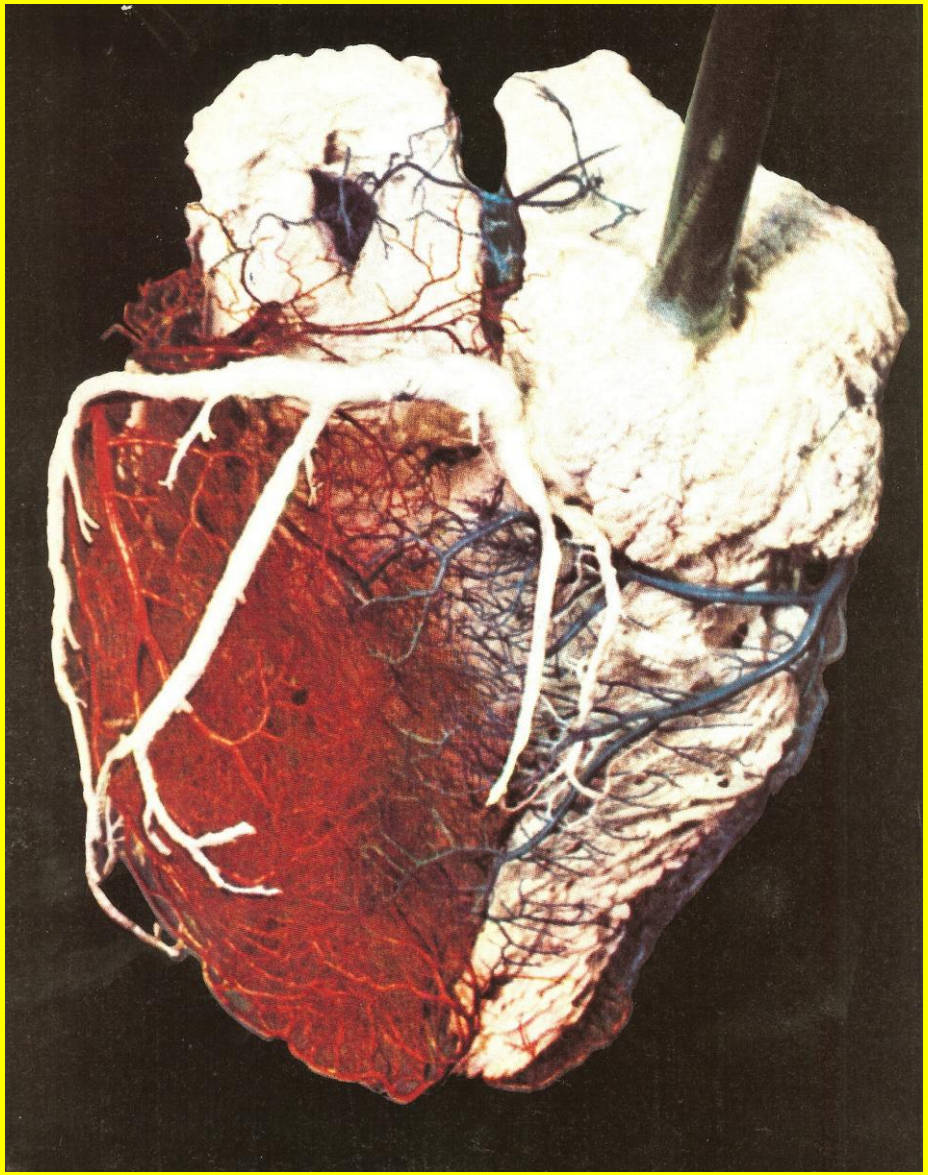
	AMOUNT	FAT	CAL-ORIES*	CHOLES-TEROL	SODIUM
PAM® AEROSOL	1¼ Sec. Spray	LOW 1 gm.	LOW 7	NONE	NONE
PAM® PUMP	10 Sprays	LOW 1 gm.	LOW 10	NONE	NONE
BUTTER	1 Tbsp.	HIGH 11.5 gm.	HIGH 102	HIGH	140 mg.**
MARGARINE	1 Tbsp.	HIGH 11.5 gm.	HIGH 102	NONE	140 mg.**
VEGETABLE COOKING OIL	1 Tbsp.	HIGH 13.6 gm.	HIGH 120	NONE	NONE
VEGETABLE SHORTENING	1 Tbsp.	HIGH 12.5 gm.	HIGH 111	NONE	NONE

PAM.® No-stick cooking, pure and simple.

*Calories absorbed into food will be less.
**Refers to salted butter and margarine only.

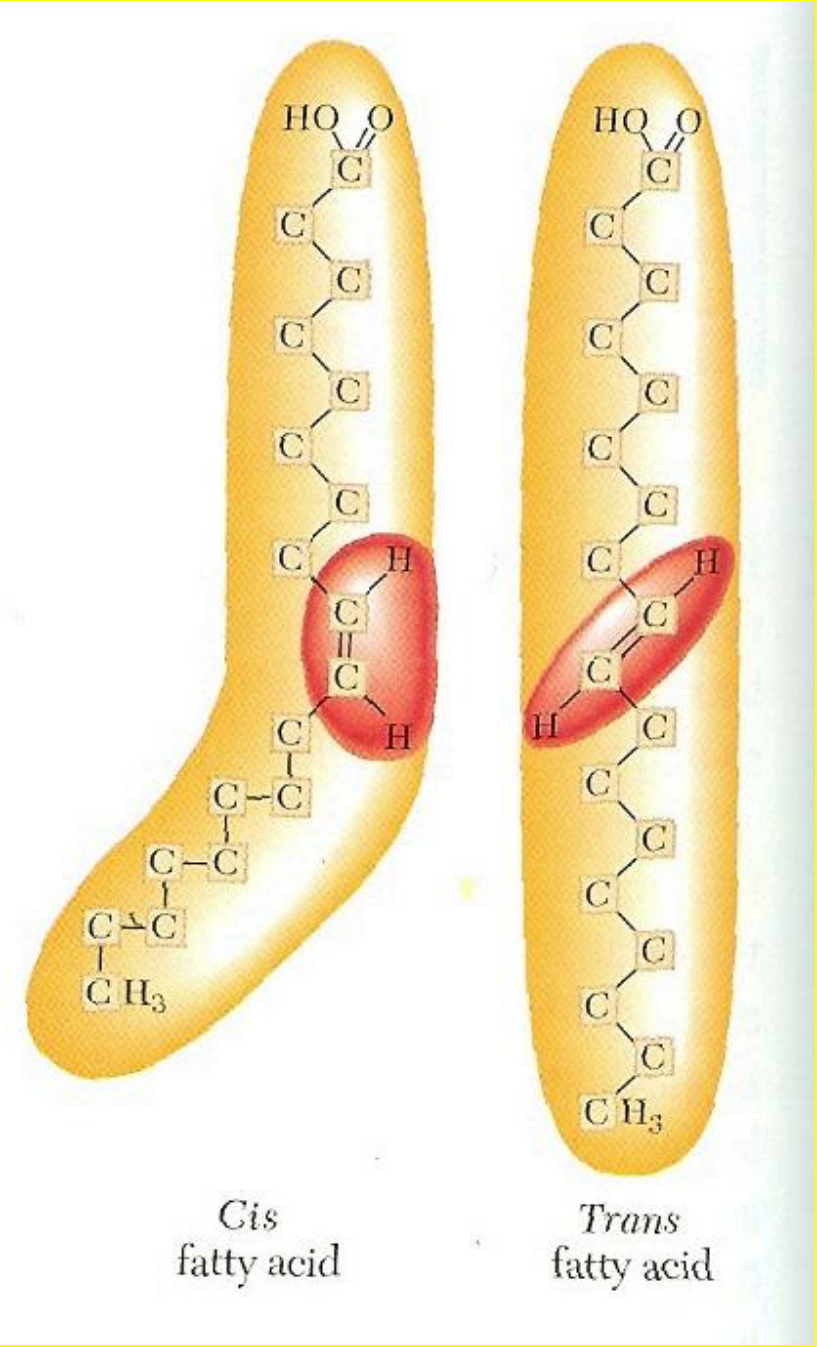
Trans Fat: Bad Fat

↑ Heart Disease Risk



Artificially modified fat: **Trans Fat**

- Bubble hydrogen gas into vegetable oil = **hydrogenation**
- **"Partially hydrogenated"** changes some double bonds → **single** bonds
- Makes fat semi-solid
- Looks more like **saturated** fat
- Changes shape- remaining double bonds
- **"Trans"** = **"Across"** in Latin


HO
O
H
H
CH_3
Cis
fatty acid
Trans
fatty acid

Why make Trans Fats?

- Last longer in deep frying
- Longer "shelf life" for processed foods
- Don't break down as quickly
- **Cheaper** to use
- Found in: cakes, cookies, crackers, pies, bread, some margarines, fried foods (French fries), potato chips, corn chips, popcorn, shortening, salad dressing, candy

Fats and You: Bottom Line

Bad Fats:

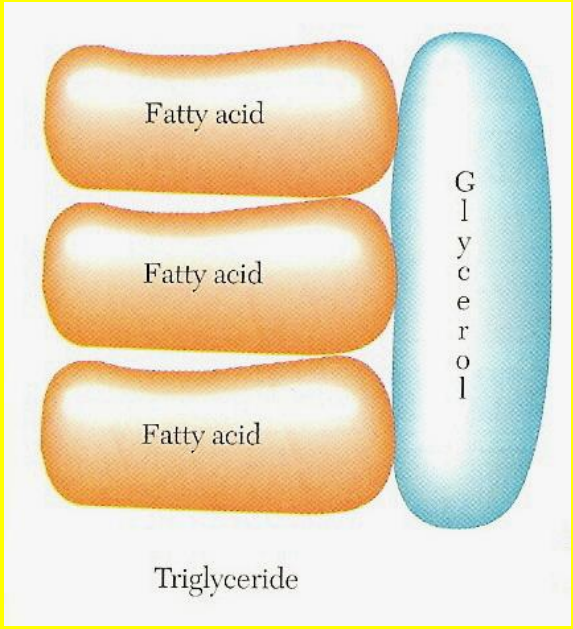
- Saturated
- Trans Fat
- Cholesterol

Good Fats:

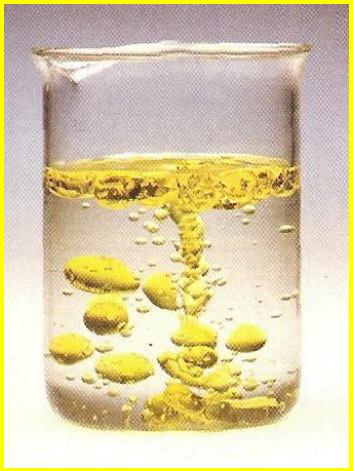
- Monounsaturated
- Polyunsaturated
- Omega-3 Fats

Fat: important source of **energy** for your cells

9 calories/gram



Problem: Fat + H_2O $\not=$ Mix

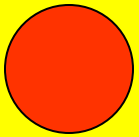


How do you dissolve fat in your blood?

Solution: **Attach** fat (lipid) to **protein**= **lipoprotein**

Lipoproteins

3 types

All spherical 

Differ: 1) Size

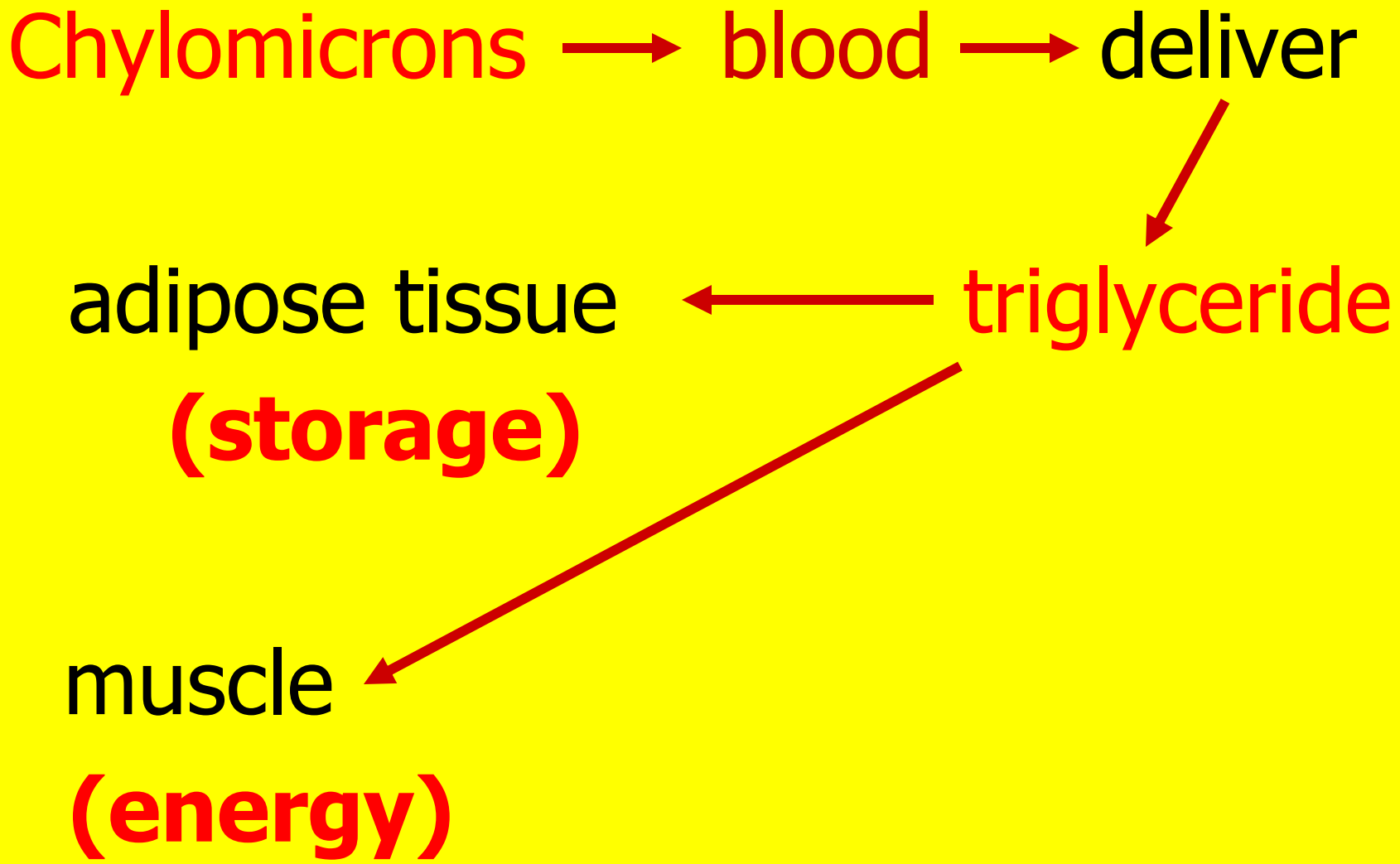
2) Type of fat

3) Amount of protein

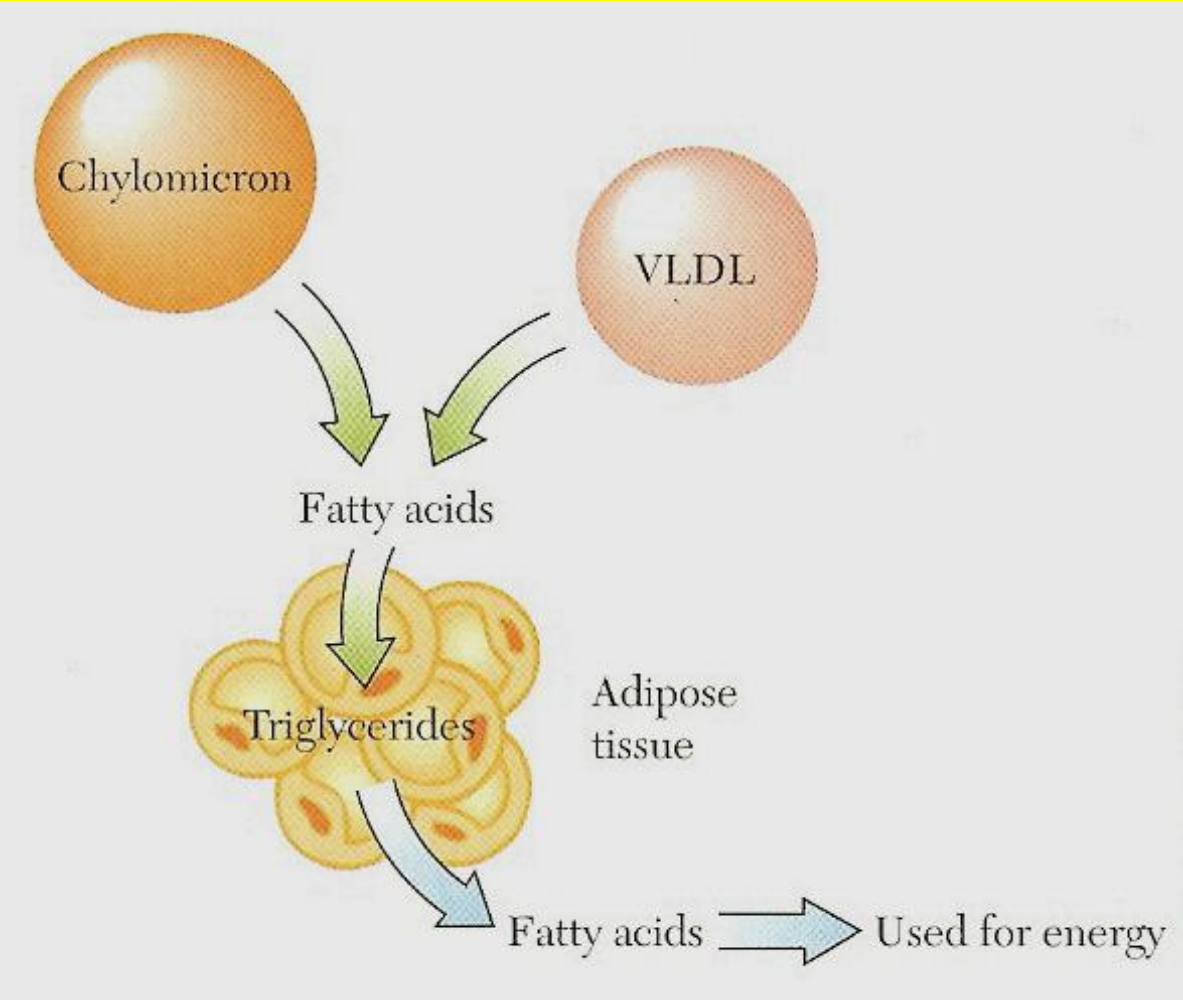
4) **Density (heaviness)**

#1 Chylomicrons

- Fat in food → broken down by enzymes → fatty acids
- Intestinal cells remake triglyceride
- Triglyceride + protein → chylomicron (large)


Chylomicrons
blood
deliver
triglyceride
adipose tissue
(storage)
muscle
(energy)

Chylomicrons : important for **fat deposition**



Adipose tissue

- Stores **excess** calories → triglyceride
- Almost **limitless** capacity- store fat
- World's fattest man: died 1983, age **42**
- Weighed **1397** pounds
- **80%** body was fat
- **4 million stored calories**

Fat Deposition

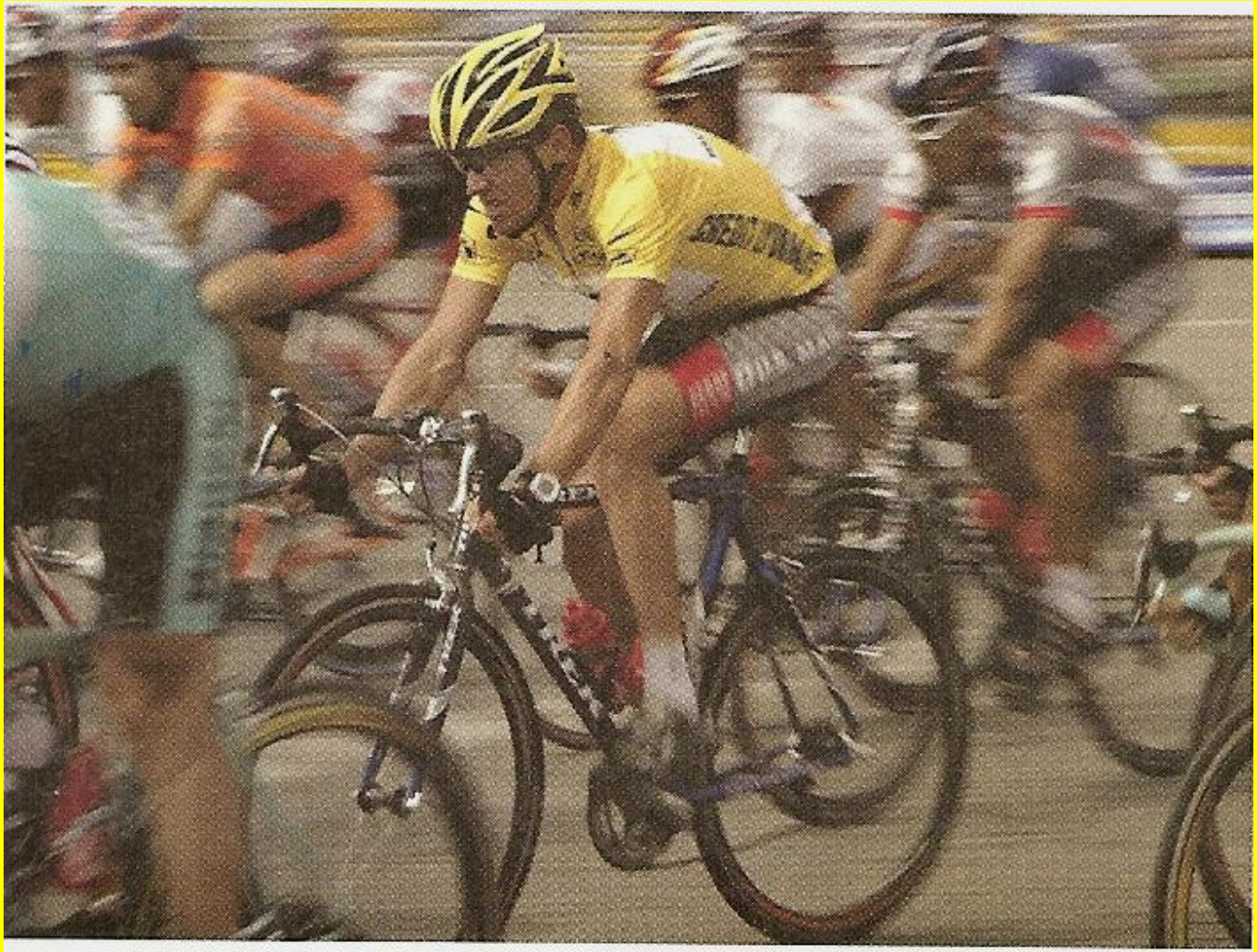
Baby seals: **50%** fat by weight

Whales: **40%** fat

Fat Mobilization

Triglyceride (adipose tissue) → fatty acids → blood → cells/tissues → Energy

- **Smoking**
- **Coffee**
- **Fasting**
- **Starvation**
- **Exercise**



The longer you exercise, the more fat you use for energy. Cyclists in long-distance races use fat stores for energy.

Fats Store En

#2 Low Density Lipoprotein

- Major cholesterol carrier in blood
- Good role vs. bad role

Good role

- Readily available **pool** of cholesterol for cell needs;
- So cells don't need to make own cholesterol- take it from LDL

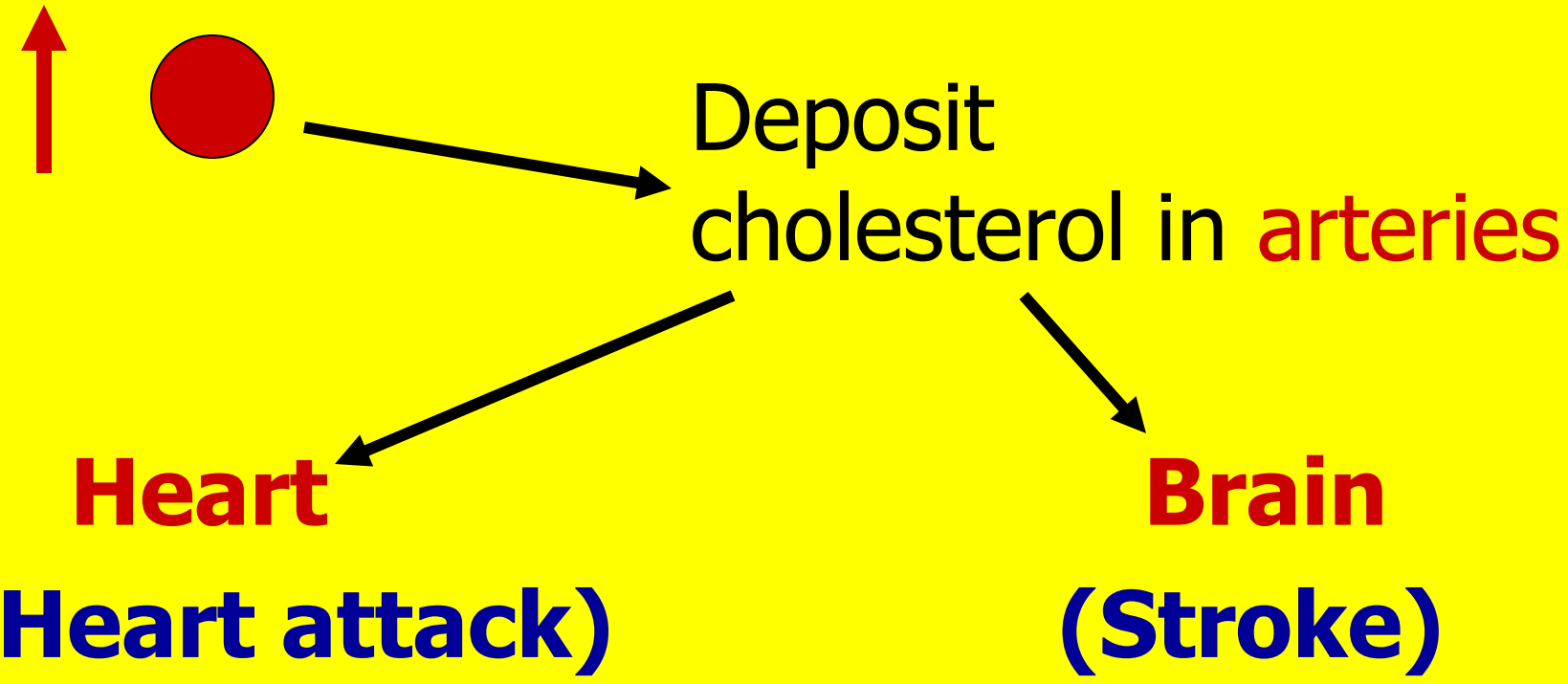
LDL

delivers cholesterol

cells: make new membranes (replacement worn out parts)

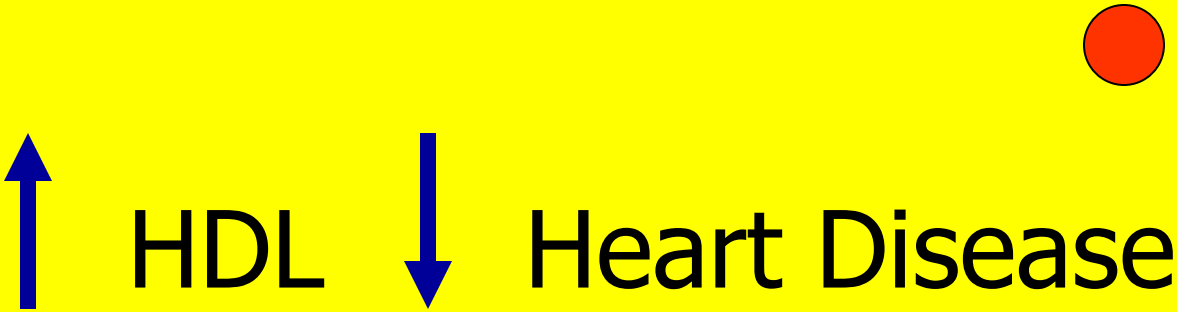
LDL

Bad Role


Deposit
cholesterol in arteries
Heart
(Heart attack)
Brain
(Stroke)

#3 High Density Lipoproteins (HDL)

- Produced in liver, intestine
- Smallest, most **dense** (heaviest)
- Rich in protein + phospholipid, some cholesterol



HDL ↓ Heart Disease

HDL removes cholesterol from cells

(arteries)

liver

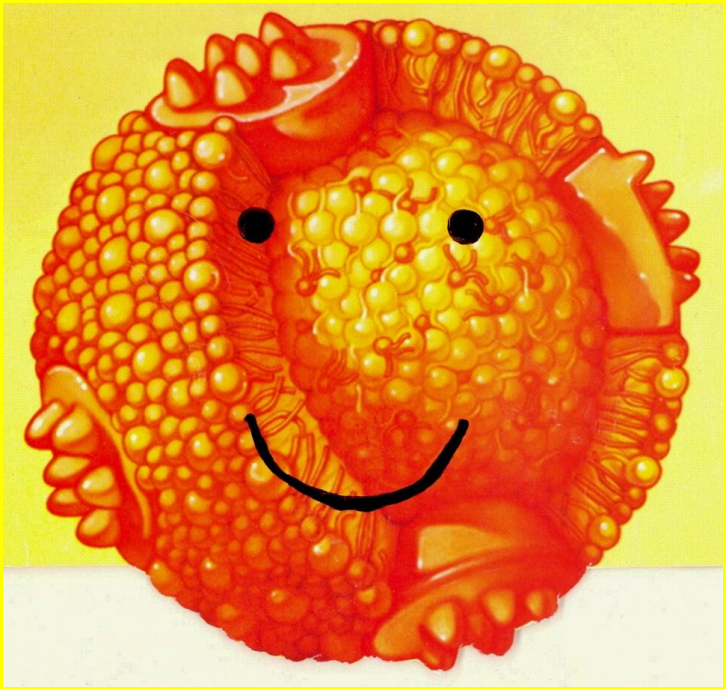
Removed in **bile**

(feces)

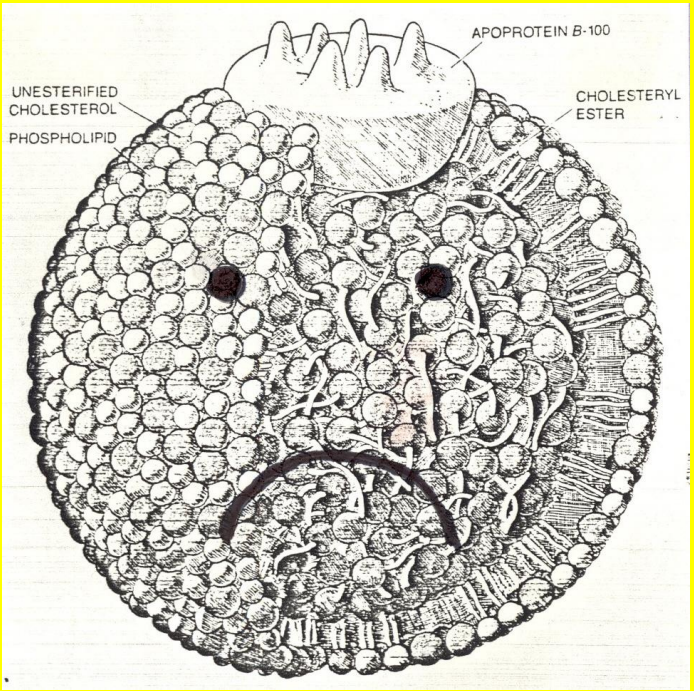
Cholesterol

The Good and The Bad

HDL



LDL



How scientists separate different lipoproteins

Ultracentrifuge

Origin of names:

Low density

High density

Where they **sink**

or **float** in tube

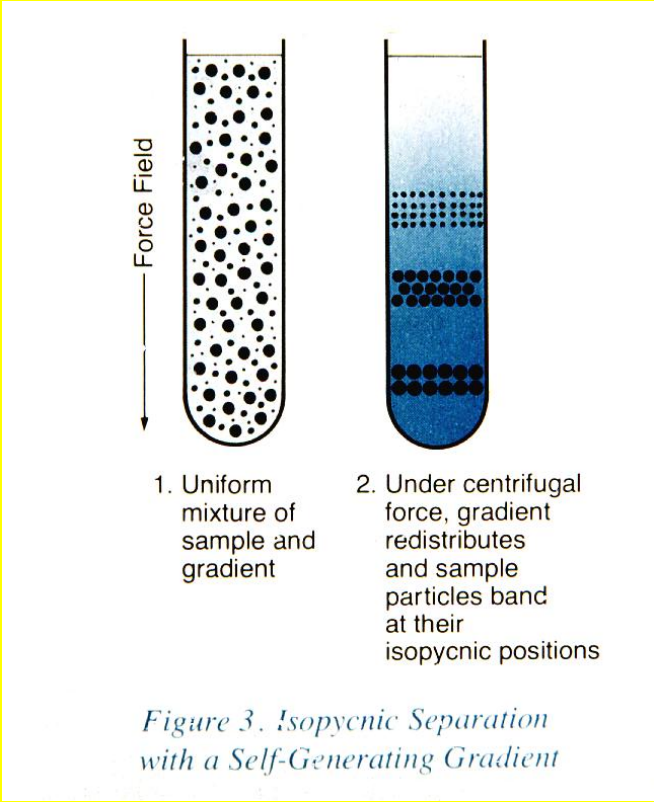


Figure 3. Isopycnic Separation with a Self-Generating Gradient

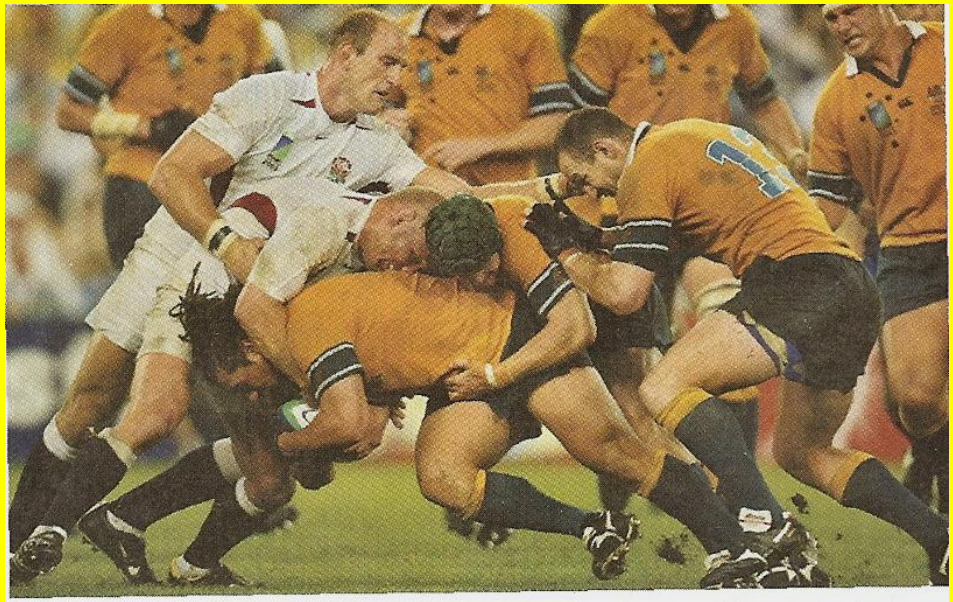
Fat Functions

- Stored energy for future use
- Important energy source: **9** calories/gram (calorically dense)

~120 calories= 1 tablespoon of butter or oil= 21/2 cups steamed broccoli= 1 slice whole wheat bread

Fat Functions

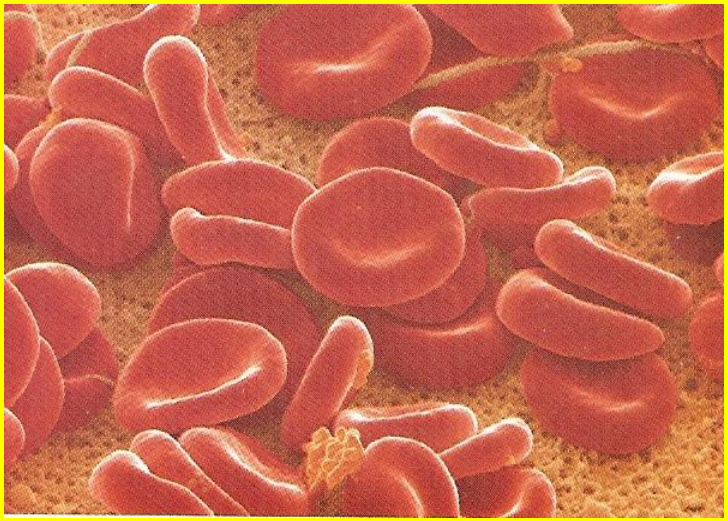
- Insulates body from temperature changes (adipose tissue under skin, around internal organs)
- Cushions/protects against shocks



Adipose tissue pads our body and protects our organs when we fall or are bruised.

Fat Functions

- Provides structure to cell membranes (regulates what goes in/out)
- Keeps cell membranes **fluid (flexible)**



Fat Functions

- **Lubricates** body surfaces: oil in skin
- **Fat makes food interesting**

- Adds taste, texture, flavor, aroma to foods

Fat Functions

- Help us feel **satiated** after meal

- Dissolves fat-soluble vitamins **(A, D, E, K)** in intestine for proper **absorption**

Baked goods are often high in invisible fats.

Visible vs. Hidden fat

Fat = 9 calories/gram

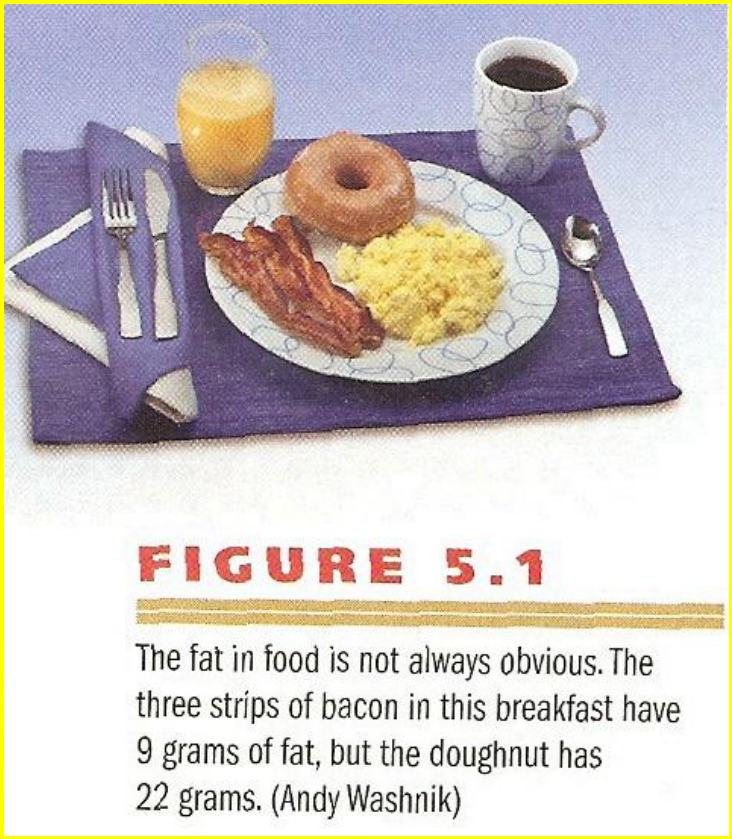


FIGURE 5.1

The fat in food is not always obvious. The three strips of bacon in this breakfast have 9 grams of fat, but the doughnut has 22 grams. (Andy Washnik)

Proteins

Proteins: C, H, O, and **N**

Protein Synthesis (in cells)

Amino acids → Polypeptides → Protein

Protein Breakdown (in cells & during digestion → absorption)

Amino acids ← Polypeptides ← Protein

Nitrogen

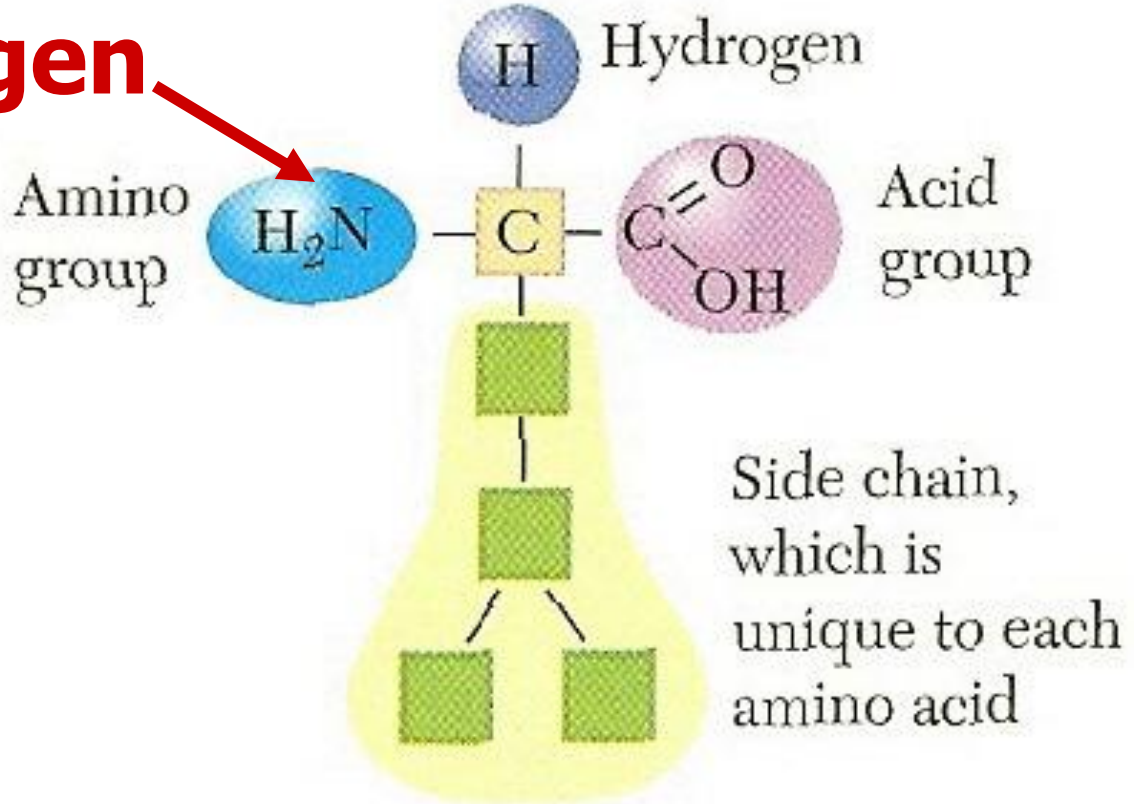
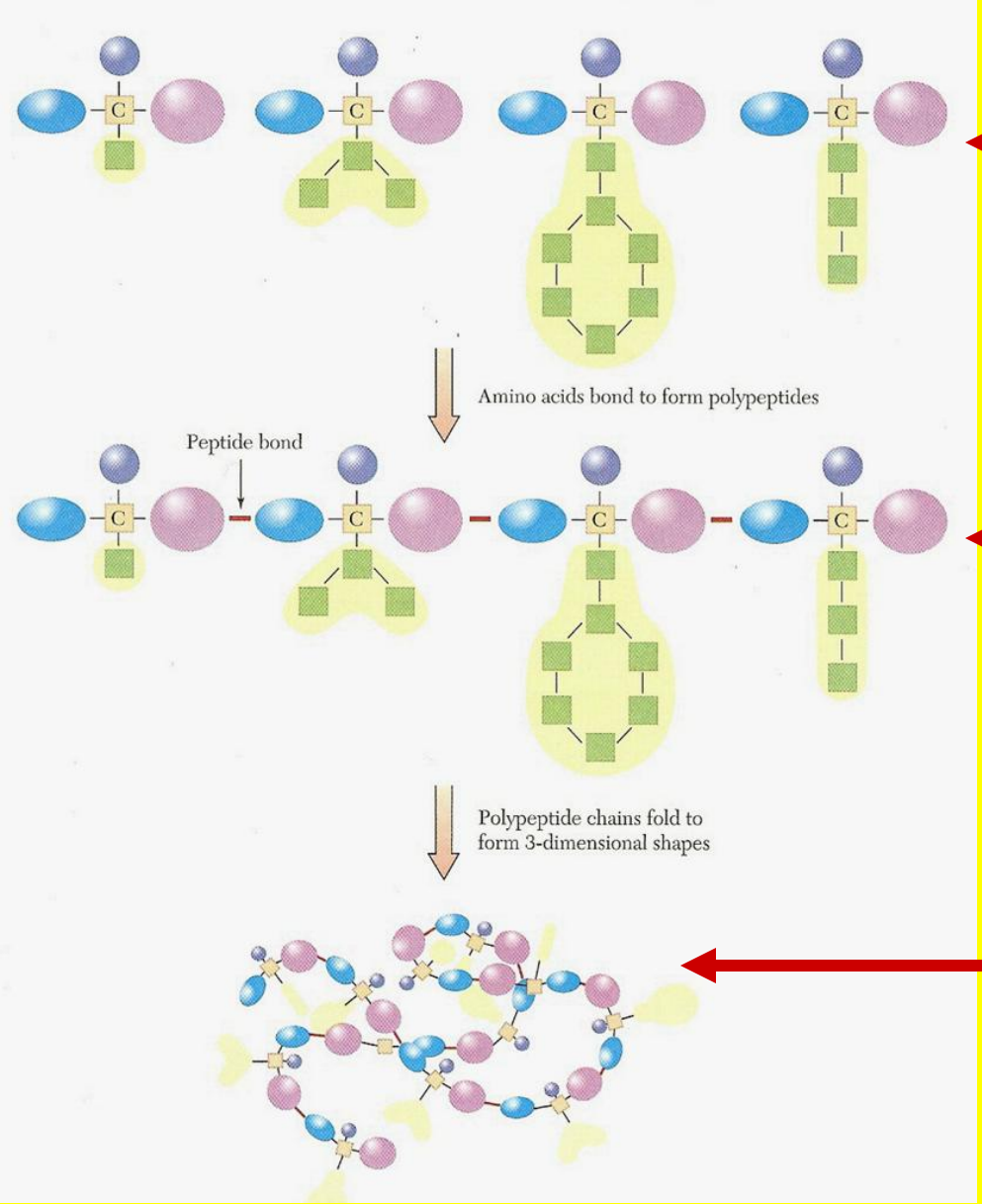


FIGURE 6.2

All amino acids have a similar structure, but each has a unique side chain.



amino acids

polypeptides

proteins

Amino Acids

20 different kinds: in human protein

11 can be made in cells =

Nonessential

Made in body or from diet

9 you can't make=

Essential

Must eat in diet

- Absence of essential amino acids in diet  Protein

Children ↓ Growth

What proteins do (functions) in your body

1) **Enzymes**: catalysts

   Speed up chemical reactions

2) Tissue Growth & Maintenance

- Protein found in every cell **(structure)**
- During growth → add tissue → need protein
- Examples: muscles/biceps: weight lifter; thighs (skaters); skin, hair, collagen (bones, teeth)

3) Movement

- Muscle proteins: muscle contractions- all your movements
- Heart muscle- beating
- Digestive tract- moving food along
- Blood vessels: constrict & dilate

4) Hormones

- Many are proteins
- Chemical messengers: produced in one place → blood → another place in body → **response**
- Pancreas → insulin → blood

  stimulates ← all cells

  glucose uptake

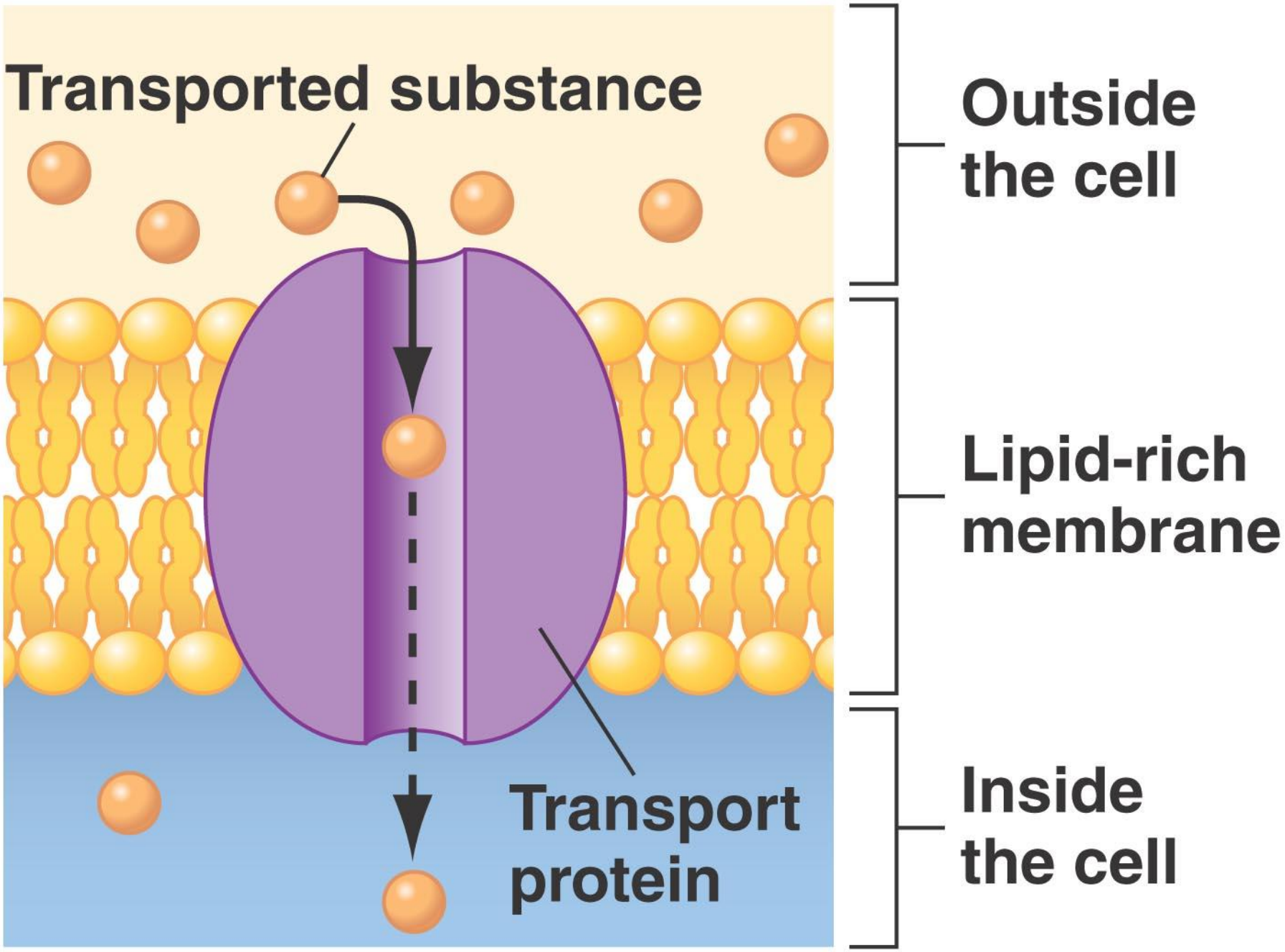
5) Antibodies

- Proteins produced when foreign material **(antigen)** enters body;
- Destroys **antigen**;
- Antigens: **bacteria, virus, transplanted organ**

6) **Transport** (carrier) molecules: help carry (shuttle) things

Examples:

- **Hemoglobin**- carries oxygen
- **Lipoproteins**- carry fats (lipids)
- Vitamin A- attached to carrier protein in blood
- **Cell membranes**: shuttle potassium into/sodium out of cells



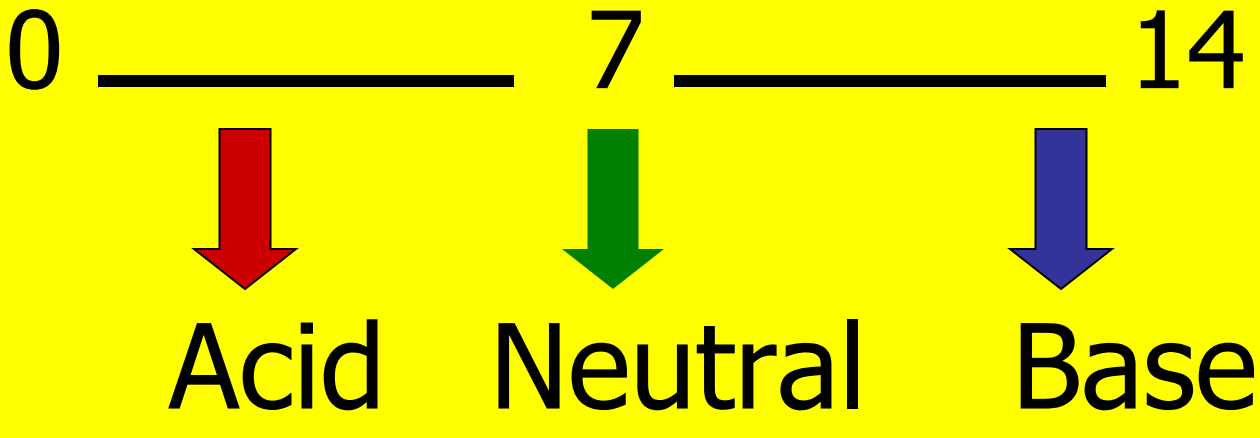
7) Fluid Balance

Proteins: maintain proper amounts of H_2O **inside/outside** of cells by absorbing & holding **water**

Edema can result from deficient protein intake. This foot with edema is swollen due to fluid

8) Blood acid/base balance

pH scale



Blood: 7.35-7.45

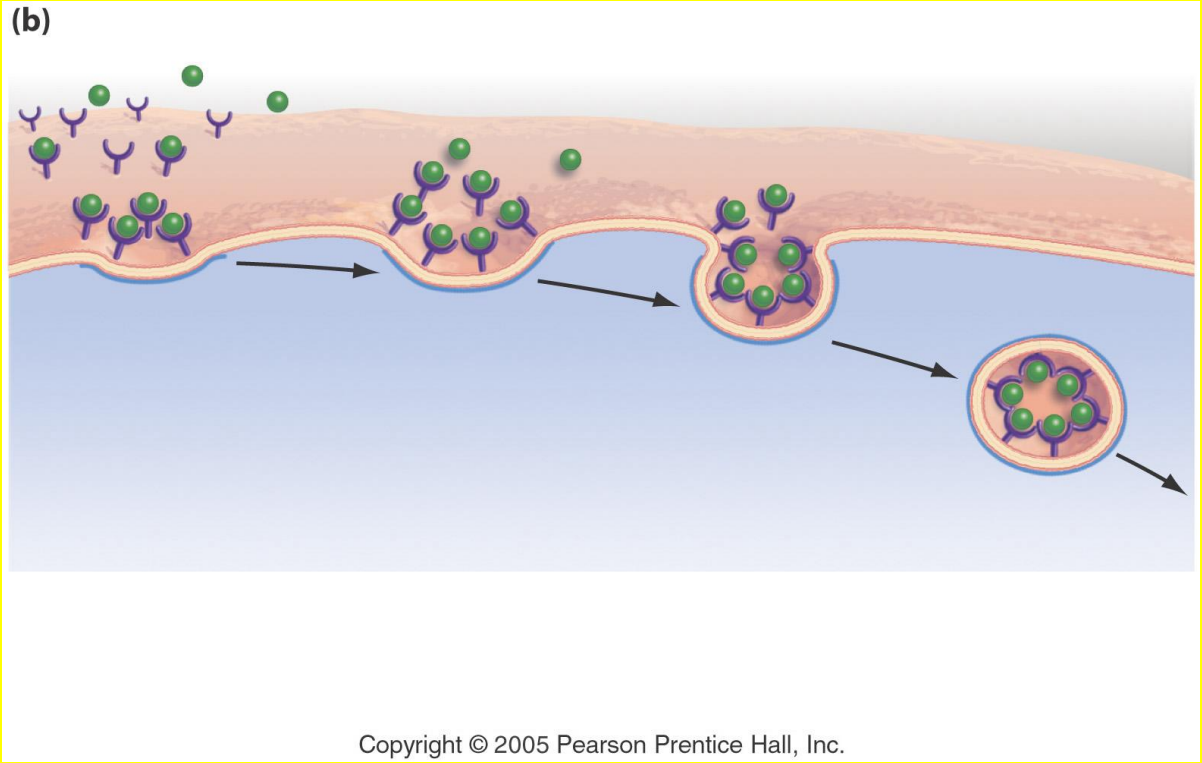
Gastric juice: 1.0-5.0

Pancreas juice: 8.4-8.9

Proteins: **buffers**- help maintain normal **pH**: blood and cells

9) Receptors on cell surface:

- Example receptors: Insulin, LDL



10) Calories- Protein: 4 calories/gram

A) How protein is used:

Proteins in food → amino acids

1st amino acids → new body proteins

(structure, enzymes, hormones)

2d amino acids → energy

or

3rd amino acids → glucose

B) If very low calories (fat and carbohydrate) & protein in diet:

Tissue proteins (enzymes, muscles) **"cannibalized"** for **energy**

Therefore: **fat & carbohydrate-"spare"** tissue protein from <u>breakdown</u>

Protein Quality

- Ease of digestion → release amino acids

- Supply proper amounts- **essential amino acids**

Protein Quality

In general

Animal proteins:

dairy products, eggs, beef, poultry, fish

High quality (complete)

Plant proteins:

Lower quality (incomplete)

Exception

soy protein

Other sources- animal proteins

- **Insects:** inexpensive protein

Examples: in Africa

ants, termites, beetle grubs, caterpillars & grasshoppers

raw, baked, or fried

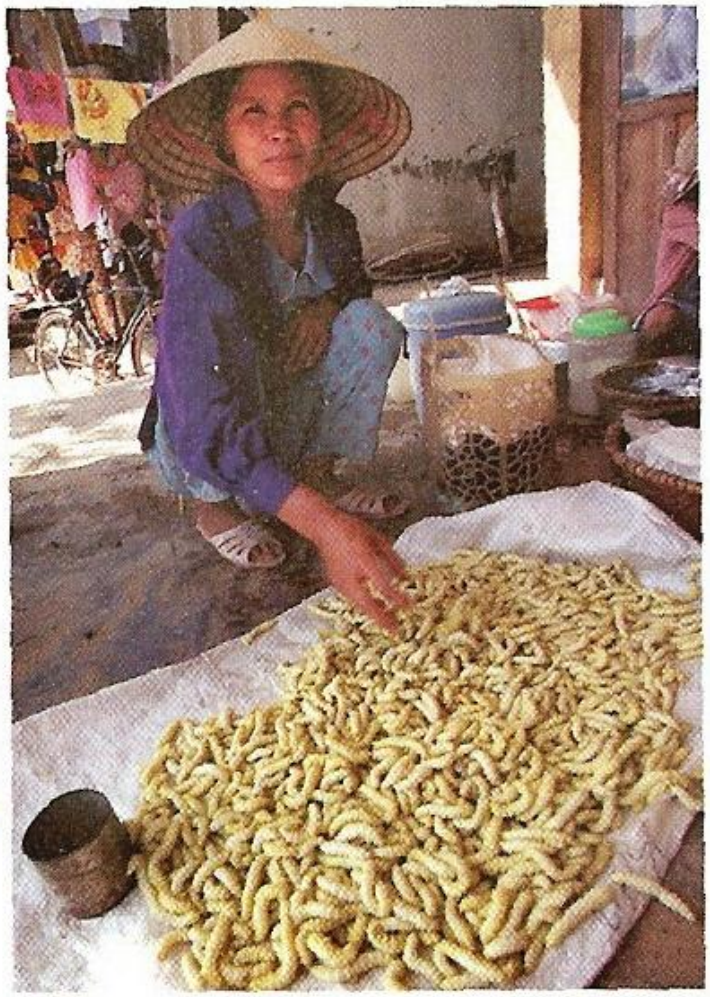


FIGURE 1.10

A plate of silkworms such as these being sold in a market in Vietnam may not be very appealing to you, but insects are a part of the diet in many parts of the world. (AFP/Getty Images)

Vegetarians

Combinations- different non-meat foods:

Mutual Supplementation

www.vrg.org

www.vegansociety.com

Vegetarians

To get enough essential amino acids:

Variety is important

- Examples: **beans, nuts, peanut butter, peas, soy products, eggs (ovo-vegetarians)**

Differences: Animal vs. Plant Foods

- **Animal Foods**
  - ↑ High quality protein
  - ↑ B vitamins
  - ↑ Minerals (iron, zinc, calcium)
  - ↓ **Fiber**
  - ↑ **Saturated fat/cholesterol (heart disease)**

Differences: Animal vs. Plant Foods

- **Plant Foods**
  - Most, not all B vitamins
  - Good amounts iron, zinc, calcium
  - ↓ Quality protein
  - ↑ **Fiber (good for you)**
  - ↑ Phytochemicals (promote health)
  - ↑ Unsaturated fat/no cholesterol **(good for you)**

Dietary Guidelines: Advantages of <u>both</u> types of food

- Whole Grains
- Fruits
- Vegetables

} **PLANTS**

- <u>Low/nonfat</u> dairy products
- <u>Low</u> fat meat

} **ANIMALS**

Nitrogen Balance

Protein breakdown → amino acids

↓

Eliminated by ← **Urea** ← Nitrogen

by **kidneys** converted

(urine) (in liver)

Diet Intake of Protein = Urine output

(nitrogen) **(nitrogen)**

Normal Situation: Being **in** Nitrogen balance

Nitrogen in urine: best measure of protein breakdown in body

Urine nitrogen should equal nitrogen (protein) in your diet

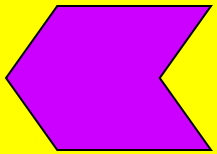
Extra Protein in Diet beyond needs

Maintenance: normal body protein levels

*** Remember: you don't store protein in your body**

Negative Nitrogen Balance

Diet intake of Protein (N)



Urine output Nitrogen

Loss of protein: breakdown of body protein

Negative Nitrogen Balance

Examples:

- Starvation/AIDS patients
- Fevers/illness/infections
- Burns
- Surgery/injury
- Forced immobilization (broken leg)
- Low protein diets

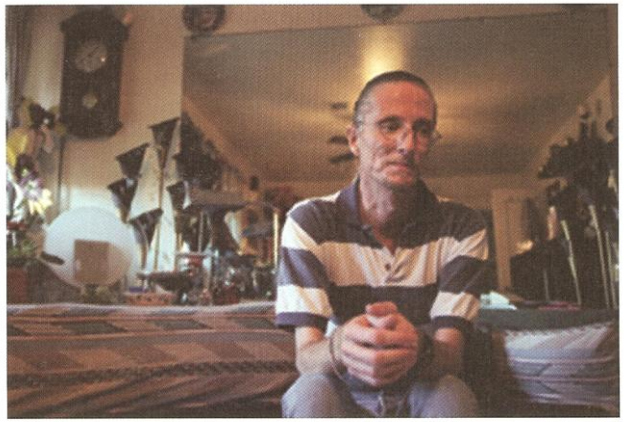
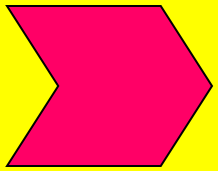


Figure 6.14 Protein-energy malnutrition occurs in several populations in the United States, including those with such wasting diseases as AIDS and cancer.

Positive Nitrogen Balance

Diet intake of Protein (N)  Urine output Nitrogen

Your body gains protein (synthesis)

Building new muscle, bone, skin

Positive Nitrogen Balance

Examples:

- Growth (children)
- Recovery: severe illness/infections (healing)
- Anabolic steroids
- Body building ↑ muscle mass
- Pregnancy

Not enough protein: world health problem

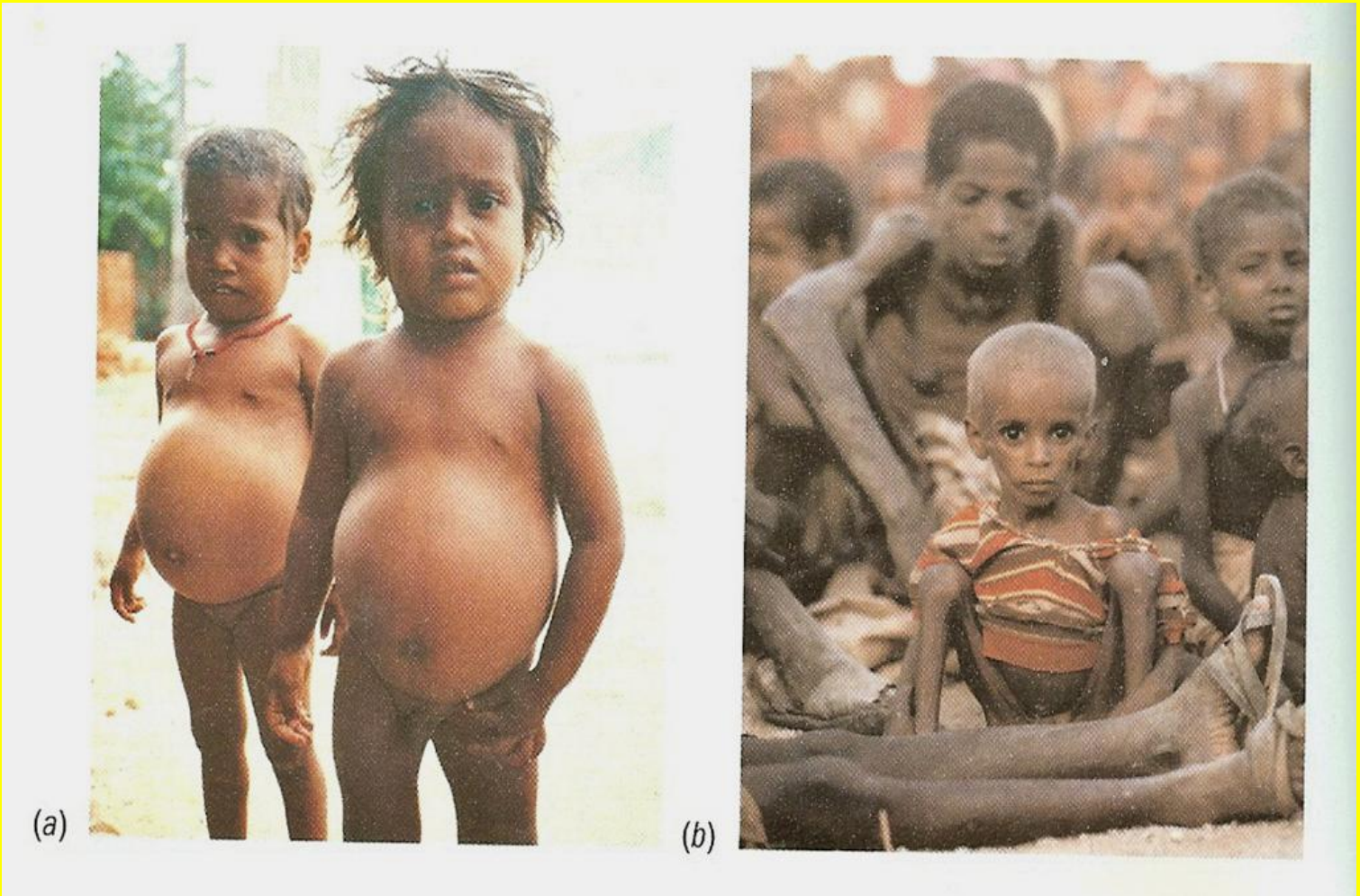
Protein/calorie malnutrition

Kwashiorkor (↓ protein)

Marasmus

(↓ calories/nutrients)

Starvation



Kwashiorkor **Marasmus**

Others: protein/calorie malnutrition

- Elderly- nursing homes/hospitals
- Homeless
- **People- eating disorders**
- People- alcohol/drug addiction
- **Wasting diseases**

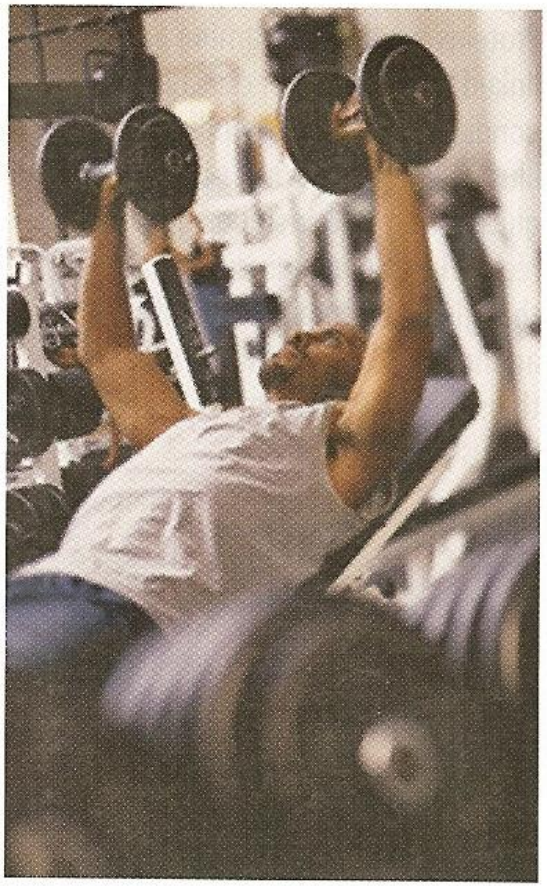
  AIDS patients

  Cancer patients

Athletes and Protein

Newer studies: athletes benefit from **1.2 to 1.7 g/kg/day** of protein

- Especially true: endurance athletes, weight lifters, resistance training, football, hockey, other power sports
- **Protein used for: repair of sports damage, lean muscle mass, "remodeling" muscle proteins (exercise stress/strain), optimal levels for body physiology**



Proteins are an integral part of our body tissues, including our muscle tissue.

<u>Vegetarians</u> : Dave Scott Ironman champ & Sean Yates Tour de France winner

Too much protein: possible problems

↑ Dietary protein → ↑ Urea production → ↑ H_2O loss/urine

- Infants: immature kidneys-can't concentrate urine;
- People with kidney disease: high protein diets: **renal failure**

Too much protein: possible problems

↑ **Risk: kidney stones/bone loss**

High **protein** diets often:

↑ saturated fat/cholesterol/calories

↓ fiber

Risk: Heart disease & weight gain

So how much protein do you need?

Calculations:

1) First calculate your weight in **kilograms**:

Weight in **pounds** divided by

2.2

RDA for Protein

Male & Female	Age (years)	RDA Factor (grams/kg)
	0-0.5	1.52
	0.5-1	1.50
	1-3	1.10
	4-8	0.95
	9-13	0.95
	14-18	0.85
	≥ 19	**0.80**

What about this?

Weight X RDA Factor =

(kilograms)

How much protein you need each day **(nitrogen balance)**

Protein: Pregnancy and Breast Feeding

Pregnancy: Non-pregnant RDA + **25g/day**

Lactation: (1st 6 months) Non-lactation RDA + **25g/day**

What do these tell you?

Assignment

Are you getting enough, too little, or too much protein in your diet?

Pick one day

Food & Drink Amount	Protein (grams)
Breakfast	
1	
2	
3	
Lunch	
1	
2	
3	
Dinner	
1	
2	
3	
Snacks	
1	
2	
3	

Total Protein (grams) _____

Typical American

Eats: **100** grams protein/day

Reference person:

154 pounds divided by 2.2= **70** kg (wt)

RDA: **70** kg X **0.8** = **56** grams/day protein

In general:

Most healthy people don't need more than 2X RDA for protein

Hot Dog Man: "The Tsunami"

July 4, 2004: Brooklyn- Nathan's famous hot dog eating contest

Takeru Kobayashi- Japan

5' 7" **132** pounds

Ate **53.5** hot dogs in 12 minutes- world record

Extra credit points

1) How much protein does he need/day?
2) How much protein did he get in 53.5 hot dogs (Fenway Franks)?

Extra Credit

Name: _____

Grams of protein I eat each day:____

My RDA (grams) for protein:____

Nitrogen balance: yes or no (circle)

Hot Dog Man

Hot Dog Man's RDA (grams):_____

Grams of hot dog protein he ate:____

Food Allergies: Allergic Reactions

- **Skin**: Redness, swelling, hives
- Circulation: drop blood pressure
- Mouth: itching/tingling of lips/tongue
- Lungs: asthma, breathing difficulty

Common Allergens

- Adults: seafood, peanuts, fish tree nuts, eggs
- **Children**: eggs, milk, peanuts, soy, wheat

Gluten Intolerance (celiac disease)

Gluten: wheat protein irritates intestine lining: cramping, diarrhea, weight loss, malabsorption nutrients

Read food labels- avoid specific foods

- Read ingredients list
- Look for **warnings**

  "contains **wheat & soy**"

  "made in a facility that processes **peanuts**" (cross-contamination)

  Dunkin' Donuts: **"contains peanuts"**

Micronutrients: **needed small amounts**

Vitamins:

- All contain **carbon**
- **Don't** provide calories
- Most **can't** be made in your body
- Source: **foods/supplements**
- Important: all normal body **functions**

Vitamin Functions:

- Building/maintaining **bone/muscle tissue**
- Making new **cells/DNA**
- Supporting **immune system** (fight disease)
- Healthy **vision/blood**
- Protect cells- harmful **oxidation (anti-oxidants)**
- Help carbohydrates, fats, proteins release their **energy**

Vitamins: 2 Groups

1. Fat Soluble

2. Water Soluble

Fat Soluble Vitamins

- Don't dissolve in H2O
- **A, D, E, K**
- **Absorbed** in intestine with **fat**
  liver/other organs ← lipoproteins
- **Stored** in tissues (liver, adipose)
- **Don't** need to consume everyday

Fat Soluble Vitamins

- Large amounts- diet/supplements
  toxic ← build up tissues
- **Found: meats, dairy products, vegetable oils, nuts, seeds**

Water Soluble Vitamins

- Dissolve in **H_2O**
- **B complex (many types) & C**
- Absorbed- intestine directly → blood → body cells
- You **don't store** large amounts
- Need to consume **everyday**

Water Soluble Vitamins

- Not enough: **deficiency**
- **Too** much: kidneys filter excess urine
- **Found: whole grains, vegetables, meat, dairy products**

Minerals

- **Don't** contain carbon
- **Not** broken down: digestion or in normal body functions

  Ex. **Calcium** in milk same as calcium in bones
- **Found: meats, dairy products, fruits, vegetables, nuts**
- Regulate many body functions

Minerals: Functions

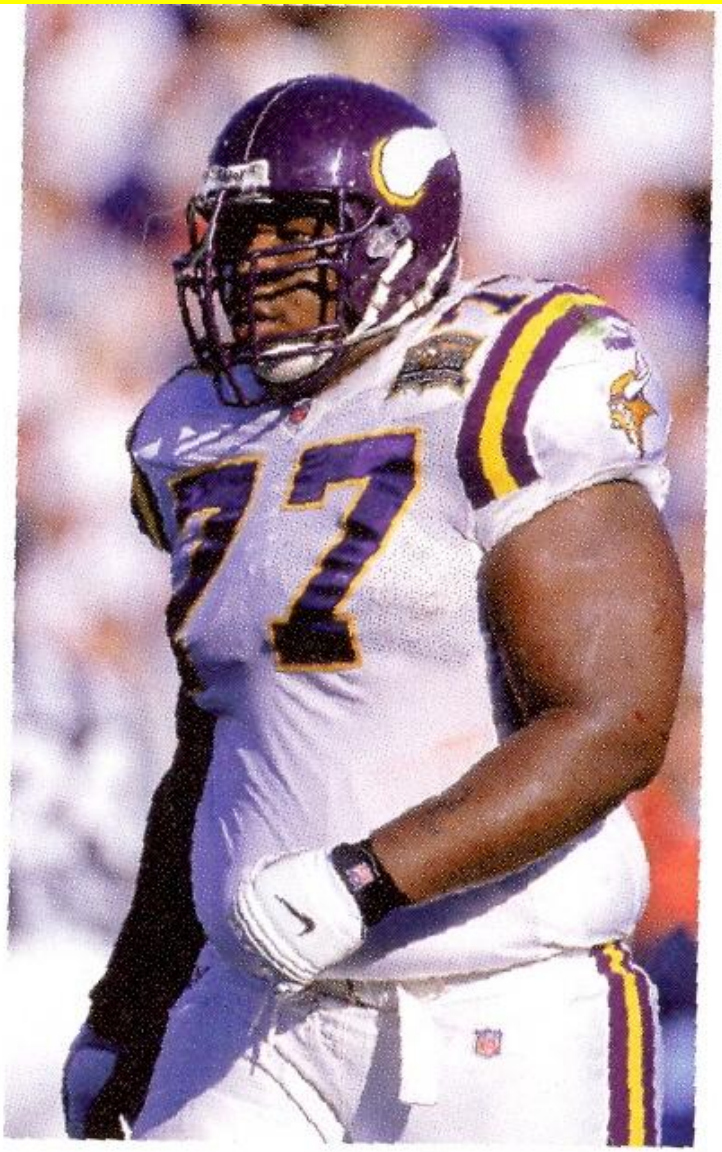
- **Body structure**: calcium, phosphorus, magnesium in **bone**
- **Regulate blood pressure:** sodium & potassium
- **Nerve impulses/muscle contractions:** calcium, magnesium, potassium, sodium
- **Fluid balance:** sodium, potassium, chloride

Water: **Macronutrient**

- Makes up **60%** body weight
- No **calories**
- Found inside/outside cells
- Critical: normal body functions
- **Lubricates** body parts
- Helps control **body temperature**
- Carries **oxygen, nutrients, wastes** in blood around body

Water

- Involved: **acid/base** balance
- Important: all chemical reactions
- You **don't** store water in body
- Loss continuously: lungs, sweat, urine
- Need adequate amounts- **everyday**



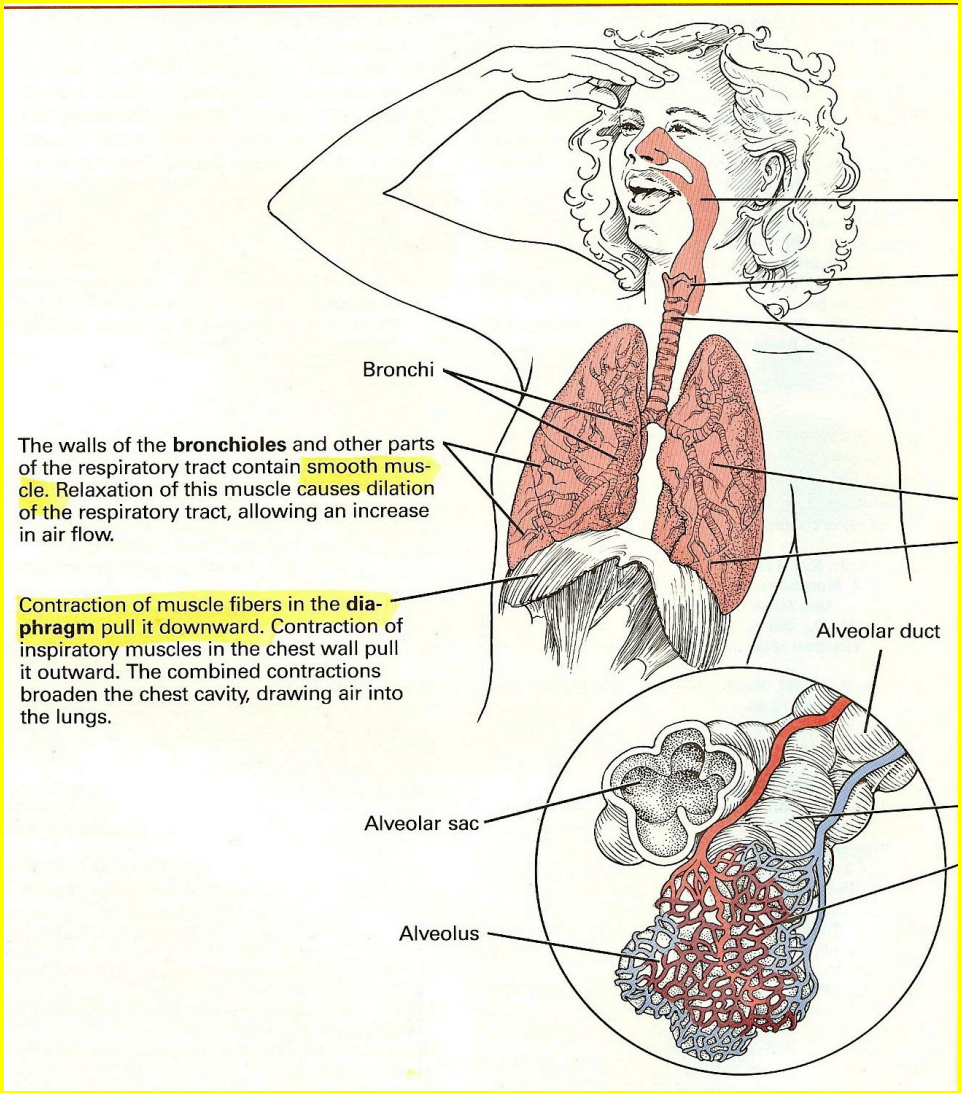
National Football League all-star Korey Stringer died in 2001 as a result of heat stroke.

Water

- Found: pure form, juices, soups, drinks, fruits, vegetables
- No water intake- **3** days: **death**
- Thirst response ↓ with **age**
- Elderly/nursing homes: concern- **dehydration**

Metabolism
&
Cell Respiration

What happens when you breathe? Do your cells breathe?



Cell Respiration: inside your cells

- Energy trapped in **chemical bonds**: carbohydrates, fats, protein

- Break chemical bonds → energy

ENERGY + P + ADP → **ATP**

(from chemical bonds of food)

(stored energy)

←

Energy **release**: all your body activities

Cell Respiration

Glucose

+

O_2

CO_2

+

H_2O

+

ATP's

Cell Respiration

Glucose + O_2 ⟶ CO_2 + H_2O + ATP's

Metabolic Poisons:

Carbon Monoxide (cars)

Hydrogen cyanide (cigarettes)

Hydrogen sulfide (rotten egg smell)