BI 358 Lecture 5

...Lab today! Yes, personal, lifetime data!
+ Outline update.

I. *Announcements* **Today *DietController Nutritional Analyses* in lab. Save 6 *.pdfs*/screenshots, flashdrive/send to your e-mail!**

II. *GI Physiology Connections* **G&H ch 72, 64, 65, 66, LS +…**

- **A. Control: local, nervous, hormonal fig 63-2, 61-3, tab 63-1…**
- **B. Secretions: mucus, H_2O +…, enzymes, hormones**
- **C. *Hydrolysis*: Central theme of digestion ch 66 p 833-42**
  1. Carbohydrate fig 66-1 2. Fat fig 66-3+4 3. Protein fig 66-2
- **D. Overview: Stomach, small intestine, accessory organs, large intestine fig 64-2, 66-6, 66-7, 65-10, 65-11, 64-5, 64-6...**

III. *Plant-based Diet: Mounting Evidence* **Multiple sources**

- **A. *American Institute for Cancer Research* Recommendations**
- **B. Blue Zones? What do the longest lived people do?**
- **C. Okinawan Longevity Diet? Why plant-based?**
- **D. Why eat carbohydrates & whole grains?**
- **E. Pondering Paleo? How much protein? USDA bias? WHO?**
- **F. TMAO, Neu5GC & disease risk?**
- **G. Environmental impact? Plant phytochemicals?**
- **H. How to prevent disease?**

? I. Longevity, weight loss & intermittent fasting?

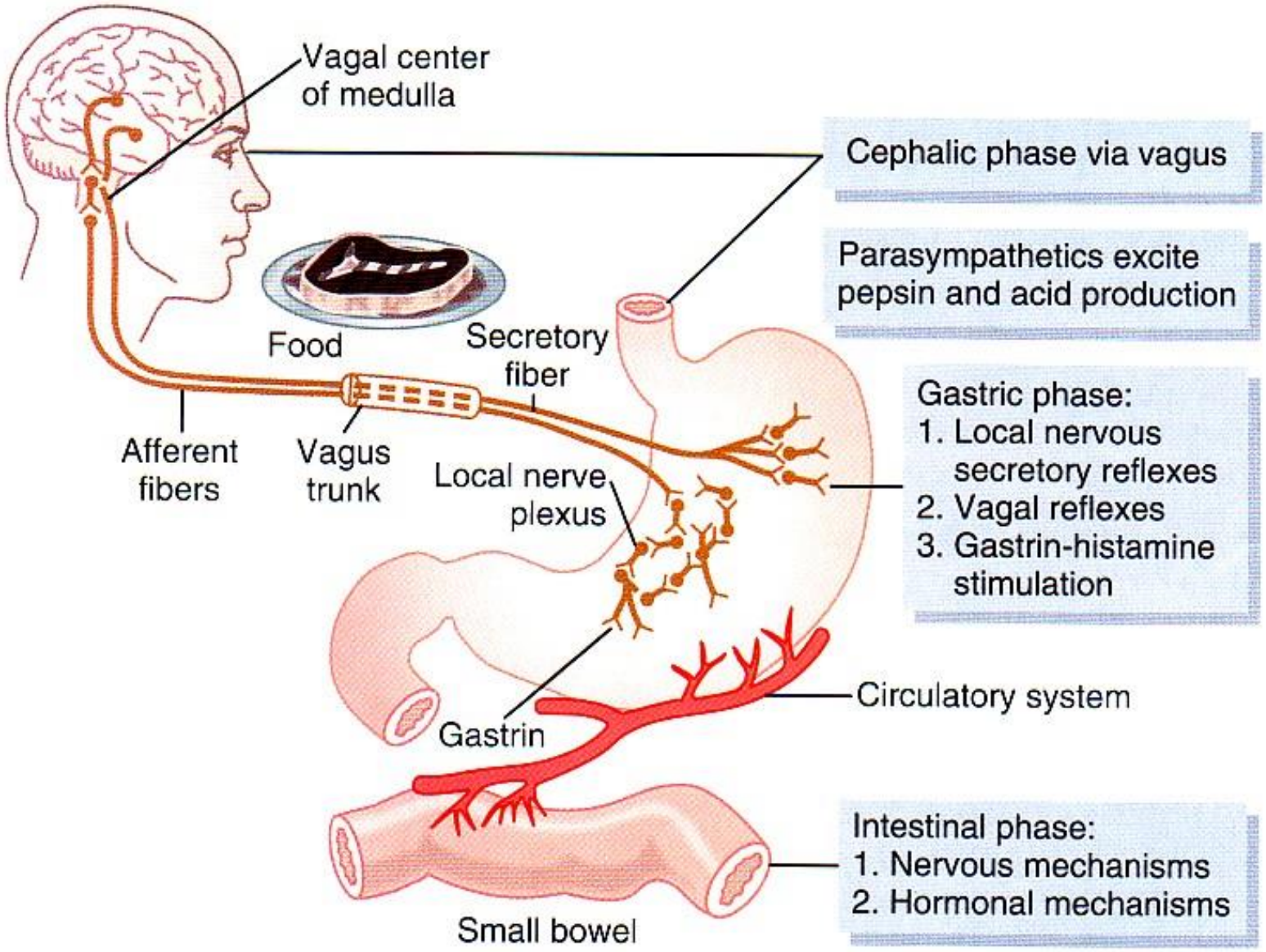


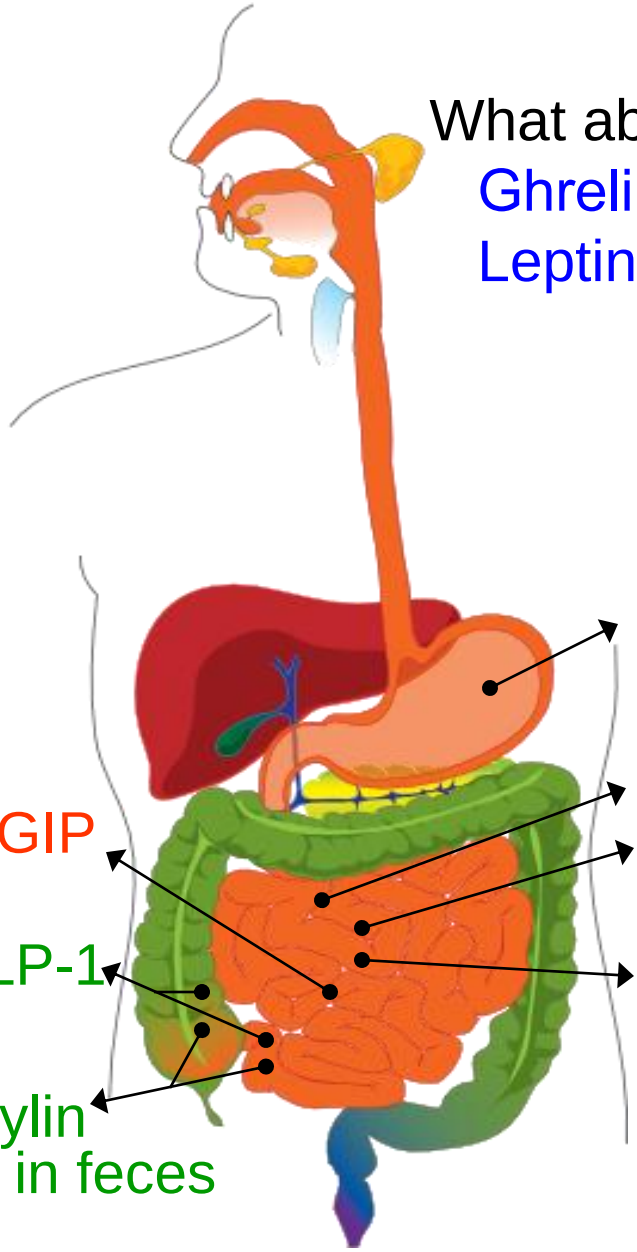
Figure 65-7 Phases of gastric secretion & their regulation.
G&H 2016 fig 65-7 p 824; G&H 2011 fig 64-7 p 780.

HORMONAL

What about feedback for hunger-satiety?

Ghrelin (stomach fundus, pancreas,…)

Leptin (adipocytes)



Gastrin → HCl, Pepsinogen by stomach

Motilin → ↑ Motility

Secretin → HCO_3^-, H_2O by pancreas

Cholecystokinin → Gallbladder contraction + Pancreatic enzymes

↓ Motility ← GIP

↑ Insulin

↓ Motility ← GLP-1

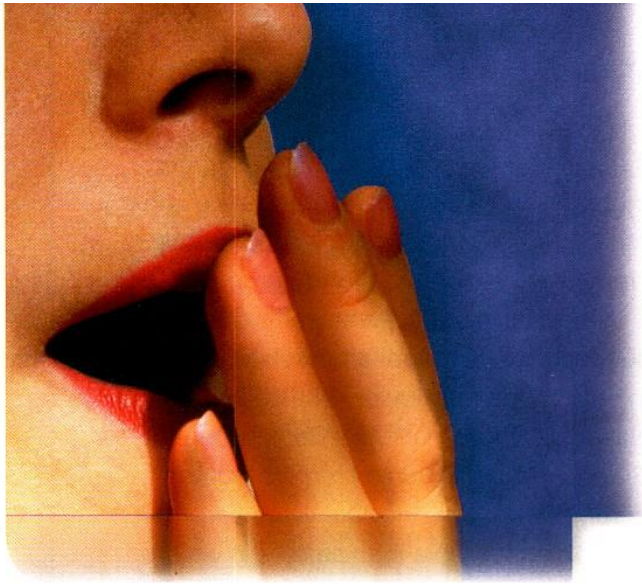
↑ Insulin

↑ Cl- ← Guanylin

↑ NaCl + H_2O in feces

G&H 2011 tab 62-1 p 758

G&H 2016 tab 63-1 p 802



Sleep More, Eat Less

promotes **Leptin** release!

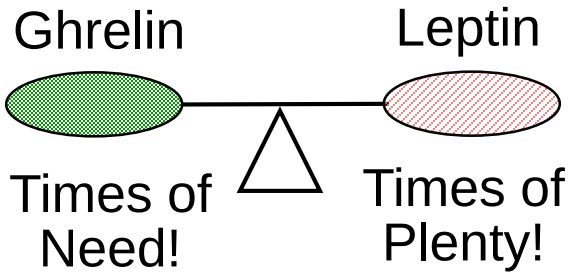
Wondering why you're so hungry? Maybe it's because you're not getting enough sleep.

Researchers allowed 12 healthy young lean men to sleep for either four or eight hours in a laboratory. After one night of four hours of sleep, the men ate 22 percent more calories the next day than they did after eight hours. They also reported being more hungry before breakfast and dinner.

In a separate study, scientists found that a single night with only four hours of sleep led to insulin resistance in nine healthy lean men and women in their 40s. After the night of restricted sleep, the participants were less able to move blood sugar into their cells, which suggests that their bodies were at least temporarily resistant to insulin. Insulin resistance can lead to heart disease, diabetes, and possibly breast cancer.

What to do: Get enough sleep. Most adults need 7 to 8 hours a night. (School-aged children need at least 9 hours.) Other studies that limit adults' sleep find higher levels of ghrelin (which makes people hungry) and lower levels of leptin (which makes people feel full) in their blood. Changes in ghrelin, leptin, and insulin resistance may explain why studies find a higher risk of obesity, heart disease, diabetes, and high blood pressure in people who get too little sleep.

Am. J. Clin. Nutr. 91: 1550, 2010 and *J. Clin. Endocrinol. Metab. 95*: 2963, 2010.



http://www.vivo.colostate.edu/hbooks/pathphys/endocrine/gi/ghrelin.html

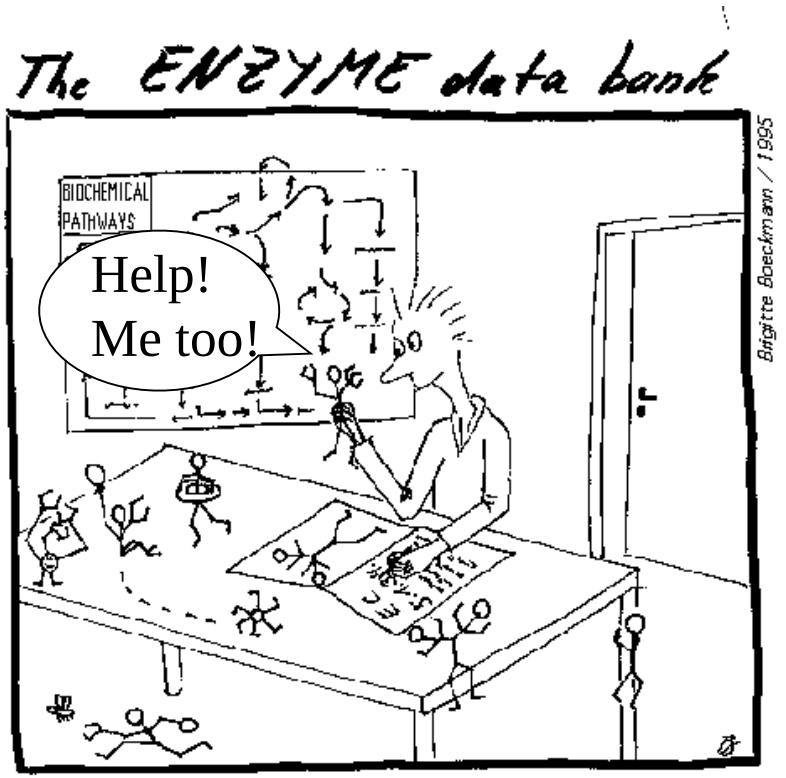
Gut Secretions

Secretion	***Release Site***
1. Mucus	**into GI Lumen**
2. Enzymes	**into GI Lumen**
3. H_2O, acids, bases+	**into GI Lumen**
4. Hormones	**into Blood**

Hydrolysis of Energy Nutrients

…Central-linking theme!!

+

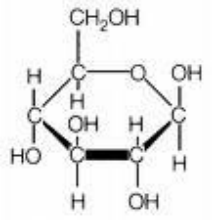


H_2O + Enzyme

Polymer to Monomer (Many to One)

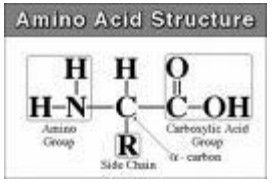
…Central-linking theme, again!!

Carbohydrate

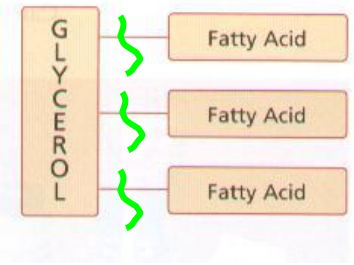


Glucose

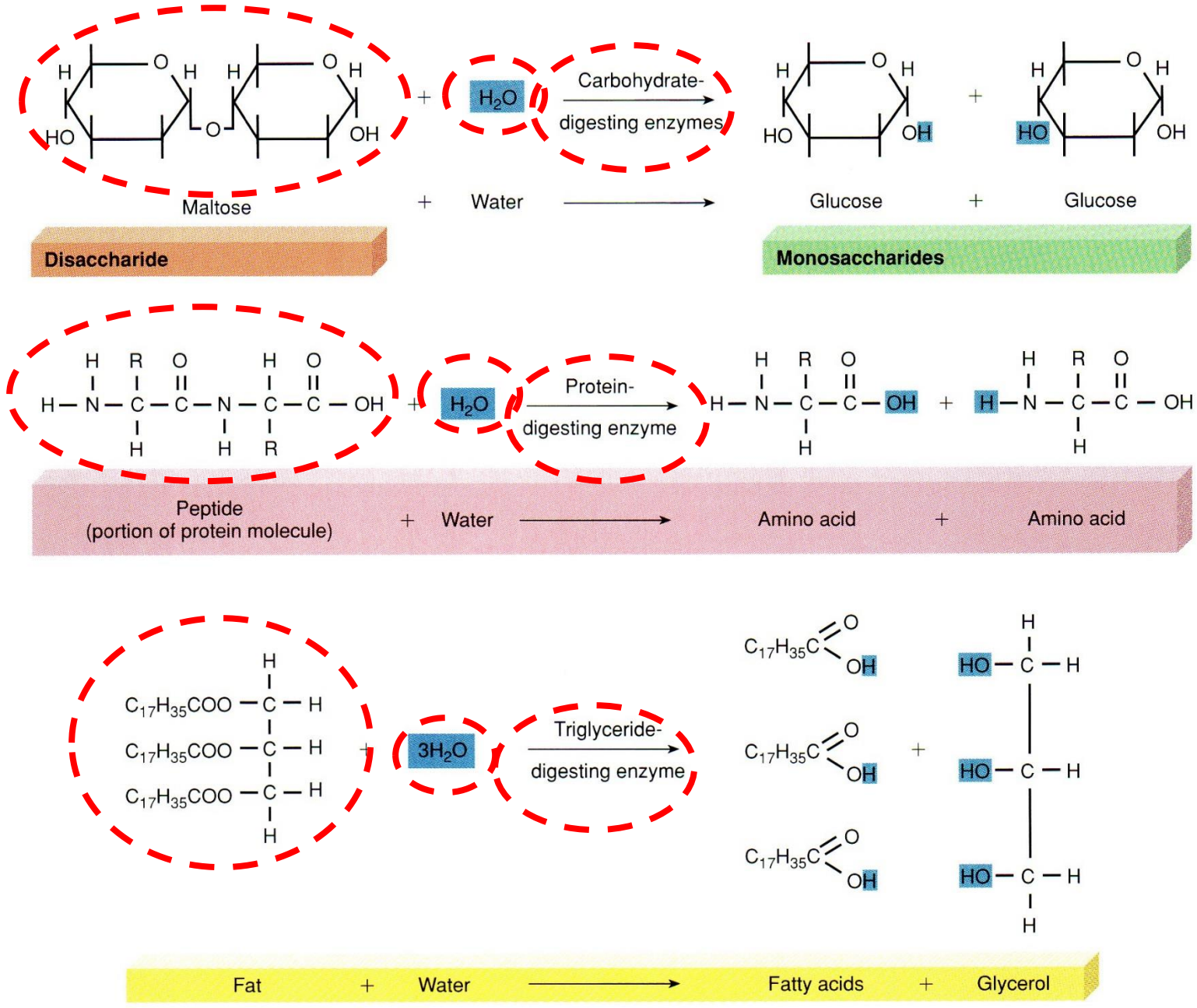
Protein
+
Fat



Amino Acids



Fatty Acids
+
Glycerol

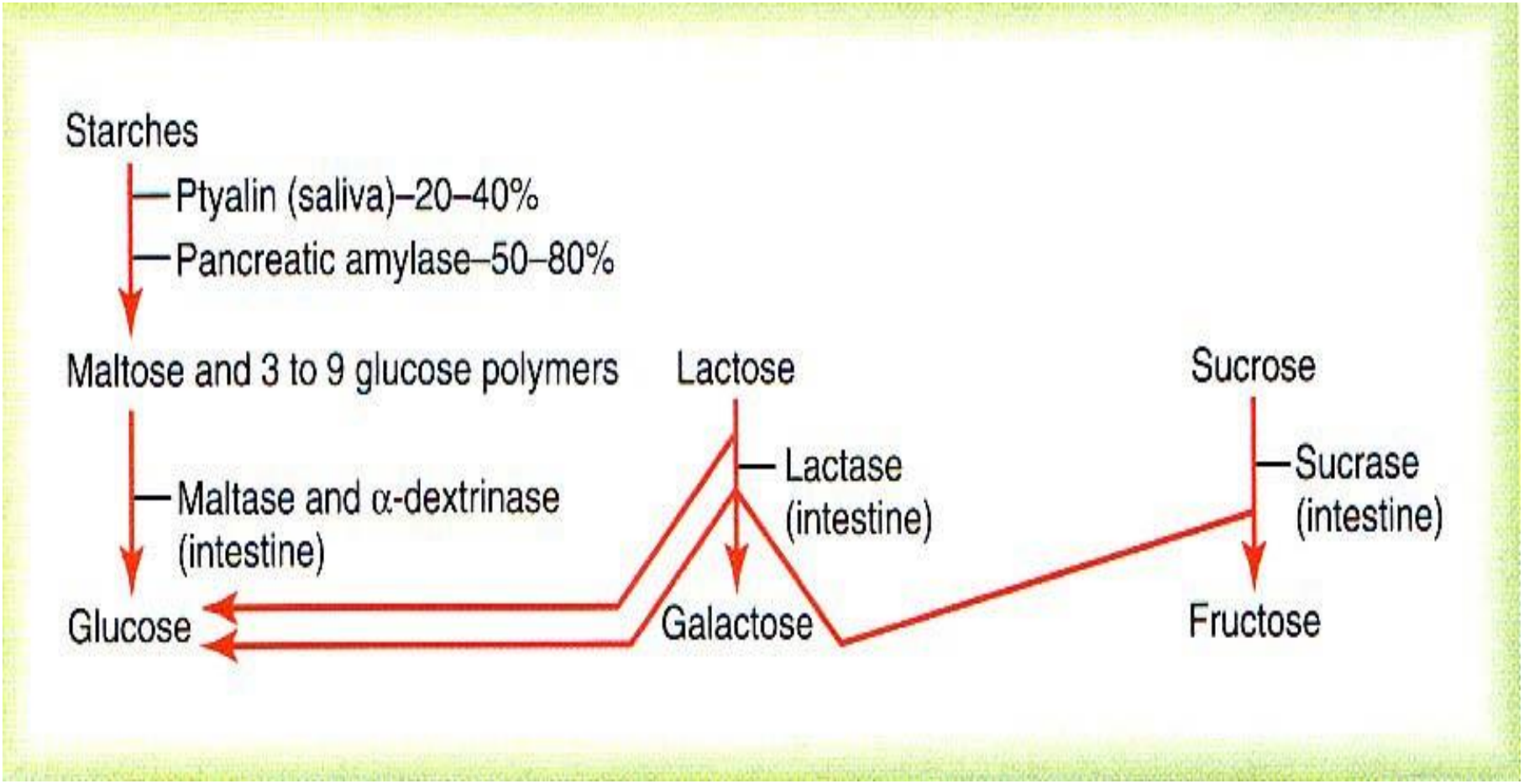


cf: G&H 2011 pp 789-93, G&H 2016 p 833-7

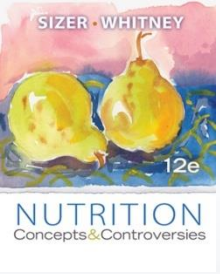
Carbohydrates in foods

Sizer & Whitney 2011 p 136

Carbohydrate Digestion = 1^0 Energy Nutrient

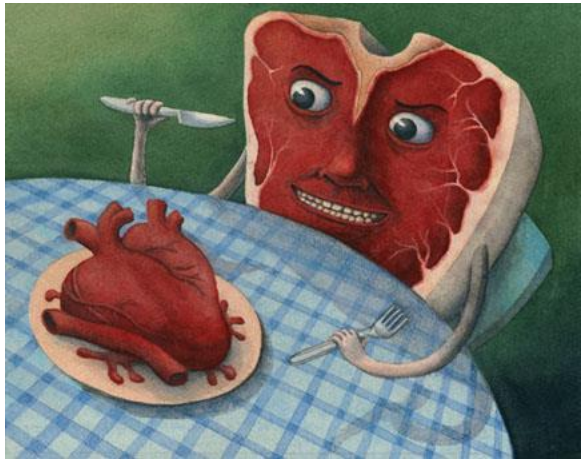


G&H 2011 fig 65-1 p 790
G&H 2016 fig 66-1 p 834

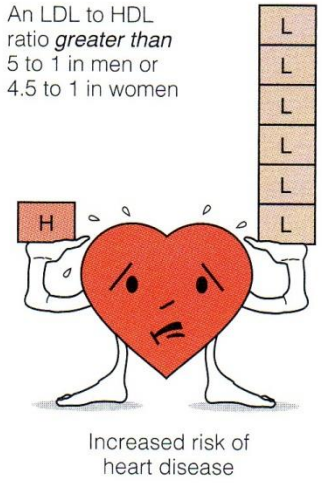


Why Do Some People Have Trouble Digesting Milk?

- Ability to digest milk carbohydrates varies
  - Lactase
    - Made by small intestine
- Symptoms of intolerance
  - Gas, diarrhea, pain, nausea?
- Milk allergy?
- Nutritional consequences
- Milk tolerance and strategies

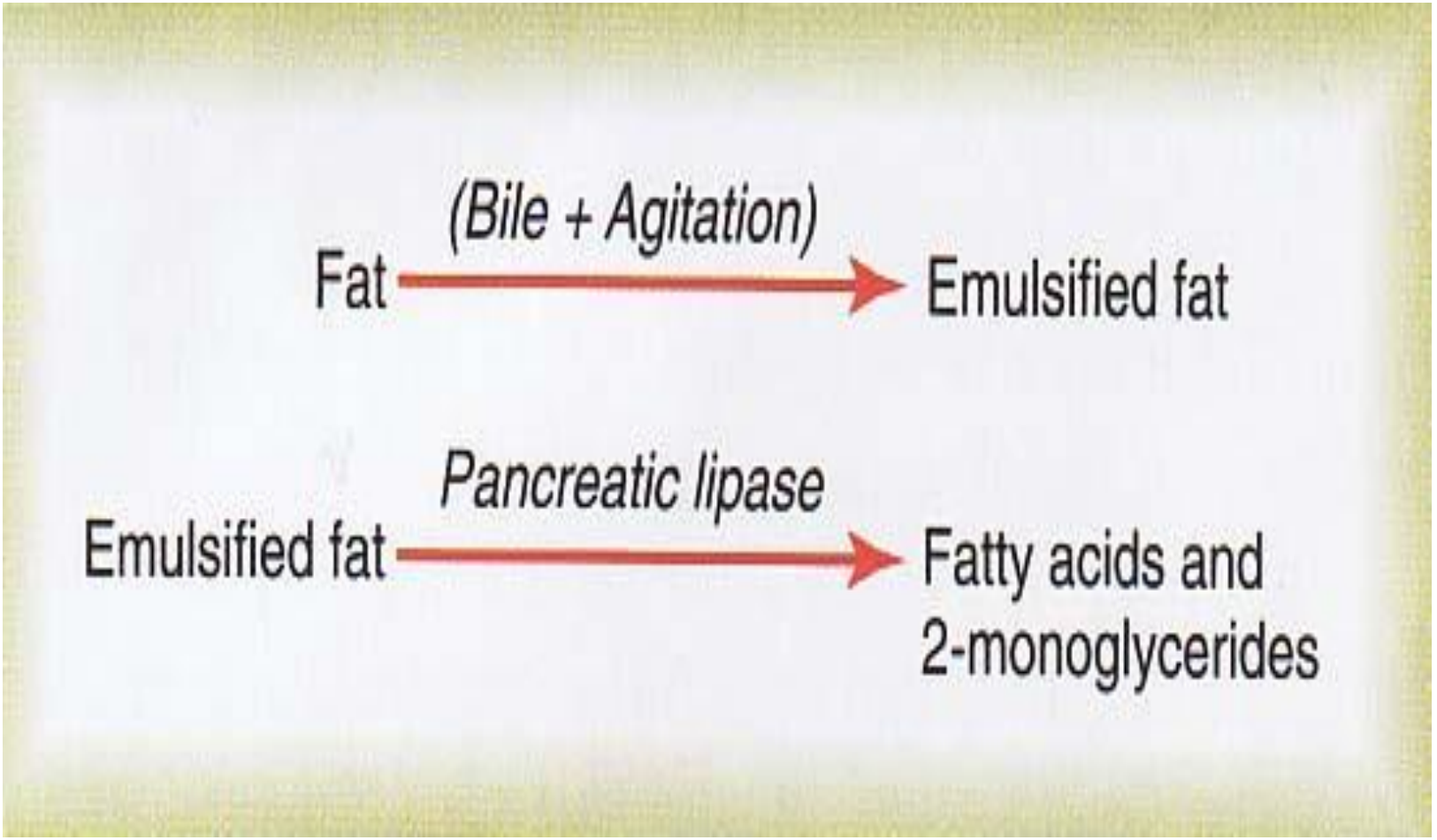


HIGH FAT FOODS

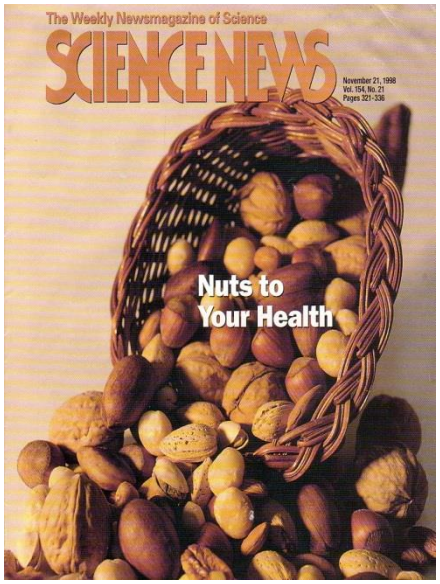



FLAVOR AROMA
SATIETY
LIPID
MEMBRANE
MAINTENANCE
LIPID
INSULATION
PADDING
LIPID
CARRIERS
FAT SOLUBLE
VITAMIN

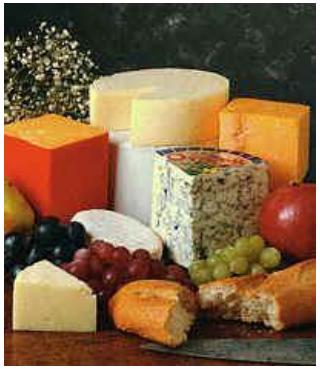
Fat Digestion = 2^0 Energy Nutrient



G&H 2011 fig 65-4 p 792
G&H 2016 fig 66-4 p 836

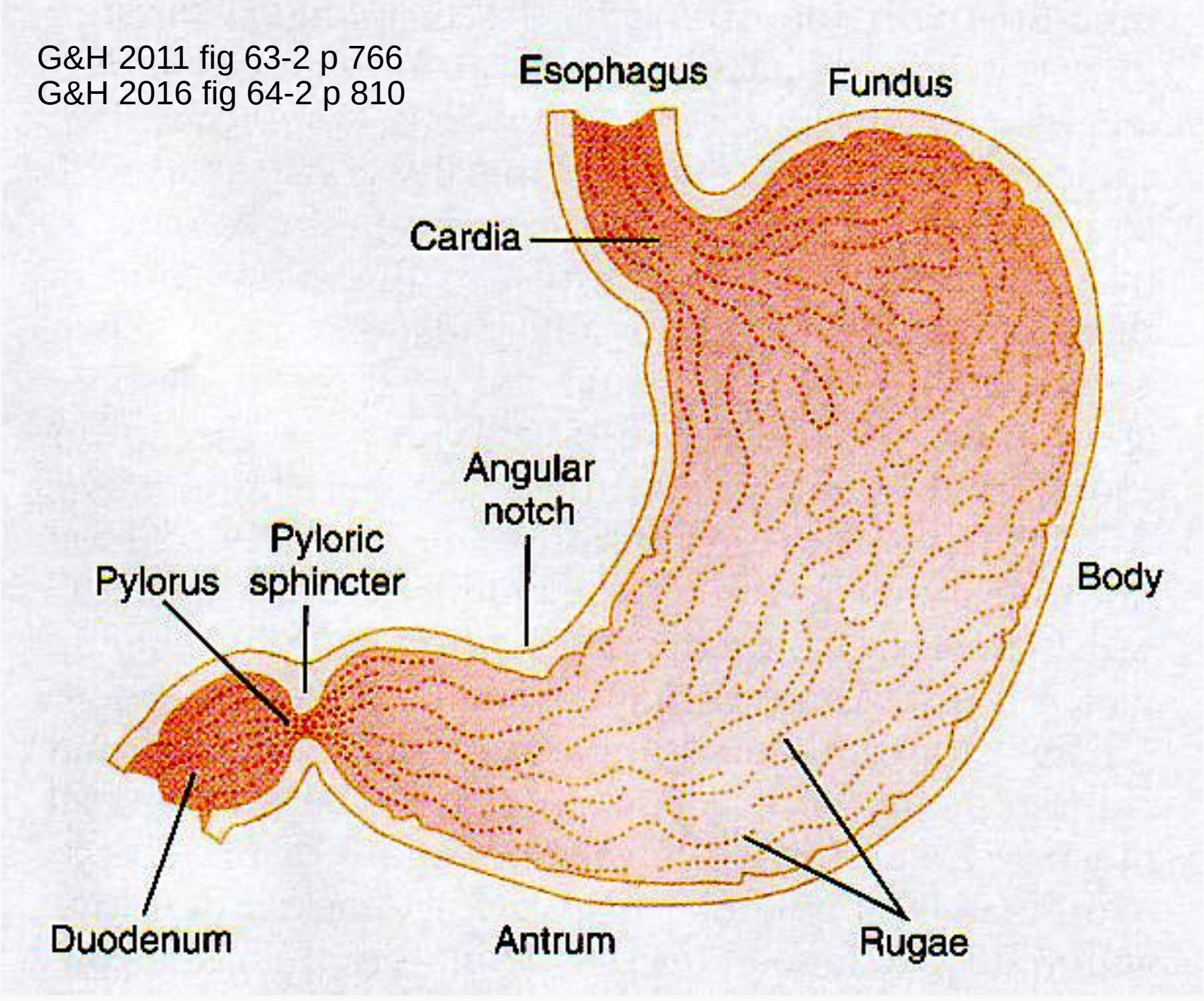


HIGH PROTEIN (FAT?)
FOODS?

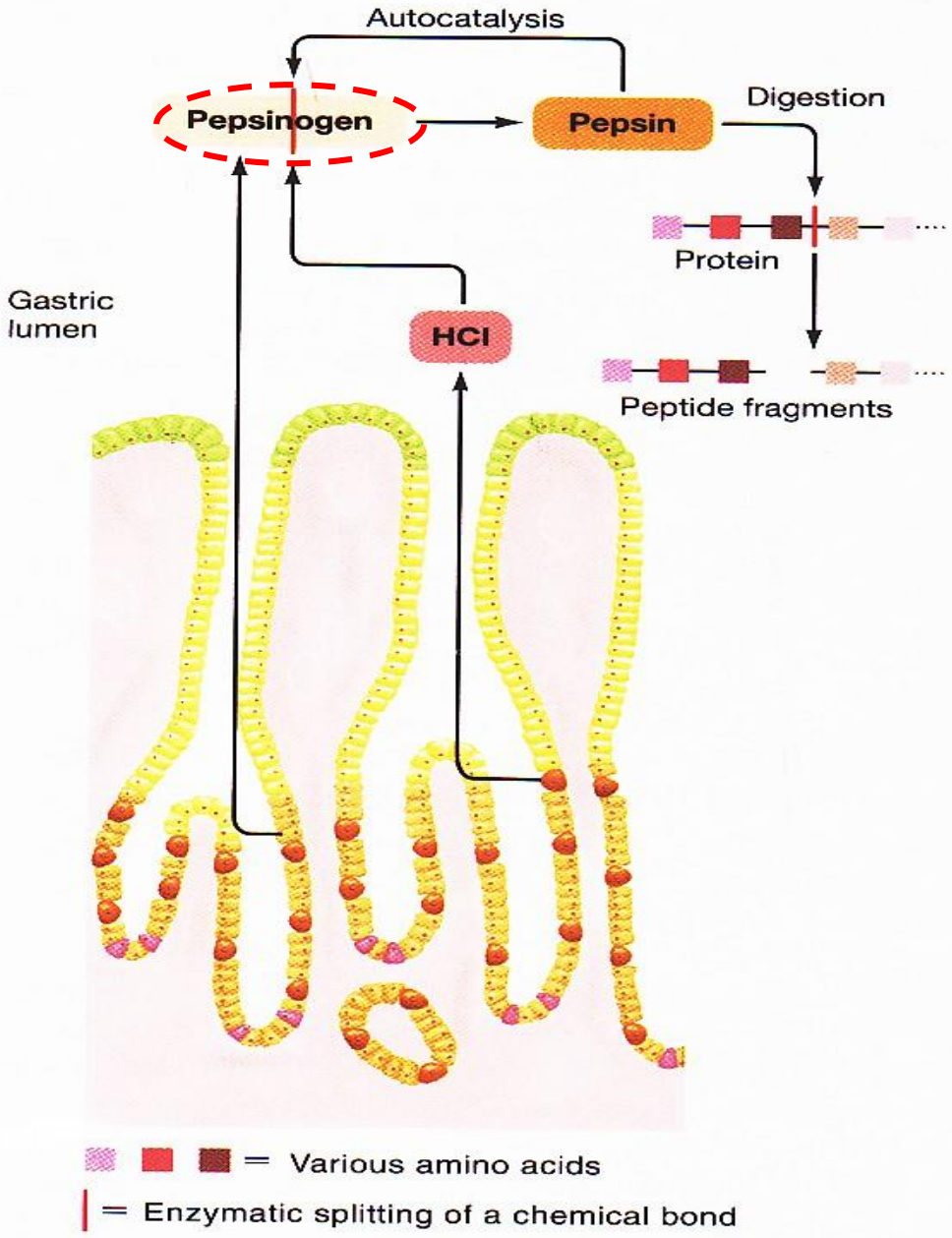


Where does *enzymatic* digestion of *protein* begin?

G&H 2011 fig 63-2 p 766
G&H 2016 fig 64-2 p 810



Zymogen = inactive precursor

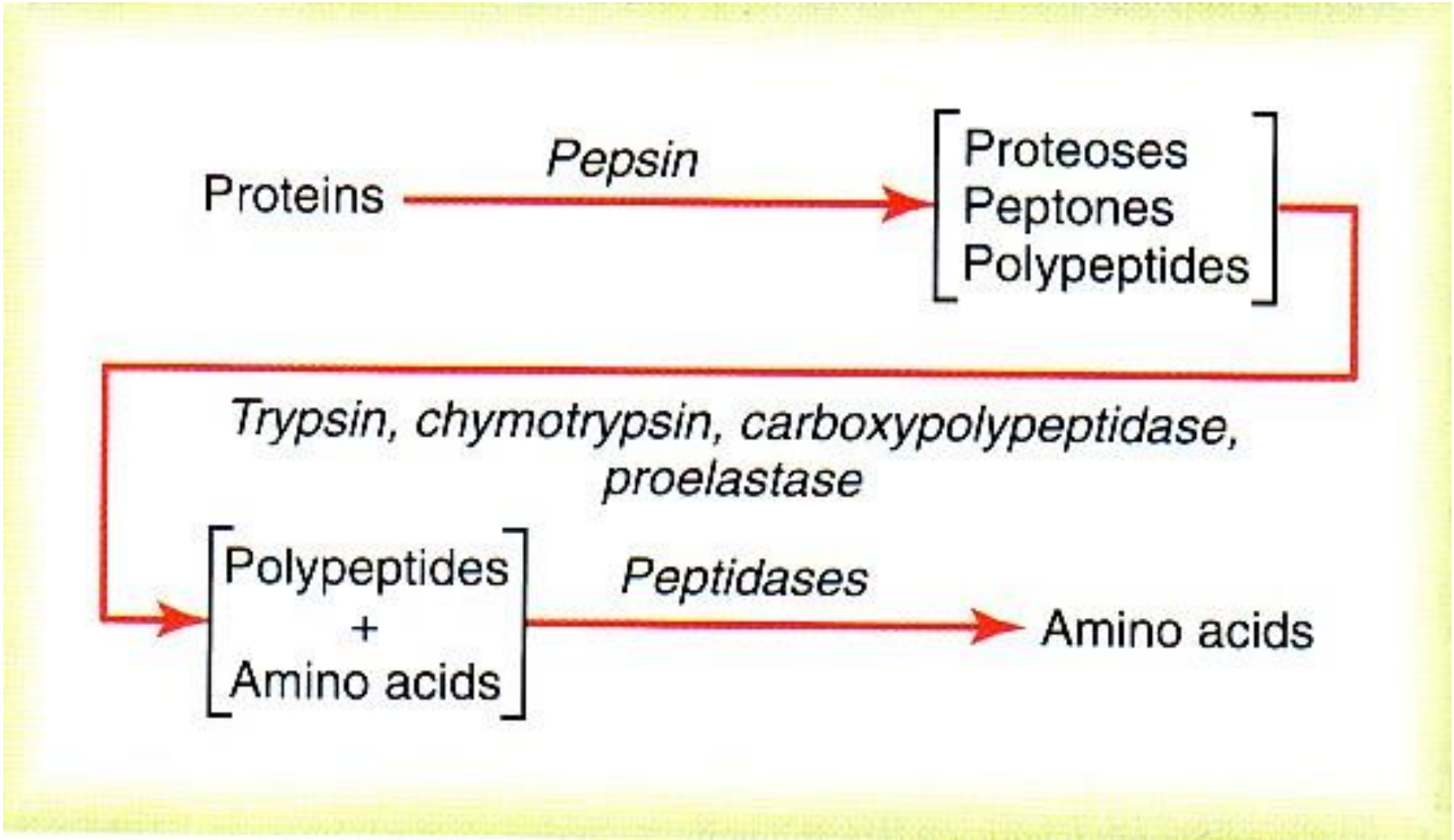


LS2 2006

G&H 2011
fig 64-4

G&H 2016
fig 65-4

Protein Digestion = 3^0 Energy Nutrient

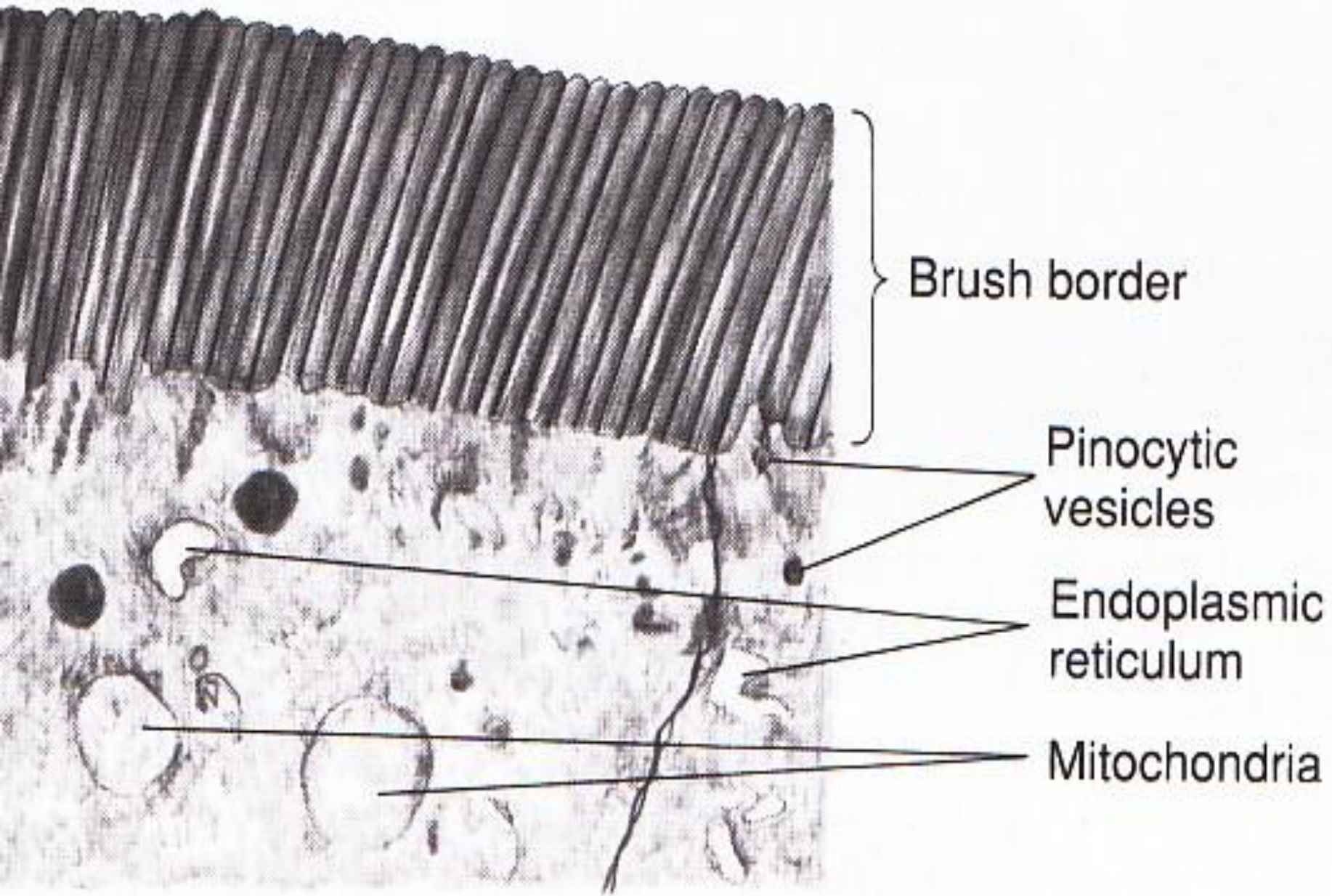


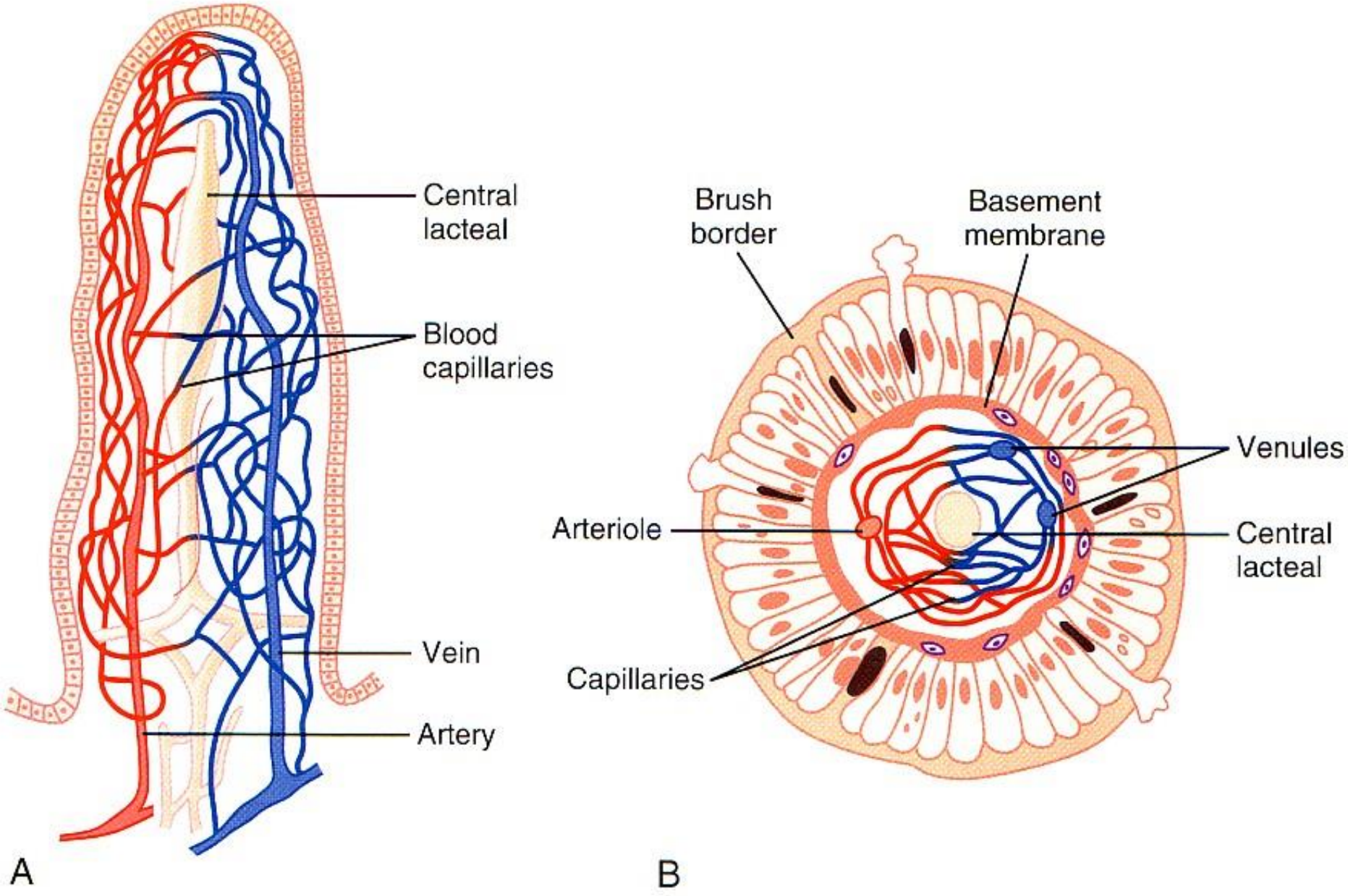
G&H 2011 fig 65-2 p 791

What is the major function of the small intestine?

Absorption!!

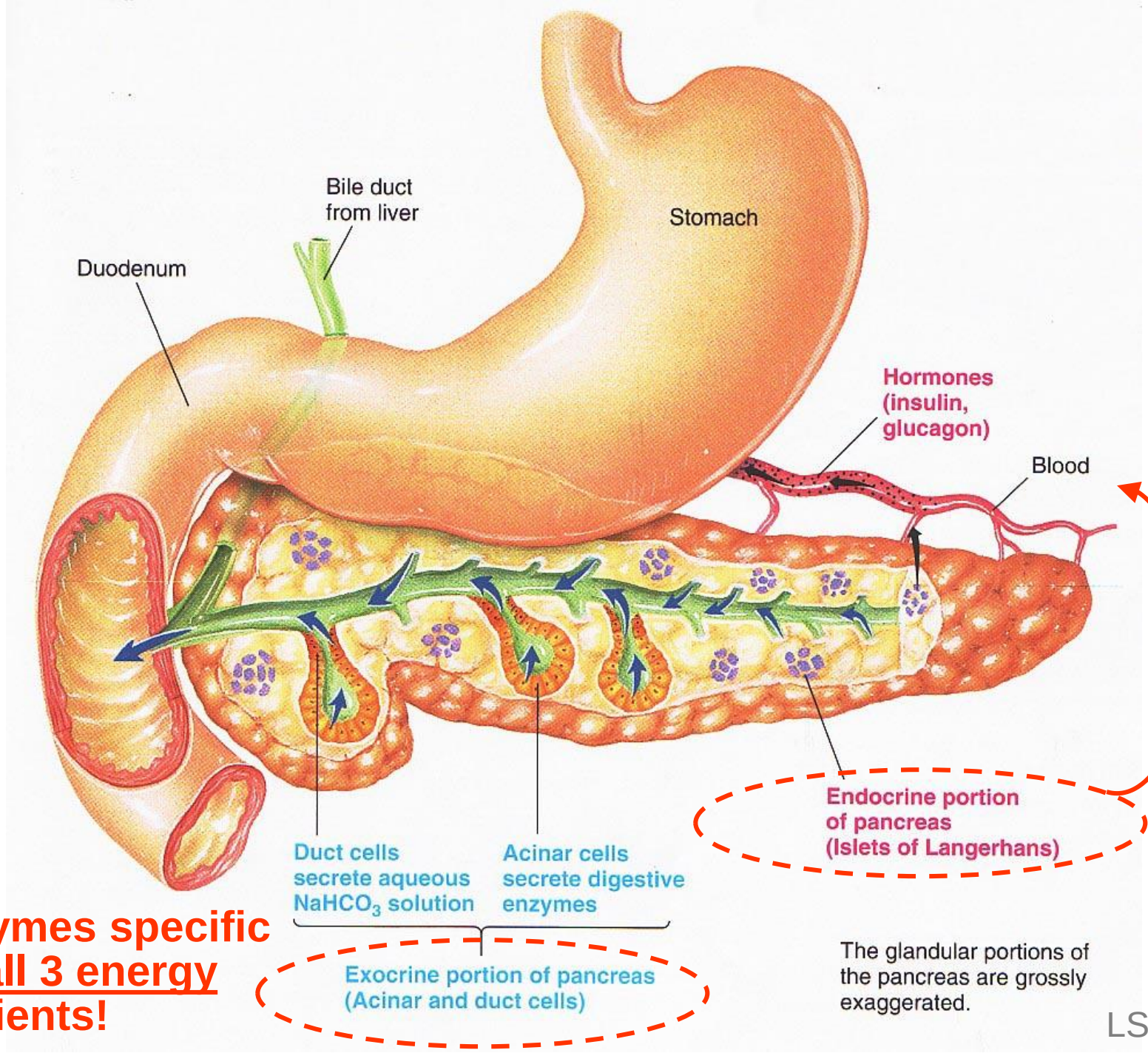
G&H 2011 fig 65-7
G&H 2016 fig 66-7



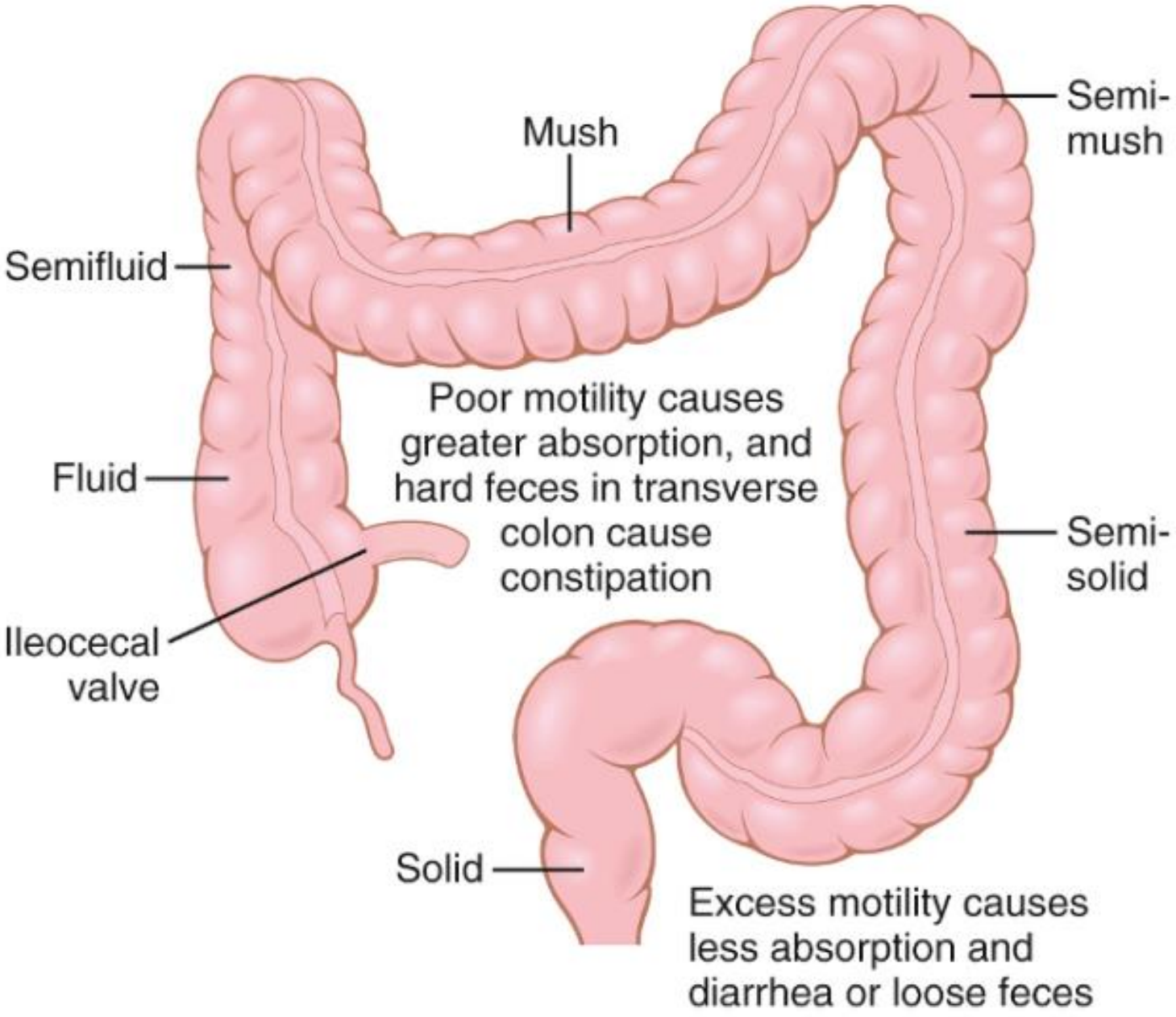


G&H 2011 fig 65-6, G&H fig 66-6

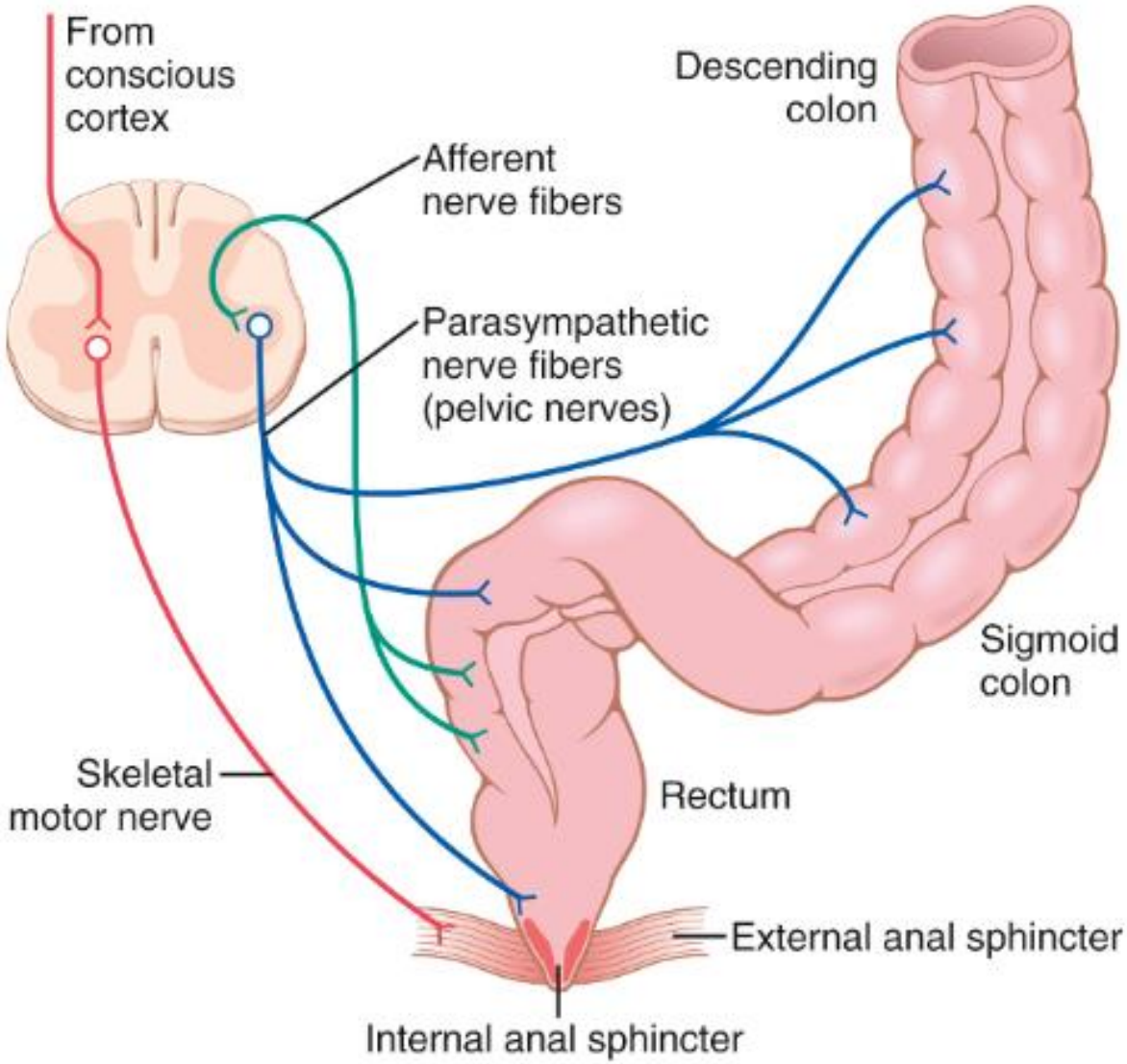
Why is the *pancreas* so unique?



Enzymes specific for <u>all 3 energy</u> nutrients!



G&H 2016 fig 64-5, G&H 2011 fig 63-5



G&H 2016 fig 64-6, G&H 2011 fig 63-6

Questions + Discussion

Plant-based diet benefits: Mounting evidence

AMERICAN INSTITUTE for CANCER RESEARCH

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.

The World's Longest-Lived People!

Blue Zones!

https://www.cbsnews.com/news/blue-zones-do-people-who-live-in-certain-areas-live-longer/, Aug 2013.

Buettner, D. *National Geographic*, Nov 2005.

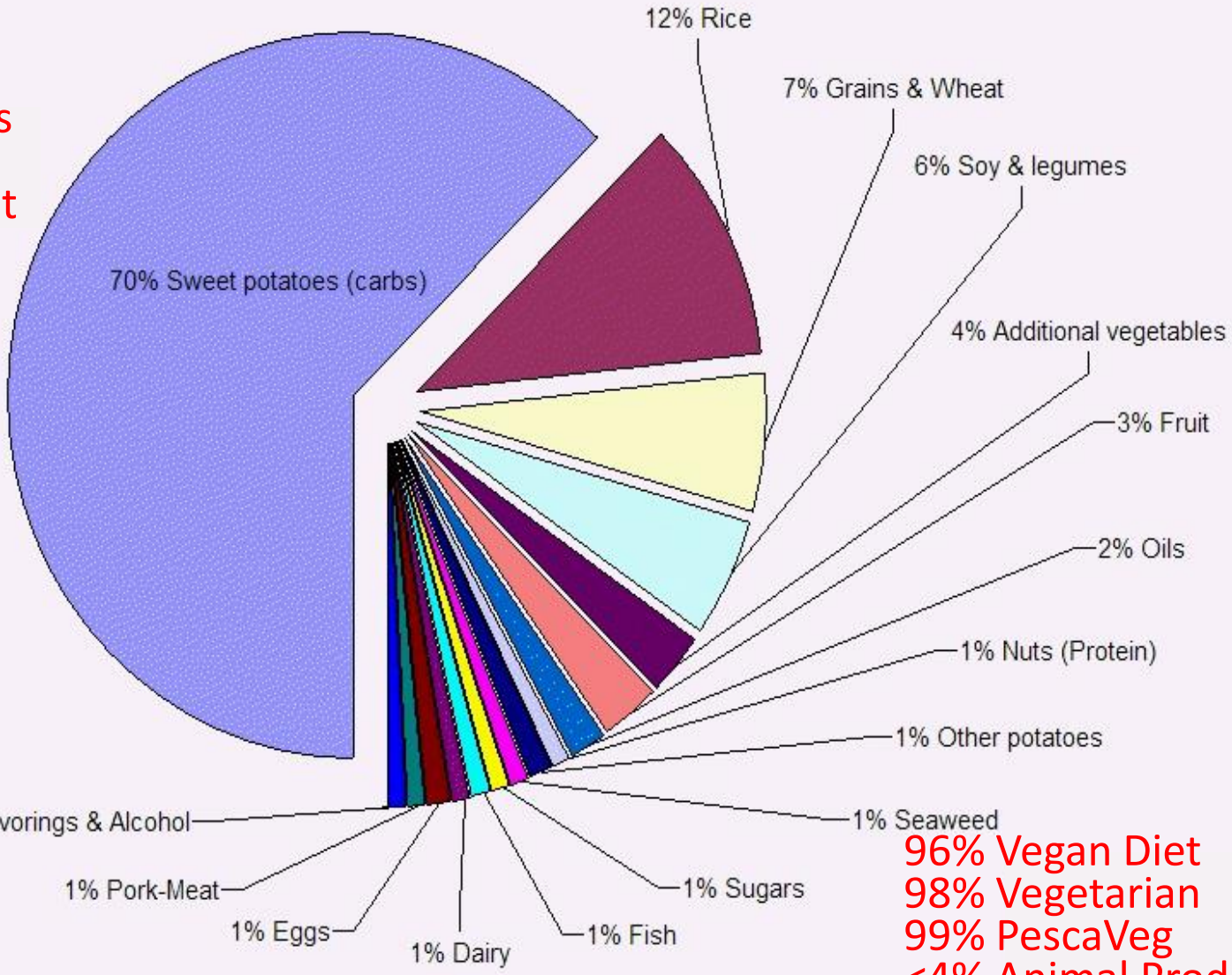
M Poulain & Coworkers. *Experimental Gerontology*, Sep 2004

Plant-based!

1. **Eat a little bit better!**
2. **Move a little bit more!**
3. **Socialize more!**
4. **Strong sense of purpose!**

https://en.wikipedia.org/wiki/Blue_Zone
https://bluezones.com/
http://www.sciencedirect.com/science/article/pii/S0531556504002141

OKINAWA LONGEVITY DIET



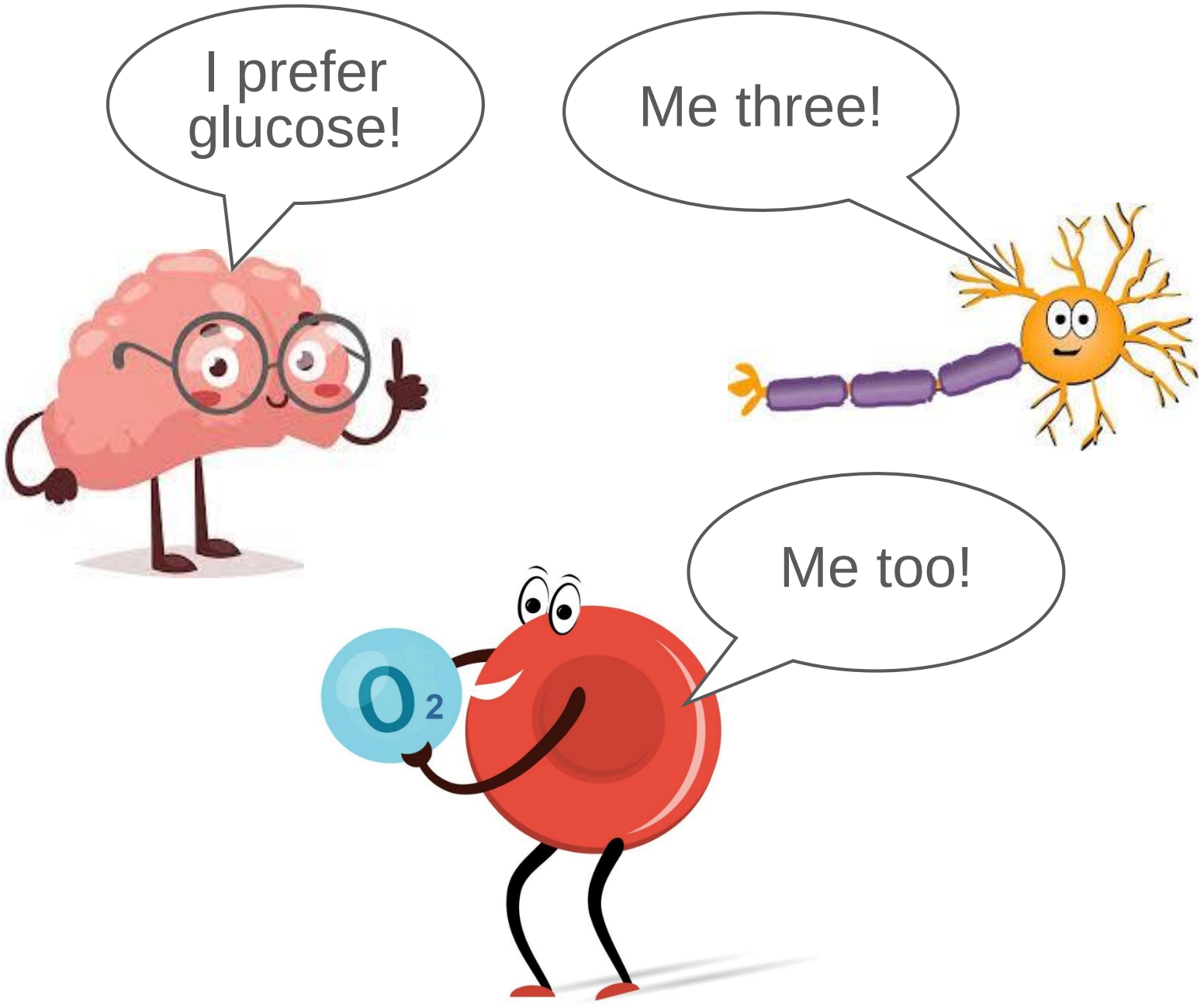
70% Sweet Potatoes
12% Rice
7% Grains & Wheat
6% Soy & legumes
4% Additional vegetables
3% Fruit
2% Oils
1% Nuts (Protein)
1% Other potatoes
1% Seaweed
1% Sugars
1% Fish
1% Dairy
1% Eggs
1% Pork-Meat
1% Flavorings & Alcohol

85% Carbohydrates
9% Protein
6% Fat
85-10-5
1785 Calories

96% Vegan Diet
98% Vegetarian
99% PescaVeg
<4% Animal Prod
<1% Fish
<1% Meat-Pork

SCIENTIFIC STUDY: "The Diet of the World's Longest-Lived People and Its Potential Impact on Morbidity and Life Span"
JOURNAL: Annals of the Academy of Sciences - Volume 1114: 434–455 (2007).

Note: These are the Actual Food Measurements of the Centenarians, not the diet of All island Okinawans or the ones who died, but the ones who lived.


I prefer glucose!
Me three!
Me too!
O2

Why Eat Whole Grains?

Based on existing evidence, eating whole grains is definitely good for our health.

Shengmin Sang, Professor of Food Science & Human Health North Carolina A&T

Fiber ↑ fullness, motility, beneficial bacteria, wt control ↓ cholesterol, insulin response, inflammation, diabetes and CVD risk…

B-vitamins thiamin, niacin, riboflavin ↑ energy metabolism

Folate ↑ red blood cells, ↓ neural tube defects

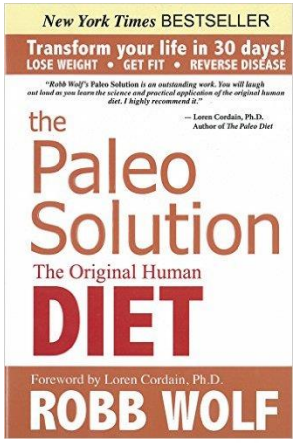
Iron ↑ O_2 carrying, ↓ iron-deficiency anemia in women

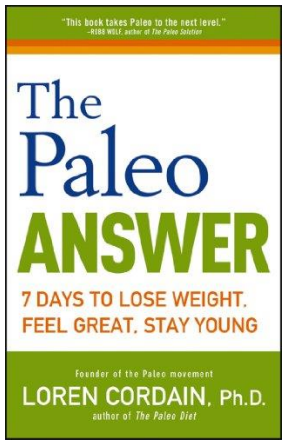
Magnesium ↑ bone building & muscle energy release

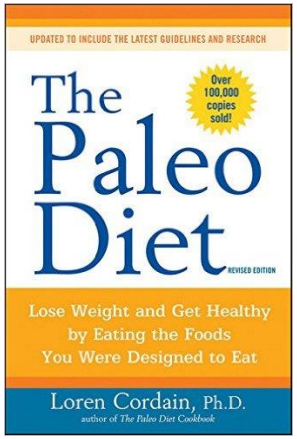
Selenium an anti-oxidant, protects body cells & ensures a healthy immune system…

https://www.choosemyplate.gov/grains-nutrients-health

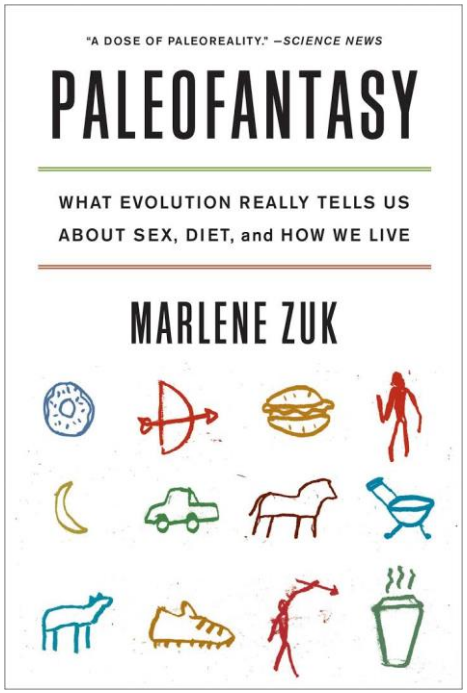
Pondering Paleo?







Evolutionary Biologist
Behavioral Ecologist
U Minnesota



http://www.nutritionaction.com/daily/how-to-diet/pondering-paleo/

How much protein do you need?

Not much! 0.8 g/kg or 0.36 g/lb of body wt/d

50 kg or 110 lb female ? ~ 40 g/d

80 kg or 176 lb male ? ~ 64 g/d

Boneless, skinless, cooked chicken breast 6-8 oz, 53 -70 g of protein!

Average US woman gets 35% > RDA!
Average US man 65% >RDA!

MyPlate launched June 2, 2011

2. **Focus on fruits. Whole fruit preferable to juice, but any fruit counts! Fill ½ your plate with fruits & vegetables!**

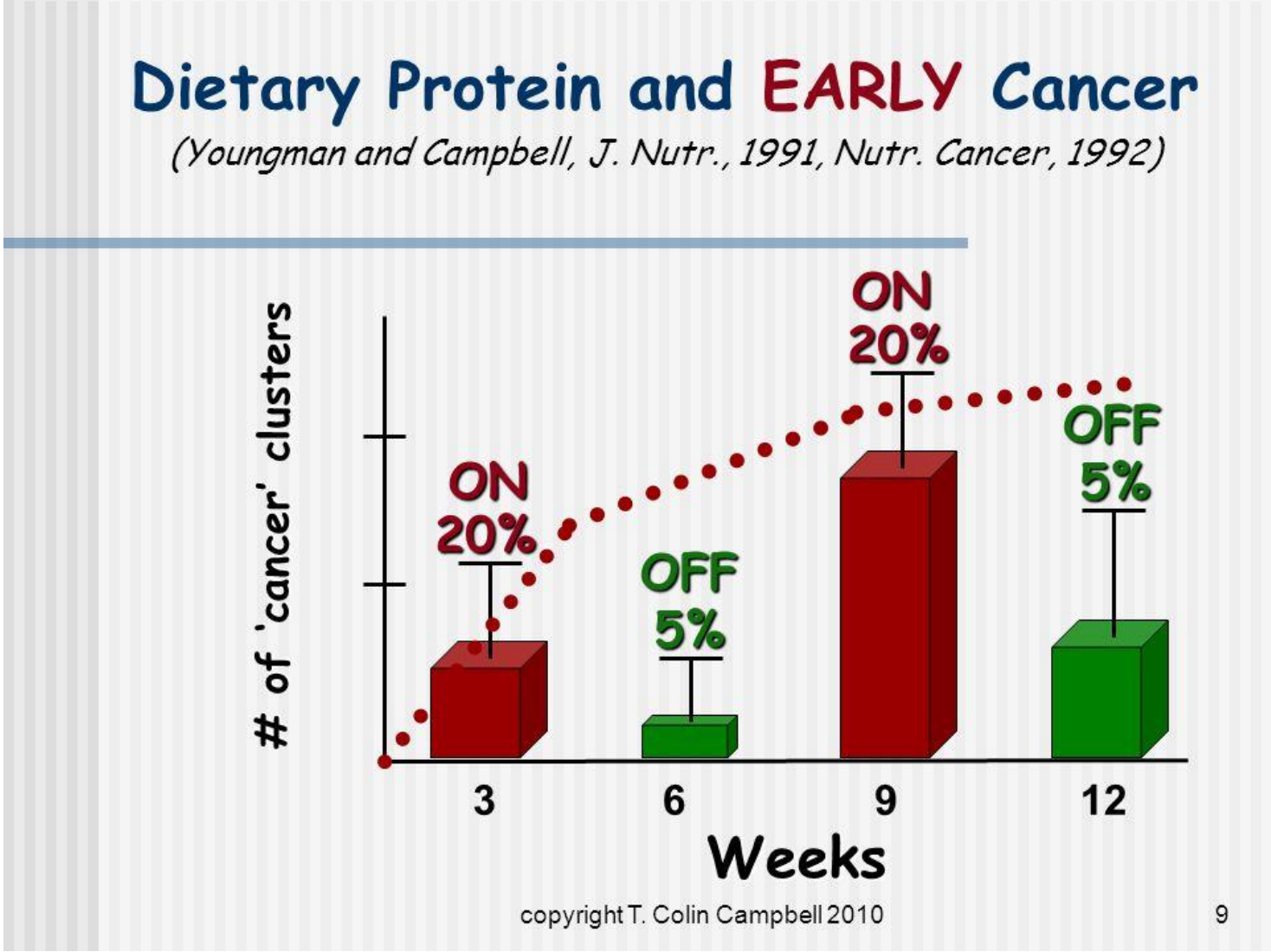
3. **Make at least ½ of your grains whole grains!**

5. **Get your calcium-rich foods. Buy skim or 1% milk. Go easy on cheese!**

1. **Vary your veggies. Fill ½ your plate with fruits & vegetables!**

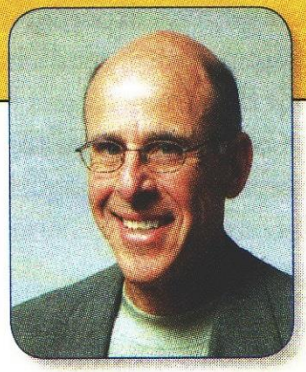
4. **Go lean with protein. Keep protein to < ¼ plate! Nuts, beans, peas, seeds, poultry, lean meat, seafood,…**

Dietary Protein, Shakes, Supplements &…?



http://www.aicr.org/about/advocacy/the-china-study.html

http://www.nutritionfacts.org/



John Swartzberg, M.D.
Chair, Editorial Board

WHO says to cut down on meat?

When I saw the headlines in October that meat was linked to cancer, I braced myself for the inevitable brouhaha. The news was that the International Agency for Research on Cancer (IARC), part of the World Health Organization (WHO), concluded that processed meats like hot dogs, bacon, and ham almost certainly increase the risk of colorectal cancer—by 18% per daily serving—and that red meat probably does as well.

But we've heard about this link many times before. Over the past 20 years, many observational studies have found that people who regularly eat red or processed meats have higher rates of several cancers, notably of the colon and rectum. And lab studies have shown that compounds formed when meat is processed (that is, smoked, salted, or cured) or cooked at high temperatures can cause cancer in animals or cells. All that research served as the basis of the IARC conclusions. But even in 2007 the World Cancer Research Fund, another key group of experts, concluded that there was "convincing" evidence that these meats increase the risk of colorectal cancer. And since 2002, WHO has advised people to moderate their consumption of processed meat, as do the still-pending 2015 Dietary Guidelines for Americans.

What elicited the most heated reaction in the press and blogosphere and especially from the meat industry was the fact that the IARC put processed meats in its Group 1—"carcinogenic to humans"—which includes tobacco smoking and asbestos. (It put red meats in Group 2A—"probably carcinogenic.") The IARC clearly explained that this classification merely indicates the strength of the evidence that something causes cancer, not the *degree* of risk. In fact, it said that the increased risk from red or processed meat is "small" for individuals, though potentially important for public health since so many people eat meat.

What about that 18% increase in risk? The IARC estimated that for every serving of processed meat (just under 2 ounces) or red meat (3½ ounces) eaten daily for years, the lifetime risk of colorectal cancer goes up by about 18%. But this is what's known as relative risk, which can be misleading. For instance, the lifetime risk of developing colorectal cancer in the U.S. is about 5%. An 18% increase does not mean 5% + 18% = 23%, but rather 5% + (18% of 5%) = 6%. That means one extra case of colorectal cancer per 100 meat eaters. In contrast, smoking increases the lifetime risk of lung cancer by roughly 2,000%—from about 1 per 100 people to about 20 per 100. So while IARC may classify both processed meat and smoking as Group 1 carcinogens, there's no comparison in their risks.

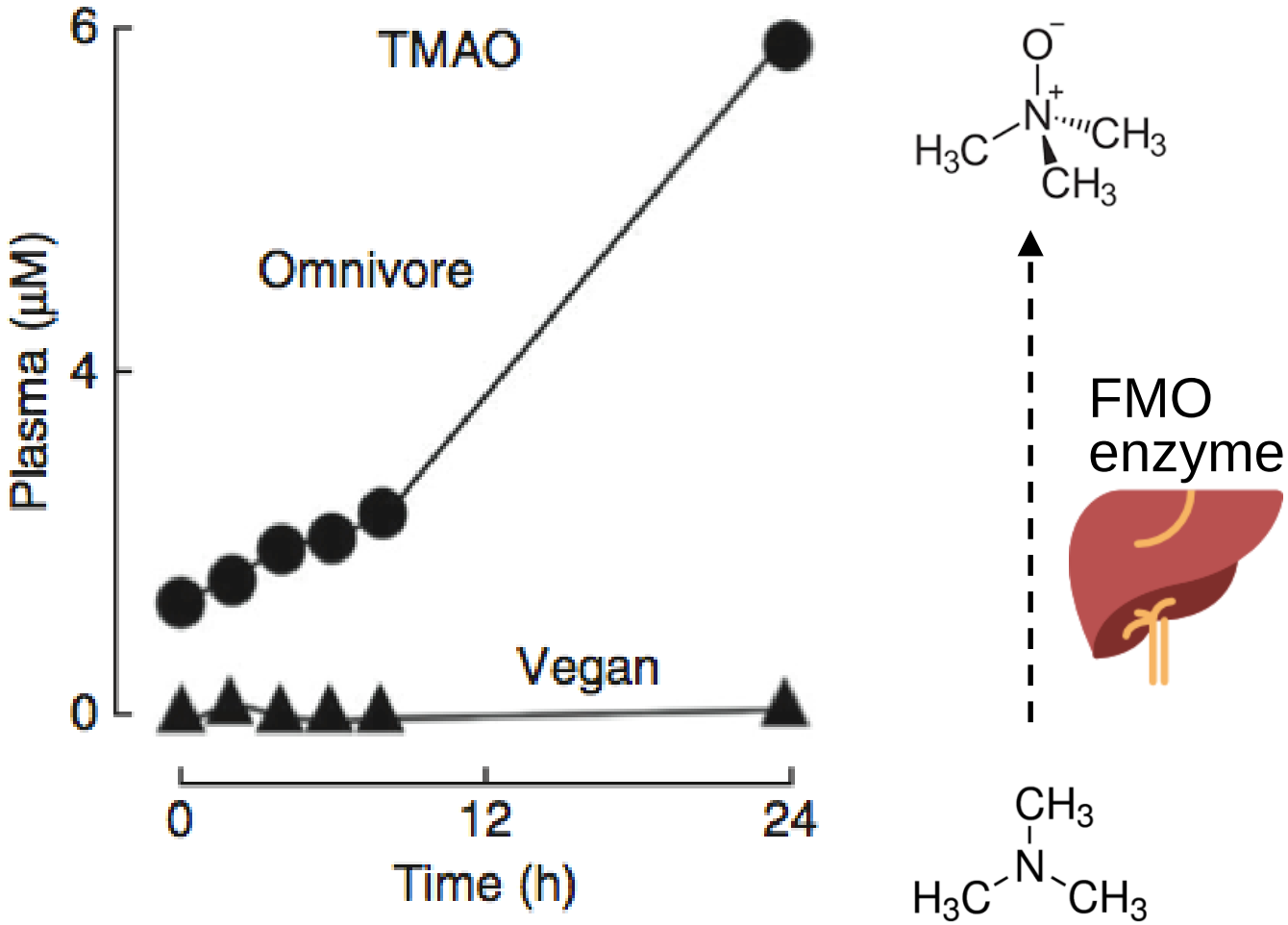
In fact, IARC cited estimates that 34,000 cancer deaths per year worldwide can be attributed to diets high in processed meat. In contrast, tobacco causes nearly 2 million cancer deaths per year.

I should add that I don't think it has been clearly established that meat causes cancer. Proving that foods cause or help prevent cancer is difficult for many reasons. Notably, the observational studies upon which the IARC classifications were largely based can only find associations—they cannot prove cause and effect.

That said, there are plenty of other reasons to moderate your intake of red meats and limit processed ones. There's strong evidence linking them to cardiovascular disease and a variety of other disorders, though it's not clear which compounds in them are the possible culprits. What's more, eating more plant-based foods and less meat is better for the planet, resulting in less greenhouse gas production.

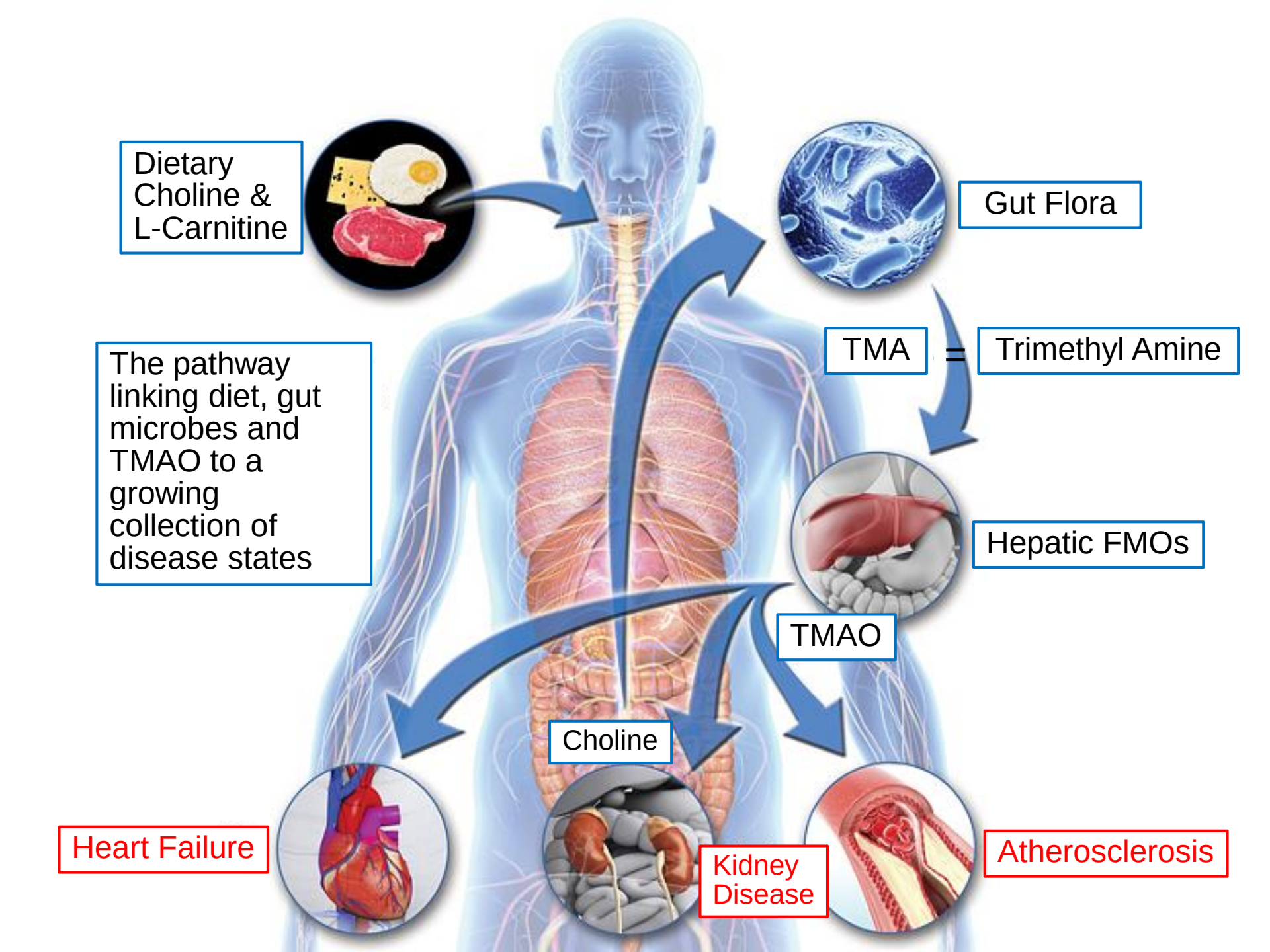
And there's a far surer way to reduce the risk of colorectal cancer than tinkering with your diet: Get screened.

Gut Bacteria Involved in Inflammation & Atherosclerosis?

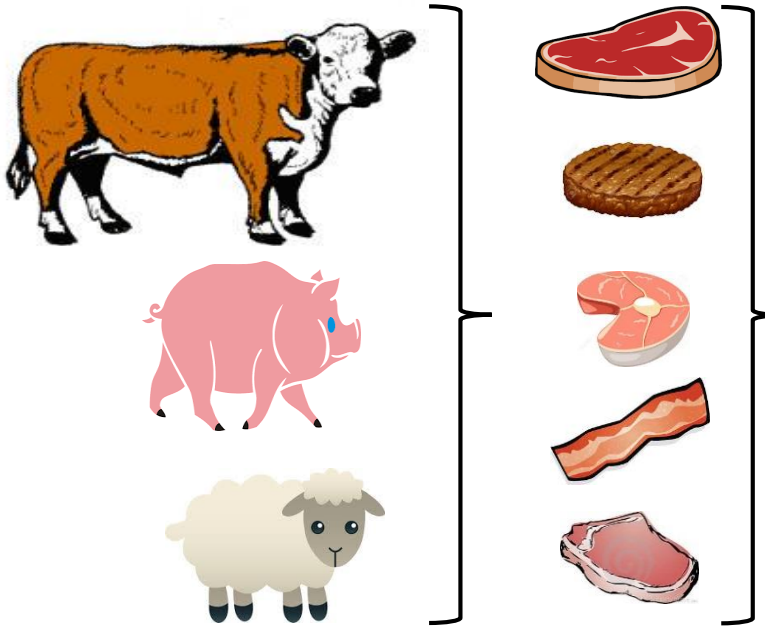


Meat & Eggs → L-Carnitine & Choline → Trimethyl Amine (TMA) → TMAO → ***Inflammation & Atherosclerosis***

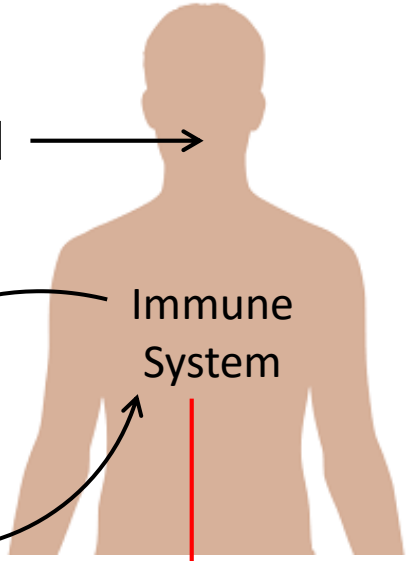
https://consultqd.clevelandclinic.org/2015/02/gut-flora-dependent-tmao-new-studies-extend-its-reach-beyond-the-arteries-to-the-heart-and-kidneys/


Dietary Choline & L-Carnitine
Gut Flora
TMA = Trimethyl Amine
The pathway linking diet, gut microbes and TMAO to a growing collection of disease states
Hepatic FMOs
TMAO
Choline
Heart Failure
Kidney Disease
Atherosclerosis

Red Meat-Derived Glycan Promotes Inflammation & Disease



N-Glycolylneuramic acid
(Neu5GC)

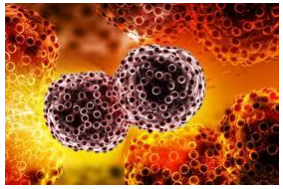


Ab to Neu5GC
Neu5GC Ab

Xeno Auto-Antigen!
Anti-Neu5GC Ab

Atherosclerosis

Cancer



Chronic Inflammation
Amyloid-A +
Acute Phase Proteins
IL-6

Source: After AN Samraj, *PNAS*, 2015, 112(2), 542-7.
http://m.pnas.org/content/112/2/542.long

Environmental Impact

Grain required for:

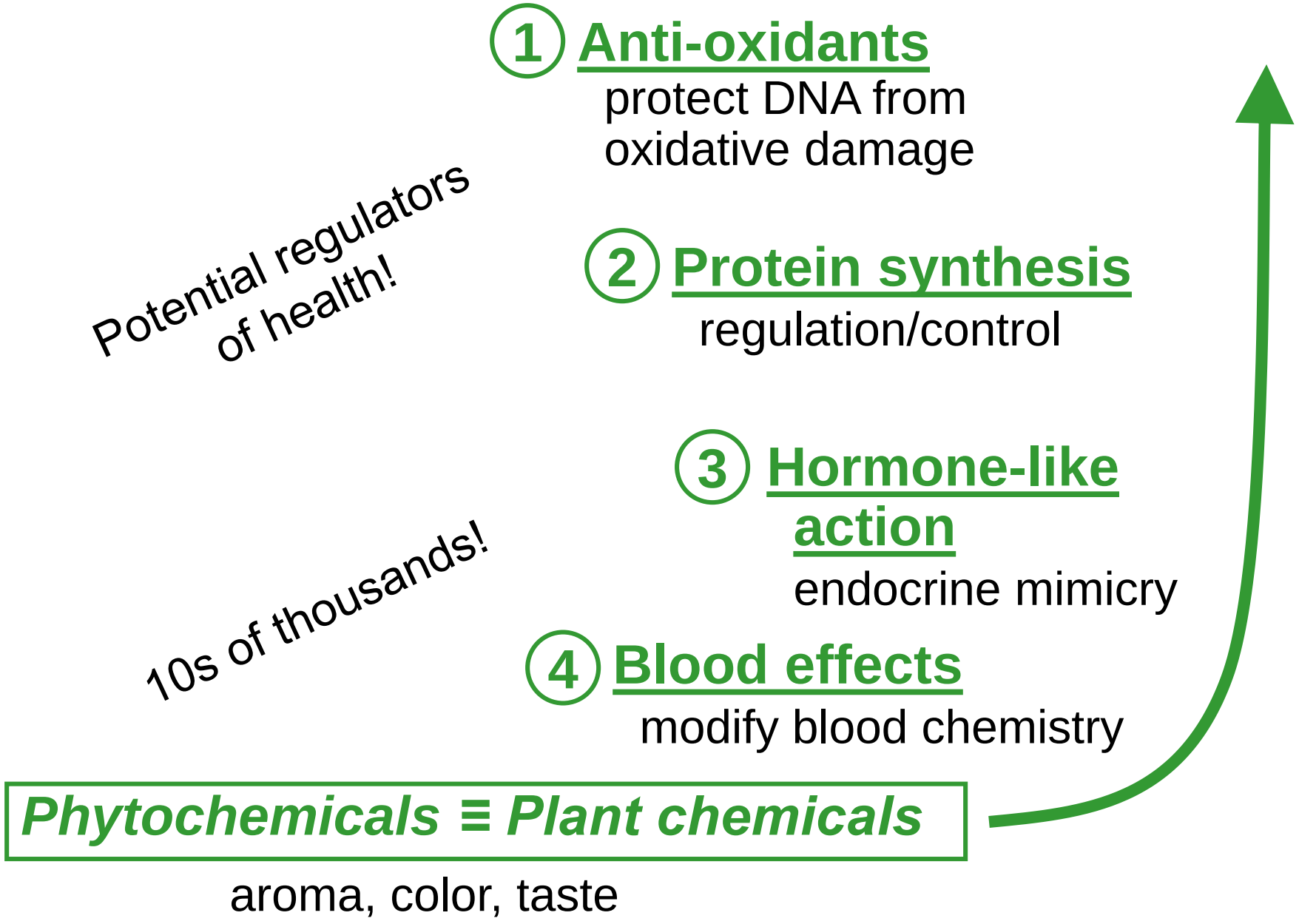
~61 kg 1 kg of Beef

~38 kg 1 kg of Pork

~13 kg 1 kg of Fish

~33% of H_2O farm animal footprint due to beef production

SOURCE: SM Downs & J Fanzo. Curr Nutr Rep, 2015, 4:313-22

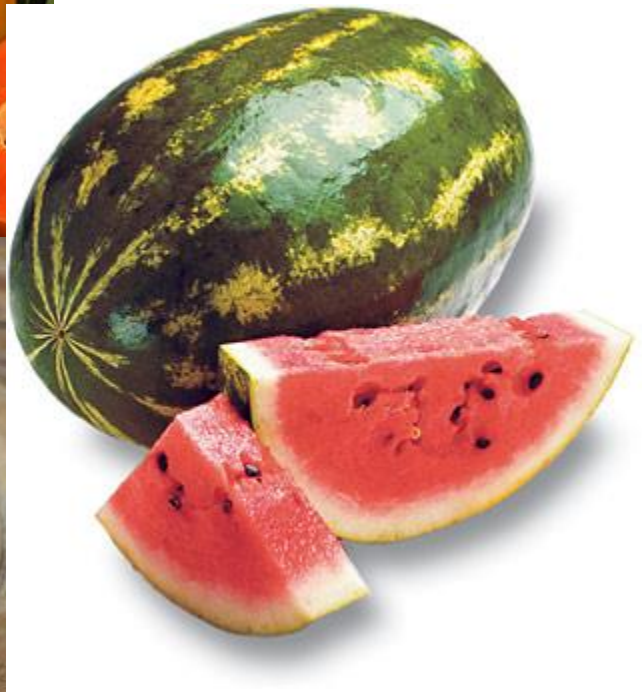

1 Anti-oxidants
protect DNA from oxidative damage
Potential regulators of health!
2 Protein synthesis
regulation/control
3 Hormone-like action
endocrine mimicry
10s of thousands!
4 Blood effects
modify blood chemistry
Phytochemicals ≡ Plant chemicals
aroma, color, taste

Broccoli sprouts may contain ~ 10,000 unique phytochemicals!

Sizer & Whitney 2011 p 66

≥ 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!



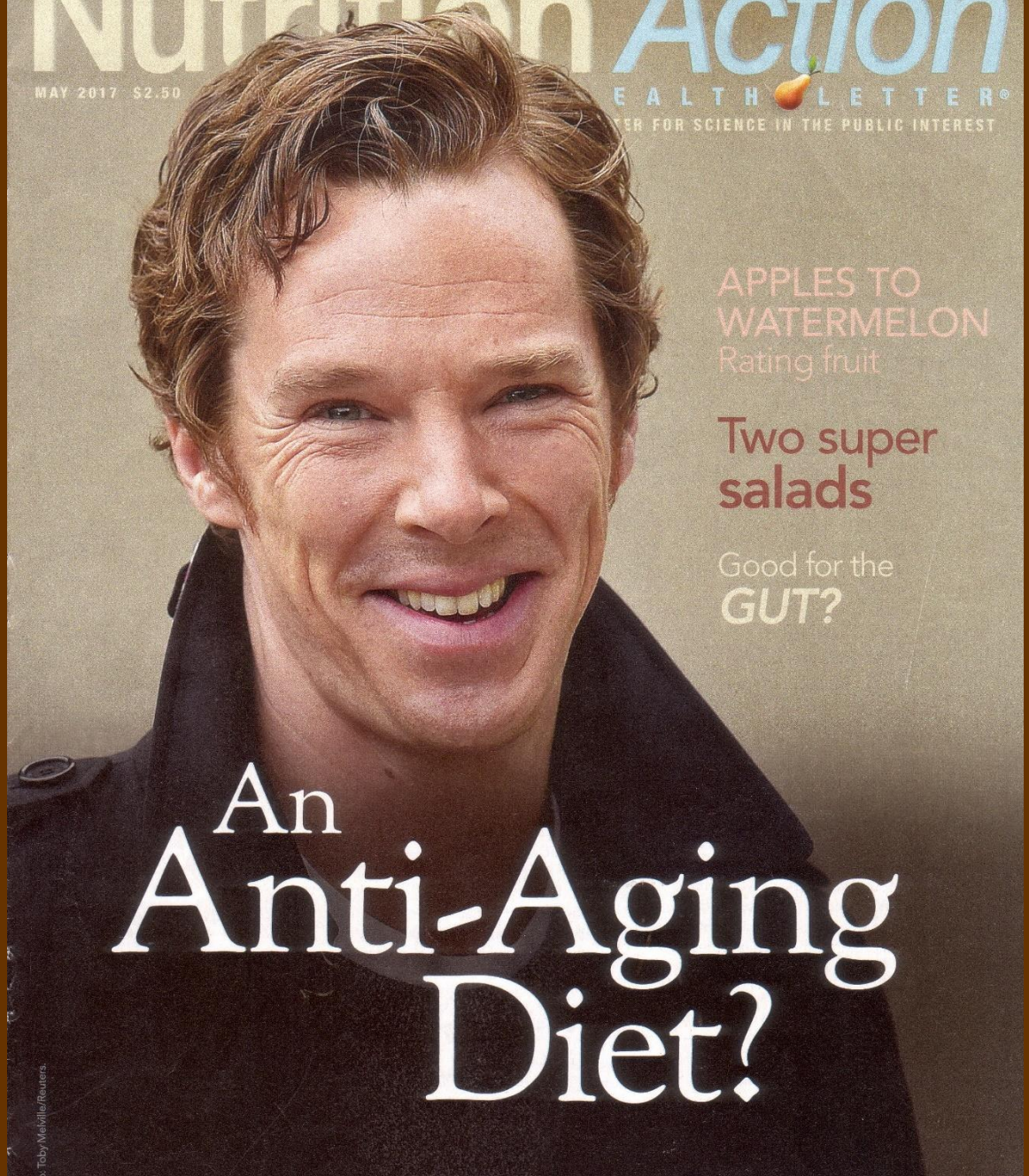
With the right food choices, physical activity, and not smoking, we could prevent about 90% of diabetes, 80% of heart disease, about & 70% of stroke!

American Institute for Cancer Research

http://www.aicr.org/reduce-your-cancer-risk/recommendations-for-cancer-prevention/

The Filthy Food Act, p. 2 | Vitamin D, calcium, & cancer, p. 8 | Almond creamers, back cover

Nutrition Action HEALTH LETTER®
MAY 2017 $2.50
CENTER FOR SCIENCE IN THE PUBLIC INTEREST



APPLES TO WATERMELON
Rating fruit

Two super salads

Good for the *GUT?*

An Anti-Aging Diet?

Toby Melville/Reuters.

CALERIE STUDY

Comprehensive Assessment of Long-term Effects of Reducing Intake of Energy

- 2-yr kcal restriction, assess biomarkers longer, healthier life
- 218 people, 21 – 51 yr, ½ ~ overwt, ½ normal wt
- Usual diet or cut kcal by 25% (achieved ~ 12% so < ½ goal)
- If cut calories, lost 10% body wt ~ 17 lb & kept off for 2 yr
- Cardiometabolic Δs: ↓ Cholesterol, ↓ Inflammatory markers, ↑ control blood sugar control w/o adverse sexual or immune function Δs

Some bone loss, but attributed to weight loss.

National Institute on Aging

PENNINGTON BIOMEDICAL RESEARCH FOUNDATION LSU

30 YEARS OF DISCOVERY

Das SK, Roberts SB, Bhapkar MV & coworkers. *Am J Clin Nutr* 2017 Apr, 105(4):913-927. https://www.ncbi.nlm.nih.gov/pubmed/28228420

5:2 Intermittent “Fasting”

2 Days a Week

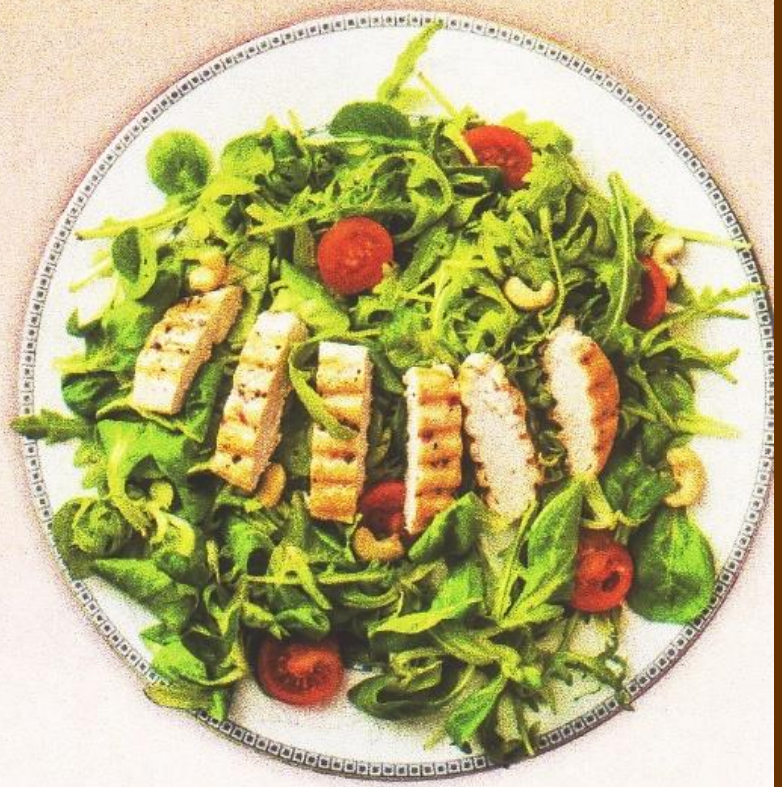
♀

500-CALORIE DAY

Breakfast

Plain low-fat yogurt with berries

200 calories



Dinner

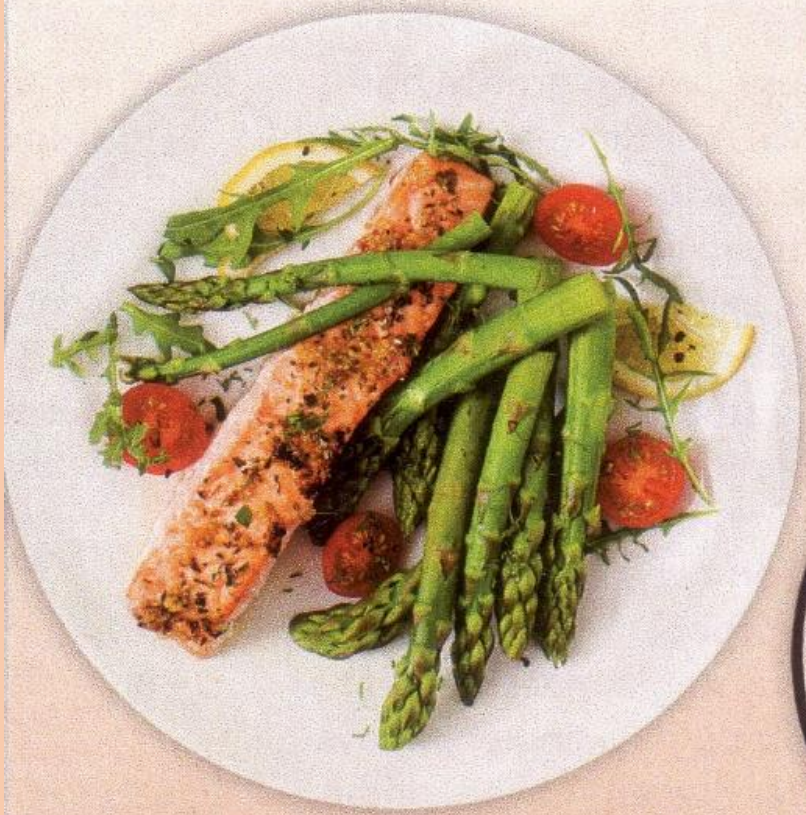
Mixed greens with grilled chicken

300 calories

NAHL 2017 May

5:2 Intermittent “Fasting”

600-CALORIE DAY



Dinner

Baked salmon with asparagus and tomatoes

350 calories

Breakfast

Oatmeal with peaches, berries, and milk

250 calories

Human Intermittent Fasting Studies

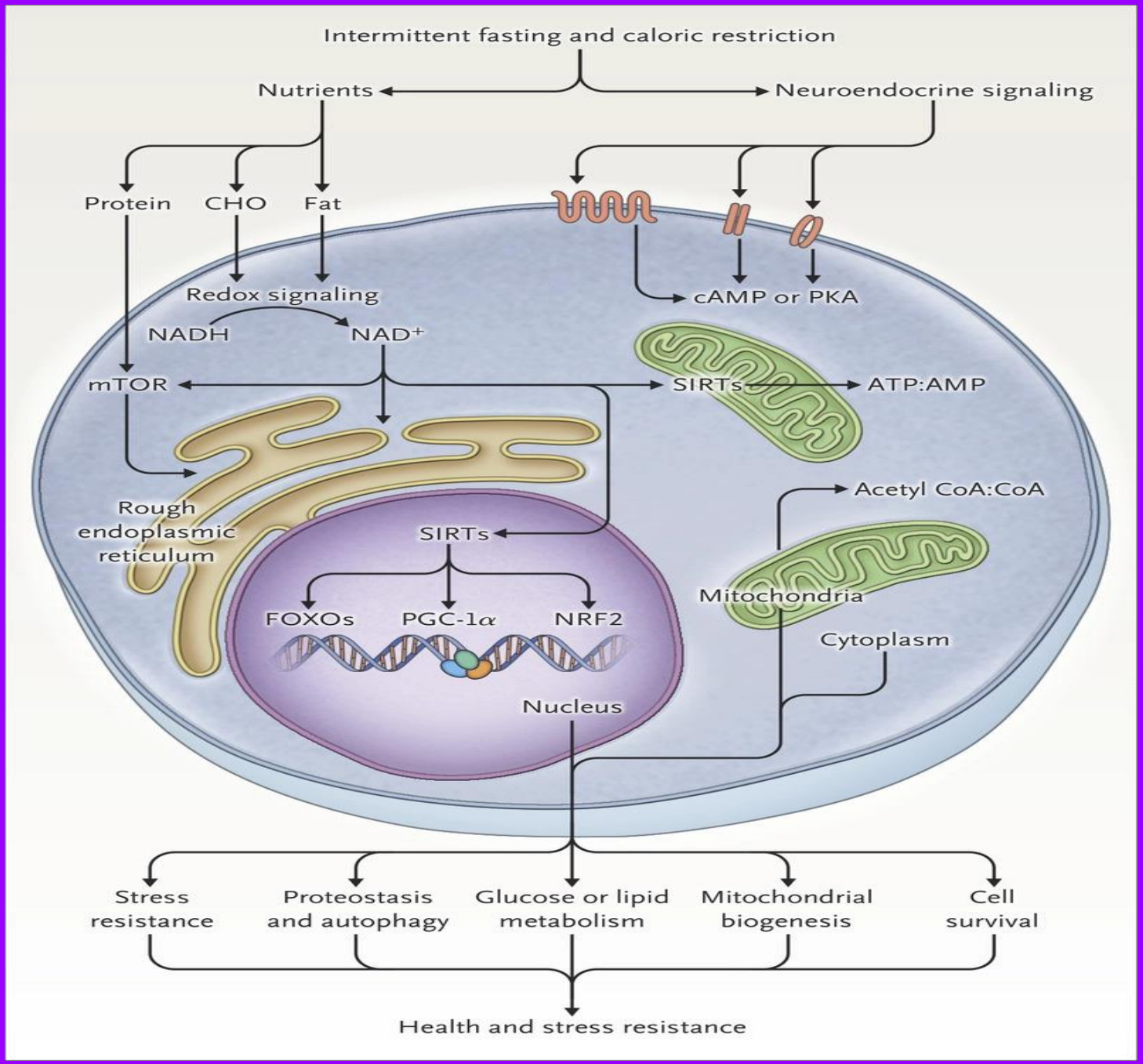
The Nightingale Centre
Wythenshawe Hospital
Southmoor Rd
Manchester
M23 9LT

UHSM
Your Hospital

- ~100 overweight or obese women
- ½ cut 25% kcal every day
- ½ ate normally 5 d, but only 650 kcal/d for 2 d/wk
- After 3 – 6 mo, each group lost ~ same amount of wt but women on 5:2 diet had better insulin function!
- Likely easier for most humans to restrict for only 2 d/wk!

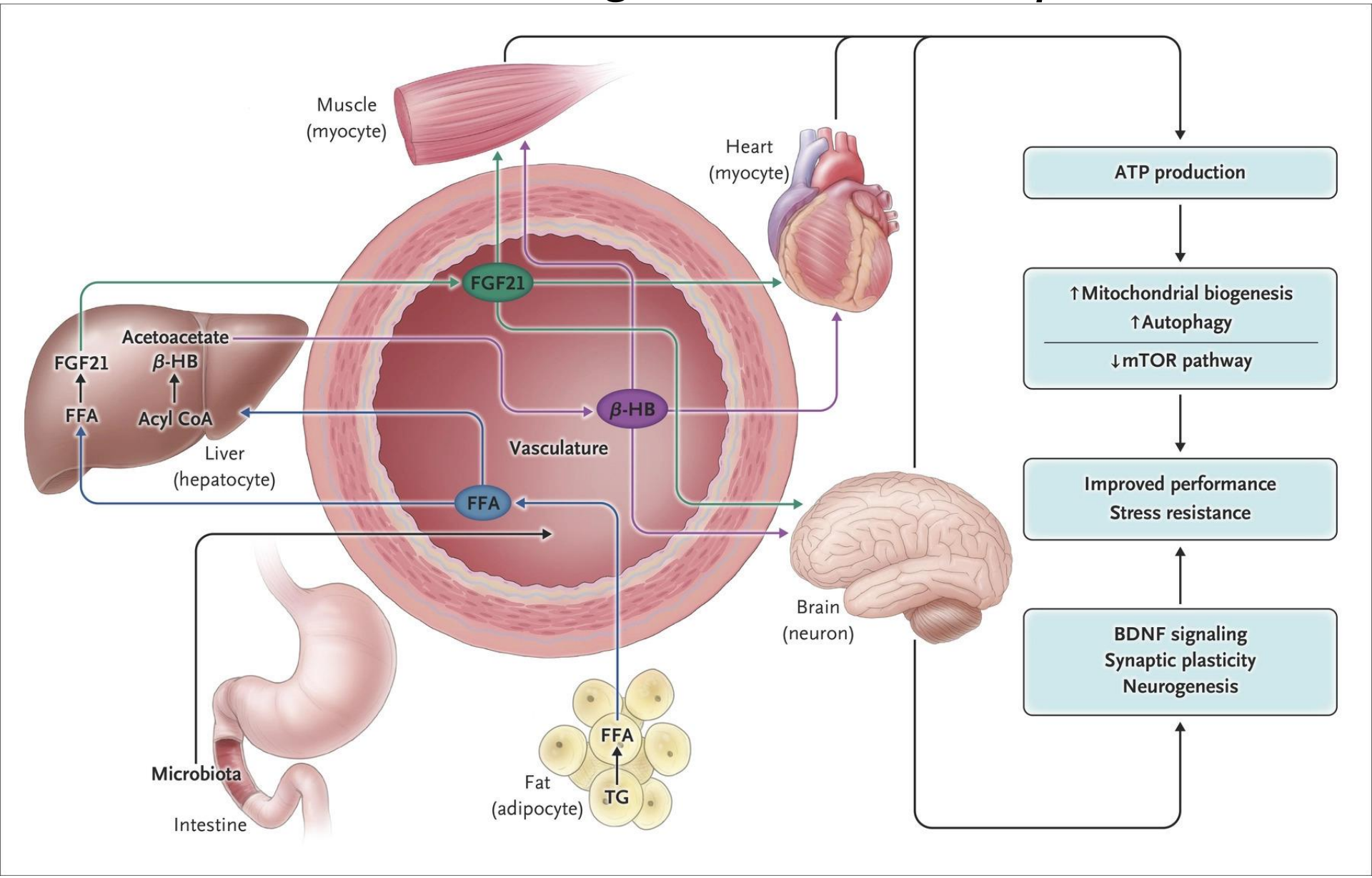
Harvie M, Wright C, Pegington M and coworkers. *Br J Nutr* 2013 Oct,110(8): 1534-47. *https://www.ncbi.nlm.nih.gov/pubmed/23591120*

Harvie M, Peginton M, Mattson M and coworkers. *Int J Obes* (London), 2011 May, 35(5):714-27. *https://www.ncbi.nlm.nih.gov/pubmed/20921964*



https://www.nejm.org/doi/full/10.1056/NEJMra1905136

Intermittent Fasting Metabolic Adaptations



https://www.nejm.org/doi/full/10.1056/NEJMra1905136