Endocrine Pancreas (Diabetes)

SESSION OBJECTIVES:

Use these session objectives to test your knowledge of the important concepts presented in this chapter and as study topics to return to prior to your exams.

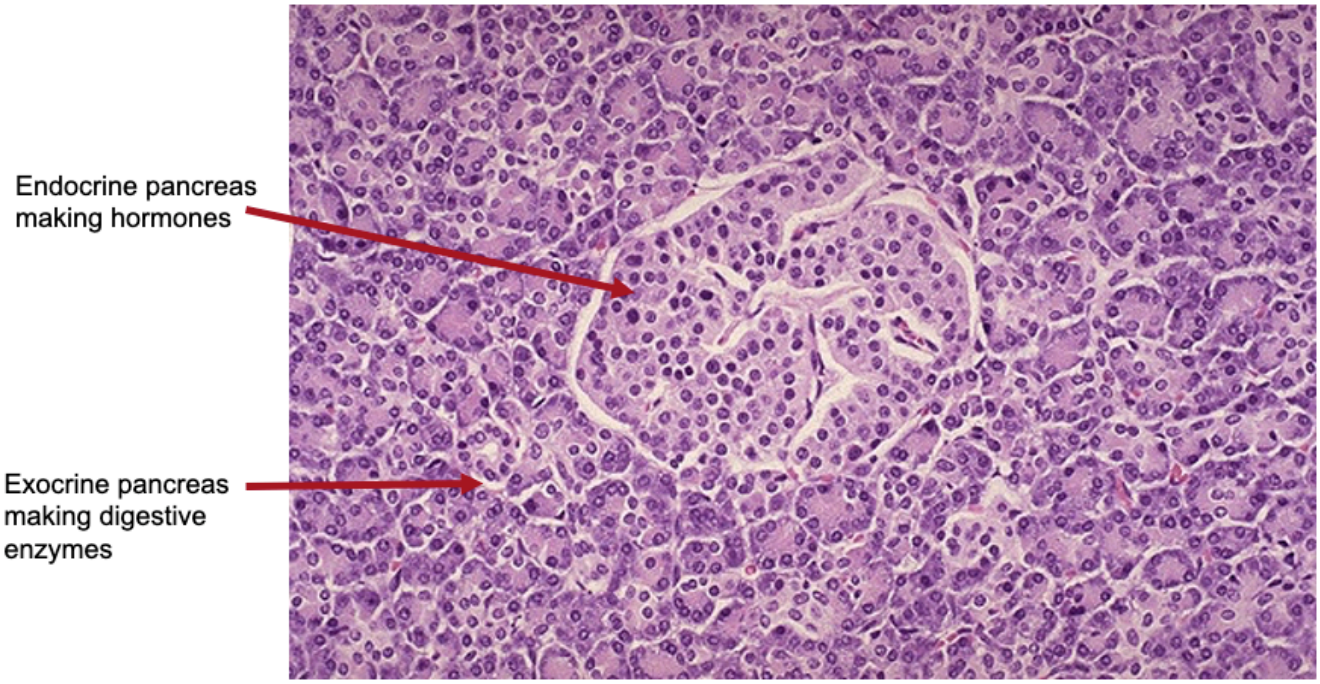
1. Describe endocrine pancreas histology.
2. Recognize pathology of type 1 diabetes in the pancreatic islets.
3. Describe the pathology of type 2 diabetes in the pancreatic islets.
4. Identify pathologic features of microvascular and macrovascular complications of diabetes.
5. Introduce basic kidney histology and features of a normal glomerulus and renal complications of diabetes.
6. Introduce basic vascular histology and features of diabetes complications.

OPTIONAL PRE-CLASS MATERIALS FOR THIS SESSION:

- Skim the **section titles**, **bolded terms,** and **image captions** from Robbin's & Kumar 11th edition, Chapter 18 to fill in any knowledge gaps you need.
- In class exercise: PathPresenter

OVERVIEW:

Diabetes mellitus is a group of metabolic disorders characterized by chronic hyperglycemia, which results from defects in insulin secretion, insulin action, or both. This pressbook will explore the histological features of both **type 1 diabetes** and **type 2 diabetes**, as well as the complications that arise due to chronic hyperglycemia.

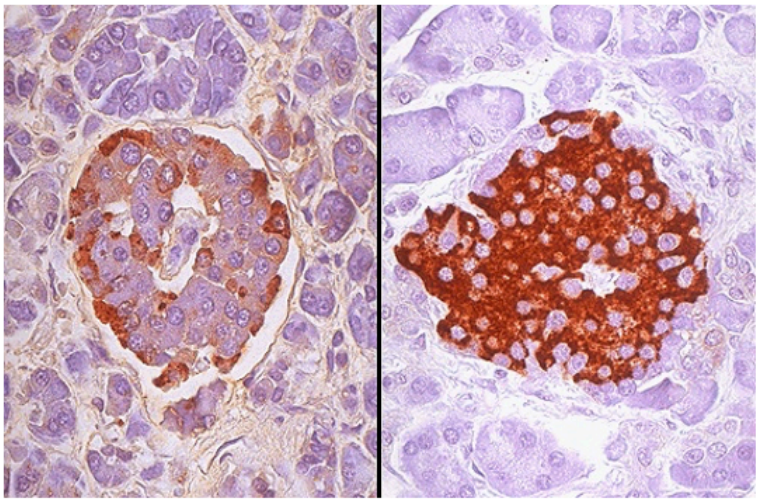


ENDOCRINE PANCREAS AND ISLETS OF LANGERHANS:

The pancreas has both exocrine and endocrine functions. The **endocrine pancreas** consists of clusters of cells known as the **Islets of Langerhans** (images below), which are responsible for producing important hormones that regulate blood sugar:

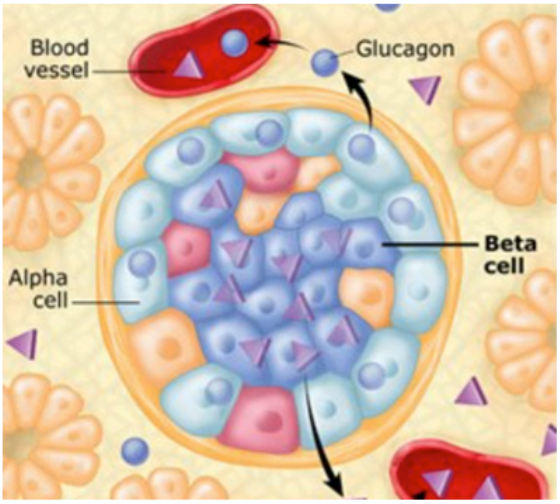
- **Beta cells**: Produce **insulin** (about 75% of islet cells).
- **Alpha cells**: Secrete **glucagon** (about 20% of islet cells).
- **Delta cells**: Release **somatostatin**, which inhibits the secretion of both insulin and glucagon.
- **Gamma cells**: Produce **pancreatic polypeptide**.
- **Epsilon cells**: Secrete **ghrelin**, which regulates hunger.

Endocrine Pancreas- Islets of Langerhans



Alpha cells: Glucagon
(20% of islet cells)

Beta cells: Insulin
(75% of islet cells)



Remaining ~5% of cells:

- Delta cells: Somatostatin
- Gamma cells: Pancreatic Peptide
- Epsilon cells: Ghrelin (hunger)

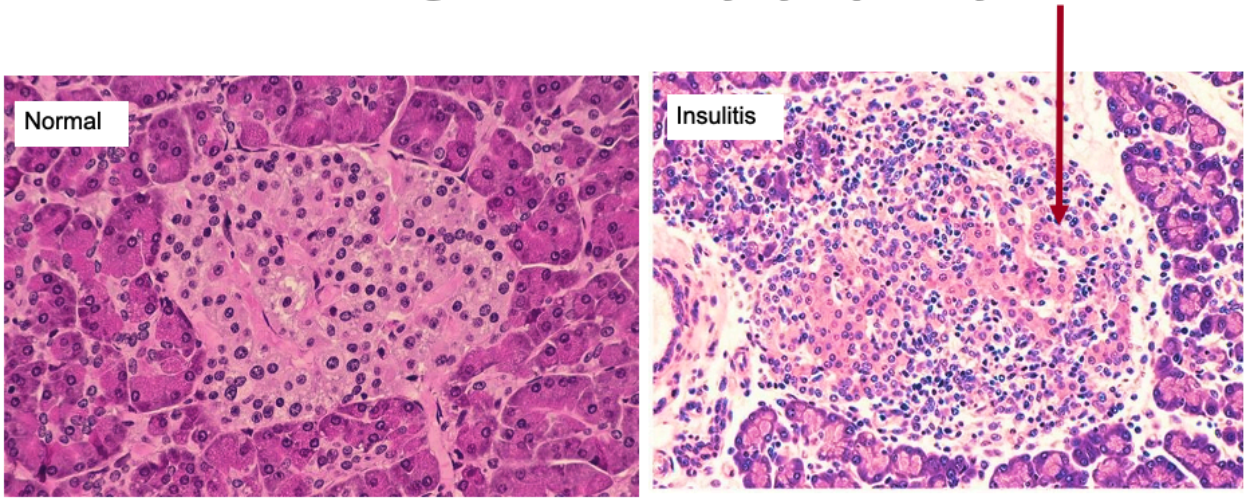
In both type 1 and type 2 diabetes, the islets undergo pathological changes that impair insulin regulation.

PATHOLOGY OF TYPE 1 DIABETES:

Type 1 diabetes is characterized by **autoimmune destruction** of the beta cells in the pancreas, leading to a lack of insulin production. The main histological feature of type 1 diabetes is **insulitis**, which is the infiltration of the islets by **lymphocytes**. This immune-mediated attack eventually leads to the destruction of the beta cells, resulting in an absolute insulin deficiency.

- **Histology**: Lymphocytic infiltration in and around the islets, which can be seen under a microscope as small, round dark cells surrounding the islet tissue.

Islets being attacked by lymphocytes



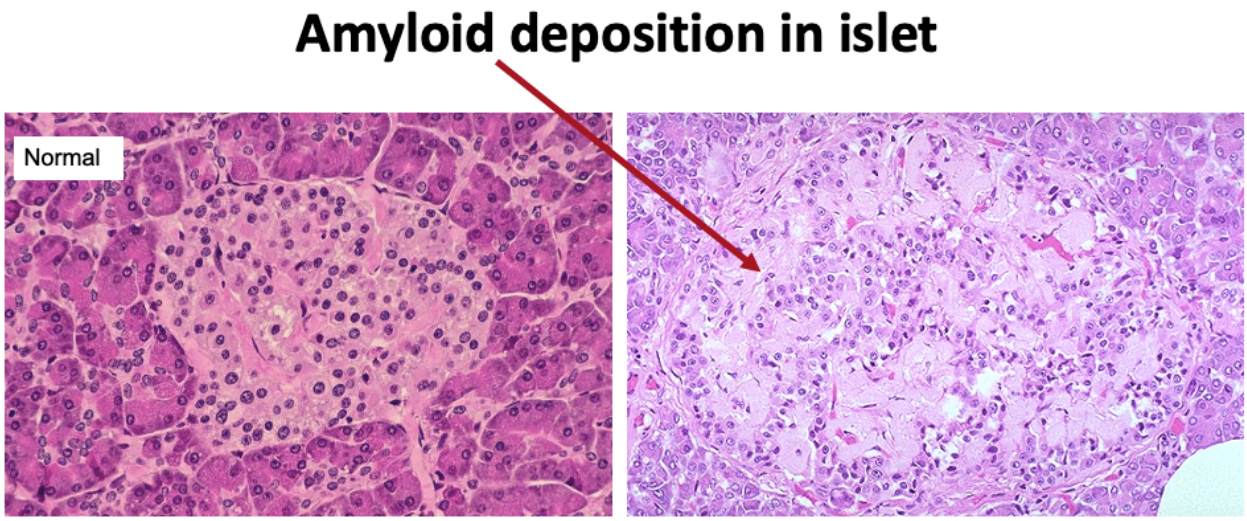
Lymphocytic infiltrates in this islet suggests an autoimmune mechanism for this process.
The destruction of the islets leads to lack of insulin that characterizes type I diabetes mellitus.

- **Clinical Relevance**: The destruction of beta cells leads to symptoms of hyperglycemia, and patients with type 1 diabetes require insulin replacement therapy.

PATHOLOGY OF TYPE 2 DIABETES:

Type 2 diabetes is characterized by **insulin resistance** and a relative lack of insulin production. Over time, beta-cell function deteriorates, and histological changes can be observed in the pancreatic islets.

- **Histology**: A hallmark of type 2 diabetes is the accumulation of **amyloid** (abnormal protein deposits) in the islets. Amyloid deposition is associated with beta-cell dysfunction and eventual beta-cell loss.



Islet beta cell failure in **type 2 diabetes** correlates with the formation of pancreatic islet **amyloid deposits of insulin**, indicating that islet **amyloid** may even play a role in beta-cell loss

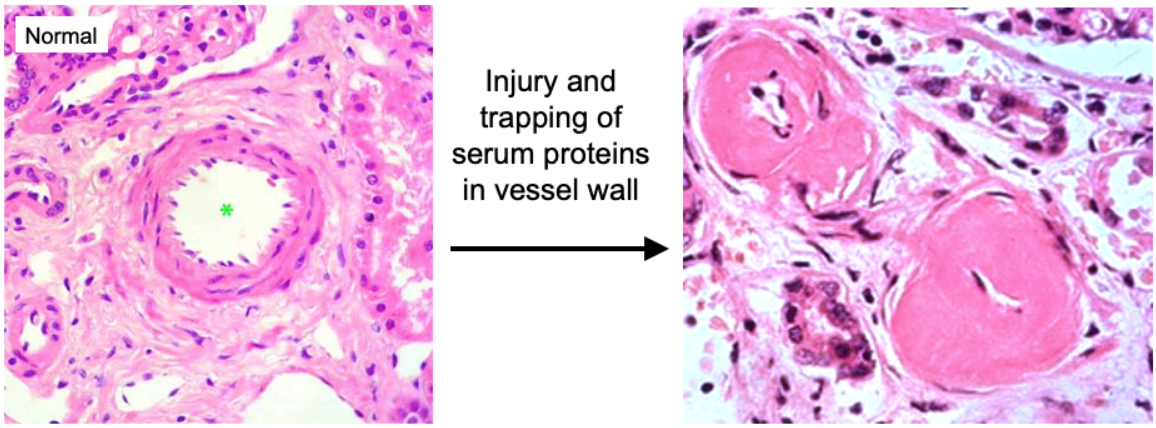
- **Clinical Relevance**: As beta-cell function declines, patients with type 2 diabetes may eventually require medications that increase insulin sensitivity or even insulin therapy.

COMPLICATIONS OF DIABETES:

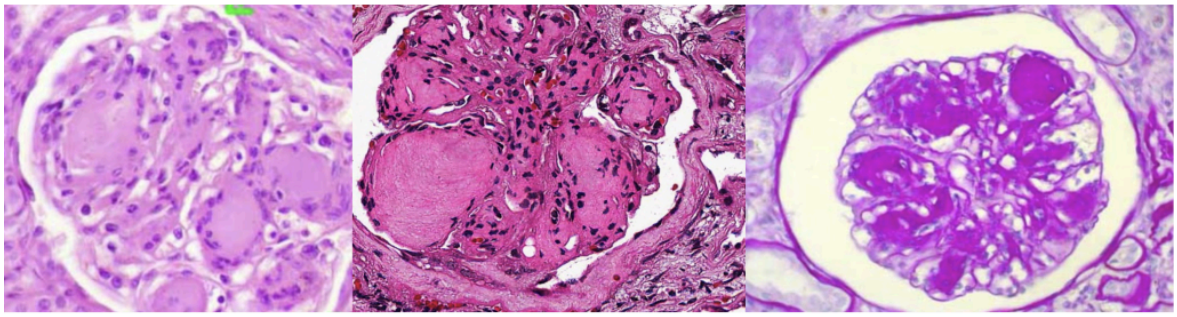
Chronic hyperglycemia in diabetes leads to significant complications affecting multiple organ systems:

- **Diabetic Nephropathy**: Hyperglycemia causes damage to the kidneys' small blood vessels, leading to **glomerular damage**. A classic histological feature is **nodular glomerulosclerosis (Kimmelstiel-Wilson nodules)**, which involves the thickening of the glomerular basement membrane and increased mesangial matrix.
    - **Histology**: Thickened blood vessels and nodules within the glomeruli.

Hyaline Arteriolosclerosis

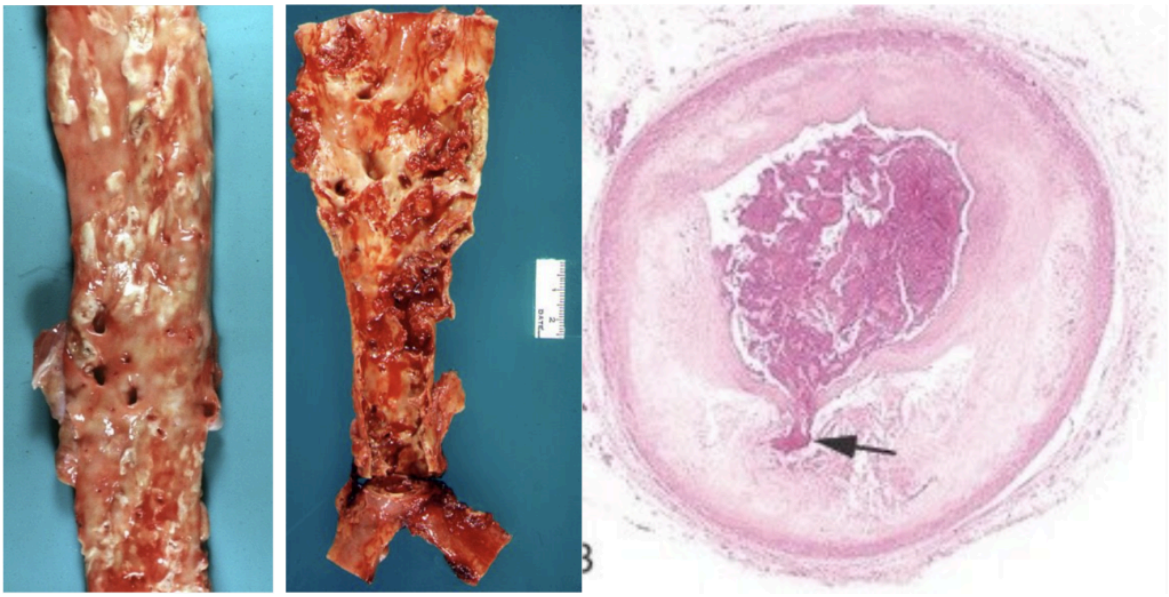


Nodular Glomerulosclerosis (Kimmelstiel Wilson Nodules)



Deposition of excess mesangial matrix

- **Diabetic Retinopathy**: Damage to the small blood vessels in the retina can cause vision loss due to **micro-aneurysms**, **hemorrhages**, and the formation of **new, fragile blood vessels** (neo-vascularization).
  - **Histology**: Thickened capillary walls and proliferation of new blood vessels.
- **Atherosclerosis**: Diabetes accelerates the development of atherosclerosis, leading to the thickening and hardening of large arteries. This results in an increased risk of heart attacks, strokes, and peripheral artery disease.
  - **Histology**: Plaque buildup and narrowing of the arterial walls.



- **Peripheral Arterial Disease and Neuropathy**: Reduced blood flow to the extremities, combined with nerve damage (neuropathy), leads to ulcers, infections, and, in severe cases, amputation.
    - **Histology**: Thickened arterial walls and loss of myelin sheaths in peripheral nerves.

This Chapter's PDF

LINK

- Note: The interactive features of this chapter are not reproducible in this PDF format.