

rupture into the intestine occurs, blood may appear in the stools. There is sometimes very great and rapid loss of weight. Pancreatic salivation (increased flow of saliva) is rare. Sugar in the urine would indicate very extensive

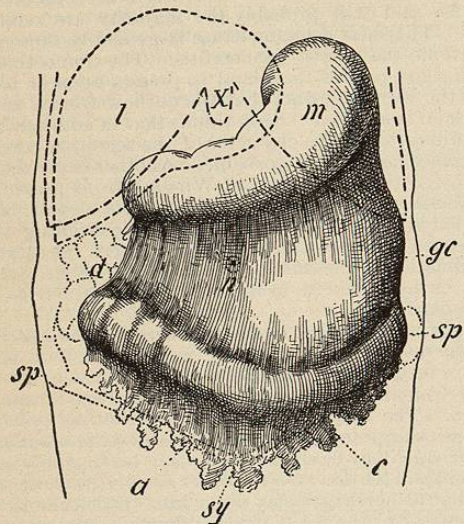


FIG. 3732.—Showing the Appearances which were Presented, in a Case of Large Pancreatic Cyst, when the Abdomen was Opened and its Contents Freely Exposed to View. The cyst, in its growth, had forced its way forward between the stomach and the colon, and was putting the ligamentum gastrocolicum upon the stretch. (After H. Kehr.)

cirrhosis of the gland. Fat in the stools is seldom found. Icterus may result from pressure. The development of a palpable tumor is the most suggestive symptom. The discovery of ferments in the sac contents is noted.

Diagnosis.—Clearly a cyst of the pancreas can be recognized only after it has reached a size that can be palpated. A palpable cyst is the most easily diagnosed of all the diseases of this deeply situated gland. The presence of a fixed fluctuating tumor in the median line above or below the umbilicus should certainly suggest pancreatic cyst.

The first fact to be clearly established is the relation of the tumor to the adjoining viscera, especially to the stomach, colon, and intestines. The inflation of the stomach and colon with air or gas will give great assistance in the determination of this relationship. If the cyst has passed forward between the stomach and colon, pushing before it the gastrocolic omentum, a clear percussion note should be heard above and below the tumor if it is a large one; and if it is small, the distended stomach and colon may meet together in front of it. If the tumor projects forward below the liver and above the stomach, the dull percussion note of the liver may be continuous with that of the tumor. The difficulty of differentiating a pancreatic cyst thus placed from a distended gall-bladder or an echinococcus cyst, or other fluid collection connected with the liver, would be very great, and probably could be accomplished only by examination of the contents removed by a Pravaz syringe. Possibly by examining the patient in the erect position, a line of tympany could be found between the liver and cyst. A pancreatic cyst would not move during inspiration or expiration.

If the tumor projected forward below the colon, the dull note of the tumor should be easily elicited between the tympany of the colon above and that of the small intestines below.

It may grow behind and push forward the stomach, or it may pass forward between the layers of the mesocolon, in which case the stomach or colon would lie immediately in front of the tumor. When so situated it is generally possible, after inflation, to establish the mobility

and freedom of the stomach or colon from involvement in the body of the tumor.

The differential diagnosis between a cystic tumor of the pancreas and a solid tumor of the spleen should not be difficult. To differentiate a cyst springing from the tail of the pancreas from an echinococcus cyst of the spleen—the only cystic growth involving the spleen—may be very difficult, and perhaps impossible except by an examination of the cyst contents.

Great difficulty may be found in differentiating between a pancreatic cyst and hydronephrosis. In hydronephrosis the bulging is generally in the lumbar region. There may also be a history of renal colic, of the passage of a renal calculus or blood, or other urinary derangement. An examination of the urine may throw light on the case. A cystoscopic examination of the bladder might show that no urine was entering from that side.

From large ovarian cysts the history should show that the growth began low down and laterally. Cysts of the mesentery are movable. Aneurisms of the aorta or its branches are pulsating and expansile.

The aspiration of cysts for diagnostic purposes is a questionable procedure. There is always a danger of puncturing a flattened-out overlying viscus, of wounding some abnormally placed vessel—and the walls of a pancreatic cyst are sometimes very vascular,—or of permitting the escape of infective contents,—as, for instance, hooklets in the case of echinococcus cysts,—or of pathogenic organisms. An exploratory incision is now so safe that it is to be recommended as an almost universal rule in place of puncture. When the fluid is obtained, its examination may be far from satisfactory. The ferments may be present, but diastatic and fat-emulsifying ferments occur in various other exudates. The only positive sign would be the presence of the ferment which digests fibrin and albumin, and it is often absent. The presence of blood would be very suggestive. It occurs, however, in ovarian cysts with a twisted pedicle. Küster thinks the presence of fat globules is characteristic of

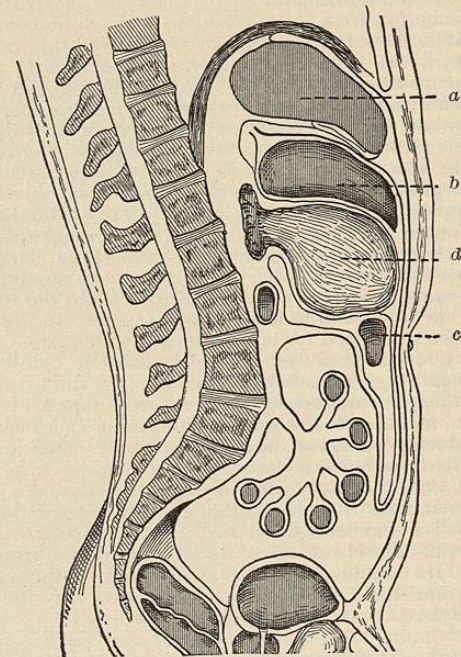


FIG. 3733.—Shows the Relations which the Pancreatic Cyst Bears to the Neighboring Organs in the Majority of Cases. (From Kehr.) a, Liver; b, stomach; c, transverse colon; d, pancreatic cyst.

pancreatic cyst. "A remarkable feature often noticed has been the transitory disappearance of the cyst. In Halsted's case the girth of the abdomen decreased from

forty-three to thirty-one inches in ten days, with profuse diarrhœa. Sometimes the disappearance has followed blows" (Osler).

Prognosis.—The rapidity of the growth of pancreatic cysts is difficult to ascertain, because the date of their commencement can seldom be determined. They are

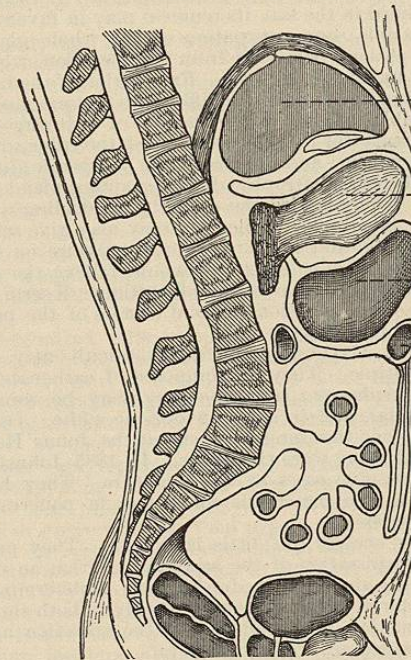


FIG. 3734.—Shows the Relations which the Pancreatic Cyst Bears to the Neighboring Organs in a Smaller Group of Cases. (From Kehr.) a, Liver; b, stomach; c, transverse colon; d, pancreatic cyst.

probably of slow growth as a rule. When following trauma or acute inflammatory processes, however, they may develop into palpable tumors in two or three weeks. Their duration is also uncertain; instances of their being present for thirty or forty years are reported. They sometimes rupture spontaneously into the stomach or intestine, as evidenced by the vomiting, or passage by rectum, of a quantity of bloody fluid. Their occasional disappearance and reappearance may possibly be explained by the assumption that in this way they periodically empty themselves into the stomach or intestine. Echinococcus cyst of the spleen is very rare. One case is reported by Heller. Rupture of a pancreatic cyst may occur into the peritoneal cavity.

Treatment.—Medical treatment is useless. Preventive treatment can influence only the most common cause of cyst development, viz., chronic indurative pancreatitis. The surgical methods which have been adopted are, puncture, application of caustics to the cystic cavity, emptying of the cyst and stitching of the cyst wall to the abdominal incision at one or two operations, opening and drainage of the cyst through a lumbar incision, and excision of the cyst wall, partially or wholly.

Puncture of the sac is to be condemned for the reasons given in the paragraph on diagnosis, and because it is insufficient.

The application of caustic to the interior of the sac wall in the case reported proved fatal.

The method which has been employed in the greatest number of cases is that first adopted by Gussenbauer, viz., the opening and emptying of the sac followed by immediate suture to the edges of the abdominal incision and drainage by means of gauze or drainage tube, or both. The incision is best made over the most prominent part of the tumor. The cyst wall should be very carefully uncovered, as far as possible, by blunt dissection.

Great care should be exercised in the ligature of overlying vessels, that none essential to the blood supply of the colon are interfered with. The wall of the sac is sometimes very thin and must be handled gently.

After carefully protecting the peritoneum by the placement of sterile gauze pads, the cyst may be incised or punctured with a trocar having a tube attached to convey the fluid into a receptacle. After the cyst wall is stitched to the abdominal incision the cavity should be packed with strips of plain sterilized gauze; iodoform gauze is to be avoided, as there is a possibility of iodoform intoxication. The fluid that escapes tends to irritate and digest the skin. This should be prevented by a liberal use of zinc ointment. Boeckel²⁵ reports ninety-nine cases treated by this method, with ninety-two recoveries and seven deaths.

The subsequent history of these cases in some respects is satisfactory. The nutrition improves wonderfully and quickly, although pancreatic juice may continue to flow from the wound. There is sometimes great difficulty in getting the fistula to close. If it does not close in five or six weeks it may remain open for years. When the opening persists, closure may be effected by the application of nitrate of silver or chloride of zinc.

The above method carried out in two stages has not been adopted in as many cases, but the results have been very good. Boeckel²⁵ reports sixteen cases and sixteen cures.

Drainage through a lumbar incision is indicated only in those cases in which the cyst lies far back in the loin. An anterior exploratory incision may show this to be the best route by which to approach the tumor.

Complete excision of the sac wall, while perhaps the ideal method, is possible only when the sac wall is well

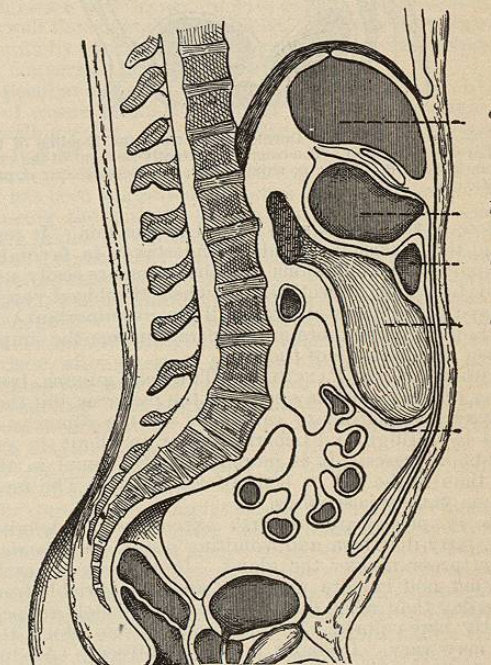


FIG. 3735.—Represents a Case in which the Pancreatic Cyst has Developed between the Laminae of the Mesocolon, coming Forward between the Transverse Colon and the Small Intestines. (From Kehr.) a, Liver; b, stomach; c, transverse colon; d, pancreatic cyst.

defined and not too closely united by adhesions to the neighboring organs. If the cyst is pedunculated, its total extirpation might be indicated. The difficulty arises in dealing with the adhesions, the blood-vessels, and the point of origin from the pancreas. The vessels are generally numerous and large. Another great diffi-

culty is to avoid injuring or tearing vessels essential to the nourishment of the colon. Koerte has collected 21 cases with 6 deaths. In 7 cases the difficulties were so great that the operation could not be completed; of these, 4 died. Boeckel reports 25 cases of total or partial excision, with 21 cured and 4 deaths. If the sac is excised, the space from which it has been removed should be packed with gauze and drained through the abdominal

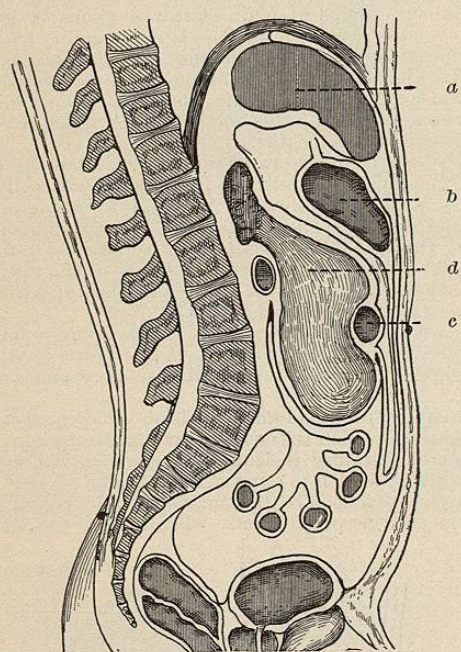


FIG. 3736.—Shows the Cyst Developed Between the Laminae of the Transverse Mesocolon. The colon lies directly in front of the cyst. (From Kehr.) a, Liver; b, stomach; c, transverse colon; d, pancreatic cyst.

incision, or through a stab wound in the loin. It may be said that excision should be undertaken in favorable cases only, when adhesions are absent or are easily separated by blunt dissection, and when the blood-vessels involved in the sac wall are small and unimportant. It is certainly a much more grave operation than the simple incision and drainage of the sac.

TUMORS OF THE PANCREAS.—Tubercle, gumma, lymphoma, and sarcoma may occur in the pancreas, but they are very rare. Primary carcinoma of the pancreas is stated by Willigk and Lebert to occur in about six per cent. of all cases. It is more frequently found in the head than in the tail or body of the gland. The most common variety is scirrhous.

The *symptoms* are at first exceedingly indefinite. Later, fatty diarrhoea and vomiting occur, with tenderness on pressure over the gland. Jaundice is an early symptom, and is more persistent and less variable from day to day than when due to stone. The stools are persistently clay-colored. In obstruction from stone the color may vary. Diabetes is seldom present. An important diagnostic point, according to Courvoisier and Ecklin, is the condition of the gall-bladder. In stone the gall-bladder is usually small and shrunken, while in carcinoma it may be very much distended and palpable as a tumor. When stone and carcinoma exist together the difficulties in diagnosis are very great. An examination under an anesthetic should be of great assistance. Emaciation is rapid and extreme. A palpable tumor is seldom found until the disease and its attendant emaciation are well advanced. The examination of the stomach contents, together with the comparatively good functioning power of that organ, should enable one to

exclude carcinoma of the stomach. The tumor sometimes becomes adherent to the stomach, and in some cases the disease has perforated the stomach wall. Hæmatemesis might give evidence of this complication.

Treatment.—The treatment of carcinoma is most difficult and unsatisfactory. In the primary course of the disease the diagnosis is wellnigh impossible. If the disease is localized in the tail, its removal may in favorable cases be feasible; but extirpation of the whole gland, even if the patient recovered from the operation, would be followed by a fatal diabetes. Extirpation of the head of the gland presents technical difficulties that are almost insurmountable. There is the danger of injuring the vessels necessary for the nourishment of the colon, duodenum, and spleen; and if both of the pancreatic ducts are tied, diabetes and atrophy of the remaining gland tissue follow. There is also the difficulty of dealing with the common bile duct. Cholecystotomy may give relief from the icterus; and if there is great pressure on the duodenum, a gastro-enterostomy would relieve the obstructive symptoms, vomiting and inanition. Koerte reports ten cases of operation on solid tumors of the pancreas with six recoveries.

PANCREATIC CALCULI.—Pancreatic calculi may be single or multiple. They are composed of carbonate of lime and phosphates. In shape they may be round, oval, or angular, and in color an opaque white. Osler states that in one thousand autopsies at the Johns Hopkins Hospital there were two cases. In 1885 Johnston collected thirty-five cases in the literature. They had been found in the pancreatic ducts and in pancreatic cysts and abscesses.

As to their *etiology* but little is known. They may result from inspissation of the secretion or from an obstruction in the ducts, or be due to some undetermined action of bacteria. Probably, as in the liver, both slowing or obstruction in the outflow of the secretion and bacterial infection are etiological factors.

The results are found in the gland itself. They are: inflammatory indurations, cyst and abscess formation, a predisposition to the development of malignant disease, and obstruction to the common bile duct from pressure upon, or the blocking of, the ampulla of Vater at the duodenal opening.

A definite *diagnosis* is seldom possible. The pain could not be differentiated from gall-stone colic. Pain in the left hypochondrium is thought to be suggestive of pancreatic calculus. Pain, vomiting, fatty stools, diabetes, and the passage of carbonate of lime stones would render the diagnosis probable. Carbonate of lime calculi, however, are sometimes formed in the intestines.

A stone might be removed from a cyst or abscess or from a dilated duct. If jaundice is present and the obstruction cannot be found and removed, cholecystotomy would be indicated.

George E. Armstrong.

REFERENCES.

- 1 Morris: Human Anatomy, 1899.
- 2 Brewer: Transactions American Surgical Assn., 1901.
- 3 Ople: The American Journ. of the Med. Sci., January, 1901.
- 4 Kehr: Handbuch der praktischen Chirurgie, vol. iii., 572.
- 5 Robson: Trans. Amer. Surg. Assn., 1901.
- 6 Draper: Trans. Assn. of Amer. Physicians, 1886.
- 7 Fitz: Allbutt's System of Medicine, vol. iv.
- 8 Prince: Boston Med. and Surg. Journ., vol. cvii., p. 55.
- 9 Tiekens: American Medicine, November 23d, 1901, p. 826.
- 10 Ecker: Henle u. Pfeuffer's Zeitschrift für rat. Med., 1862, xiv.
- 11 Auberg: Quoted by Generisch.
- 12 Symington: Journ. of Anatomy and Physiology, 1885, xix.
- 13 Generisch: International Medical Congress, 1891, ii.
- 14 Oser: Nothnagel's Specielle Pathologie und Therapie, viii., 2, 1898.
- 15 Brewer: Trans. Amer. Surg. Assn., 1901, p. 172.
- 16 Flexner: University Medical Magazine, vol. xiii., p. 780.
- 17 Katz and Winkler: Quoted by Flexner.
- 18 Cammidge: Quoted by Robson.
- 19 Osler: Practice of Medicine, 1898.
- 20 Chiari: Handbuch der praktischen Chirurgie, 1900, vol. iii., p. 370.
- 21 Dieckhoff: Nothnagel's Specielle Pathologie und Therapie, viii., 2, 1898.
- 22 Bloodgood: Progressive Medicine, December, 1901.
- 23 Kehr: Handbuch der praktischen Chirurgie.
- 24 Koerte: Archiv für klinische Chirurgie, Bd. xlvi., 1894.
- 25 Baeckel: Revue de Chirurgie, September 16th, 1900.
- 26 Ople: Journ. of Exper. Med., January, 1901.
- 27 Koerte: Quoted by Osler.

PANCREATIN.—**PANCREATINUM.** "A mixture of the enzymes naturally existing in the pancreas of warm-blooded animals, usually obtained from the fresh pancreas of the hog (*Sus scrofa* Linné; class, Mammalia; order, Pachydermata). A yellowish, yellowish-white, or grayish amorphous powder, odorless, or having a faint, peculiar, not unpleasant odor, and a somewhat meat-like taste.

"Slowly and almost completely soluble in water, insoluble in alcohol.

"Pancreatin digests albuminoids, and converts starch into sugar; prolonged contact with mineral acids renders it inert.

"If there be added to 100 c.c. of tepid water contained in a flask, 0.28 gm. of pancreatin and 1.5 gm. of sodium bicarbonate, and afterward 400 c.c. of fresh cow's milk previously heated to 38° C. (100.4° F.), and if this mixture be maintained at the same temperature for thirty minutes, the milk should be so completely peptonized that if a small portion of it be transferred to a test tube and mixed with some nitric acid, no coagulation should occur.

"Peptonized milk, prepared in the manner just described, or even when the process is allowed to go on to the development of a very distinct bitter flavor, should not have an odor suggestive of rancidity."

The pancreas contains four distinct enzymes which are known by their action: the proteolytic—trypsin; the diastasic—amyllopsin or diastase; the milk-curdling; and the fat-splitting. No one of these ferments has been isolated. The proteolytic enzyme converts proteids with equal or greater facility than pepsin, but it differs from pepsin in respect to the media in which it exerts its activity, and also in respect to the final products of its action. Trypsin bears no relation to an alkaline medium which corresponds to the dependence of pepsin upon acid; it acts with equal facility in a neutral or a faintly alkaline medium. Alkalies, more particularly sodium carbonate or bicarbonate, up to one per cent. of the digesting mass, are generally stated to be most favorable to the action of trypsin; the writer, however, has not found in digestion in vitro that sodium bicarbonate in 0.1 per cent. to 1 per cent. has given better results than parallel tests in which the alkali was omitted, while more than traces of free alkali were found unfavorable. Trypsin in antiseptic solutions (with thymol) containing as small an amount as 0.1 per cent. anhydrous sodium carbonate, has been found to undergo rapid deterioration at ordinary room temperature. While the pancreas juice obtained from living animals is alkaline, the pancreas gland, as soon as it may be conveniently treated upon removal from the recently killed animal, will be found to give an acid reaction. Aqueous infusions, glycerin or hydro-alcoholic extract, from such gland are invariably acid to litmus, and the acid present in these solutions does not in the slightest degree interfere with the pancreas enzymes in vitro; this acidity is reasonably to be attributed to nucleic acid, and undoubtedly the proteid is bound up in the cell with acid. The ash is invariably acid, containing phosphoric acid and potash, presumably acid phosphate. Minute percentages of mineral (0.03 per cent. HCl) and organic (0.25 per cent. acetic) acids do not interfere with the action of trypsin, but have been observed slightly to enhance it. Furthermore, the latent mother ferment, trypsinogen, is developed by the influence of the acid constituents of the gastric juice, and probably likewise of foodstuffs, for in the treatment of the gland itself it is found that the addition of minute amounts of organic acids yields the ferment in an active form from the trypsinogen. Trypsin, however, is very sensitive to more than traces of free mineral acid, 0.1 per cent. to 0.15 per cent. HCl destroying it immediately, and subsequent neutralization failing to revive it. So far, therefore, as may be gathered from these facts there is no evidence in support of the impression which has gained so much credence—that pancreatin depends upon an alkali for activity or in any way bears such a relation to an alkali as pepsin does to acid.

Trypsin converts native proteids into soluble and diffusible forms of albumoses and peptones which differ in no known way from those derived from peptic action, and causes by prolonged digestion a further cleavage of these proteids into simpler nitrogenous bodies—the amido-acids, leucin, tyrosin, etc., and hexone bases, ammonia, etc. Recent researches have led to the opinion that the development of these proteids into these crystalline bodies is essential to their complete utilization in nutrition.

Trypsin exhibits a special affinity for the digestion of certain native forms of proteids—fibrin, muscular tissue, both raw and cooked; these are promptly digested by the trypsin, whereas its action upon coagulated egg albumen is very slow in comparison with that of pepsin.

The products of peptic digestion (those intermediary between raw proteid and true peptone, syntonin and albumoses) are likewise, after neutralization, quickly converted into peptone by trypsin. Rapidity of action seems to be the natural function of trypsin. It exhibits a peculiar affinity for the casein of milk, as natively existing in milk, peptonizing this proteid with great celerity without the intervention of an alkali.

Certain differences in the physical phenomena observed in tryptic and peptic digestion have led some to suppose that trypsin exerts a peculiar erosive action. The swelling of tissue, the gelatinous character which fibrin almost instantly assumes under pepsin acid digestion, is not to be accounted for by any peculiar action of the pepsin itself; it is due to the influence of the hydrochloric acid which combines with raw proteins to form syntonin—this being very penetrable by the enzyme. In fact, one is struck with the similarity in adaptation to digestion, between gelatinous starch and this swollen, gelatinous fibrin. Boiled albumen presents no visible difference in its digestion with trypsin or with pepsin, for the acid does not swell the coagulated albumen. Trypsin (like pepsin) acts only by effecting the solution of the surface exposed—by conversion into more soluble forms.

A peculiar effect of trypsin upon milk is the conversion of casein into a form which becomes coagulable at the boiling point. This partially peptonized casein has been termed "metacasein," which, upon more complete conversion, loses its coagulability. This behavior of milk has been suggested (Roberts) as a convenient means of testing the activity of pancreatin, simply by ascertaining under certain conditions the time at which this "onset" point of conversion occurs. This is an extremely interesting reaction, and significant of the peculiar nature of casein, which, unlike other forms of native proteid, is not coagulable by heat, probably owing to its peculiar combination with inorganic constituents, losing this characteristic, after a certain amount of digestion and again becoming non-coagulable like other peptonized proteids. By rendering milk slightly alkaline by the addition of sodium bicarbonate or potassium bicarbonate, this metacasein reaction is prevented, and the milk then at any period of peptonization may be heated to the boiling point without curdling.

The starch-converting ferment of pancreatin, commonly known both as amyllopsin and as diastase, very rapidly liquefies starch paste, converting starch into maltose. Raw or uncooked starch is similarly converted, though less rapidly, the action being proportionate to the diffusion of the starch, to the surface presented to the digestive ferment, completely cooked gelatinous starch being with great facility brought into complete contact.

The products of pancreas digestion of starch are apparently identical with those of diastase from other sources—the achroo-dextrins, dextrins, and maltose. Amylopsin is extremely susceptible to the influence of chemical reagents. Its action is not enhanced in the slightest degree in alkaline media; indeed, it is greatly enfeebled by free alkali; it is also weakened by acids (mineral and organic) beyond a very slight percentage. Acids which tend to promote the development of trypsin exhibit no corresponding behavior on amylopsin. In vitro, in neutral media, or as found in its normal association with the acids of the pancreas gland or in extracts or