Al-Mustaqbal University

College of Technology and Health Sciences

Medical physics Department

Medical Physics

First Semester

3rd stage

Lesson-9

Pancreas

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Pancreas

What is Pancreas?

Pancreas is an abdominal organ located behind the stomach and surrounded by spleen, liver and small intestine. It is a vital part of the digestive system and is responsible for regulating blood sugar levels.

The pancreas secretes digestive enzymes such as amylase, proteases and lipase into the duodenum. These enzymes help in digesting sugar, proteins and fat respectively. Islets of Langerhans are embedded in the pancreas that secretes hormones such as insulin and glucagon into the blood

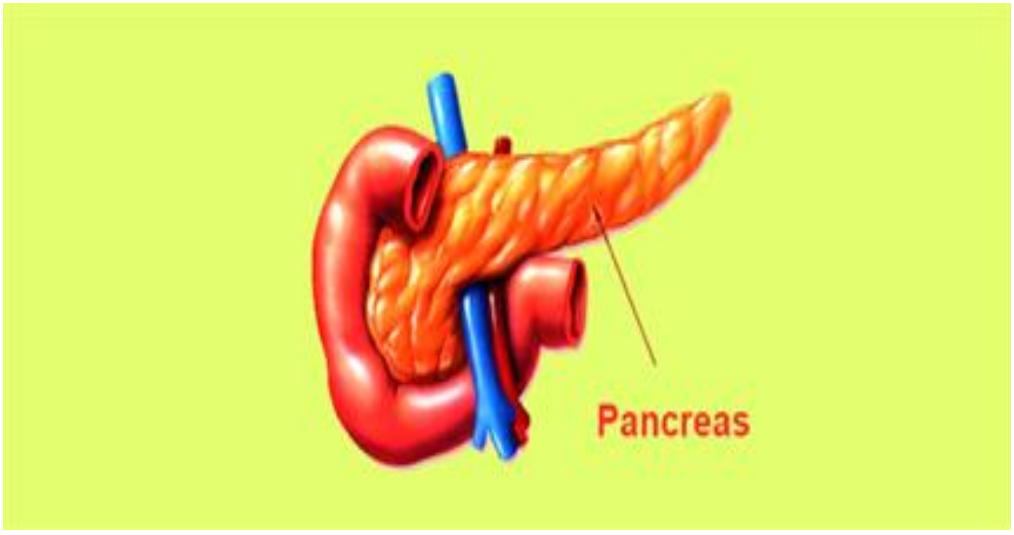

Diagram of Pancreas

Pancreas Location

The pancreas is located in the abdomen. A part of it is placed between the stomach and the spine. The other part finds its place in the curve of the first section of the small intestine, known as the duodenum.

The head of the pancreas is on the right side of the abdomen and is connected to the duodenum through the pancreatic duct. The tail of the pancreas extends to the left side of the body.

Pancreatic Diseases

Due to the inaccessibility of pancreas, the evaluation of pancreatic diseases could be difficult.

Disorders that affect the pancreas include precancerous conditions, pancreatitis, and pancreatic cancer. Each disorder exhibits different symptoms and needs different treatments.

Pancreatitis

Pancreatitis is swelling when the pancreatic enzyme is secreted and begins to digest the organ itself. It could exist as painful attacks or a chronic condition that lasts for years.

Precursors to Pancreatic Cancer

The primary reason for pancreatic cancer is yet to be known, but there are risk factors that increase the danger of

developing diseases. Some of the factors include smoking or hereditary cancer syndromes.

Pancreatic Cancer

Pancreatic adenocarcinoma is one of the most common forms of pancreatic cancer. It is an exocrine tumour that arises from the cells that line the pancreatic duct. A tumour of the endocrine gland accounts for less than 5% of all pancreatic tumours and is referred to as islet or neuroendocrine.

Pancreas Function

The pancreas performs the following functions:

Exocrine Function

The pancreas consists of exocrine glands that produce enzymes trypsin and chymotrypsin that are essential for digestion. These enzymes contain chymotrypsin and trypsin to digest proteins, amylase for the digestion of carbohydrates and lipase to break down fats. These pancreatic juices are liberated into the system of ducts and culminated in the pancreatic duct when the food enters the stomach.

Endocrine Function

The endocrine part of the pancreas comprises Islets of Langerhans that release insulin and glucagon directly into the

bloodstream. They help in regulating the blood sugar levels of the body.

Blood glucose regulation

Cells within the pancreas help to maintain blood glucose levels (homeostasis). The cells that do this are located within the pancreatic islets that are present throughout the pancreas. When blood glucose levels are low, alpha cells secrete glucagon, which increases blood glucose levels. When blood glucose levels are high beta cells secrete insulin to decrease glucose in blood. Delta cells in the islet also secrete somatostatin which decreases the release of insulin and glucagon.

Glucagon acts to increase glucose levels by promoting the creation of glucose and the breakdown of glycogen to glucose in the liver. It also decreases the uptake of glucose in fat and muscle. Glucagon release is stimulated by low blood glucose or insulin levels, and during exercise Insulin acts to decrease blood glucose levels by facilitating uptake by cells (particularly skeletal muscle), and promoting its use in the creation of proteins, fats and carbohydrates. Insulin is initially created as a precursor form called preproinsulin. This is converted to proinsulin and cleaved by C-peptide to insulin which is then stored in granules in beta cells. Glucose is taken into the beta cells and degraded. The end effect of this is to cause depolarisation of the cell membrane which stimulates the release of the insulin.

The main factor influencing the secretion of insulin and glucagon are the levels of glucose in blood plasma. Low blood sugar stimulates glucagon release, and high blood sugar stimulates insulin release. Other factors also influence the secretion of these hormones. Some amino acids, that are byproducts of the digestion of protein, stimulate insulin and glucagon release. Somatostatin acts as an inhibitor of both insulin and glucagon. The autonomic nervous system also plays a role. Activation of Beta-2 receptors of the sympathetic nervous system by catecholamines secreted from sympathetic nerves stimulates secretion of insulin and glucagon whereas activation of Alpha-1 receptors inhibits secretion. M3 receptors of the parasympathetic nervous system act when stimulated by the right vagus nerve to stimulate release of insulin from beta cells.

Digestion

The pancreas has a role in digestion, highlighted here. Ducts in the pancreas (green) conduct digestive enzymes into the duodenum. This image also shows a pancreatic islet, part of the endocrine pancreas, which contains cells responsible for secretion of insulin and glucagon.

The pancreas plays a vital role in the digestive system. It does this by secreting a fluid that contains digestive enzymes into the duodenum, the first part of the small intestine that receives food from the stomach. These enzymes help to break down carbohydrates, proteins and lipids (fats). This role is called the

"exocrine" role of the pancreas. The cells that do this are arranged in clusters called acini. Secretions into the middle of the acinus accumulate in intralobular ducts, which drain to the main pancreatic duct, which drains directly into the duodenum. About 1.5–3 liters of fluid are secreted in this manner every day.

The cells in each acinus are filled with granules containing the digestive enzymes. These are secreted in an inactive form termed zymogens or proenzymes. When released into the duodenum, they are activated by the enzyme enterokinase present in the lining of the duodenum. The proenzymes are cleaved, creating a cascade of activating enzymes.

Enzymes that break down proteins begin with activation of trypsinogen to trypsin. The free trypsin then cleaves the rest of the trypsinogen, as well as chymotrypsinogen to its active form chymotrypsin.

Enzymes secreted involved in the digestion of fats include lipase, phospholipase A2, lysophospholipase, and cholesterol esterase.

Enzymes that break down starch and other carbohydrates include amylase.

These enzymes are secreted in a fluid rich in bicarbonate. Bicarbonate helps maintain an alkaline pH for the fluid, a pH in which most of the enzymes act most efficiently, and also helps to neutralise the stomach acids that enter the duodenum. Secretion is influenced by hormones including secretin,

cholecystokinin, and VIP, as well as acetylcholine stimulation from the vagus nerve. Secretin is released from the S cells which form part of the lining of the duodenum in response to stimulation by gastric acid. Along with VIP, it increases the secretion of enzymes and bicarbonate. Cholecystokinin is released from Ito cells of the lining of the duodenum and jejunum mostly in response to long chain fatty acids, and increases the effects of secretin. At a cellular level, bicarbonate is secreted from centroacinar and ductal cells through a sodium and bicarbonate cotransporter that acts because of membrane depolarisation caused by the cystic fibrosis transmembrane conductance regulator. Secretin and VIP act to increase the opening of the cystic fibrosis transmembrane conductance regulator, which leads to more membrane depolarisation and more secretion of bicarbonate.

A variety of mechanisms act to ensure that the digestive action of the pancreas does not act to digest pancreatic tissue itself. These include the secretion of inactive enzymes (zymogens), the secretion of the protective enzyme trypsin inhibitor, which inactivates trypsin, the changes in pH that occur with bicarbonate secretion that stimulate digestion only when the pancreas is stimulated, and the fact that the low calcium within cells causes inactivation of trypsin.