Midterm Review Slides
BI 121 Lecture 1

I. Announcements: Please check & sign attendance roster. Not on list? See Pat during a break or after class. Lab 1 Histology tomorrow in 130 HUE: 12 n & 1 pm sections.

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?
Structure begets function!
Structure gives rise to function!
Structure & function are inseparable!
Preoperative Diagnoses: R Knee
Degenerative Joint Disease (DJD) = arthritis
Varus malalignment = bow-leg

Procedures:
Arthroscopy & microfracture
High Tibial Osteotomy (HTO)
Packing bone graft substitute

Blocks/Medications:
Femoral n. block
General anesthesia
IV Morphine, Oral Oxycontin + Oxycodone,
Tylenol, Injectable Lovenox (enoxaparin Na)

William Sterett, MD
Ben Hogan, PAC
Vail Summit Orthopedics
1. Arthroscopy clean-up
2. Debridement complete
3. Microfracture with awl
4. Punctuate bleeding
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
Organs are made up $\geq 2$ tissue types

**Organ:**
Body structure that integrates different tissues and carries out a specific function

- **Epithelial tissue:** protection, secretion, absorption
- **Connective tissue:** structural support
- **Muscle tissue:** movement
- **Nervous tissue:** communication, coordination, control

**LS fig 1-2 p 4**
Which body systems?
BI 121 Lecture 2

**I. Announcements** Lab today 12 n & 1 pm. Q last time?

**II. Connections** Extracellular fluid (ECF) & Homeostasis

A. ECF: Plasma vs. Interstitium?
B. Dr Evonuk Balances LS pp 5 - 15
C. *Physiology in the News* Are we like watermelons?
D. Simplified Model DO Norris *cf:* fig 1- 8 LS
E. Negative feedback? Positive feedback? LS pp 14 - 15
F. Balances & e.g. $\text{H}_2\text{O}$, $\text{T}^\circ\text{C}$, BP Dr Evonuk + LS pp 8 - 10

**III. Cell Anatomy, Physiology & Compartmentalization** ch 2 (LS)

B. Basic survival skills ch 1 p 3
C. Organelles ≡ Membranous, cytoplasmic specialty shops!
   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. *Physiol News* Moms eggs execute Dad’s mitochondria?
E. What about vaults? LS 2006, p 32 + *Science News*
Where is extracellular fluid?

As long as between/outside cells, ECF everywhere?

G&H 2011
ICF = Intracellular

ECF = Extracellular

Plasma
(within CV System)

Interstitium
(eg, between muscle cells)
Dr. Evonuk’s 6 Balances

Metabolic

ANALYTIC

CATABOLIC

H₂O

pH

Ion+/-

O₂/CO₂

ToC

Carbon Dioxide

Electricity

SALT

Bicarbonate and pH Balance

Captain Calcium
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!
**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
H₂O

**INPUT**
Dietary Drink: 1200 mL
Dietary Eat: 400 mL
Oxidation: 400 mL
Total = 2000 mL

**OUTPUT**
Urine: 1000 mL
Sweat + Insensible: 900 mL
Feces: 100 mL
Total = 2000 mL

**BALANCE!**


**ICF:** 35L
**ECF:** 14L
**Interstitium:** 11L
**Plasma:** 3L

70% H₂O = 49L

70 kg

H₂O

 바 İlkina: 1200 mL
Dietary Eat: 400 mL
Oxidation: 400 mL
Total = 2000 mL

OUTPUT
Urine: 1000 mL
Sweat + Insensible: 900 mL
Feces: 100 mL
Total = 2000 mL

**BALANCE!**
Controller = Hypothalamus with Set Point

True Diurnal Variation

- Protein Denaturation
- Mild Hypothermia
- Profound Hypothermia

Temperature Scale:
- 37°C (98.6°F) - Normal Body Temperature
- 35°C
- 33°C
- < 30°C - Hypothermia
- 29°C - Lethal
- 42°C - Lethal
- 110°F - Lethal

Time of Day:
- 0600 1400 0600 1400
Venous Pooling → Electrochemical Signal $I'$ → CV Control Center Brain Stem

Baroreceptors/Pressure Receptors eg, in Carotids & Aorta

Seated to Standing

NB: Corrective Change Opposes Original Input

$E$ → Electrochemical Signal eg, Symp Accel N

$E'$ → $E$

↑ BP

↑ HR

↑ VC

$CV$ Control Center
Cytoplasm = Cell - Nucleus

[Extract nucleus; includes organelles]

Cytosol = Cytoplasm - Organelles

[Extract organelles; complex gel-liquid]
BI 121 Lecture 3  Anatomy & Physiology Lab tomorrow!

I. Announcements  Q from lecture or lab?

II. Cell Physiology Connections  LS ch 2
   A. Compartment advantage + Cell survival skills!
   B. Organelles ≡ ICF specialty shops: 1. ER– rough & smooth
      pp 20-34, fig 2-1 thru 2-8, pp 20-7, tab 2-1 p 36
   C. Physiol News  Moms eggs execute Dad’s mitochondria?

III. Anaerobic vs Aerobic Metabolism Summary  LS ch 2 pp 26-33
    A. Key differences fig 2-15 + vpl
    B. Selected details: Glycolysis, CAC, ETC, fig 2-9 thru 2-12

IV. 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
**Why Compartments? Advantage?**

*Incompatible* reactions can take place *Simultaneously*!!

...gobble! gobble!

- Lysosome
- DNA
- Nucleus
Basic Cell Survival Skills?
1. Get food
2. Use food
3. Rid wastes
4. Move
5. Reproduce

How to live?

Nucleus or nose?
1 e.g. Cell of 100 Trillion!
Rough & Smooth Endoplasmic Reticulum (ER): Protein & Lipid Synthesizing Factories

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

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

fig 2-2 LS 2012
Secretion of Proteins Produced by ER
Lysosomes vs. Peroxisomes
Catalase Enzyme Reaction in Peroxisomes
Neutralize Toxin at Production Site!

2H₂O₂ → 2H₂O + O₂
Mitochondria: Energy Organelles
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 species 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.

AEROBIC = MITOCHONDRION

w/O₂

ANAEROBIC = CYTOSOL

without O₂

1. Immediate/ATP-PC
2. Glycolysis
BI 121 Lecture 4

I. **Announcements** Nutrition Analysis Lab next Tuesday!

II. **Anaerobic & Aerobic Metabolism Connections** LS ch 2 +

III. **Introduction to Genetics** LS 2012 ch 2 p 20-1 + Appendix C
   A. What’s a gene? Where located? Why important?
      p A-18, fig C-2, C-3
   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!

IV. **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!
   C. Diet or exercise? Diet composition & endurance? Fasting?
      Zuti & Golding 1976; Sacks [AHA NPAM Council](https://www.ahacouncil.org) 2009;
      AMDR? Adjusted Macronutrient Distribution Range!
   D. Nutrition Quackery, Balanced Approach Kleiner, Monaco+
4 oz → 3 oz

Deck of Cards

≡ 1 c

4 oz → 3 oz

raw → cooked

≡ 1/3 c

≡ 1 c

≡ 1 oz

≡ 1.5 oz

≡ 1/4 c

≡ 1.5 oz
% ATP Supplied

ATP-PC/Immediate
15 - 30 s

Glycolysis
1.5 - 3 m

Oxygen System
≥ 3 - 5 m

Mitochondria

Cytosol

Anaerobic

Aerobic

Performance Time

Power Output

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! Move things! Macroscopic!

3. Mechanical Work

Adenosine

\( \text{P}_i \)
Anaerobic vs. Aerobic Metabolism

**Anaerobic Glycolysis**
"sugar dissolving" without O$_2$. Net of 2 ATP per molecule of glucose

**Aerobic Metabolism**
+mitochondrial processing of glucose with O$_2$. Net of 32 ATP per molecule of glucose
AEROBIC w/O₂

ANAEROBIC Immediate/ATP-PC

MITOCHONDRIA

CYTOSOL

Glycolysis

Immediate/ATP-PC
Stages of Cellular Metabolism/Respiration

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

**Aerobic Metabolism Mitochondria**
- Pyruvate to acetate
- Acetyl-CoA
- Electrons carried by NADH and FADH$_2$
- Citric acid cycle
- 2 ATP
- Oxidative phosphorylation (electron transport system and chemiosmosis)
- 28 ATP

**fig 2-9 LS 2012**
Goals of Aerobic Metabolism

AEROBIC = MITOCHONDRION

w/O₂

CITRIC ACID CYCLE

harvest electrons

“cash in”

ELECTRON TRANSPORT CHAIN

for ATP Energy!!
I. Announcements
Lab 3 tomorrow Nutritional Analyses.

II. Nutritional Physiology in the News
UCB Wellness Letter, June 2011, Salt–beyond hypertension

III. 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!
C. Diet or exercise? Diet composition & endurance? Fasting?
   Zuti & Golding 1976; Sacks AHA NPAM Council 2009;
   AMDR? Adjusted Macronutrient Distribution Range!
D. 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: the central linking theme! LS p 438, Fox 2009
C. What’s missing? LS fig 15-1 p 438
D. GI-Donut analogy? Dr. Lorraine Brilla WWU
F. Organ-by-organ review LS tab 15-1 pp 440-1 + DC fig 3-1
More Reasons to Shake the Salt Habit

Stop me!

① ↓blood vessel vasodilation w/in 30 min by ingesting 1500 mg Na+!
② ↑Ca²⁺ excretion ↑bone loss, risk of osteoporosis & fractures.
③ May directly impair kidney function & ↑risk of kidney stones.
④ GI cancer risk, inflammation?

UCB Wellness Letter Jun 2011 p 5
Macronutrients & Micronutrients
Essential for Life

**Macronutrients**

- H₂O/Water
- ¹⁰ Carbohydrates
- ²⁰ Fats/Triglycerides/Lipids
- ³⁰ Proteins

**Sample Food Sources**

- Water, other drinks, fruits & vegetables
- Grains, vegetables, fruits, dairy products
- Meats, full-fat dairy products, oils
- Meats, legumes, dairy vegetables

**Micronutrients**

- Vitamins (A, D, E, K; C + B)
- Minerals (K⁺, Na⁺, Ca²⁺, Mg²⁺, Fe²⁺, Zn²⁺,...)

**NB:** Need only minute quantities!

- Vegetables, vegetable oils, fruits, citrus, grains, dairy
- Fruits, vegetables, grains, nuts, dairy, meats, processed foods

**Energy nutrients = yield ATP**
Regular Physical Activity: Exercise! Exercise!!

- Use sparingly: Fats, oils, and sweets
- 3 or more servings: Milk, yogurt, and cheese
- 5 or more servings: Vegetable group
- 2–3 servings: Meat, poultry, fish, dry beans, eggs, and nuts group
- 2–4 servings: Fruit group
- 6–11 servings: Bread, rice, pasta group
- ½ whole grain

KEY
- Fat (naturally occurring and added)
- Sugars (added)

“good” fats!

saturated & trans fats!
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!

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

Dietary Composition examples:
- High-fat diet: ~1/3 endurance
- Normal mixed diet: 114 min
- High-carbohydrate diet: 167 min

eg, Atkins!
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...
We’re better at storing fat vs carbohydrate!

Dietary Fat

3 % Kcal

Body Fat

23 % Kcal

Dietary Carbohydrate
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

26 lb Water
20 lb Lean Body Mass
14 lb Fat

Fat < ¼ total wt loss!
**Dr. Sacks’ Conclusions:**

We conclude that healthful diets with varying emphases on carbohydrate, fat & protein levels can all achieve clinically meaningful weight loss & maintenance of weight loss over a 2-yr period. The results give people who need to lose weight the flexibility to choose a diet that they can stick with, as long as it’s heart healthy. Such diets can also be tailored for individuals based on their personal & cultural preferences & in this regard may have the best chance for long-term success.
### US Dietary Recommended Intakes (DRI) Committee Acceptable Macronutrient Distribution Ranges (AMDR)

<table>
<thead>
<tr>
<th>Energy Nutrient</th>
<th>% Total Calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrate</td>
<td>45-65%</td>
</tr>
<tr>
<td>Fat</td>
<td>20-35%</td>
</tr>
<tr>
<td>Protein</td>
<td>10-35%</td>
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</tbody>
</table>
Kleiner's & Monaco's Top 10 Hit List for Nutrition Quackery

1. Treatment based on unproven theory calling for non-toxic, painless therapy.

2. Author's/purveyor's credentials aren't recognized in scientific community.

3. No reports in scientific, peer-reviewed literature but rather mass media used for marketing.

4. Purveyors claim medical establishment is against them & play on public's paranoia about phantom greed of medical establishment.

5. Treatments, potions, drugs manufactured according to secret formula.

6. Excessive claims promising miraculous cures, disease prevention or life extension.

7. Emotional images rather than facts used to support claims.

8. Treatments require special nutritional support including health food products, vitamins and/or minerals.

9. Clients are cautioned about discussing program to avoid negative.

10. Programs based on drugs or treatments not labeled for such use.
LOWER CARBOHYDRATE

ELIMINATE CALORIES
or FOOD GROUPS
ENCOURAGE FASTING

LOWER FAT

ADEQUACY
BALANCE
CONSISTENCY
& MODERATION

AHA + DASH + MAYO CLINIC

PEER-REVIEWED = TEXTS → RESEARCH

NOT PEER-REVIEWED = TRADE BOOKS

TRADE BOOKS

PEER-REVIEWED = TEXTS → 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!!

H₂O + Enzyme

The ENZYME data bank
Polymer to Monomer
(Many to One)

Carbohydrate → Glucose

Protein + Fat → Amino Acids

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 + NaHCO$_3$ + 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
Common Control Mechanisms

1. Local (autoregulation)
2. Nervous (rapidly-acting)
3. Hormonal (slower-acting/reinforcing)
BI 121 Lecture 6 + Q + ½ Midterm Review

I. **Announcements** Next session Q? ~½ review, then Midterm. Fun Lab 3 Nutrition today! Sample Suisse Calculation? Q?

II. **Nutrition in the News** Be a whiz at healthy grilling! American Institute for Cancer Research, Grilling Quiz!

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 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

IV. **Midterm Review** Discussion + Q?
How Do I Calculate the % of Total Calories from Carbohydrate, Fat & Protein?

Carbohydrate  
46 g x 4 kcal/g = 184 kcal  
% Carbohydrate = 184/567 = 0.326 ≡ ~33%

Fat  
39 g x 9 kcal/g = 351 kcal  
% Fat = 351/567 = 0.619 ≡ ~ 62%

Protein  
8 g x 4 kcal/g = 32 kcal  
% Protein = 32/567 = 0.056 ≡ ~ 6%

∑ = 567 kcal
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.** Cook small portions/kebabs.

AICR Newsletter, Summer 2006
Zymogen = an inactive precursor

LS 2012 fig 15-9 p 452
Endocrine + Exocrine functions; Makes enzymes for digesting all 3 energy nutrients!
http://www.cdc.gov/ulcer/
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 *H. pylori* infection.
• Antibiotics are the new cure for ulcers.
• Eliminating *H. pylori* infections with antibiotics means that your ulcer can be cured for good.
Large Intestine Structure & Function

Ascending colon
Ileocelecal valve
Cecum
Appendix
Rectum
Internal anal sphincter (smooth muscle)
External anal sphincter (skeletal muscle)
Anal canal

Descending colon
Haustra
Transverse colon
Sigmoid colon
Lab 3: Nutritional Analyses via 2 Programs

ChooseMyPlate.gov

Diet Analysis+

https://www.supertracker.usda.gov/