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Human Biology

Digestive System and Nutrition
Discussion Questions

1. What is the major role of the large intestine? What nutrients are absorbed there?

The major role of the large intestine is to absorb water (as well as some salts). After nutrients are absorbed from chyme in the small intestine, the remaining food-fluid muck is waste but the water remains important to maintaining homeostasis within the body. Interestingly, the large intestine does not absorb "leftover" nutrients that the small intestine may have missed. In fact, it does not absorb nutrients from our food at all; rather, the large intestine absorbs vitamins K and B produced by bacteria that dwell within. It is strange to think that vitamins our body needs--K for clotting blood and B for coenzymes that serve many functions--do not come from food we eat or even supplements we take but are actually produced by the flora in our digestive system!

2. What are the major functions of the small intestine? After blood flows into the capillaries of the small intestine, what organ is the next in line after blood leaves the small intestine? Why is this set up this way?

The small intestine completes the process of digestion and is also responsible for absorption of nutrients into the bloodstream. Enzymes within the small intestine finish digesting by further breaking down chyme from the stomach to ensure that nutrient molecules are small enough to pass into the blood and lymphatic capillaries. Amylase from the pancreas works to break down carbohydrates while pancreatic trypsin works with intestinal enzymes to break protein down into amino acids. The process of digesting fat is a bit more complicated because bile from the gallbladder and liver must first emulsify fat, then lipase hydrolyzes the fat, which forms both fatty acids and monoglycerides. Digestion is completed by brush border enzymes along the microvilli lining the extensive surface area of the small intestine. Although this may seem like a minor detail at the end of the digestive process, the discomfort experienced by people with lactose intolerance--who lack the brush border enzyme lactase--shows how much of an impact a single type of enzyme can have in the complex process of digesting food! Once food has been broken down into its component nutrients, sugars and amino acids enter the bloodstream via capillaries in the villus. Monoglycerides and fatty acids form lipoproteins called chylomicrons which enter the lymphatic vessels through lacteal and eventually make their way back into the bloodstream.

One of my favorite parts about learning about the human biology is discovering in detail all the safeguards built into the body. The preceding paragraph seems to outline a nice thorough end to digestion but our body takes the extra step of filtering our nutrient-rich blood in the liver. The liver serves a surprisingly large number of important functions, from cleaning out the toxins in our blood to storing vitamins and iron, to storing glycogen to help maintain homeostasis in blood glucose levels. In addition, the liver also makes plasma proteins from amino acids and regulates blood cholesterol

levels by converting some cholesterol into bile salts and using additional cholesterol, water, and bicarbonate to form bile that will help break down fats during digestion.

Although I'm sure all of the liver's jobs are extremely important, the cleaning and storing functions stand out to me when considering the digestion process more broadly. As our bodies work to turn food down into accessible nutrients that we need, we hear the terms "break down" and "absorb" and "synthesize" repeatedly but the term "filter" does not come up until fairly late in the process. Just considering the crud so many Americans eat makes it clear that a digestive filter is a biological necessity! The storage function of the liver is really critical as well. Since humans don't eat continuously, we need quick acting mechanisms that allow us to store essential nutrients. Any parent who has reluctantly said, "what matters is what s/he eats over the course of a few days, not that s/he skipped veggies for two days"--and I include myself in that group--should thank the liver for hanging on to vitamins to buy our picky eaters time to get more of what they need!

3. The liver is the organ that does most of the 'metabolizing' in the body. What does the term 'metabolism' mean? Waste products of metabolism can be water soluble or oily. The kidneys get rid of the water soluble waste products. How does the liver get rid of the oily type of waste products?

Metabolism refers to the chemical reactions that occur in cells. The liver is considered an important metabolic organ because it facilitates chemical reactions that are necessary for fats, carbohydrates, and proteins to serve their varied functions within the body. It's interesting to note that the liver metabolizes both to build things up (i.e., create plasma proteins) and to break things down (i.e., hemoglobin), so it really serves many different metabolic functions.

More commonly, people understand metabolism to mean the "basal metabolic rate," which refers to how much energy the body needs to function at rest. I have been interested in this since first encountering the term metabolism at the start of our course because I was curious about how the millions of chemical reactions in our body actually relate to our notion of having a "good" versus a "slow" metabolism. Although I am growing in my understanding of the metabolic processes that are required for life, I am a bit stuck on how technical "basal metabolic rate" really is. As someone who eats heartily but is fairly trim, I always assumed I have a "good metabolism." But what exactly does that mean? Do chemical reactions actually happen faster in my body than in the body of someone with a slower metabolism? I've read that genetics and body composition can influence BMR but I don't understand whether, at its core, BMR simply means zippier chemical reactions (or perhaps more of them). Does a faster metabolism possibly relate to the number or effectiveness of enzymes and coenzymes one possesses? And I won't even get started on how all of this makes one prone to be either a high or low energy person because I would love to know if that is just a squishy pseudo-scientific term or whether seemingly energetic people actually produce more ATP . . .

But back to the liver: I am not highly confident in my answer but I think that the liver uses oily wastes to create bile, which not only breaks down fats in the digestive process but is also is also returned the the large intestine where excess bile is excreted in the form of feces.

4. What is a vitamin? Why are they 'vital', meaning required to continue staying alive? What is the difference between a vitamin and a dietary supplement? How might you decide if a certain supplement might be useful to you?

Vitamins are organic compounds that assist in the body's metabolic functions. They cannot be produced by our body in sufficient quantities, so vitamins must be consumed through food. Vitamins are often parts of coenzymes, which facilitate chemical reactions in the body (a question I have here is: why do we need to resupply vitamins daily when coenzymes get reused (or are we really just re-supplying them for their other metabolic functions?) Although we need vitamins in fairly small amounts, they are still a vital element of our body's chemical processes.

As a health teacher, I appreciate the term "dietary supplement" because it emphasizes the enhancing function of vitamin and minerals we take in pill form, rather than implying that we can replace nutritious food simply by popping a pill. My sense from working with kids--although I think many adults believe this, too--is that people believe a supplement can take the place of eating fruits and vegetables. "If I have my gummy in the morning," kids seem to reason, "then who cares that I hate veggies?" However, by isolating particular vitamins and minerals, synthetic vitamins lose some of the other benefits conveyed by foods such as fiber, antioxidants, or carotenoids. There also seems to be some evidence that vitamins are more effective and potent in concert with the other attributes of whole foods, which are lost when they are taken as supplements (health.harvard.edu/staying-healthy/Should-you-get-your-Nutrients-from-food-or-from-supplements).

I personally do not take a multi-vitamin, although I give them to my children. I eat a balanced, nutritious diet loaded with veggies, fruit, and whole grains, so I am comfortable with my regular vitamin intake through food. By skipping a multi-vite, I find I hold myself more accountable for what I eat--this is super nerdy but I really do think about MyPlate every day and try to build meals to meet my family's nutrient needs! I do, however, take a vitamin D and an iron supplement each day because in blood work over the years, I have been found deficient in both. It is actually pretty stunning to see the difference in my energy if I forget to take D and iron for a week or two! I don't know too many kids (or adults) who truly follow the MyPlate recommendations every day, so I think multivitamins are a good idea for children and grown ups who don't eat very well. For adults who are committed to eating a varied, nutritious diet, however, I think it's wise to discuss the results of blood work with one's physician to identify any deficiencies, then add dietary supplements as needed. This has the added benefit of ensuring that a deficiency is addressed more thoroughly instead of relying on the "catch all" of a multi-vite (for example, a multivitamin alone would not supply me within enough iron to make up my chronic deficit)

4. What is the definition of a calorie? Thinking in terms of energy, when a certain amount of food equals so-and-so calories, what does this mean? For the same amount of food, how many calories can one get from fat, carbohydrates, and protein? If one regularly takes in more calories than one burns in daily activity, can one still lose weight?

I'm responding to this topic because I think it's important but I honestly don't understand it well and, as a health teacher, I think I should! I know that calories serve as a measure of the energy we get from our food. The definition that pops up first in online searches relates to the amount of heat required to raise 1 gram of water one degree Celsius but I can't figure out if that has any connection to the nutritional definition of calories or not.

More broadly, what trips me up with the notion of calories as a measure of energy is how we are defining energy. Does this strictly mean the amount of ATP molecules potentially created by digesting certain foods or is there a different definition of "energy" at play? If there is a broader meaning to caloric energy, what is it? And if calories really are all about the chemical process of ATP breaking down to release energy, why is that not made more clear? Also, given the important role all essential nutrients play in our bodies, why have calories gained such prominence as a quantitative measure to guide how much food we consume? Why do we focus so much on a vague notion of energy rather than considering the number of carbohydrates, proteins, etc. that our bodies need for proper function? Is this just a case of human laziness--that we latch on to calories because they are a quick and easy thing to remember and really analyzing an entire food label seems too complex? Or perhaps calories as a concept is more important than I think but, again, I am stuck on how precise we are being about the meaning of energy. Also, if a person were to consume the correct quantity of essential nutrients for their body's optimal function, would that not include the right amount of "energy?"

What is a bit easier to understand is that a gram of fat in food contains 9 calories, while a gram of protein or carbohydrates contains 4 calories. Although our bodies do not necessarily use and store all foods in the same way, we cannot lose weight if we consume more calories than we burn. After all, if we are not using the extra energy that I find so confusing, it will remain in our bodies in some form. Unfortunately, it seems too easy to latch on to calorie counting and miss the bigger picture of what our body needs nutritionally. Most of my upper elementary age students assume that calories are bad, which is obviously not the case, but I would rather have them focus on meeting their various nutrient needs than simply counting energy in hopes of maintaining or losing weight!