# PHYSIOLOGICAL INAUGURAL DISSERTATION ON DIGESTION

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Which, with supreme divine approval, and by the authority of the very
**Reverend George Baird, SS.T.P.,**
Principal of the University of Edinburgh;

And by the consent of the most distinguished academic senate and the decree of the most noble faculty of medicine;
Is submitted to the examination of the learned by

**Algernon Hicks,**
Englishman, Fellow of the Plinian Natural History Society,

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"Who'd pique himself on intellect, whose use Depends so much upon the gastric juice." -- BYRON.

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On the first of August, at the usual hour and place.

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To the Most Famous Man

**Robert Hooper, M.D., S.L.S.,**

Bachelor of Medicine in the University of
Oxford, Fellow of the Royal College of
Physicians, London, and Physician of St.
Mary's Hospital,
etc. etc. etc.

Who has deserved a reputation among all for the courtesy and
refinement of manners, as well as for skill in the art of Apollo,

This small work, a modest token of esteem, is
dedicated by the author.

**To My Dearest Father**

These first fruits of my studies, with the devotion that befits a son,

Are dedicated by

**Algernon Hicks.**

## PHYSIOLOGICAL INAUGURAL DISSERTATION ON DIGESTION

BY ALGERNON HICKS.

Many organs contribute to the digestion of food, designed with marvelous skill for this purpose. It must be admitted, however, that physiologists have not yet fully understood the actions and functions of all the parts involved in this process. Nonetheless, they have revealed this function and the laws by which it is governed to such an extent that physicians have received great assistance from their work in devising methods of treatment, and it is likely that even greater aid will be gained in the future.

Therefore, no one involved in treating the sick should be unaware of what physiologists have discovered for certain regarding a bodily function disrupted in so many cases, which, when disturbed, gives rise to many dire ailments.

I intend to present a few points on this function, not with the aim of presenting anything new or instructing others, but since the occasion requires me to write about something, to acquire a more accurate understanding of the function that is so essential for anyone engaging in medicine to know.

Before food is adapted to restore the body’s loss, it undergoes changes in several organs: first in the mouth, then in the stomach, and subsequently in the duodenum; later absorbed in the mesenteric glands, and finally received into the blood and carried to the lungs, it becomes thoroughly similar to the body's nature, suitable to become part of it. However, in this attempt, it is not my intention to go beyond those changes that occur in the alimentary canal, or as physicians commonly call it, in the primary pathways.

## ON THE CHANGES THAT PRECEDE DIGESTION

Food taken into the mouth is broken down by the teeth and mixed with saliva to be converted into pulp. This transformation allows it to descend more easily to the stomach and causes less damage to the delicate structure of the parts through which it will pass. Furthermore, it is now more adapted to undergo the action of the stomach, as food not well processed by the teeth does not digest as easily in that organ. This is obvious, as the structure of the stomach is not designed to divide and grind the ingested material. Birds, which lack teeth, not only have a very strong and muscular stomach, but also swallow grit and stones with their food to facilitate the appropriate grinding.

The contribution of saliva to digestion is evident from the fact that, if saliva is excessively discharged from the mouth, food is poorly digested, and dyspepsia, which is very difficult to cure, arises. To cite another example from birds, which have no glands to pour saliva into the mouth, there is a specific organ, the crop, where a change similar to that which occurs in the mouths of other animals takes place.

Once this transformation is completed, the mass is gathered on the tongue, the mouth is closed, and the tip of the tongue is pushed upwards, creating a path for the food to be moved backwards. The bolus is then compressed between the tongue and the palate and moved further back. The pharynx and surrounding areas elevate, shortening the passage and allowing the bolus to pass more easily through the glottis. Once it reaches the pharynx, it is propelled into the esophagus by constricting action, and from there, it is transmitted into the stomach by the contractions of the esophagus.

## ON THE TRANSFORMATION OF FOOD IN THE STOMACH

The stomach is a pyramidal sac with its apex pointing downward and to the right. It is curved, with a larger curvature at the front and bottom, and a smaller one at the back, facing the spine. Its size varies based on a person's habits regarding food quantity. It consists of several layers, the main ones being the outer serous layer, which is part of the peritoneum; the muscular layer, composed of longitudinal and transverse fibers; and the inner mucous layer, which is ample and quite wrinkled when the stomach is empty. Blood is abundantly supplied by arteries derived from the celiac artery or its branches. The veins lead to the portal vein. It is also rich in nerves coming from the eighth pair and the sympathetic nervous system.

The stomach forms an angle with the esophagus which becomes smaller after ingesting food, making it more difficult for the stomach's actions to reject food. However, the contraction of the esophagus itself and the descent of its internal lining contribute more to this than the angle between it and the stomach. To prevent food from descending into the duodenum before being converted into chyme, there is a muscular sphincter at the pylorus that only relaxes upon contact with properly formed chyme. The mucous glands abound in the internal lining of the stomach, especially near the cardia and pylorus; it seems that the entire membrane secretes a useful fluid in digestion known as gastric juice.

Once food is received in the stomach, it is held there for a longer or shorter period and transforms into a pulpy, grayish, slightly yellow mass called chyme. This transformation appears to occur more on the left side of the stomach, or the larger end; and not the entire mass is changed at once. The external parts close to the stomach walls transform into this new form first, and subsequently the next closest parts do, until the entire mass undergoes the necessary transformation. The initial parts turned into chyme are moved toward the pylorus by the stomach’s action, making way for the remaining parts.

Regarding the forces that accomplish this transformation, a few words should be said. In the stomach, food undergoes considerable pressure due to the organ's muscular fibers and mild agitation from diaphragm movements during breathing, as well as body heat, and the action of gastric juice. Physiologists have attributed digestion in the stomach to each of these forces; each proposed their own theory, supported by arguments and experiments. From the earliest times, digestion was attributed to fermentation and decay similar to what heat induces in food outside the body, and the grinding generated by the organ's muscular nature. These opinions are now rightly obsolete; for the past half-century, physiologists have almost unanimously agreed that the secretions of the stomach are the main cause of digestion. Stevens, Spallanzani, and many others adopted this view, and through numerous carefully conducted experiments, they persuaded physiologists that digestion should be attributed to no other cause.

This view has flourished for many years, though some recent physiologists have tried to overturn it. It is mainly supported by experiments where food was enclosed in perforated metal globules; after being ingested by a man hired for the purpose and eventually excreted, the food was found transformed into chyme. This experiment clearly shows that grinding is not the cause of digestion, as nothing could penetrate the globules except the fluid; it is rightly inferred that gastric juice forms the chyme. Other experiments of the same kind are perhaps less reliable, yet many still suggest this view is correct.

Above all, anything proving other views false also supports this one. It is clearly evident that neither fermentation nor decay occurs in healthy digestion, demonstrated by experiments where food rejected from the stomach after a period showed no signs of fermentation or decay. Furthermore, it is proven that the secreted gastric juice can inhibit fermentation and decay. Decayed food introduced into the stomach and later expelled by vomiting becomes sweet again. It is protested today that gastric juice cannot convert food into chyme outside the body; however, we should not conclude from this that it cannot achieve this effect under natural conditions as intended.

Some modern physiologists prefer attributing digestion to nervous power, with which the stomach is undoubtedly abundantly equipped. It indeed seems established that digestion does not occur if the vagus nerve in the neck is severed. However, it is well known that nervous power is necessary for bodily secretions, so digestion fails in this case due to the lack of the fluid whose action usually accomplishes this process.

Nonetheless, it must be admitted that this matter is complex, and experiments by the best physiologists do not consistently agree. But we shall not stray far from the truth if we conclude that gastric juice, if not the agent of digestion, is nevertheless essential for it. This conclusion, even if unsatisfactory to physiologists, will be quite useful for doctors in investigating stomach disorders and proposing their remedies.

## ON FURTHER CHANGES OF FOOD

Proceeding to further food transformations, the chyme formed in the stomach passes through the pylorus into the duodenum, where it becomes suitable for producing chyle.

In the duodenum, two significant fluids, bile and pancreatic juice, are introduced to transform the food. Bile, secreted by the liver and stored in the gallbladder, is expelled by the organ's activity and by the pressure of the distended intestine when chyme arrives. Bile, a soap-like fluid, helps convert chyme into chyle, though exactly how is not fully understood. Some believe it mixes oily with aqueous parts, while others suggest it separates waste and precipitates chyle onto intestinal walls—this latter notion is incorrect, as intact bile is not found in waste, and living processes can't be explained by chemical principles alone. The importance of bile is clear from the digestive issues that accompany its absence.

The pancreatic juice is similar to saliva and seems to have a similar function in the duodenum as saliva does in the mouth.

Once mixed with these juices, the food mass travels through the small intestine—specifically the jejunum and ileum. As it descends, specialized absorbing vessels extract chyle, which is transported through the mesenteric glands to the thoracic duct and then into the bloodstream. There it mixes completely with the blood in the heart and is ultimately exposed to the air in the lungs, becoming the body’s nourishment.

It is uncertain whether chyle is formed in the intestine and then absorbed by lacteal vessels or if these vessels actively draw out and select chyle from the mass passing through the intestines. Since we can't explain chyle formation chemically, it must be considered a vital action. The idea is that if a vital action is necessary, it's more likely situated at the openings of the lacteal vessels than in any other organ. Lacteal vessels are akin to plant roots, drawing nutrients from the chyme, much as roots absorb from soil. In the body, similar absorbing actions occur, such as interstitial absorption, where material is not removed intact but broken down and reformed.

To quote a cited author:

"This operation of chylification is the result of the particular action of the lacteals, requiring their integrity and living state; it varies according to their organic conditions. The role of the lacteals is evident, as chyle is not preformed in the chyme; this involves not just a simple pumping action but the actual formation of a fluid."

"Secondly, this operation is neither a physical nor mechanical action, as it involves changing the nature of the material. It’s been compared to imbibition, suggesting pre-existing chyle in chyme, which is not the case. Description of intestinal pressure extracting chyle has been criticized since the chyle doesn't exist in the chyme beforehand."

"This operation is also not a chemical action in the general sense because it cannot be explained by general chemical laws; there are no chemical correlations between chyme as the material and chyle as the product."

The long, convoluted intestine allows complete extraction of chyle from the food mass. Lacteal vessels are not found in the stomach or upper duodenum but begin in the lower duodenum, abundantly in the jejunum, and fade in the ileum. The mucous membrane, where lacteal openings are, is extended by folds, slowing the passage of the food mass and allowing more chyle to be extracted.

Concerning the properties of chyle, little is known. Collected from the thoracic duct, it separates into two parts, similar to blood—coagulum and serum. The liquid resembles blood serum and can be coagulated by heat, acids, or alcohol, sharing salts with blood serum but also containing a unique substance similar to fat. The coagulum has parts akin to fibrin and blood's coloring matter; its fibrin-like part is less tenacious, resembling albumin. There's also a fat-like substance in the coagulum.

During these transformations, various gases are released, differing in stomach and intestines. According to Magendie's experiments on those executed, considerable oxygen and carbonic acid gas exist in the stomach, with traces of pure hydrogen and significant amounts of nitrogen. In the small intestine, no oxygen, more carbonic acid than in the stomach, more hydrogen, and often more nitrogen were found. In the large intestine, no oxygen, more carbonic acid gas than in the small intestine, some pure hydrogen, and a significant amount of carbureted hydrogen with nitrogen were detected.

The source of these gases remains uncertain, though it's likely they're released from the food mass during transformations. The mentioned physiologist claims to have observed air bubbles emitted by chyme, possibly secreted by the stomach and intestinal mucous membranes. Something similar occurs in the lungs, and eminent physiologists and pathologists like Hunter and Baillie have considered air secretion common in the body. This should be remembered by physiologists, and not overly trusted to any unconfirmed view; deeper understanding of body processes may reveal new roles for intestinal gas.

## ON THE EXPULSION OF FECAL MATTER

The portion of the food mass to be excreted, that which remains after chyle is absorbed, is propelled downwards by the intestines' own action, known as peristaltic motion. It reaches the large intestine, where it gradually becomes less liquid as aqueous parts are absorbed, and finally accumulates in the rectum to be expelled.

Chemists have recently examined fecal matter to better understand the intestines' role in transforming food; such investigations were expected to contribute significantly. However, almost nothing of substantial importance has been discovered except that minimal intact bile remains in feces, with most dissolved and altered before the mass reaches the large intestine.

Peristaltic motion of the intestines is accomplished by circular and longitudinal muscular fibers lining the canal. The contraction of these fibers seems to depend on the stimulation by material that contacts them. Thus, the motion varies between slower and faster, depending on the quantity and nature of the contents. Secretions entering the intestines ideally promote this action. Bile is particularly necessary, evident from constipation commonly observed in jaundice. However, other secretions are also required; in dyspepsia, likely due to deficient secretion from the intestinal mucous membrane, like a lack of gastric juice secretion, constipation occurs. Constipation is also common in febrile diseases, where secretions are generally suppressed. Recognizing that bowel movements are stimulated by medications that increase mucous membrane secretions leaves no doubt that such secretions prompt fiber movement.

These points encompass, I believe, the main aspects of digestion. I admit, what has been presented may seem somewhat disorganized and lacking in precise order. Due to the constraints of this paper, it's impossible to delve into every detail. Consequently, an accurate layout couldn't be used, and in tracing food through the canal, I had to discuss anatomy and physiology as needed to clarify the subject at hand.

THE END.

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