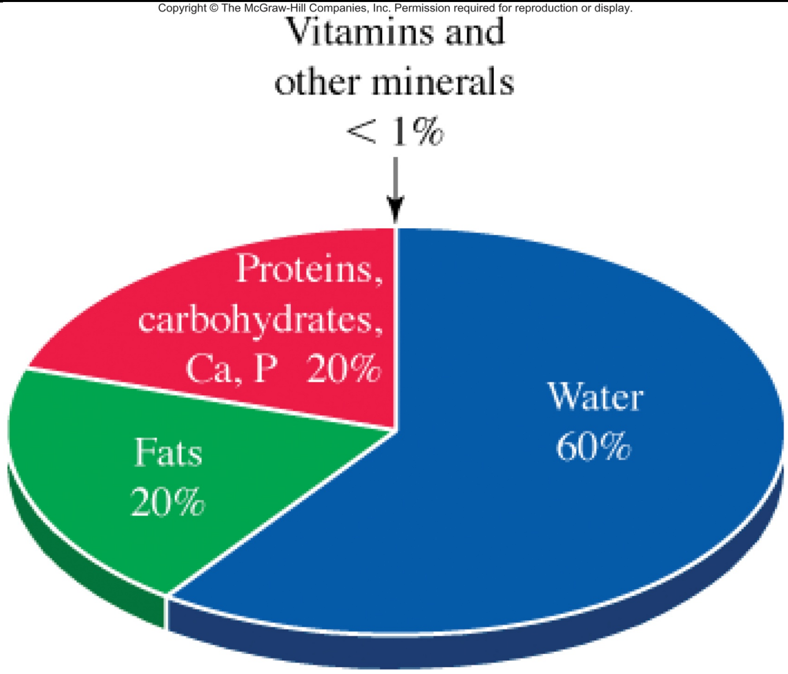
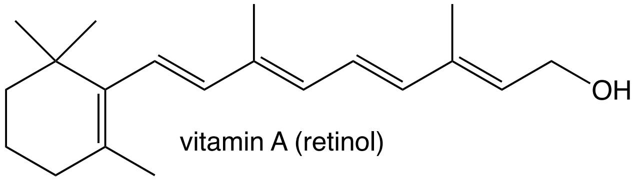


Macronutrients: fats, proteins, carbohydrates

Essential amino acids

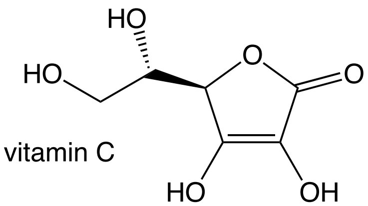
Vitamins and minerals

Hydrophobic



vitamin A (retinol)

Hydrophilic



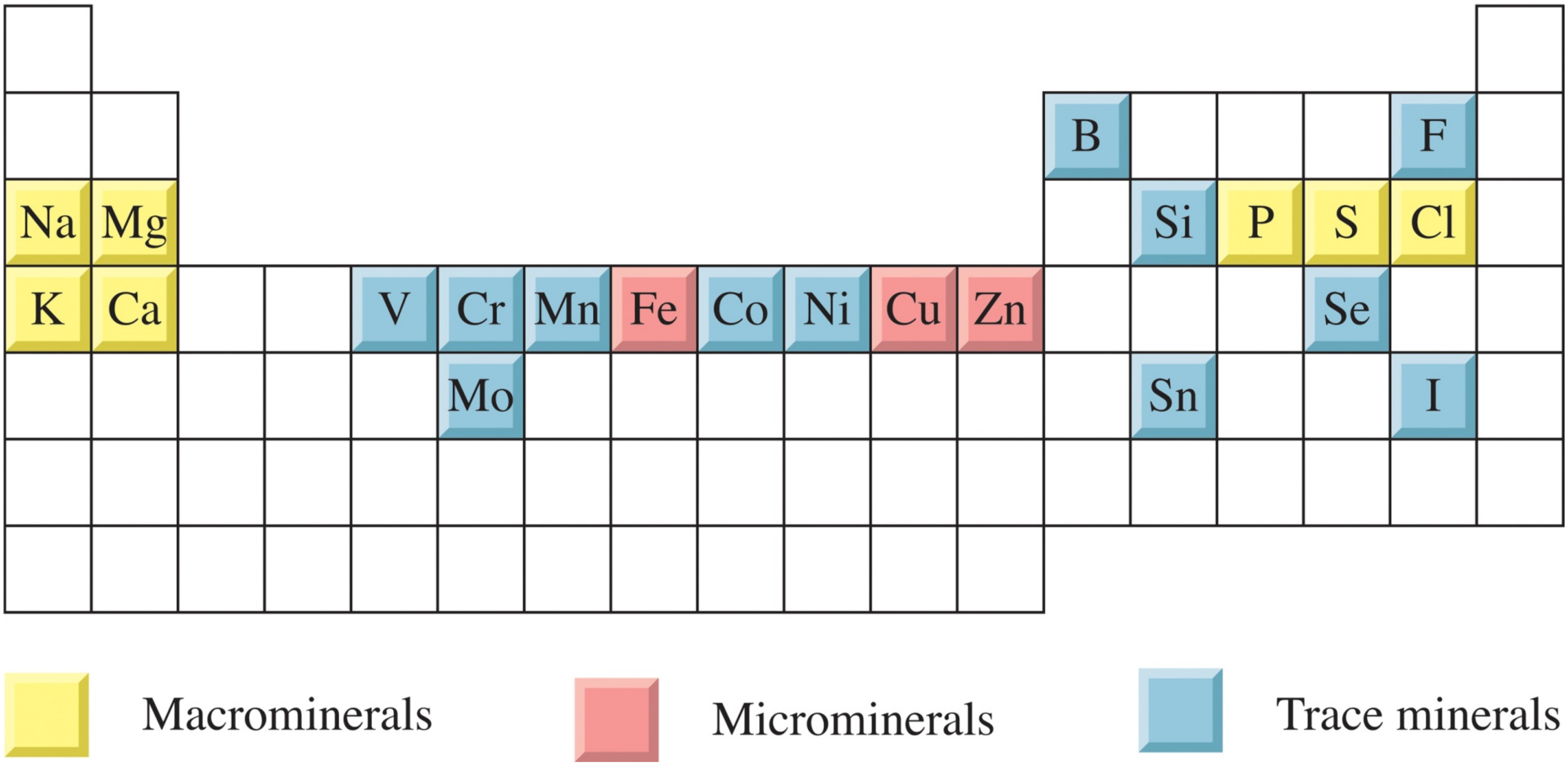
vitamin C

Table 11.1 Percent Water, Fat, Carbohydrates, and Protein in Selected Foods

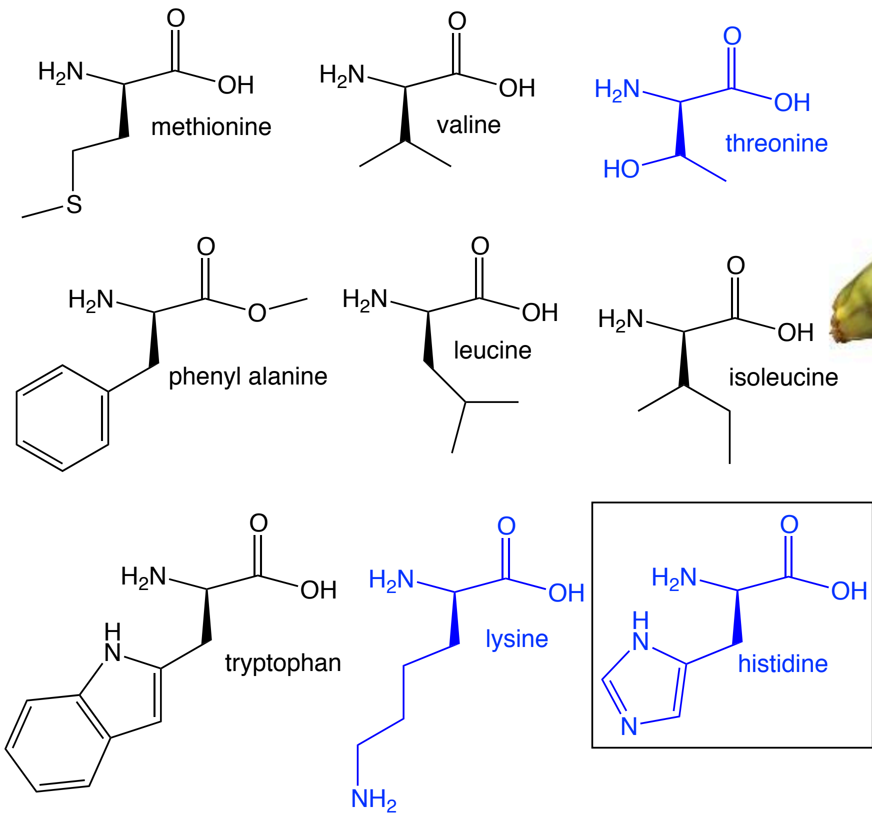
Food	Water	Fat	Carbohydrates	Protein
white bread	37	4	48	8
2% milk	89	2	5	3
chocolate chip cookies	3	23	69	4
peanut butter	1	50	19	25
sirloin steak	57	15	0	28
tuna fish	63	2	0	30
black beans (cooked)	66	<1	23	9

Source: U.S. Department of Agriculture, Agricultural Research Service, *Home and Garden Bulletin* 72, 2002.

Nutritional periodic Table



Essential amino acids



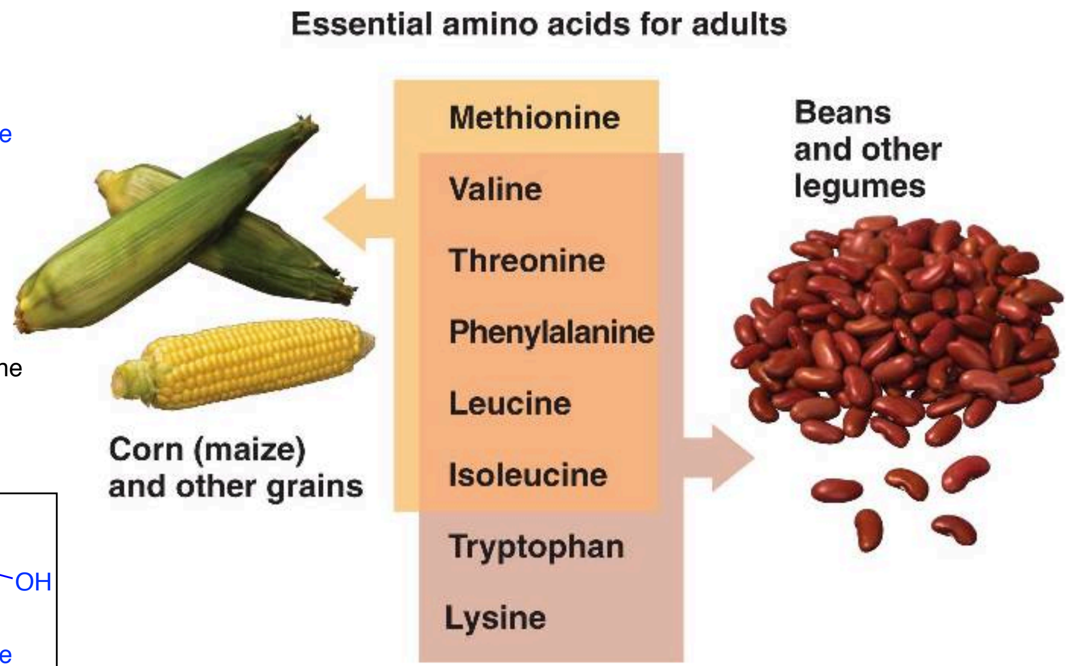
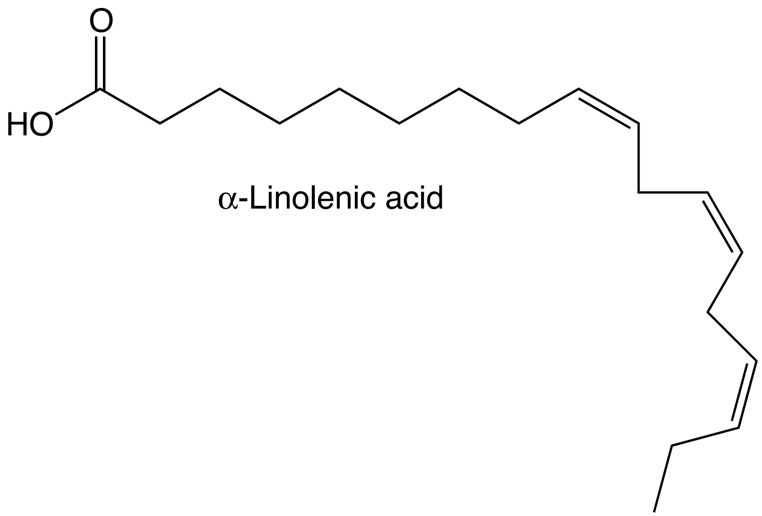


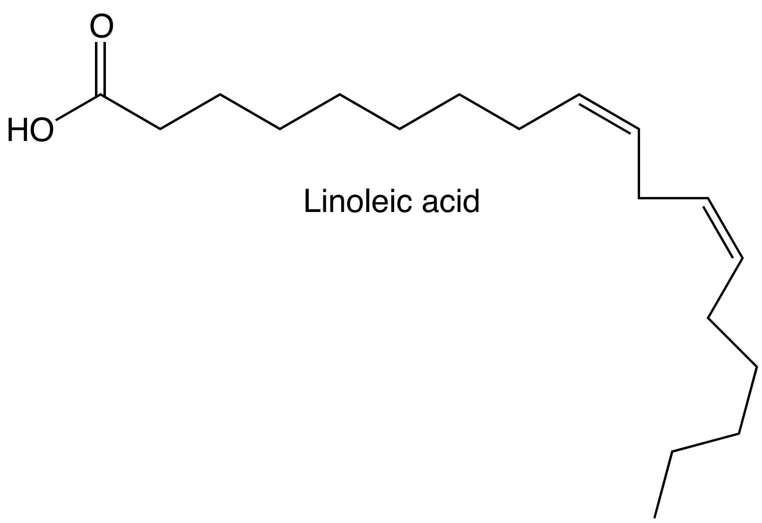
Table 11.5 The Essential Amino Acids

histidine	lysine	threonine
isoleucine	methionine	tryptophan
leucine	phenylalanine	valine

Essential fatty acids



α-Linolenic acid



Linoleic acid

Caloric "Need"

Table 11.7 Estimated Calorie Requirements (United States)

	ACTIVITY LEVEL		
Age (yr)	Sedentary*	Moderately Active†	Active‡
Females			
14–18	1800	2000	2400
19–30	2000	2000–2200	2400
31–50	1800	2000	2200
51+	1600	1800	2000–2200
Males			
14–18	2200	2400–2800	2800–3200
19–30	2400	2600–2800	3000
31–50	2200	2400–2600	2800–3000
51+	2000	2200–2400	2400–2800

* *Sedentary* means a lifestyle that includes only the light physical activity associated with typical day-to-day life.

† *Moderately active* means a lifestyle that includes physical activity equivalent to walking about 1–3 miles per day at 3–4 miles per hour, in addition to the light physical activity associated with typical day-to-day life.

‡ *Active* means a lifestyle that includes physical activity equivalent to walking more than 3 miles per day at 3–4 miles per hour, in addition to the light physical activity associated with typical day-to-day life.

Source: Dietary Guidelines for Americans, 2005, USDA.

Energy use

Table 11.8 Energy Expenditure for Common Physical Activities*

Moderate Physical Activity	Cal/hr	Vigorous Physical Activity	Cal/hr
hiking	370	jogging (5 mph)	590
light gardening/yard work	330	heavy yard work (chopping wood)	440
dancing	330	swimming (freestyle laps)	510
golf (walking, carrying clubs)	330	aerobics	480
bicycling (<10 mph)	290	bicycling (>10 mph)	590
walking (3.5 mph)	280	walking (4.5 mph)	460
weight lifting (light workout)	220	weightlifting (vigorous workout)	440
stretching	180	basketball (vigorous)	440

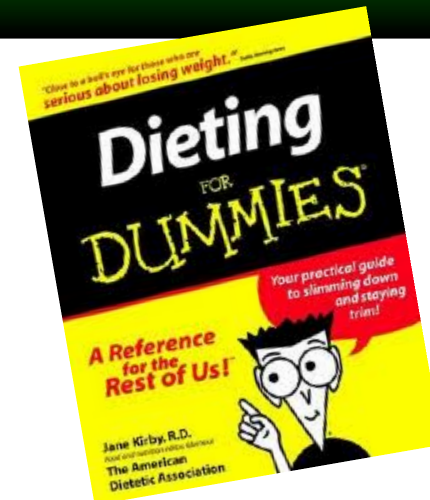
* Values include both resting metabolic rate and activity expenditure for a 70-kg (154-pound) person. Calories burned per hour are higher for persons heavier than 154 pounds and lower for persons who weigh less.

Feeling the heat

How long would you have to walk to "burn off" a snickers bar?
(271 Calories per snickers; 280 Calories per hour for walking)

$$271\ \text{Calories} \times \frac{1\ \text{hr}}{280\ \text{Calories}} = 0.97\ \text{hr}$$

Feeling the Heat



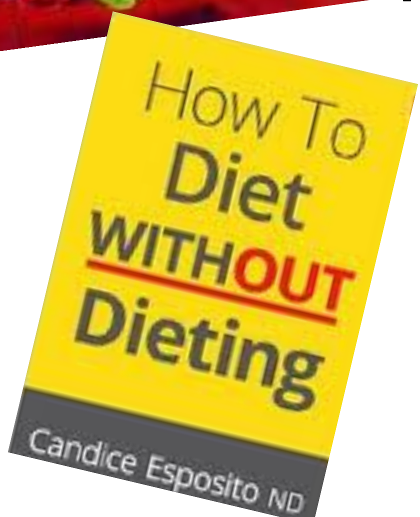
The average human needs about 2000 Cal per day.

Times 4 that's ~8000 kJ per day.

8 Snickers bars! 12 12 oz. Cokes!

Want a more balanced diet?

How about 6 Snickers bars and 3 Cokes?



9 Cal/g➔3500 Calories/lb

Feeling the heat

How long would you have to jog to lose a pound of fat?
(3500 Calories per pound; 590 Calories per hour for jogging)

$$3500\ \text{Calories} \times \frac{1\ \text{hr}}{590\ \text{Calories}} = 5.9\ \text{hr}$$

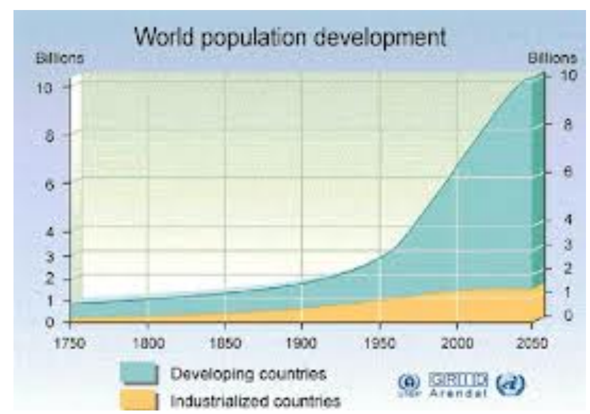
Feeling the Heat Globally

World Population

7 billion

As of October 31, 2011

China 1.3 billion (19.2%)
India 1.2 billion (17%)
European Union 500 million (7.1%)
USA 315 million (4.5%)
Indonesia 238 million (3.3%)
Brazil 197 million (2.8%)
Pakistan 181 million (2.6%)
Nigeria 170 million (2.4%)



Feeding the World

7 billion (7×10^9) people

As of October 31, 2011

8000 kJ per person per day

3 million (3×10^6) kJ per person per year

7 billion x 3 million = 21×10^{15} kJ = 21×10^{18} J

1 Exajoule (EJ) = 10^{18} J

21 EJ to feed the world

21×10^{18} J x 1 tank of gas/2.1×10^9 J = 10 billion

(US passenger fleet = 250 million; fill up 50 times/year = 12.5 billion)

21×10^{18} J x 1 Snickers bar/1.0×10^6 J = 21 trillion (2 billion sold in 2011)

Feeling the Heat Globally

Energy Use in 2011

7 billion (7 x 10^9) people

As of October 31, 2011

21 EJ to feed the world

World 540 EJ – 100% **(with 1.3 billion people)** **77 GJ/person**
China 115 EJ – 21.3% **(with 1.3 billion people)** **88 GJ/person**
USA 100 EJ – 18.5% **(with 315 million people)** **317 GJ/person**
EU 74 EJ – 13.8% **(with 500 million people)** **148 GJ/person**
Former SU 45 EJ – 8.3% **(with 285 million people)** **158 GJ/person**

Feeling the Heat Globally

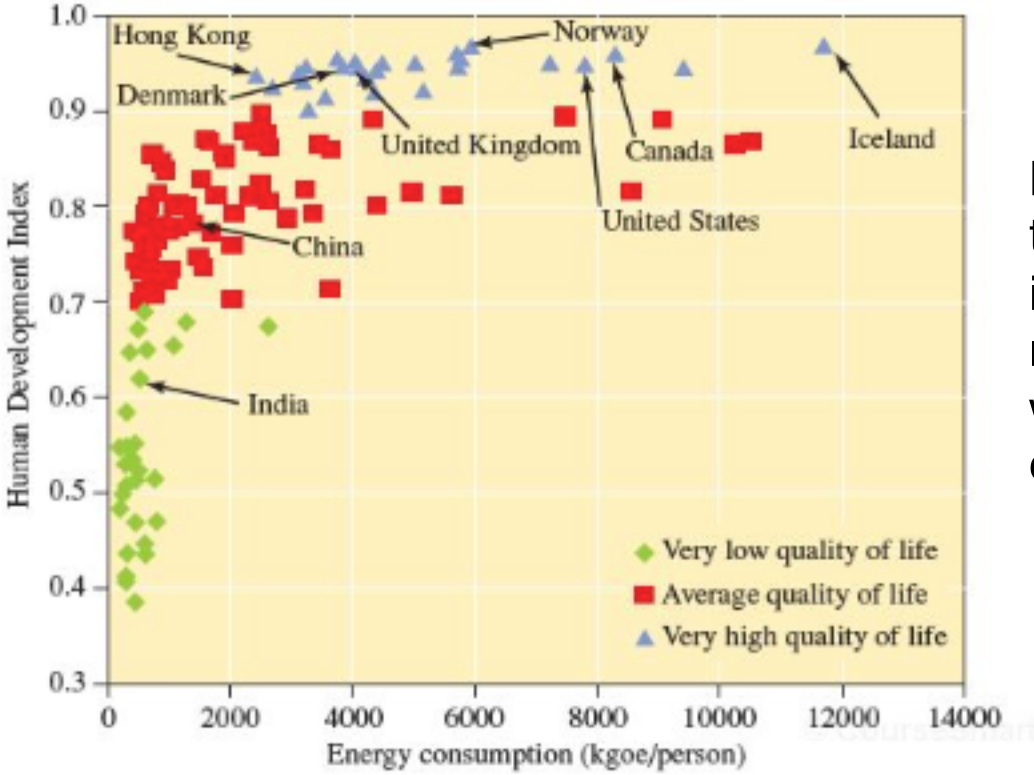


Figure 4.26

The relationship between Human Development Index and energy consumption. Energy consumption is reported in kilograms of oil equivalent (kgoe) per person. 1 kgoe = 4.4×10^{10} J or the approximate energy released in burning a kilogram of oil.

Source: United Nations Human Development Report 2007/2008.

Based on countries shown on the graph such as Hong Kong, it is possible to substantially reduce energy consumption without necessarily decreasing quality of life.

1 kgoe – 4.4×10^{7} J (not 10^{10} as the caption says)
1000 kgoe/person = 44 GJ/person

Reactive Nitrogen

Dinitrogen gas is 78% of the atmosphere, but it's inert (i.e. useless) to the vast majority of living things…reactive forms are more useful but also potentially more dangerous:

Table 6.3 Some Reactive Forms of Nitrogen

Name	Chemical Formula
nitrogen monoxide	NO
nitrogen dioxide	NO_2
nitrous oxide	N_2O
nitrate ion	NO_3^-
nitrite ion	NO_2^-
nitric acid	HNO_3
ammonia	NH_3
ammonium ion	NH_4^+

Note: All are naturally occurring.

pollutants → NO, NO_2, N_2O

nitrous oxide → *greenhouse gas*

ammonia → *fertilizer*

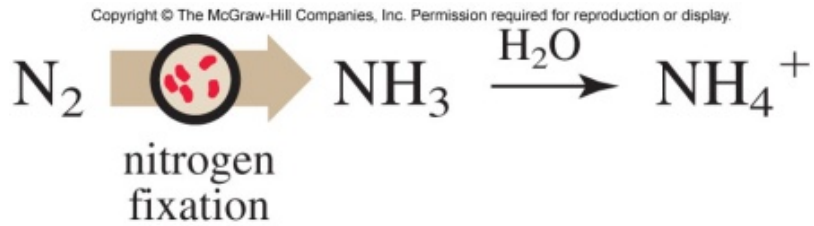
ammonium ion → *in aerosols*

Plants can use these forms → NO_3^-, NH_4^+

Redox in the Nitrogen Cycle

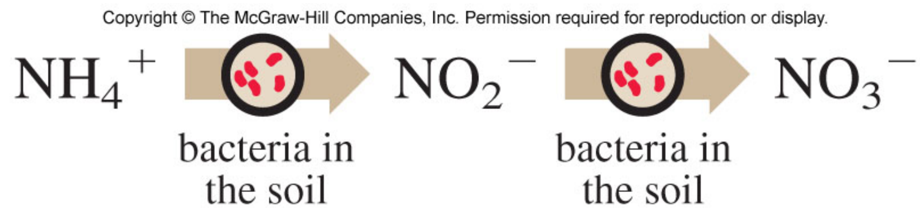
- 1) Nitrogen fixation by soil bacteria

N(0) N(-III) N(-III)



- 2) Nitrification

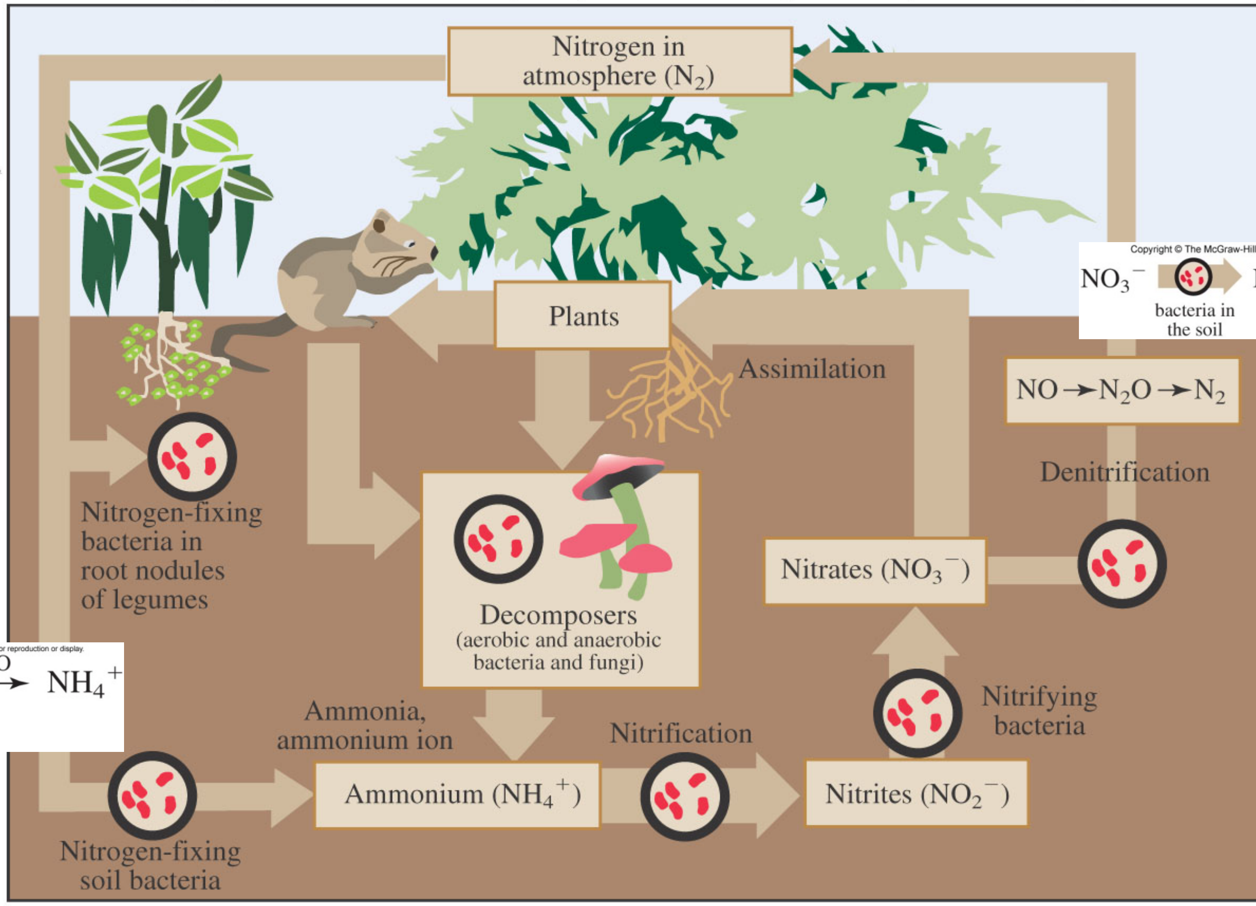
N(III) N(V)

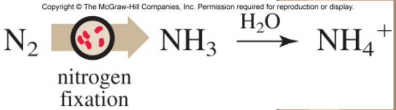


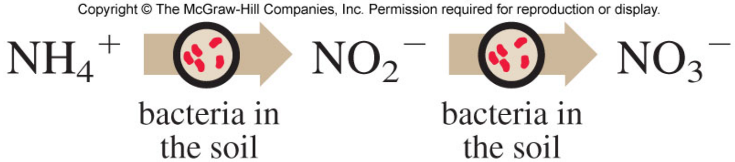
- 3) Denitrification

N(II) N(tricky) N(0)

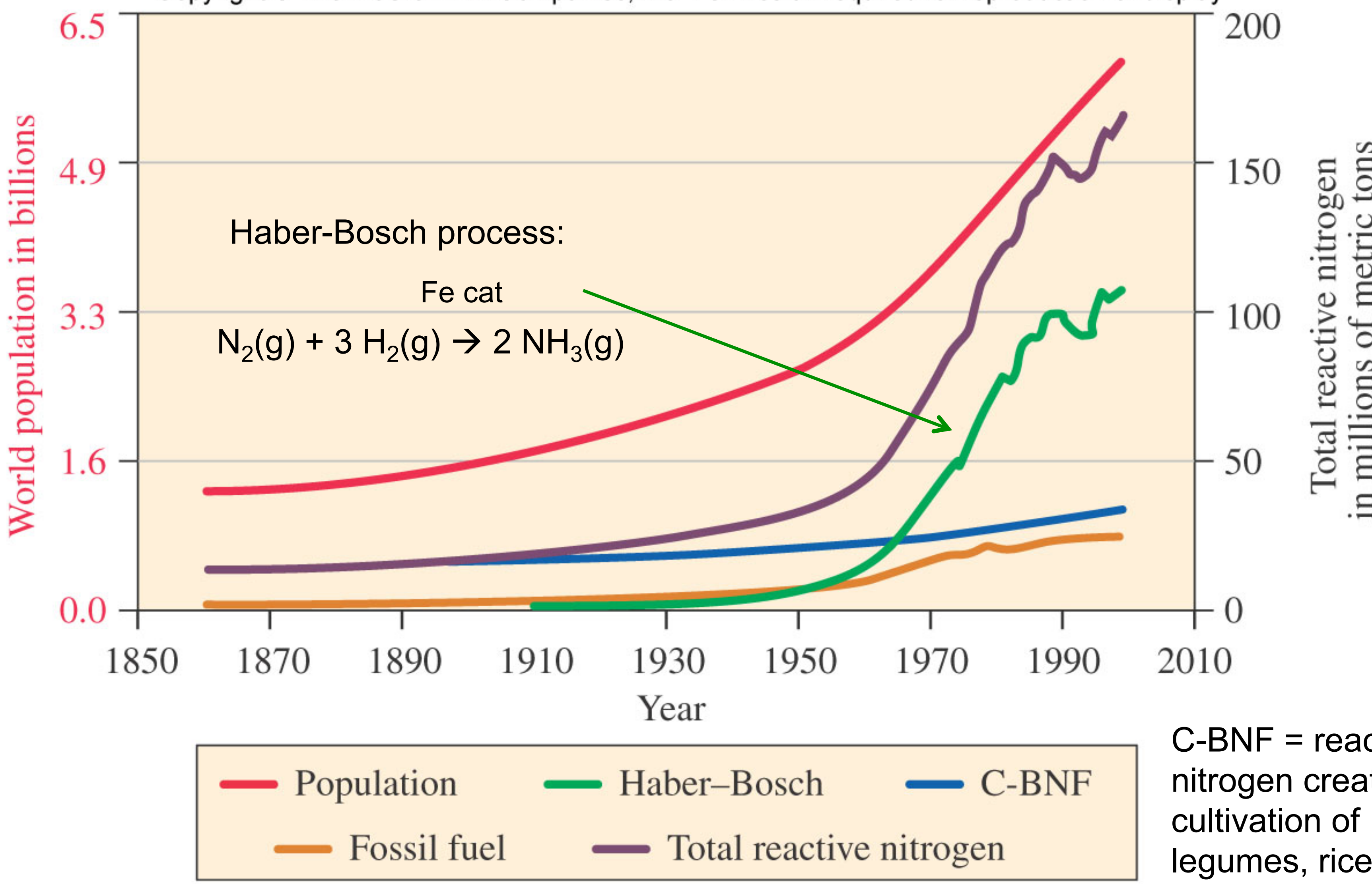
The Nitrogen Cycle







Link Between Reactive Nitrogen and Population Growth



Haber-Bosch process:

Fe cat

$N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$

C-BNF = reactive nitrogen created from cultivation of legumes, rice, and sugarcane