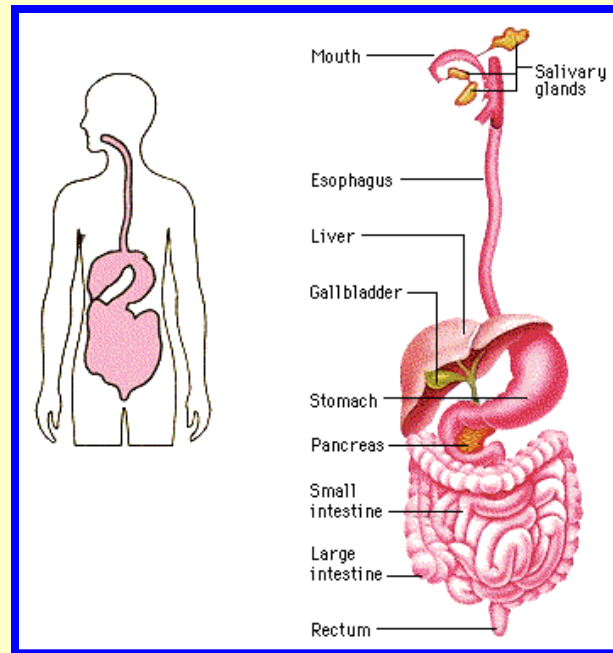


營養與老化 (00070115)

Nutrition and Aging

Gastrointestinal Tract and Nutrition



http://bp0.blogger.com/_FlhB437Wa_U/R-hl4KZC7oI/AAAAAAAAAUs/-jnREiZaY4U/s320/gi-tract.gif

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Learning Objectives

- **Age-related changes in GI tract**
- **Nutrient absorption**
- **Nutrition suggestions**

References

- **Geriatric Nutrition: The Health Professional's Handbook (2006, 3rd ed) Ronni Chernoff, Jones and Bartlett Publishers, Inc.**
- **Nutrition in Aging (1997, 3rd ed) Schlenker, ED. William C. Brown**

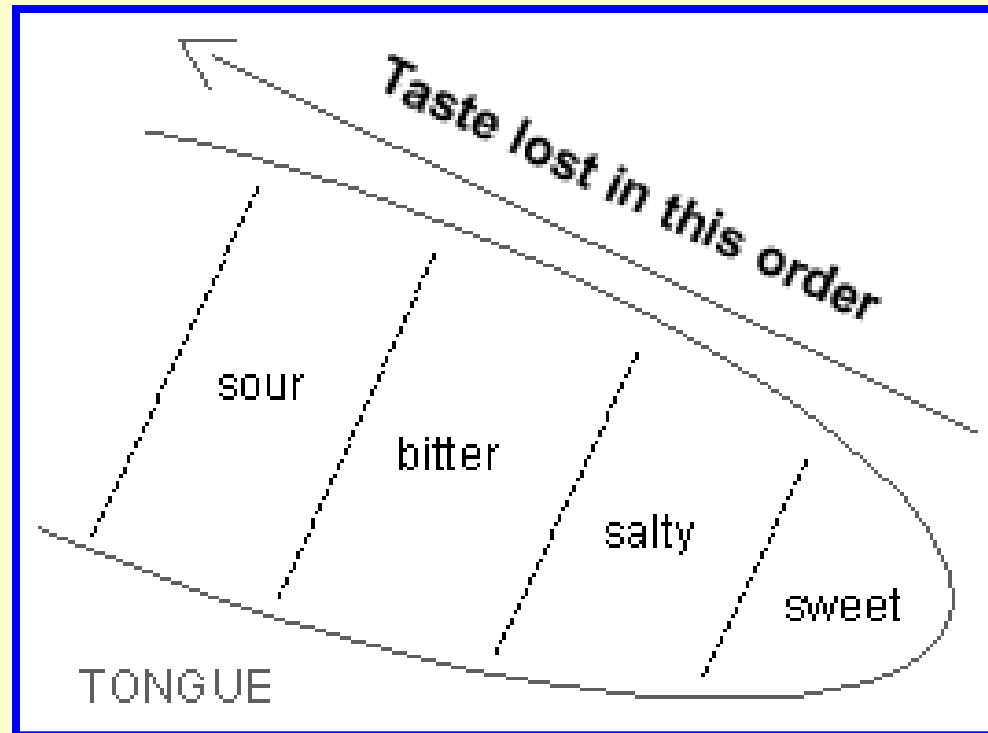
Age-Related Changes in GI Tract

- **physiological changes in the mouth**
- **physiological changes in esophagus**
- **parietal cells lose their efficiency in secreting hydrochloric acid**
- **↓ intestinal motility**
- **↓ strength (kg/cm²) of the intestinal wall**
- **change brush border membrane (BBM) enzyme activity**
- **physiological changes in pancreas**
- **physiological changes in liver and gallbladder**

Physiological Changes in the Mouth

- loss of teeth
- changes in tongue

no. & functions of taste buds (to 1/6 of 20 yr old by late 70's)

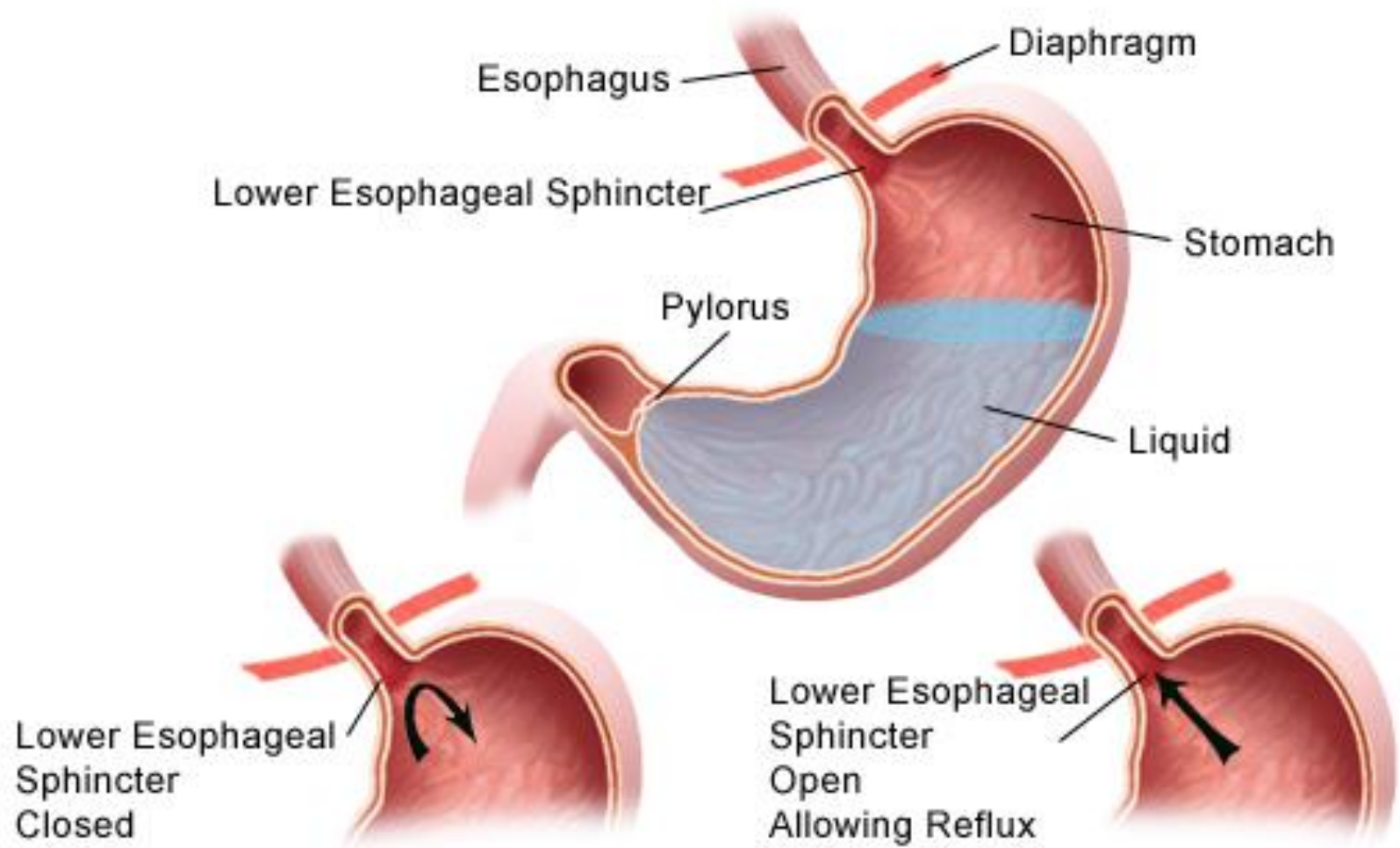


Physiological Changes in Esophagus

- esophageal smooth m. become thicken & weaken
- presbyesophagus
- disordered esophageal contraction
- gastroesophageal reflux
 - ∴ weakening of the lower esophageal sphincter
 - ∴ heart burn



Gastroesophageal Reflux



http://www.vcuhealth.org/images/ei_0199.gif

Changes in Parietal Cells

- achlorhydria or hypochlorhydria and ↓ intrinsic factor

affect digestion and absorption

↓ vitamin B₁₂ absorption

bacterial overgrowth

compete for vitamin B complex → deficiency

- atrophic gastritis

↓ cell proliferation

↓ immunoglobulins

Nutritional Consequences of Atrophic Gastritis

- Decreased availability and absorption of food-bound **vitamin B12** (not crystalline B12)
- Decreased absorption of **calcium carbonate**, if it is taken without food (Recker, 1985)
- Decreased absorption of **non-heme iron**
(Skikne, Lynch et al. 1981)

(c) 2005, Lisa Neff, M.D.

Changes in Intestinal Functions

- prolong transit time in the GI tract
constipation
4~8× more common than in younger subjects
- ↓ wall elasticity
highest strength of the intestinal wall: 10~19 yr
↓ elasticity of rectum and descending colon →
constipation

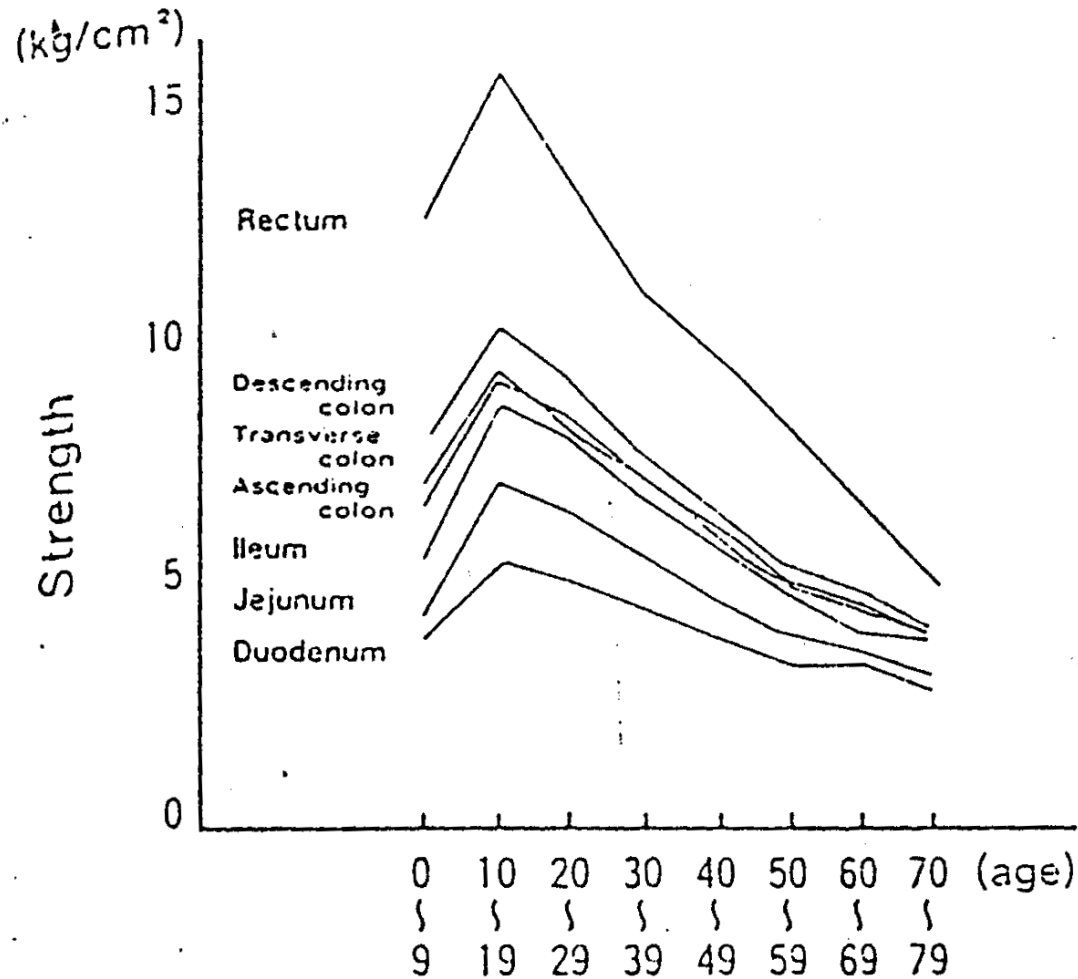


Figure 1. Strength of the bowel wall with increasing age, by decade. From Iwasaki, Kyoto Prefectural University.

Changes in Enzyme Activity

- ↓ lactase activity
- ↑ alkaline phosphatase, maltase, and leucine aminopeptidase activities in rats

turnover rate of SI is longer

↑ substrate levels within the lumen



<http://www.bellezaydietas.com/products/lactaid2.jpg>

Changes in Accessory Organs

- ↓ size and weight of pancreas (> 70 yr)

pancreatic insufficiency

- ↓ liver weight (> 50 yr)
- fatty liver → ↑ liver size
- gallstones (calculi)

condensed bile pigments & calcium salts

♀ > ♂

whites > blacks

Table 12.3. Changes in Organ Function with Aging That May Influence Nutrient Status^a

Organ function	Physical change	Importance to nutrition
Taste and smell	Decreased taste buds; decreased papilla on tongue; decrease in taste and olfactory nerve endings; change in taste and smell threshold	Loss of ability to detect salt and sweet; decreased palatability causing poor food intake
Saliva secretion	Saliva flow may be reduced	Doubtful clinical significance
Esophageal function and swallowing	Minor changes including disordered contractions and spontaneous gastroesophageal reflux	Doubtful clinical significance
Gastric function and emptying	Decreased secretion of HCL, IF, and pepsin in 20% of healthy population >60 years of age (atrophic gastritis); rapid rate of emptying of liquids, increased proximal small bowel pH, bacterial overgrowth in bowel	Decreased bioavailability of mineral, vitamins, and proteins; decreased absorption of protein bound vitamin B ₁₂ and folate; increase in bacterial folate synthesis to counteract malabsorption
Liver and biliary function	Minor structural and biochemical changes; activity and drug metabolizing enzymes reduced	Rate of albumin synthesis may be decreased; drug dosages may need to be lower
Pancreatic secretion	Slightly lower bicarbonate and enzyme outputs	Doubtful clinical significance
Intestinal morphology and function	Insignificant or no changes in small bowel morphology	Doubtful clinical significance
Intestinal microflora	Bacterial overgrowth in proximal small bowel	Functional significance unknown; influences supply of water-soluble vitamins and vitamin K

^a Taken from Rosenberg et al. (1989).

TABLE 4-2 *Age-Related Changes in Digestive Hormones and Secretions*

	Digestive Function	Level of Secretion
Hormones		
Gastrin	Stimulates flow of gastric enzymes and hydrochloric acid	No change; may increase in some individuals
Secretin	Stimulates secretion of pancreatic juice rich in bicarbonate and promotes production of bile by the liver	No change observed
Cholecystokinin (CCK)	Stimulates secretion of pancreatic juice rich in enzymes and bicarbonate and causes ejection of bile, from the gallbladder to the duodenum	Increased
Secretions		
Saliva	Moistens food and aids in mastication and swallowing	Generally no change; decreased in some individuals
Salivary amylase	Breaks down starch to dextrins and some maltose	No change; may increase in some individuals
Hydrochloric acid	Activates pepsinogen to pepsin for protein digestion; causes some breakdown of sucrose to glucose and fructose	Decreased to some extent in many individuals
Pepsin	Breaks down complete proteins to peptides and peptones	May decrease in volume
Pancreatic juice	Contains pancreatic amylase, pancreatic lipase and trypsin for digestion of carbohydrates, lipids, and proteins, respectively; contains bicarbonate, which neutralizes the acidity of chyme	May decrease in volume
Pancreatic amylase	Breaks down starch and glycogen to maltose	May decrease in volume
Trypsin	Splits peptide bonds to form small polypeptides and amino acids	No change observed
Pancreatic lipase	Hydrolyzes triglycerides to monoglycerides, fatty acids and glycerol	May decrease in volume
Bile	Emulsifies lipids to smaller fat particles for digestion; combines with lipids and fatty acids to form micelles	No change
Disaccharidases	Breaks down disaccharides to monosaccharides	Lactase—decreased Maltase—unchanged Sucrase—unchanged

Carbohydrate Absorption

exp. 1

- 5 g D-xylose (monosaccharide pentose, iv injection)
- absorbed by SI
- degradation rate: low
- measure urinary D-xylose excretion ratio as an index of carbohydrate absorption
- age-related **reduction** in D-xylose absorption
 - ↓ renal function, but absorption is not affected

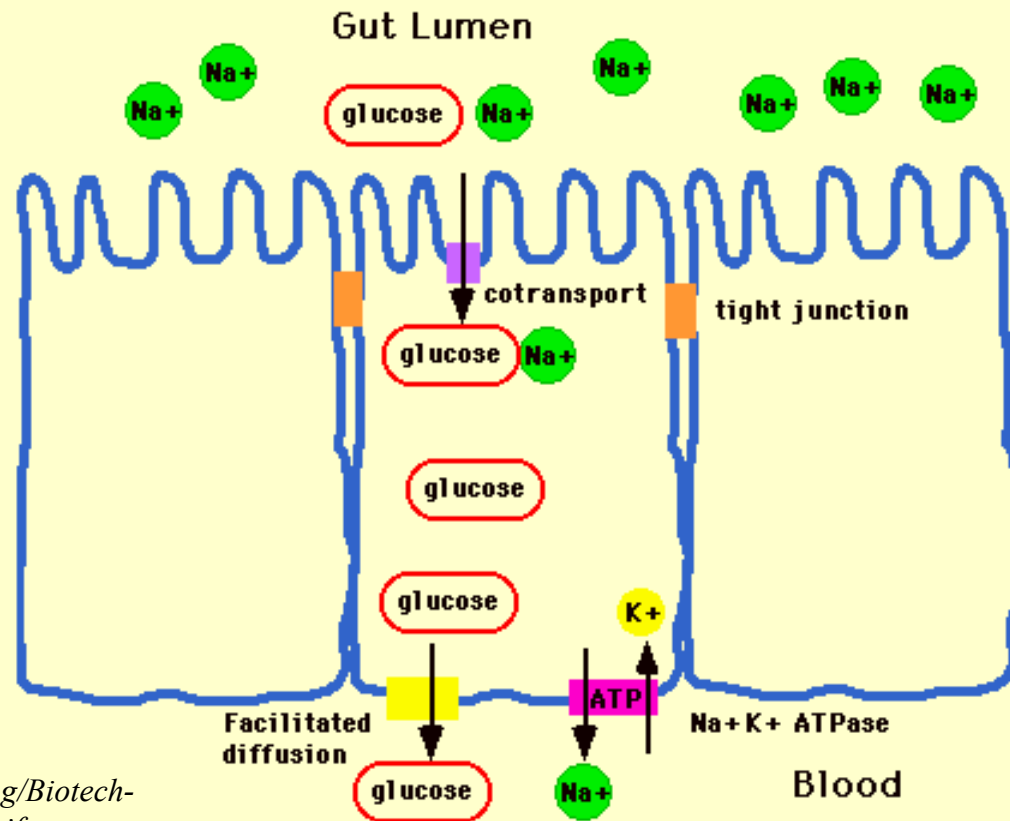
Carbohydrate Absorption

exp. 2

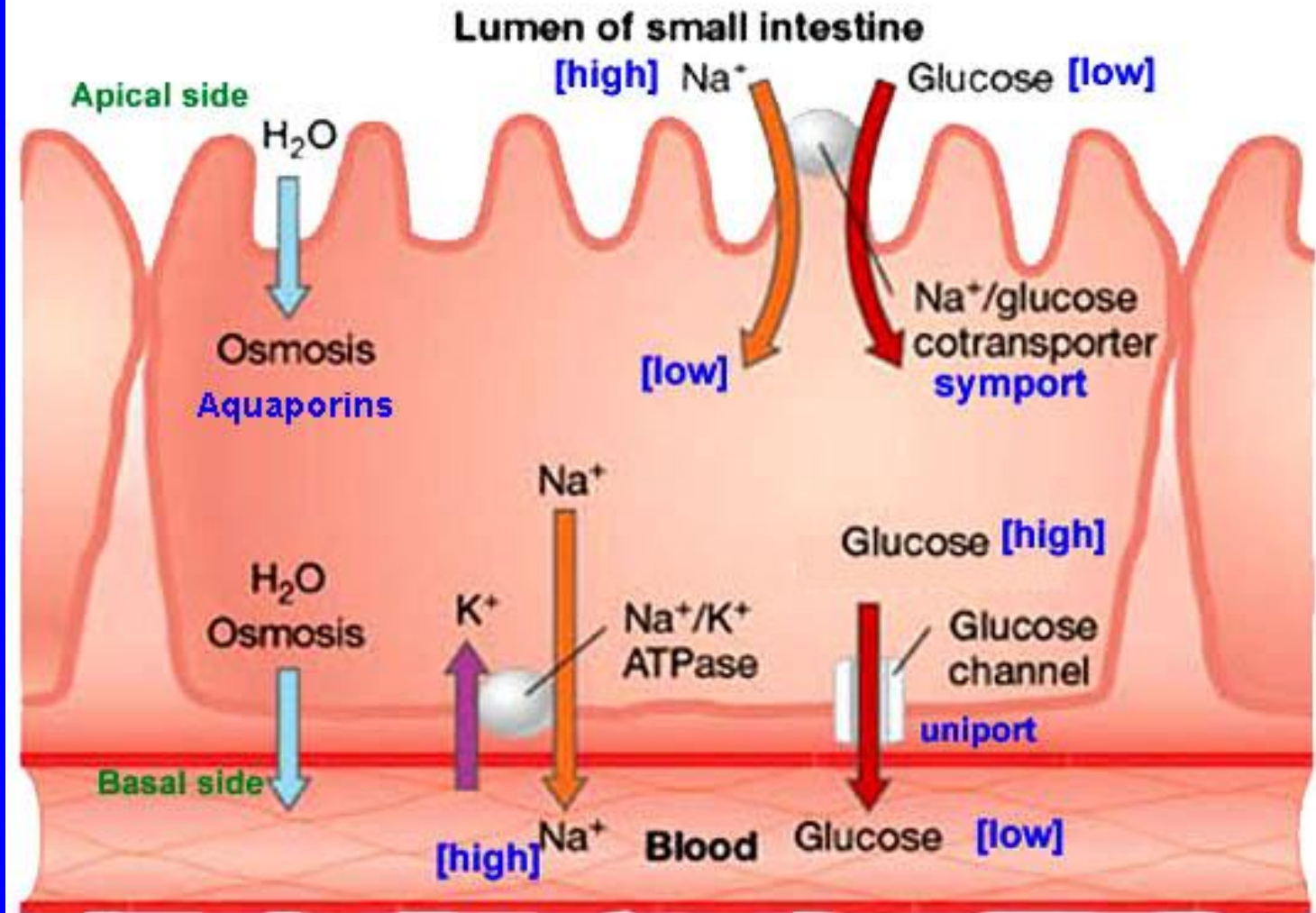
- D-glucose absorption
- half-saturated concentration in old group >> in young group
↓ affinity of D-glucose to carrier by aging
no change in the properties of the carrier

Carbohydrate Absorption

- ↓ maltose hydrolysis
- ↓ glucose, lactose absorption
- alteration in membrane digestion earlier than changes in transport systems



(c) Model of glucose absorption



Fat Absorption

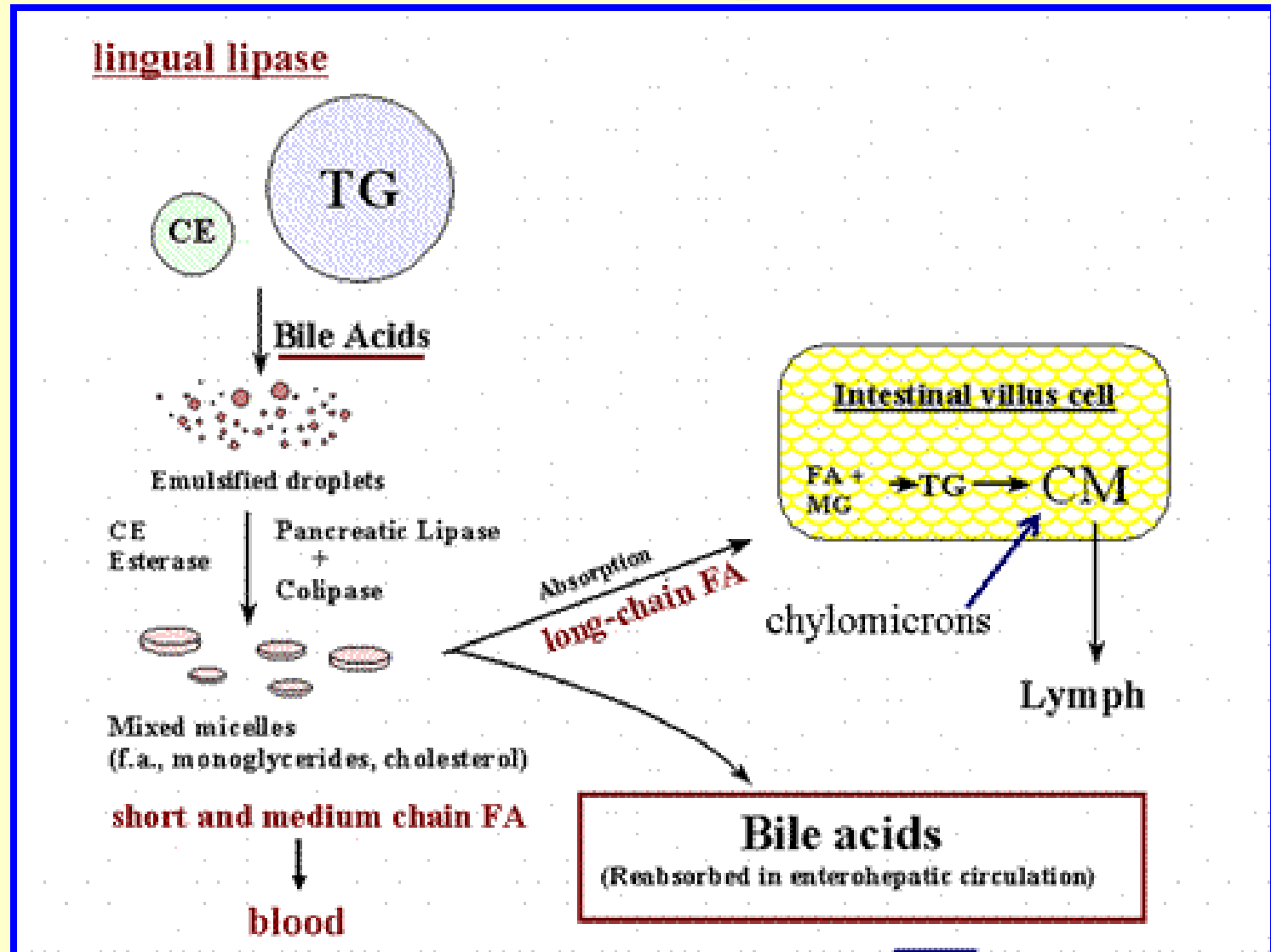
digestion & absorption of long-chain fatty acids

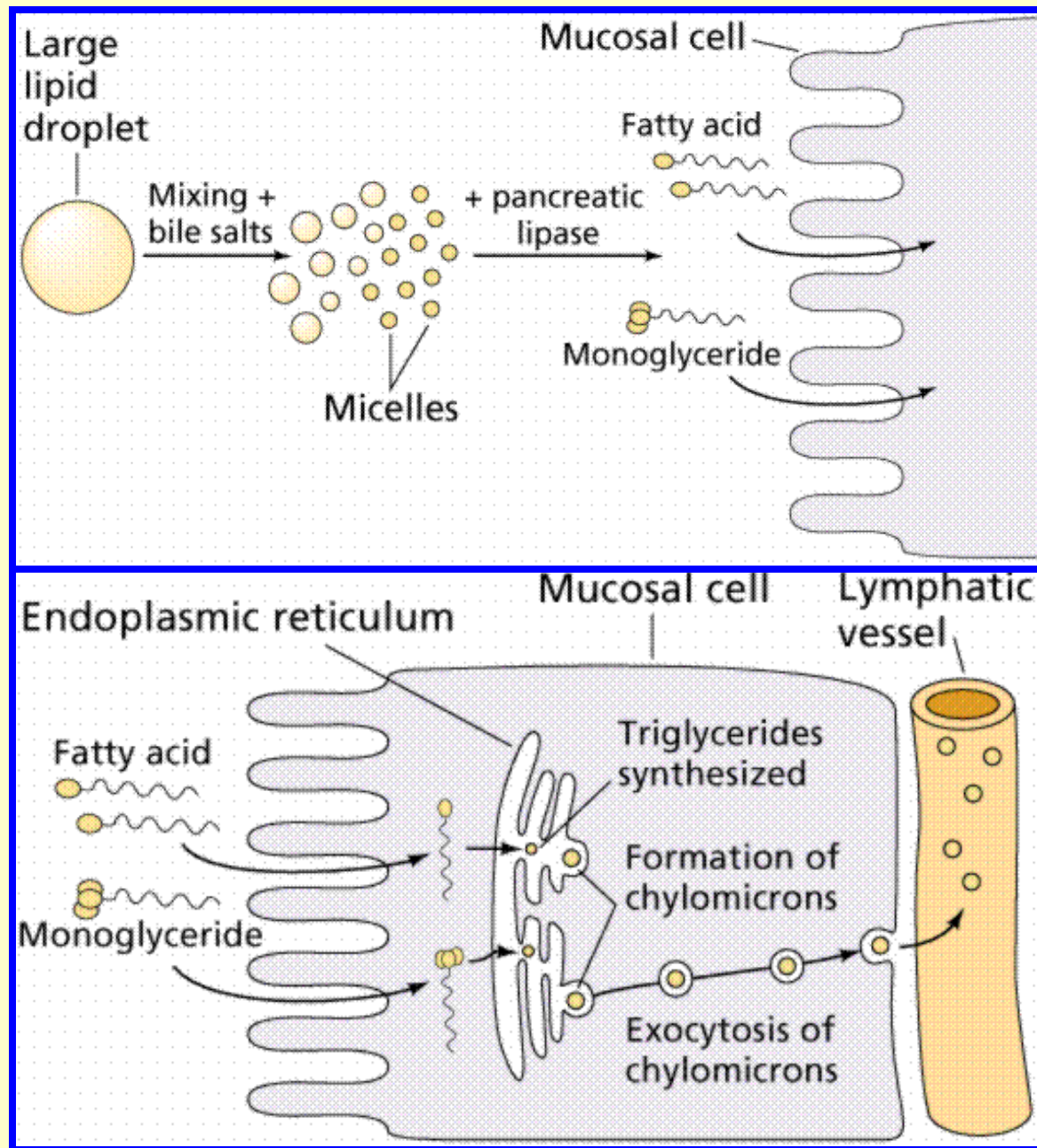
- **formation of an emulsion in the stomach**
- **✓ hydrolysis of TG in the presence of pancreatic lipase**
- **✓ formation of a complex micelle composed of bile acids, fatty acids and monoglyceride**
- **diffusion of fatty acids through microvillous membrane**
- **✓ resynthesis of TG in mucosal cells**
- **formation of chylomicrons**
- **transfer of chylomicrons to lymph ducts**

Fat Absorption

- excessive fat ingestion → ↑ fetal fat excretion in person > 70 yr
- ↓ esterification of fatty acids into TG
- impairment of fat resynthesis within intestinal mucosa
 - ↓ acyl CoA:monoglyceride acyltransferase activity
- ↓ pancreatic lipase activity and bile secretion

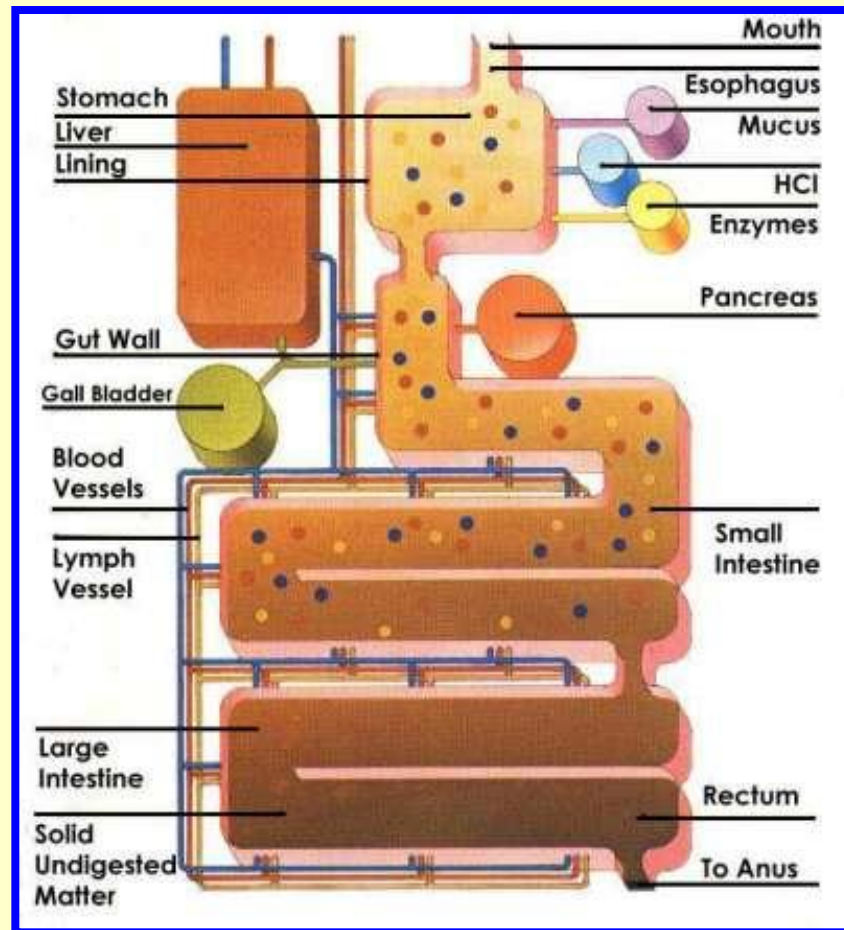
Fat Absorption





Protein Absorption

- ↓ protein digestion efficiency
- ↓ secretion of pepsin & other proteolytic enzymes



Nutrition Suggestions

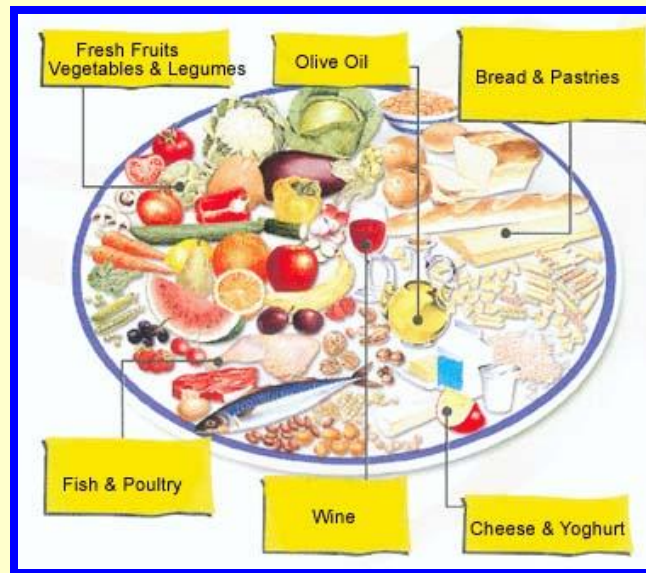
in Japan

- dietary fiber intake: 23 g/d → 16 g/d
- fat intake: 18 g/d → 56 g/d
- ↑ incidence of colon cancer
- ↑ constipation

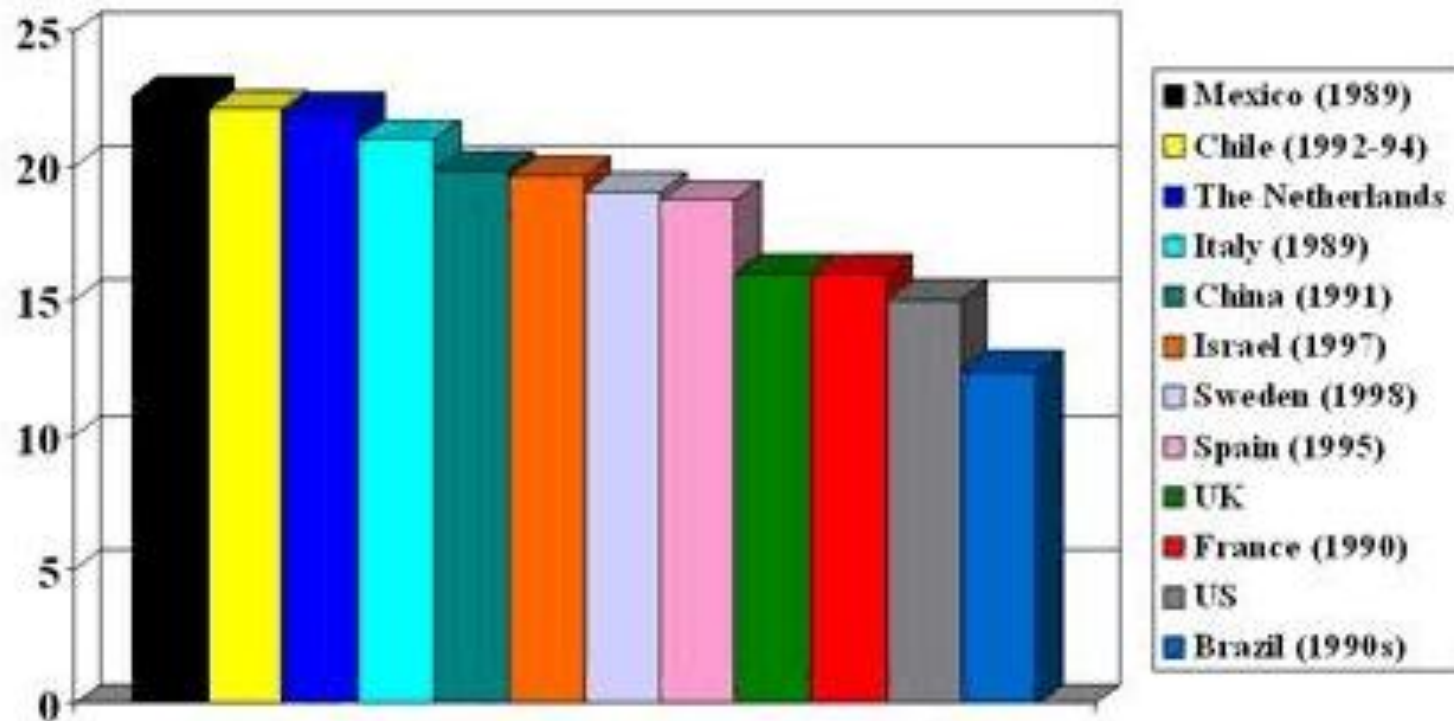


Nutrition Suggestions

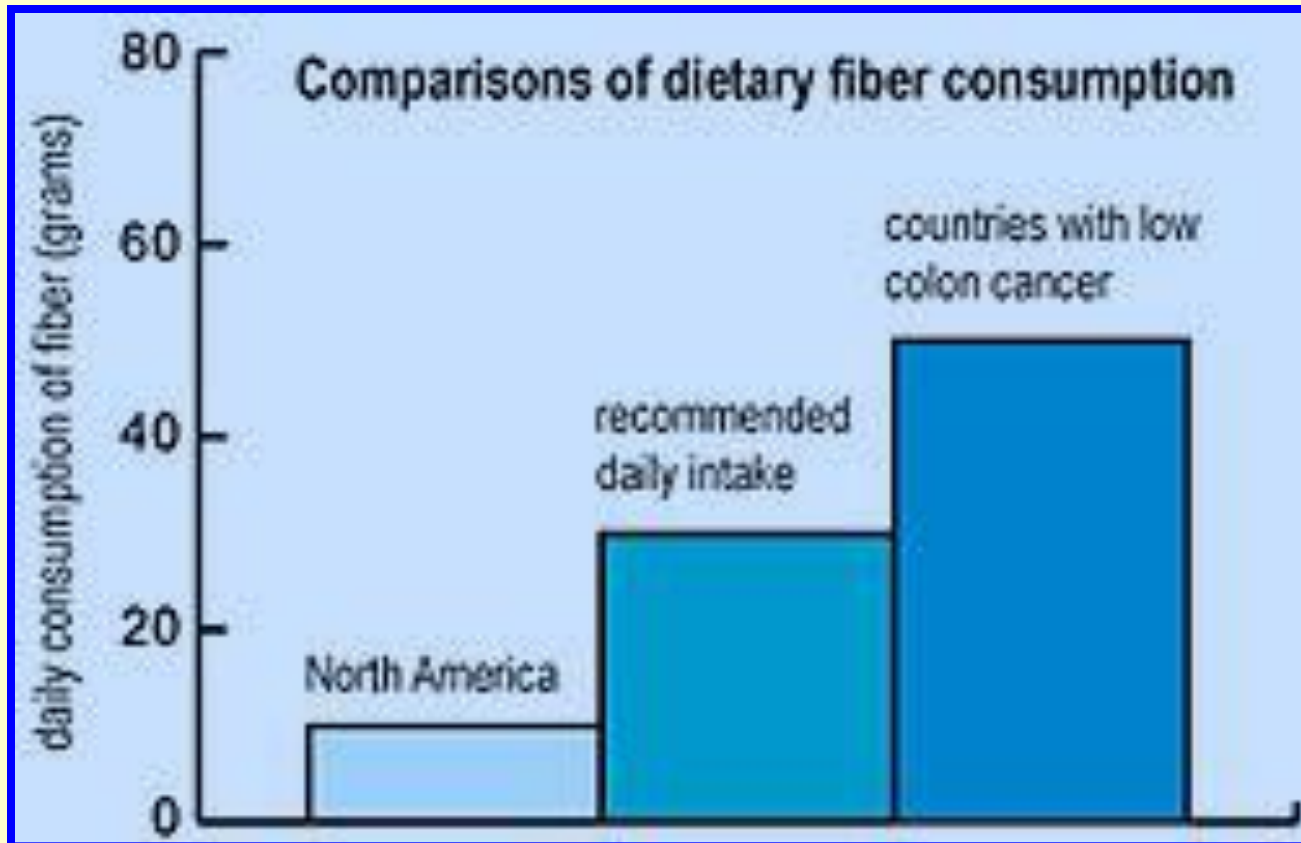
- calorie restriction (not starvation)
- modified Mediterranean diet
- **50-55%** complex carbohydrates (fruits, vegetables)
- **20-25%** protein (preferably from plant sources)
- **25-30%** fat
- **5%** sweets, candies and dessert



Consumption of Dietary Fiber



Sources: *Handbook of Dietary Fiber* (Marcel Dekker, 2001), NHANES II



Average North American intake 10 g

Recommended daily intake for dietary fiber 20-35 g

Countries with low colorectal cancer rates 40-50 g

http://www.ascentahealth.com/Products/fiberworks_info.php

Fiber

Food sources of fiber include whole wheat, bran, fresh or dried fruits, and vegetables



<http://medicineworld.org/images/blogs/fiber-diet-761055.jpg>

Soluble fiber can be found in foods such as oatbran, barley, nuts, seeds, beans, lentils, fruits (citrus, apples), strawberries and many vegetables



Soluble fiber sources



Insoluble fiber is found in foods such as whole wheat and whole grain products, vegetables, and wheat bran

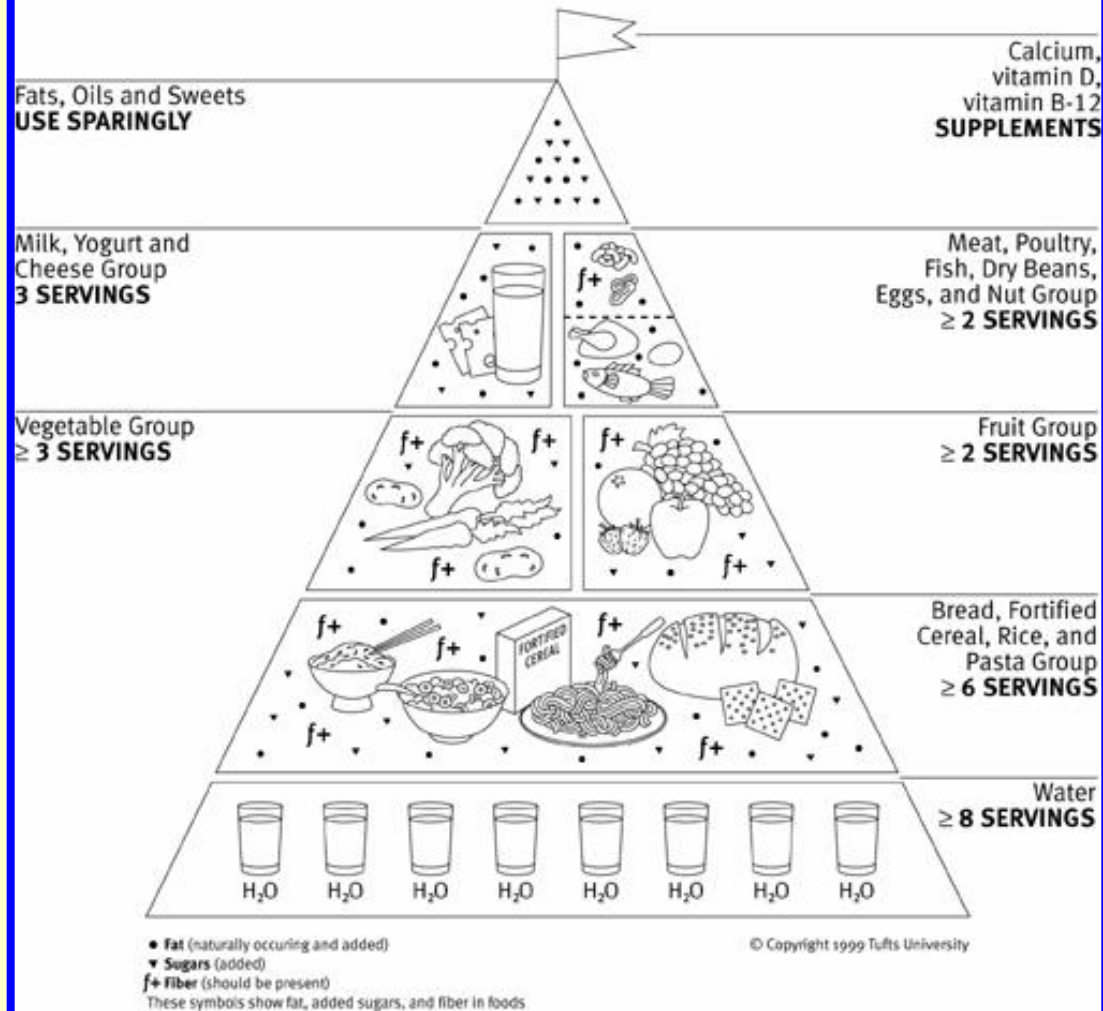


Insoluble fiber sources



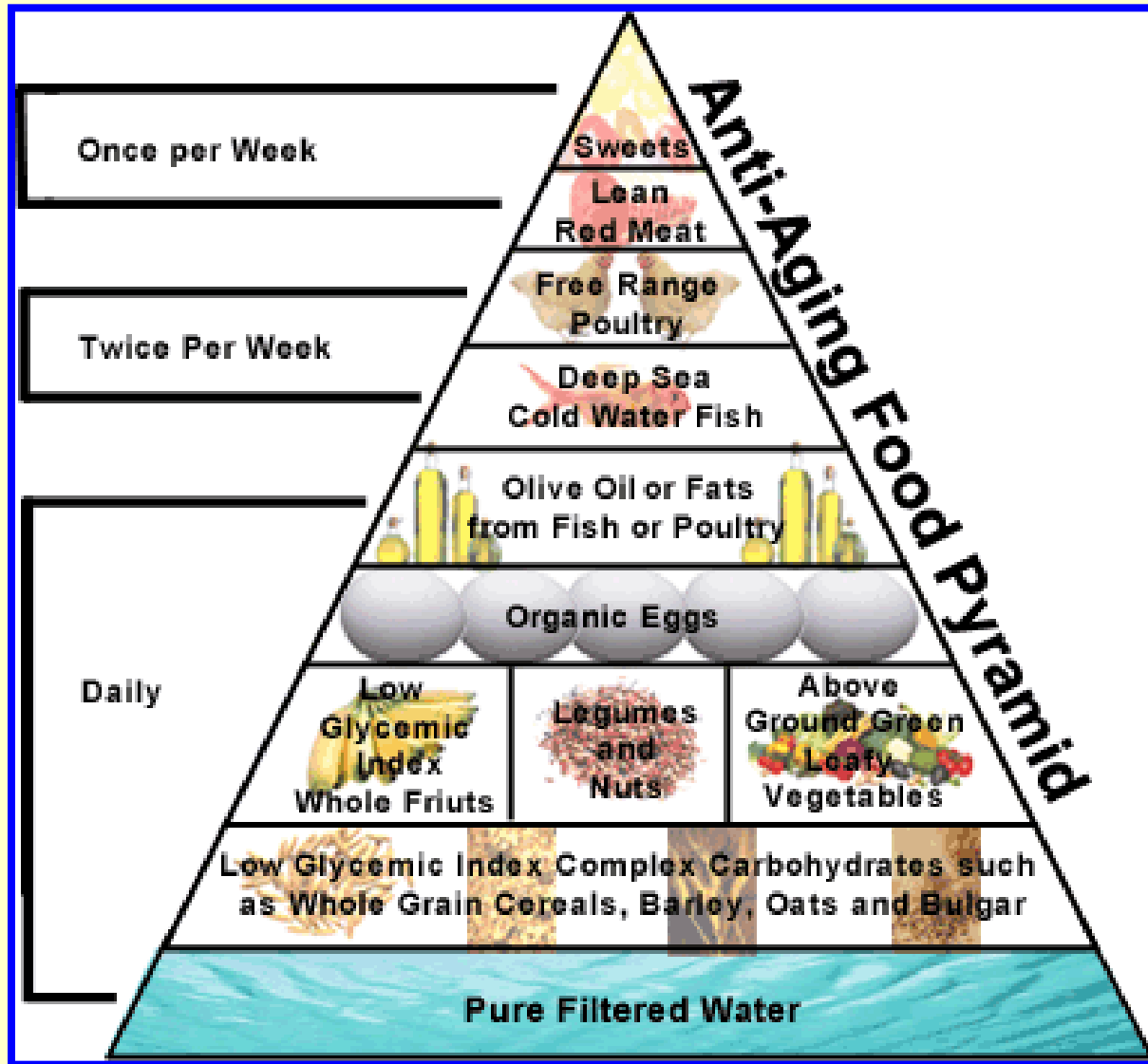
ADAM.

Modified Food Pyramid for 70+ Adults



J Nutr 1999;129:751-753

<http://www.ars.usda.gov/is/np/fnr/p/pyramid70.gif>



bulgar



Summary

- **Weakening of the lower esophageal sphincter**
- **Nutrition intake**
 - **calorie restriction (not starvation)**
 - **modified Mediterranean diet**