Body Composition

Chapters 18 and 23

Somatotype (Body Type)

- Soft roundness?
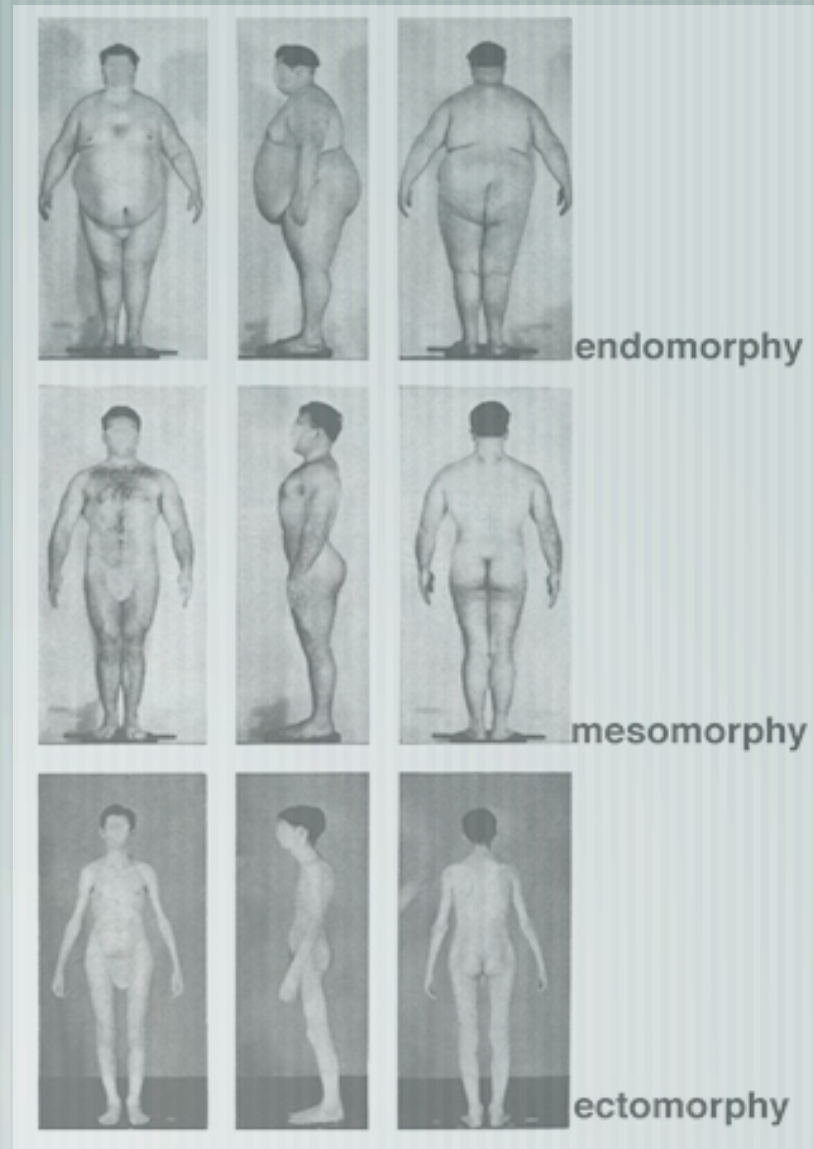 - endormorphy
- High muscle mass?
  - mesomorphy
- Linearity and fragility?
  - ectomorphy

Body Composition Methods

Height Weight Tables e.g. Metropolitan Life Insurance

Body Mass Index

Percent Body Fat

Height / Weight for Women & Men

Height Feet Inches	Small Frame	Medium Frame	Large Frame
4' 10"	102-111	109-121	118-131
4' 11"	103-113	111-123	120-134
5' 0"	104-115	113-126	122-137
5' 1"	106-118	115-129	125-140
5' 2"	108-121	118-132	128-143
5' 3"	111-124	121-135	131-147
5' 4"	114-127	124-138	134-151
5' 5"	117-130	127-141	137-155
5' 6"	120-133	130-144	140-159
5' 7"	123-136	133-147	143-163
5' 8"	126-139	136-150	146-167
5' 9"	129-142	139-153	149-170
5' 10"	132-145	142-156	152-173
5' 11"	135-148	145-159	155-176
6' 0"	138-151	148-162	158-179

Weights at ages 25-59 based on lowest mortality. Weight in pounds according to frame (in indoor clothing weighing 3 lbs.; shoes with 1" heels)

Height Feet Inches	Small Frame	Medium Frame	Large Frame
5' 2"	128-134	131-141	138-150
5' 3"	130-136	133-143	140-153
5'' 4"	132-138	135-145	142-156
5' 5"	134-140	137-148	144-160
5' 6"	136-142	139-151	146-164
5' 7"	138-145	142-154	149-168
5' 8"	140-148	145-157	152-172
5' 9"	142-151	148-160	155-176
5' 10"	144-154	151-163	158-180
5' 11"	146-157	154-166	161-184
6' 0"	149-160	157-170	164-188
6' 1"	152-164	160-174	168-192
6' 2"	155-168	164-178	172-197
6' 3"	158-172	167-182	176-202
6' 4"	162-176	171-187	181-207

Weights at ages 25-59 based on lowest mortality. Weight in pounds according to frame (in indoor clothing weighing 5 lbs.; shoes with 1" heels)

Body mass index

BMI = Wt (kg) ÷ Ht (m²)
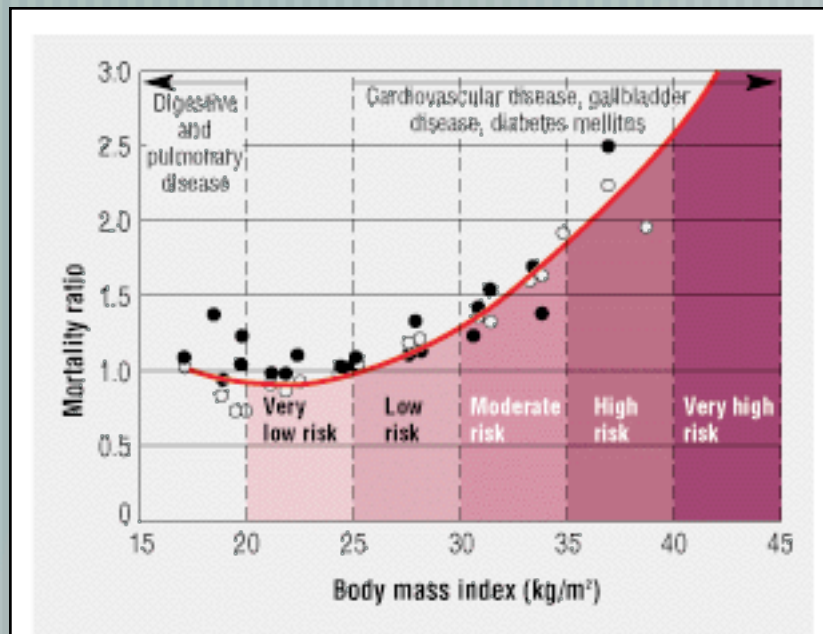
Figure 4. Relationship of body mass index to disease risks.

© 2003. George A. Bray

Underweight	< 18.5
Normal	**18.5 - 24.9**
Overweight	**25.0 - 29.9**
Obesity I	**30.0** - 34.9
Obesity II	35.0 - 39.9
Obesity III	> 40.0

Body Composition

Two-component system

— Fat-free mass

— Fat mass

— different densities

Underwater Weighing

Jack — 6.50 kg

Dave — 5.00 kg
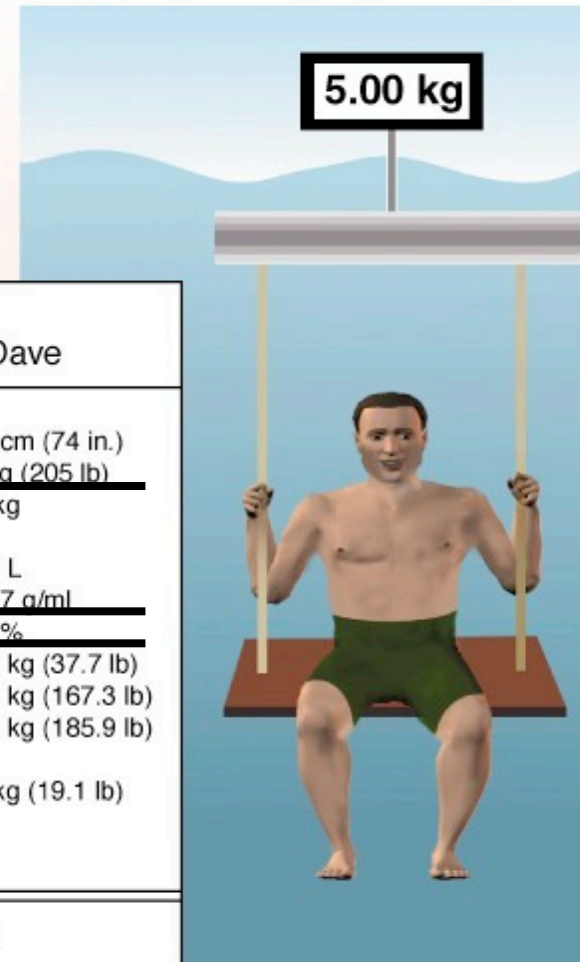
Variable	Jack	Dave
Height	188 cm (74 in.)	188 cm (74 in.)
Weight	93 kg (205 lb)	93 kg (205 lb)
Underwater weight	6.5 kg	5.0 kg
Volume	86.5 L	88.0 L
Density	1.075 g/ml	1.057 g/ml
Relative fat	10.5%	18.4%
Fat weight	9.7 kg (21.4 lb)	17.1 kg (37.7 lb)
Fat-free weight	83.3 kg (183.6 lb)	75.9 kg (167.3 lb)
Goal weight at 10% fat	92.6 kg (204.2 lb)	84.3 kg (185.9 lb)
Weight loss to achieve goal weight	0.4 kg (0.8 lb)	8.7 kg (19.1 lb)

Note. volume = weight − underwater weight
density = weight ÷ volume

Hydrostatic (Underwater) Weighing

Density = Mass ÷ Volume

— How is mass measured?

— How is volume measured?

Percent body fat = (495 ÷ **Density**) - 450

Underwater Weighing

Accuracy ± 2.0% at best

Lung volume

Air Plethysmography (Bod Pod)

Air Plethysmography (Bod Pod)
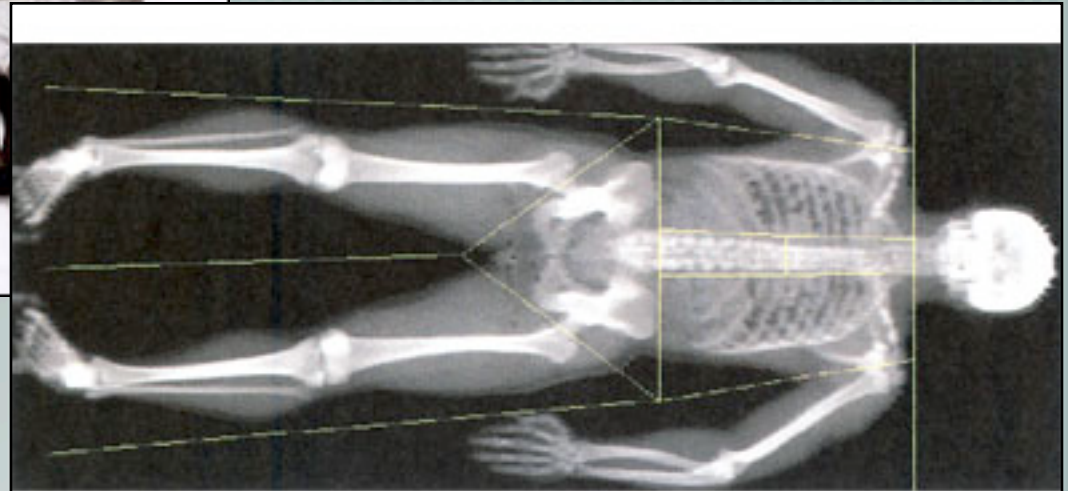
Measures **volume** from the amount of air displaced

- **Density** = Mass ÷ Volume

- **Percent body fat** = (495 ÷ **Density**) - 450

Accuracy ± 2-3%

Dual Energy X-Ray Absorptiometry (DEXA)

Accuracy ± 1-3%

DXA Results Summary:

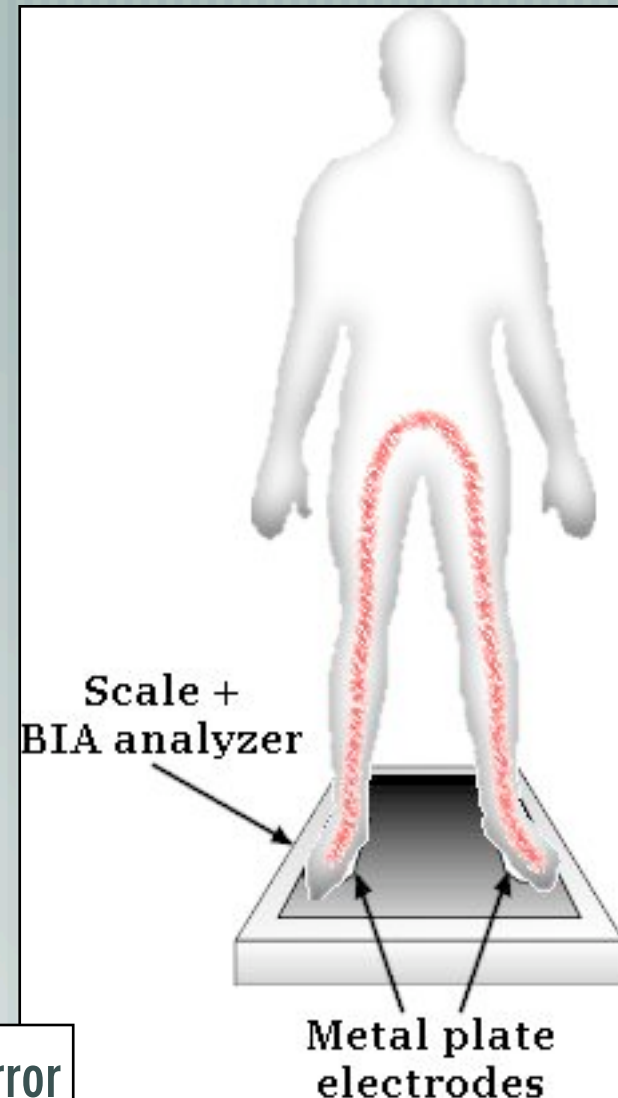| Region	BMC (g)	Fat (g)	Lean (g)	Lean+BMC (g)	Total Mass (g)	% Fat
L Arm	241.83	688.3	4341.9	4583.7	5272.1	13.1
R Arm	240.06	619.8	4574.3	4814.4	5434.2	11.4
Trunk	764.20	5359.8	29824.6	30588.8	35948.6	14.9
L Leg	602.89	2580.3	10541.8	11144.7	13725.0	18.8
R Leg	637.27	2819.1	10677.0	11314.2	14133.4	19.9
Subtotal	2486.24	12067.3	59959.6	62445.9	74513.2	16.2
Head	629.91	1118.3	4407.2	5037.1	6155.5	18.2
Total	3116.15	13185.6	64366.9	67483.0	80668.6	16.3

Bioelectrical Impedance Analysis

- Measures body water
- Fat-free mass is higher in water
- Accuracy ± 2 or more%

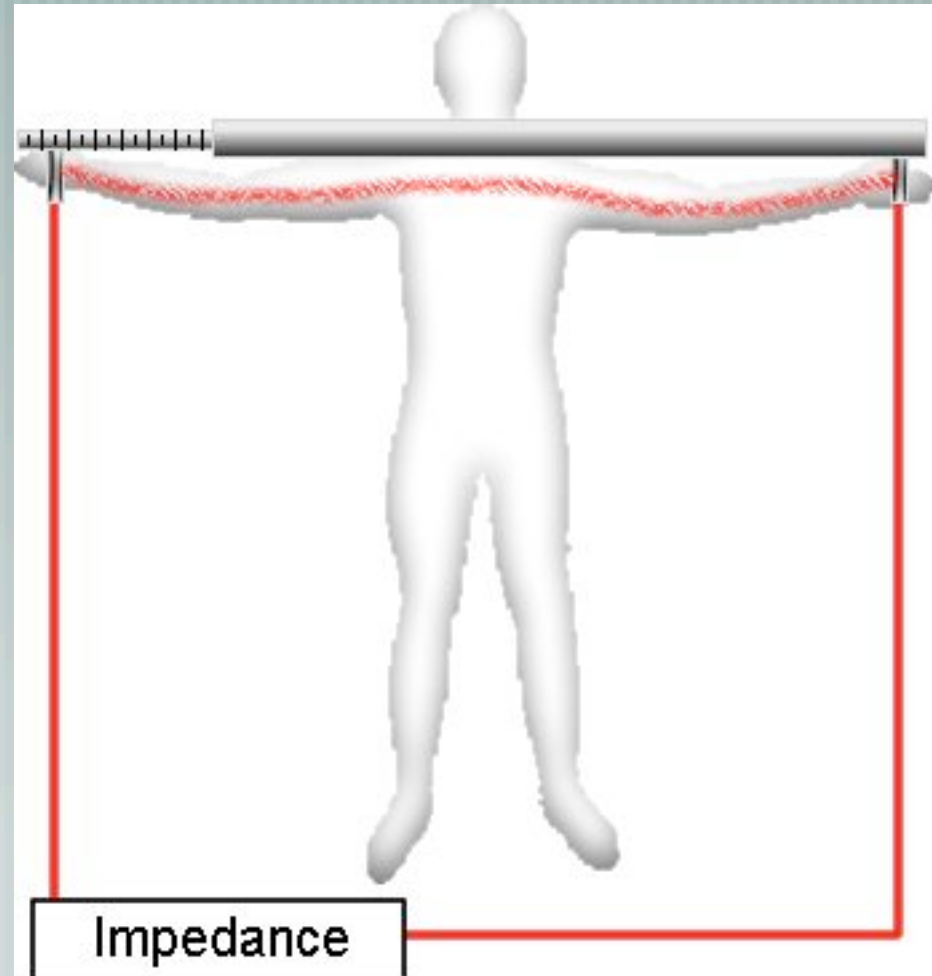Sensing electrodes (red)

BIS

Current electrodes (black)

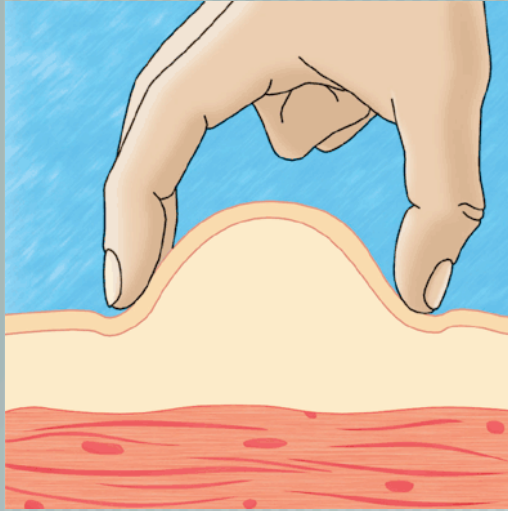# Bioelectrical Impedance Analysis

Scale +
BIA analyzer
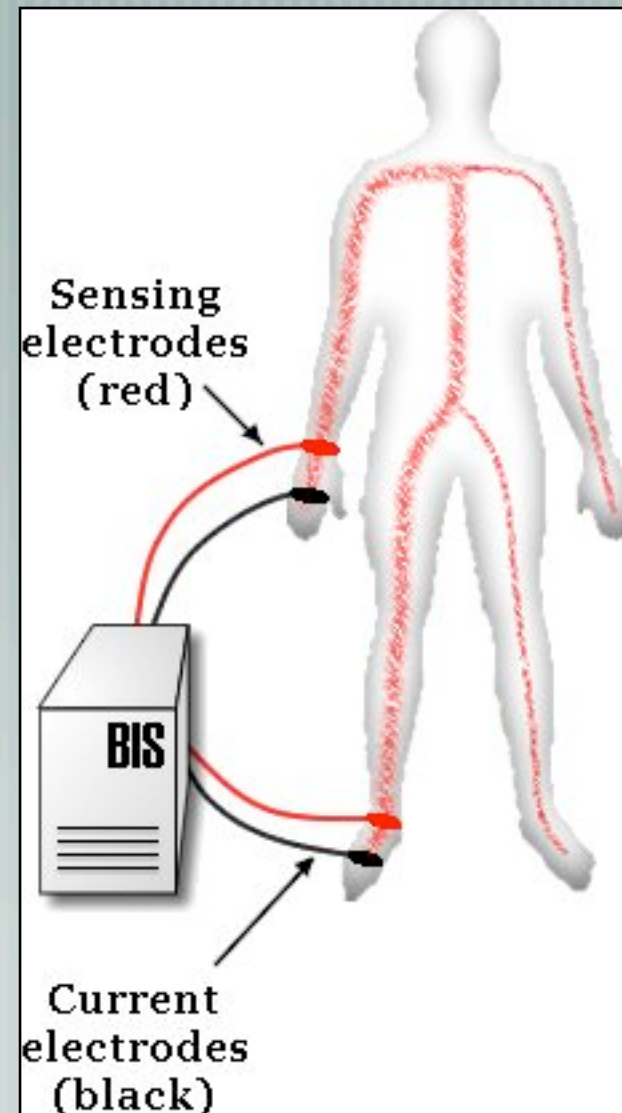
Metal plate
electrodes

Greater error

Bioelectrical Impedance Analysis

Skinfold Thickness

A. Triceps
B. Subscapula
C. Iliac
D. Abdomen
E. Thigh

Bone
Fat
Muscle
Skin
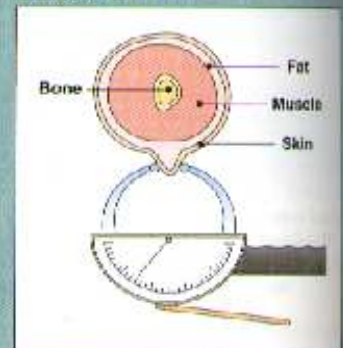
Skinfold Equations

Females:

Density = 1.0994921 - (0.0009929 X sum of 3 SKFs) + (0.0000023 X [sum of 3 SKFs]2) - (0.0001392 X age).

Males:

Density = 1.0938 - (0.0008267 X sum of 3 SKFs*) + (0.0000016 X [sum of 3 SKFs]2) - (0.0002574 X age).

Percent body fat = (495 ÷ **Density**) - 450

Accuracy 3.7% or more

Body Fat Values

- Men
  - **Recommended for health = 10-20%**
  - **Obese > 25%**
  - Recommended for performance = ?
  - Essential fat = 3-5%
- Females
  - **Recommended for health = 15-25%**
  - **Obese > 30%**
  - Recommended for performance = ?
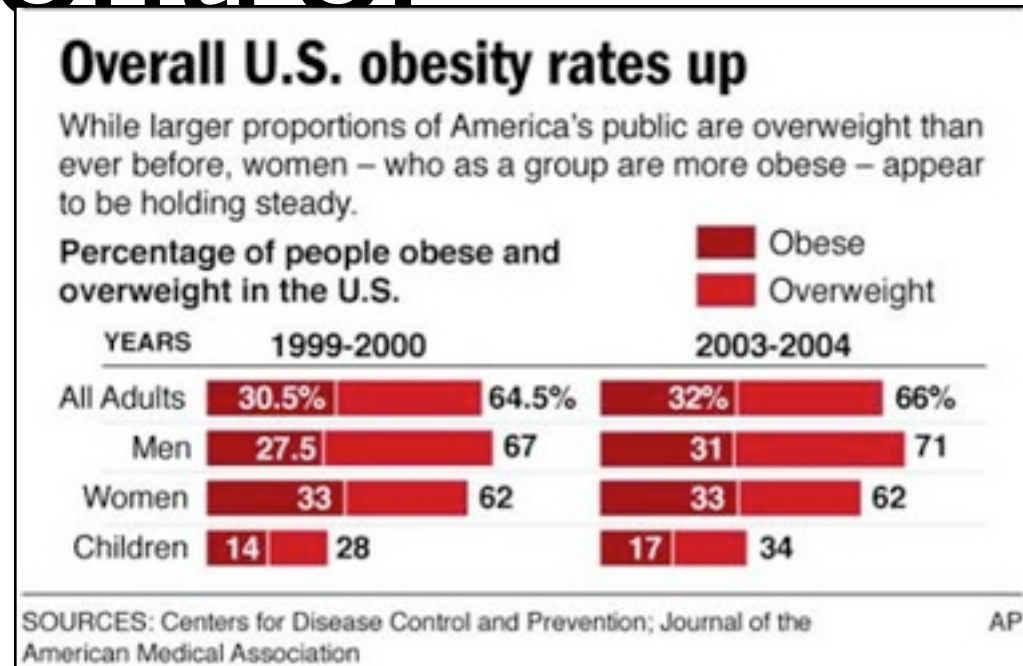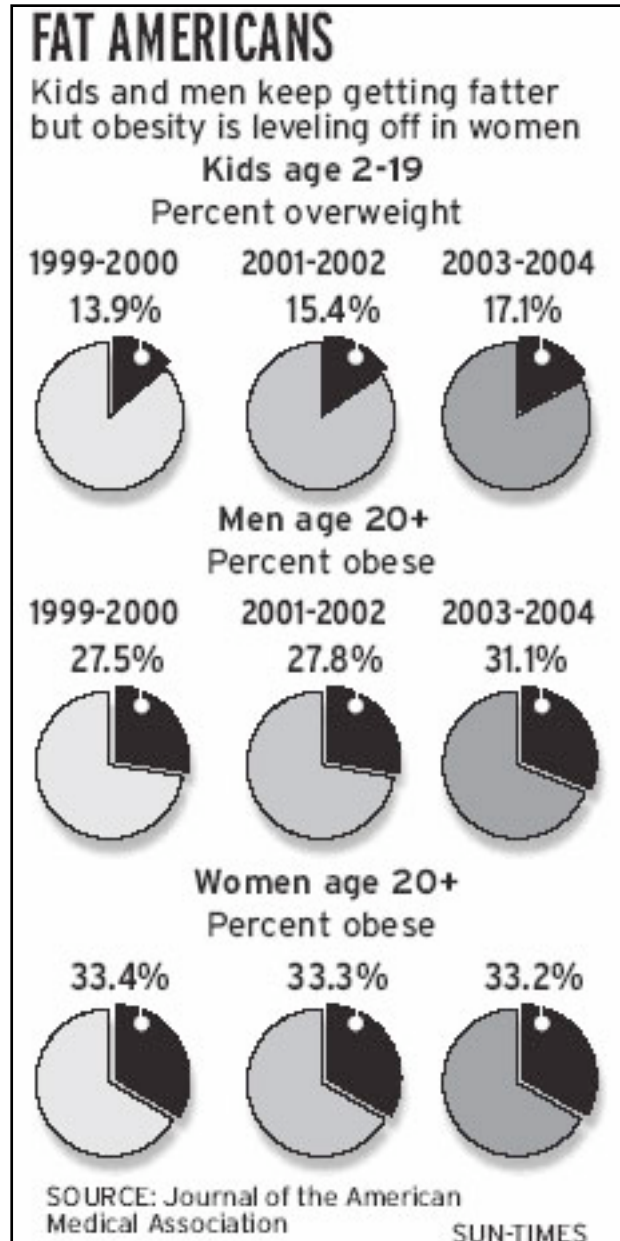 - Essential fat = 12-15%

Obesity and Weight Control

F.Y.I.

- BMI of ≥30 classification of obesity

- Prevalence of obesity in U.S. adults increased

  - 15% in 1976-80

  - 23.3% in 1988-94

  - 30.9% in 1999-2000

  - Include those classified as overweight (BMI 25-29)

  - Prevalence of overweight & obesity is 64.5%

Obesity and Weight Control

FAT AMERICANS

Kids and men keep getting fatter but obesity is leveling off in women

Kids age 2-19
Percent overweight

1999-2000	2001-2002	2003-2004
13.9%	15.4%	17.1%

Men age 20+
Percent obese

1999-2000	2001-2002	2003-2004
27.5%	27.8%	31.1%

Women age 20+
Percent obese

| 33.4% | 33.3% | 33.2% |

SOURCE: Journal of the American Medical Association

SUN-TIMES

Overall U.S. obesity rates up

While larger proportions of America's public are overweight than ever before, women – who as a group are more obese – appear to be holding steady.

Percentage of people obese and overweight in the U.S.

■ Obese
■ Overweight

YEARS	1999-2000		2003-2004	
All Adults	30.5%	64.5%	32%	66%
Men	27.5	67	31	71
Women	33	62	33	62
Children	14	28	17	34

SOURCES: Centers for Disease Control and Prevention; Journal of the American Medical Association
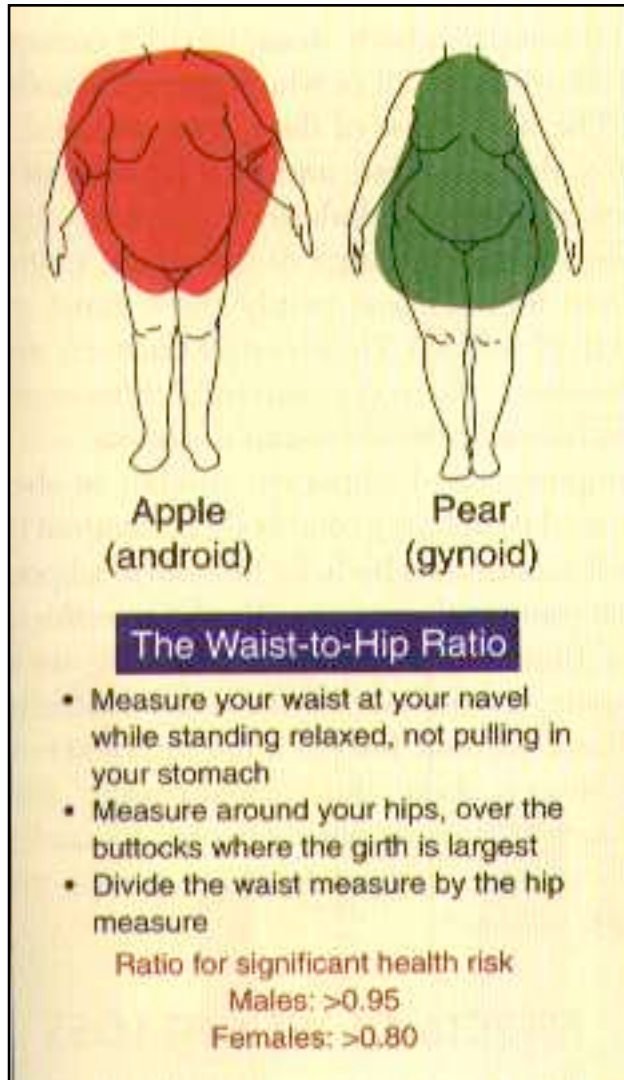
AP

Prevalence of Overweight and Obesity in the United States, 1999–2004

Cynthia L. Ogden, PhD; Margaret D. Carroll, MSPH; Lester R. Curtin, PhD; Margaret A. McDowell, MPH, RD; Carolyn J. Tabak, MD, MPH; Katherine M. Flegal, PhD

JAMA. 2006;295:1549-1555.

Waist to Hip Ratio

Apple (android)   Pear (gynoid)

The Waist-to-Hip Ratio

- Measure your waist at your navel while standing relaxed, not pulling in your stomach
- Measure around your hips, over the buttocks where the girth is largest
- Divide the waist measure by the hip measure

Ratio for significant health risk
Males: >0.95
Females: >0.80

- Not all obesity levels are the

- **Upper body**

- ratio > 0.95 for men

- ratio > 0.80 for women

Waist-Circumference

- Men < 40 inches

- Women < 35 inches
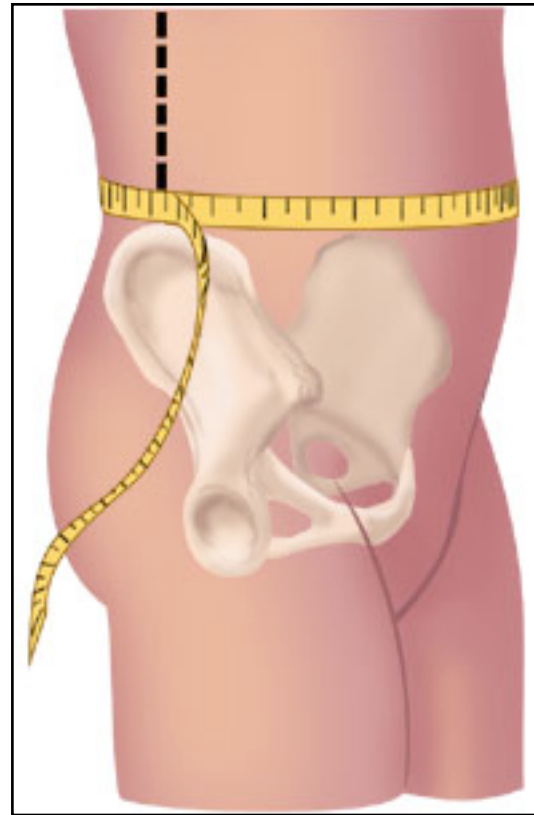
Obesity

- Prevalence of overweight in children and adolescents (ages 6-19)

  - 5-7% in late 1970

  - 11% in 1988-94

  - 15% in 2000

Obesity

☑

- Normal weight = 25 billion
  - Obese = 60-80 billion
- Less severe obesity
  - Fat cell **hypertrophy**
- Severe obesity (fat mass >30 kg)
  - Fat cell **hyperplasia**)
- Weight loss
  - Fat cell atrophy only
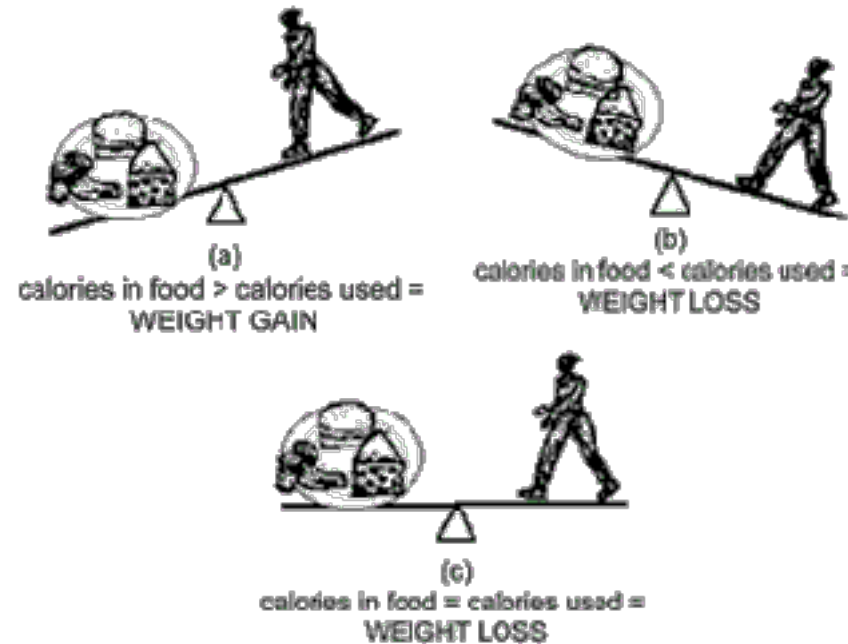 - Hyperplasia = more difficult weight loss/maintenance

Obesity ☑

- Genetic factors
  - **25%** of the transmissible variance for fat mass and percent body fat
- Cultural factors (**30**%)
- Individual choices (**45**%)

Weight Loss ☑

- Caloric balance or imbalance

  - Energy In > Energy Out = Weight Gain

  - Energy In < Energy Out = Weight Loss

- Caloric expenditure

  - RMR = 60-75%

  - Thermic effect of food = 10%

  - Physical activity = 15-30% of daily caloric expenditure

(a) calories in food > calories used = WEIGHT GAIN

(b) calories in food < calories used = WEIGHT LOSS

(c) calories in food = calories used = WEIGHT LOSS

Weight Loss

Weight loss greater than 1-2 pounds per week.

Where is the weight loss coming from?

- Fat
- Water
- Muscle

Energy And Nutrient Balance

- Calories of "Energy In" and "Energy Out" are not constant.

- Nutrient balance

  - **Excess carbohydrate and protein intake are not "converted" to fat.**

  - Rather, it causes less fat to be oxidized and therefore more fat to be stored.
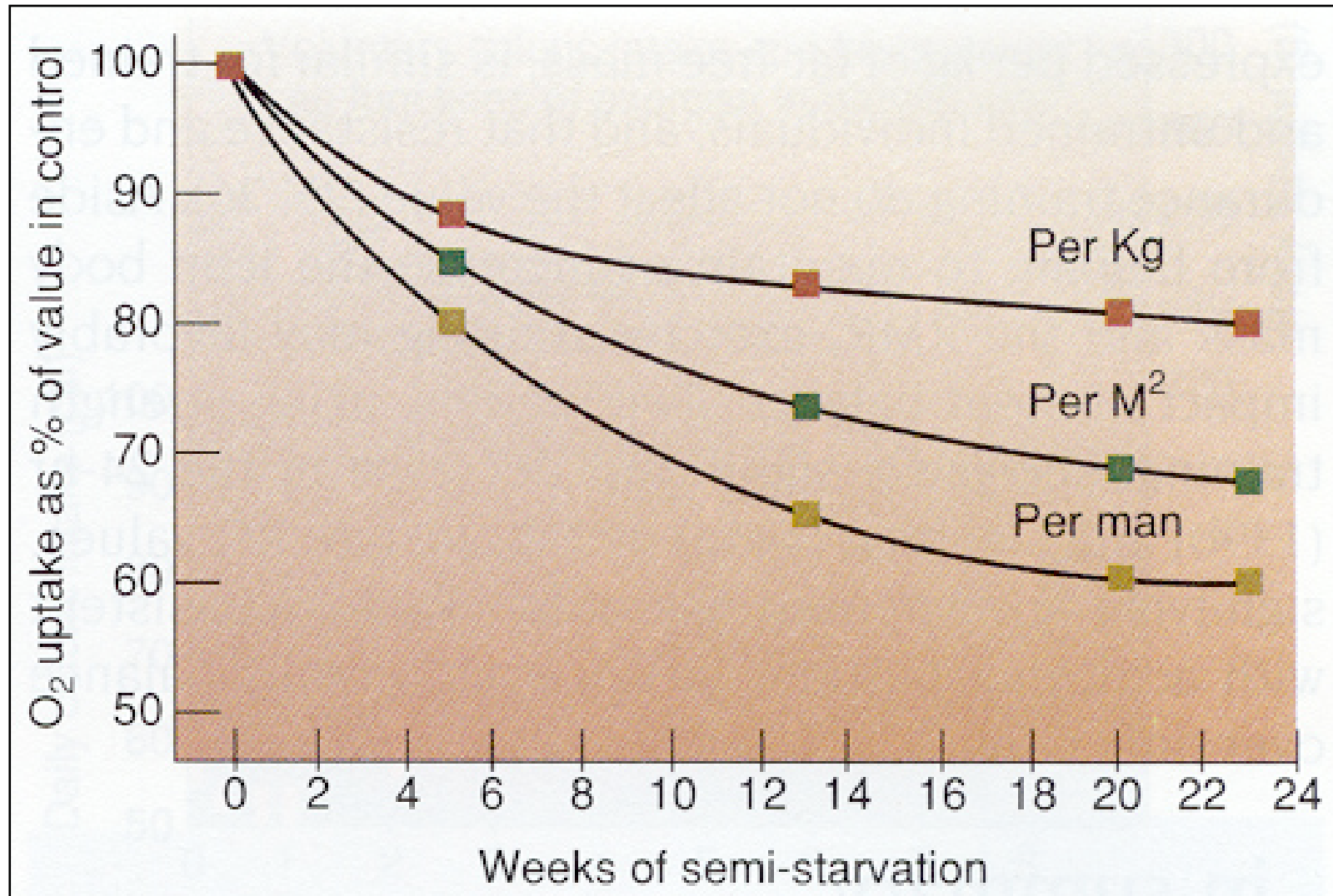
Weight Loss

- Recommendations:

  - **1-2 lbs of weight loss per week**

  - **500-1000 fewer calories per day**

    - **3,500-7,000 per week**

Diet and Weight Loss ☑

- Common to reduce energy intake by 1,000-1,500 kcals/day

- Very-low calorie diets (< 800 kcal/day)

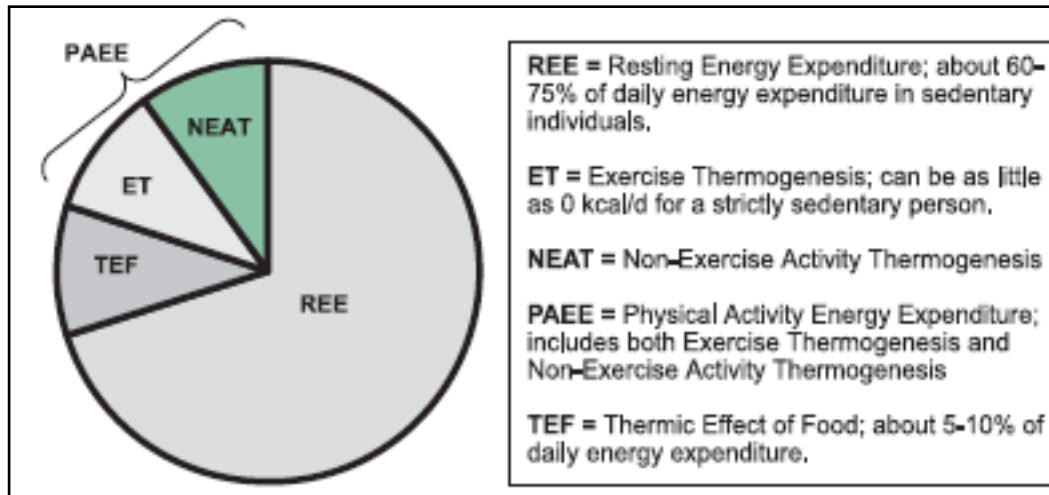 - temporary results at best

  - medical supervision

Caloric Intake and Resting Metabolic Rate

Metabolic Rate ☑

- Resting metabolic rate = **1 kcal/kg/hour**

  - For a 183 pound person, RMR = 2000 kcals.

- 60-75% of daily caloric expenditure

PAEE

NEAT

ET

TEF

REE

REE = Resting Energy Expenditure; about 60–75% of daily energy expenditure in sedentary individuals.

ET = Exercise Thermogenesis; can be as little as 0 kcal/d for a strictly sedentary person.

NEAT = Non-Exercise Activity Thermogenesis

PAEE = Physical Activity Energy Expenditure; includes both Exercise Thermogenesis and Non-Exercise Activity Thermogenesis

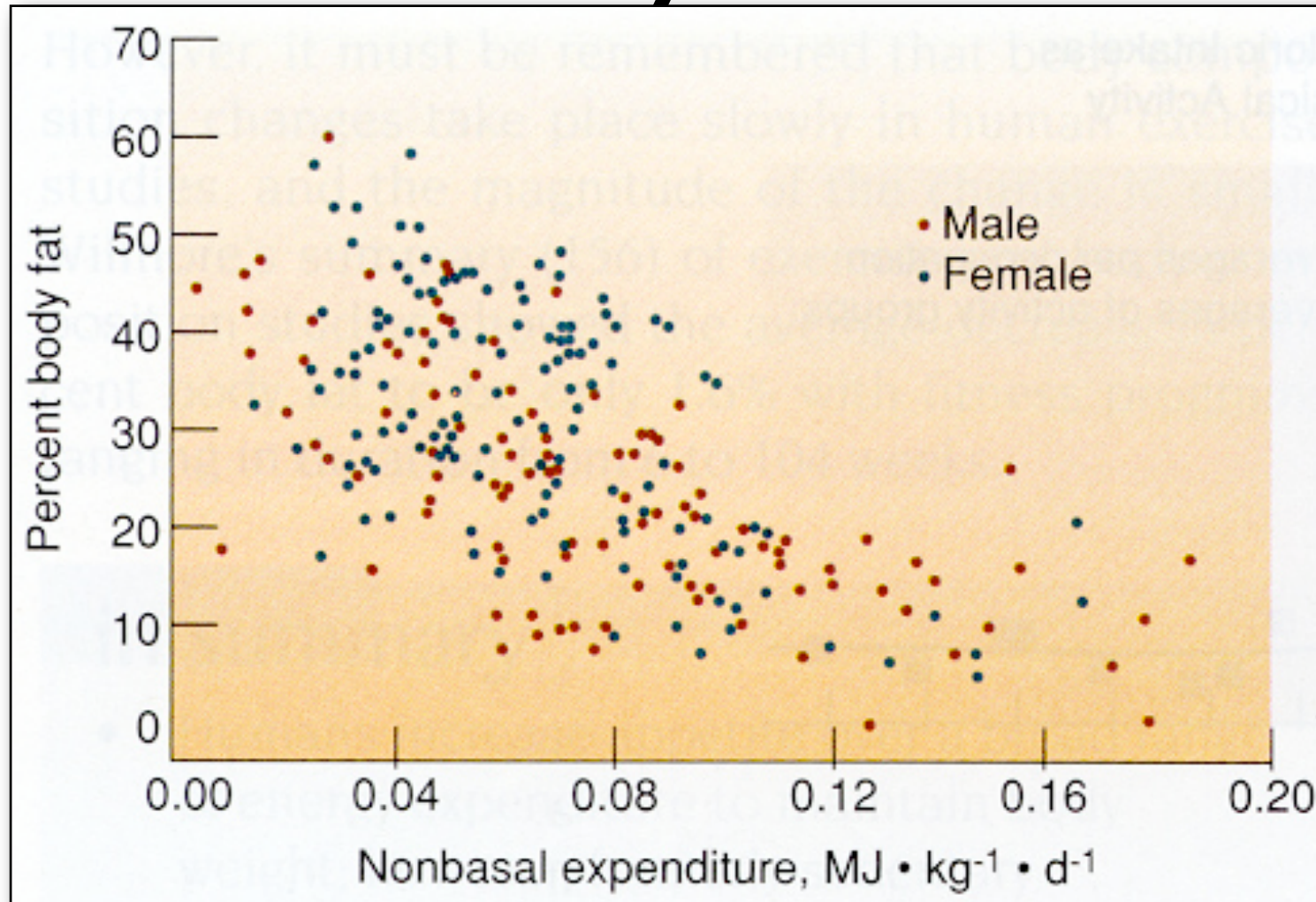**TEF** = Thermic Effect of Food; about 5-10% of daily energy expenditure.

Metabolic Rate

- Caloric intake

- Muscle mass

- Hormones

- etc.

Diet Composition

- Diet composition on weight loss is uncertain

- Why might a high protein diet be helpful with weight loss?

- Increase thermogenesis and satiety

Physical Activity and Body Fat

Exercise and Weight Loss

Exercise and Weight Loss ☑

- Exercise alone

  - less effective than diet alone

  - Duration:

    - 150 min/wk up to 300 min/wk

    - **> 2000 calories/wk**

- Caloric expenditure

  - 0.77 kcal / kg / mile for walking

  - 1.53 kcal / kg/ mile for running

| ACTIVITY	BODY WEIGHT (lbs)			
	120	160	200	240
Swimming, 25 yds/min	220	293	367	440
Walking, 3 mph	256	341	427	512
Tennis, singles	320	427	533	640
Bicycling, 12 mph	328	437	547	656
Cross-country skiing	560	747	933	1,120
Jogging, 5.5 mph	592	789	987	1,184
Running, 10 mph	1,024	1,365	1,707	2,048

Exercise and Weight Loss

- Exercise may be most critical to help <u>maintain</u> weight loss

- Exercise helps to maintain muscle mass and metabolic rate

Exercise and Weight Loss

- Aerobic exercise v Resistance exercise

  - resting metabolic rate

- Duration v Intensity

Fat Burning Zone?
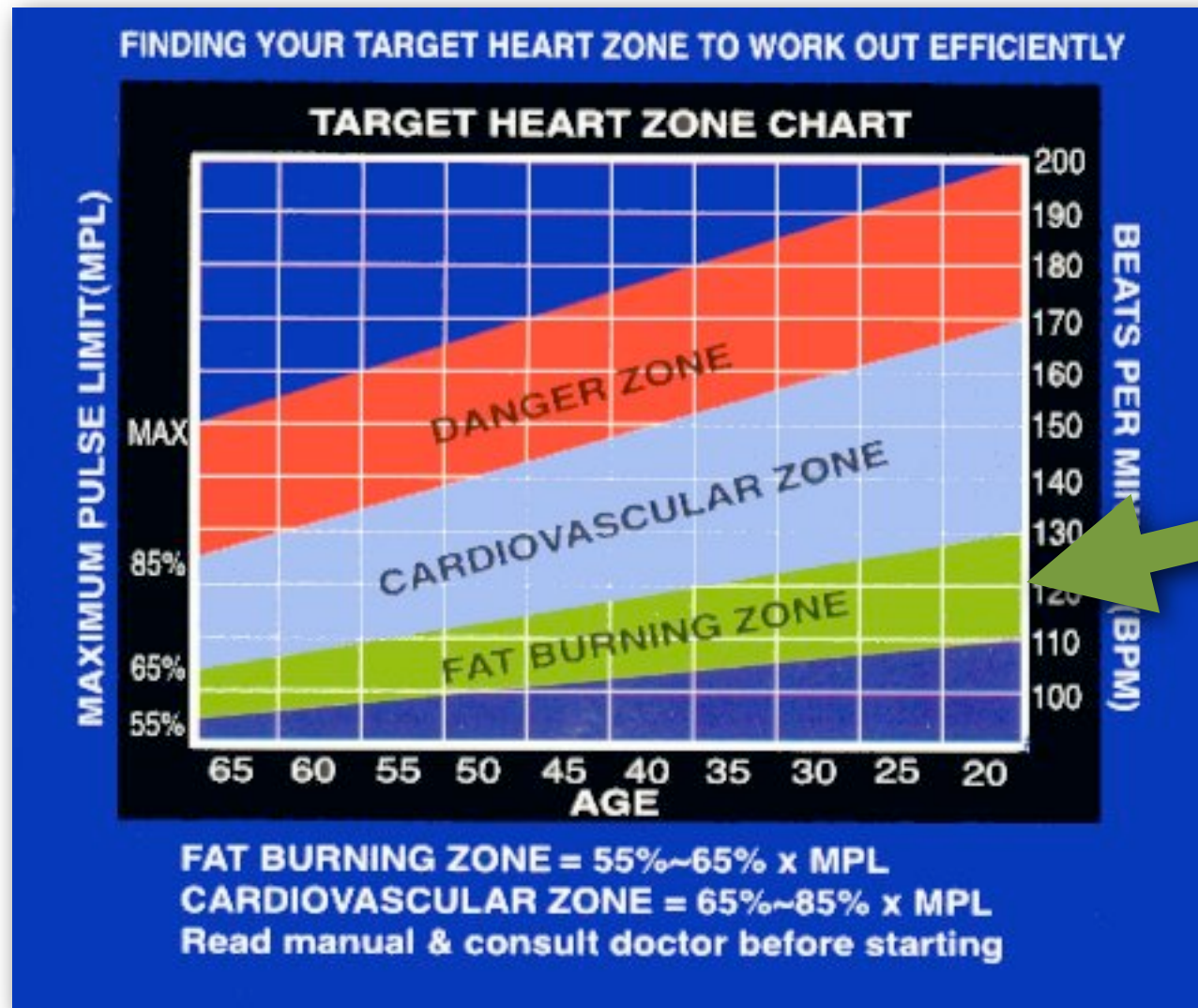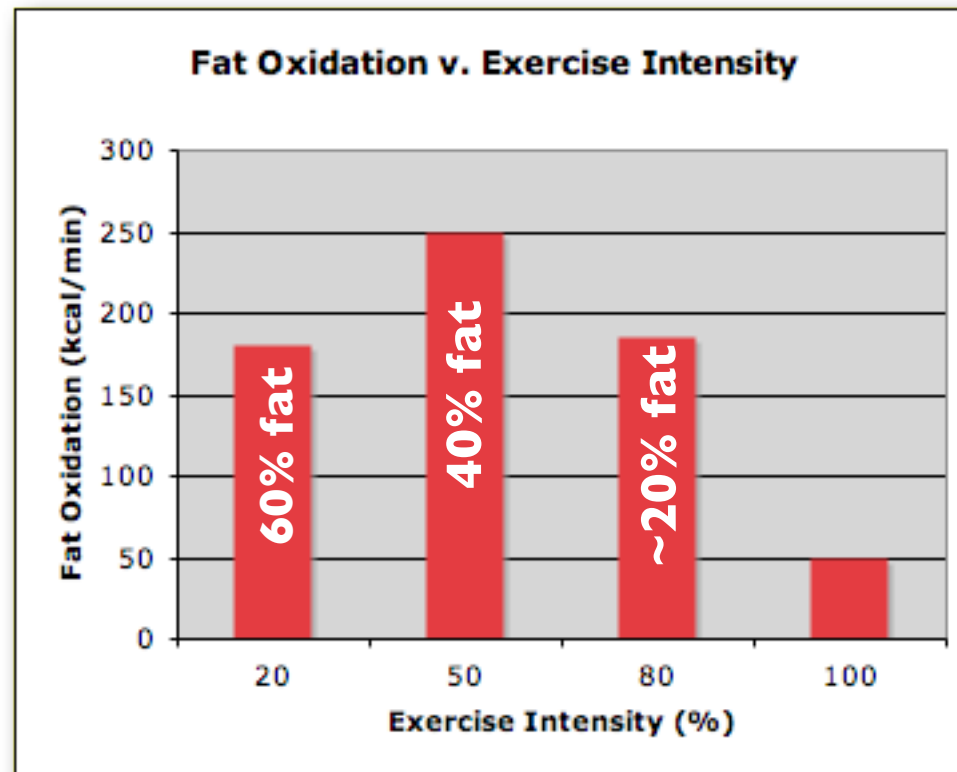
Exercise and Fat Metabolism

A

B

- Would you rather have 10% of person A's money or 90% of person B's money?

Exercise and Fat Metabolism

- Is low-intensity exercise best for burning fat? [A Closer Look 4.3]

Weight Loss

- Successful weight loss

  - diet and exercise

  - **Diet: limited caloric intake** (source of calories is unimportant)

  - **Exercise: expended ~400 kcal/day**