OUTLINE

- Embryology
- Anatomy
- Physiology
DEFINITION

A glandular organ in the digestive system and endocrine system
EMBRYOLOGY

- Develops from 2 buds arising from endoderm of the caudal part of the foregut
- Ventral pancreatic bud develops from proximal end of hepatic diverticulum (forms liver & gall bladder)
- Dorsal pancreatic bud develops from dorsal wall of duodenum
- Most of pancreas derived from dorsal pancreatic bud
EMBRYOLOGY

- Duodenum rotates to the right becoming C-shaped
- Ventral bud moves dorsally to lie below and behind dorsal bud
- 2 buds fuse together in the dorsal mesentery
EMBRYOLOGY

- **Ventral bud forms:**
  - Uncinate process
  - Inferior part of head

- **Dorsal bud forms:**
  - Upper part of head
  - Neck
  - Body
  - Tail of pancreas
EMBRYOLOGY

- Main pancreatic duct formed from:
  - Duct of ventral bud
  - Distal part of dorsal bud duct

- Accessory pancreatic duct formed from:
  - Proximal part of dorsal bud duct
CONGENITAL ANOMALIES

- **Accessory pancreatic tissue**: Located in wall of stomach or duodenum
- **Annular pancreas**: thin flat band of pancreatic tissue surrounding 2nd part of duodenum. Can cause duodenal obstruction
CONGENITAL ANOMALIES

- **Pancreas divisum**: Pancreatic buds fail to fuse
ANATOMY

- Retro-peritoneal gland at 2\textsuperscript{nd} lumbar level extending in oblique, transverse position

- Divided into:
  - Head
  - Neck
  - Body
  - Tail

- Both exocrine and endocrine functions
ANATOMY – Pancreas Head

- Surface marking: L2
- Relations:
  - Posterior: IVC, Aorta, Lt & Rt renal vns, CBD
  - Uncinate: Posterior = Aorta
    Anterior = SMV/SMA
ANATOMY – Pancreas Neck

- Surface marking: L1
- Relations:
  - Posterior: SMV/SMA (emerge inferiorly), Portal vein (confluence SMV, Splenic vn)
  - Superior: D1
  - Right: Gastroduodenal artery
ANATOMY – Pancreas Body

- Surface marking: L1
- Relations:
  - Anterior: Lesser sac, Stomach
  - Posterior: Lt renal vn, Lt crus, aorta, Lt psoas, Lt adrenal, Lt renal hilum, Splenic vn
  - Superior: Splenic artery
  - Inferior: Transverse mesocolon
ANATOMY – Pancreas Tail

- Surface marking: T12
- Within lienorenal ligament
- Up to splenic hilum
- Relations:
  - Posterior: Kidney
  - Inferior: Colon
ANATOMY – Pancreas Ducts

- Main duct (of Wirsung):
  Joins CBD at Ampulla of Vater

- Normal diameter of main duct (of Wirsung):
  Head: 4 mm
  Neck: 3 mm
  Tail: 2 mm
  > 70yrs: 5-6 mm
ANATOMY – Pancreas Ducts

- Ampulla:
  - Major:
    - Duct of Wirsung
    - Surface marking: L2
    - Opens in D2, 7.5-10cm distal from pylorus
  - Minor:
    - 2cm proximal to major papilla
ANATOMY – Pancreas Ducts

- Main duct/CBD at Ampulla
  - Common with CBD: 90%
    - Y 70%
    - V 20%
  - Separate duodenal entry: 10%
    - U 10%
ANATOMY – Arterial Supply

- Splenic artery:
  - 3 biggest branches are:
    - Dorsal pancreatic artery
    - Pancreatica Magna (midportion of body)
    - Caudal pancreatic artery (tail)

- Superior pancreaticoduodenal:
  - Coeliac > Common hepatic > Gastroduodenal
  - Divides into anterior and posterior branches

- Inferior pancreaticoduodenal:
  - Direct branch off SMA
  - Divides into anterior and posterior branches
  - Anastomosis with superior pancreaticoduodenal
ANATOMY – Arterial Supply

Diagram showing the arterial supply to the gastrointestinal tract, including:
- Celiac trunk
- Left gastric artery
- Left gastroepiploic artery
- Splenic artery
- Spleen
- Caudal pancreatic artery
- Great pancreatic artery
- Dorsal pancreatic artery
- Inferior pancreatic artery
- Superior mesenteric artery
- Upper jejunal arteries

Key arteries:
- Abdominal aorta
- Common hepatic artery
- Gastro-duodenal artery
- Proper hepatic artery
- Right gastroepiploic artery
- Posterosuperior pancreaticoduodenal artery
- Anterosuperior pancreaticoduodenal artery
- Posterior pancreaticoduodenal arcade
- Anterior pancreaticoduodenal arcade
- Duodenum
- Pre-pancreatic arcade
- Vasa recta
- Posterior inferior pancreaticoduodenal artery
- Anterior inferior pancreaticoduodenal artery
ANATOMY – Venous drainage

- Head:
  - Superior pancreaticoduodenal vn:
    - Rt gastroepiploic vn & middle colic → SMV
  - Inferior pancreaticoduodenal vn:
    - SMV

- Neck, Body, Tail:
  - Small tributaries to splenic vein
ANATOMY – Venous drainage

- Anterosuperior pancreaticoduodenal vein
- Posterosuperior pancreaticoduodenal vein
- Right gastroepiploic vein
- Superior right colic vein
- Anteroinferior pancreaticoduodenal vein
- Henle's trunk
- Portal vein
- Pyloric vein
- Coronary vein
- Splenic vein
- Middle colic vein
- Inferior mesenteric vein
- Posteroinferior pancreaticoduodenal vein
- Superior mesenteric vein
- First jejunal vein
- Jejuno/intermediate vein
- Ileocolic vein
ANATOMY – Lymph drainage

- Head:
  - Upper → Coeliac
  - Lower & uncinated → SM group

- Neck, Body, Tail:
  - → Retropancreatic & Splenic
ANATOMY – Nerve supply

- Parasympathetic:
  - Posterior vagus & Coeliac ganglia
  - Stimulate both endocrine and exocrine secretion

- Sympathetic:
  - Splanchnics T6-10 & Coeliac plexus
  - Predominantly inhibitory effect
ANATOMY - Structure

- Lobules separated by septa:
  - Acini: Exocrine
  - Islets of Langerhans: Endocrine

- Ducts:
  - Intercalated ducts at acini
    > Intralobular ducts
    > Interlobular ducts
    > Main duct
HISTOLOGY

- **Alpha cells** secrete **Glucagon**
- **D cells** secrete **Somatostatin**
- **Beta cells** secrete **Insulin, Amylin**

![Diagram of the pancreas and small intestine](image)

- **Exocrine cells**
- **Endocrine cells**
- **Islet of Langerhans**
  - **Alpha cells**
  - **Beta cells**
  - **D cells**
PHYSIOLOGY

- Production of pancreatic hormones by 3 cell types:
  1) Alpha cells → glucagon
  2) Beta cells → insulin
  3) Delta cells → somatostatin
Three cell types are present, A (glucagon secretion), B (Insulin secretion) and D (Somatostatin secretion)

A and D cells are located around the perimeter while B cells are located in the interior
Pancreatic Hormones, Insulin & Glucagon, Regulate Metabolism
Physiology – Role of Insulin

- Acts on tissues (especially liver, skeletal muscle, adipose) to increase uptake of glucose and amino acids.
  - Without insulin, most tissues do not take in glucose and amino acids well (except brain).

- Increases glycogen production (glucose storage) in the liver and muscle.

- Stimulates lipid synthesis from free fatty acids and triglycerides in adipose tissue.

- Also stimulates potassium uptake by cells (role in potassium homeostasis).
Major stimulus is increased blood glucose levels
- After meal, blood glucose increases
- Insulin released
- Insulin causes uptake of glucose into tissues
- Blood glucose levels decrease.

Insulin levels decline as blood glucose declines

Glucagon stimulates insulin secretion (glucagon has opposite actions).
**PHYSIOLOGY – Role of Glucagon**

- Acts on liver to cause breakdown of glycogen (glycogenolysis), releasing glucose into the bloodstream.
- Inhibits glycolysis
- Increases production of glucose from amino acids (gluconeogenesis).
- Increases lipolysis, to free fatty acids for metabolism.

**Result:** maintenance of blood glucose levels during fasting.
PHYSIOLOGY – Glucagon regulation

- Increased blood glucose **inhibits** glucagon release
- Insulin **inhibits** glucagon secretion

- Amino acids **stimulate** (high protein, low carbohydrate meal)
- Stress: Epinephrine acts on beta-adrenergic receptors on alpha cells, **increasing** gluagon release (increases availability of glucose for energy)
Insulin Beta cells of pancreas stimulated to release insulin into the blood

Body cells take up more glucose

Blood glucose level declines to a set point; stimulus for insulin release diminishes

Liver takes up glucose and stores it as glycogen

High blood glucose level

STIMULUS: Rising blood glucose level (e.g., after eating a carbohydrate-rich meal)

Homeostasis: Normal blood glucose level (about 90 mg/100 mL)

Liver breaks down glycogen and releases glucose to the blood

Glucagon

Alpha cells of pancreas stimulated to release glucagon into the blood

Blood glucose level rises to set point; stimulus for glucagon release diminishes

STIMULUS: Declining blood glucose level (e.g., after skipping a meal)
PHYSIOLOGY - Somatostatin

- Secreted by Delta cells

- Suppresses release of GIT hormones:
  - Gastrin, Cholecystokinin, Secretin, Motilin, VIP, GIP

- Decreases rate of gastric emptying

- Decreases smooth muscle contractions and blood flow within intestine
Suppresses release of pancreatic hormones:
- Inhibits insulin & glucagon

Suppresses exocrine secretory action of pancreas.
Control via hormones secreted by stomach & duodenum in response to distension:
- Gastrin, CCK, Secretin

2 Main classes of exocrine pancreatic secretions:
- Secretin → Bicarbonate ions
- CCK → Digestive enzymes
PHYSIOLOGY – Exocrine function

- Bicarbonate ions neutralize acidic chyme
- Pancreas main source of enzymes for fat/lipid and protein digestion. Major proteases:
  - Trypsinogen, Chymotrypsinogen
  - Lipase, amylase
  - Phospholipase, Cholesterol esterase
- Precursors activated by enteropeptidases
QUESTIONS?

WHAT'S THAT?

I DON'T KNOW, BUT IT'S BEEN THERE ALL DAY.

GIVE ME A BOOST

Cyanide and Happiness © Explosm.net