I. **Announcements**: Please check & sign attendance roster. Not on list? See Pat during break/> class. *Lab 1 Histology* tomorrow in 130 HUE: 12 n & 1 pm sections. Much fun!!

II. **Introduction**: Staff, office hr, required sources, course overview, grading, expectations & success. Q?

III. **Human Physiology** LS ch 1, DC Module 1
   A. What? cf: Anatomy LS p 1
   B. Where? Body Levels of Organization LS pp1-6, DC pp1-5
   C. How? Different Study Approaches LS p 1

IV. **Homeostasis** LS ch 1, DC Module 1
   A. What? Maintenance of ECF LS p 8
   B. Where? ECF = Plasma + Interstitium LS fig 1-4 p 8
   C. How? Simplified Homeostatic Model cf: LS fig 1-7 p 14 Balances LS p 9, DC pp 5-6
   D. Why? Cell survival! LS fig 1-5 p 9, DC p 5
ANATOMY vs PHYSIOLOGY
STRUCTURE vs FUNCTION
WHAT? vs HOW?
WHERE? vs WHY?

vs

vs

vs
Structure begets function! Structure gives rise to function! Structure & function are inseparable!
High-Tibial Osteotomy (HTO) to Realign the Joint

1. Oscillating saw cut
2. R plate/scaffolding insert
3. Align, stabilize w/screws & pack defect
Body Levels of Organization

1. Molecular
2. Cellular
3. Tissue
4. Organ
5. System

Entire Organism, like you & me!
Nerve conducts

Muscle contracts

Connective connects!!

Epithelial covers
Epithelial tissue gives rise to glands: (a) exocrine & (b) endocrine

(a) Exocrine gland

(b) Endocrine gland
Which body systems?
Maintenance of a relative constancy in the Internal environment = ECF = fluid outside of cells

milieu interieur?

100 trillion cells working intimately

Claude Bernard

Walter B. Cannon
Where is extracellular fluid?

As long as between/outside cells, ECF everywhere?

G&H 2011
Blood 121 Lecture 2

I. **Announcements** Lab 1 Histology today! 130 HUE. Fun! Please record your diet on p 3-7 LM & analyze it by Friday with [https://www.supertracker.usda.gov/](https://www.supertracker.usda.gov/) Estimating quantities. Q?

II. **Homeostasis** LS ch 1, DC Module 1
   A. **What**? Maintenance of ECF LS p 8
   B. **Where**? ECF = Plasma + Interstitium + ? LS fig 1-4 p 8
   C. **Homeostatic Balances**? LS p 9, DC pp 5-6
   D. **Why**? Cell survival! LS fig 1-5 p 9, DC p 5
   E. **Physiology in the News** H₂O? Are we like watermelons?
   F. **How** are balances maintained? Simplified Homeostatic Model *cf:* LS fig 1-7 p 14; T℃ + BP balance *e.g.* + vs. - FB

III. **Cell Anatomy, Physiology & Compartmentalization** LS ch 2
   B. Basic survival skills LS ch 1 p 3
   C. Organelles ≡ Intracellular specialty shops Endoplasmic Reticulum (ER), Golgi, Lysosomes, Peroxisomes & Mitochondria, LS fig 2-1, 2-2, 2-3 pp 20-3
ICF = Intracellular

ECF = Extracellular

Plasma (within CV System)

Interstitium (eg, between muscle cells)

https://www.youtube.com/watch?v=B658Yn3INYc
Dr. Evonuk’s 6 Balances

- Metabolic
  - ANA-
  - CATA-

- H$_2$O
- T$_{oC}$

- $O_2/CO_2$
- Ion$^+/-$
- pH

- Carbon Dioxide
- Electricity
- Bicarbonate and pH Balance
Drink about 1 L per 1000 calories energy expenditure!!

Human ~ 2/3 H₂O
~ 60 – 70 %

= ~40 – 48 kg H₂O

NB: So 2000 kcal →
drink 2000 mL
≡ 67.63 fl oz
≡ ~ 8 cups!
Invariably, Negative Feedback
NB: Though most often negative feedback, there are exceptions:

Selected +FB eg:

- LH Surge + Ovulation
- Oxytocin + Uterine Contraction
- Blood Clotting Cascade
- cAMP Cascade
- Na+ influx during AP
**Blood Pressure Homeostasis**

- **BP**: Venous Pooling
- **I**: Seated to Standing
- **R**: Baroreceptors/Pressure Receptors eg, in Carotids & Aorta
- **I’**: Electrochemical Signal
- **C**: CV Control Center Brain Stem
- **O**: Electrochemical Signal eg, Symp Accel N
- **E**: Baroreceptors/Pressure Receptors eg, in Carotids & Aorta
- **Ef**: Blood Pressure Homeostasis

**NB**: Corrective Change $\Delta$ Opposes Original Input $I$

**Short-term vs long-term!**
I. Announcements AEC Notes? aec.uoregon.edu/peer-notetaking

II. Connections Q re: Homeostatic Model for BP? Active work!

III. Cell Anatomy, Physiology & Compartmentalization LS ch 2
   B. Basic survival skills ch 1 p 3
   C. Organelles ≡ Intracellular specialty shops w/membranes
      1. Endoplasmic Reticulum (ER) 2. Golgi 3. Lysosomes
      fig 2-1, 2-2, 2-3, 2-4, 2-5, 2-6, 2-7, 2-8 pp 20-7 tab 2-1 p 36
   D. What about vaults? LS 2006, p 32
   E. Physiol News Moms eggs execute Dad’s mitochondria?

IV. Anaerobic vs Aerobic Metabolism Overview Many sources!
    Mathews & Fox 1976... LS 2012 pp 26-33, fig 2-15 p 33

V. Introduction to Genetics LS 2012 ch 2 p 20-1 + Appendix C
   A. What’s a gene? Where? p A-18, fig C-2, C-3
   B. Why are genes important? p A-18
   C. What’s DNA & what does it look like? pp A-18 thru A-20
   D. How does information flow in the cell? fig C-6
   E. How does DNA differ from RNA? pp A-20 thru A-22
   G. How are proteins made? fig C-7, C-9

...Anatomy & Physiology Lab Thurs! Fun again!
How Big? 100 Cells Lengthwise = 1 mm!!

1. Cell Membrane

2. Nuclear Membrane

**Why Compartments? Advantage?**

*Incompatible* reactions can take place

**Simultaneously!!**
1 Sample Cartoon of 100 Trillion (100 x 10^{12}) Cells!

[Diagram of a cell with labeled organelles such as Mitochondria, Peroxisomes, Lysosomes, Golgi Complex, Endoplasmic Reticulum, Centrioles, Microtubules, Vesicles, Cell Membrane, Cytoplasm, Nuclear pore, Nucleus, Rough ER, Smooth ER, Ribosome (attached to rough ER), Free ribosome, Microfilaments, and Organelles in the Cytoplasm.

http://opb.pbslearningmedia.org/resource/tdc02.sci.life.cell.organelles/organelles-in-the-cytoplasm/]

fig 2-1 LS 2012
**Rough & Smooth Endoplasmic Reticulum (ER):**

Protein & Lipid Synthesizing Factories

Smooth ER:
1. packages new proteins in transport vesicles
2. stores calcium in muscles

fig 2-2 LS 2012
Instructions for building proteins leave the nucleus and enter the cytoplasm.

Proteins (colored strands) are assembled on ribosomes attached to the ER or free in the cytoplasm.

1. Rough ER

2. Transport vesicles

3. Golgi complex

4. Secretory vesicles

5. Secretion (exocytosis)

6. Lysosome

7. Fig 2-3 LS 2012
Exocytosis: Primary Means of Secretion
Lysosomes vs. Peroxisomes
Film: Neutrophil engulfing bacterium

http://devreotes.johnshopkins.edu/videos

L. Nilsson, Nat Geog 1986 10,000 x
Catalase Enzyme Reaction in Peroxisomes
Neutralize Toxin at Production Site!

2H₂O₂ → 2H₂O + O₂

Catalase
BI 121 Lecture 4

Anatomy & Physiology Lab today!...
Exam I next Thursday > 4th of July!!

I. **Announcements** Nutrition Analysis Lab next Thursday! Please record your diet on p 3-7 LM & complete analysis by tomorrow using [https://www.supertracker.usda.gov/](https://www.supertracker.usda.gov/) Q?

II. **Physiol News** Moms eggs execute Dad’s mitochondria?

III. **Cell Physiology, Mitochondria & Metabolism Connections**

   LS 2012 fig 2-9 thru 2-12, 2-15 +…Mathews & Fox 1976

IV. **Introduction to Genetics** LS ch 2 p 20-1 + Appendix C

   B. How does information flow in the cell? fig C-6
   C. How does DNA differ from RNA? pp A-20 thru A-22
   E. How & where are proteins made? fig C-7, C-9
   F. Class skit: Making proteins @ ribosomes!

V. **Nutrition Primer** DC Module 2, Sizer & Whitney(S&W) Sci Lib

   A. Essential Nutrients: H₂O, ¹⁰ Carbohydrates, ²⁰ Fats, ³⁰ Proteins, Vitamins, Minerals; Macro- vs Micro-?
   B. Dietary Guidelines: USDA, AICR, Eat Like the Rainbow!
Mom’s eggs execute Dad’s mitochondria

In “Hamlet,” Rosencrantz and Guildenstern deliver a letter to the rulers of England that carries the ill-fated duo’s own death sentence. Perhaps Shakespeare knew a bit about reproductive biology.

Scientists have now found that during a sperm’s creation, its mitochondria—energy-producing units that power all cells—acquire molecular tags that mark them for destruction once the sperm fertilizes an egg. This death sentence, a protein called ubiquitin, may explain why mammals inherit the DNA within mitochondria only from their mothers, a biotypes mitochondrial inheritance. Sperm mitochondria sometimes avoid destruction when two different species of mice mate, and Schatten’s team has shown this also holds true in cattle. It’s hard to understand how an egg distinguishes between paternal mitochondria of closely related species, says Schon.

When paternal mitochondria escape destruction in normal mating, the resulting embryo may suffer. Schatten notes that a colleague has found sperm mitochondria in some defective embryos from infertility clinics.

Inside a fertilized egg, with its two sets of chromosomes (blue), the protein ubiquitin (red) tags sperm mitochondria (yellow).

AEROBIC w/O$_2$ = MITOCHONDRION

ANAEROBIC without O$_2$ = CYTOSOL
1. Immediate/ATP-PC
2. Glycolysis
ATP Supplied

Performance Time

Power Output

ATP - PC/
Immediate

15 - 30 s

Glycolysis

1.5 – 3 m

Anaerobic

Cytosol

Mitochondria

Oxygen System

≥ 3 – 5 m

Anaerobic

Aerobic

Modified after Mathews & Fox
Cleave One High Energy Phosphate Bond To Do Work!!

7 – 10 KiloCalories/KCal

1. Synthesis of Macromolecules
   Make big things from little things!

2. Membrane Transport
   Move things! Microscopic!

3. Mechanical Work
   Move things! Macroscopic!
Anaerobic vs. Aerobic Metabolism

**Anaerobic Glycolysis**
"sugar dissolving" without \( \text{O}_2 \). Net of 2 ATP per molecule of glucose

**Aerobic Metabolism**
+ mitochondrial processing of glucose with \( \text{O}_2 \). Net of 32 ATP per molecule of glucose
<table>
<thead>
<tr>
<th>PRIMARY FUEL</th>
<th>ACTIVITY</th>
<th>% AEROBIC (Oxidative Energy System)</th>
<th>% ANAEROBIC (Immediate &amp; Non-Oxidative Energy Systems)</th>
<th>TIME (Min:Sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAT, CARBOHYDRATE &amp; PROTEIN</td>
<td>Marathon</td>
<td>100</td>
<td>0</td>
<td>135:00</td>
</tr>
<tr>
<td>CARBOHYDRATE</td>
<td>Cross-Country Sking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CARBOHYDRATE (Glucose &amp; Glycogen)</td>
<td>10-K Run</td>
<td>90</td>
<td>10</td>
<td>29:00</td>
</tr>
<tr>
<td></td>
<td>3-Mile Run</td>
<td>80</td>
<td>20</td>
<td>14:00</td>
</tr>
<tr>
<td></td>
<td>2-Mile Run</td>
<td>70</td>
<td>30</td>
<td>9:00</td>
</tr>
<tr>
<td></td>
<td>800-Meter Swim</td>
<td>60</td>
<td>40</td>
<td>3:45</td>
</tr>
<tr>
<td></td>
<td>1-Mile Run</td>
<td>50</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Boxing</td>
<td>40</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Circuit Weight Training</td>
<td>30</td>
<td>70</td>
<td>1:30</td>
</tr>
<tr>
<td></td>
<td>Soccer</td>
<td>20</td>
<td>80</td>
<td>0:50</td>
</tr>
<tr>
<td></td>
<td>Lacrosse</td>
<td>10</td>
<td>90</td>
<td>0:20</td>
</tr>
<tr>
<td></td>
<td>Tennis</td>
<td></td>
<td></td>
<td>0:10</td>
</tr>
<tr>
<td>Cytosol</td>
<td>Glycolysis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitochondria</td>
<td>Immediate/ATP-PC</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Stages of Cellular Metabolism/Respiration

**Anaerobic**
- **Glycolysis**
  - Cytosol

**Aerobic**
- **Metabolism**
  - Mitochondria
  - Matrix
  - Inner Membrane

1. **Glycolysis**
   - Cytosol
   - Glucose and other fuel molecules
   - Pyruvate
   - 2 ATP

2. **Pyruvate to acetate**
   - Acetyl-CoA
   - Electrons carried by NADH and FADH₂
   - Citric acid cycle
   - 2 ATP

3. **Oxidative phosphorylation**
   - (electron transport system and chemiosmosis)
   - 28 ATP
Goals of Aerobic Metabolism

AEROBIC w/O₂ = MITOCHONDRION

CITRIC ACID CYCLE

harvest electrons e⁻ e⁻ e⁻ e⁻ e⁻ e⁻

“cash in”

ELECTRON TRANSPORT CHAIN

for ATP Energy!!
What does DNA look like? Double-helix!!
Gene = *Stretch of DNA that codes for a protein*

cf: LS fig C-3
What does DNA do, day-to-day?

- **DNA**
  - Replication
  - Transcription

- **RNA**
  - Translation
  - @ ribosomes

- **Protein**
  - Cytoplasm
  - Nucleus

*cf: LS fig C-6*
DNA vs RNA?

1. Double-stranded
2. Deoxyribose (without oxygen)
3. A, T, C, G
   Thymine
4. Self-replicative (can copy itself)
5. Nucleus (+mitochondria)

1. Single-stranded
2. Ribose (with oxygen)
3. A, U, C, G
   Uracil
4. Needs DNA as template
5. 1\(^0\) Cytoplasm (but Nucleus origin)
6. mRNA, rRNA, tRNA
**Triplets of bases code for amino acids, the building blocks of proteins**

<table>
<thead>
<tr>
<th>DNA code word</th>
<th>mRNA codon</th>
<th>tRNA anti-codon</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAT</td>
<td>AUA</td>
<td>UAU</td>
</tr>
<tr>
<td>ACG</td>
<td>UGC</td>
<td>ACG</td>
</tr>
<tr>
<td>TTT</td>
<td>AAA</td>
<td>UUU</td>
</tr>
<tr>
<td>TAC</td>
<td>AUG</td>
<td>UAC</td>
</tr>
</tbody>
</table>
Translation? Ribosomes Make Proteins

LS 2012 fig C-7
I. Announcements  

II. Nutritional Physiology in the News  

III. Nutrition Primer  
DC Module 2, Sizer & Whitney (S&W) Sci Lib
A. Dietary Guidelines: USDA, AICR, Eat Like the Rainbow!
B. Best path to weight loss? Diet or exercise or both? Dietary composition & endurance? Fasting? Zuti & Golding 1976; Sacks AHA NPAM 2009; AMDR?
C. Nutrition Quackery, Balanced Approach Kleiner, Monaco+

IV. Digestion  
LS 2012 ch 15, pp 437-9, DC Module 3 pp 17-23
A. Steps of digestion Dr. Evonuk + LS pp 437- 9; DC p 23
B. Hydrolysis + monomer to polymer: central linking themes! LS p 438, Fox 2009 +
C. What’s missing? LS fig 15-1 p 438
D. GI-Donut analogy + Control mechanisms. Dr. Brilla @ WWU
E. Gut secretions LS p 438, 440-1
F. Organ-by-organ review LS tab 15-1 pp 440-1 + DC fig 3-1
Pondering Paleo?

Evolutionary Biologist
Behavioral Ecologist
U Minnesota

http://www.nutritionaction.com/daily/how-to-diet/pondering-paleo/
The pathway linking diet, gut microbes and TMAO to a growing collection of disease states:

- Atherosclerosis
- Heart Failure
- Kidney Disease
- Atherosclerosis

Dietary Choline & L-Carnitine

Gut Flora

Hepatic FMOs

TMAO

Trimethyl Amine

With the right food choices, physical activity, and not smoking, we could prevent about ~90% of diabetes, 80% of heart disease & 70% of stroke!
Can Lifestyle Modifications Alter Blood Pressure, Cardiovascular & Kidney Disease Risk?

↓ 5-20 mm Hg
↓ 4-9 mm Hg
↓ 2-8 mm Hg

Do the DASH!

↓ 8-14 mm Hg
↓ 2-4 mm Hg

American Heart Association®
2017
5 times per wk? ≡ 106,600 calories/yr ≡ ± 30.5 lb fat/yr

Better choices!
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!

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

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

MyPlate launched June 2, 2011

ChooseMyPlate.gov
Diet & Health Guidelines for Cancer Prevention

1. Choose a diet rich in variety of plant-based foods.
2. Eat plenty of vegetables & fruits.
3. Maintain a healthy weight & be physically active.
4. Drink alcohol only in moderation, if at all.
5. Select foods low in fat & salt.

And always, remember...

Do not smoke or use tobacco in any form.

American Institute for Cancer Research (AICR)

NB: Each group 500 kcal deficit/day, 16 weeks
Dietary Composition & Physical Endurance

- eg, Atkins!
- ~ 1/3 endurance!

- High-fat diet
- Normal mixed diet
- High-carbohydrate diet

Maximum endurance time:
- 57 min
- 114 min
- 167 min
Negative Effects of Low Carbohydrate

1. ↑ fatigue/exhaustion central & peripheral!
2. ↓ glucose – brain + spinal cord, rbcs thrive upon.
3. ↓ variety which reduces intake of phytochemicals, vitamins, minerals & fiber.
4. ↑ risk of respiratory infections.

+ gall stones, ↓ thermoregulation...
To Help Lower Body Wt & %Fat
EXERCISE!! +Minimize These!!

FAT  9 Kcal/g
ETOH 7 Kcal/g
CARB 4 Kcal/g
PRO  4 Kcal/g

NB: Minimize not Eliminate! Moderation not Abstinence!!
60-day Fast???

Lost 60 lb!! Wow!!

Yet

\[
\begin{aligned}
&26 \text{ lb Water} \\
&20 \text{ lb Lean Body Mass} \\
&14 \text{ lb Fat}
\end{aligned}
\]

Fat < $\frac{1}{4}$ total wt loss!
Successful Dieting – National Weight Control Registry

- 5000 people, ≥ 30 lb weight loss, ≥ 5 yr
- High-carbohydrate (55-60%), low-fat (24%) diet with the rest (~16-21%) from protein
- Wholesome vs. high-sugar carbohydrates including fruits, vegetables, high-fiber foods
- Conscious of calories knowing that total calories count, no matter what diet type
- Eight of 10 ate breakfast daily which may help better manage calories during the day
- Self-monitor, weigh themselves ≥ 1x/wk & many still keep food dairies
- Much planned physical activity, 60-90 min/d, 10 walking + looked for other ways to be active

http://www.nwcr.ws/Research/published%20research.htm
UC Berkeley Wellness Engagement Calendar, September 2013
Which Diets are Best?

- Not Plant-based
- Lower Carbohydrate

- Plant-based
- Lower Fat

Not Peer-Reviewed = Trade Book → Opinion

Peer-Reviewed = Text Books → Research
Digestion Steps

1. Ingestion
2. Mechanical Digestion
3. Chemical Digestion
4. Peristalsis
5. Absorption
6. Storage
7. Defecation

Hydrolysis of Energy Nutrients

Hi gang!!
You need me for digestion!!

$H_2O + \text{Enzyme}$
BI 121 Lecture 6

I. **Announcements** Next session Q? ~½ review, then Exam I. Fun Lab 3 Nutrition after Exam I! Q?

II. **Nutrition News + Connections** Be a whiz at healthy grilling! **American Institute for Cancer Research, Grilling Quiz!** **Dietary Guidelines for Americans 2015-2020, Blue Zones?**

III. **Digestion Connections** LS ch 15, DC Module pp 17-23
A. Histology of the gut LS fig 15-2, 15-3 p 442-3
B. Stomach protein digestion + zymogens? LS fig 15-7, 15-9
C. Accessory organs: Pancreas & Liver + Recycling!
   LS pp 457-63
   [http://www.cdc.gov/ulcer](http://www.cdc.gov/ulcer) Beyond the Basics LS p 456
E. Summary of chemical digestion LS tab 15-5 p 466
F. Large intestine? LS fig 15-24 pp 472-4

Hey – I'll be ready because I book it!!
American Institute for Cancer Research (AICR) Healthy Grilling Quiz Summary

1. **Marinade, marinade, marinade**! By doing so, you can decrease carcinogens formed during grilling by ≤ 96%!

2. **Cover the grill with aluminum foil**, turn gas down or wait for low-burning embers, cook to the side.

3. **Best choices for grilling include vegetables and fruits** (no HCAs + enzymes to inactivate HCAs!), and lean meats (e.g., fish & skinless chicken ↓ PAHs).

4. **Flip meat every minute** to reduce charring & remove charred portions prior to eating.

5. **To limit cancer risk, eat no more than 3 oz grilled red meat in a day**! Cook small portions/kebabs.

AICR Newsletter, Summer 2006
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.
A healthy eating pattern includes:

- **Variety of vegetables** from all subgroups: dark green, red & orange, legumes, starchy & other
- **Fruits**, especially whole fruits
- **Grains**, at least half of which are whole grains
- **Fat-free or low-fat dairy**, including milk, yogurt, cheese &/or fortified soy beverages
- **Variety of protein foods** including seafood, lean meats & poultry, eggs, legumes & nuts, seeds & soy products
- **Oils** (healthy)

A healthy eating pattern limits:

- **Saturated fats** & **trans fats**, added **sugars** & **sodium**
- **Balance calories with physical activity** to manage weight.

The World’s Longest-Lived People!  

Blue Zones!

Lomo Linda, CALIFORNIA  
Sardinia, ITALY  
Okinawa, JAPAN  
Nicoya, COSTA RICA  
Ikaria, GREECE

M Poulain & Coworkers. Experimental Gerontology, Sep 2004
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/
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

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

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

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.
Polymer to Monomer (Many to One)

Carbohydrate

Glucose

Protein + Fat

Amino Acids

Fatty Acids + Glycerol

...Central-linking theme!!
GI-DONUT ANALOGY

GI LUMEN

BODY
# Gut Secretions

<table>
<thead>
<tr>
<th>Secretion</th>
<th>Release Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mucus</td>
<td>into GI Lumen</td>
</tr>
<tr>
<td>2. Enzymes</td>
<td>into GI Lumen</td>
</tr>
<tr>
<td>3. (\text{H}_2\text{O}), acids, bases+</td>
<td>into GI Lumen</td>
</tr>
<tr>
<td>4. Hormones</td>
<td>into Blood</td>
</tr>
</tbody>
</table>
1. **Mouth**
- Ingestion: entry way
- Salivary gland secretion
- Mucus + enzymes
- Enzymatic digestion: carbohydrate
- Mastication = chewing
- Deglutition = swallowing

2. **Esophagus**
- Rapid transit
- Peristalsis
- Secretion: mucus

3. **Stomach**
- Mixing
- Peristalsis
- Secretion: mucus + HCl
- + enzymes
- Enzymatic digestion: protein + butter fat!

4. **Liver - Gall Bladder**
- Emulsification = detergent action of bile + secretion

5. **Pancreas**
- Secretion: mucus + NaHCO₃ + enzymes
- Enzymatic digestion: carbohydrate, fat, protein

6. **Small Intestine**
- Absorption
- Secretion: mucus + enzymes
- Enzymatic digestion: carbohydrate, fat, protein
- Peristalsis

7. **Large Intestine**
- Dehydration
- Secretion + absorption
- Storage + peristalsis
Zymogen = an inactive precursor

![Diagram showing the activation of pepsinogen to pepsin and the digestion of protein into peptide fragments](LS 2012 fig 15-9 p 452)
Endocrine + Exocrine functions; Makes enzymes for digesting all 3 energy nutrients!
Ulcer Facts

• Most ulcers are caused by an infection, not spicy food, acid or stress.
• The most common ulcer symptom is burning pain in the stomach.
• Your doctor can test you for \textit{H. pylori} infection.
• Antibiotics are the new cure for ulcers.
• Eliminating \textit{H. pylori} infections with antibiotics means that your ulcer can be cured for good.
Large Intestine Structure & Function

- Transverse colon
- Haustra
- Descending colon
- Ascending colon
- Ileocecal valve
- Cecum
- Appendix
- Rectum
- Sigmoid colon
- Internal anal sphincter (smooth muscle)
- External anal sphincter (skeletal muscle)
- Anal canal

LS 2012 fig 15-24 p 472