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Nachos are great...if you are among the lucky ones whose bodies can digest them. When digestion goes according to plan, the small intestine performs most of your chemical digestion in the duodenum, while accessory organs including the liver, gallbladder, and pancreas contribute enzymes that all but finish the job. Then your large intestine, which is actually shorter than the small intestine, tries to extract the last bit of nutrition, including the occasional attempt to turn nachos into energy, which for most humans, ends in gassy failure. Pssst... we made flashcards to help you review the content in this episode! Find them on the free Crash Course App! Download it here for Apple Devices: Download it here for Android Devices: Chapters: Introduction: Lactose Intolerance 00:00 The Small Intestine 1:41 Parts of the Small Intestine: Duodenum, Jejunum, Ileum 2:53 The Duodenum 3:16 The Liver 4:17 The Gallbladder 5:14 The Pancreas 5:35 The Large Intestine 6:37 Why Nachos Might Make You Gassy 7:46 How Do We Poop? 8:13 Review 9:10 Credits 9:48 *** Crash Course is on Patreon! You can support us directly by signing up at Thanks to the following Patrons for their generous monthly contributions that help keep Crash Course free for everyone forever: Mark , Elliot Beter, Moritz Schmidt, Jeffrey Thompson, Ian Dundore, Jacob Ash, Jessica Wode, Today I Found Out, Christy Huddleston, James Craver, Chris Peters, SR Foxley, Steve Marshall, Simun Niclasen, Eric Kitchen, Robert Kunz, Avi Yashchin, Jason A Saslow, Jan Schmid, Daniel Baulig, Christian , Anna-Ester Volozh -- Want to find Crash Course elsewhere on the internet? Facebook - Twitter - Tumblr - Support Crash Course on Patreon: CC Kids: You know, we've been talking about a lot of serious stuff here lately. Heart failure, respiratory gas exchange, people with holes in their stomachs, nachos. Some might even say that I've been flaunting my ability to eat, digest, and enjoy a plate of chips and melted cheese. And I wouldn't blame them if they did, because sadly nachos aren't for everyone. In fact, I can safely say that nachos are really only a good idea for about a third of humans. For the rest, what may start as a party in your mouth will surely end in gastric distress. Such is the fate of the lactose intolerant. Lactose is basically milk sugar that can only be digested with the help of a special intestinal enzyme, lactase, which many adults do not produce enough of. In fact, way back in the day, none of us did, until about 7500 years ago when a particularly handy genetic mutation popped up in central Europe. This, so called lactase persistence trait, probably spread as Neolithic groups trekked north and west through Europe. Today nearly 90% of adult Britons and Scandinavians can chug all the milk they want, where as down toward the Mediterranean probably less than 40% have lactase persistence, and fewer than 10% in Africa and Asia. Now, technically, a lactose intolerant person can still consume dairy at their own risk, but since their own bodies can't break down lactose, the job is left to the three pound bacteria farm living in their large intestines. Bacteria that try their hardest to make something of those milk sugars; the results of which are gas, and bloating, and diarrhea. So it turns out, nachos aren't just a good way to talk about how the digestive system works, they're also a good way to talk about what happens when it doesn't.[Intro]Remember how the stomach is great at obliterating matter, but not so hot when it comes to actually chemically digesting stuff, or really absorbing much of anything? You might say that the stomach lacks subtly. But luckily, it's got friends in low places and the small intestine is more than happy to pick up the slack and provide a cozy environment where your food is at long last, disassembled and absorbed by your cells.Now, there's a lot of mechanical action and peristalsis going on here, but there's also a ton of chemical digesting, too. And while home brewed intestinal juices help digest the chyme your stomach turns food into, the real power actually comes from the outside helpers-the liver, gall bladder and pancreas. Now, the small intestine is called small, not because it's short, but because it's about half the diameter of the large intestine. The thing is actually like 6 or 7 meters long. Not only that, but the whole thing is lined with epithelial tissue that has more folds than an origami octopus. These folds are lined with tiny, hair-like villi, and even tinier, microvilli, that create a truly impressive surface area; large enough that if it were unfolded it would cover a tennis court.It's this massive surface area and the countless capillaries just beneath it, that make the small intestine such a champion absorber of nutrients. It shares the same four tissue layers seen throughout the GI tract, and it has three main subdivisions. Straight out of the stomach and snuggled around the pancreas, you've got the relatively short, and mostly immovable, duodenum, which is where most of the chemical digestion occurs. The middle section is the jejunum. where most of the absorption takes place. And finally, at the end, running into the large intestine, is the ileum, where important vitamins, like A, B12, E, D and K, are absorbed. But the duodenum is what you might call the business end of the small intestine. It receives chyme and gastric juices from the stomach through the pyloric sphincter, but it also imports bile from the liver and gall bladder, enzymes from the pancreas, and it creates its own home grown mix of enzymes. Some of the imported enzymes eventually pass through your system on the wave of gooey chyme, but other enzymes are actually bound to cell membranes in the intestinal mucosal layer, and they're reusable. Enzymes are proteins, and proteins are expensive, so these compounds, known as brush border enzymes, can just sit around and process food as it passes by without your body having to make new ones. And the lactase that so many of us don't have is one of these.Now, the duodenum communicates with the stomach in the last phase of gastric regulation, which we talked about in the last episode, the intestinal phase. This is where the duodenum lets the stomach know with hormones and nerves signals when, and how much, chyme to release so it doesn't get overwhelmed all at once. It's also where stuff, like bicarbonate from the pancreas, gets dumped to help neutralize the stomach acid so it doesn't burn a hole in your guts.And this brings me to your crucial accessory organs, the things apart from the alimentary canal that never come into contact with ingested material, but still play an essential role in digestion. And first up, the liver.The liver is a massive, fatty, four-lobed, and very important organ and lives directly under your diaphragm. And fun fact--it can fully regenerate itself after an injury or surgery with as little as 25% of its original tissue. The liver serves tons of critical metabolic and regulatory roles that we don't have time to get in to right now, but its main role in the digestive system is to make bile. Bile is the missing ingredient your body needs to attack fatty foods, which is a tricky business. In part, that's because fat isn't water soluble, and since your insides are mostly water, fats will clump together becoming hard to digest. To keep fat from clumping, you need an emulsifier. So bile comes in to keep big hydrophobic fat molecules from sticking together, which allows lipid hungry enzymes to move in break them down into fatty acids and monoglycerides that you can then digest and absorb.While your liver creates the bile, it gets stored and concentrated in the neighboring gallbladder, a thin, green sac cozied up to the liver. It gets the signal when chyme slides into the duodenum, which activates the enteroendocrine cells to release a pair of hormones. Those hormones in turn tell the gall bladder to contract and squirt bile through the cystic and bile ducts into the duodenum. Another crucial accessory organ is the pancreas, a gland that looks like a fist full of cottage cheese stuffed in a plastic bag. The pancreas also does lots of important things for your body, especially related to your endocrine system. But for our purposes today, just know that it brews up a powerful enzyme cocktail that is also triggered by those same two hormones. The pancreatic juice is kind of like the Neapolitan ice cream of bodily secretions. It's like everybody's favorite ingredients all put together, and when you mix them, the result is especially powerful. You've got trypsin and peptidase, which break proteins down into amino acids, and you have lipases that turn triglycerides into fatty acids and glycerol. Amylase, meanwhile, reduces carbs to fructose and sucrose, and nuclease busts the nucleic acids that are in DNA and RNA into nucleotides. Once all those macro-molecules have been disassembled into their monomers, the small intestine's epithelial cells can finally absorb and transport them through your capillaries and into the blood stream, where they can travel, pretty much, to any cell in your body, and be used to build collagen or store fat, or replace dying cells. The final and true purpose behind all of that eating that you do. So, once the chyme has worked through your small intestine, it passes through the ileocecal valve and then hits the cecum, the first part of the large intestine where, congratulations, your food is now officially feces.The large intestine, consisting of the colon, rectum and anus, is relatively short, at about 1.5 meters. And it provides a nice little frame for the small intestine here at the end of the alimentary canal. And now your body has sucked up almost all of the nutrients it can, and it's basically just pushing indigestible goo around so the large intestine doesn't have a lot of hard work to do. Its main functions are to absorb any remaining water, so you don't have constant diarrhea, and to store the rest until it's ready to exit the body. It also plays host to hundreds of species and trillions of individual gut bacteria which digest what ever chyme your body couldn't, releasing essential B and K vitamins, and some short fatty acids, which the large intestine still can absorb. In doing so, they also produce gases, like carbon dioxide and methane and sulfurous compounds called mercaptans and hydrogen sulfide, which eventually, pass.Ok, I know what you're thinking now. You're like, "Hank, what's up with the nachos? Surely, you're not just going to bring up nachos at the beginning of the episode without explaining how they can turn on you." Well, I've never disappointed you before, have I?Those of us who can't produce the enzyme lactase in our small intestine, simply let milk and cheese pass through the organ untouched, leaving the digestion to those bacteria in the large intestine. And those bacteria possess about 1000 different kinds of enzymes of their own, including lactase. But their digestion process produces a whole lot of extra gas, which is why nachos may leave me feeling cheesy and satisfied, but leave you bloated and crampy and malodorous. But enough farting around, let's wrap up this fantastic journey.Fecal matter keeps moving through in a couple of different ways. Slow moving haustral contractions keep mixing it and chopping it in the large intestine, occurring about every 30 minutes or so, and lasting about a minute. Most people also experience a few mass peristalsis movements a day; big, intense contractions that clear out a large swath of intestine at once, pushing the feces into the rectum. These often occur just after eating. Once in the rectum, your poop stimulates receptors that tap the parasympathetic defecation reflex, which signals the colon and rectum to contract and the internal anal sphincter to relax. This forces the poop into the anal canal, sending more messages to the brain that allow us to decide to voluntarily open the external anal sphincter, or just hold it for a minute while we find a bathroom. And when that moment arrives, what was once food says farewell to the alimentary canal that temporarily held it, and passes back into the light of day. And that, my friends, is the end of your digestive system. Pretty cool, right? And so it's all over. But that doesn't mean you should forget about what we learned today, which is that the small intestine performs most of your chemical digestion in the duodenum, while accessory organs, including the liver, gallbladder, and pancreas, contribute enzymes that all but finish the job. Then the large intestine, which is actually shorter than the small intestine, tries to extract the last big of nutrition, including the occasional attempt to turn nachos into energy, which for most humans, ends in gassy failure. Thank you to all of our Patreon patrons who help make Crash Course possible, not only for themselves, but for everyone through their monthly contributions. If you like Crash Course, and want to help us keep making videos like this one, go to patreon.com/crashcourse. This episode was filmed in the Dr. Cheryl C. Kinney Crash Course Studio. It was written by Kathleen Yale, written by Blake de Pastino, and our consultant was Dr. Brandon Jackson. It was directed by Nicholas Jenkins, edited by Nicole Sweeney, our set designer is Michael Aranda and the graphics team is Thought Cafe. Nachos are great...if you are among the lucky ones whose body can digest them. 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