Normal structure and function

- lobulated gland; **exocrine** and endocrine
- secretory units and a ductal system (1 or 2 main pancreatic ducts)
- portal system of capillaries from islets (endocrine) perfuses much of the acini (exocrine)
- enzymes released as proenzymes
- limited regenerative ability

Pancreatic normal ductal anatomy.

Pancreatic acini, showing the radial orientation of the pyramidal exocrine acinar cells. The cytoplasm is devoted to the synthesis and packaging of digestive enzymes for secretion into a central lumen.

EM of pancreatic acinar cells – numerous secretory (zymogen) granules.

1. Developmental anomalies of the pancreas

1.1 Ectopic pancreatic tissue

• dislocated portions of duodenal buds during embryonic development.
• small nodules stomach/intestine, liver, spleen, mesentery
• usually incidental

A nodule of **ectopic pancreatic tissue** on the small intestinal serosa (arrows).
1.2 Pancreatic hypoplasia

- sporadic in dogs and calves
- defect of acinar tissue (endocrine tissue often normal)

Pancreatic hypoplasia, dog. Virtually no pancreatic tissue is present. Pancreatic remnants are indicated by arrows.
Pancreatic hypoplasia

- in dogs (Juvenile pancreatic atrophy)
- hypoplasia / atrophy?
- German shepherds, 6-12 months
- steatorrhea/diarrhea, emaciation
- gross: ↓ amount of tissue except main ducts
- micro: few normal lobules, ongoing degeneration of ducts / acini

Pancreatic hypoplasia, dogs. Virtually no pancreatic tissue is present. Pancreatic remnants are indicated by arrows.
2. Degeneration and atrophy

2.1 Pancreatic atrophy

• local or systemic diseases → atrophy

• causes include:
  - protein-calorie deficiency (atrophy also in muscles, liver).
  - ductal obstruction → parenchymal inflammation / fibrosis, not uniform along the organ; islets fare better.

Segmental pancreatic atrophy, adult dog. There is a portion of normal pancreas (n) and a contiguous area of atrophy (arrows).
2.2 Pancreatic lithiasis

- incidentally in cattle
- composed of calcium carbonate / calcium phosphate.
- secondary to local inflammation.

Mild pancreatic fibrosis and calculi, bull. The pancreatic duct has been opened to show multiple calculi.
3. Inflammation

3.1 Acute pancreatitis/acute pancreatic necrosis

• important in dogs

• predominance of necrosis over inflammation

• pathogenesis: *in situ* activation of proenzymes → parenchymal autodigestion → activation plasma mediators → systemic effects

• predisposing factors:
  - obese females, high-fat meal
  - surgical manipulation / hypotension;
  - certain drugs;
  - familial predisposition (miniature schnauzer)

• prognosis:
  - self–limited to fatal
  - transient to permanent loss of function
Acute pancreatitis in humans (cont’d)

• primarily due to biliary calculi or alcohol abuse;
• hemorrhagic pancreatitis most severe form (rare in dogs)
• reflux of duodenal content into the pancreatic duct $\rightarrow$ activation of proenzymes
• lesions **centrilobular** in early stages

**Acute pancreatitis.** The pancreas has been sectioned longitudinally to reveal dark areas of hemorrhage in the head of the organ and a focal area of pale fat necrosis in the peripancreatic fat (*arrow*).
Three proposed pathways in the pathogenesis of acute pancreatitis

Interrelationships between the four plasma mediator systems triggered by activation of factor XII (Hageman factor). Note that thrombin induces inflammation by binding to protease-activated receptors (principally PAR-1) on platelets, endothelium, smooth muscle cells, and other cells.

HMWK, high molecular weight kininogen.

Acute pancreatitis/pancreatic necrosis (dogs)

- gross lesions are either locally extensive or multifocal.
- in early stages of the disease, lesions are **perilobular** (periphery of the blood circulation)

The arrows show the perilobular area initially affected in acute pancreatitis of dogs
Acute pancreatitis/pancreatic necrosis (cont’d)

**Gross appearance**

Acute pancreatitis, dogs. Early stage that shows expansion of the pancreas by clear gelatinous material (edema) and areas of hemorrhage (top). Multifocal areas of necrosis covered by fibrin (yellow material) and hyperemia (bottom, right) may also be found. Diffuse hemorrhage (bottom, left)
Acute pancreatitis/pancreatic necrosis (cont’d)

Hemorrhagic pancreatitis secondary to DIC (Disseminated Intravascular Coagulation) in a dog.

Multifocal fat necrosis (chalky-white areas scattered in the peripancreatic fat, dog. P, pancreas)
Acute pancreatitis/pancreatic necrosis (cont’d)

- necrosis of parenchyma and adjacent adipose tissue; severe inflammation.

**Acute pancreatitis.** The microscopic field shows a region of fat necrosis on the right (f) and focal pancreatic parenchymal necrosis (n, *center*).
3.2 Chronic interstitial pancreatitis

- in **dogs**, sequela of repeated episodes of acute pancreatitis:
  - subclinical or leads to pancreatic insufficiency and **diabetes mellitus**
- in **cats**, usually coexists with cholangitis; the pancreatic and biliary ducts fuse prior to entering the duodenum.
Chronic interstitial pancreatitis (cont’d)

- parenchymal atrophy, fibrosis and chronic inflammation.

**Chronic pancreatitis in an older cat.** The organ is shrunken and nodular as a result of interstitial fibrosis and nodular hyperplasia.

_Histo:_ **Chronic pancreatitis, pancreas, dogs.**

Remaining exocrine pancreatic cells are separated into small lobules by abundant fibrous connective tissue (_F_), which contains chronic inflammatory cells (_arrow_).

Comparison of the sequelae of acute and chronic pancreatitis in humans

**acute pancreatitis**
- shock, acute respiratory distress syndrome, acute renal failure
- disseminated intravascular coagulation
- pancreatic pseudocysts and abscesses
- duodenal obstruction

**chronic pancreatitis**
- pancreatic pseudocysts
- pancreatic duct obstruction
- maldigestion, steatorrhea
- secondary diabetes mellitus

(Robbins and Cotran Pathologic Basis of Disease. 2005)
Sequelae of chronic pancreatitis

Atrophy (a), fibrosis (F) and cystic dilation of ducts (d)

Pseudocyst (p). A: Cavitated area (p). B: Necroinflammatory tissue lining the cavity

Chronic pancreatitis (horse, bottom, right). Fibrosis (F) and ductal dilation (d)

Source: Robbins & Cotran Pathologic Basis of Disease © 2007 Elsevier
3.3 Parasitic infections/diseases of pancreas

**Strongylus equinus granulomas**, pancreas horse. Several hard yellow nodules (arrows) scattered.

http://w3.vet.cornell.edu/nst/nst.asp

**Chronic pancreatitis**. Cross section of a parasite (*Eurytrema* spp, arrow) in a dilated, thick walled duct (d) and small round lobules (L) caught in the connective tissue (F)

http://w3.vet.cornell.edu/nst/nst.asp
4 Hyperplastic and neoplastic conditions

4.1 Pancreatic nodular hyperplasia

- incidental finding in old dogs, cats and cattle

Pancreatic nodular exocrine hyperplasia, pancreas, dog. Hyperplastic nodules are white-yellow and project above the surface. Microscopically hyperplastic nodules (N) are composed of numerous small acini, most of which, in this case, lack typical zymogen granules.
4.2 Pancreatic adenoma

- extremely rare; well demarcated
- single or multiple
- larger than, and not as numerous as, hyperplastic nodules
4.3 Pancreatic adenocarcinoma

- dogs and cats;
- single or multiple,
- schirrous (desmoplasia)
- necrosis and hemorrhage

Pancreatic carcinoma, dog. The mass has invaded the mesentery, wall of the stomach, and gastrosplenic ligament. The mass is lobulated and very firm due to the proliferation of schirrous connective tissue.
Pancreatic adenocarcinoma (cont’d)

• very aggressive → metastasis to the peritoneum, liver & local LN
• invasion / obstruction of duodenum and / or bile duct (post-hepatic jaundice).

Metastases of pancreatic adenocarcinoma in a dog’s liver (right) and invasion of mesenteric lymphatic vessels (lymphatic permeation), left.
A little advice

If you want to avoid this:

Best wishes in the final exam

…. say **salud** just once!