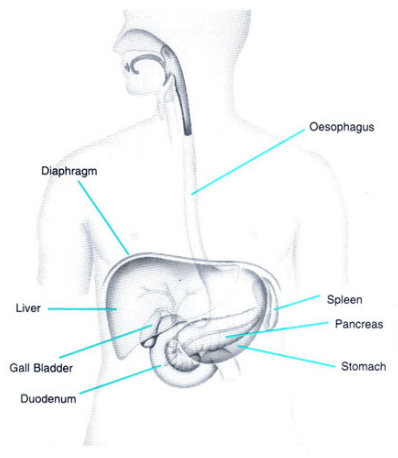
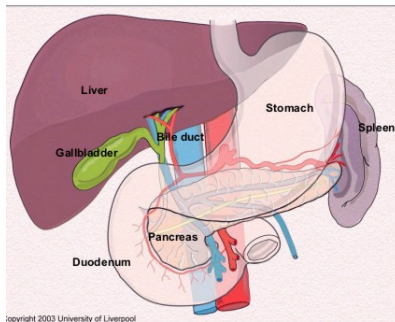


About the Pancreas

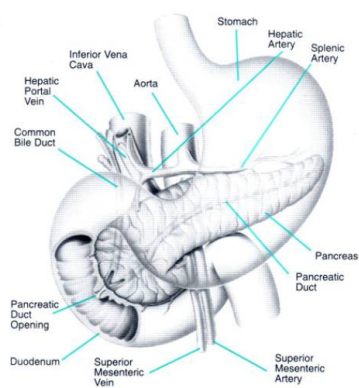


What is the Pancreas

The pancreas is a solid gland measuring 20-25cm in length, 4-6cm in width and 3-4cm in depth. It is firmly attached in the back of the abdominal cavity behind the stomach. The pancreas is divided into 5 parts - the head, the uncinuate process, the neck, the body and the tail. The head of the gland is closely attached to the duodenum which is the first part of the small intestine into which the stomach empties liquids and partially digested food. The head of the gland is situated just to the right of the midline of the abdomen and below the right rib-cage.



The uncinuate process is an extension of the lower part of the head of the gland which surrounds important blood vessels. The body and tail of the pancreas lie at an angle so that the tail of the pancreas is situated beneath the extreme edge of the left rib cage. The tail of the gland is closely attached to the central part of the spleen with which it shares a common blood supply. Running behind the neck and uncinuate process are many important blood vessels which supply the liver, the rest of the gut organs and the kidneys, including the aorta (an artery) which takes all the blood to the lower abdomen and legs, and the inferior vena cava (a vein) which returns blood from these areas. The splenic vein runs immediately under the tail and body of the pancreas and joins with the hepatic portal vein that runs immediately under the neck of the pancreas.



Running along the length of the pancreas within its centre is the main pancreatic duct, which empties pancreatic juice into the duodenum. Also running through the middle of the head of the pancreas is the main bile duct which also empties into the duodenum. (The main bile duct carries bile from the liver where it is made and also from the gallbladder where it is stored). In most people the pancreatic duct and bile duct join together just before they open into the duodenum through a large fleshy nipple called the ampulla of Vater (after the person who described this).

Surrounding the openings of each of these ducts are small muscles that control the release of pancreas juice and bile and thus act as valves (also called sphincters). There is also a valve that regulates the pancreas juice and bile together and this sits in the ampulla. This common valve is called the sphincter of Oddi, also named after the man who described this.

About one in ten people have two separate pancreatic ducts, one that opens as normal through the ampulla of Vater and the other through a smaller nipple (as called a papilla). For this reason the ampulla of Vater is sometimes called the major papilla and the other smaller opening is called the minor papilla.

Because the pancreas duct is divided into two separate ducts the condition is called pancreas divisum (the Latin term for divided is divisum). The pancreatic duct that opens through the minor papilla is called the accessory pancreatic duct (normally this joins the main pancreatic duct rather than opening separately into the duodenum).

WHAT DOES THE PANCREAS DO?

The pancreas does two important things:

- It makes enzymes which are necessary to digest food in the intestines.
- It produces insulin to enable every part of the body to use glucose (sugar).

1. DIGESTION

Food is partly broken down by the acid and churning action of the stomach. After 1-2 hours food is slowly released into the duodenum through a valve called the pylorus. Here, and as it moves along the rest of the small bowel, the food is broken down into tiny particles. Nutrients are absorbed by the small intestine and used for energy and maintaining strong muscles and bones. Unwanted material passes into the large bowel (colon) and after 24 hours or so is excreted as stool via the rectum and anus.

Digestion of food which consists of carbohydrates (e.g. glucose), proteins (e.g. meat) and fat (e.g. butter) is not possible without the pancreas. Groups of glands in the pancreas (called acini) make 30 or so different enzymes each of which is responsible for breaking down clumps of different types of food into small particles for absorption. These enzymes are collected from the small glands in the pancreas into small ducts and finally into the main pancreatic duct to be released into the duodenum.

The enzymes when they are first made in the acini are not active (otherwise they would digest the pancreas as well!). When they pass into the duodenum however, they are made active by the juice of the duodenum. The main enzymes are called amylase for digesting carbohydrates, trypsin for digesting proteins and lipase for digesting fats.

Digestion is also assisted by enzymes made and released by the salivary glands (amylase), tongue (lipase), stomach (pepsin and lipase) and small intestine (peptidases).

The digestion of fat is very special. Fat needs to be dispersed before the pancreatic enzymes can properly break it down. This dispersion of fats is made by bile acids, which are present in bile produced by the liver and stored in the gall bladder. Bile acids act in exactly the same way as detergents, which are used to wash up greasy dishes. Therefore, both bile acids and pancreatic enzymes are needed for fat digestion. This is why the main pancreatic duct and the main bile duct join up together so that pancreatic juice and bile can be emptied together. If there are not enough pancreatic enzymes, fat is not digested and the stools (bowel motions) become pale and greasy. These greasy stools may become difficult to flush away from the toilet and may give off a strong offensive smell. Doctors call this steatorrhea, which is a way of saying fatty stool.

For the same reason if the main bile duct becomes blocked then the bile cannot get into the duodenum. This means that the fat cannot be properly digested and results in the stools becoming pale in colour. Because the bile made by the liver cannot go into the bowel it goes into the blood and out through the kidneys into the urine. This results in the eyes and skin becoming yellow and is known as yellow jaundice. As the bile is in the urine this now becomes dark in colour. Because the flow of bile is blocked (or obstructed), doctors call this condition obstructive jaundice. As the bile duct goes through the head of the pancreas yellow jaundice can be caused by disease of the pancreas (such as pancreatitis or cancer).

2. INSULIN AND GLUCOSE METABOLISM:

All the cells of the body use glucose as a source of energy in order to maintain their different functions (e.g. electrical activity of the brain and contraction of the heart and muscles). Sugar comes directly from digestion or is made in the liver from concentrated forms of sugar

(glycogen). The level of sugar in the blood is kept constant by special control mechanisms involving hormones. There are many different types of hormones each with a specific task. Hormones act as messengers and work like a key opening the lock of a door.

Hormones are made in different places, are then secreted into the blood and will work on cells at many different sites. Insulin is a hormone which unlocks a special 'door' in the cells of the body to allow glucose to pass in to the cells. If insulin is lacking, then sugar diabetes develops (doctors call this diabetes mellitus). Instead of entering the cells of the body, the sugar stays in the blood which is very harmful at high concentrations. Insulin is made in special groups of cells called islets of Langerhans which are dispersed throughout the pancreas gland.

A large proportion of the islets (pronounced 'eye-lets') are in the tail of the gland.

Most of the pancreas can be removed but there are usually enough islets remaining to make insulin sufficient to prevent sugar diabetes from occurring.

As you are probably aware, diabetes can be treated by taking regular injections of insulin, which can be taken from the pancreas of animals (e.g. pork insulin) or made by genetic engineering (so called 'human' insulin).

Enzyme production and insulin production are independent. Because digestive enzymes and insulin are made by different parts of the pancreas, a problem with enzyme production does not mean necessarily that there will be a problem with insulin production.

Similarly, if there is a problem with insulin production, this does not mean necessarily that there will be a problem with enzyme production.

Assuming that the pancreas was normal to begin with, increasing loss of the pancreas gland (by disease or surgery) usually results in more loss of enzyme production before there is obvious loss of insulin production. Another way of saying this, is that the insulin 'reserve' is much more than the enzyme 'reserve' of the pancreas.

SPECIAL INVESTIGATIONS FOR PROBLEMS WITH THE PANCREAS

Your doctor may need to do some tests to find out more about your particular problem. Perhaps you've already undergone one or more of them. The next section describes what these tests are, how and why they are done, and how they can help your doctor to treat your problem.

ULTRASONOGRAPHY OR ULTRASOUND (US) SCAN:

This is a simple, painless and relatively quick investigation which can be used to obtain a 'picture' of the inside of the abdomen. The only preparation needed is for you to avoid eating for 6-8 hours prior to the test, as any fluid or food which is taken by mouth can obscure the pictures produced. Pictures are made using harmless sound waves. These waves bounce off interfaces between dense and less dense structures. The sound waves will

not cross solid areas (such as bone) or areas containing air or other gas. Usually only a fairly simple picture of the pancreas, liver, bile ducts and gallbladder can be obtained.

The test is performed while you lie fully awake on a simple couch. A special jelly, a bit like vaseline is used to enable the 'probe', which produces and collects the sound waves, to be moved over the skin of the abdomen. The radiologist (or his assistant called a radiographer) moves the probe around and looks at a TV screen while this is done to see what pictures are being made. Although sound waves are generated during the procedure these cannot be heard.

COMPUTERISED TOMOGRAPHY (CT SCAN)

This is more complex and time consuming than an ultrasound scan but produces excellent pictures of the pancreas and other abdominal structures. As with ultrasound you need to avoid eating for 6-8 hours beforehand and is performed while you are fully awake.

You lie on a special couch attached to the CT scanner which looks like a large 'doughnut'. A CT scan uses X-rays which are emitted and collected through 360°. The couch is made to move through the doughnut as the X-rays are then put together by a computer to produce the pictures at different levels of the abdomen. In order to make it easier to interpret the structures in the abdomen, you will be asked to swallow a liquid (or 'contrast'). This fills the stomach and the intestines. Another injection of a different contrast ('dye') is given into a vein (usually in the arm) during the second half of the procedure. This helps to show up the blood vessels.

FINE NEEDLE ASPIRATION (FNA)

BIOPSY OR CYTOLOGY

USING ULTRASOUND OR CT SCAN

A small piece of tissue from the pancreas may need to be taken to help make a diagnosis. There are many ways that this can be done especially using an ultrasound scan or a CT scan to tell the doctor where to pass the needle. These procedures are always done in the X-ray department and require additional informed, written consent.

The procedure is done using sterile procedures, so the skin is cleaned with an antiseptic and special gowns are used. Local anaesthetic is injected into the skin. A very fine needle is then introduced and its tip positioned using pictures from the scan before any tissue is taken.

If solid tissue is taken, however small this is called a biopsy and is examined by a pathologist using a microscope (called histology). Because a fine needle is used it is called a fine needle biopsy.

If only some individual cells have been removed these are also examined by a special pathologist called a cytologist and the examination is called cytology. Because the cells are obtained by a sucking action (or aspiration) on the needle using a syringe, the procedure is called fine needle aspiration (FNA) for cytology or just FNA.

Are needle biopsy and aspiration cytology safe?:

These procedures are safe and accurate in specialist centres. Complications such as bleeding or acute pancreatitis can occur, but only very occasionally.

ENDOLUMINAL ULTRASOUND (EUS)

This is a special investigation for taking ultrasound pictures of the pancreas, pancreatic and bile ducts and surrounding tissue such as blood vessels. The pictures are taken by a special probe inserted into the stomach and duodenum.

Because the ultrasound probe is much closer to the pancreas, EUS can provide pictures that much clearer than the usual ultrasound scan. The pictures that it provides are complementary to those given by ultrasound or CT.

EUS is performed using special flexible telescope with an ultrasound probe at its tip. The telescope (or endoscope - hence endoscopic ultrasound) is passed into the mouth, down the gullet and into the stomach. At this point the ultrasound probe is switched on and the pancreas can be seen through the stomach wall.

The pictures are displayed on a television screen and copies of the images can be made. The telescope is then passed into the duodenum to obtain different views of the pancreas and also of the bile ducts, gallbladder and the liver.

If your doctor decides you should have an EUS it is essential that you do not eat or drink anything for at least 8 hours before the test. The procedure is done on a flat couch under sedation. You will be asked to sign a consent form agreeing to this procedure because it is complicated. Normally you are taken on a trolley to the endoscopy or X-ray department and, after being checked by a nurse, asked to move onto the flat couch. You will be asked to lie on your left side with your left arm behind your back and be given a throat spray of local anaesthetic. This tastes awful but the feeling quickly goes and it will stop any coughing during the procedure. At this stage you are given a strong sedative by injection.

This is enough to make most patients very sleepy but not fully unconscious. It is very important that you are as relaxed as possible before and during the procedure. The telescope is easily passed into the mouth and stomach. There is then a strange sensation as air is introduced into the stomach. Belching should be avoided as the air helps the endoscopist to pass the tip of the telescope into the duodenum. Most patients usually do not remember anything of the procedure.

EUS may be used to remove small cells using a small needle inserted into an area that your doctor believes to be important. Cells are drawn up a small tube (or cannula) using a small syringe. This procedure is therefore called EUS aspiration cytology (or EUS FNA) .

The results may be explained to you or a relative on the ward but the best time to discuss the findings is at the next out-patient visit or the next day on the ward. The results of cytology are often not easy to interpret and may take a while for them to become available. Sometimes this may take up to two weeks.

If you are an out-patient, full details will also be sent to your GP. The results usually combined with other tests to provide an overall diagnosis. It is always necessary for a friend or relative to drive you home if you have had an EUS as an out-patient because it takes several hours of the effects of the drugs to wear off.

ERCP

This is a special investigation for taking pictures of the bile and pancreatic ducts and is mainly used for treatment of bile duct and pancreatic duct problems . The full name of ERCP is rather a mouthful: endoscopic retrograde cholangio-pancreatography! As with EUS it involves inserting a flexible telescope or endoscope (also called a duodenoscope) into the mouth. This is passed down the gullet and into the stomach and then into the duodenum opposite the opening of the bile duct and pancreatic duct.

A small tube (cannula) is then pushed into the opening (ampulla of Vater) and contrast ('dye') is injected into the ducts. You lie on an X-ray table to enable pictures of the ducts to be taken while the contrast is injected. If your doctor decides you should have an ERCP it is essential that you do not eat or drink anything for at least 8 hours before the test.

Usually a plastic tube is put into a vein of the right forearm or the back of the hand before you go to the X-ray department. You may need a drip of intravenous fluids and be given one or more antibiotics in the drip.

You will be asked to sign a consent form agreeing to this procedure because it is complicated. Normally you are taken on a trolley to the X-ray department and, after being checked by a nurse, asked to move onto the X-ray table. As with EUS, you will be asked to lie on your left side with your left arm behind your back and be given a throat spray of local anaesthetic. This tastes awful but the feeling quickly goes and it will stop any coughing during the procedure. A second spray may then be given under the tongue, which contains a substance to help the ampulla of Vater open up during the procedure. A strong sedative is now given by injection.

This is enough to make most patients very sleepy but not fully unconscious. As with EUS, it is very important that you are as relaxed as possible before and during the procedure. The telescope is easily passed into the mouth and stomach. There is then a strange sensation as air is introduced into the stomach. Belching should be avoided as the air helps the endoscopist to pass the tip of the telescope into the duodenum. Most patients usually do not remember anything of the procedure.

To treat bile duct or pancreatic problems by this means, it is common to cut the sphincter of Oddi (see above) using a small electric current on the tip of the cannula (see above). This procedure cutting the sphincter is called a sphincterotomy. Because it is performed using an endoscope its full name is endoscopic sphincterotomy . By cutting the sphincter it makes it easier to insert bigger instruments into the bile duct or pancreatic duct to remove any gallstones or pancreatic stones.

Sometimes it is necessary to insert a temporary (plastic) or permanent (metal mesh) tube into the bile duct to keep a good flow of bile. These tubes are called biliary stents - after Dr Stent who first used these small tubes. Stents or temporary tubes (also called a cannula) may also be inserted into the main pancreatic duct.

A plastic stent is often a temporary measure to relieve jaundice and may precede surgery.

A metal stent (in the form of a wire mesh) is usually a permanent measure. It does not preclude major surgery but the operation is more challenging for the surgeon.

A small piece of tissue can be removed using minute tweezers (called forceps). This small piece of tissue is called a biopsy and is checked by histology. This procedure is therefore called endoscopic biopsy.

A small brush may also be used to brush the side walls of the bile duct or pancreatic duct to obtain small cells that can be checked by cytology. This procedure is therefore called brush cytology .

The results may be explained to you or a relative on the ward but it can take time to receive the results of histology or biopsy. If you have been treated mainly as an out-patient, then the best time to discuss the findings and any procedures is at the next out-patient visit or the next day on the ward.

If you are an out-patient, full details will also be sent to your GP. The results are not always easy to interpret and are usually combined with other tests to provide an overall diagnosis.

It is always necessary for a friend or relative to drive you home if you have had an ERCP as an out-patient because it takes several hours of the effects of the drugs to wear off.

Is ERCP safe?:

ERCP is safe with no complications in about 95% of cases. There are occasionally complications from ERCP however, the most common of which are abdominal pain, acute pancreatitis, biliary infection and bleeding.

If the procedure was planned as a day case procedure, it will be necessary to keep you in hospital overnight if there has been a complication.

In most cases, the complications improve, and patients are soon discharged. Very occasionally the complication is serious and death may result in a very small proportion of cases. For patients that are having ERCP for treatment (such as having a stent inserted or removed) special precautions are taken to reduce the risk. These precautions usually include having a drip running in extra fluid into an arm or neck vein, antibiotics and a bladder tube (urinary catheter) and a urinary collecting bag to make sure that the kidneys (which make the urine) are working properly.

For these reasons, an ERCP must be:

- Performed by a specialist.
- Performed for a good reason.

MAGNETIC RESONANCE IMAGING (MRI)

An MRI scan is similar to a CT scan but uses magnetic resonance to image the pancreas instead of X-rays. Very powerful magnets are used to generate the pictures. For this reason patients that have certain metal parts inside their bodies (that can respond to the magnet) must not have this procedure. Most modern appliances introduced into patients, such as clips during open surgery or a heart valve with metal parts, are made of material which cannot respond to the magnet and are therefore safe. As a precaution you must tell your doctors if you have any such appliances in your body to let them decide.

MRI scans have the advantage that no X-rays are emitted and therefore are particularly suited to patients who need to have many such tests. The type of pictures produced by MRI however are not the same as CT and the decision of which to use and when to use them will rest with your doctors.

MRI can also be used to provide very good pictures of the bile ducts and pancreatic ducts. This procedure is called MRCP, which is short for magnetic resonance cholangio-pancreatography.

PTHC

Sometimes it is not possible to approach the bile duct or to enter the bile duct using ERCP. In this situation it may be necessary to insert a very fine needle into the bile duct by going first through the skin on the right side and then finding a branch of the main bile duct in the liver. Therefore the full name of this procedure is percutaneous transhepatic cholangiography and is always performed in the X-ray department.

Pictures of the bile ducts are taken after injecting some 'dye' or contrast. PTHC can be used to provide temporary drainage of bile, remove gallstones from the bile duct, perform brush cytology (see above) and insert a biliary stent (see above), which may be either plastic or metal.

PTHC is usually done using an ultrasound scan or a CT scan to tell the doctor where to pass the needle. The procedure is done using sterile procedures, so the skin is cleaned with an antiseptic and special gowns are used. Before the needle is passed local anaesthetic is injected into the skin. The needle may need to be passed between the lower ribs on the right hand side but this is quite safe.

In difficult situations both PTHC and ERCP are performed together - one technique makes it easier for the other technique to be successful. When both techniques are used together it is known as a combined procedure or rendezvous procedure. PTHC requires additional informed, written consent.

Is PTHC safe?:

PTHC is safe with no complications in about 95% of cases. There are occasionally complications from PTHC however, the most common of which are abdominal pain, biliary infection, bleeding and a bile collection or abscess. In most cases, the complications improve. Occasionally the complication is serious and death may result in a very small proportion of cases.

Special precautions are taken before the procedure is performed to reduce the risk. These precautions usually include having drip running in extra fluid into an arm or neck vein, antibiotics and a bladder tube (urinary catheter) and urinary collecting bag to make sure that the kidneys (which make the urine) are working properly.

This procedure is only performed if it is really necessary and is only performed in specialist centres.

PET Scan

This is a special scan performed in the Nuclear Medicine Department and is sometimes performed in certain centres if there is uncertainty as to the diagnosis. In other words this is performed if the doctors are not sure if you have chronic pancreatitis or a small pancreatic cancer. It is also used in some centres to see if the pancreas cancer has spread to other organs. It is also used to see how well some new treatments work in cases in which the cancer cannot be removed by surgery.

The full term for a PET scan is Positron Emission Tomography. Patients are fasted for 6 hours before going to the Nuclear Medicine Department. You are asked to lie down on a special couch underneath a special camera called a gamma camera. Fifteen minutes or so after the intravenous injection of a special chemical the camera will take images of your pancreas. The chemical contains a small amount of relatively harmless radioactivity. The PET scan is performed in the Nuclear Medicine Department which has special facilities to contain the radioactivity. The results will be explained to you by your doctors once they have put together the information from the PET scan as well as other tests such as results from the CT scan.