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Antioxidant Nutrients

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Section A

Antioxidant Nutrients

Antioxidant Nutrients

- Ascorbic acid
- Alpha-tocopherol
- Beta-carotene
- Selenium
- Manganese

Oxidants and Antioxidants

Pro-Oxidants

- Substrate oxidation
- Antimicrobial defense
- Radiation
- Sunlight
- Ionized compounds
- Aging
- Oxygen

Antioxidants

- Free radical scavengers:
  - —Extracellular/ circulating
  - —Cellular
    - Cytosolic
    - Membrane-bound

What Is a Free Radical?

- An unbound compound (i.e., free) having one or more unpaired electrons

R – O – H	° – O – H
Hydroxyl group	**Hydroxyl radical**
(good guy)	(bad guy)

Examples of Free Radicals and their Half-Lives

Hydroxyl radical		$HO^{\bullet}$	1×10^{-9} sec.
Singlet oxygen		$^{1}O_2$	1×10^{-6}
Alkoxyl radical	$RO^{\bullet}$		1×10^{-6}
Peroxyl radical		$ROO^{\bullet}$	7
Semiquinone radical	$Q^{\bullet-}$		days

Free Radical Formation

- Oxidation of substrates with high oxygen affinity (for example, fatty acids)
- Microbial lysis
- Environmental exposure (sunlight, radiation, high-oxygen levels)

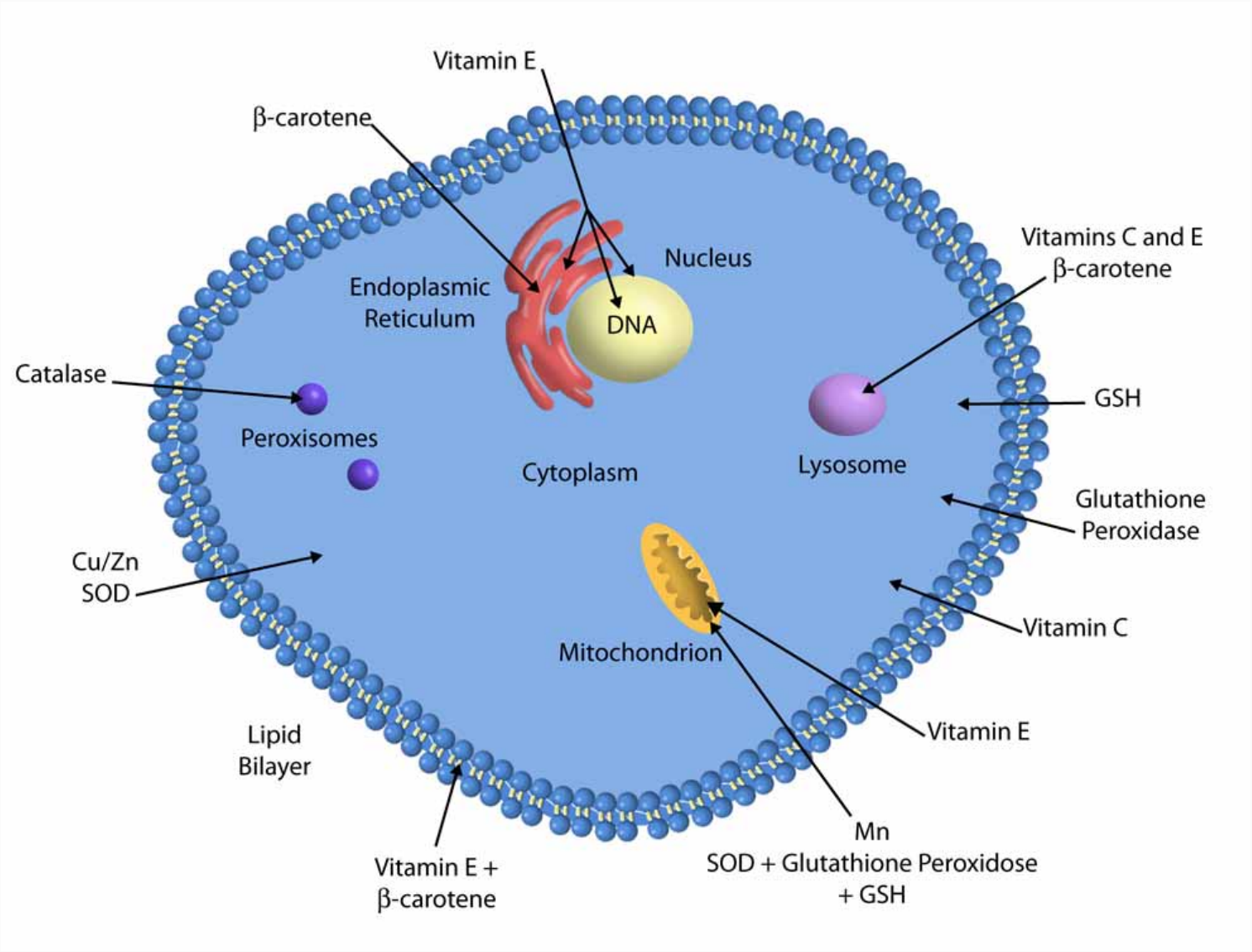
Antioxidant Systems of Physiological Relevance in Humans

- **Water-Soluble**
  - Ascorbate
  - Glutathione
  - Urate
  - Bilirubin

Antioxidant Systems of Physiological Relevance in Humans

- **Lipid-soluble**
  - Alpha-tocopherol
  - Beta-carotene
  - Lycopene
  - Lutein
  - Zeaxanthin
  - Ubiquinol-10

Antioxidant Systems in Cells



Antioxidant Defense Processes

- **Prevention**—Balance between oxidative load and antioxidant function
- **Interception**—Local antioxidant levels
- **Repair**—Mostly enzymatic

Antioxidant Defense Processes

- **Prevention**—Vitamin E, ascorbic acid, beta-carotene
- **Interception**—Vitamin E, glutathione, superoxide dismutase
- **Repair**—DNA repair system, reductases

Role of Nutrients in Antioxidant Systems

- **Vitamin E**
  - Protects lipids from the cell membrane bilayer from attack by free radicals
- **Vitamin C**
  - Quenches $^1O_2$ in cytosol
  - Recycles vitamin E after it captures free radicals

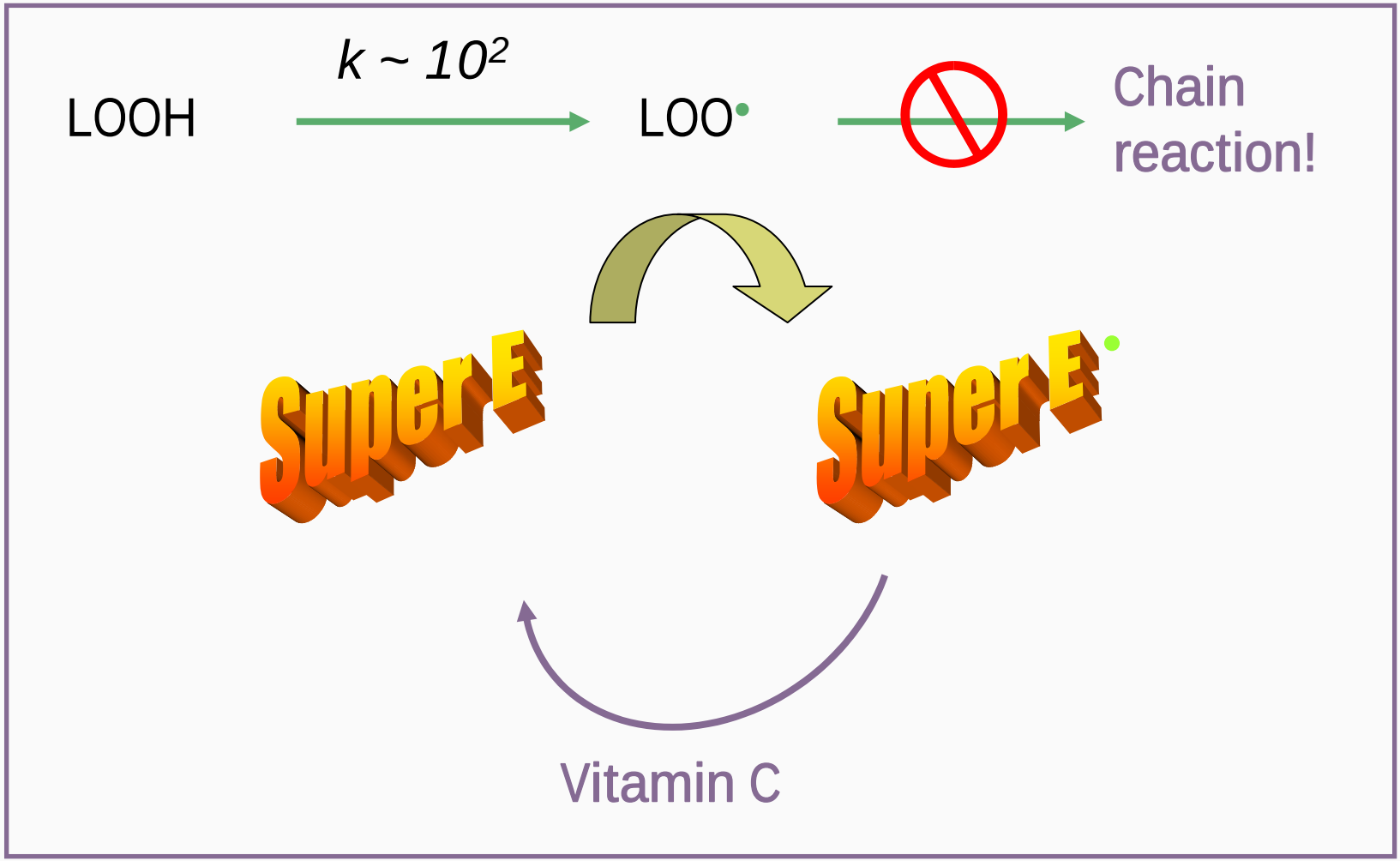
Role of Nutrients in Antioxidant Systems

- **Carotenoids**
  - Beta-carotene quenches $^1O_2$; may also inhibit free-radical-generating reactions
  - Autoregenerate with release of thermal energy

Role of Nutrients in Antioxidant Systems

- **Selenium**
  - Constituent of glutathione peroxidase
- **Manganese**
  - Constituent of superoxide dismutase (MnSOD)
- **Copper, zinc**
  - Constituents of superoxide dismutase (CuZnSOD)

Antioxidant Mechanism of Vitamin E



"Protective" Intake Levels of Antioxidant Nutrients

	Protective level*	RDA
Vitamin C	>600 mg	60
Vitamin E	>200 IU	10
Selenium	70–120 µg	70

** Daily intakes associated with a risk reduction of 25% or more*

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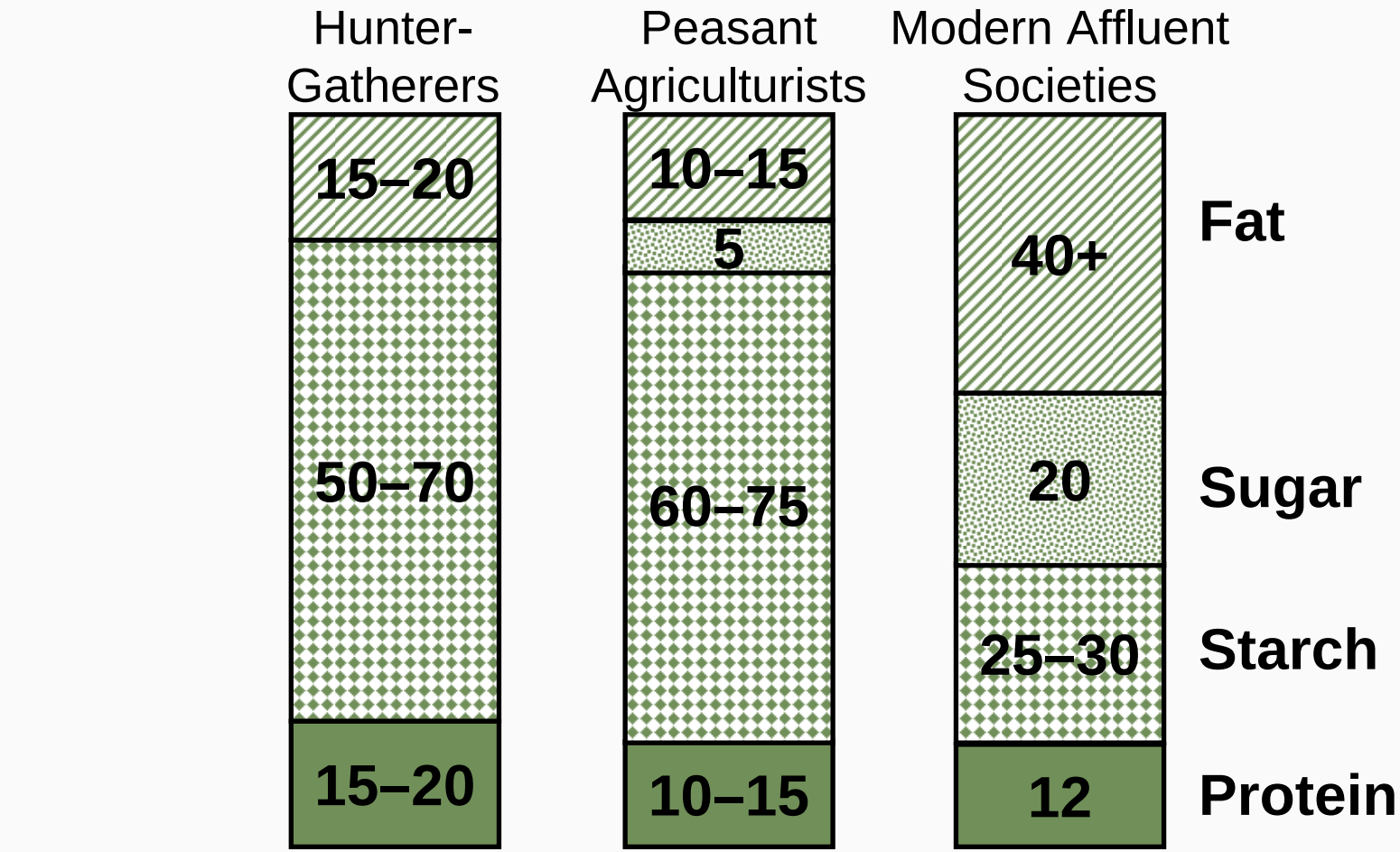
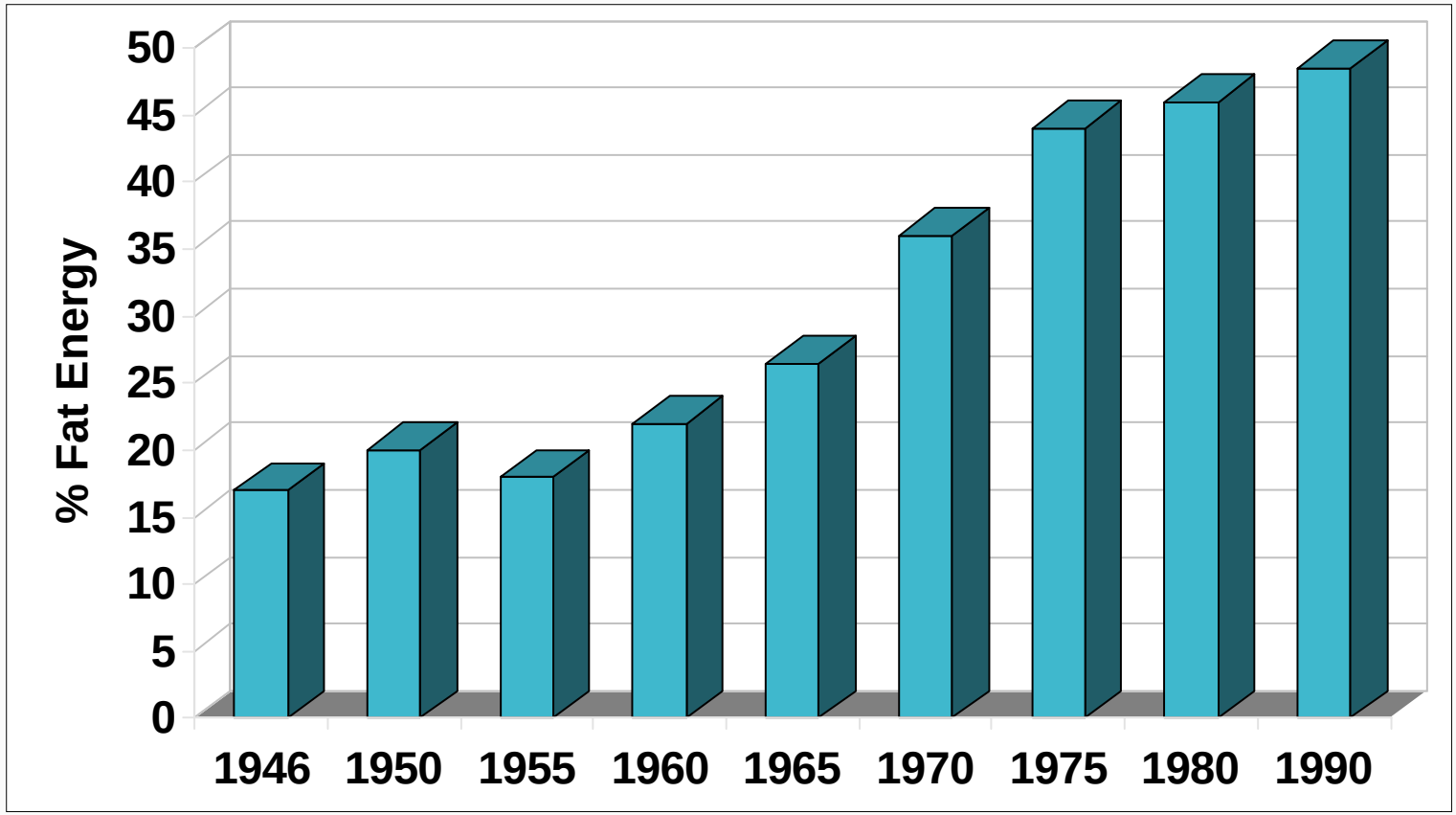
Section B

Diet and Chronic Diseases

Evolution of the Human Diet



Nutrition Transition Fat Consumption Patterns—Japan



Notes Available

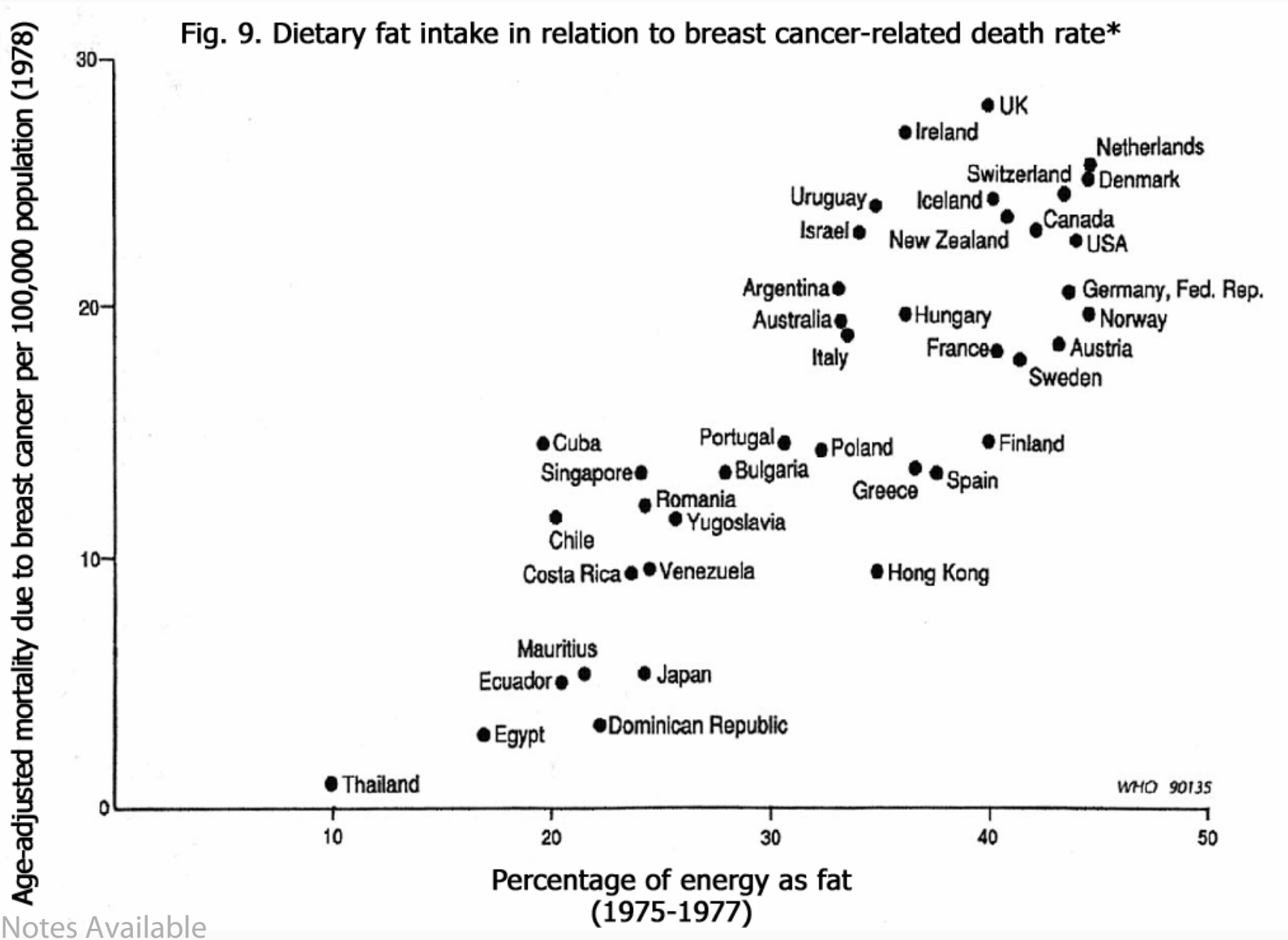
Diet Constituents Implicated on Disease Risk

- Fats
- Cholesterol
- Fiber
- Antioxidant vitamins and minerals
- Sugar
- Protein
- Calcium and vitamin D
- Folic acid
- Iron

Criteria for Diet-Disease Relationships

- Strength of association
- Dose-response relationship
- Temporally correct association
- Consistency of association
- Specificity of association
- Biological plausibility

Dietary Fat Intake and Breast Cancer-Related Deaths



Notes Available

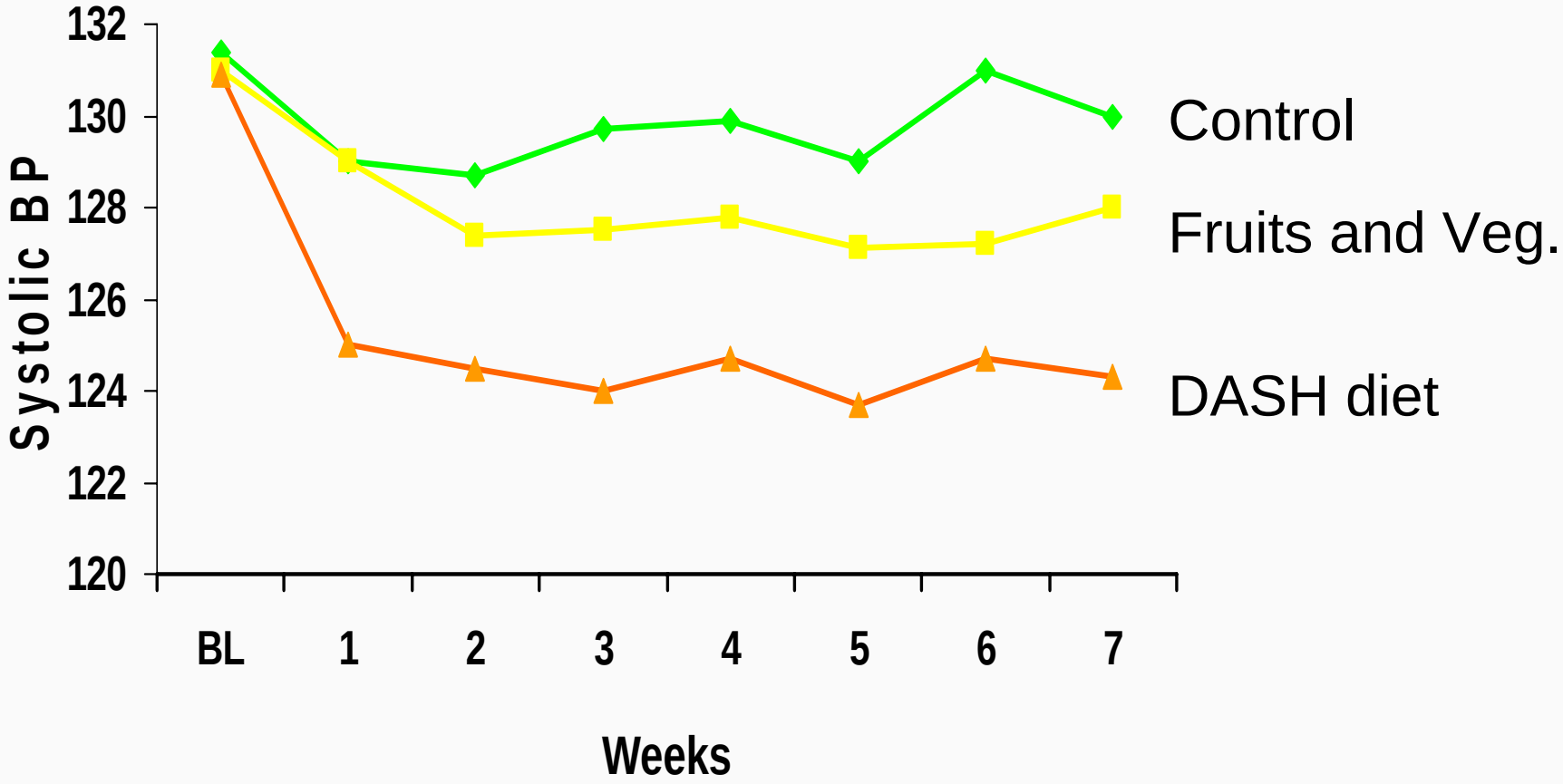
Fish Consumption and Risk of CVD

	Fish Consumption, g/day			
	0	<18	18–34	>35
MI	1.0	0.88	0.76	0.56
CHD	1.0	0.88	0.84	0.62
CVD	1.0	0.94	0.89	0.74
All causes	1.0	1.02	0.98	0.85

Diet and Blood Pressure

- Sodium
- Calcium
- Potassium
- Magnesium
- Alcohol

The DASH Study



Notes Available

Dietary Patterns and Blood Pressure: The DASH Diet

	Control	F & V	DASH
Fat (% cal)	36	36	26
Cholesterol (mg)	233	184	150
Fiber (g)	9	31	31
Potassium (mg)	1752	4101	4415
Magnesium (mg)	176	423	480
Calcium (mg)	443	534	1265
Sodium (mg)	3028	2816	2859

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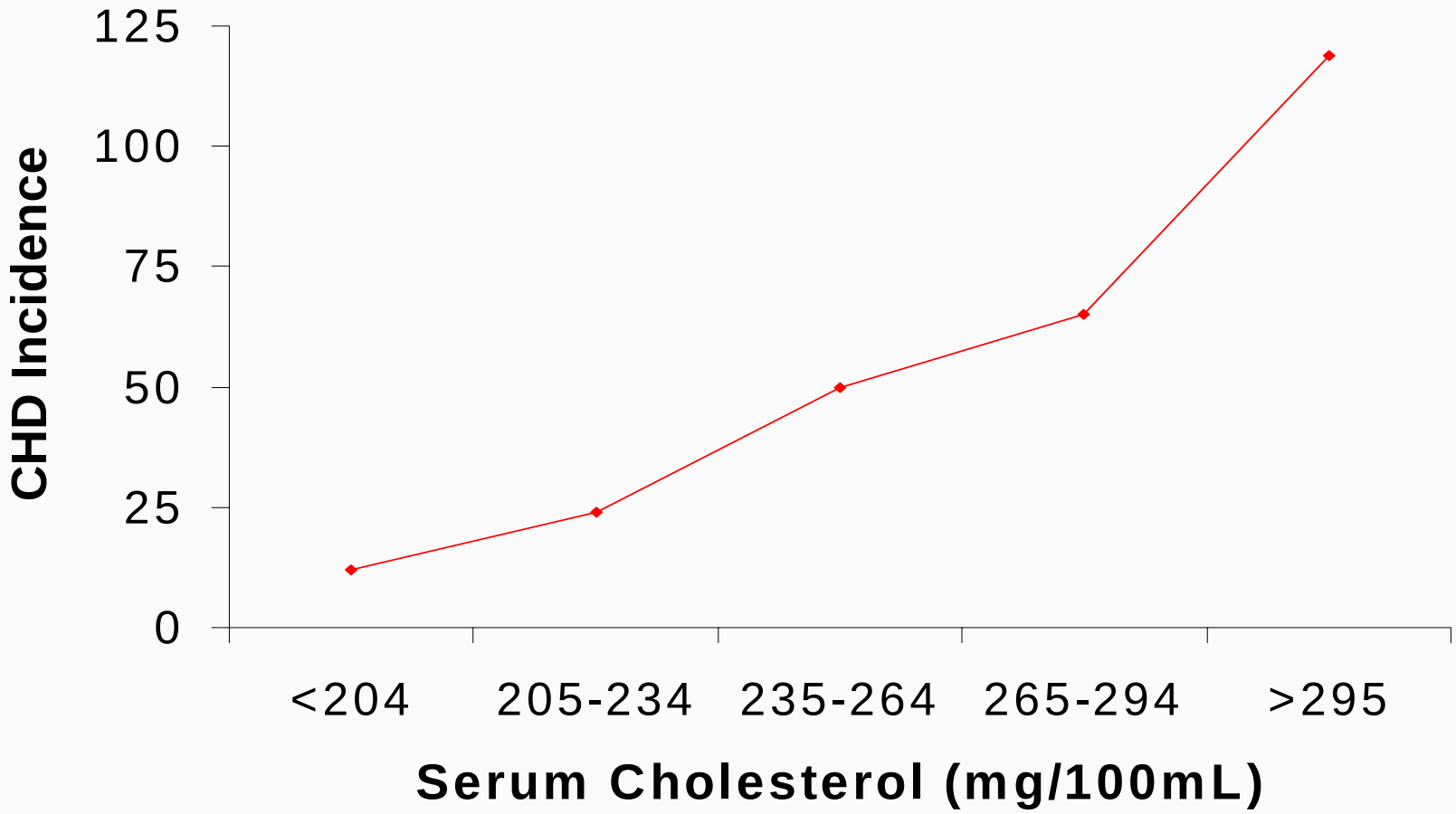
Section C

Fats and Cardiovascular Disease

Serum Cholesterol and Coronary Heart Disease

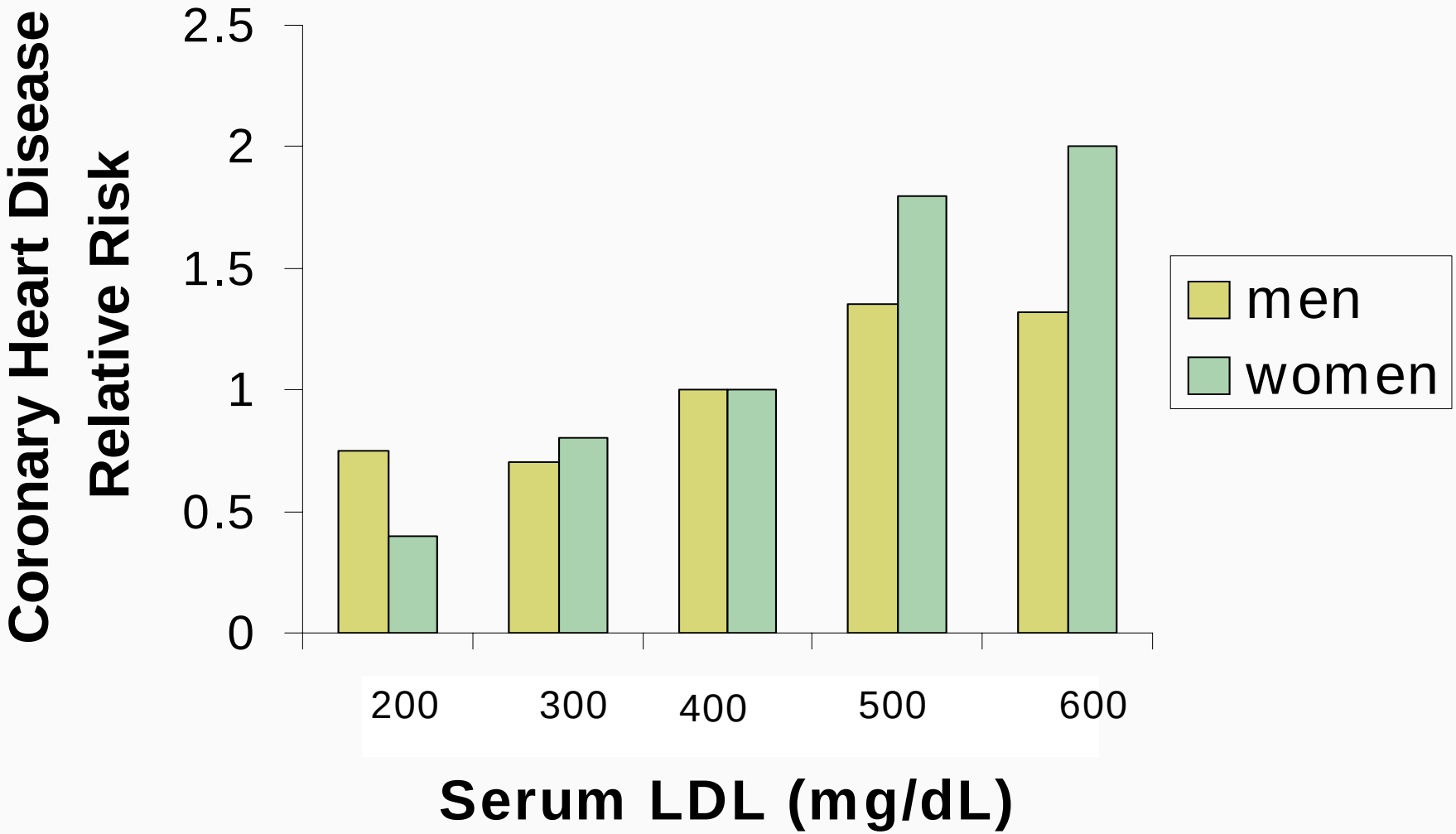


Notes Available

Cholesterol and CVD

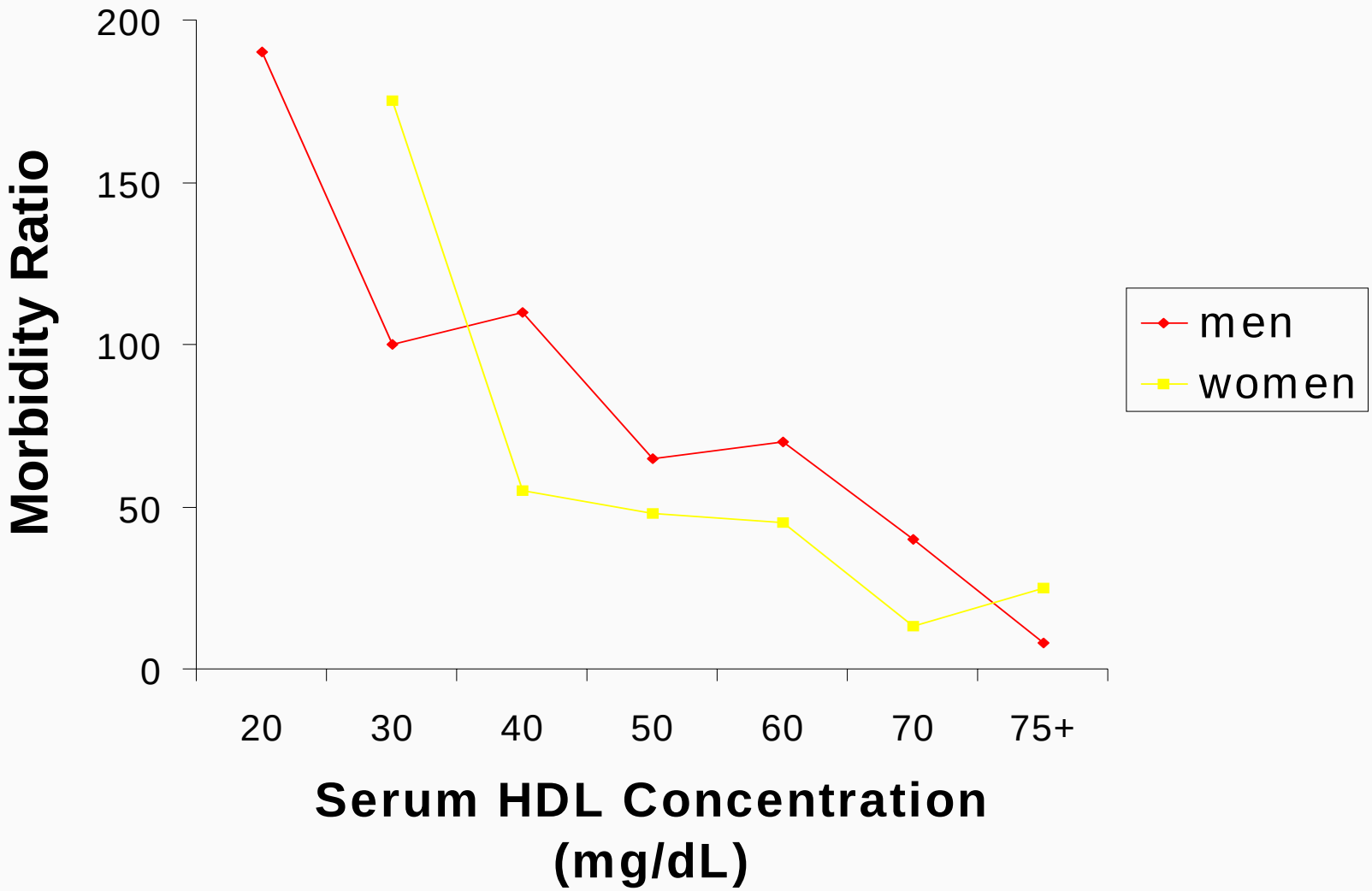
- The cholesterol hypothesis of coronary heart disease
- Dietary cholesterol, blood cholesterol, and atherosclerosis
- Dietary factors affecting blood cholesterol levels
- Non-dietary factors affecting blood cholesterol levels

Serum LDL and CHD Risk



Notes Available

Serum HDL and CHD



Notes Available

Diet and Atherosclerosis

- **Low-fat diets**
  - Lower blood cholesterol but also tend to lower LDL and HDL
- **Low-saturated, high-monounsaturated diets**
  - Lower blood cholesterol and LDL, tend to increase HDL

Diet and Atherosclerosis

- **High-carbohydrate diets**
  - Modest lowering effect on all lipid fractions, but rise in TG
- **Fish oils**
  - Strong lowering effect on blood TG, but minor effect of lipoprotein fractions

Dietary Factors Affecting Blood Cholesterol

- **Increase**
  - Saturated fat
  - Cholesterol
  - Trans fatty acids
- **Decrease**
  - Monounsaturated fat
  - PUFA (fish oil)
  - Fiber

Non-Dietary Factors Affecting Blood Cholesterol

- **Increase**
  - Smoking
  - Excess body fat
  - Alcohol
- **Decrease**
  - Exercise
  - Estrogens

Other Nutrients Associated with Risk of CHD

- Folic acid
- Vitamins B_6 and B_{12}
- Iron

Folate and Vitamin B: Interrelationships