Pancreas: Anatomy, Physiology, Investigations Congenital anomalies

Dept of Surgery

Anatomy

Lies transversely in the retroperitoneal space, between the duodenum on the right and the spleen on the left

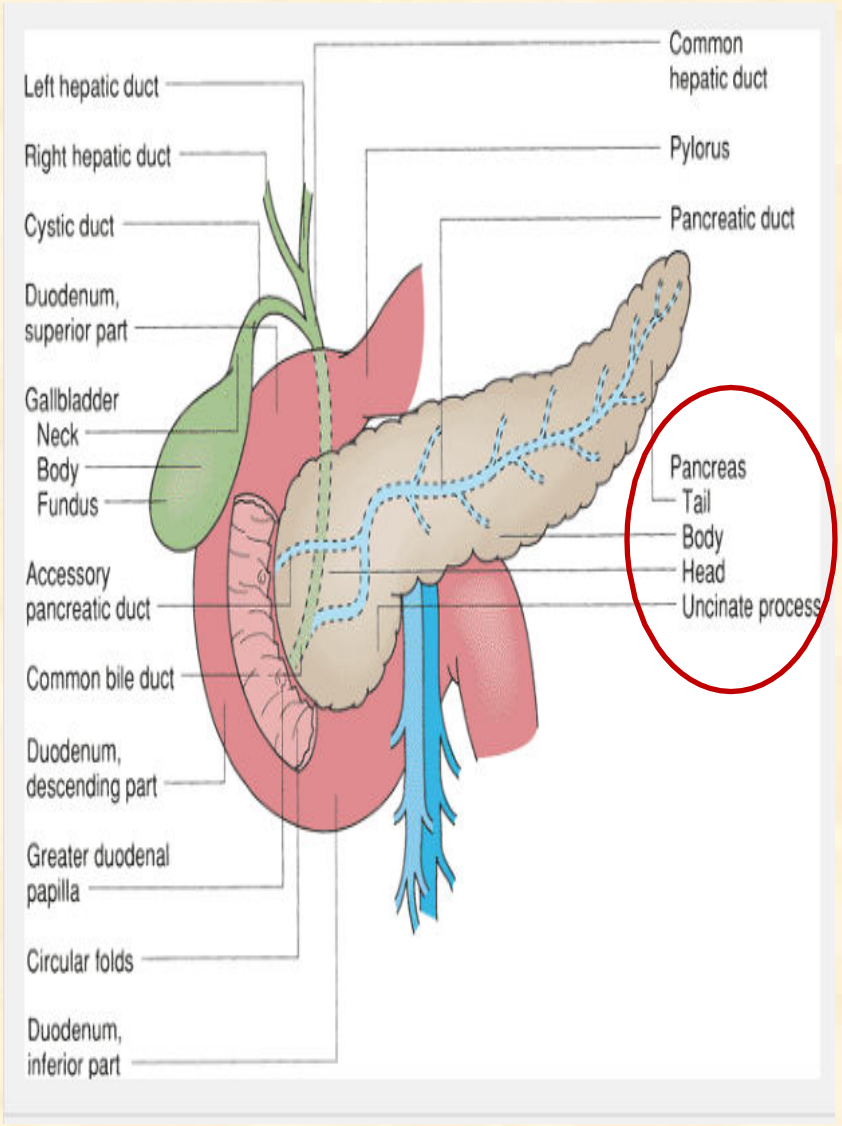
Related anteriorly to the omental bursa above, the greater sac below, and the transverse mesocolon

Fixed organ

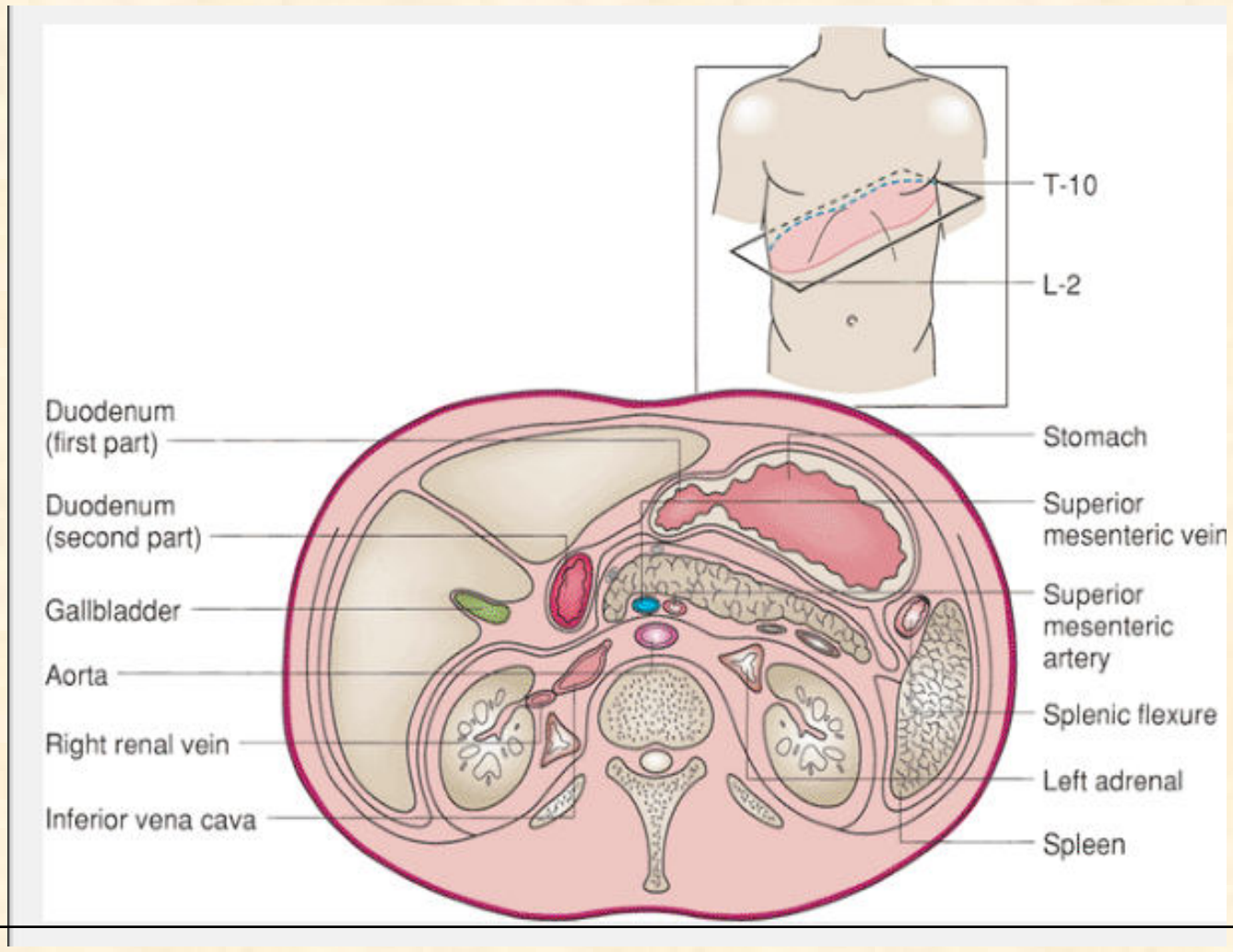
level of the L2 vertebra

From the duodenal C loop to the hilum of the spleen

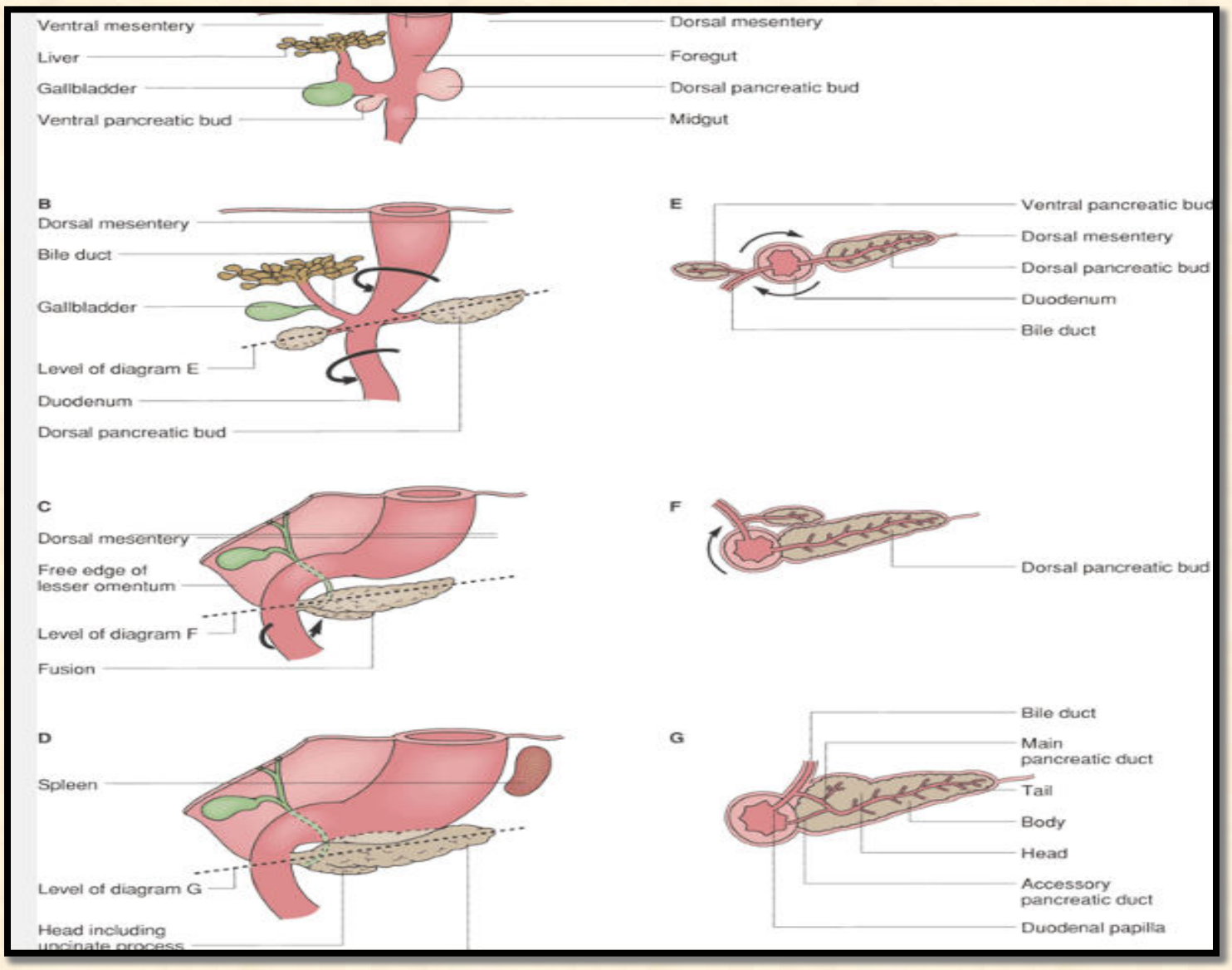
Divided into four parts



Cross-sectional relation of the pancreas to other abdominal structures



Embryology



Pancreatic Ducts

Main pancreatic duct (duct of Wirsung), joins the CBD to empty into the duodenum at the ampulla of Vater

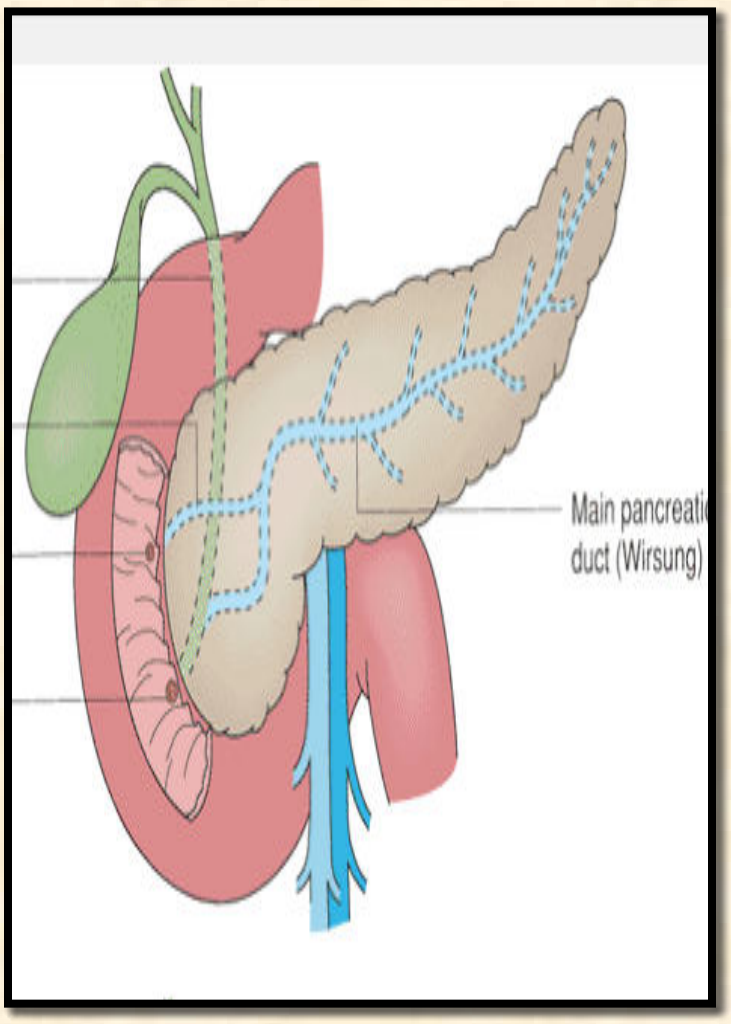
Diameter -- 2 to 4 mm

Pressure --15 to 30 mm Hg

Lesser duct (duct of Santorini)

Drains superior portion of head of the Pancreas

Empties separately into the 2nd part of duodenum through the minor papilla

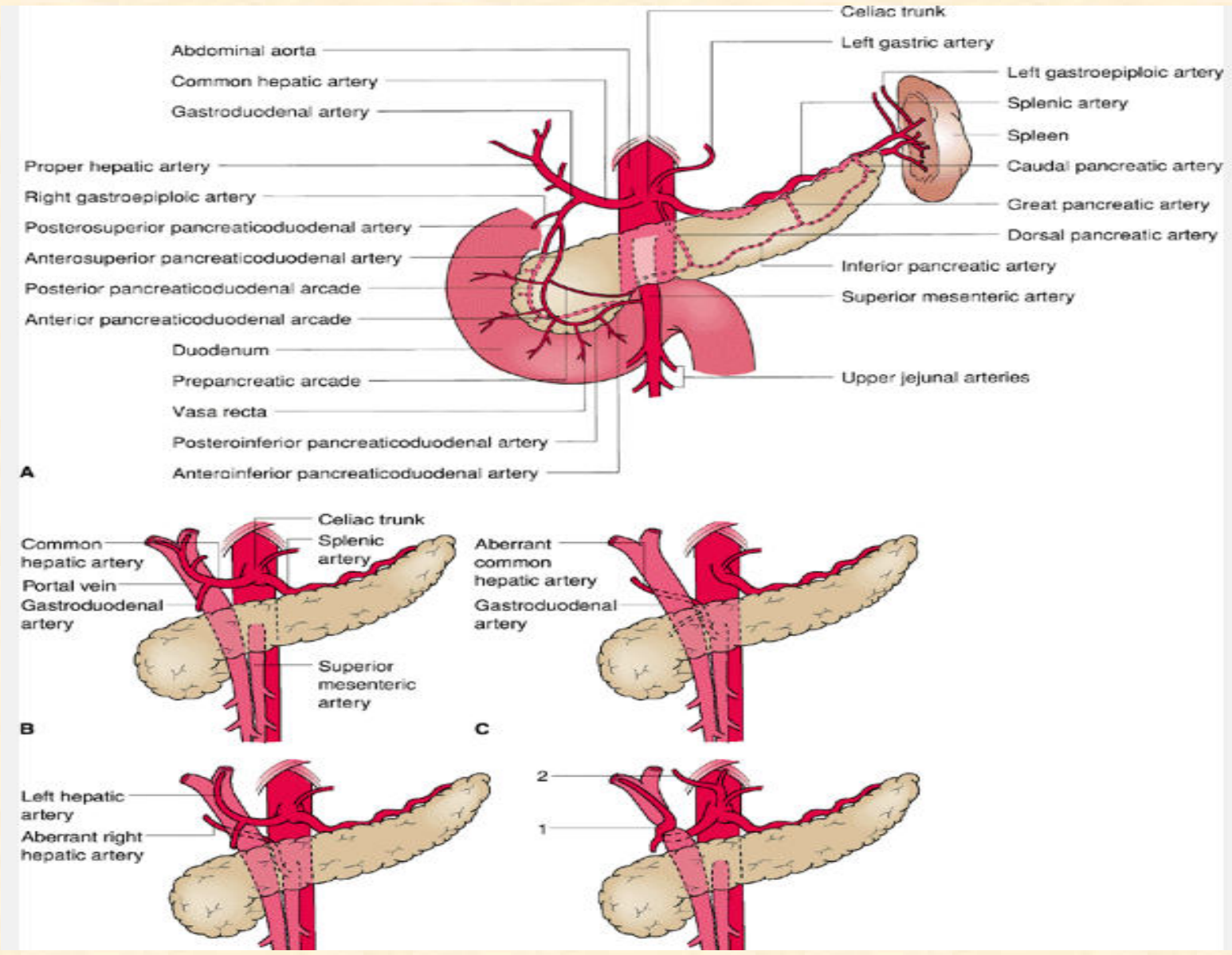


Arterial Supply

Celiac

Superior mesenteric artery

Splenic artery



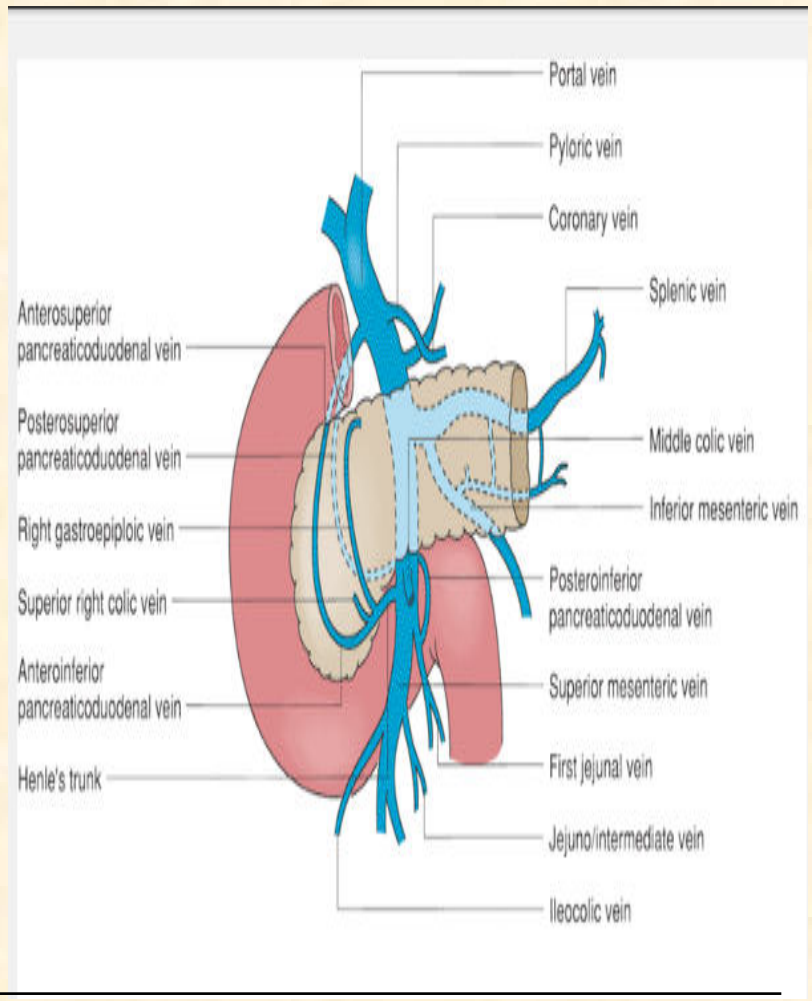
Venous Drainage

Suprapancreatic portal vein

Retropancreatic portal vein

Splenic veins

Infrapancreatic SMV

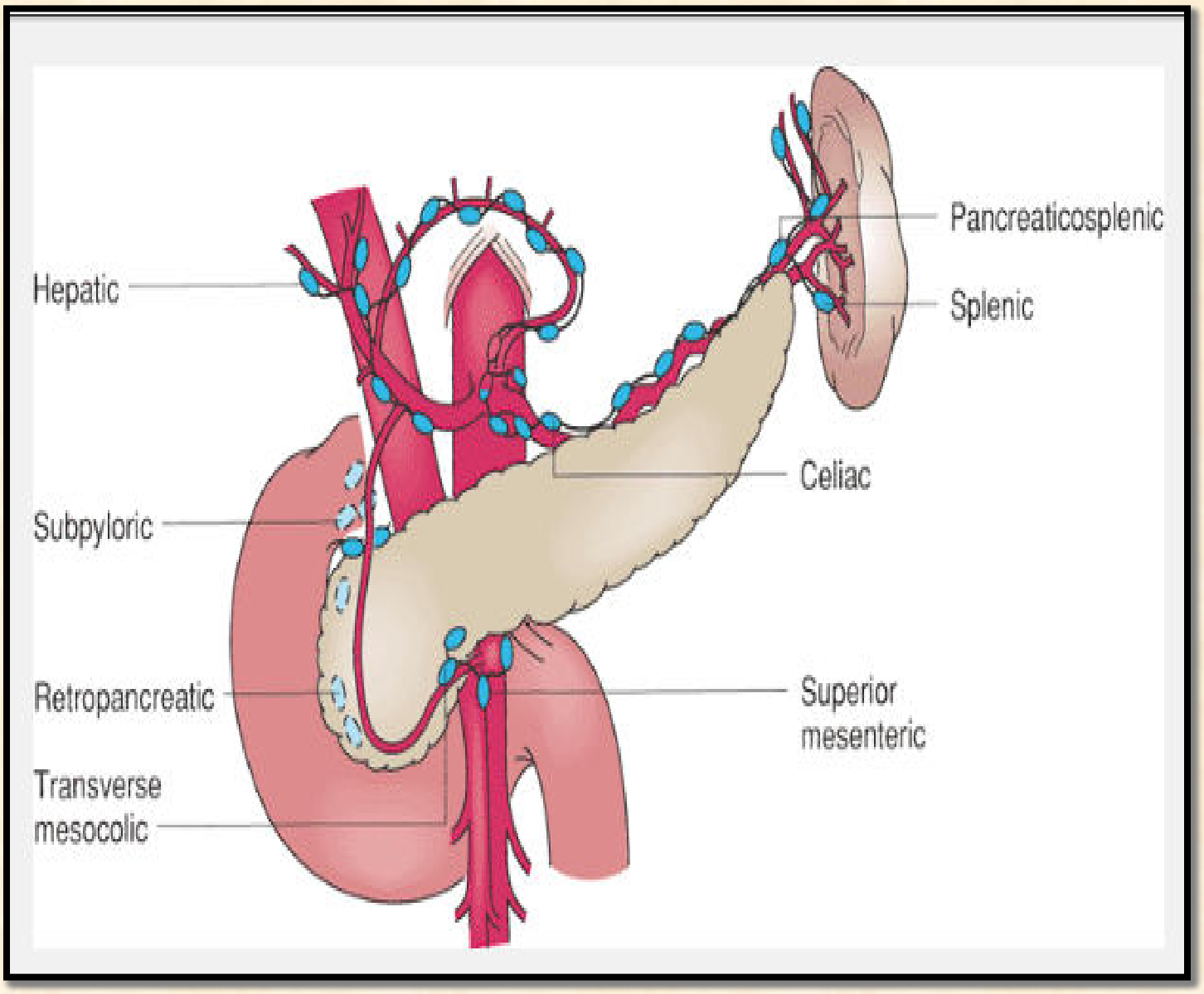


Lymphatic Drainage

Drain into **five** main nodal groups

- Superior nodes drain the upper half of the head of the pancreas
- Anterior lymphatic drain to the prepyloric and infrapyloric nodes
- Inferior group of nodes drain to the superior mesenteric and periaortic nodes
- Posterior pancreaticoduodenal lymph nodes drain into right periaortic nodes
- Splenic group of nodes drain into the interceliomesenteric lymph nodes

The absence of a peritoneal barrier on the posterior surface of the pancreas results in direct communication of the intrapancreatic lymphatics with retroperitoneal tissues, and this contributes to the high incidence of recurrence after presumably curative resections of pancreatic cancer



Histology

Exocrine Structure

Acinar cells secrete the enzymes responsible for digestion

Ductular network carry the exocrine secretions into the duodenum

Constitute 80% to 90% of the pancreatic mass

Endocrine Structure

Islets of Langerhans responsible for the secretion of hormones that control glucose homeostasis

Contains

- alpha (A)-- glucagon
- beta (B)-- insulin
- delta (D)-- somatostatin
- pancreatic polypeptide (PP) or F cells– PP

Accounts for 2% of the pancreatic mass

Pancreatic Exocrine Enzymes

Enzyme	Substrate	Product
Carbohydrate		
Amylase (active)	Starch; glycogen	Glucose, maltose, maltotriose, dextrins
Protein		
Endopeptidases	Cleave bonds between amino acids	Amino acids, dipeptides
Trypsinogen (inactive) $\xrightarrow{\text{Enterokinase}}$ Trypsin (active)		
Chymotrypsinosin (inactive) $\xrightarrow{\text{Enterokinase}}$ Chymotrypsin (active)		
Proelastase (inactive) $\xrightarrow{\text{Enterokinase}}$ Elastase (active)		
Exopeptidases	Cleave amino acids from end of peptide chains	
Procarboxy peptidase A&B (inactive) $\xrightarrow{\text{Enterokinase}}$ Carboxypeptidase A&B (active)		
Fat		
Pancreatic lipase (active)	Triglycerides	2-Monoglycerides fatty acids
Phospholipase A_2 (inactive) $\xrightarrow{\text{Trypsin}}$ Phospholipase A_2 (active)	Phospholipase	
Cholesterol esterase	Neutral lipids	

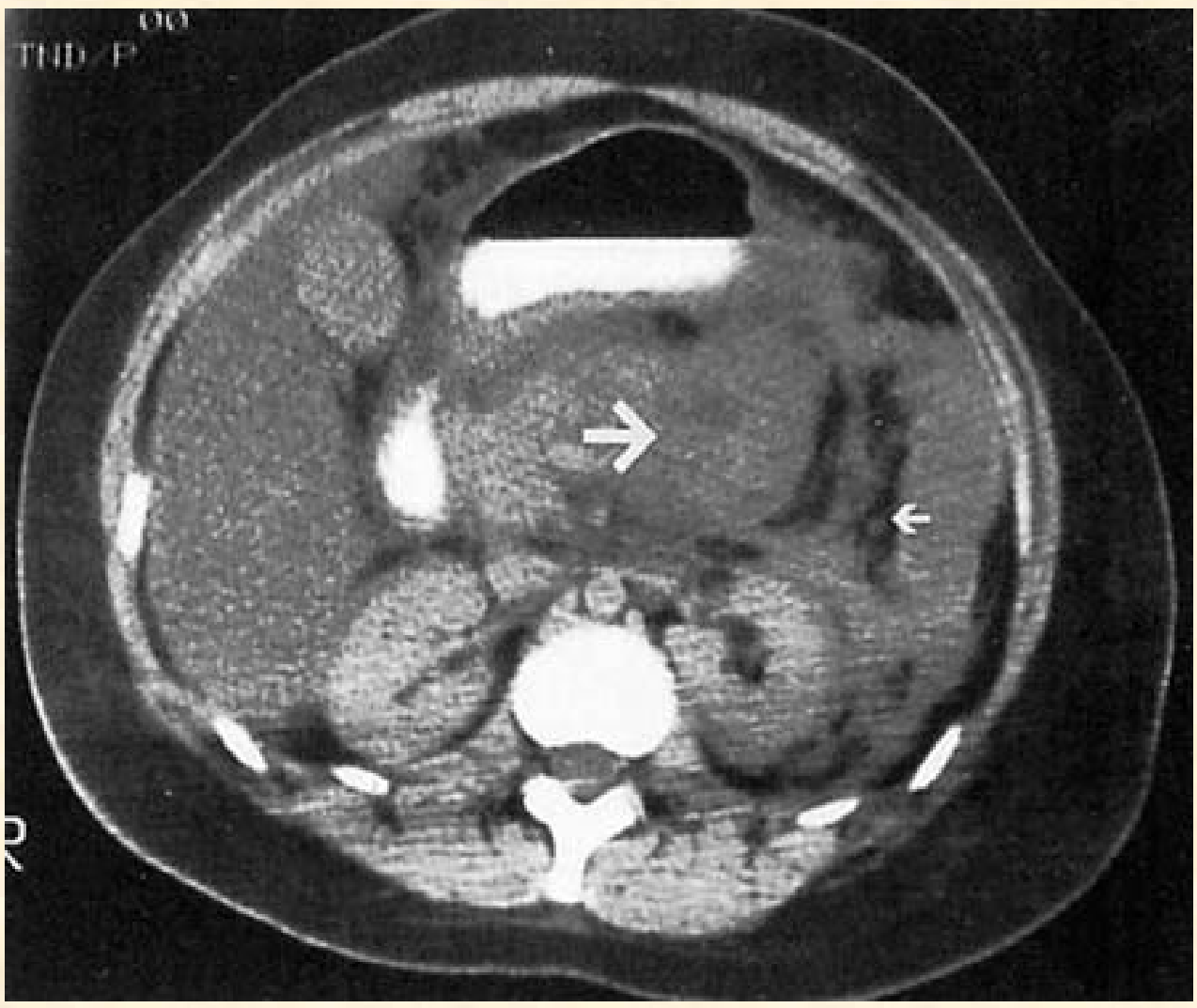
Pancreatic Endocrine Enzymes

Hormones	Islet Cell	Functions
Insulin	β (beta cell)	Decreased gluconeogenesis, glycogenolysis, fatty acid breakdown and ketogenesis
		Increased glycogenesis, protein synthesis
Glucagon	α (alpha cell)	Opposite effects of insulin; increased hepatic glycogenolysis and gluconeogenesis
Somatostatin	δ (delta cell)	Inhibits gastrointestinal secretion
		Inhibits secretion and action of all gastrointestinal endocrine peptides
		Inhibits cell growth
Pancreatic polypeptide	PP (PP cell)	Inhibits pancreatic exocrine secretion and section of insulin
		Facilitates hepatic effect of insulin
Amylin (IAPP)	β (beta cell)	Counterregulates insulin secretion and function
Pancreastatin	β (beta cell)	Decreases insulin and somatostatin release
		Increases glucagon release
		Decreases pancreatic exocrine secretion

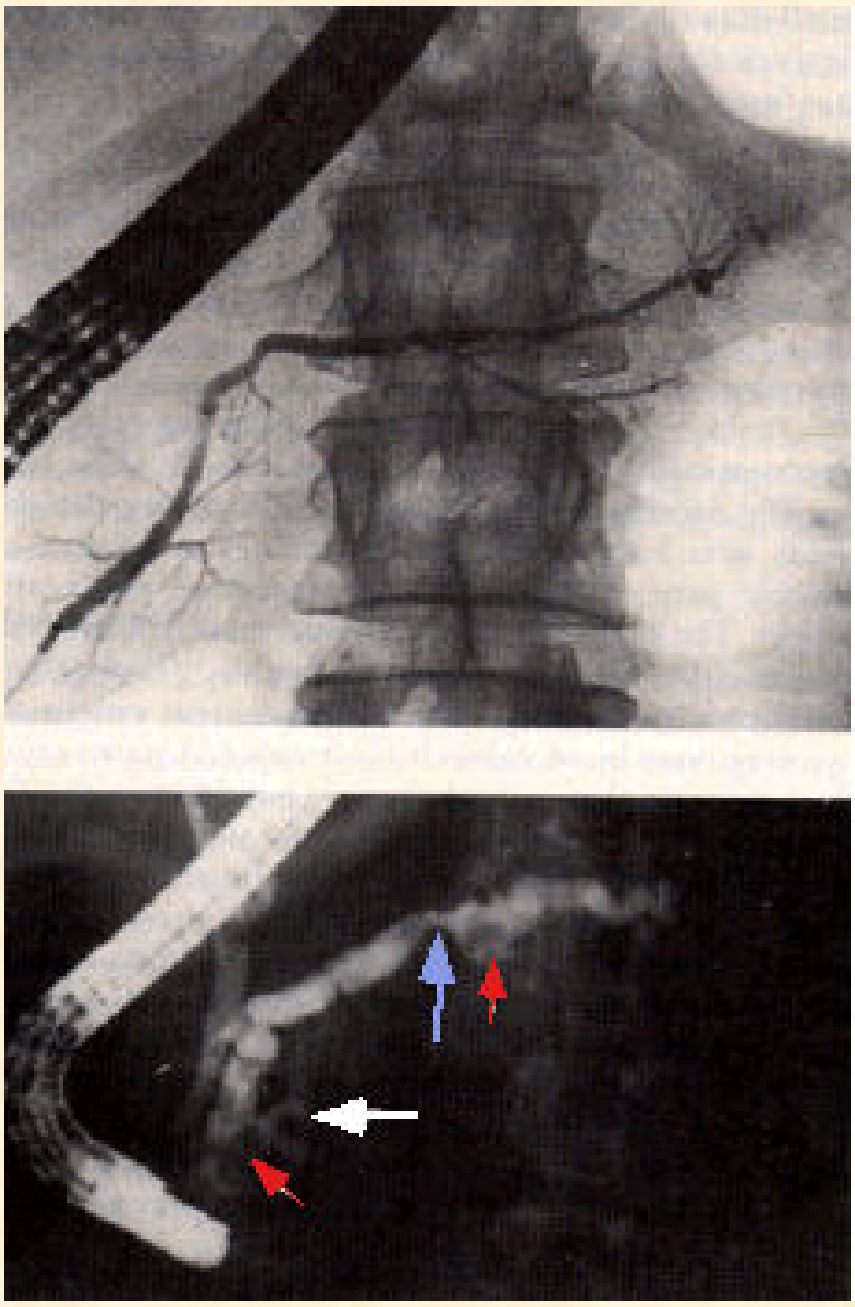
Investigations

- Serum Markers
  - Amylase, lipase, trypsinogen, and elastase
  - CA 19.9 (Tumor Marker)
- Lundh meal test
- Ultrasound
- EUS
- CECT Scan
- MRCP
- ERCP

Ultrasound image of normal pancreas (left) and acute pancreatitis (right). Evidence of parenchymal edema and peripancreatic fluid accumulation is seen



Non necrotizing acute pancreatitis



ERCP in chronic pancreatitis
Top panel: Normal subtraction endoscopic retrograde pancreatogram shows the filling of normal side branches and a smooth, nondilated main ductal system. Bottom panel: Endoscopic retrograde pancreatogram in a patient with chronic pancreatitis, revealing a dilated, tortuous main duct that contains stones or protein plugs (lucencies in duct marked by short red arrows). A stricture is visible in the midportion of the duct (blue arrow) and there is dilation of the uncinate-process branch (white arrow). (With permission from Steer, ML, Waxman, I, Freedman, SD, N Engl J Med 1995; 332:1482.)

Congenital Anomalies

The complex process by which the dorsal and ventral pancreatic primordia fuse during pancreatic development gives rise to congenital variations

Agenesis

Very rarely, the pancreas may be totally absent

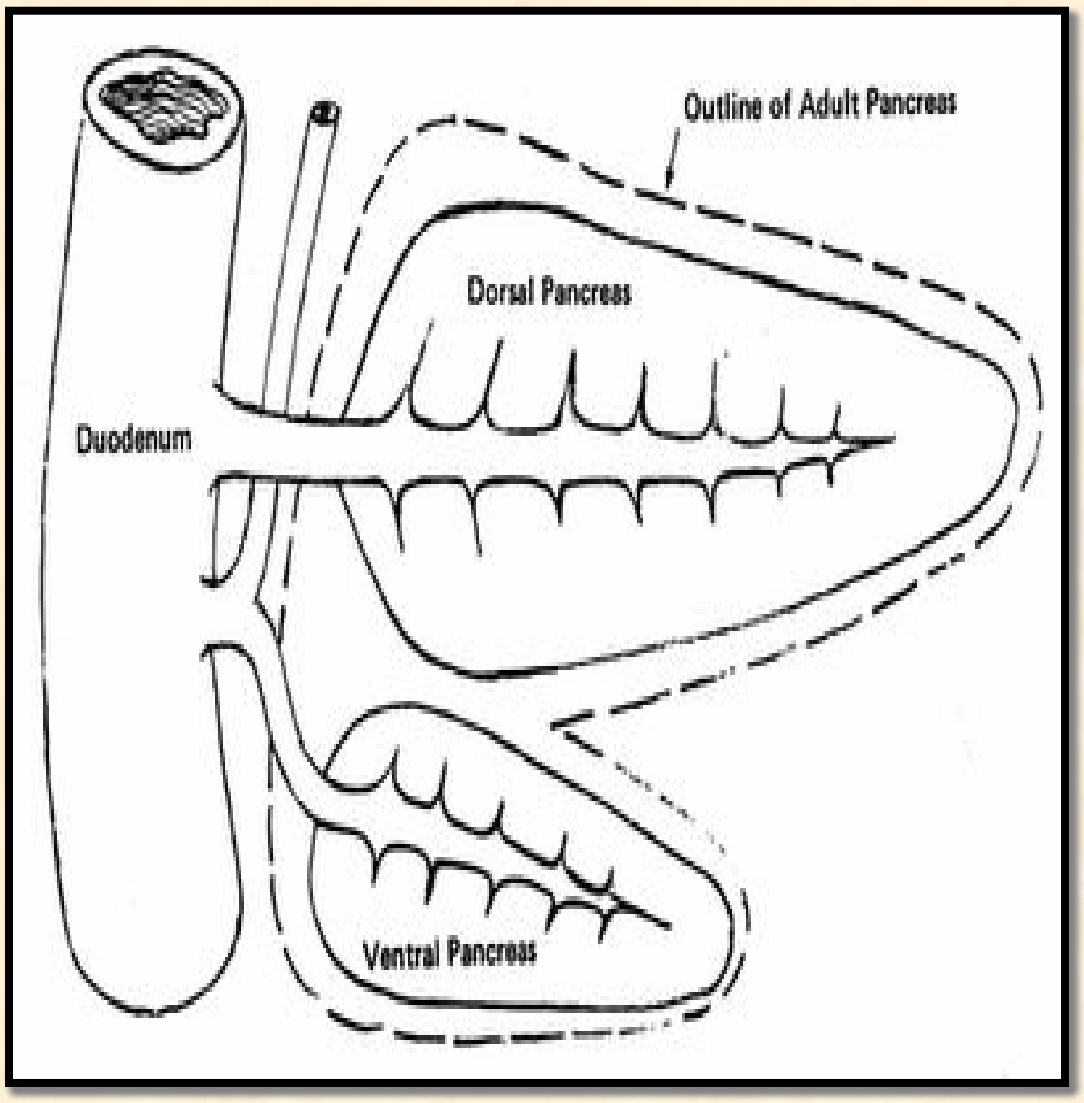
The homeodomain transcription factor IPF1 (PDX1) is critical for the development of the pancreas, and germ line (inherited) homozygous mutations in the *IPF1* gene on **chromosome 13q12.1** have been reported in a patient with pancreatic agenesis

Pancreas divisum

Most common clinically significant

Incidence of 3% to 10%

Caused by a failure of the fetal duct systems of the dorsal and ventral pancreatic primordia to fuse



Cystic fibrosis

- Autosomal recessive
- More in Caucasians
- Incidence 1 in 2500 live births in U.K.
- Defect is mutation in CFTR gene on Ch 7
- High levels of Na^{2+},Cl^{2-} ions in sweat

Annular pancreas

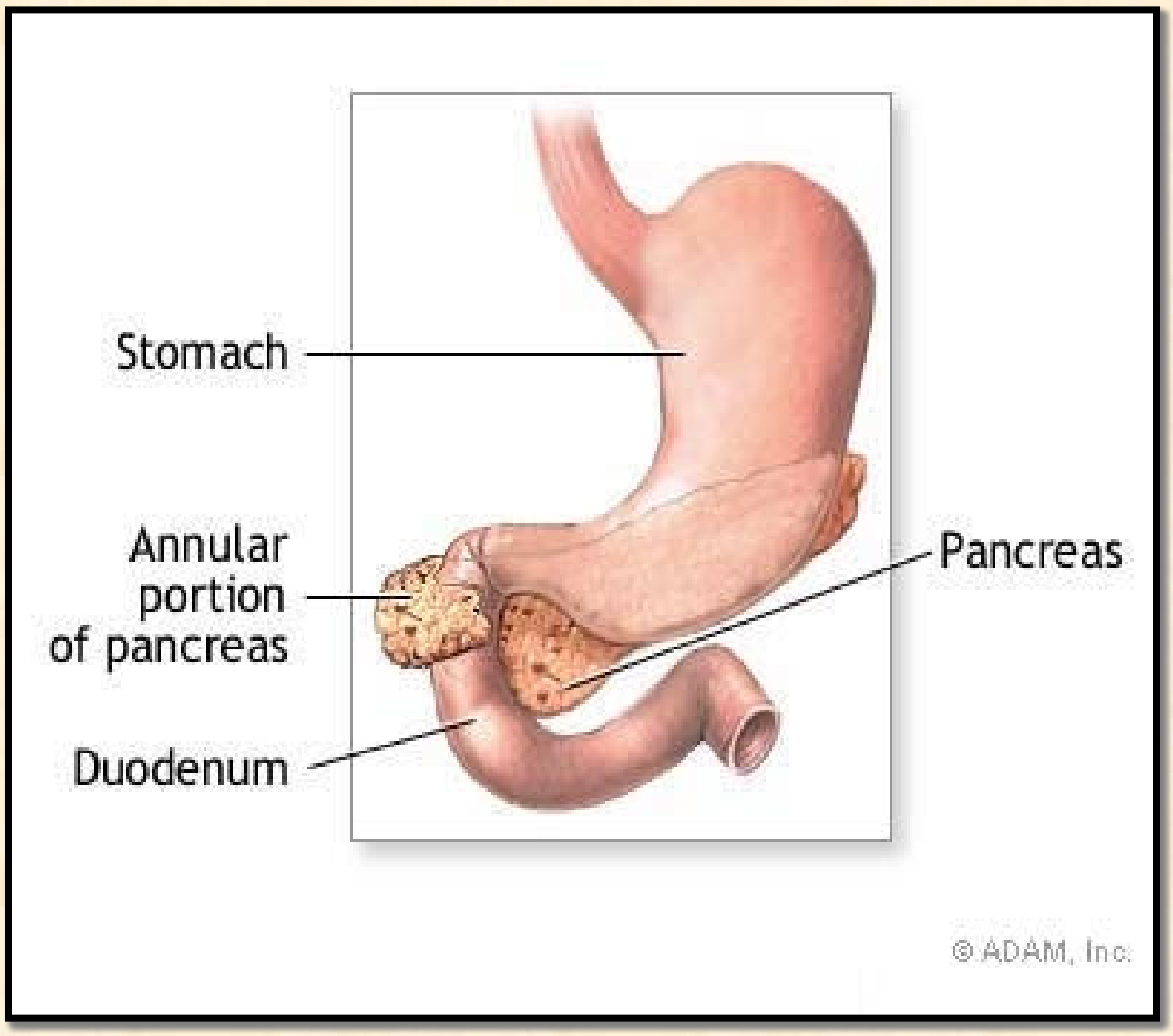
Develops when one portion of the ventral pancreatic primordium becomes fixed, while the other portion of this primordium is drawn around the 2nd or 3rd duodenum

Can be associated with congenital duodenal atresia/ stenosis

Common in children with Down's syndrome

Present with signs and symptoms of duodenal obstruction such as gastric distention and vomiting

Tx- Duodenoduodenostomy



Ectopic pancreas

Found in about 2% autopsy specimen

Sites for ectopia are stomach and duodenum, followed by the jejunum, Meckel diverticula, and ileum

May cause pain from localized inflammation, or, rarely, may incite mucosal bleeding

Approximately 2% of islet cell tumors arise in ectopic pancreatic tissue.