Cardiovascular System, Disease, and Health

Preventable Deaths in USA (1990-2000)

Causes	# (%) in 1990	# (%) in 2000
Tobacco	400,000 (19)	435,000 (18)
Poor diet and physical activity (obesity)	300,000 (14)	400,000 (17)
Alcohol consumption	100,000 (5)	85,000 (4)
Microbial agents	90,000 (4)	75,000 (3)
Toxic agents	60,000 (3)	55,000 (2)
Motor vehicle accidents	25,000 (1)	43,000 (2)
Firearms	35,000 (2)	29,000 (1)
Sexual behavior	30,000 (1)	20,000 (<1)
Illicit drug use	20,000 (<1)	17,000 (<1)
Total	1,060,000 (50*)	1,159,000 (48%*)

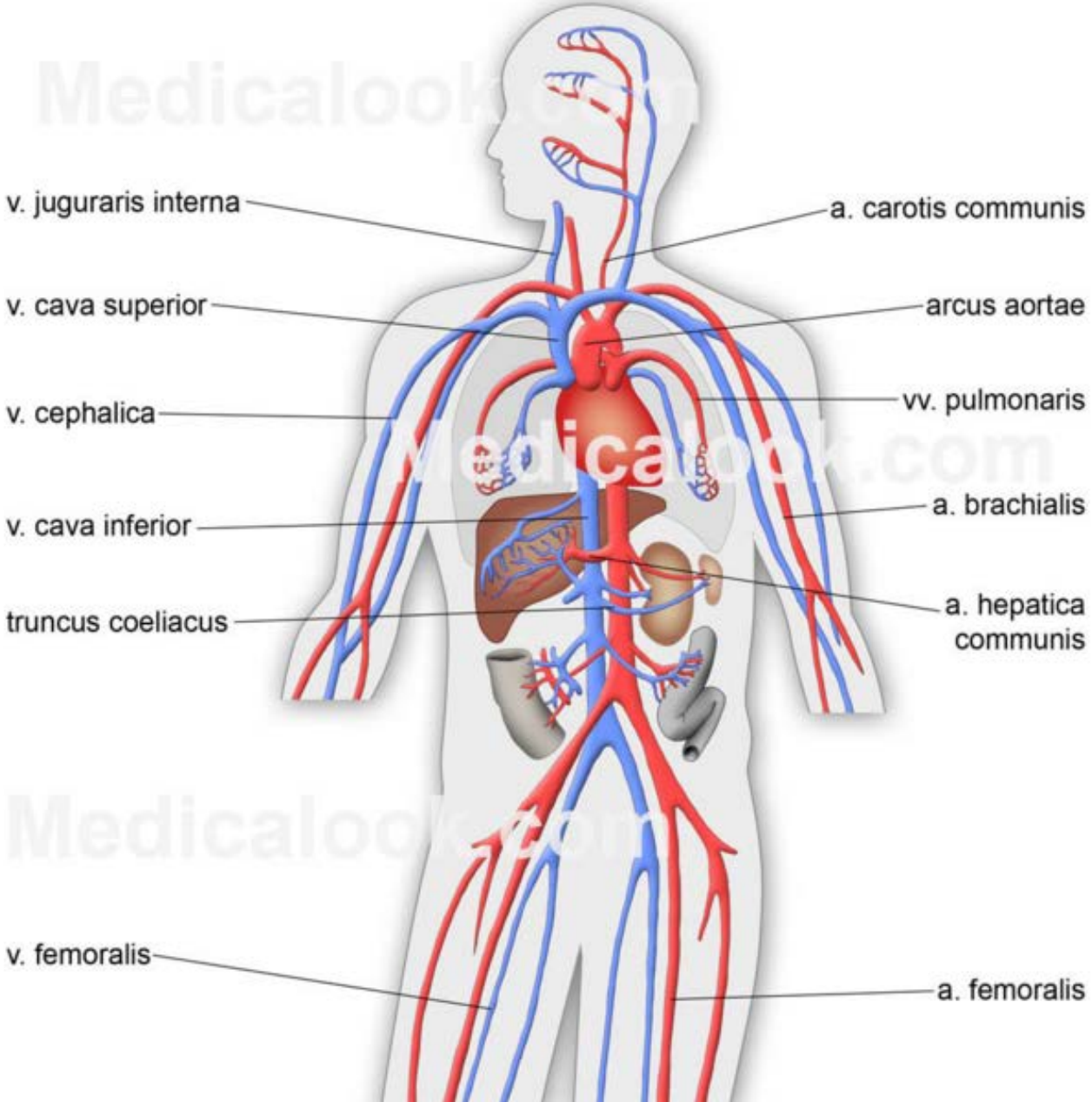
Mokdad AH et al. *JAMA* 2004;291:1238-1245

Cardiovascular Diseases

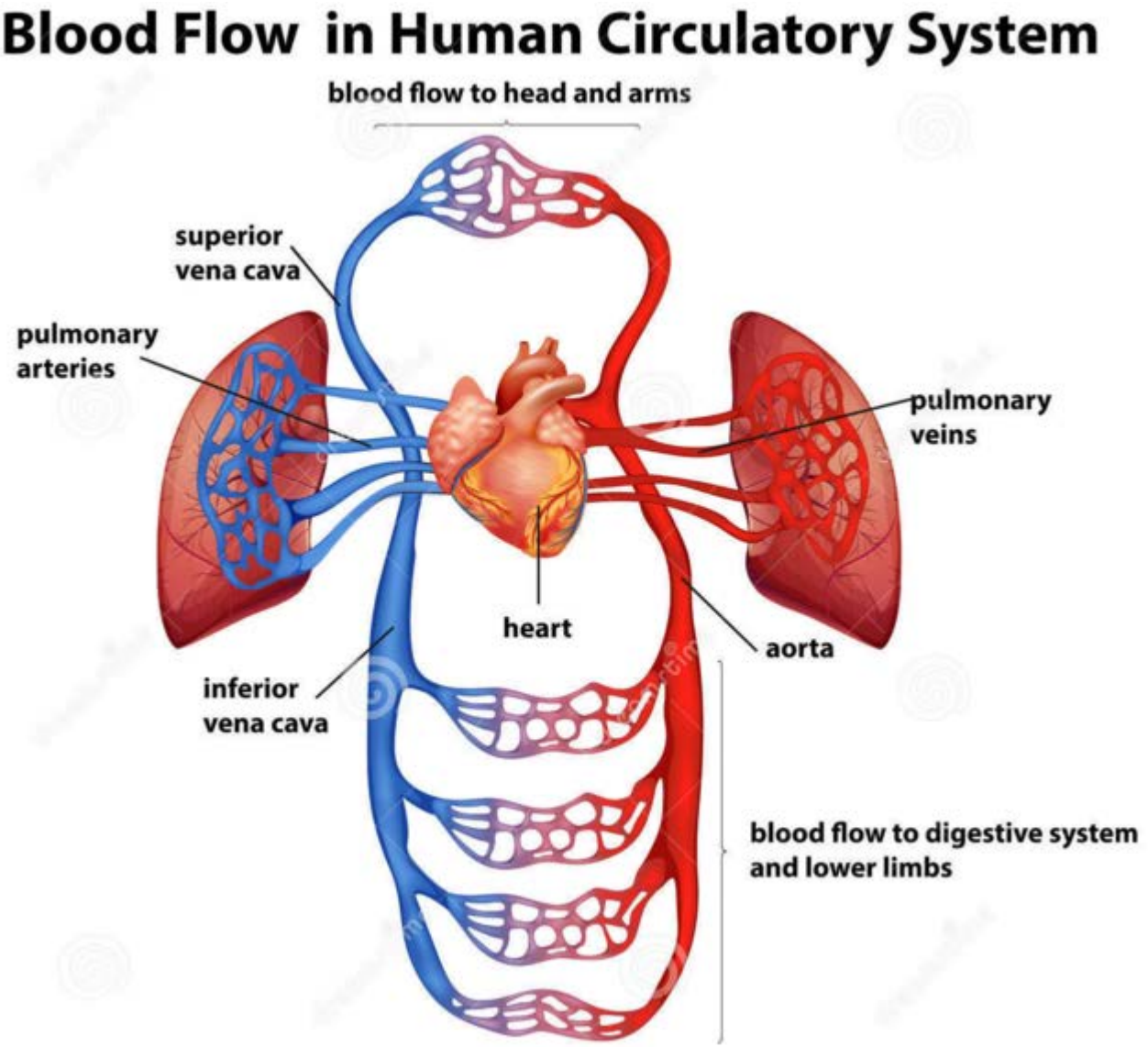
- Myocardial Infarction
  - A fancy word for a heart attack
- Stroke
  - Blood flow to the brain in cut off
- Abdominal aneurysms
  - Enlarged aorta (main supply of blood to the body)
- Lower limb ischemia
  - Severe blockage of blood flow in lower limbs

These largely influence the morbidity and mortality in Western style populations

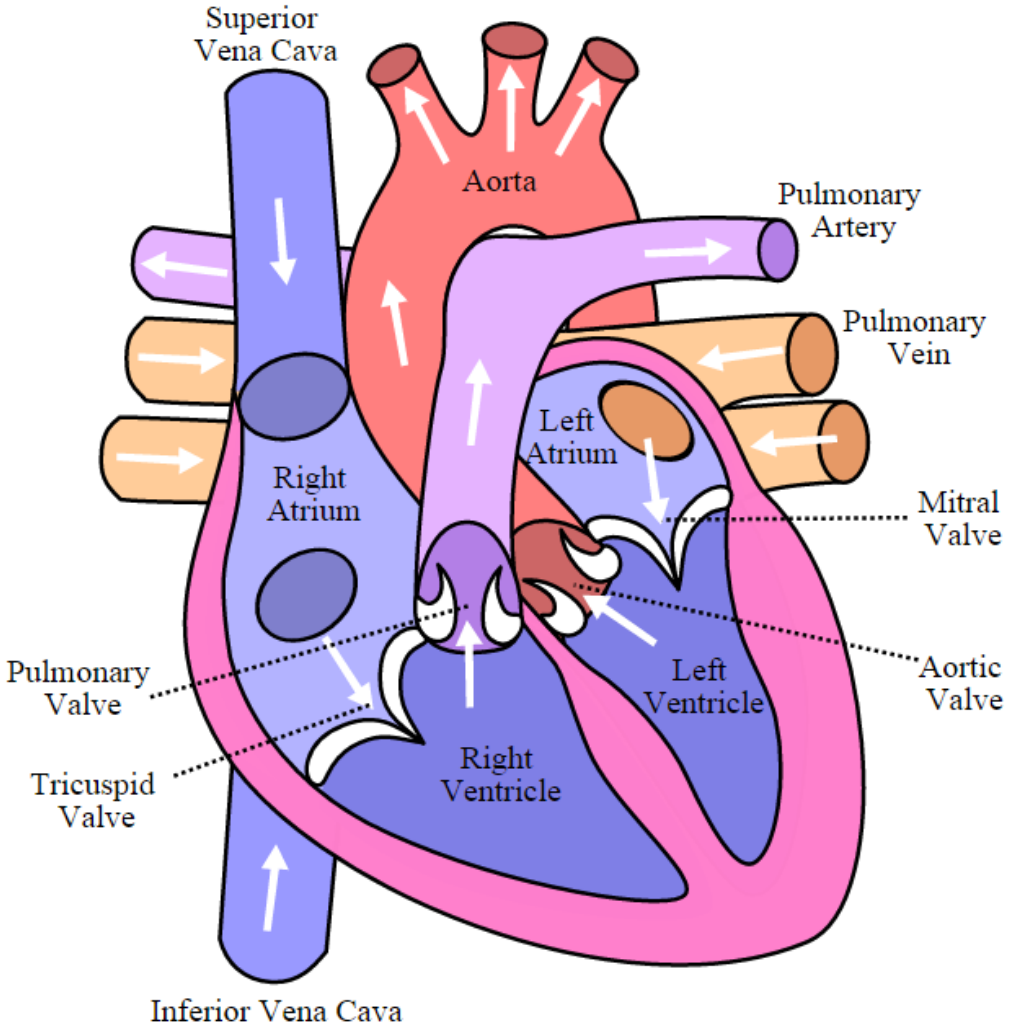
Circulatory System



Circulatory System

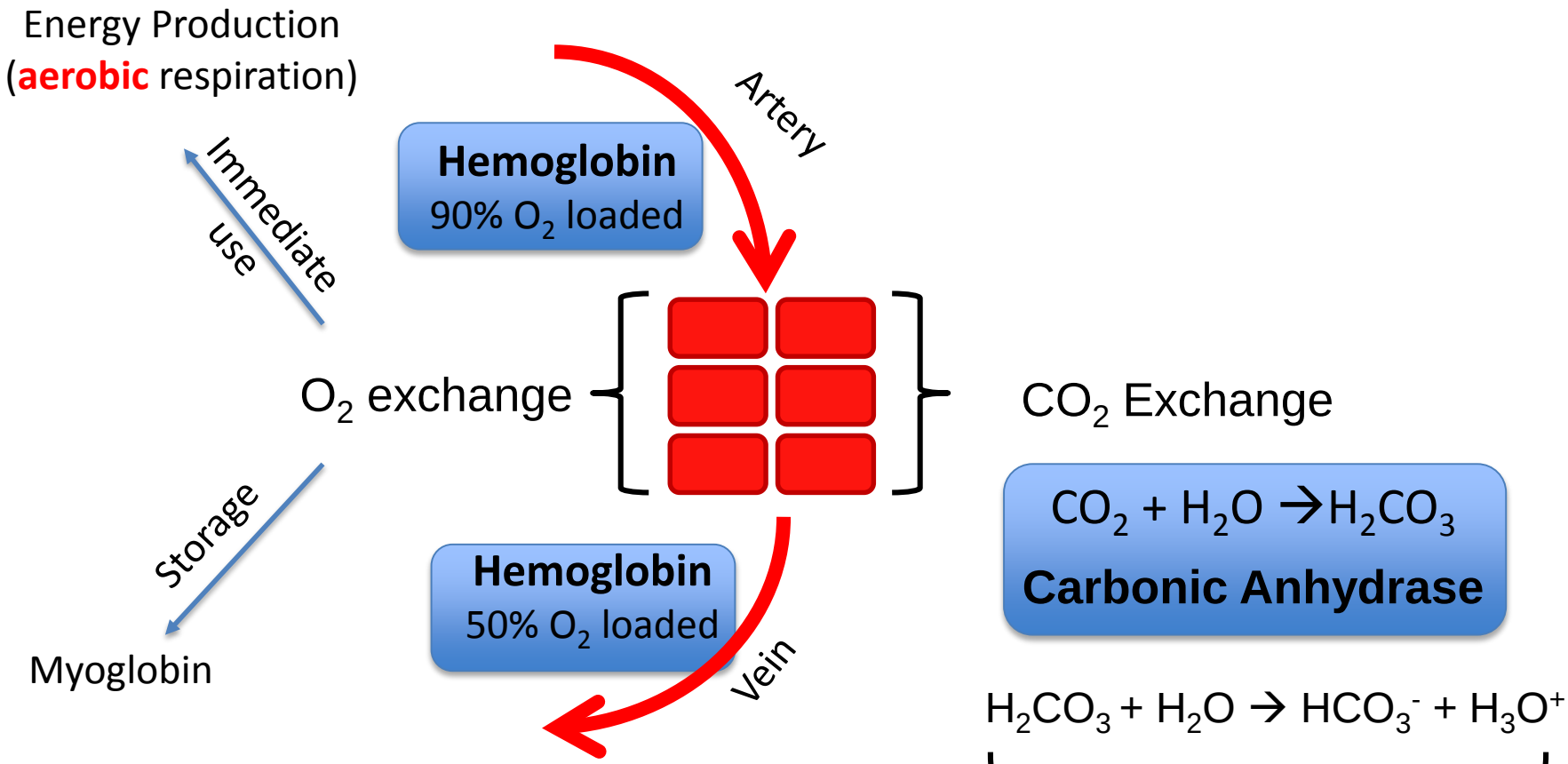


Circulatory System



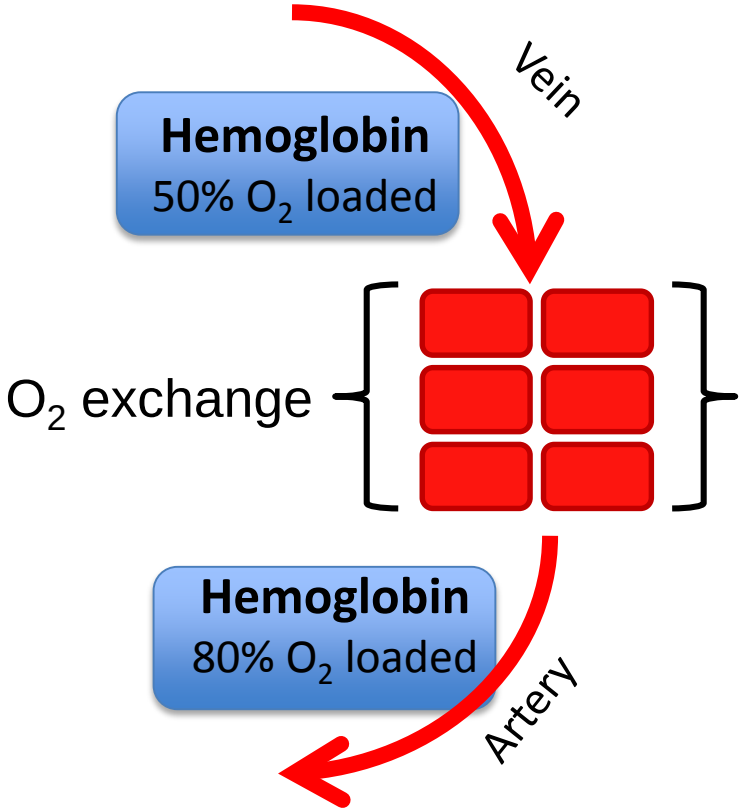
O_2/CO_2 Transport @ Muscle Tissue

Capillary = bottleneck



O_2/CO_2 Transport @ Lungs

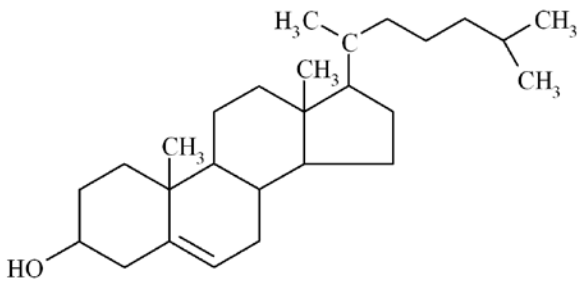
Capillary = bottleneck



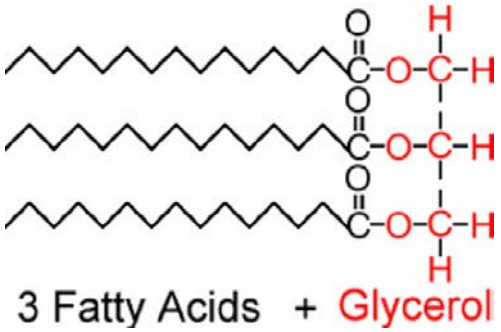
$H_2CO_3 + H_2O \leftarrow HCO_3^- + H_3O^+$

Types of Lipid Molecules

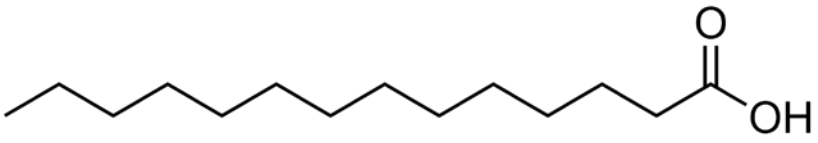
Cholesterol



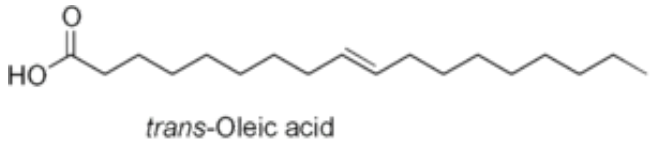
Triglycerides



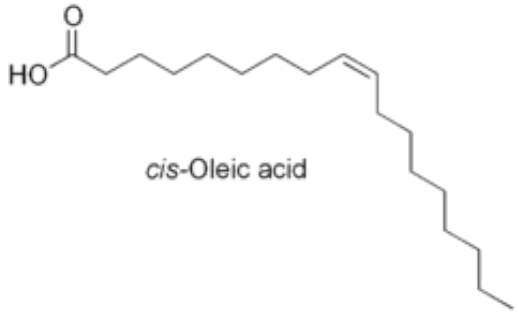
Saturated Fatty Acid



Unsaturated Fatty Acid

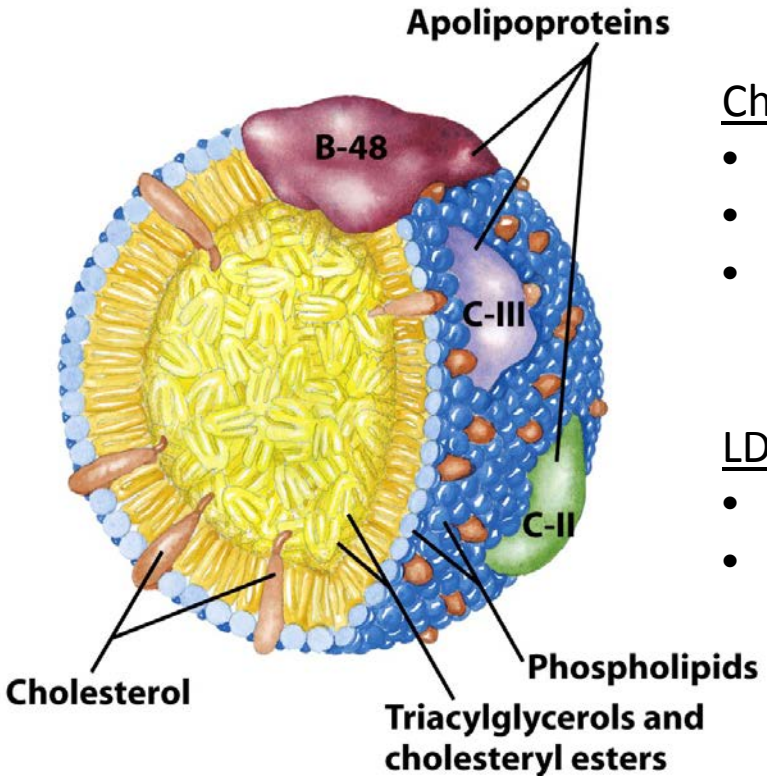


trans-Oleic acid



cis-Oleic acid

The Good, the Bad and the Ugly



Chlyomicrons

- Dietary fat/cholesterol transport to cells
- Originate in intestinal mucosa cells
- 1-2% protein, 85-88% triglycerides, ~8% phospholipids, ~3% cholesteryl esters and ~1% cholesterol

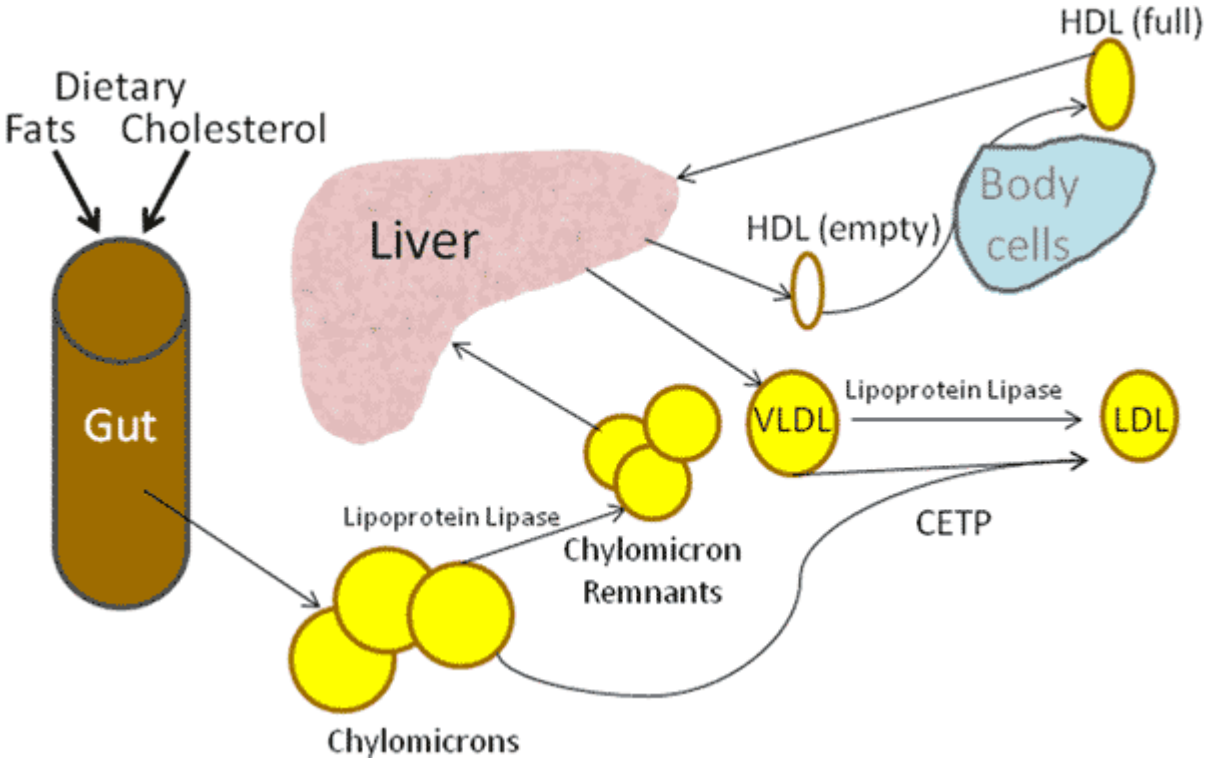
LDL (Low Density Lipoprotein) – "Bad" Cholestrol

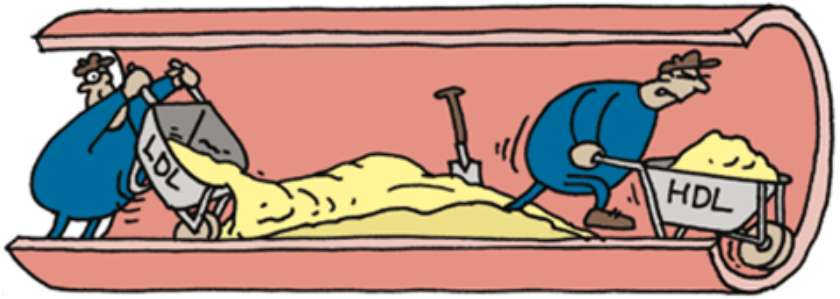
- Cholesterol transport from liver to cells
- One of the lipoproteins (B-100) is recognized by LDL receptors. This triggers encapsulation of LDL and release of cholesterol to be used in the plasma membrane
- 20-22% protein, 10-15% triglycerides, 20-28% phospholipids, 37-48% cholesteryl esters, and 8-10% cholesterol

HDL (High Density Lipoprotein)

- Cholesterol transport to liver for degradation (or recycling)
- Cholesterol "scavenger"
- 55% protein, 3-15% triglycerides, 26-46% phospholipids, 15-30% cholesteryl esters, and 2-10% cholesterol

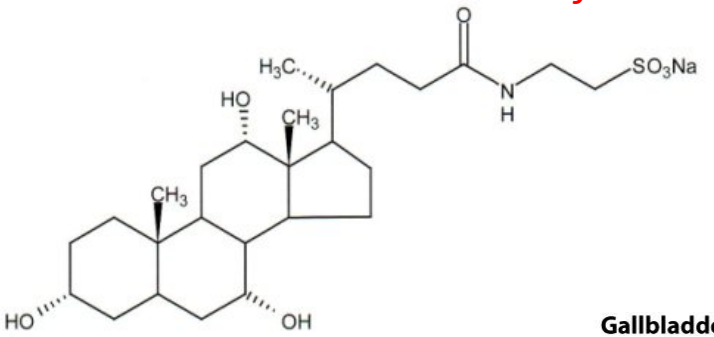
Fat Particles





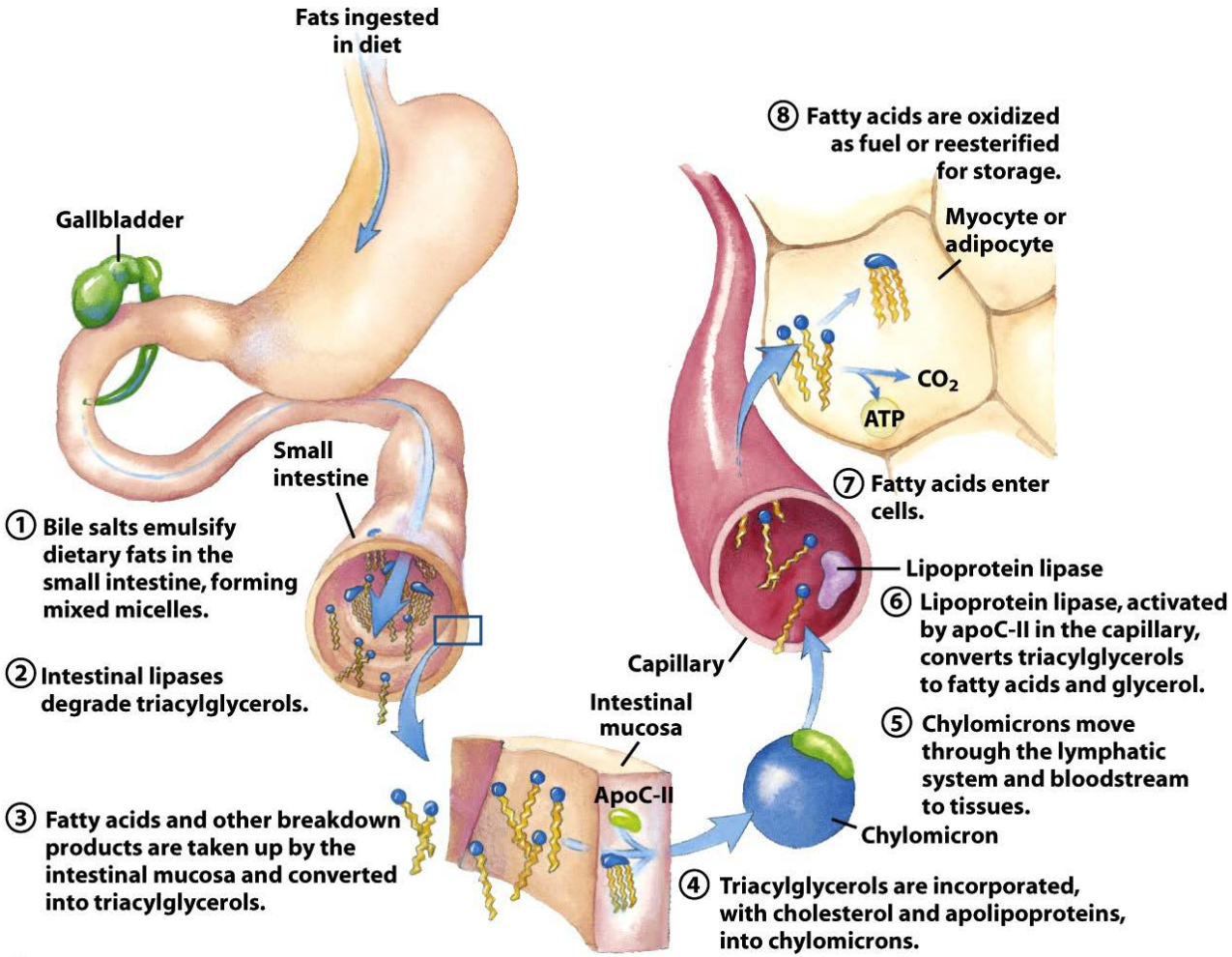
Dietary Lipid Digestion

Bile Salts: Polar Derivatives of Cholesterol – made in liver and stored in gallbladder



Required for dietary fat absorption (as well as absorption of Vitamins A, D, E, and K)

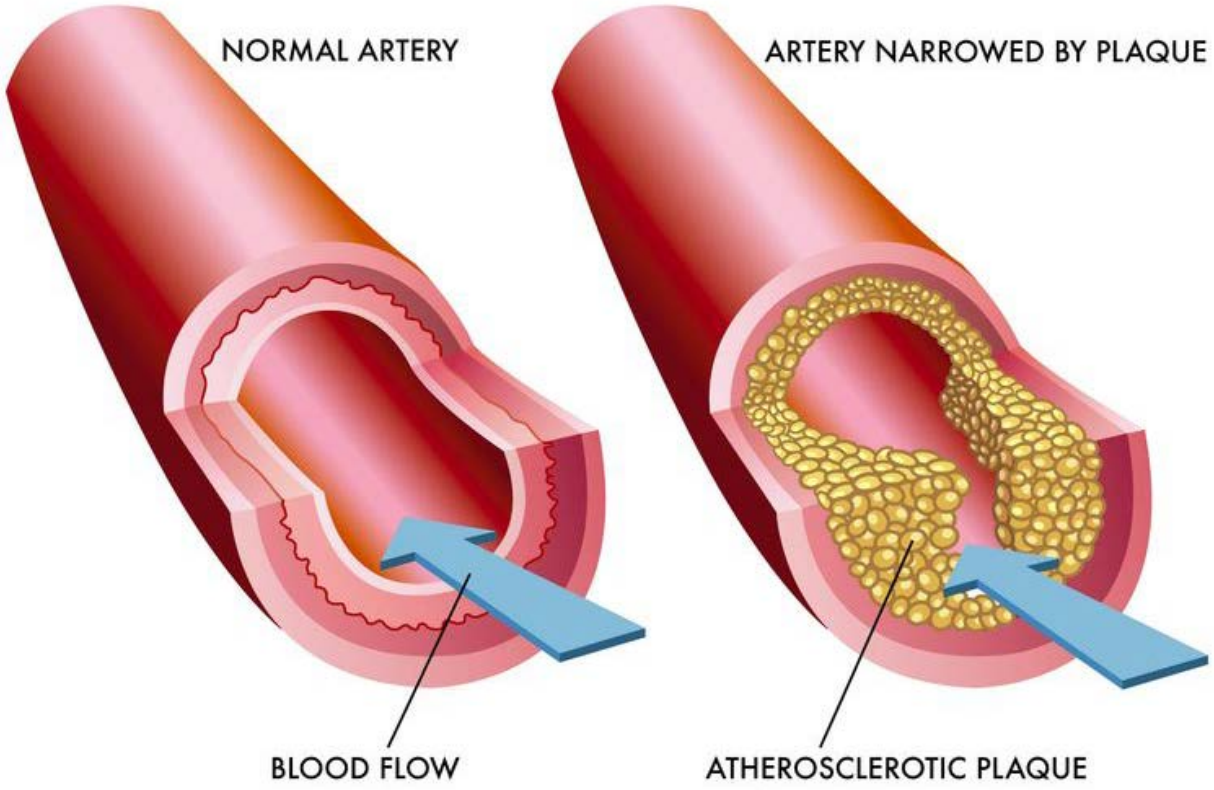
Facilitated by Bile Salts



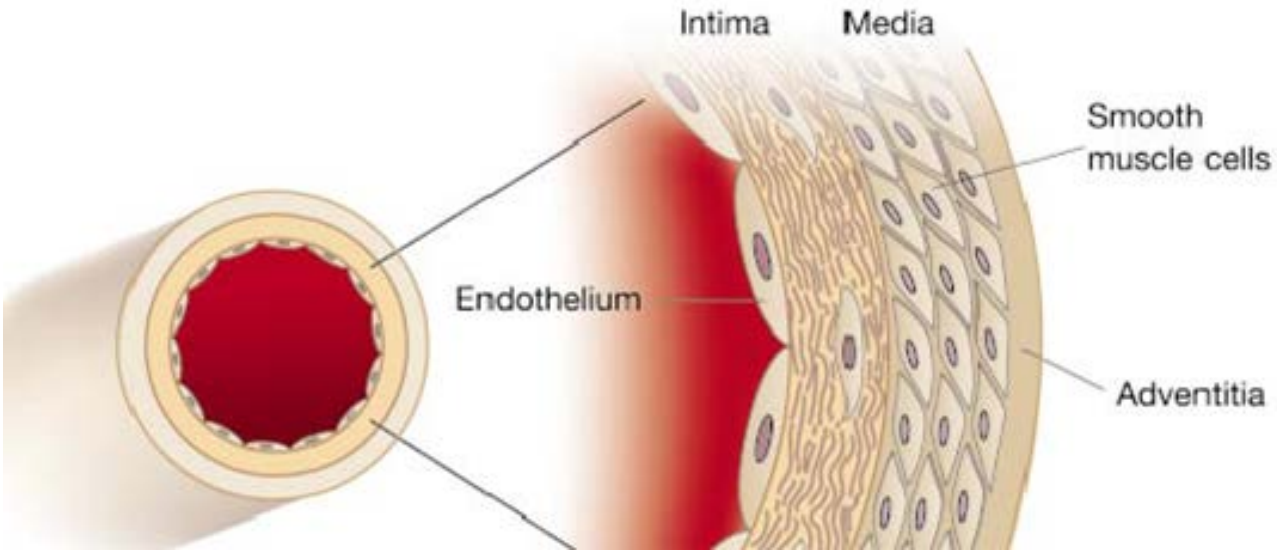
Lipid Uptake and Transport

Atherosclerosis

Atherosclerosis is a disease process which is triggered by sometimes subtle physical or chemical insults to the endothelial cell layer of arteries.



Atherosclerosis

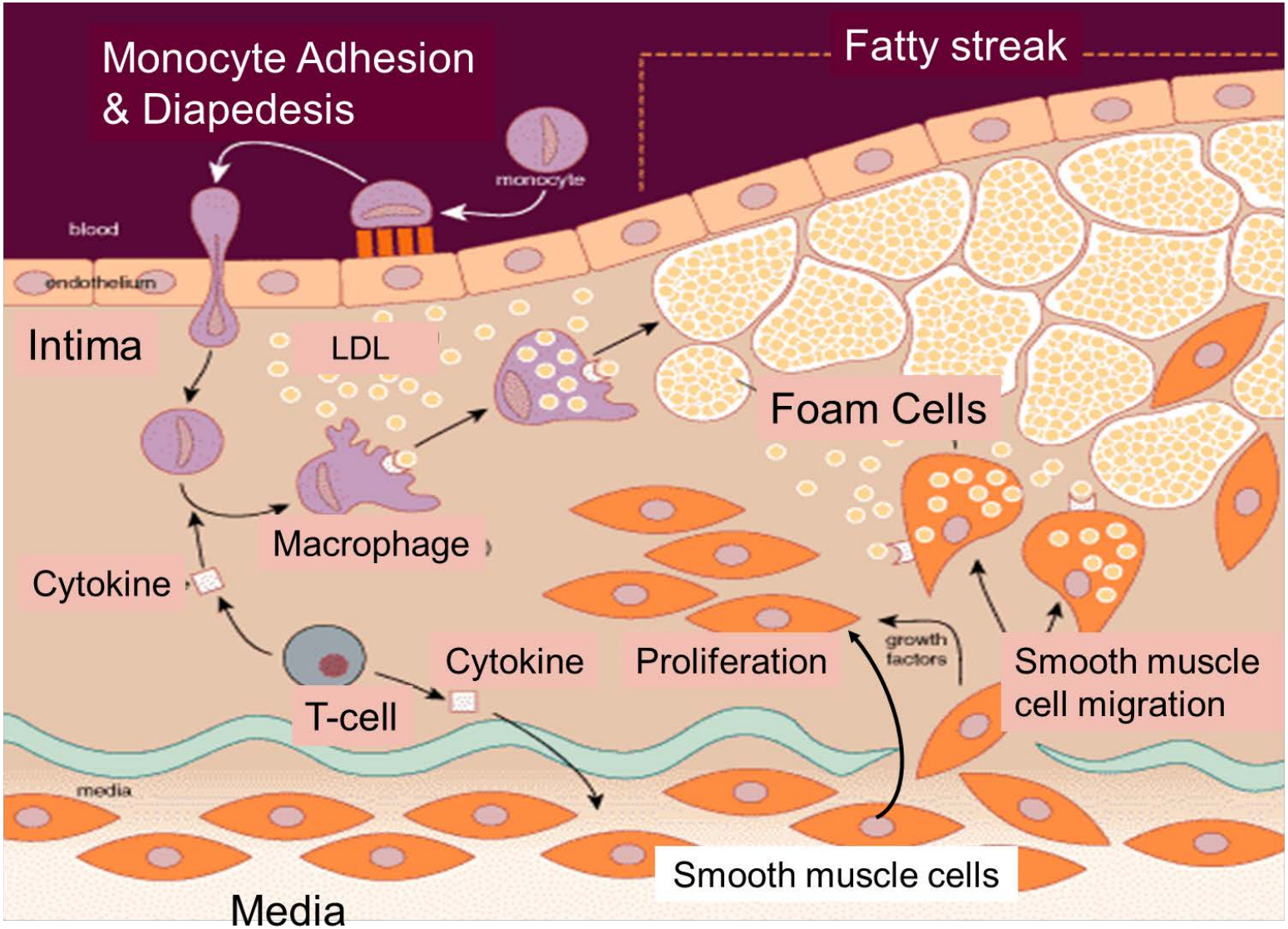


Atherosclerosis

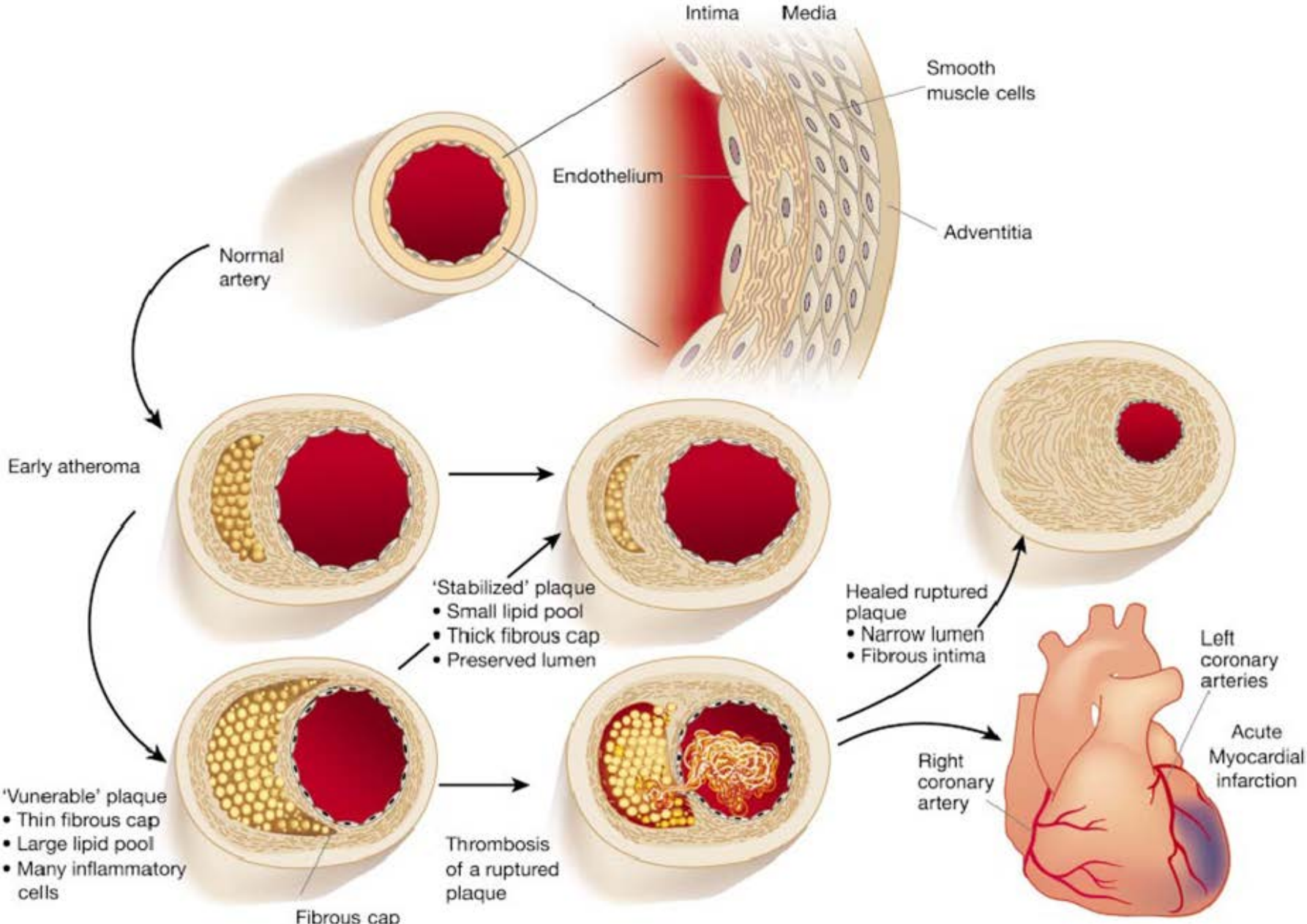
Response to Injury theory – Atherogenesis is triggered in response to some external stress

- Physical injury or stress as a result of direct trauma or hypertension
- Turbulent blood flow, for example, where arteries branch
- Circulation of reactive oxygen species (free radicals), e.g., from smoking or air pollutants
- Hyperlipidemia (high blood concentrations of LDL or VLDL)
- Chronically elevated blood glucose levels

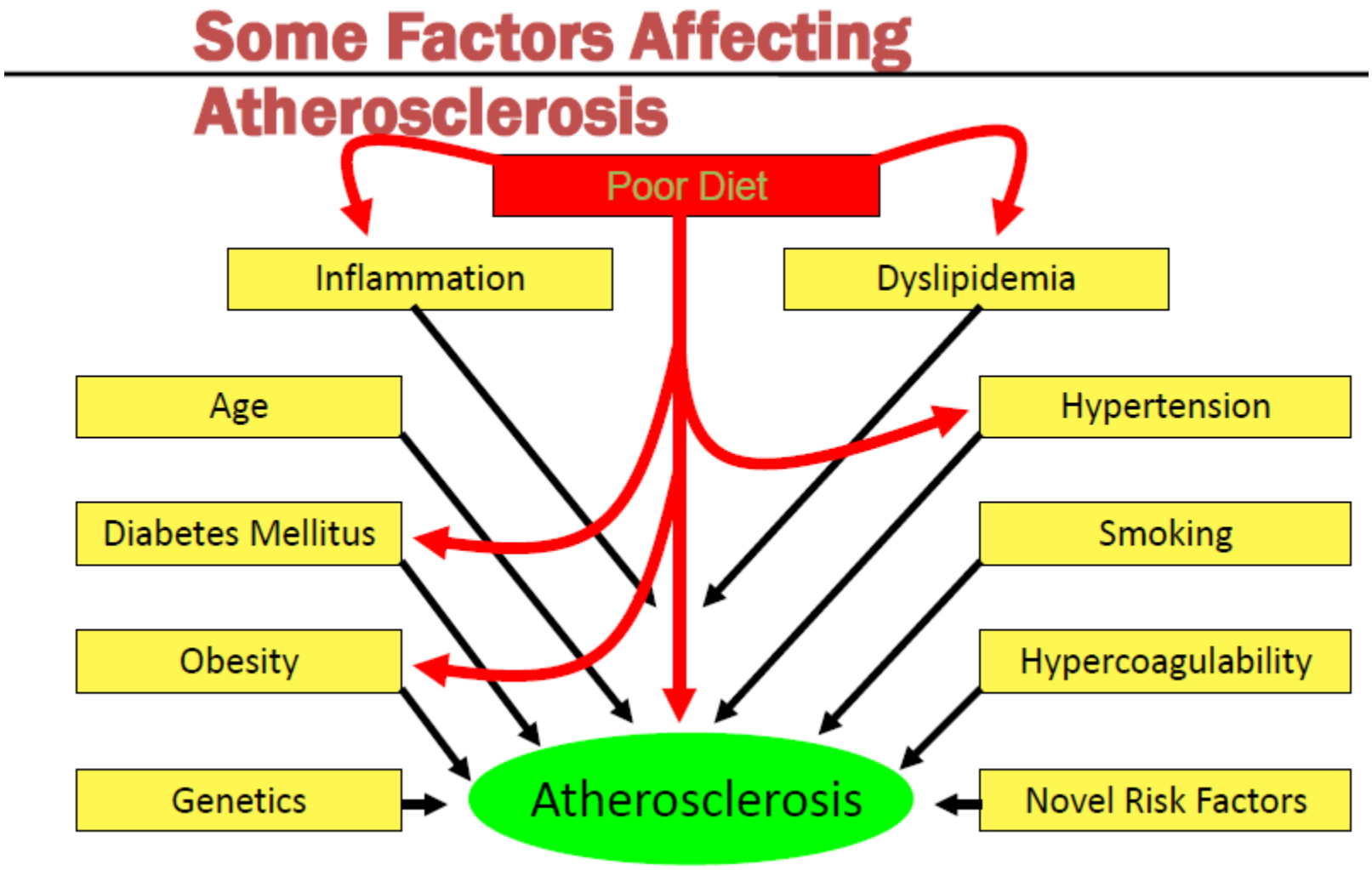
Atherosclerosis



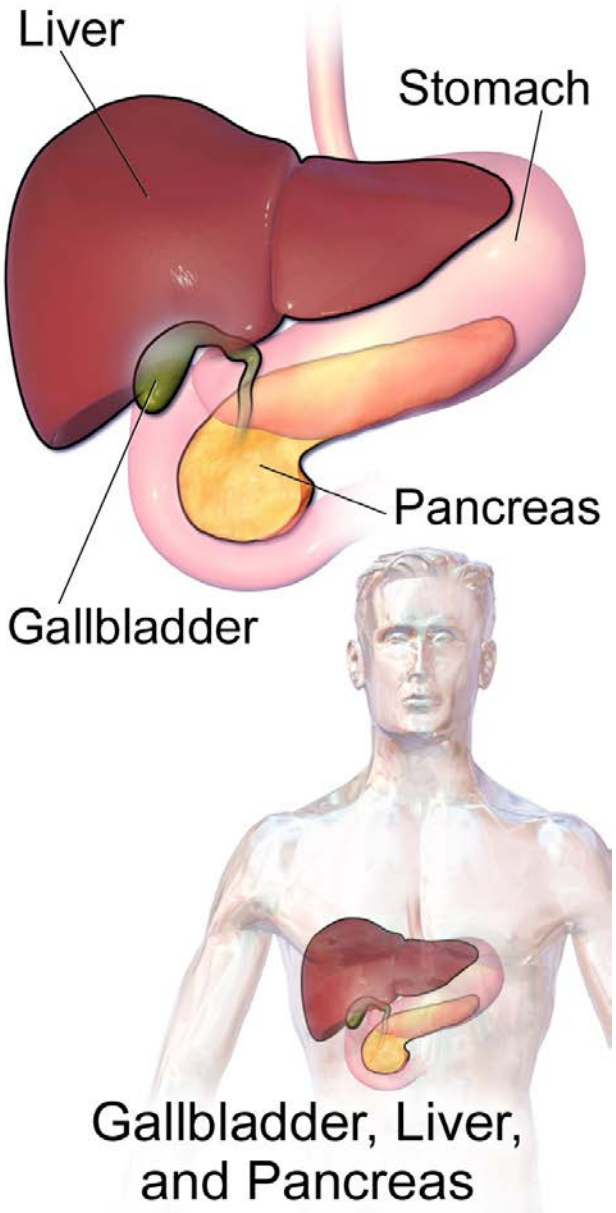
Atherosclerosis



Atherosclerosis

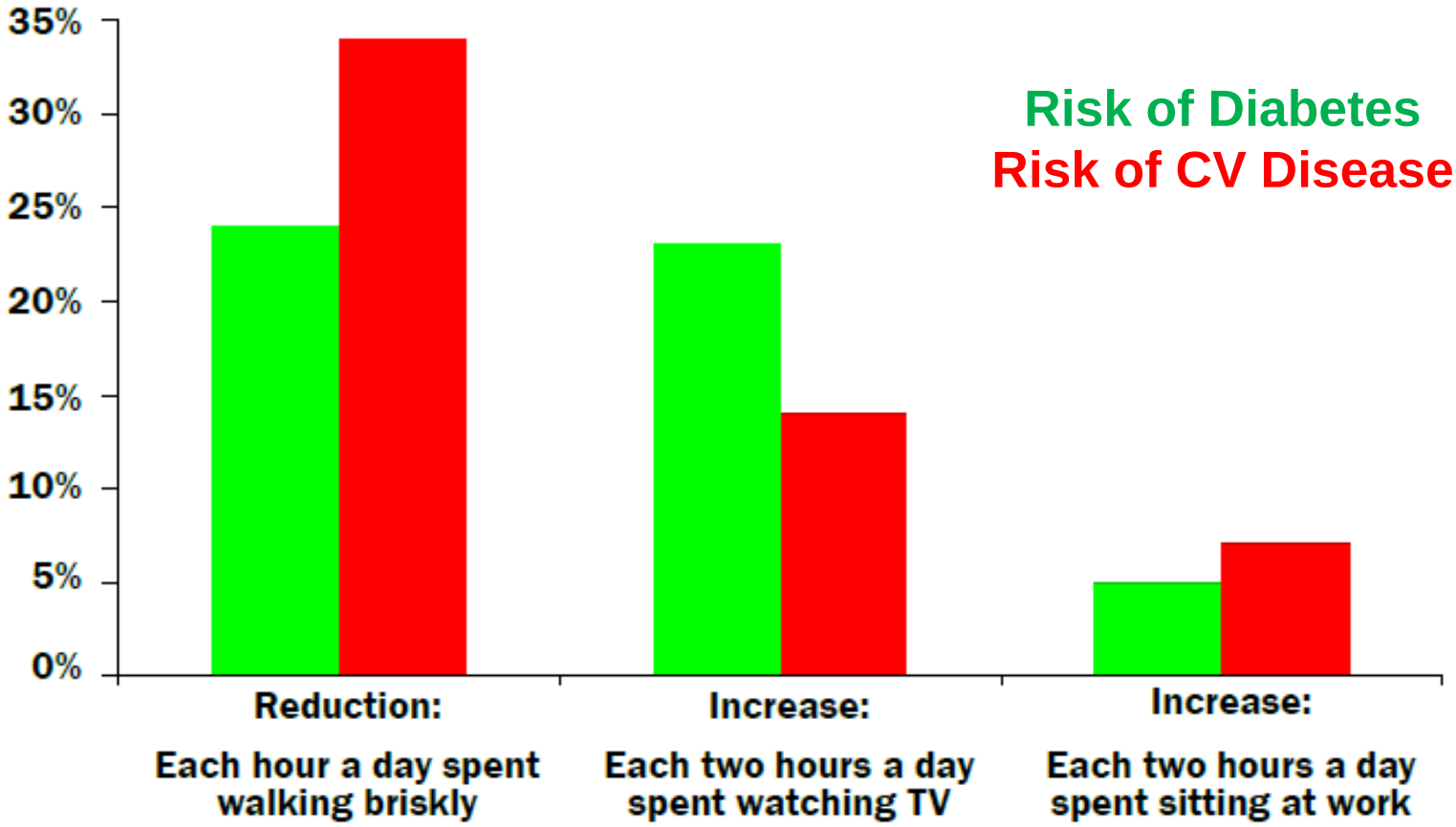


Dietary Lipid Digestion – important organs



Lipid Uptake and Transport

Make a prediction: how will exercise effect risk of obesity and cardiovascular disease?

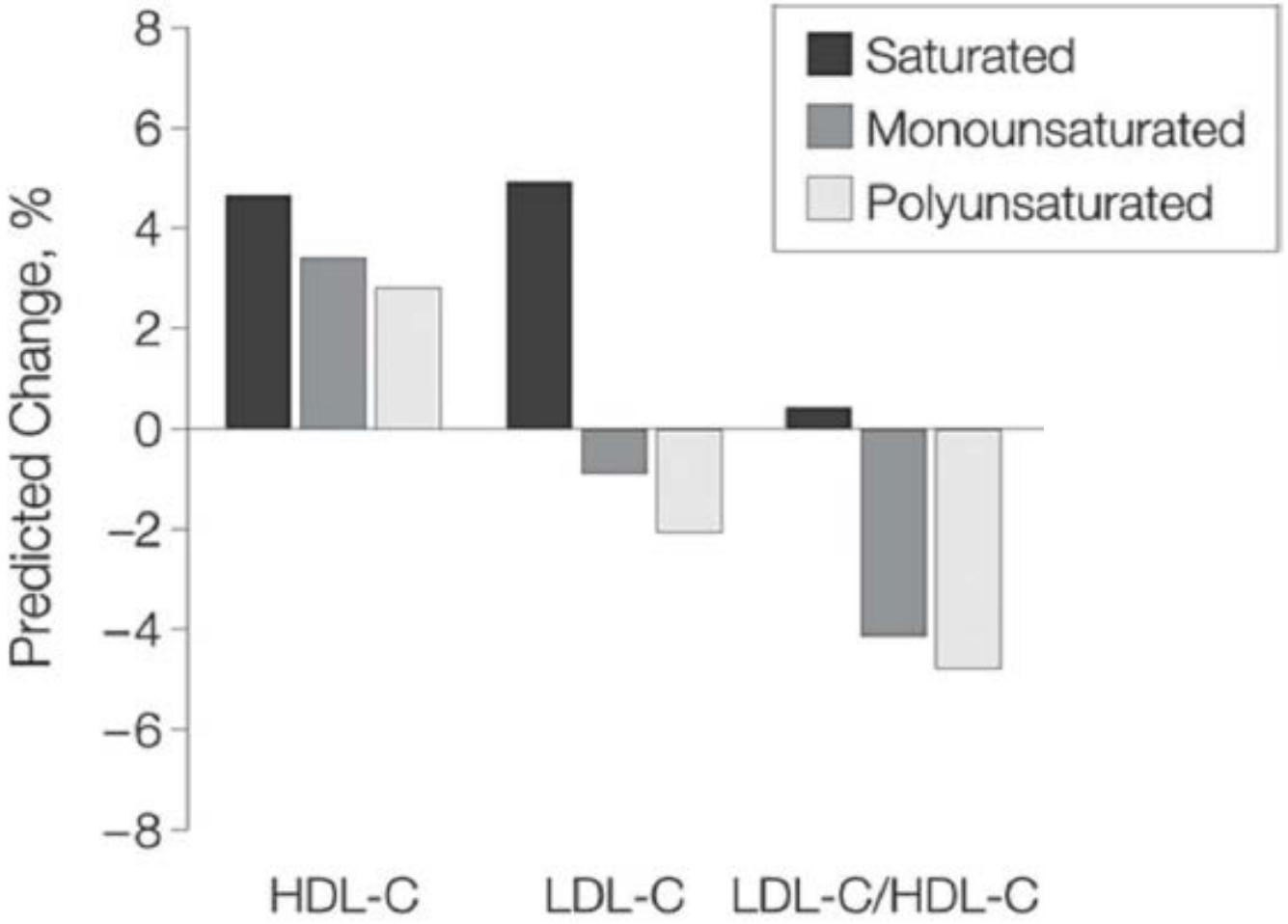


Source: Hu FB et al. *JAMA* 2003;289:1785-1791

Make a prediction: what will happen to LDL and HDL levels when 5% of dietary carbohydrates are replaced with:

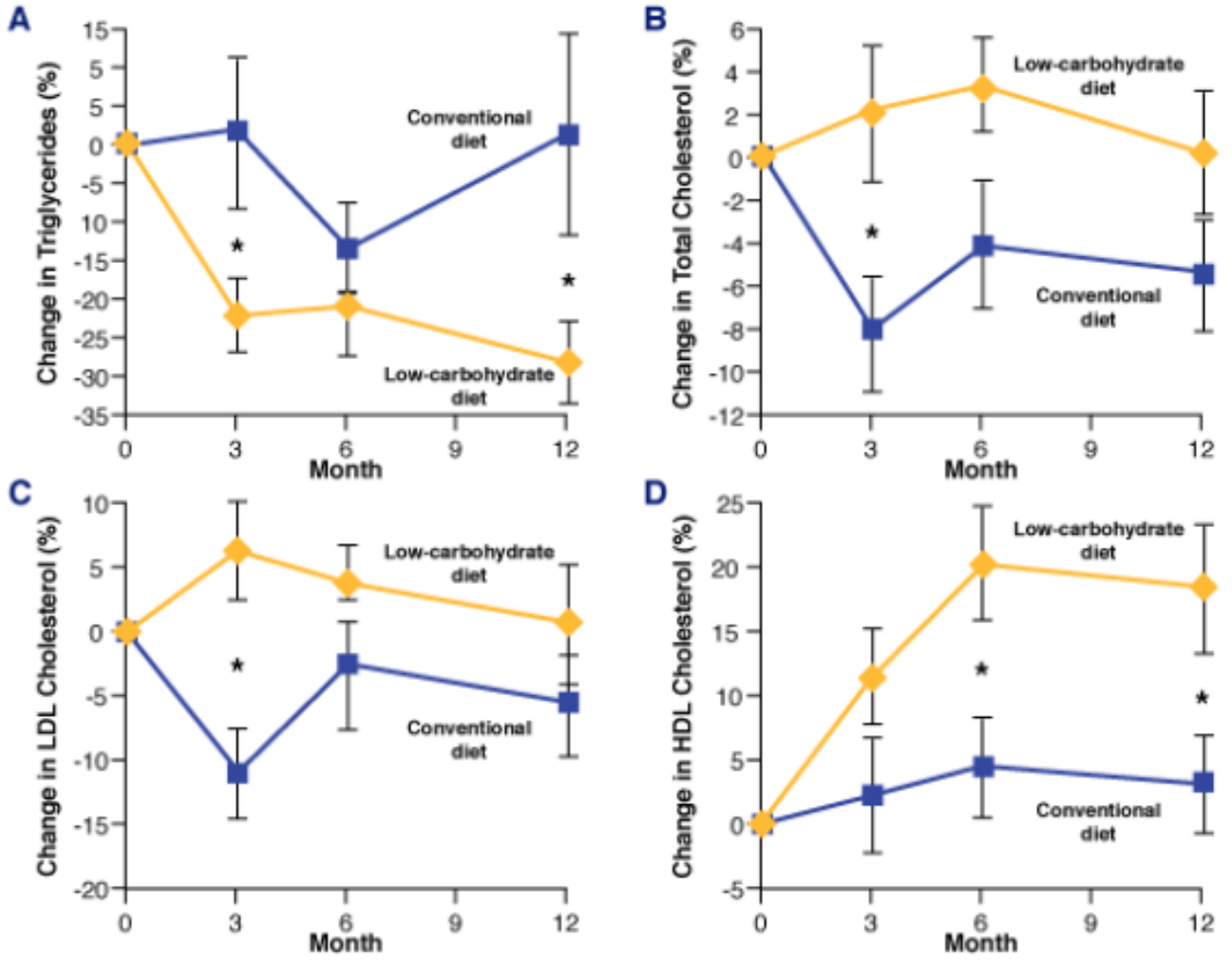
Saturated Fatty Acids

Unsaturated Fatty Acids

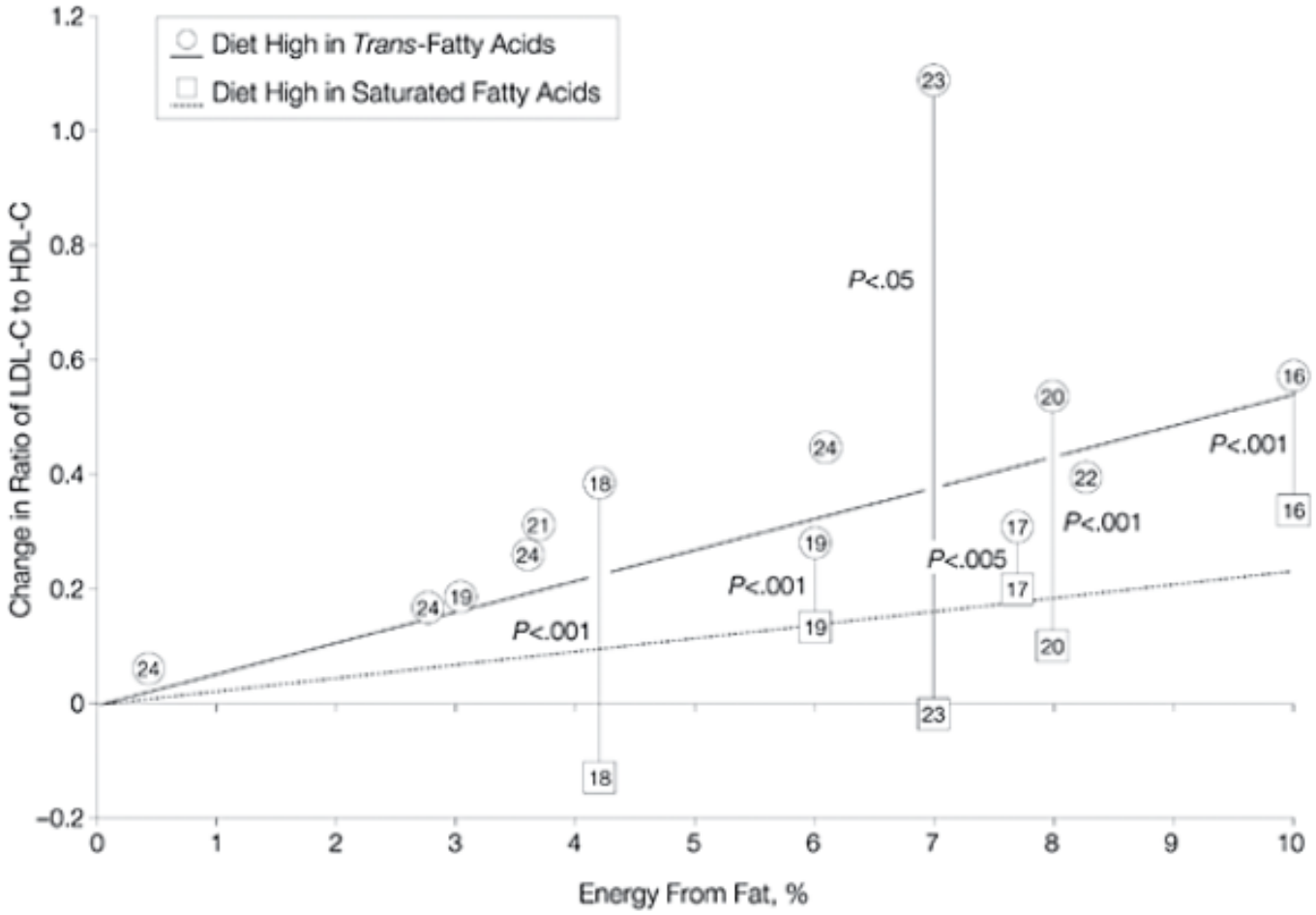


Diet and Lipid Levels

How do you think a low carbohydrate diet will influence the levels of cholesterol, LDL, and HDL?



Trans-fatty acids increase LDL and lower HDL relative to cis-unsaturated fatty acids.



Ascherio A, et al. *N Engl J Med.*1999;340:1994-1998.