# BI 358 Lecture 6

…Fun Discussion + Blood Lab on Tuesday!!

I. ***Announcements*** **Quiz 2 Tuesday covers GI Physiol + Nutrition ≡ Lectures 4, 5 + 6 (1st ½). Discussion then wbc differential lab! Please read p 5-2 + articles sent by e-mail! By 5 pm Tuesday send nutrition reports to Anna *alakuni3@uoregon.edu* or Conor *conoro@uoregon.edu*. Outline update? Q?**

II. ***Nutrition Connections*** **-Sodium-Sugar, +Plants+Fish+Exercise?**

III. ***Blood + Body Resistance to Infection I***

**G&H ch 32, 33, LS, Stuart Fox, Daniel Chiras (DC), Basiro Davey**

A. **Blood: cell + fragments vs liquid (plasma vs serum) LS**
B. **Red blood cells, white blood cells, platelets, Demo? LS, DC**
C. **Red blood cell production, hemoglobin G&H pp 413-9**
   **G&H fig 32-1 thru 32-6 +..., Fox**
D. **Pathogen? Microbe that causes disease, Davey pp 5-6**
E. **Barriers to infection Davey fig 2.1 p 12, fig 2.2 p 13**
F. ***National Geographic,* The Wars Within, Lennart Nilsson**
   ***http://www.lennartnilsson.com/***
G. **WBC effectors: Innate & adaptive immunity G&H pp 433-7**
   **G&H fig 34-1 + Davey fig 2.2 p 13, fig 3.4 p 24, fig 3.12 p 36**
H. **Medical Physiology News Handwashing to prevent infection! US Centers for Disease Control**

## NUTRITION SCORECARD (PER SERVING)

| SODIUM | FAT | FIBER | ANTIOXIDANT |
|---|---|---|---|
| 50mg | 2.5g | 4g | 45% RDI* |

*VITAMIN A

Health Valley Organic®

American Heart Association CERTIFIED Meets Criteria For Heart-Healthy Food

# NO SALT ADDED Vegetable SOUP

USDA ORGANIC

NET WT 15 OZ (425g)

*Our Organic Vegetable Soup is made with the finest ingredients and has* ***No Salt Added.*** *It is also an excellent source of antioxidant vitamin C (20%) and antioxidant vitamin A (45%) and a good source of fiber (4g).*

**READY TO SERVE - DO NOT ADD WATER**

**STOVE:** Heat, stir as necessary.

**MICROWAVE:** Heat in a covered microwave safe bowl on HIGH for about 2 minutes or until hot. Remove carefully.

**QUESTIONS/COMMENTS:** 1-800-434-4246, or visit **www.healthvalley.com**.

# Nutrition Facts

Serv. Size 1 Cup (240g)
Servings about 2
**Calories** 100
Fat Cal. 25

| Amount/serving | % DV* | Amount/serving | % DV* |
|---|---|---|---|
| **Total Fat** 2.5g | **4%** | **Total Carb.** 18g | **6%** |
| Sat. Fat 0g | **0%** | Dietary Fiber 4g | **16%** |
| *Trans* Fat 0g | | Sugars 4g | |
| **Cholest.** 0mg | **0%** | **Protein** 3g | **5%** |
| **Sodium** 50mg | **2%** | | |

*Percent Daily Values (DV) are based on a 2,000 calorie die

Vitamin A 45% • Vitamin C 20% • Calcium 4% • Iron 8%

This Health Valley Organic® Soup contains 50 milligrams sodium per serving. Other leading brands contain 860 milligrams sodium or more per serving. This is not a sodium free food.

**Exchanges:**
2 Vegetable, ½ Starch

**MADE WITH NO GENETICALLY ENGINEERED INGREDIENTS.**

† Can lining not derived from BPA

Leading brands ≥ 860 mg per serving!

If whole can x2!

| | |
|---|---|
| Vit A | 90% |
| Vit C | 40% |
| $Ca^{2+}$ | 8% |
| $Fe^{2+}$ | 16% |

**INGREDIENTS:** FILTERED WATER, ORGANIC POTATOES, ORGANIC CARROTS, ORGANIC CELERY, ORGANIC TOMATOES, ORGANIC PEAS, ORGANIC GREEN BEANS, ORGANIC CORN, ORGANIC ONIONS, ORGANIC TOMATO PASTE, ORGANIC CORN STARCH, ORGANIC BROCCOLI, ORGANIC RED KIDNEY BEANS, ORGANIC EXPELLER PRESSED CANOLA OIL, ORGANIC EVAPORATED CANE JUICE, ORGANIC SPINACH, ORGANIC ONION POWDER, ORGANIC GARLIC GRANULES, ORGANIC SPICES, ORGANIC CONCENTRATED LEMON JUICE, ORGANIC WHITE PEPPER, ORGANIC CAYENNE PEPPER, VITAMIN A PALMITATE.

Certified GF™ Gluten-Free GFCO.org

NON-BPA LINING†

X2071-008

0 35742 22101 7

**MANUFACTURED FOR DISTRIBUTION BY:**
THE HAIN CELESTIAL GROUP, INC., LAKE SUCCESS, NY 11042 USA

**CERTIFIED ORGANIC BY QUALITY ASSURANCE INTERNATIONAL (QAI)**

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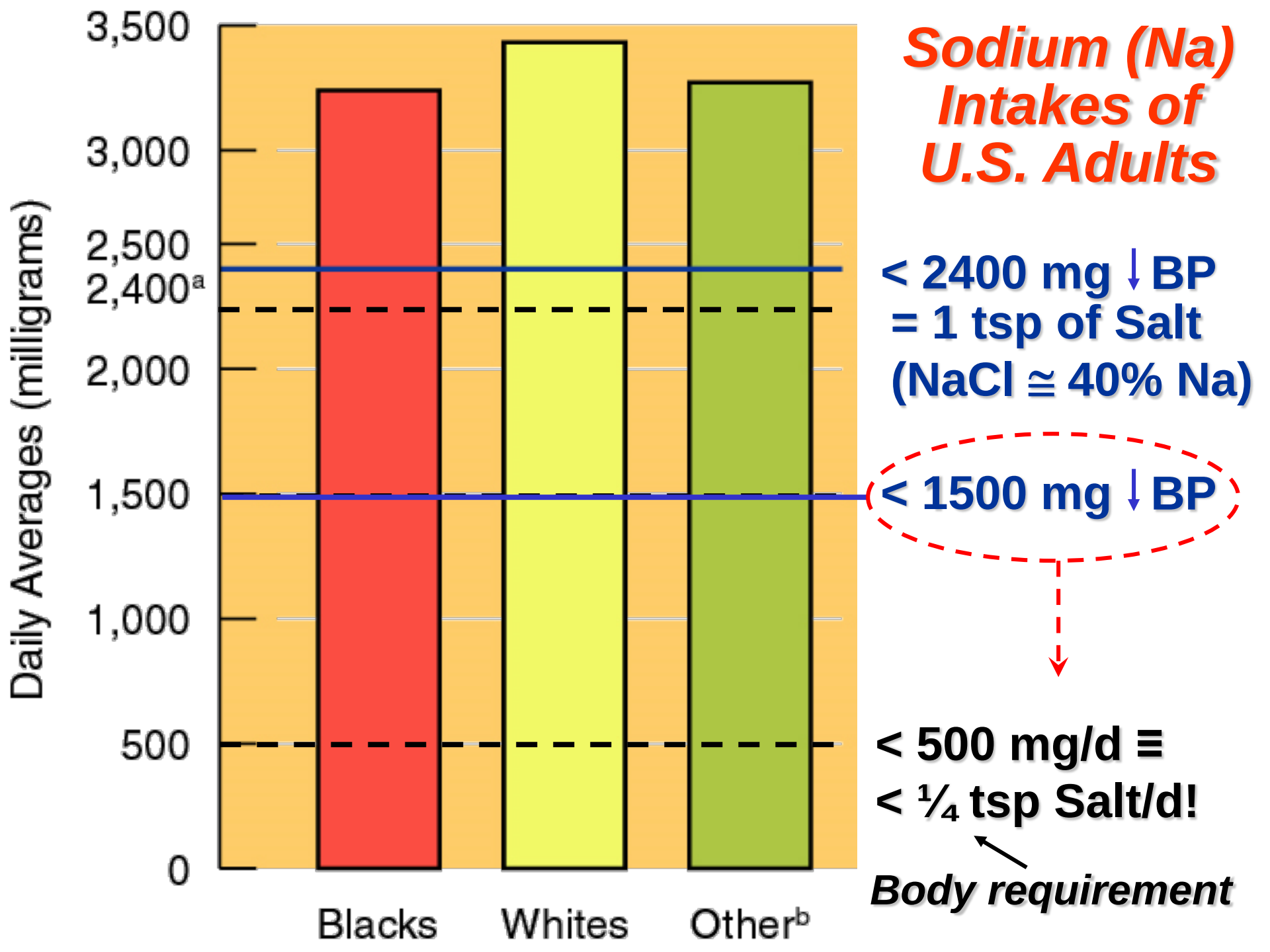
# Why Lower Sodium?

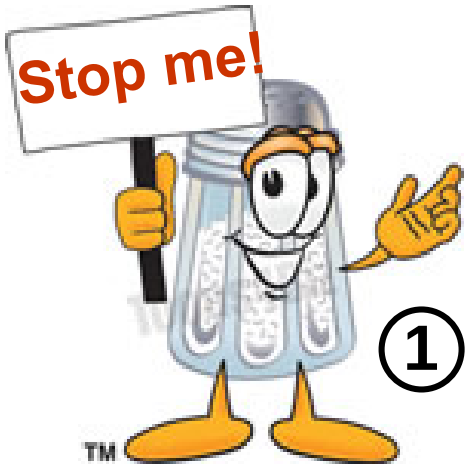
# *Sodium Reduction as a Means to Prevent Cardiovascular Disease and Stroke*

1. ***Approximately 90% of Americans will develop high blood pressure or hypertension over their lifetime.***
2. ***BP-related diseases: stroke, CHD, heart failure & kidney disease are leading causes of morbidity & mortality in the US & throughout the world.***
3. ***Independent of its effects on BP, excess sodium intake adversely affects the heart, kidneys & blood vessels.***
4. ***Reducing sodium intake to < 1500 mg/d should reduce American deaths from CVD & stroke by 20%.***

***http://sodiumbreakup.heart.org/***


Sodium (Na) Intakes of U.S. Adults
Daily Averages (milligrams)
3,500
3,000
2,500
2,400[a]
2,000
1,500
1,000
500
0
Blacks
Whites
Other[b]
< 2400 mg ↓ BP
= 1 tsp of Salt
(NaCl ≅ 40% Na)
< 1500 mg ↓ BP
< 500 mg/d ≡
< ¼ tsp Salt/d!
Body requirement

# *More Reasons to Shake the Salt Habit*



① ↓blood vessel vasodilation w/in 30 min by ingesting 1500 mg Na+!

② ↑$Ca^{2+}$ excretion ↑bone loss, risk of osteoporosis & fractures.

③ May directly impair kidney function & ↑risk of kidney stones.

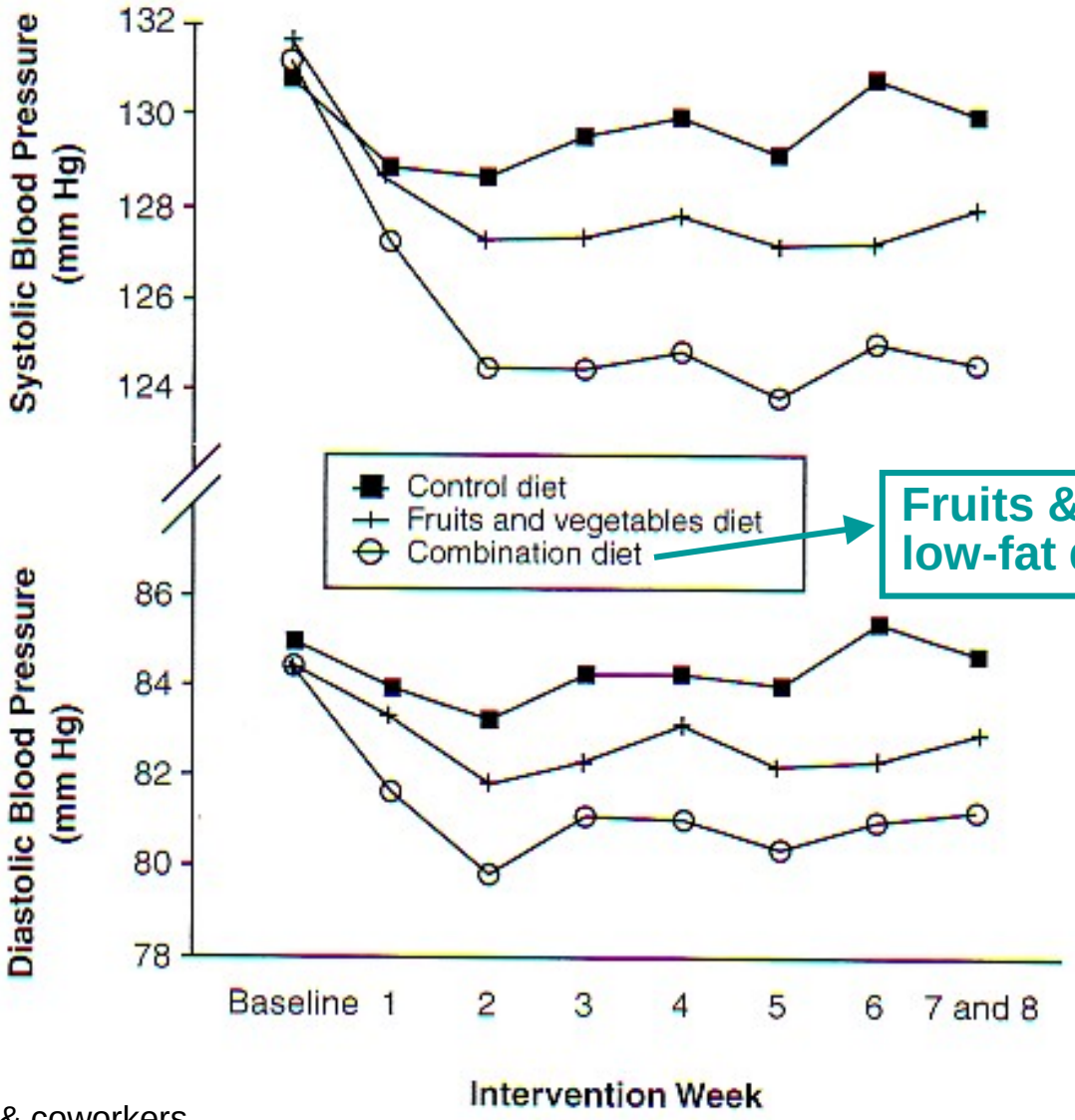
④ GI cancer risk, inflammation?

I'm outta here!!

*UCB WellnessLetter* Jun 2011, Jan 2012

*Mayo Clinic* How to tame your salt habit!

# *Dietary Approaches to Stop Hypertension (DASH)*




**Fruits & vegetables + low-fat dairy products**

***SOURCE***: LJ Appel & coworkers, *NEJM* 1997,336:1117-24

***http://www.nhlbi.nih.gov/health/health-topics/topics/dash***

# Why Lower Simple Sugars?

***Each person in the US ingests ~ ¾ cup or 31 tsp of refined sugars added to foods & beverages each day ≡ > 140 lb per year!***

Sizer & Whitney 2011 p 145

# *Sugar in processed foods?*

1 Tbs creamer = 2 tsp sugar

12 oz cola ≥ 10 tsp sugar

8 oz sweetened yogurt = 8 tsp sugar

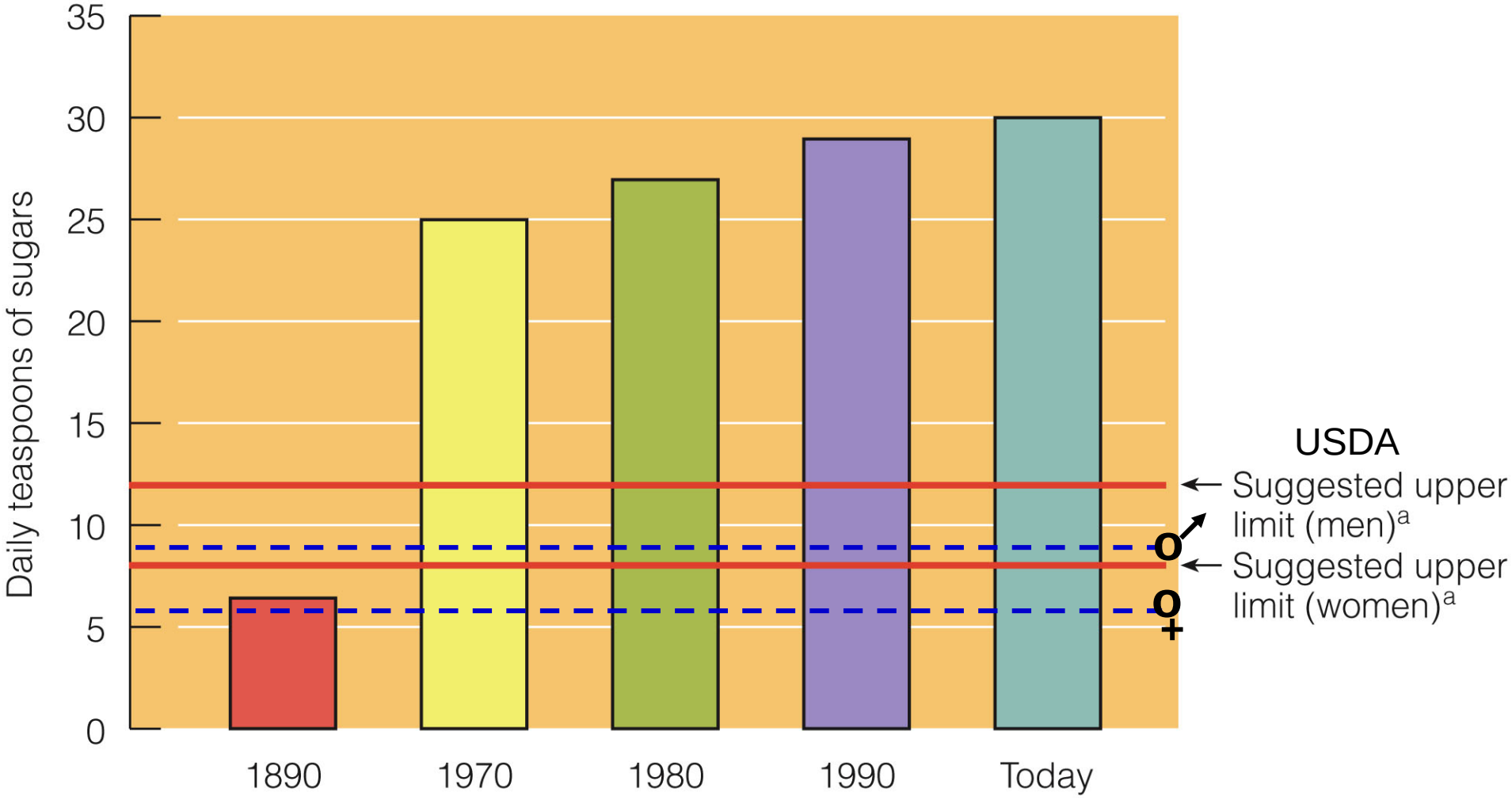
1 Tbs ketchup = 1 tsp sugar

½ cup canned corn = 1 tsp sugar

2 oz chocolate = 8 tsp sugar

Sizer & Whitney 2011 fig 4-17 p 139

# *Added Sugars: Average US Supply per Person*




**AHA suggested upper limits!**

S&W 2011 fig C4-4 p 145

# DIABETES

## How to Play Defense

BY BONNIE LIEBMAN

"Number of people with diabetes increases to 24 million," announced the Centers for Disease Control and Prevention in June.

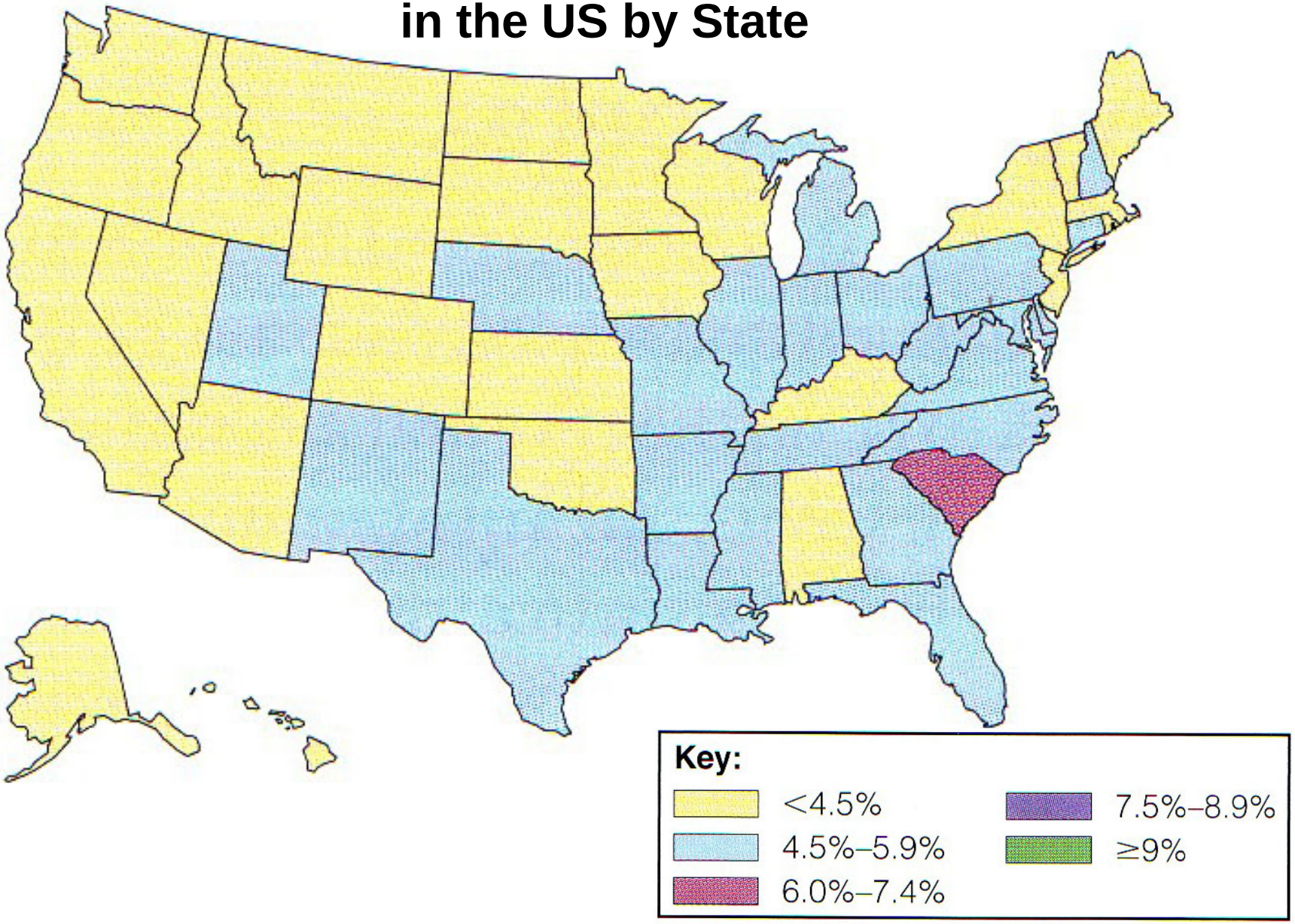
One out of four Americans aged 60 or older now has the disease. Another 57 million people—40 percent of those aged 40 to 70—have pre-diabetes. Diabetes has even started to show up in teenagers.

"We've seen strong and sustained increases in the incidence of diabetes since 1990, and they show no signs of slowing down," notes Linda Geiss, chief of diabetes surveillance at the CDC. "It's like a runaway train."

Is there any good news about an epidemic that's out of control?

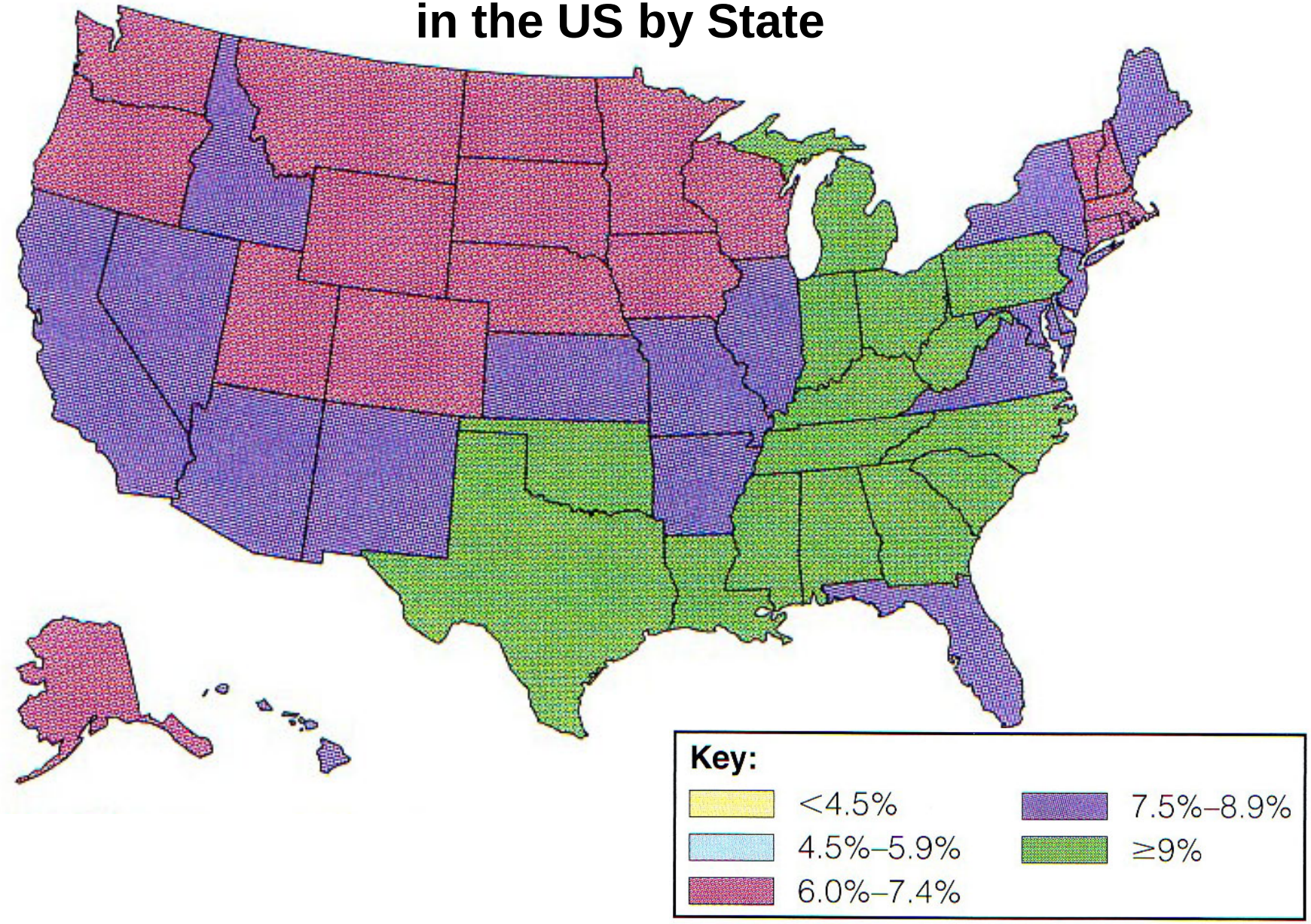
"Diabetes is an almost totally avoidable disease," says Walter Willett of the Harvard School of Public Health in Boston. "We estimate that more than 92 percent of the cases could be avoided by diet and lifestyle."

# 1994 Diabetes Prevalence in the US by State



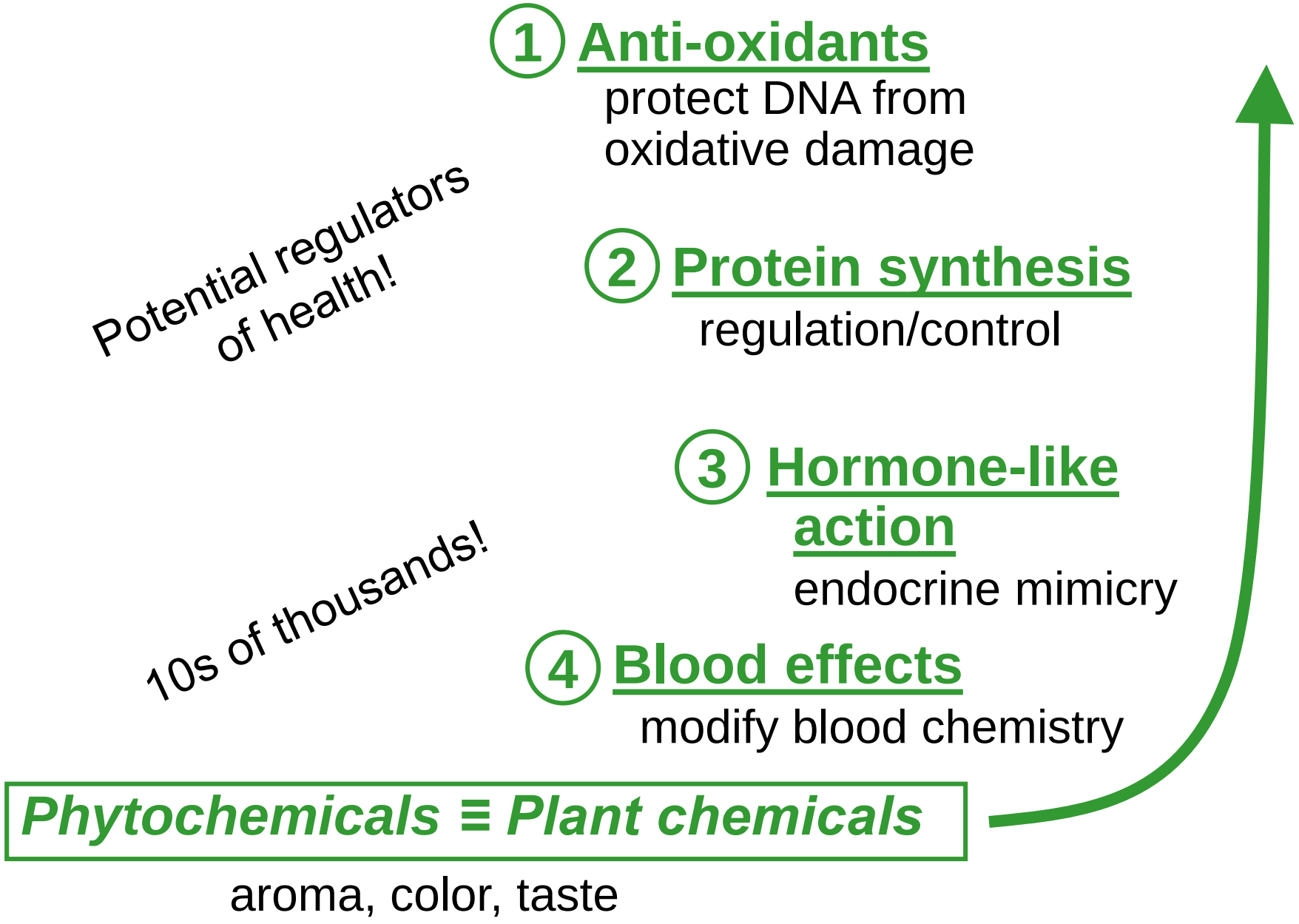

*Source*: Centers for Disease Control, Division of Diabetes Translation, *http://www.cdc.gov/diabetes/statistics*, S&W 2014 fig 4-15 p139A.

# 2010 Diabetes Prevalence in the US by State




*Source*: Centers for Disease Control, Division of Diabetes Translation, *http://www.cdc.gov/diabetes/statistics*, S&W 2014 fig 4-15 p139B.

Why More Fruits, Vegetables Whole Grains & Beans?


1 Anti-oxidants
protect DNA from oxidative damage
Potential regulators of health!
2 Protein synthesis
regulation/control
3 Hormone-like action
endocrine mimicry
10s of thousands!
4 Blood effects
modify blood chemistry
Phytochemicals ≡ Plant chemicals
aroma, color, taste

# *Recommendations for* ***CANCER PREVENTION***

1. Be as lean as possible without becoming underweight.
2. Be physically active for at least 30 minutes every day.
3. Avoid sugary drinks. Limit the consumption of energy-dense foods particularly processed foods high in added sugar, or low in fiber, or high in fat.
4. Eat more of a variety of vegetables, fruits, whole grains & legumes such as beans.
5. Limit consumption of red meats (such as beef, pork & lamb) & avoid processed meats.
6. If consumed at all, limit alcoholic drinks to 2 for men & 1 for women a day.
7. Limit consumption of salty foods & foods processed with salt (sodium).
8. Don't use supplements to protect against cancer.

# *American Institute for Cancer Research Foods that Fight Cancer*

Beans fiber, saponins, protease inhibitors, phytic acid.

Berries fiber, vitamin C, ellagic acid, flavonoids

Cruciferous Vegetables glucosinolates: glucoraphin → sulphoraphane, crambene, indole-3-carbinol & isothiocyanates

Dark Green Leafy Vegetables fiber, folate, carotenoids: $1^0$ lutein & zeaxanthin; saponins, flavonoids

Flaxseed lignans (a phyto-E), α-linolenic acid (an Ω-3)

Garlic organosulfurs: allicin, alliin, allyl sulfides; quercetin,...

Grapes and Grape Juice resveratrol (a polyphenol)

Green Tea catechins (class of flavonoids), polyphenols

Soy isoflavones, saponins, phenolic acids, phytic acid, phytosterols, protein kinase inhibitors

Tomatoes lycopene

Whole Grain fiber, vitamins, minerals, 100s of phytochemicals: antioxidants, phenols, lignans (a phyto-E), saponins

***http://www.aicr.org/site/PageServer?pagename=foodsthatfightcancer_home***

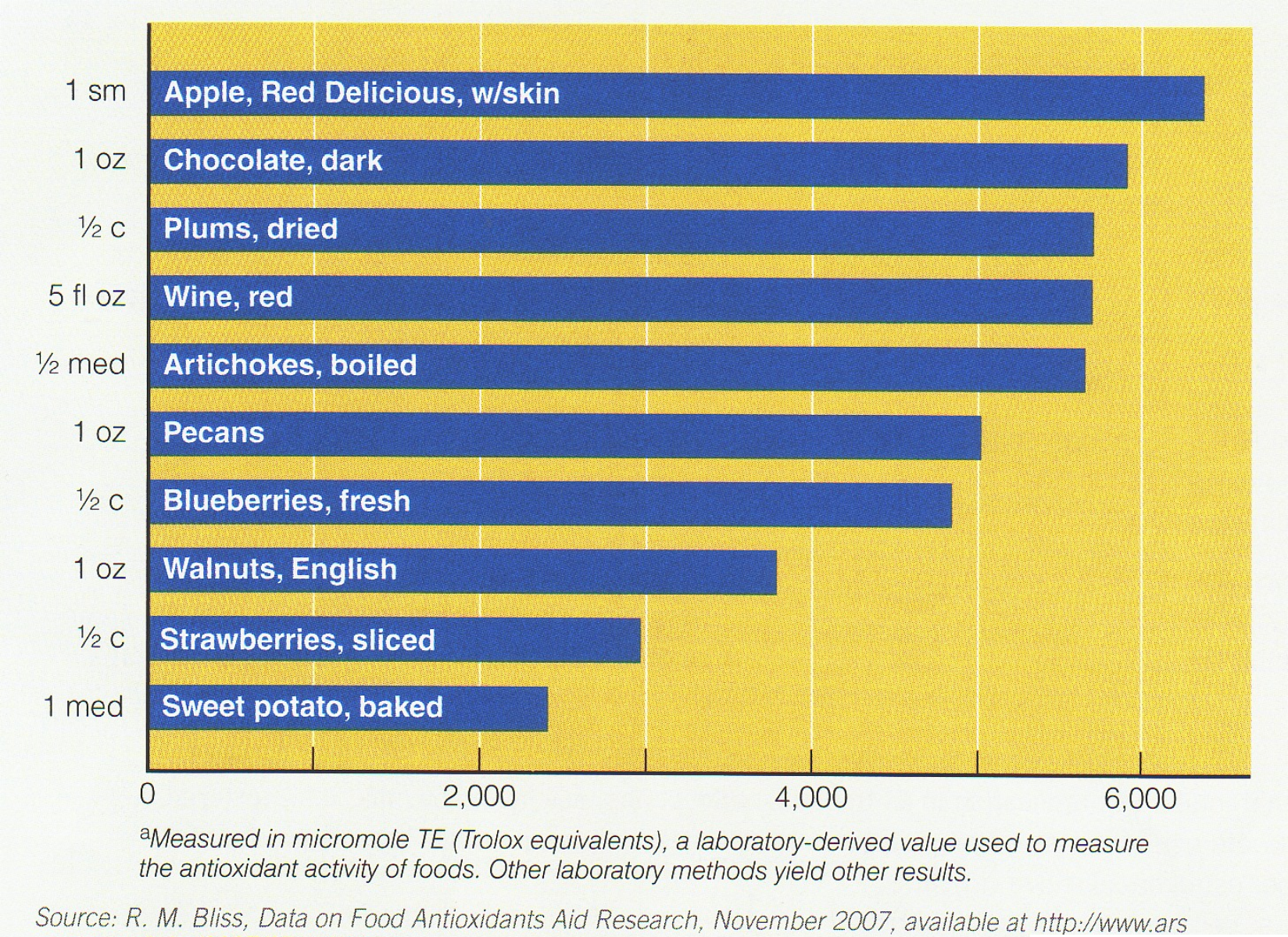
TABLE C2-3

# Common Foods Ranked by Antioxidant Content

1. Blackberries
2. Walnuts
3. Strawberries
4. Spinach
5. Artichokes, prepared
6. Cranberries
7. Coffee
8. Raspberries
9. Pecans
10. Blueberries
11. Cloves, ground
12. Grape juice, cranberry juice, pomegranate juice
13. Chocolate, dark, unsweetened
14. Cherries, sour
15. Wine, red

Sizer & Whitney 2011 Table C2-3 p 64

# *Antioxidant Capacity Depends Upon Seasons, Storage, Testing Methods, Variety…*




[a]*Measured in micromole TE (Trolox equivalents), a laboratory-derived value used to measure the antioxidant activity of foods. Other laboratory methods yield other results.*

*Source: R. M. Bliss, Data on Food Antioxidants Aid Research, November 2007, available at http://www.ars.usda.gov/is/pr/2007/071106.htm.*

S&W 2014 fig C2-1 p 66

# *Broccoli sprouts may contain ~ 10,000 unique phytochemicals!*

Sizer & Whitney 2011 p 66

# A Wealth of Phytochemicals

All cruciferous vegetables contain powerful cancer-fighting phytochemicals, including:

*diindolylmethane* (DIM), one of many *indoles* found in these vegetables, has been shown to inhibit proteins associated with breast and ovarian cancers.

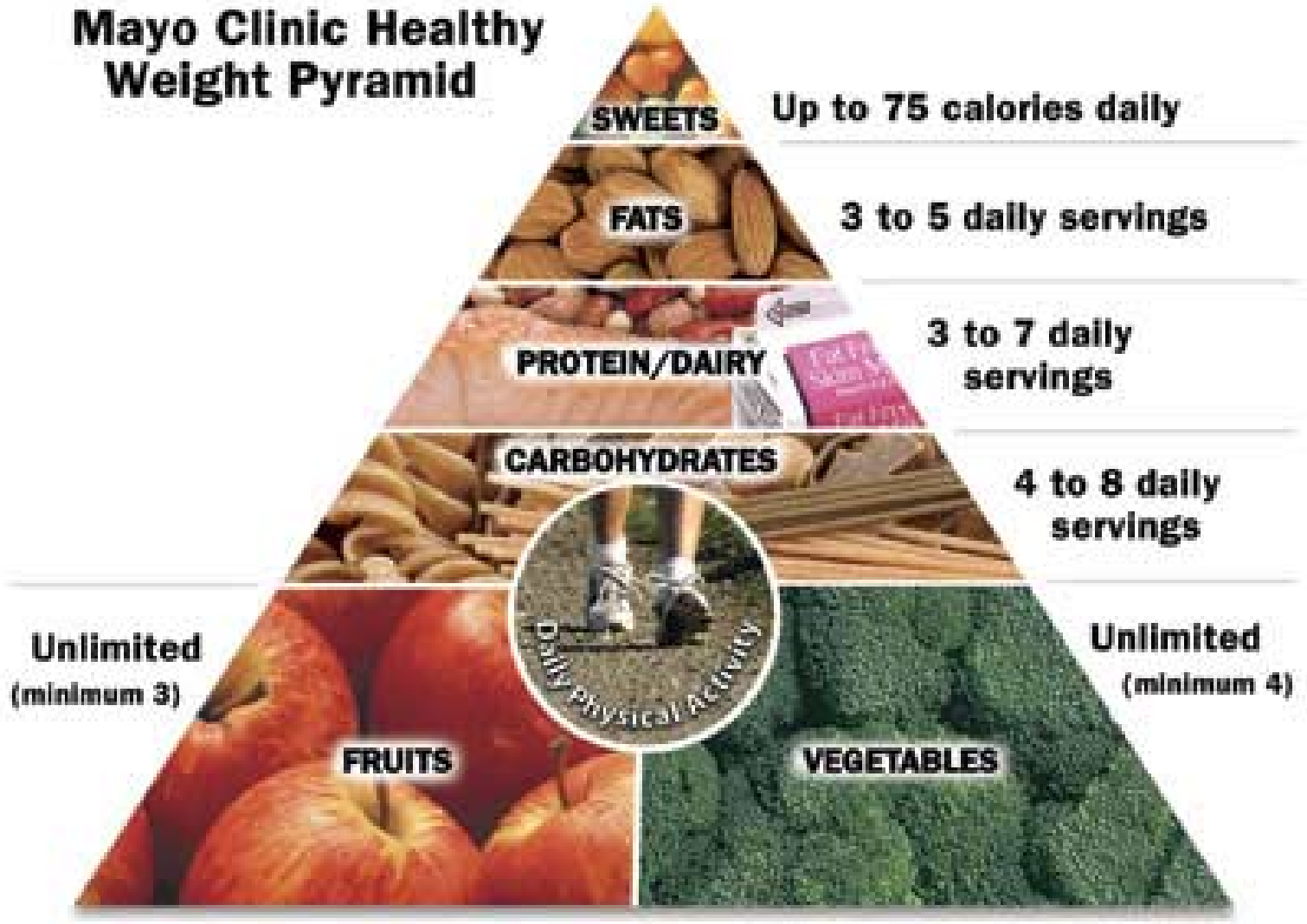
*crambene*, plentiful in Brussels sprouts, may offer the most preventive benefits when combined with *indole-3-carbinol (I3C)*.

*glucosinolates*, which turn into powerful protective agents called *isothiocyanates* when a cruciferous vegetable is chewed or chopped. May reduce inflammation, a factor in cancer development.

# ≥ 5 tomato-containing meals per week may protect from cancers of the esophagus, stomach & prostate !

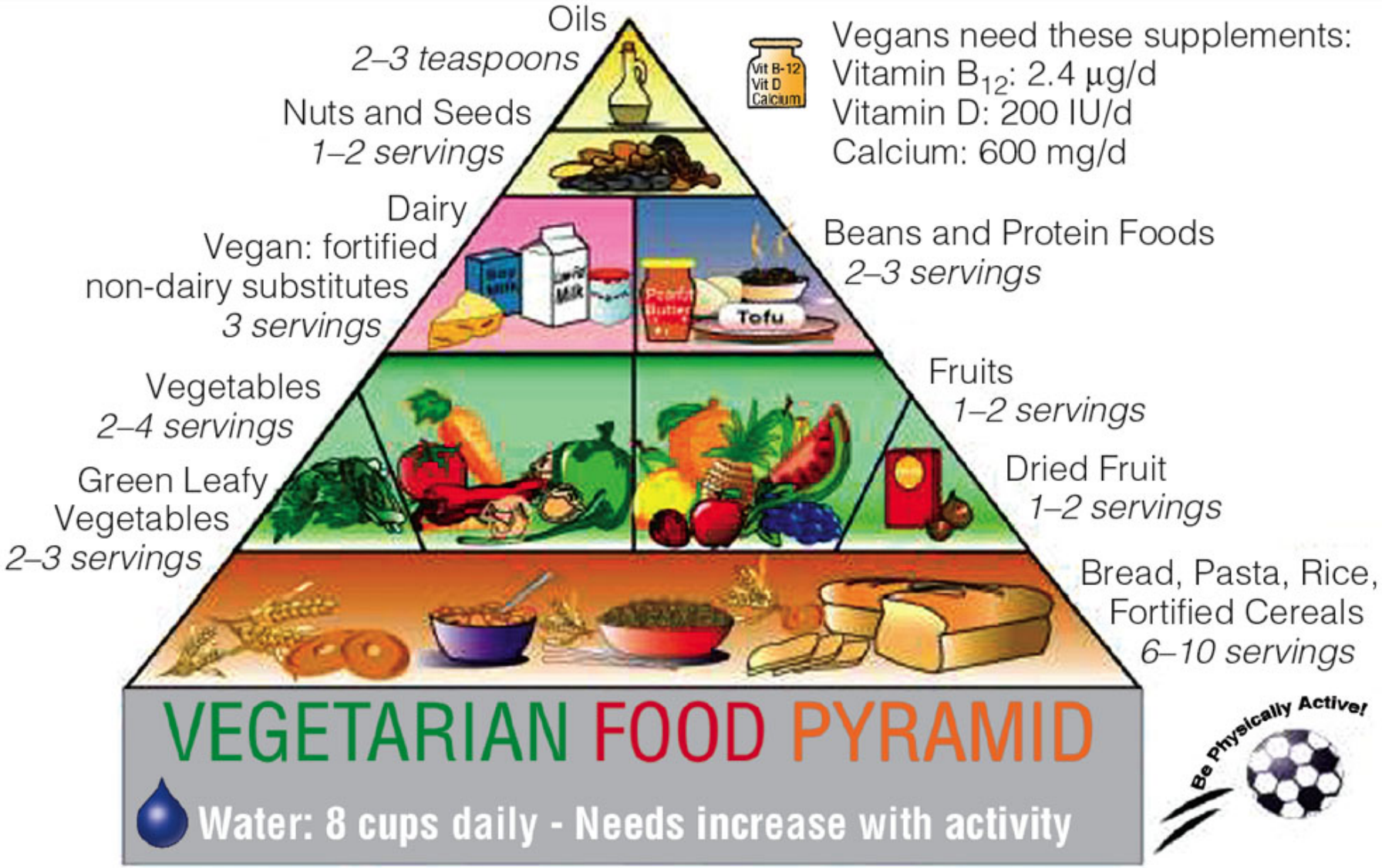
***...but, the phytochemical candidate, lycopene with anti-oxidant activity is also in guava, papaya, pink grapefruit & watermelon!***

# *The Mayo Clinic Diet Emphasizes Vegetables, Fruits & Whole Grains, Too!*




[http://www.mayoclinic.org/healthy-living/weight-loss/in-depth/mayo-clinic-diet/art-20045460](http://www.mayoclinic.org/healthy-living/weight-loss/in-depth/mayo-clinic-diet/art-20045460)

# Vegetarian Food Pyramid? Yes, but be a scientist!




© 2006 Wadsworth - Thomson

***SOURCES*: Sizer & Whitney 2006 *Nutrition: Concepts & Controversies*;**
**Venti & Johnston 2002 *Journal of Nutrition* 132:1050-4.**

# *Environmental Working Group Suggestions*

## 12 Most Contaminated
## Buy These Organic

- Apples
- Bell Peppers

- Celery

- Cherries

- Imported Grapes
- Nectarines

- Peaches

- Pears

- Potatoes

- Red Raspberries
- Spinach

- Strawberries

## 12 Least Contaminated
## Not as Much Concern

- Asparagus
- Avocados
- Bananas
- Broccoli
- Cauliflower
- Corn (sweet)
- Kiwi
- Mangos
- Onions
- Papaya
- Pineapples
- Peas (sweet)

…Now Clean 15!!
+Cabbage,
Eggplant,
Grapefruit

***http://www.ewg.org/foodnews/***

# Why Fish & Healthy Oils?

# *AHA Statistical Fact Sheet 2013 Update*
# *What do Americans* eat per day?*

**Whole grains**: 0.5-0.8 servings/d

Only 3-5% consume ≥ 3 servings/d

**Vegetables**: 1.3-2.2 servings/d

Only 3-7% consume ≥ 5 servings/d

**Fruits**: 1.1-1.8 servings/d

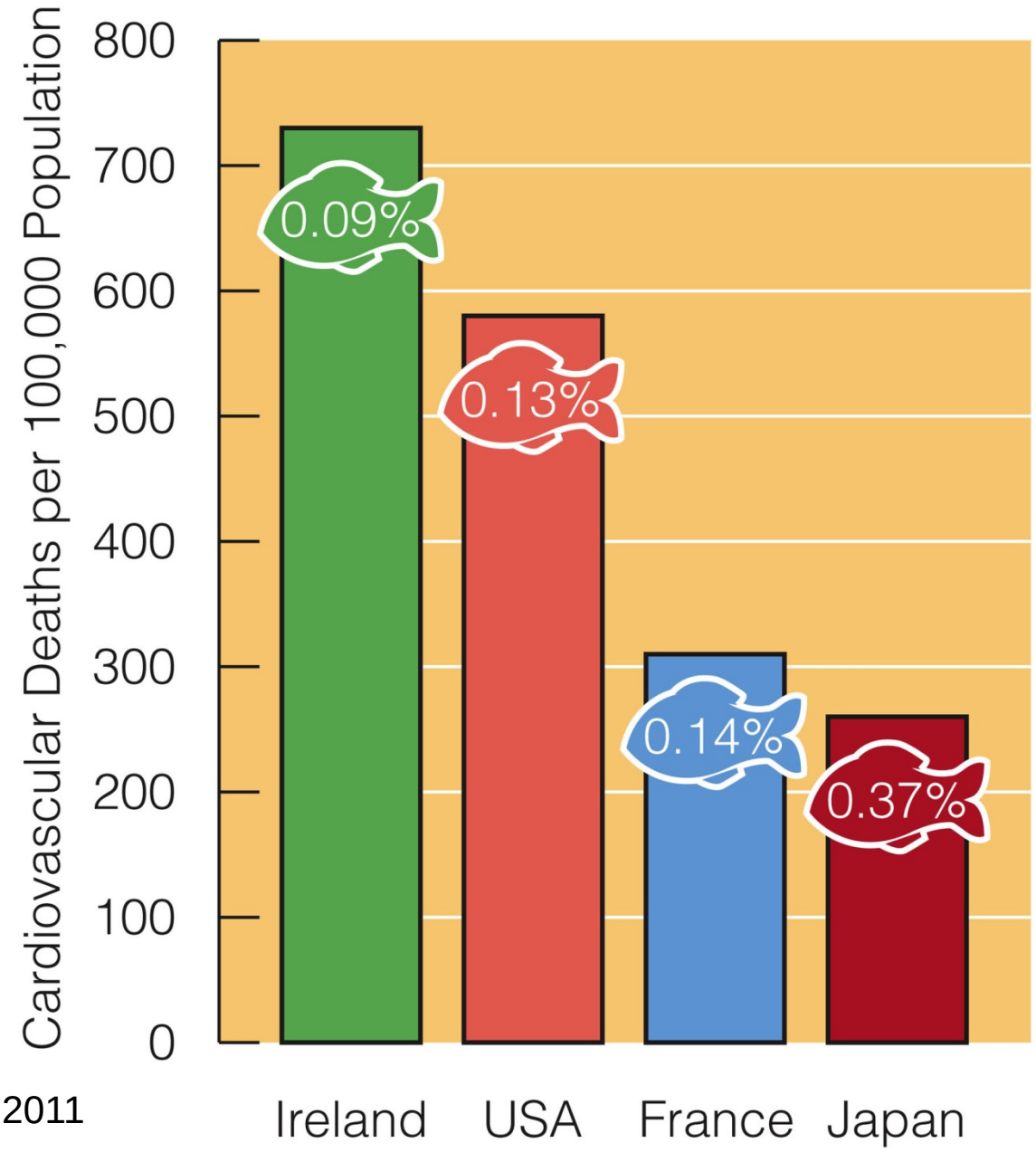
Only 6-11% consume ≥ 4 servings/d

**Fish & Shellfish** 1.2-1.7 servings/wk

75%-80% or more consume < 2 servings/wk

*http://www.heart.org/idc/groups/heart-public/@wcm/@sop/@smd/documents/downloadable/ucm_319591.pdf*

# *Fish Oil Intakes & Cardiovascular Death Rates*




Sizer & Whitney 2011
fig 5-12 p 167

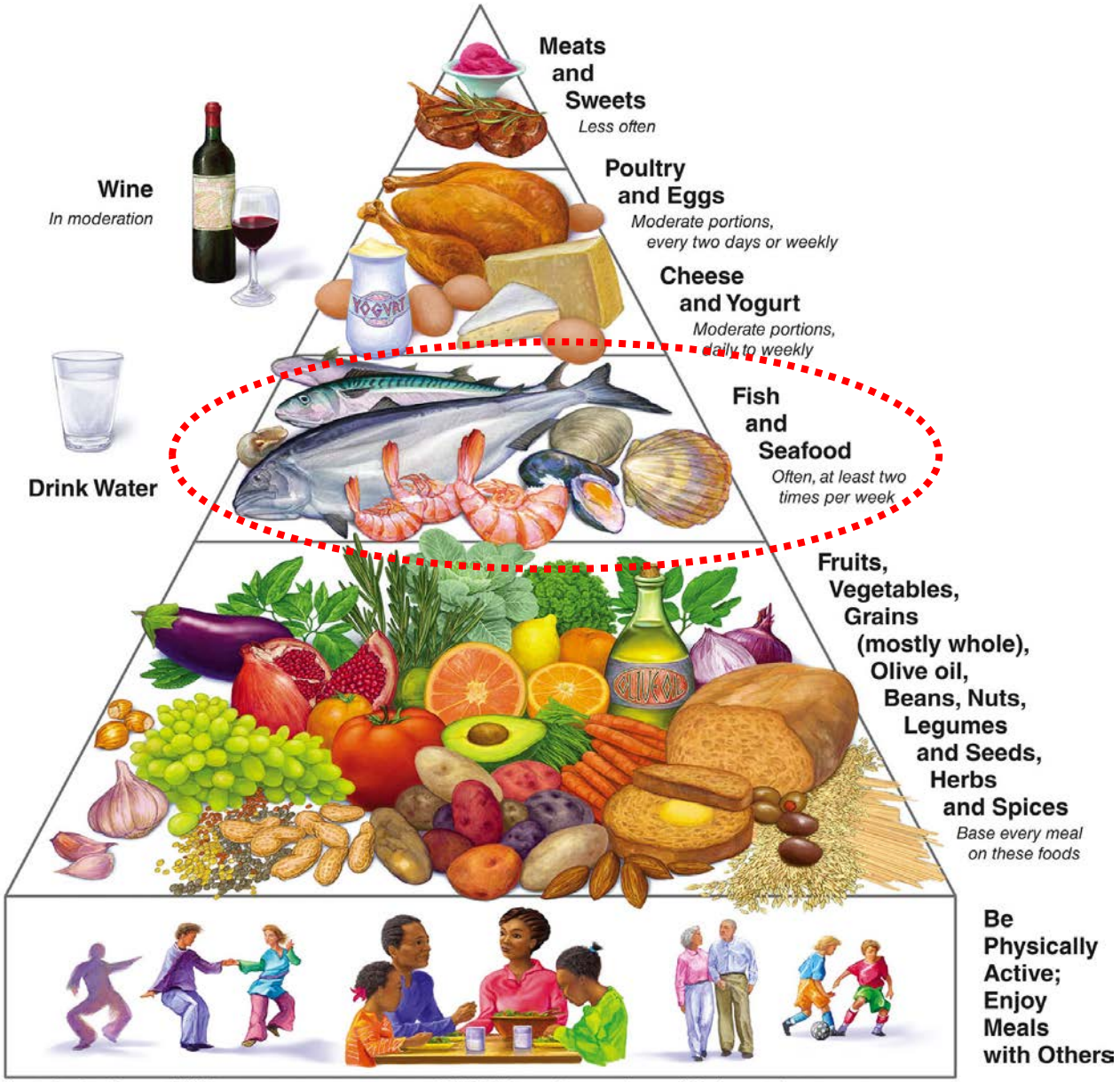
***Deep cold water fish are fabulous sources of Ω-3 fatty acids!***

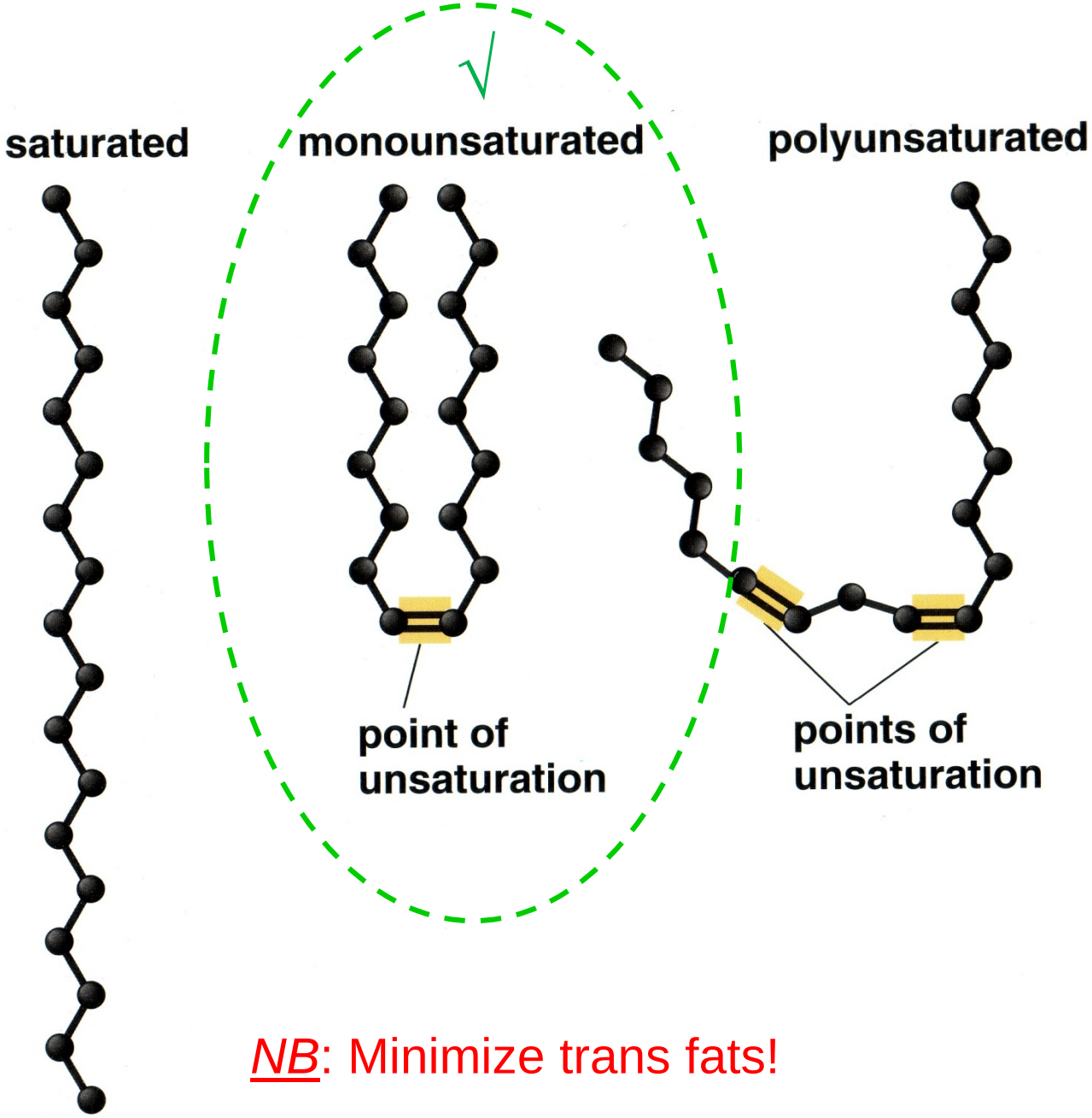
Sizer & Whitney 2011
p 167

# Mediterranean Diet Pyramid

*A contemporary approach to delicious, healthy eating*

S&W 2011 fig C5-2 p 188

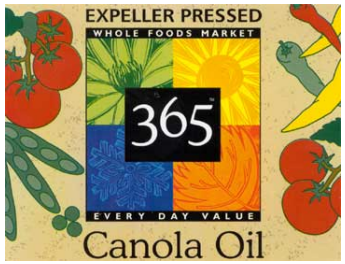


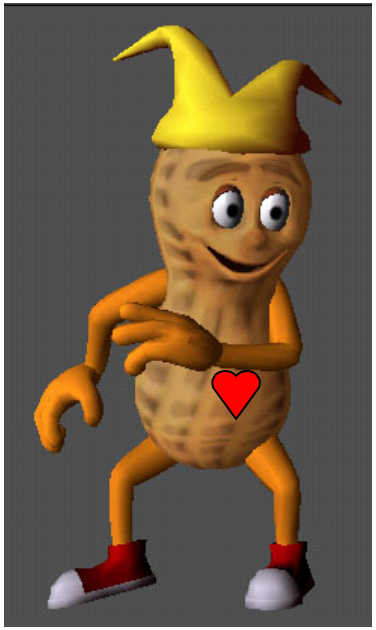



*NB*: Minimize trans fats!

# Healthy Oils to Minimize Atherosclerosis

## HAPOC?





# *Essential Fatty Acids: Ω-6 Linoleic & Ω-3 Linolenic Acids*

Linoleic → Arachadonic Acid → Inflammatory Cascade

Linolenic → EPA, DHA → Anti-inflammatory

***Emphasize good fats from plant sources like avocados!***

Sizer & Whitney 2011 p 155

# *Preventing Cancer: Strategies That Can Reduce Your Risk*
# *UC Berkeley Wellness Reports, 2012*

1. Don't smoke or use any tobacco product.
2. Keep the weight off.
3. Get off the couch.
4. Eat a healthy diet.
5. Drink less alcohol.
6. Limit high-heat cooking.
7. Limit sun exposure.
8. Limit radiation from medical imaging tests.
9. Test your home for radon.
10. Test your water for arsenic.
11. Decrease workplace exposure to carcinogens.
12. Limit your exposure to air pollution (outdoors & indoors).

University of California, Berkeley
Wellness Letter

American Heart Association®

Learn and Live℠

# Diet & Lifestyle Recommendations

1. ***Use up at least as many calories as you take in!***
2. ***Eat a variety of nutritious foods from all food groups.***
3. ***Eat less of the nutrient-poor foods.***
4. ***Don't smoke tobacco — and stay away from tobacco smoke.***

***http://www.heart.org/HEARTORG/GettingHealthy/NutritionCenter/HealthyDietGoals/Dictionary-of-Nutrition_UCM_305855_Article.jsp***

American Heart Association®

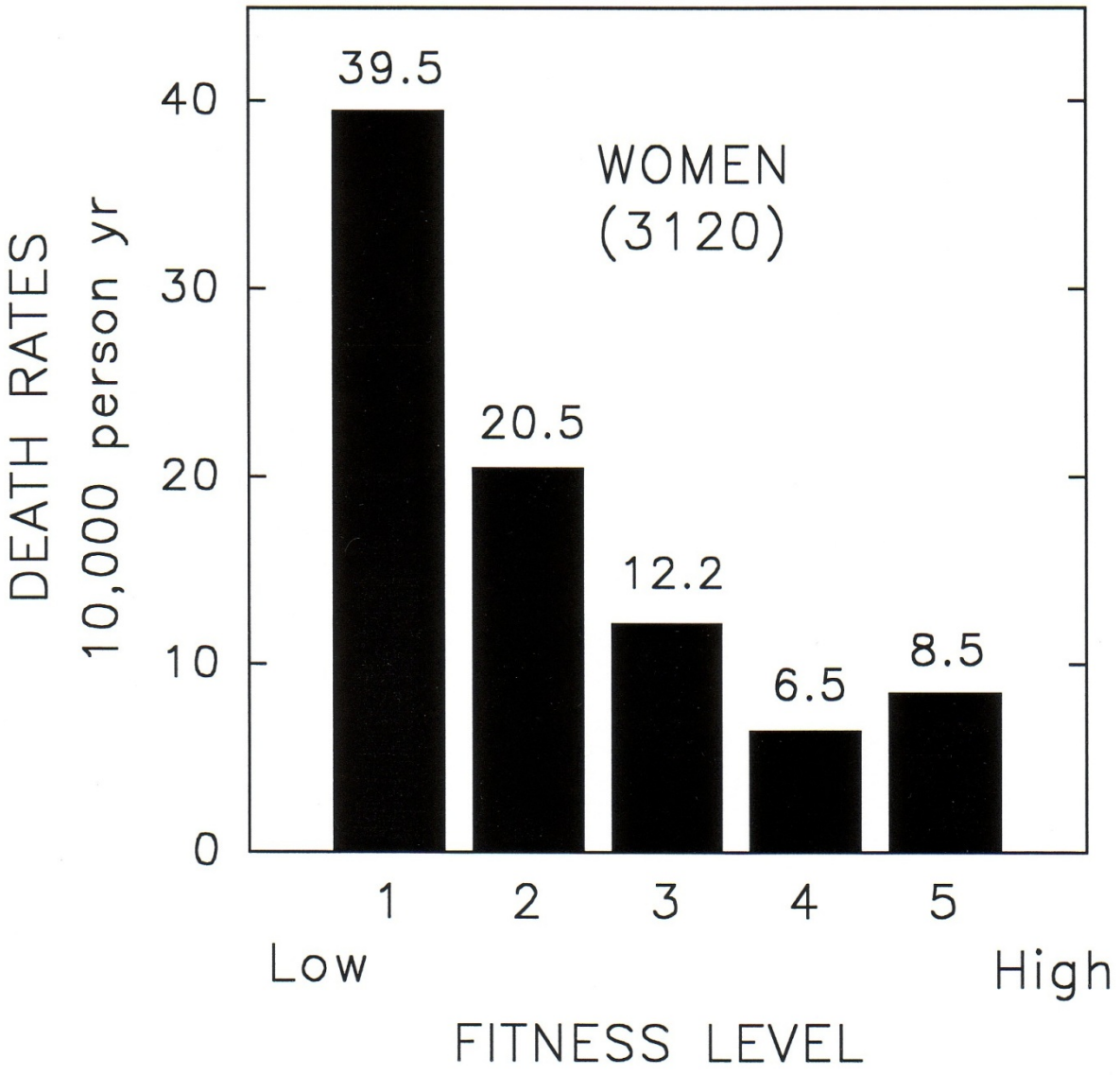
Learn and Live℠

# Daily Food Choice Recommendations

1. *Choose lean meats & poultry without skin & prepare them without added saturated & trans fat.*
2. *Select fat-free,1 percent fat & low-fat dairy products.*
3. *Cut back on foods containing partially hydrogenated vegetable oils to reduce trans fat.*
4. *Cut back on foods high in dietary cholesterol. Aim to eat less than 300 milligrams of cholesterol each day.*
5. *Cut back on beverages and foods with added sugars.*
6. *Choose and prepare foods with little or no salt. Aim to eat less than 1,500 milligrams of sodium per day.*
7. *If you drink alcohol, drink in moderation. 1 drink/day if you're a woman & 2 drinks/day if you're a man.*
8. *Follow AHA recommendations when you eat out & keep an eye on portion sizes.*

Why exercise?

# THE REWARD OF FITNESS: LONGEVITY




***SOURCE***: SN Blair & associates, JAMA, 1989, 263(15), 2395-401.

# *Exercise is a must based on its insulin-like effect!*

Sizer & Whitney 2011 p 135

*100s of other reasons! Exercise –*

↑ lean body mass, ↑ cardiac output, ↑ myocardial contractility, ↑ central & peripheral blood flow, ↑ fibrinolytic activity, ↑ HDL cholesterol, ↑ work capacity, ↑ sleep quality, ↓ % body fat, ↓ TOT & LDL cholesterol,↓ triglycerides, ↓ platelet aggregation, ↓ blood pressure, ↓ CVD risk,...

AMERICAN COLLEGE of SPORTS MEDICINE

# *Guidelines: Healthy Adults < 65 yr*

American Heart Association. *Learn and Live*

**Do moderately intense aerobic exercise**
**30 min/d, 5 d/wk**

***OR***

**Do vigorously intense aerobic exercise**
**20 min/d, 3 d/wk**

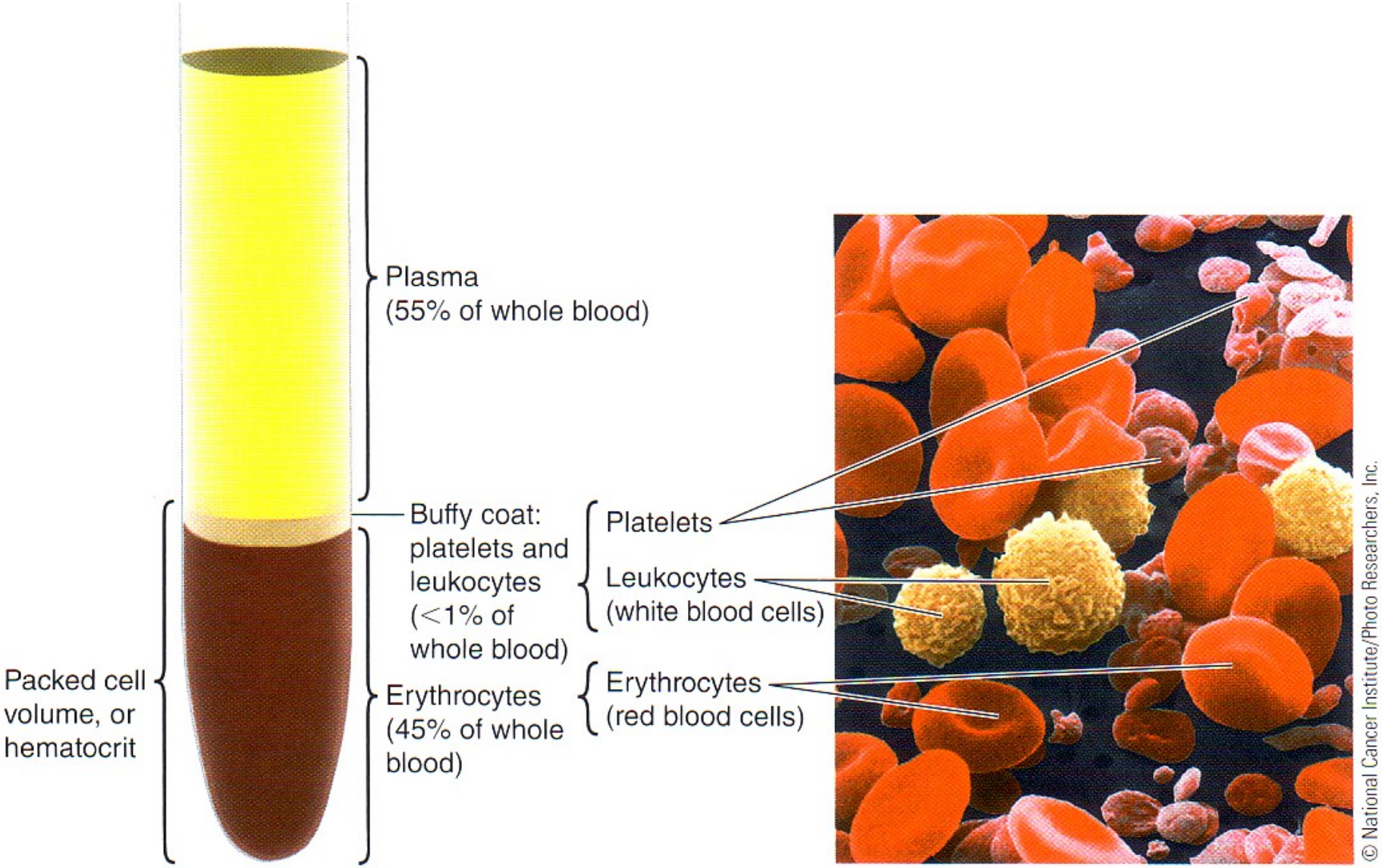
***AND***

**Do 8-10 strength-training exercises**
**8-12 repetitions/each exercise, 2 d/wk**

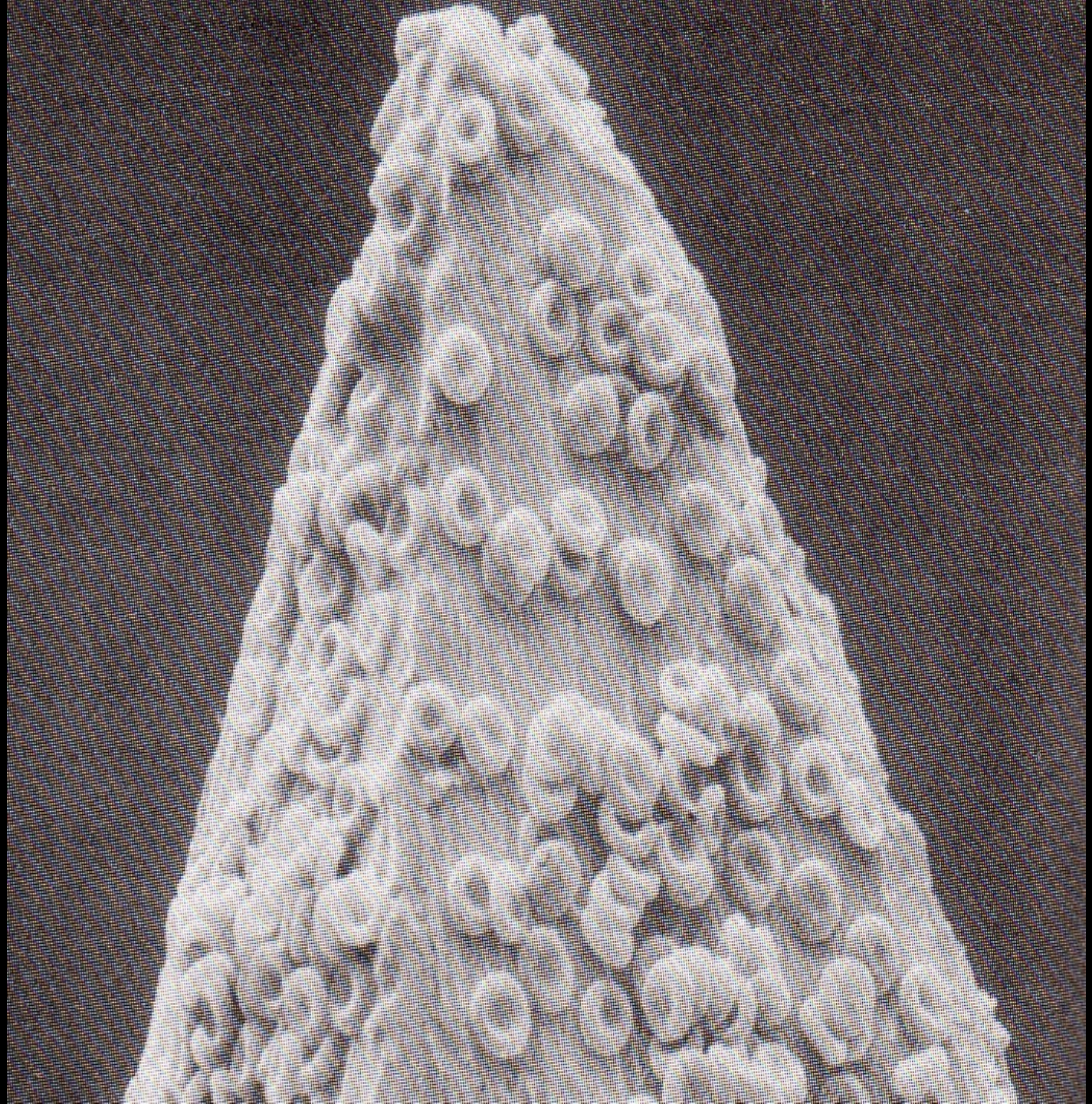
*http://www.acsm.org/access-public-information/position-stands*
*http://www.acsm.org/access-public-information/brochures-fact-sheets/fact-sheets*

# Federal exercise guidelines include strength training for all

# What's in Blood? Plasma & Blood Cells

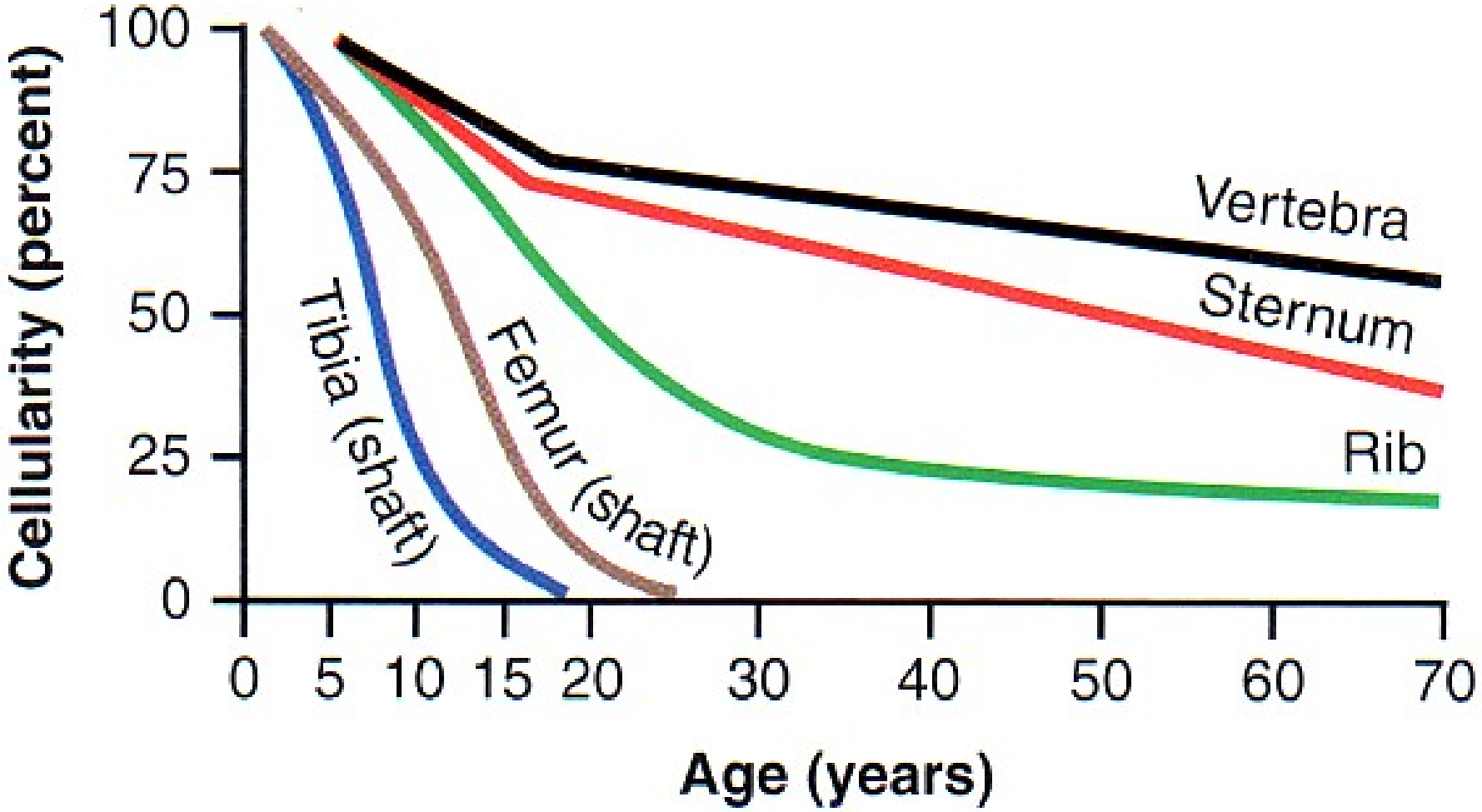



LS 2012 fig 11-1



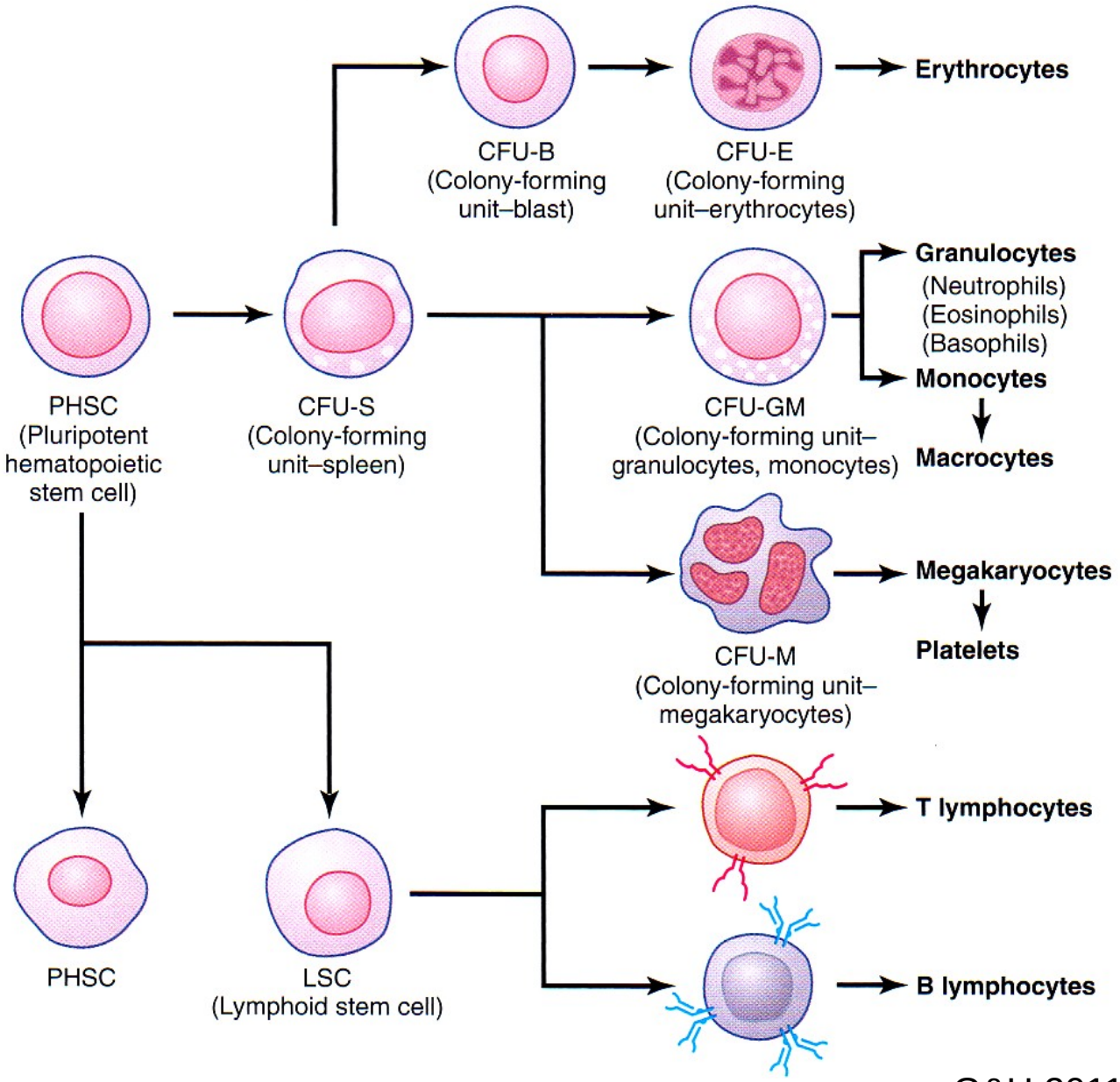
2000 x GMBH,
Nat Geog 1986
Jun p 714

# *Dermal bone production of red blood cells*



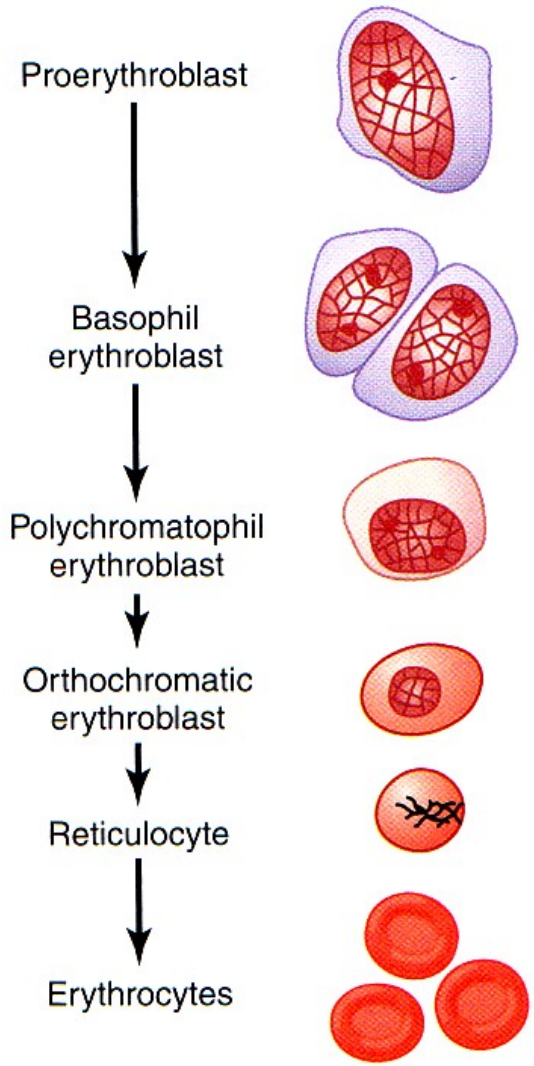

G&H 2011 fig 32-1 p 414

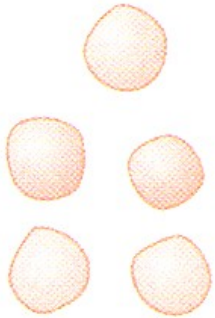
# *Pluripotent Hematopoietic Stem Cell Lines*



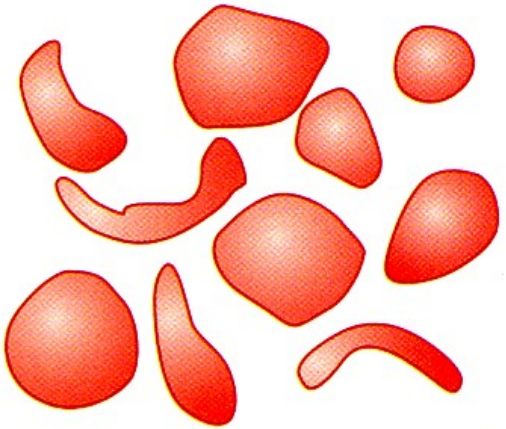

G&H 2011 fig 32-2 p 414

# Red Blood Cell Genesis

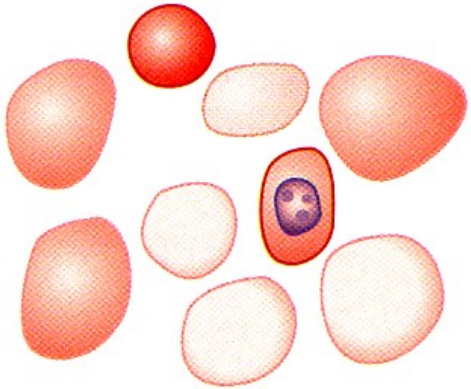


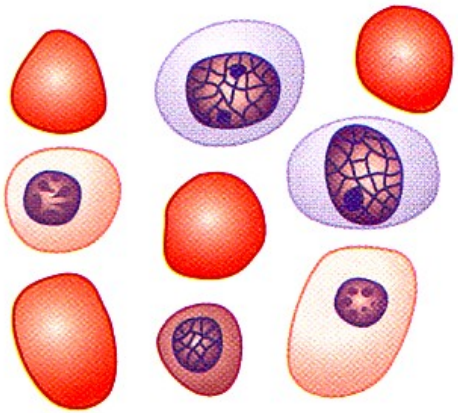
Microcytic, hypochromic anemia



Sickle cell anemia



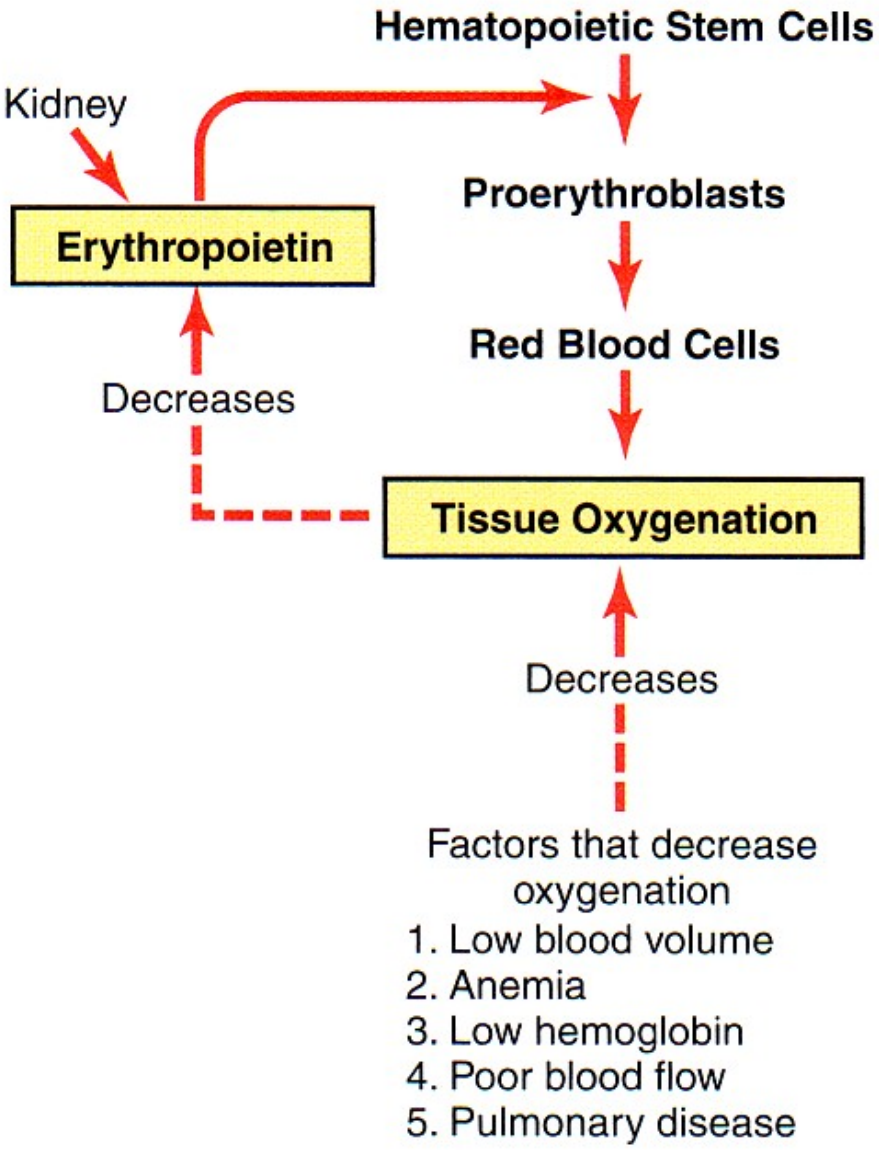
Megaloblastic anemia



Erythroblastosis fetalis

G&H 2011 fig 32-3 p 415

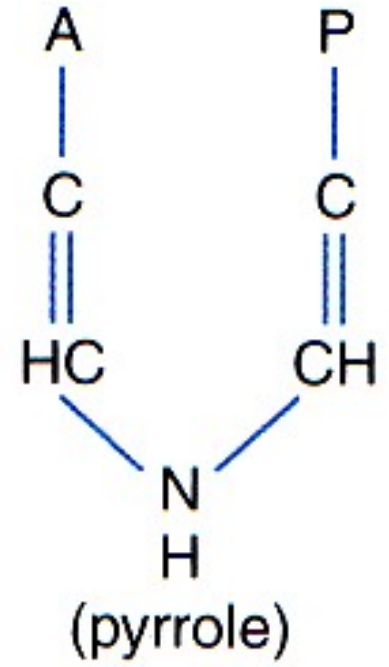
# Erythropoietin Regulates RBC Production




G&H 2011 fig 32-4 p 416

# *Hemoglobin Formation*

**Citric Acid Cycle**

I. 2 succinyl-CoA + 2 glycine → 

(pyrrole)

II. 4 pyrrole → protoporphyrin IX

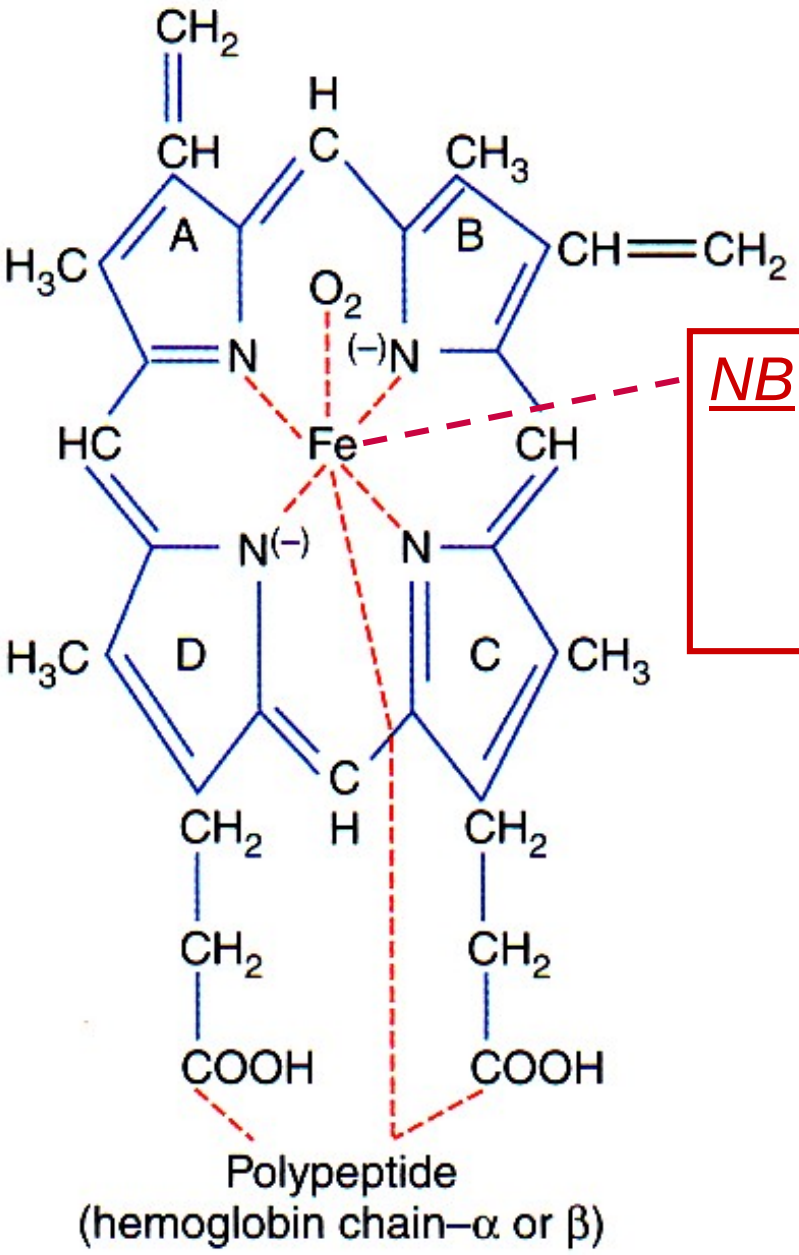
III. protoporphyrin IX + $Fe^{++}$ → heme

IV. heme + polypeptide → hemoglobin chain (α or β)

V. 2 α chains + 2 β chains → hemoglobin A

G&H 2011 fig 32-5 p 417

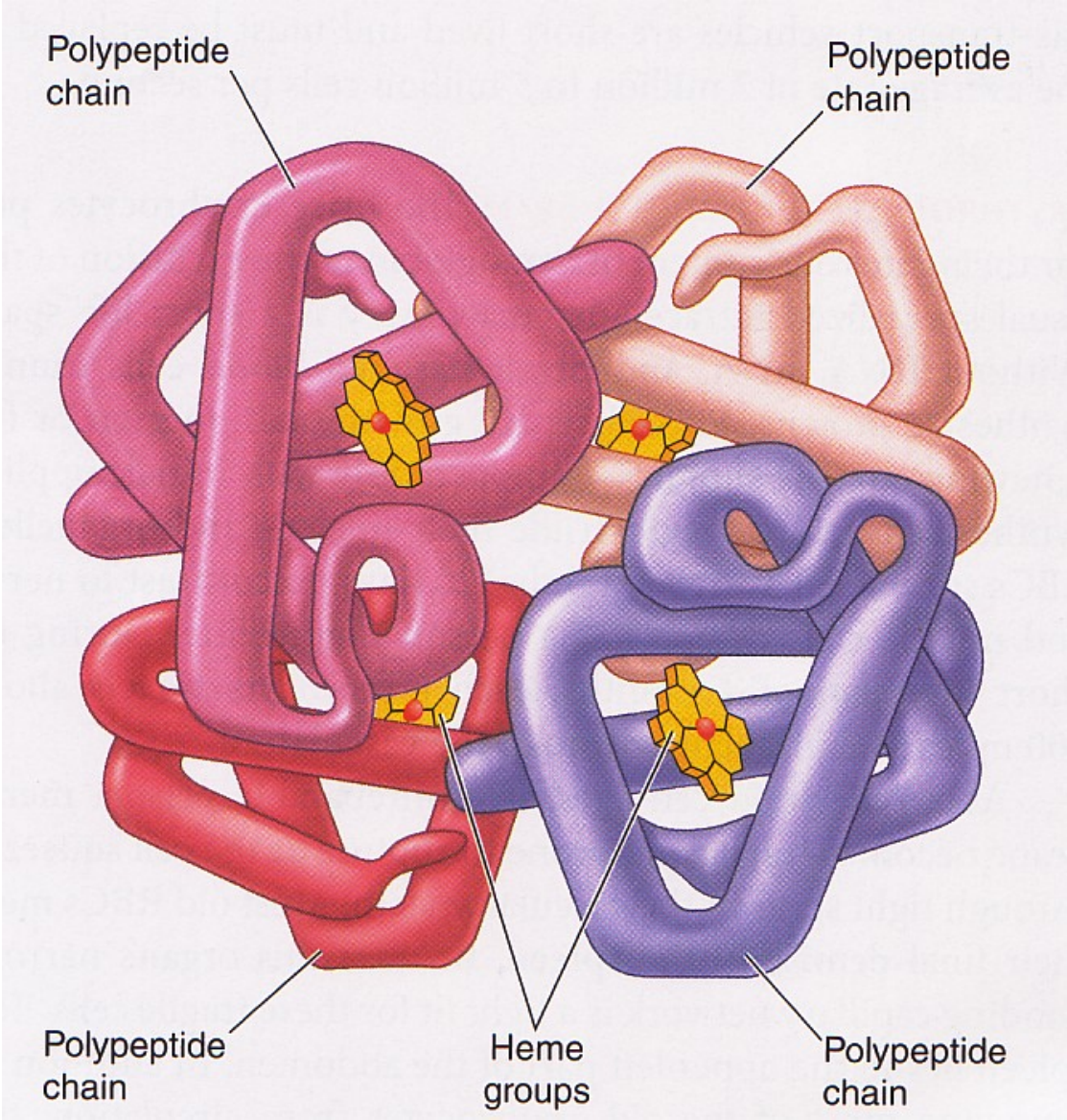
# Heme Structure




*NB*: CO carbon monoxide binds w/~200-fold > affinity than $O_2$

G&H 2011 fig 32-6 p 418

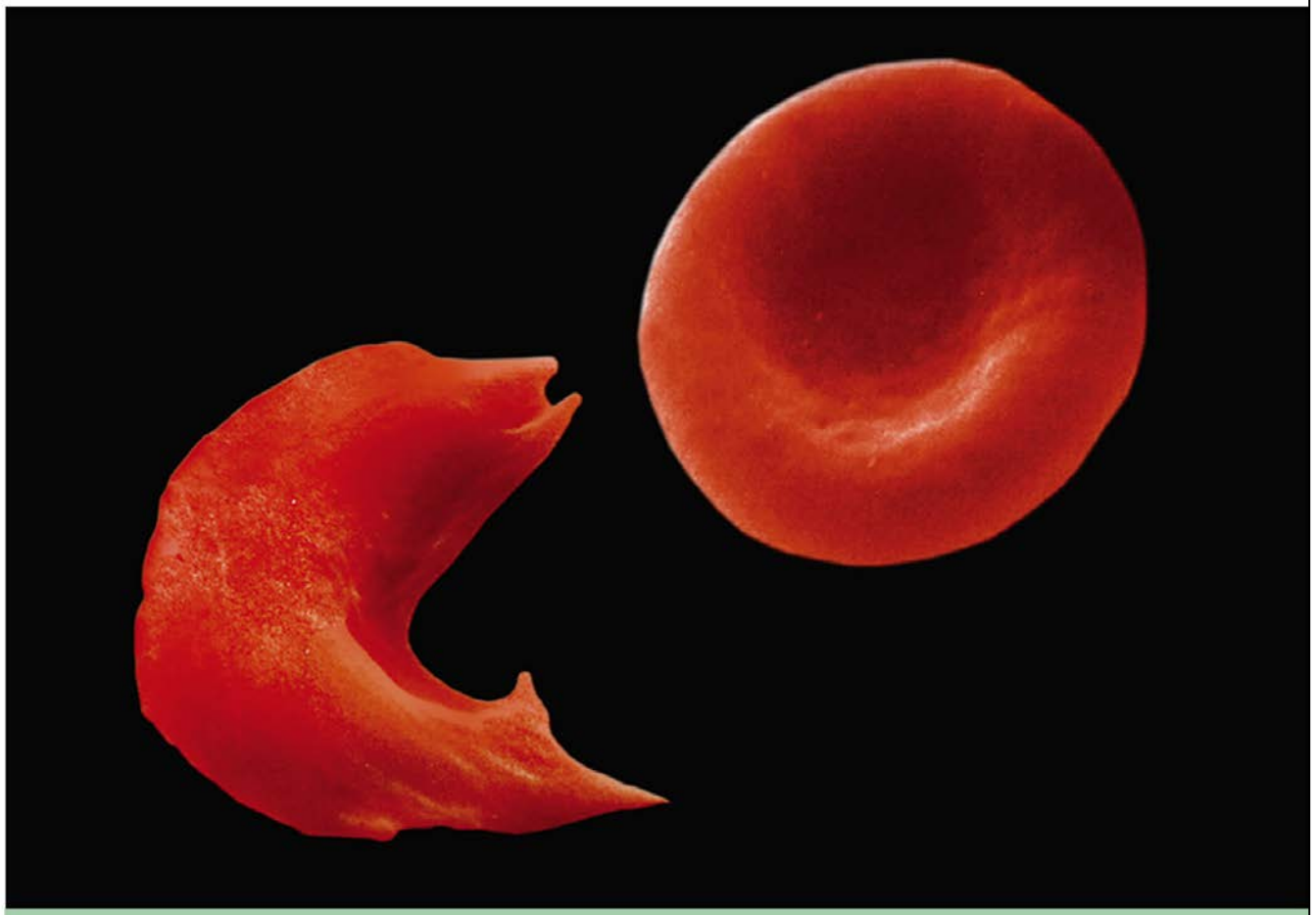
# Hemoglobin Structure




L Sherwood 2011 fig 11-2

Sickle-shaped blood cells

Normal red blood cells



© Dr. Stanley Flegler/Visuals Unlimited

**What a difference one amino acid can make!**

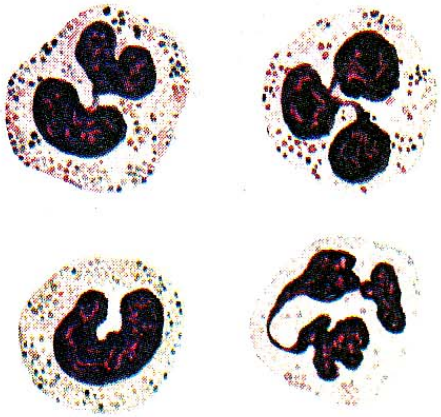
Amino acid sequence of normal hemoglobin:

Val–His–Leu–Thr–Pro–Glu–Glu

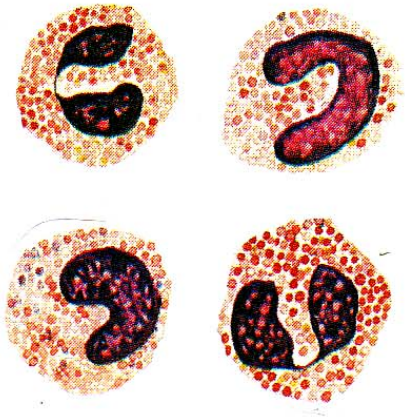
Amino acid sequence of sickle-cell hemoglobin:

Val–His–Leu–Thr–Pro–Val–Glu

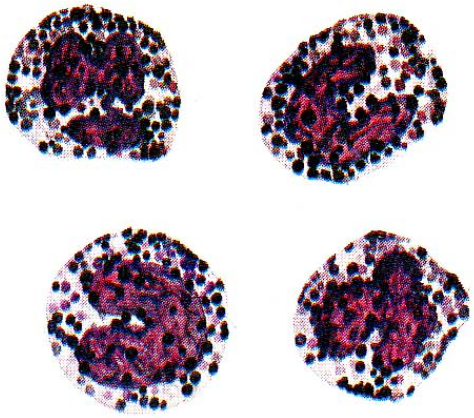
S&W 2011 fig 6-5 p 194



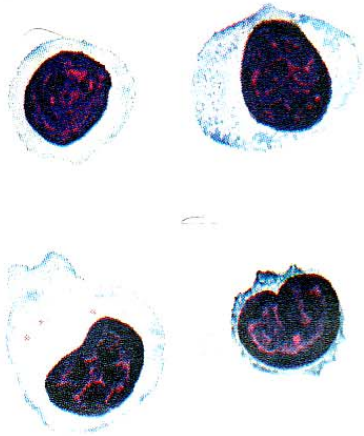
NEUTROPHILS



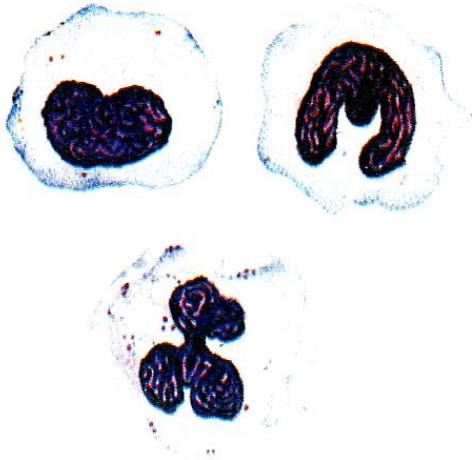
EOSINOPHILS



BASOPHILS

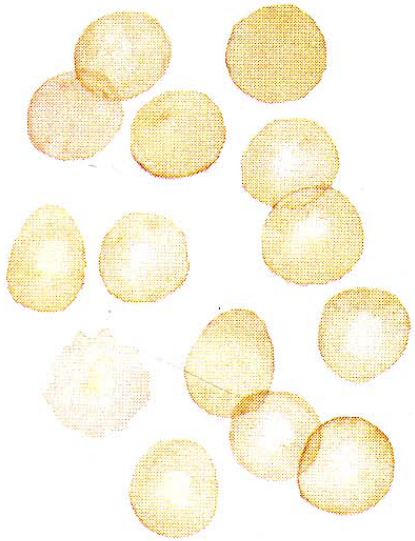


LYMPHOCYTES



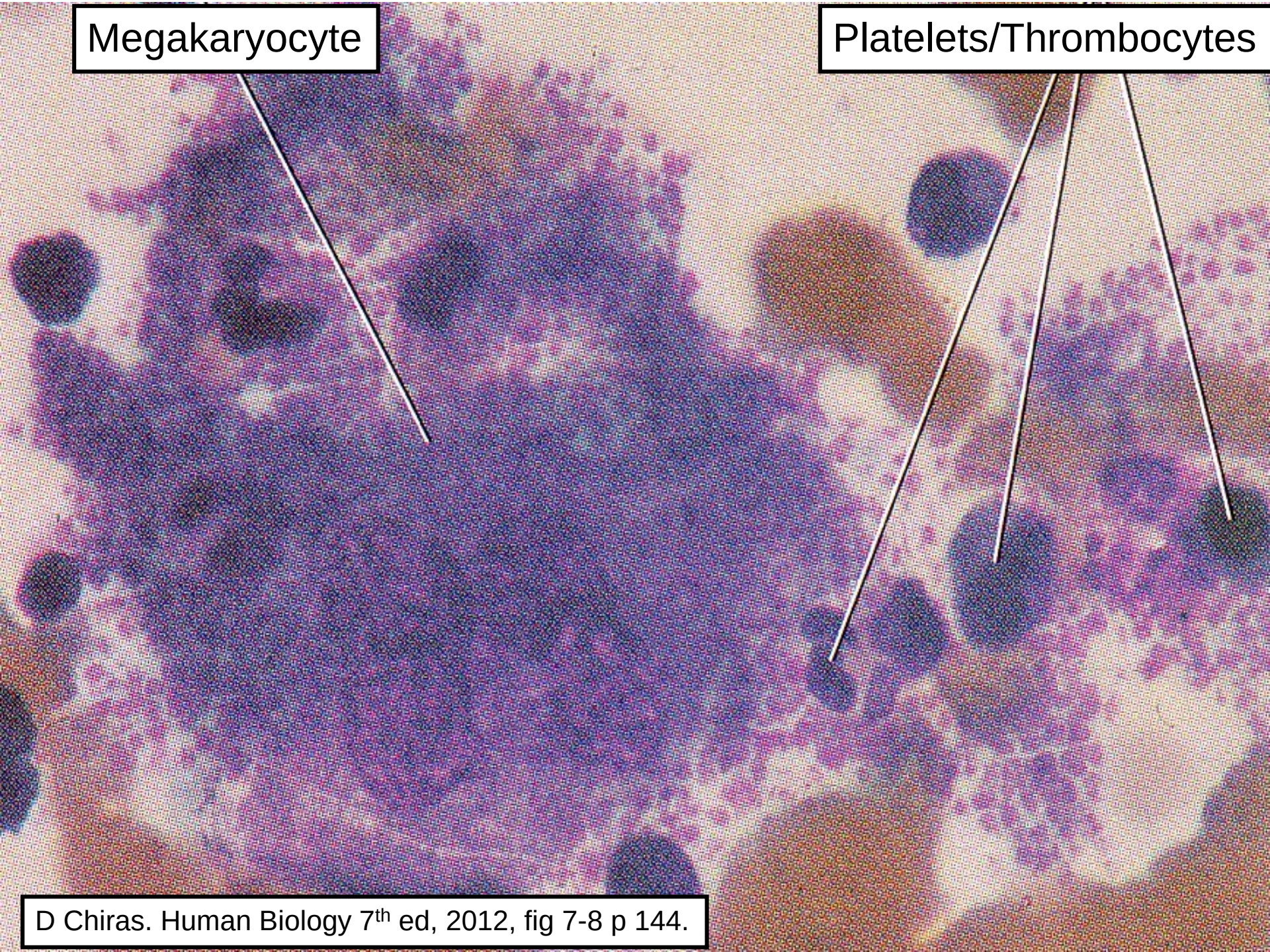
MONOCYTES

PLATELETS



ERYTHROCYTES

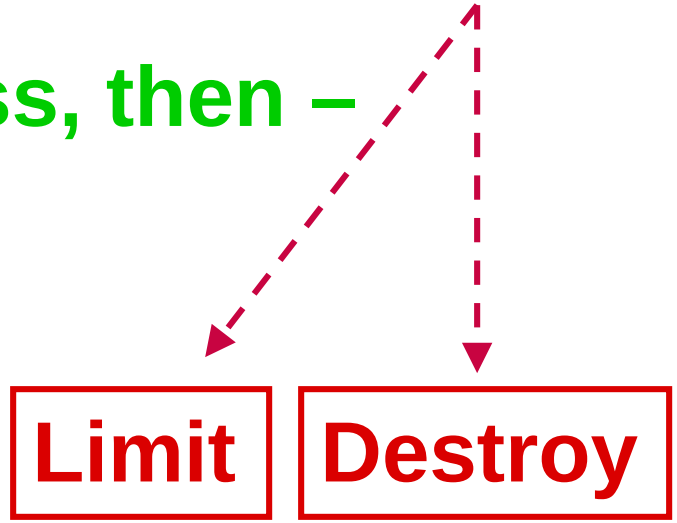
SI Fox 1987 p 376




D Chiras. Human Biology 7th ed, 2012, fig 7-8 p 144.

# *Immune Response*

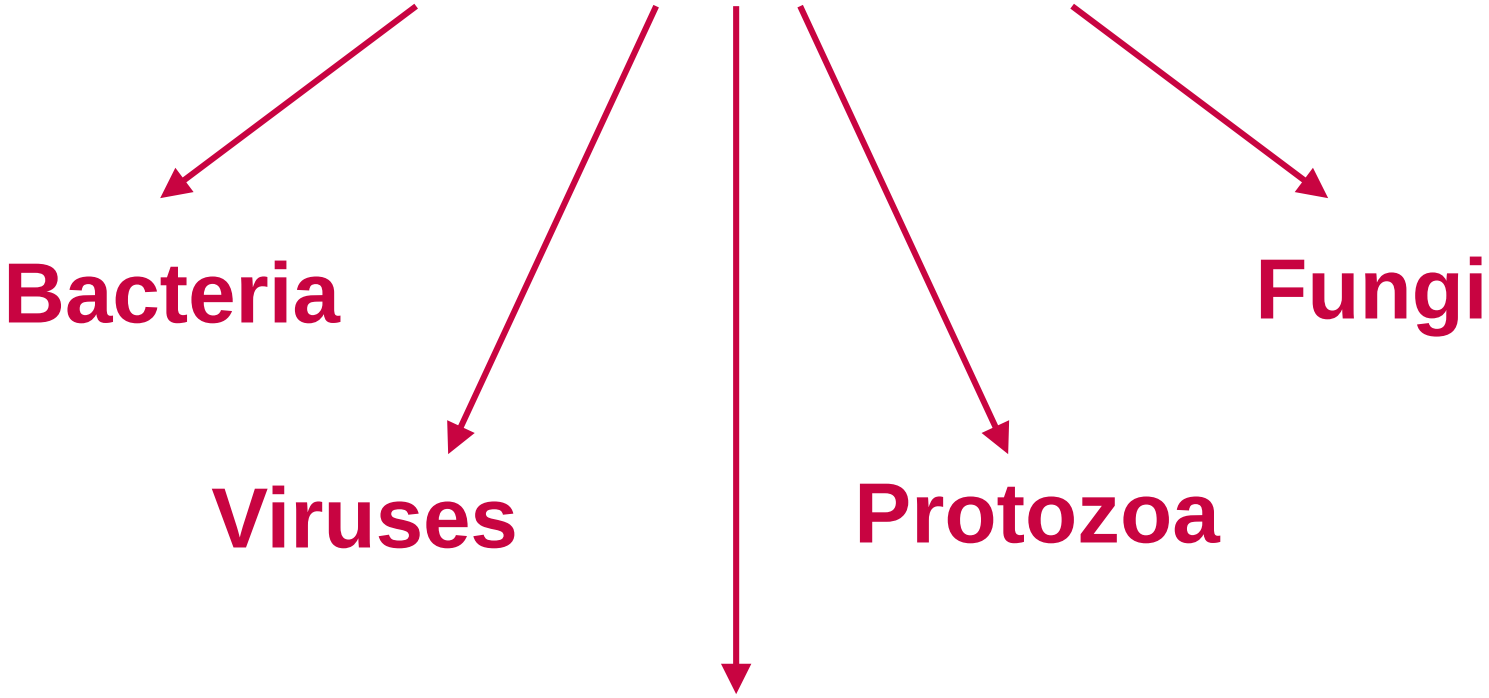
1. **Detect invader or ID toxic product.**
2. **Communicate to network.**
3. **Recruit coordinated, multi-pronged attack.**
4. **Amplify & if yes to success, then –**
5. **Suppress**




Davey 1990 p 6

# *Pathogen?*

**Microbes that cause disease!**




Davey 1990 p 5

# *Pathogens & Parasites Cause:*

1. **70-80% of deaths in less developed countries**
2. **Tens of millions of deaths due to infectious diseases**
3. **> 20 million childhood deaths per year in Asia, Africa & Latin America due to diarrheal infections alone**
4. **Yet < 2% deaths in modern, industrialized countries!**

*World Health Organization 2011 Statistics +*
*http://www.who.int/whosis/whostat/2011/en/index.html*
*http://www.who.int/bulletin/volumes/86/9/07-050054.pdf*

Davey 1990 p 5

# *Why such striking differences across the world?*

1. **Poor sanitation**
2. **Contaminated water supply**
3. **Contaminated food supply**
4. **Malnutrition**
5. **Existing infections**
6. **Patchy, inadequately-funded vaccinations**
7. **AIDS superimposed on top of 1-6!**

Davey 1990 p 5

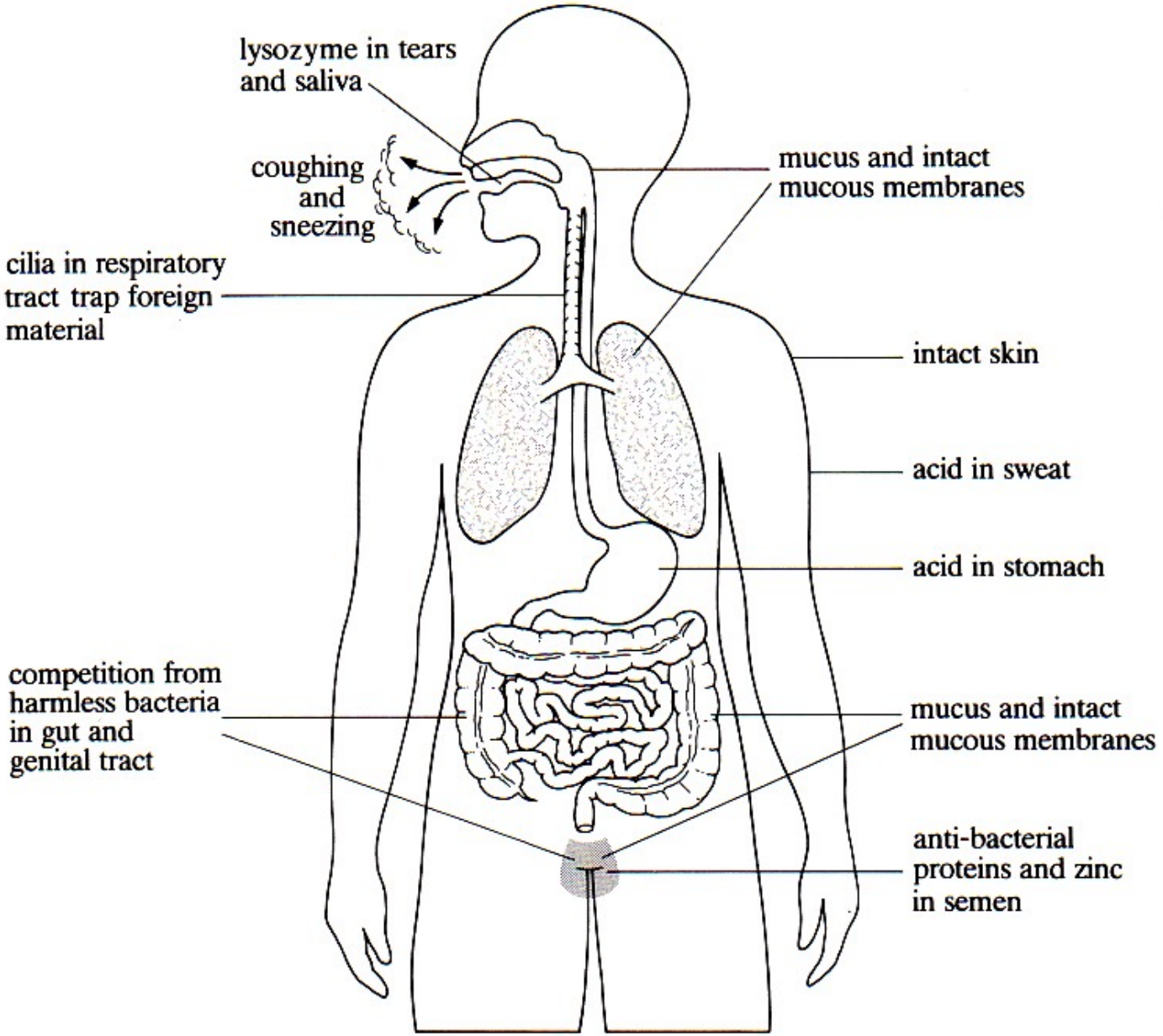
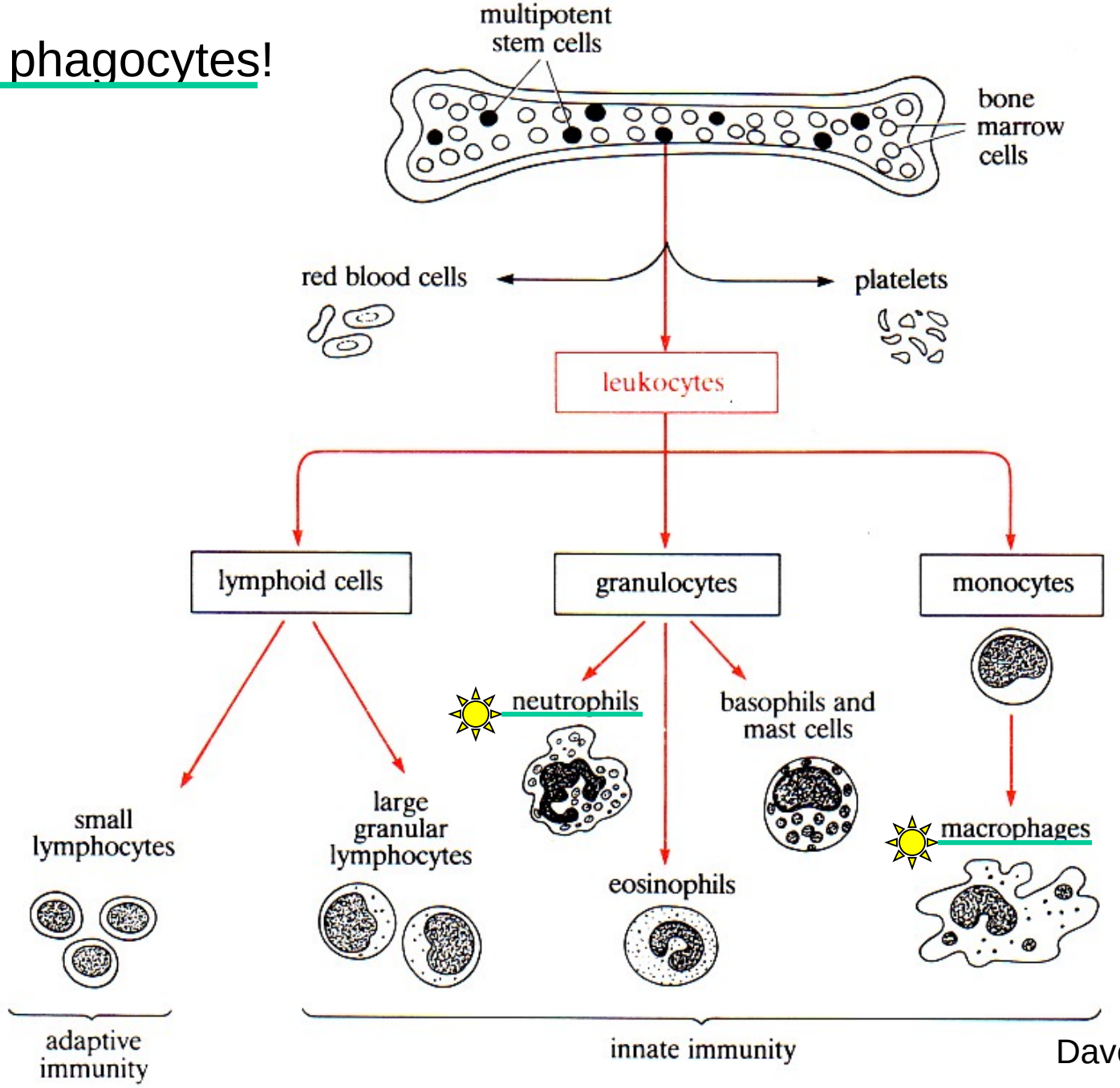



FIGURE 2.1 Summary of the main physical, chemical and mechanical barriers to infection entering the human body.

Davey 1990 p 12

# Good phagocytes!




Davey 1990 p 13

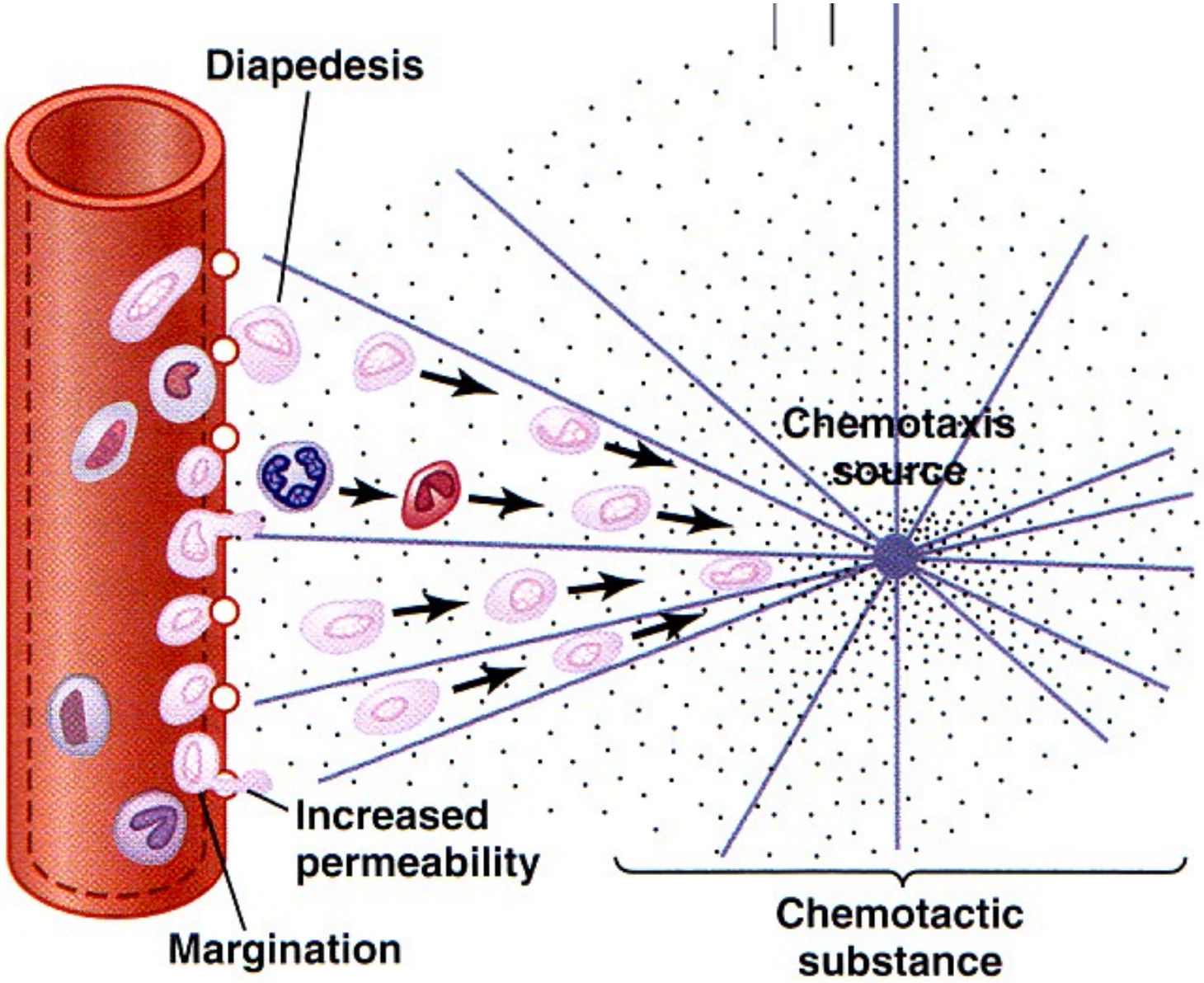
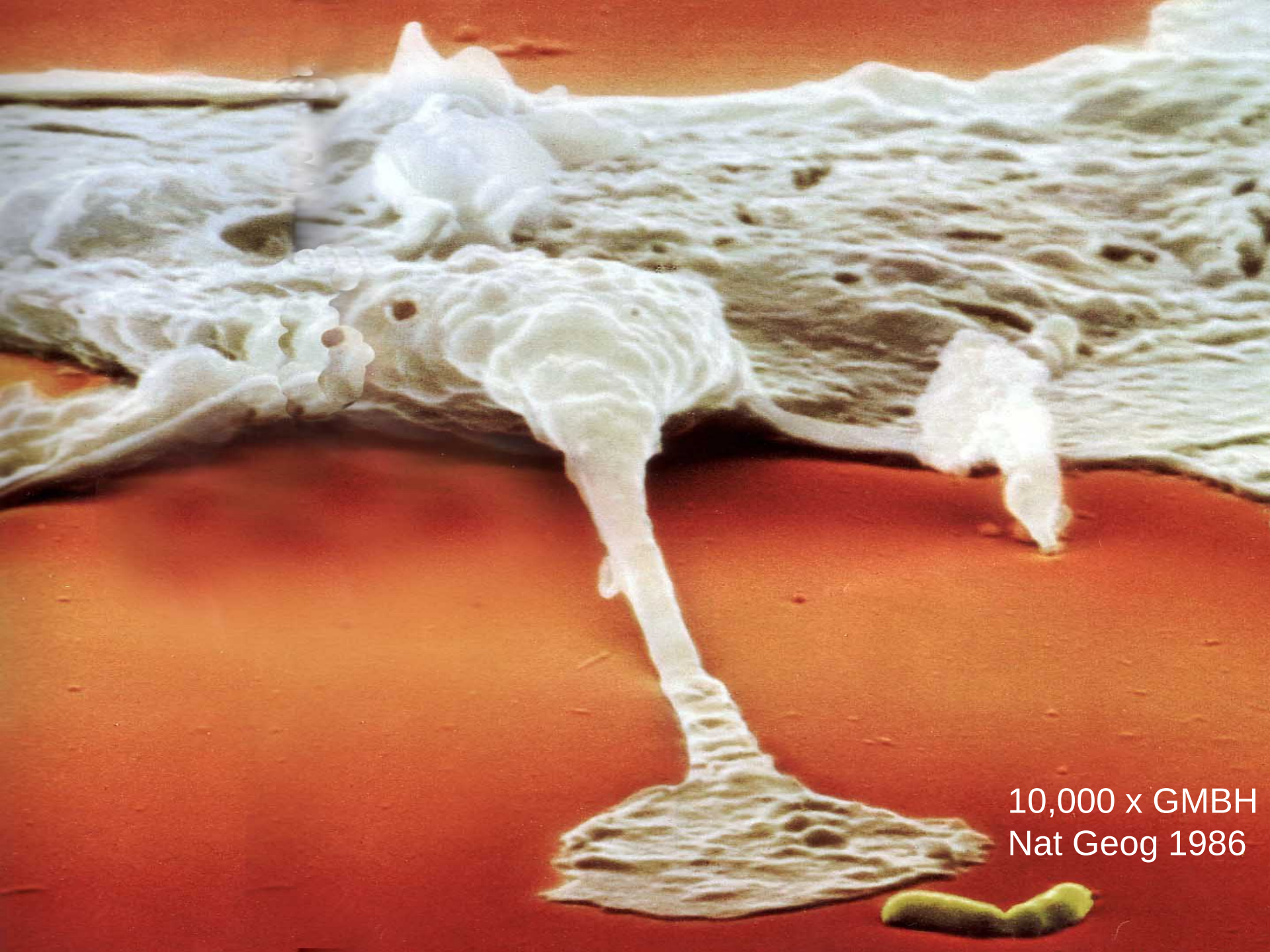
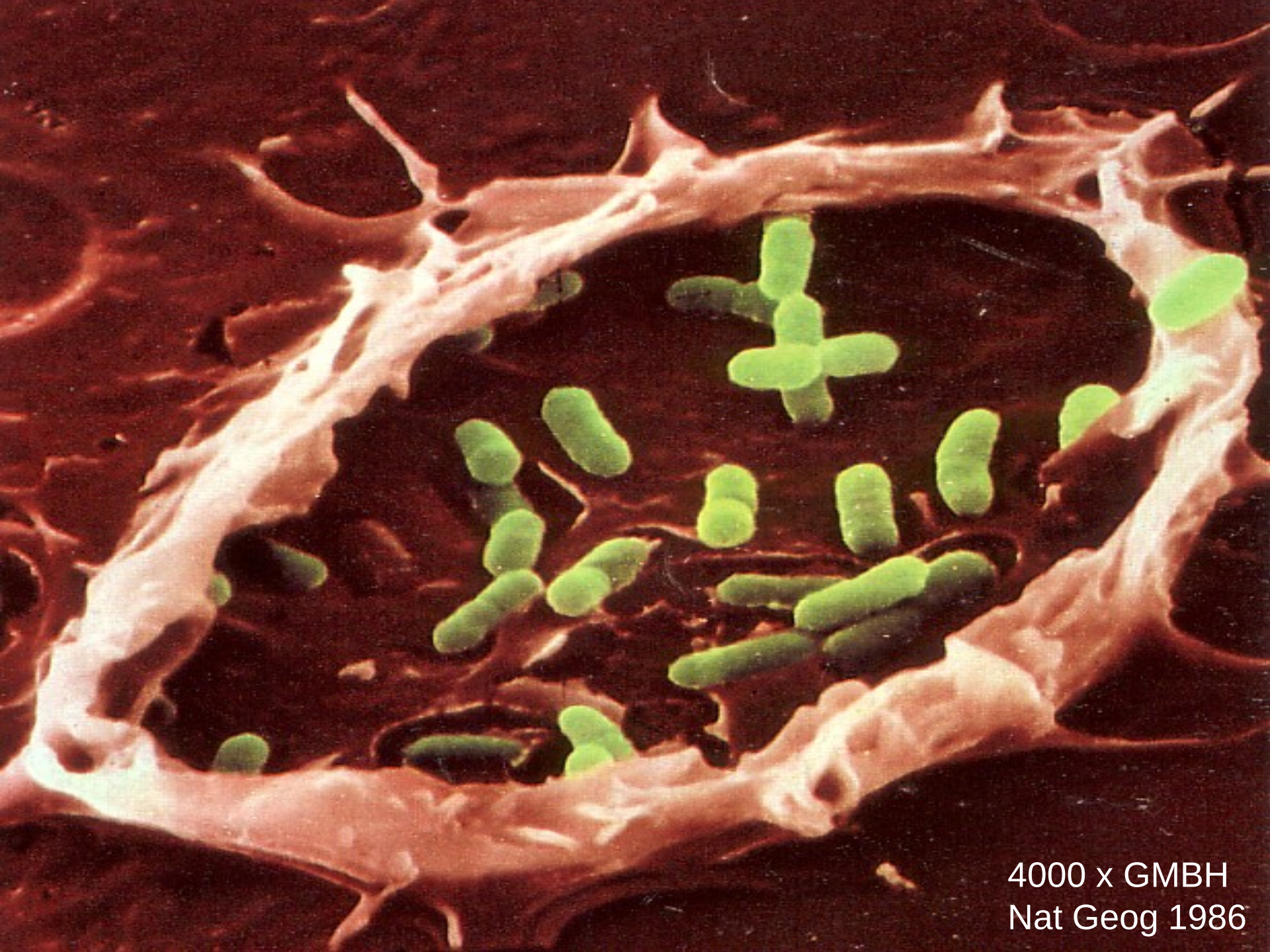



**Figure 33-2** Movement of neutrophils by *diapedesis* through capillary pores and by *chemotaxis* toward an area of tissue damage. G&H 2011


10,000 x GMBH
Nat Geog 1986


4000 x GMBH
Nat Geog 1986

7000 x GMBH
Nat Geog 1986

3000 x GMBH
Nat Geog 1986

# Hand-washing

**The right way to wash your hands:**

Thoroughly wash with soap and warm running water — rubbing your hands together for at least 10 seconds.

Hand-washing is the single most effective thing you can do to reduce the spread of colds and other infectious disease.

It's not necessary to use anti-bacterial soaps when washing up. Regular soap and water do the job just fine.

Also, using germicidal soaps too often may produce antibiotic-resistant bacteria.

*Source: Hospital Infections Program, U.S. Centers for Disease Control and Prevention*

***NB*: Happy Birthday Song 20-30 sec!!!**

***http://www.squidsoap.com/***