TEAM GARNER

PROTEIN DIGESTION AND ABSORPTION

ULTIMATE NUTRITION MENTORSHIP

PROTEIN DIGESTION AND ABSORPTION

Now that you have completed Week 1 and have a much better understanding of your true self and where the crosshairs of your life are going to be dialed moving forward, it's now time to start sharpening your blades in the science and art of nutrition. First up, we will be tackling the physiology behind protein digestion and absorption. Later this week we will be diving into the important documents and video lectures revolving around protein intake, structure, function, and optimal timing strategies.

Although digestion, absorption and assimilation may not be as *"sexy"* a topic as pre and post-workout protein and other muscle building strategies, it's still very important to know. My objective within this whole course is for you to have a comprehensive understanding of what nutrition really is, and in order to truly understand something you must first:

1. Look at it
2. Break it down into its individual categories
3. Understand the individual categories
4. Put it all back together again and look at it as a whole

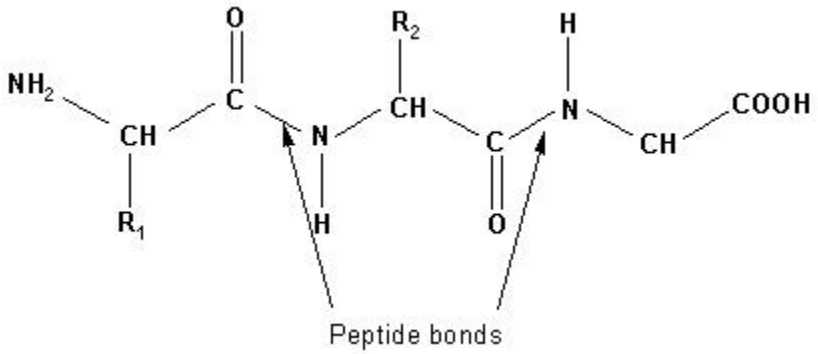
Digestion is an integral part of knowing what goes on in those individual categories of thinking and builds the backbone of your entire thinking and coaching models.

I'm going to go through the step by step process of protein digestion and absorption within the body. I am taking the liberty here of breaking protein digestion down to a more relatable, useful content make-up as well instead of directing you towards any textbooks for reading. Although textbooks offer fantastic information and is where I learned almost all of what I know about protein digestion, you end up going through a lot of dense, seemingly useless content along the way. I'm going to save you hours of anatomy memorization that you will never end up using to help your clients or develop your career.

For those of you interested, I have listed within this week's recommended reading section a couple of my favorite textbooks for a complete and thorough review on the topic.

PROTEIN DIGESTION

Proteins are amino acids bound together by peptide linkages.



The digestion of protein actually begins before you even put it in your mouth through what is known as the celphalic phase of gastric secretion. Just the simple sight, smell, or thought of food can stimulate the limbic system to kick off gastric secretion. For example, ever look at or smell a holiday dinner but you're not allowed to start eating yet?

Your stomach grumbles, mouth waters, the aroma in your nose is intoxicating, and just everything in your body is trying to prevent you from screaming to say, *"All right, who cares about that family that is late for everything, let's start without them!"*

That's the cephalic phase, all those visual and olfactory cues are quite literally beginning the digestive process before you even begin to eat. An estimated 20% secretion of gastric juices are released before the food enters your mouth. Mouth watering is priming for enzymes in the mouth to break down your food and support easier mastication, your stomach begins secreting hydrochloric acid (HCL) and enzymes to prepare for the incoming food; and many other appetite signals are pushing themselves forward urging you to pick up the fork and apologize to the late relatives later.

Beyond this, we need proper mastication in the mouth, effective transportation of the food contents down and through the esophagus, where it then meets its official entry into the stomach. From here, things start to get a little more complex.

PHASES OF GASTRIC SECRETION		
PHASE	**PERCENTAGE OF TOTAL SECERETION**	**TRIGGER**
Cephalic phase	20%	Sight, smell, taste, and thought
Gastric phase	70%	Food entering the stomach
Intestinal phase	10%	Food entering the upper portion of the small intestine

Upon entering the stomach, the chief cells located on the gastric glands of the stomach walls secrete HCL which is essential towards properly breaking down protein, sterilizing the stomach food contents from unwanted parasites/bacteria, and the ultimate absorption capacity of minerals such as zinc and calcium. HCL production is something that can decrease in overall secretion volume due to high levels of stress or in people who have thyroid issues, so under these circumstances proper digestion may not be taking place. Additionally, chronic gastritis (inflammation of the gut) can cause damage to the cells responsible for proper gastric secretion and overtime can result in hypochlorhydria (low HCL).

This is important to care about because the stomach is the first digestive organ the protein from your meal enters so if improper digestion occurs here it can create a snowball like effect down through the small and large intestine. This can't be corrected for because they can't do the same job that the stomach does. In other words, bad digestion north = bad digestion south. It's easy to conceptualize that if something isn't done properly in the beginning of the chain, that the rest of the chain is going to suffer.

A low pH within the stomach is required for optimal (and safe) digestion, but also without a low pH in the stomach vitamin B12 (commonly found in red meat) would not be able to get released from your food. Within the same vein, gastric cells also secrete intrinsic factor which binds itself to B12 and protects it until it reaches the ileum where actual absorption will take place. Thus, chronic gastritis and other stomach issues can also result in pernicious anemia (a deficiency in the production of red blood cells through a lack of B12) overtime.

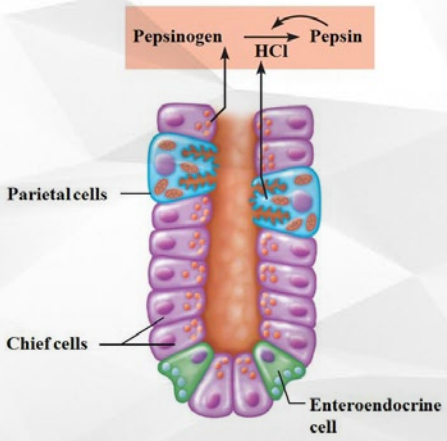
GASTRIC SECRETION				
GLANDS OF THE STOMACH	**SECRETES**			
Gastric	HCL	Pepsinogen	Intrinsic factor	Mucus
Pyloric	Mucus	Gastrin		

In a nutshell, you can think about protein digestion in two major steps:

1. Digestion (breakdown) in the stomach
2. Absorption in the small intestine

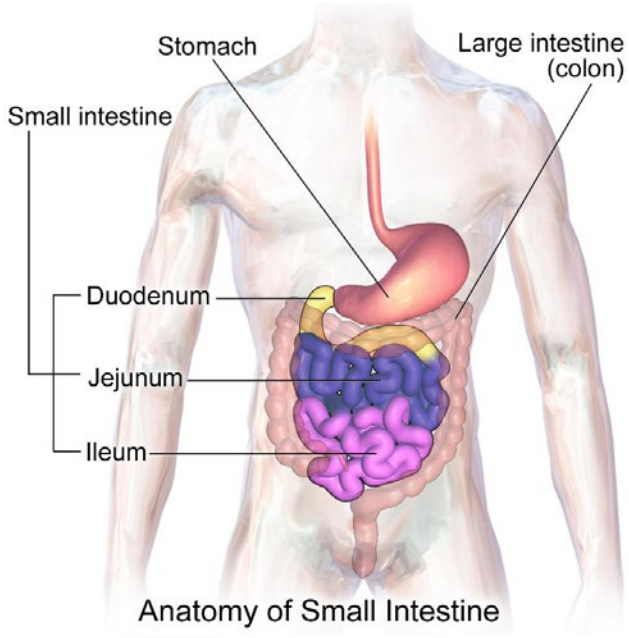
The gastric gland in the stomach also secretes pepsinogen, pepsinogen then gets converted to pepsin in the presence of HCL. The reason why it remains in its inactive form (pepsinogen) prior to the digestive processes kicking off is because its active form (pepsin) is a very powerful enzyme and if it hung around in your stomach always in its active form it would actually start breaking down your own stomach and other organs. Not exactly what we're after!

In addition to the mucus being secreted by the gastric gland but mostly by the pyloric gland, the entire surface of the stomach has a continuous layer of mucous cells which lubricate the food and protects the stomach from these acid and enzyme secretions. Moreover, this mucous contains immune cells that fight off bacteria during and after digestion. In fact, within the mucus lining of the stomach you will find ~70% of the human body's immune cells.



Close up representation of stomach cell activity

The now converted pepsinogen to the active pepsin initiates protein digestion by breaking those peptide bonds down resulting in the protein being broken down into what are known as polypeptides. Peptides are simply bonded chains of amino acids, poly means 5 bonded amino acids, whereas di and tri peptides represent 2 or 3 amino acids bonded together. After this the polypeptides travel down to where the majority of the rest of protein digestion will be taking place, in the duodenum and jejunum.

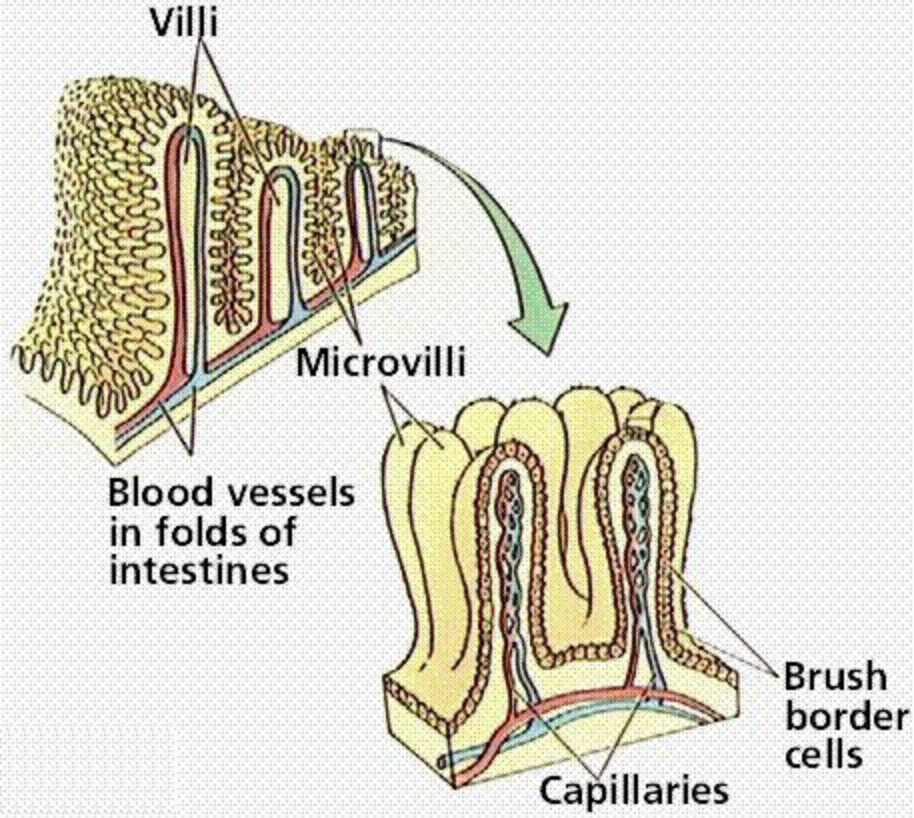


Anatomy of Small Intestine

When the food enters the duodenum stage of the small intestine, the pancreas begins to secrete enzymes for further breakdown of the proteins into dipeptides and tripeptides. These enzymes are:

1. Trypsin
2. Chymotrypsin
3. Proelastase
4. Polypeptidase

Once these proteins have been broken down into dipeptides and tripeptides, they continue on down the G.I. tract and are subject to contact with a series of digestive components known as microvilli. These are finger like projections which are housed all along the walls of the small intestine and allows the food the maximal digestible/absorption surface area it needs to come in contact with before excretion.



Basic view of villi and microvilli

The dipeptides and tripeptides are further broken down into single amino acids by the brush border enzymes that are on the microvilli of the duodenum and jejunum. These breakdown enzymes are called aminopeptidases and are considered brush border enzymes because as the content of the food literally brushes by them, the food is being broken down and absorbed into the bloodstream.

Something that is important to note here is that only amino acids should be absorbed at the end of protein digestion. If the gastrointestinal system is dysfunctional, a peptide or whole protein may be absorbed and can cause serious immunological disturbances, such as leaky gut or irritable bowel syndrome.

In its most simple form, protein digestion follows this path:
Protein → Polypeptides → Di and Tripeptides → Amino acids and some peptides → Bloodstream

PROTEIN ABSORPTION

Having travelled all the way from the mouth to the villi at the end of digestion but prior to absorption, we now have free form amino acids and some di and tri peptides. Protein chains longer than 3 amino acids in length are almost never absorbed in a healthy digestive state, but can slip through the cracks in cases of leaky gut (more on this in the *"inside out"* gut section).

After breakdown from the villi, the intestines utilize a variety of amino acid transporters to get it through and into the bloodstream to continue the absorption process. Meaning, once protein is broken down into absorbable components, it doesn't just assimilate through the small intestine. Certain transporters are required that can only carry certain amino acids. The intricate details of the separate amino acid transporters aren't very practical towards your knowledge base with one exception, mass dosing single amino acids or Branched Chain Amino Acids (BCAA's).

Many people have been told to mass dose BCAA's, but at a fundamental level of absorption we know that there can be competition between amino acids for transport. What this means is the very likely scenario that when you mass dose certain aminos you are also doing either one, or both of the following:

1. Impairing the absorption of other amino acids
2. Running out of readily available transporters for BCAA's and creating a *"back up"* in the G.I. tract during exercise

Both of these are not giving you any advantage, and the cost benefit analysis done based on your body composition, performance, and wallet using this strategy does not pan out in the research at all as you will find out in more detail in later sections. It should also be mentioned here as well that transporters also exist for di and tri peptides to be pulled through the small intestinal wall.

The small intestine can utilize up to 50% of the ingested protein from a meal all by itself for hormone creation and its very own protein synthesis. The amount utilized and retained from the G.I. tract depends largely on the amino acid profile of the protein itself along with the total amount ingested. For example, many people know that glutamine is good for G.I. health so it comes as no surprise when I tell you that the gut will absorb a lot of the ingested glutamine within a given protein's amino acid profile for its own use.

What's not immediately used up by the gut typically follows one of three paths:

1. Storage in the gut for later release during a fasted state
2. Sent off to the liver for further metabolism and transportation
3. Continues its travels down to the large intestine to be eaten up by bacteria or to be pooped out

Since 1 and 3 are pretty straight forward, let's talk a bit about the liver (*"Seriously Dan when are you going to tell me how it gets to my biceps?"*)

Once a transporter has grabbed the amino acid or peptide bond it travels through the hepatic portal vein towards the liver where lots of metabolization takes place. The liver acts as a monitor of the amino acid content within the varying systems of the body and adjusts its metabolization accordingly. Like the small intestine, the liver will utilize a large percentage of the incoming amino acids for the creation of a variety of different proteins/enzymes while only a small percentage (mostly BCAA's) are then released out into the bloodstream for further transportation.

Further breakdown of amino acids in the liver first begins with the removal of the amino group from the amino acid itself, leaving the carbon skeleton and some ammonium. After this, further metabolization happens in two integrated ways:

1. Transamination – Transamination occurs when one amino acid donates its amino group to another compound in order to create a new amino acid, this is how the body creates its own "non-essential amino acids"

2. Deamination – Deamination is the process in which the ammonium enters the urea cycle for ultimate excretion in the urine.

After the body has completed its liver metabolism processes, the remaining amino acids are now ready to be released out into the bloodstream for use by other organs and your muscle tissue. At this point in time after the liver and small intestine have both done their duties, and we are left with less than 25% of the original amino acids consumed in the meal, this remaining amino acid content consisting mostly of BCAAs (this occurs even when amino acids are given intravenously, the liver and the gut still get nearly all of it). Much of this remaining BCAA content is metabolized by the skeletal muscle.

This circulating collaboration of leftover amino acids is typically referred to as the "amino acid pool" by researchers and enthusiasts alike. It should be noted however that each individual tissue or organ system has its own amino acid pool, as well as there are circulating amino acids in the blood. So there is no pool of actual amino acids sitting at one place in your body that people are referring to. When discussion of the amino acid pool is being had they are referring to the combination of all of those pools plus the ones in circulation. The size of the amino acid pool is quite small, averaging out at 130g of amino acids in adults, 30g of which being taurine. Only 5g of amino acids are present in the bloodstream in a normal state. These numbers are tightly controlled by the body through biophysical and biochemical mechanisms due to its extreme importance towards our health.

Additionally, much like the body can't distinguish glucose from bread compared to glucose from sweet potato, it also cannot differentiate an amino acid source from protein ingested. Meaning, your body doesn't care if the amino acid leucine came from milk, chicken, your own body (yes catabolized muscle tissue can feed into the amino acid pool as well), or your protein shake. Once it's in circulation that leucine will play the same role. However it must be understood that I am not saying all proteins are the same, I am saying once the metabolized amino acids enter circulation they are the same.

ABSORPTION SUMMARY

1. After digestion but before absorption, proteins are broken down into single amino acids, di and tri peptides

2. Heavy metabolization occurs within the small intestine which in turn takes up to half of the consumed protein for its own use. Beyond this, it is either passed on down the large intestine for bacteria food and excretion, or, sent on through for liver metabolism

3. Within the liver, deamination and transamination occurs alongside plenty of more metabolic processes utilizing much of the leftover amino acids for creation of other proteins

4. The remaining percentage of amino acids (largely comprising of BCAA's at this point) enter the bloodstream for use by other organs, muscle tissue, or to enter the amino acid pool

-Dan Garner

DAN GARNER
TEAM GARNER FOUNDER AND CEO