to, as for example, "Arabia," which is mentioned three times in 7718, but the earliest reference under the name is 7732.

There are omissions that may be explained by the fact that the "Subject Index" is not intended to be a Concordance, still less a Word Concordance. But all reference, either under main entry or subentry, to *Divine Word,* a term used many times in numbers 474, 903 to 914; to conservation, existence, subsistence, perpetual as main entries, subentries, or cross references enabling the finding of the statement, "conservation is perpetual creation, just as subsistence is perpetual existence" (n. 12); and to other subjects that might well be a matter of inquiry, is omitted from the Index, yet the subjects are to be found in the work itself.

The construction of a "Subject Index" such as is under review is admittedly extremely difficult. Whether it is the most satisfactory type of Index is questionable. Perhaps only a far more thorough examination of it than has been made is necessary to determine this. But whatever the verdict, we would pay tribute to the immense amount of work put into the "Subject Index" of the eight volumes of *The Word Explained.*

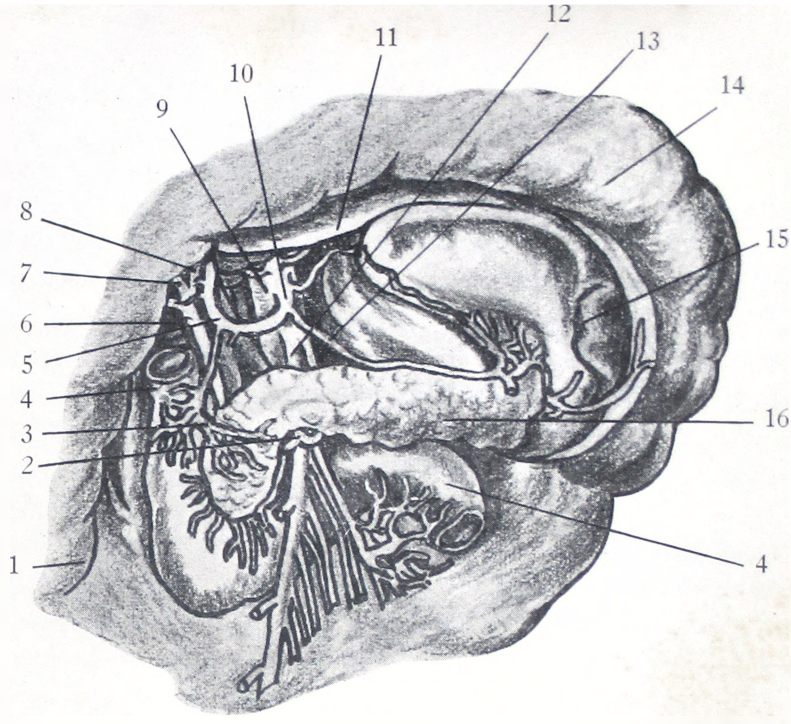
FREDERICK E. GYLLENHAAL

THE PANCREAS

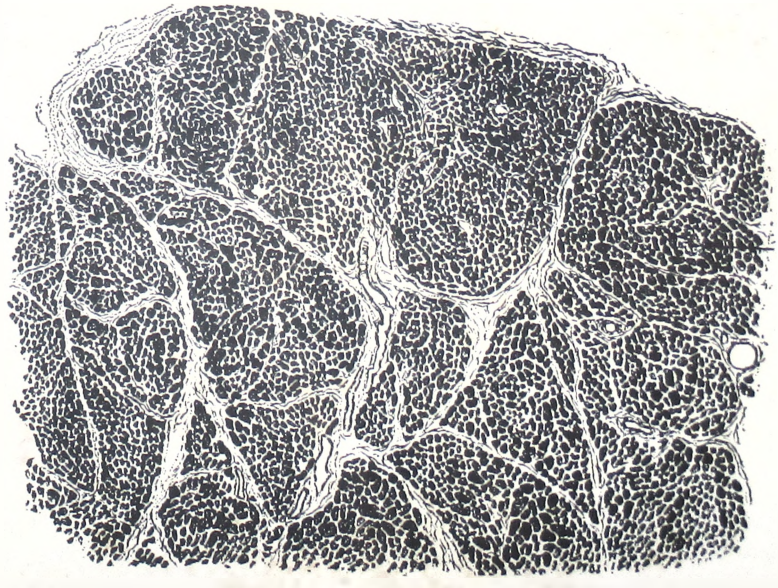
Adapted from Swedenborg's *Animal Kingdom*

BY DONALD G. GLADISH, M.D.

The pancreas is a large flat gland situated behind the stomach and reaching from the duodenum transversely towards the spleen. It is connected with the duodenum, the mesentery, and the spleen. It is eight or nine inches long, two finger-breadths broad, and about one finger-breadth thick. Its weight is about three ounces, though it greatly varies. It is broadest near the duodenum and becomes gradually narrower towards the spleen. Surrounding it is a membrane which is continuous with the peritoneum. Where it is attached to the colon, this membrane is called the mesocolon. Its substance is glandular, formed by a conglomeration of many lesser parts, and contains glands of both external and internal secretion. Its arteries arise from the coeliac, splenic, and superior mesenteric arteries, and its veins from the splenic vein; its nerves are from the vagus and intercostal.



1 Ascending colon
2 Inf. pancreatico-duodenal artery
3 Sup. pancreatico-duodenal artery
4 Duodenum
5 Hepatic artery
6 Ductus choledochus (common bile duct)
7 Cystic duct
8 Hepatic duct
9 Abdominal aorta
10 Coeliac axis
11 Under surface of left lobe of liver
12 Sup. mesenteric artery
13 Splenic artery
14 Transverse colon turned up
15 Spleen
16 Pancreas



Section of Pancreas × 20

The pancreas has an excretory duct composed of a number of lesser ducts. It is situated in the middle of the pancreas where it resembles an empty vein of about the caliber of a thin straw. This is named the pancreatic duct or duct of Wirsung. It usually empties into the extremity of the common bile duct.

The pancreatic juice is excreted into the duodenum where it digests proteins, fats, and carbohydrates. Besides these glands which secrete these digestive enzymes, there are glands of internal secretion, scattered through the substance of the pancreas, which are called "isles of Langerhans" which secrete insulin directly into the blood stream. This insulin controls the use and metabolism of sugar in the body.

In order to know the office of the pancreas, it is absolutely necessary to know the offices of all the viscera among which it lies concealed and to which it is connected. Looked at singly, apart from the other viscera, it appears to be merely a large gland which prepares a juice for tempering the bile, anointing and cleansing the intestines, digesting the food and diluting the chyle; but what further services it performs, remains concealed.

The juice is derived from prior causes, which produce these effects, and if these be unknown, reason comprehends nothing more than what is apprehended by the senses. Nor can the causes be discovered without a consideration of the offices of the other members which belong to the same society and constitute the more universal series of causes or effects. The more universal the cause, the more numerous the members which concur with it, and from the several members when explored and woven together in the mind, we discover what each one contributes to the common effect, and, in the present case, what lies concealed in the pancreatic juice.

The offices of the abdominal viscera are: 1. To prepare the chyle. This is the office of the stomach and intestines. 2. To purify it, which is the office of the liver and the mesenteric and conglobate glands. 3. To introduce it into the blood, which is the office of the thoracic ducts, the lymphatics which empty into it, the veins and the liver. 4. To purify the blood. This is the office of the spleen, and, in the fetus, of the succenturiate kidneys (the suprarenal bodies). 5. To secrete the better parts of the blood and serum, which is the office of the pancreas, the omentum, and finally the liver. 6. To circulate them—the office of the pancreatic and hepatic ducts and of the intestines. 7. To excrete the worth-

less parts of the serum—the office of the kidneys and ureters. 8. To throw them out—the office of the bladder and urethra. 9. To excrete the worthless parts of the blood—the office of the gall bladder. 10. To throw them out—the office of the cystic duct and the choledochus (hepatic duct) and, finally, of the colon and rectum.

Thus all the abdominal viscera form a single series which may be called the superior universal series; for they all look to a common effect, end, and use, namely, the blood. This series is divided into three inferior universal series—one which looks primarily to the *chyle,* another which looks to the *serum,* and a third which looks to the purification of the *blood* now formed from the chyle and serum. Each of these series is subdivided into several inferior series, there being those which prepare the *chyle,* refine it, and introduce it into the blood; those which purify the *serum,* secrete it and excrete it; and those which do the like for the *blood.* Each of these is again divided into several others; for example, of those which *prepare the chyle,* there are some which grind the food, some which digest it, extracting its essential juices, some which besprinkle it with saliva, and some which unite the saliva with the extracts, and thus produce the *chyle.*

There are many other subdivisions which terminate only in the very simplest divisions of the series, that is, in the capillaries. This is the reason why no two of even the minutest veins or arteries carry blood or serum of the same nature, each being dedicated to some most particular office distinct from that of the vessel next to it. Thus here, in the pancreas, no two glands invite an absolutely like blood or serum. From this can be seen the relationship which these series, that is, these viscera and their offices, have in their contact with each other, and the order in which they are subordinated the one to the other.

The pancreas is a uniting medium between the spleen and the liver. It purifies the blood for the spleen, and draws off the serum, sending the parts secreted away by three paths—one leading to the omentum, mesentery, and mesocolon, another to the portal vein of the liver, and a third to its own duct. The latter furnishes the pancreatic juice which is thrown into the duodenum and then circulated in union with the bile from the liver and gall bladder. Thus, as the intermediary member, the contribution of the pancreas is, that a complete action and sequence of effects, ends, and

uses may exist and subsist, and, consequently, a most perfect state in the subordination of the efficient causes.

This, then, is the cause of the existence of the pancreas and spleen. For nature in all her methods and processes ever intends and strives after the greatest degree of perfection. Therefore, when proceeding or about to proceed to an end, she calls to her aid all the causes which can possibly promote that end—that is to say, an entire series of subordinate causes; and these she multiplies in proportion to the nature, eminence, and necessity of the end.

In a series, if the series is to have a conclusion, there must be at least a trine, namely, a first, a middle, and a last; and these must be so ordered that the first term disposes the second, and disposes the last both mediately and immediately. Sometimes even a quadrin is necessary, or a sequence still more multiple, according to the distance between the first term and the last. Whatever be the relation, there must be at least a trine to procure harmony. Thus there is a trine that purifies the blood, namely, the spleen, pancreas, and liver. A trine that secretes the blood and serum, namely, the pancreas, omentum, and liver. A trine that circulates the secretions, namely, the pancreatic, hepatic, and cystic ducts. A trine that prepares the chyle, namely, the stomach and the small and large intestines. A trine also that secretes and excretes the worthless parts of the serum, to wit, the kidneys, ureters, and bladder.

As all the viscera of the abdomen perform a common series of operations, so there is a series in each viscus, organ, and member, and each should be contemplated as a series, society, and completion of the operations peculiar to it. This is particularly apparent in the pancreas which is divided into masses, congeries, and tuberosities, and these into lesser ones and least, the latter being the very glands wherein the progression of its series ends and from which it commences.

When the pancreas is carefully examined in series with its fellow members, it instructs us as to the nature of the subordination of its efficient causes, and the nature of the influx, communication, and conclusion of its operations.

I. The spleen flows into the pancreas, and the pancreas into the spleen, by means of nervous fibers and blood vessels. In like manner, the pancreas flows into the liver, and the liver into the gall bladder. By means of the nervous fibers, these viscera are

inaugurated into a communion of operations—a communion which is represented by the blood vessels.

II. The spleen derives its blood from the trunk of the aorta by the coeliac artery; the pancreas derives its blood from the same source; also from the spleen itself, and directly from the aorta by the superior mesenteric artery. The liver derives its venous blood from the pancreas, and thereby from the spleen; also from the stomach, intestines, and mesentery; and its arterial blood from the aorta by the right branch of the coeliac artery and by a branch of the phrenic artery. Since the pancreas is the mediate purifier of the blood, as the liver is the ultimate purifier of both the blood and the chyle, it is important to inquire into the sources whence its blood—the raw material of its operations—comes. Deriving the blood which it is to purify not only from the spleen but from two other sources, it can act independently from the spleen, so that if the operation of the spleen be diminished or fail, the pancreas and liver will be able to take its place.

III. The spleen sends its purified blood into the splenic vein and the lymphatics. The blood which is to be purified, it receives by way of the pancreas, and when purified, transmits it by the same way to the portal vein; while the pancreas sends out the blood which it has repurged in its own way, partly into the omentum, partly into the pancreatic duct, partly into the great splenic vein and from this to the portal vein. The liver again sends its purified blood into the vena cava, and also into its own lymphatics, and the unpurified residue into the hepatic duct, while the blood which is to suffer the last purgation it sends into the gall bladder.

IV. Finally, the *pancreas, liver,* and *gall bladder* mingle their secretions; for the pancreatic duct, or duct of Wirsung, empties into the ductus choledochus or common bile duct which is formed by the hepatic and cystic ducts. This is the conclusion of the operations.

These particulars show in what way the pancreas is subordinate and serves as a mediate cause between the spleen and the liver; namely, that it acts both mediately and immediately; or that it is a cause operating through the spleen and a cause operating by itself; so likewise the liver. Consequently, when either lose their vigor, which is not infrequently the case, the other takes its place and assumes the reins, though in a comparatively imperfect manner;

for nature ever goes to meet any dangers that may befall the body, and provides that it be not injured or destroyed.

The same considerations also show that the pancreas makes common cause with the spleen in one way, and with the liver in another; also that the liver in still another way again makes common cause with the gall bladder; and that yet there is a continual series and progression of these causes and operations.

In consequence of the coördination and subordination of the viscera and their offices, no portion of the blood can possibly circulate anywhere in the trunk without being purified and expurgated by means of these members—the blood of the middle region by the spleen, that of the middle and lower or abdominal region by the pancreas, and that of the middle and lower region and at the same time that of the higher or thoracic region by the liver; for the spleen derives its blood from the trunk of the aorta by the coeliac artery; the pancreas, from the same trunk and also from the hepatic branch of the same artery and, below, from a branch of the superior mesenteric artery. The liver likewise draws its blood from the aorta by the coeliac axis and also from the arteries. Thus the provinces are so ordered, that nowhere is there the least drop of impure blood that is not invited and drawn to one or the other of these organs, just as there is nothing of the impure serum that is not derived to the kidneys.

As to the glandular nature of the pancreas, this we learn from the liver, the two being related in form, operation, and use. The liver is furnished with a common coat derived from the peritoneum; so likewise the pancreas. The common coat of the liver grows finer and finer until it reaches the glands; so likewise the common coat of the pancreas. The liver is divided into lobes; the pancreas into masses which, while not truly lobes, are yet distinguished into beds and tiny masses, to the number, as it appears, of forty or fifty; the partitions between them are evident from the irregularity of the surface, and such partitions are commonly called lobes. Each lobe of the liver is subdivided, and ultimately into glands; so likewise each mass of the pancreas. Every gland of the liver is composed of a last production of the common membrane, of arterial and venous threads, and of fibrillae; so likewise every gland of the pancreas. A branch of the portal vein approaches, enters, and perforates each gland of the liver; in like manner a branch of the splenic artery perforates each gland of the pancreas. Whatever

the branch of the portal vein conveys to the gland of the liver is separated into three kinds; so likewise is what the branch of the [splenic] artery conveys to the glands of the pancreas. The gland of the liver carries off one kind of secretion through the hepatic veins to the vena cava; the gland of the pancreas likewise one kind through the pancreatic veins to the splenic veins. The gland of the liver throws out a second kind by fine cells all the way to the surface and ultimately to the lymphatics; so likewise the gland of the pancreas, but into the cellular and adipose coats of the omentum, mesentery, and mesocolon. The gland of the liver expresses a third kind through the bile ducts into the hepatic duct; the gland of the pancreas its third kind through ducts into the pancreatic duct. The liver transmits its bile into the common bile duct; so likewise the pancreas transmits its juice into the same duct.

The liver does all these things silently, tranquilly, mildly; so likewise the pancreas. When the gland of the liver expands and invites the blood, the portal vein contracts and impels it, and vice versa. The pancreas acts by a similar alternation and reciprocation; and in both cases this is done by movements synchronous with the respiration of the lungs.

The pancreas, like the liver, has no muscular coat to excite it to manifest motion. The nature of the function of these organs demands that such should be the case; for to allow various kinds of fluid to be distinctly secreted, separated, and thrown out, requires the utmost concord of motions; so that when the gland invites the blood, the splenic artery shall intrude it or express it from itself, and vice versa. Thus there is an alternate reciprocation of the motions of expansion and contraction, just as in the liver. From this alternate reciprocation and expansion and contraction comes an apparent rest such that there seems to be no other motion; for the general contraction of the mass, and the synchronous expansion of the glands, and vice versa, puts on all the appearance of a state of absolute tranquillity; although there is not the least part or part of a part which does not pulsate.

The pancreatic juice can still less be said to be thrown away than the hepatic and cystic biles. Like them, it is put in circulation, and like them it performs a use in its circulation. But the pancreatic juice has a more signal use than the hepatic bile, and still more than the cystic bile. Not only is it secreted before the hepatic bile, but the latter contains not only the impurities of the

blood but also the crudities of the chyle. The glands of the pancreas do not invite or receive all the blood of the splenic artery, but only that portion which they are competent to secern, the rest being sent off by the anastomosing arteries and veins into the splenic vein, to go ultimately to the liver. It seems possible to infer this from the frequent anastomoses, and the softness of the substance of the pancreas as compared with that of the liver.

By the mixture of the pancreatic juice with the hepatic and cystic biles, a universal salivary menstruum is prepared which is adapted to every necessity and demand of the intestines which digest the food to be digested. The pancreatic juice is the first cause, the hepatic bile the second, and the cystic bile the third.

Every humor which nature produces is of so perfect a nature that it becomes a universal menstruum; for all that is in it, is put there for continuing the life of the body. If defect or fault there be, it arises from ourselves—from the intemperance of our appetites, the unbridled excess of our passions and their collision with the affections of the mind and soul, and from very numerous other causes.

As the pancreatic, hepatic, and cystic juices constitute a universal menstruum for further digesting the food in the intestines, so the blood of the splenic vein, after passing through the pancreas and being there a second time purified, is a universal menstruum for refining the chyle in the liver. So again the lymph of the lymphatics of the liver, and many other viscera, is a universal menstruum for refining the chyle that escapes by way of the mesentery. Thus there are as many ministering menstrua and appliances as there are departments in the elaboration and refinement of the chyle.

From the circles above referred to, it may also somewhat be known to what province in the Grand Man, and correspondently in the body, spirits and angels belong. The circles of those who belong to the province of the *Lymphatics* are slight and rapid, like gently flowing water, so that scarcely any circling can be perceived. They who belong to the Lymphatics are afterwards conveyed into places which they said have reference to the *Mesentery,* and where I was told that there are, as it were, labyrinths, and that they are afterwards taken away to various places in the Grand Man to serve for use, as is done with the chyle in the body (*A.C.* n. 5181).