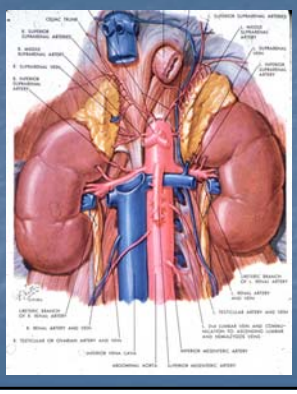
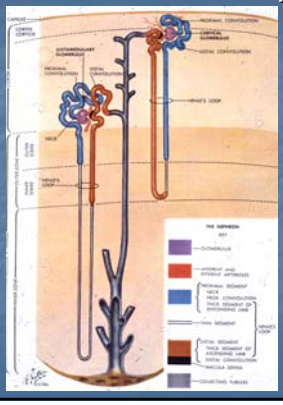
Renal Disease

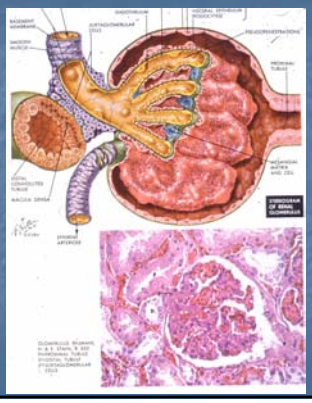
Basic Anatomy



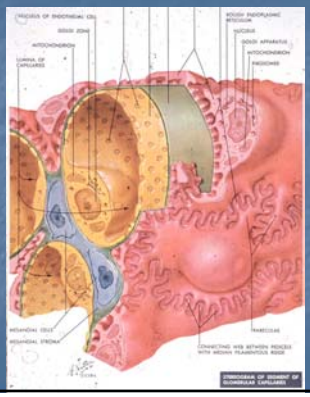
Renal Microanatomy



Glomerular Microanatomy

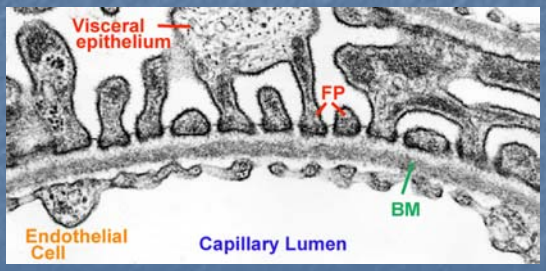


The Business End of the Kidney



A Little Higher Please

The Details



Renal Functions

- The Kidney does lots of stuff
  - RBC production
    - Erythropoietin
  - Calcium metabolism
    - By means of phosphate elimination.
  - Acid-Base balance.
  - Na^+ and K^+ balance
  - Processes Budweiser into urine

Amniotic Fluid

- Amniotic fluid is mostly urine produced by the developing fetus.
- No urine, no kidneys or
- Major malconnections of lower urinary tract.
- If the expectant mother is 'small for dates', the fetus may have problems with renal development.

Big Ticket Items

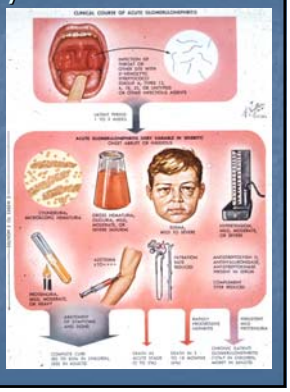
- Immunological injury
  - Glomerulus
  - Interstitial tissue
- Vascular injury or compromise
  - Diabetes
  - Hypertension
- Infections
  - Upper urinary tract
  - Lower urinary tract

Clinical Syndromes

- Nephritic syndrome
- Nephrotic syndrome
- Chronic renal failure
- Localized pain

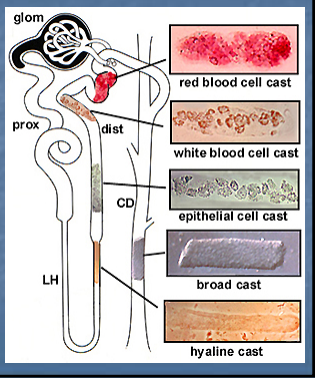
Nephritic Syndrome

- **Acute** injury, multiple possible causes
  - Major, acute injury to the glomerular basement membrane.
- Basic clinical pattern
  - RBCs in the urine
  - RBC casts in urine
  - Decreased urine output
  - Increased protein
  - Increased B/P



Urinary Casts

- Material cleared or shed by a sick glomerulus.
- Congeals within the
  - Convoluted tubules or
  - Collecting ducts
- Creates a 'cast' of the interior of the duct it formed in.
- Is Cleared in urine.
- Observed microscopically



Clinical Syndromes

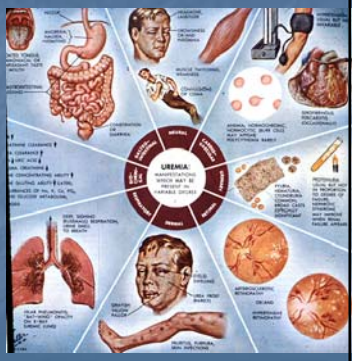
- Nephritic syndrome
- Nephrotic syndrome
- Chronic renal failure
- Localized pain

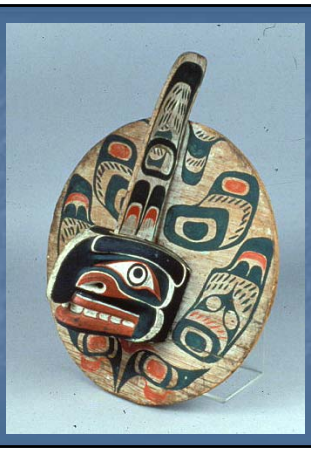
Nephrotic Syndrome

- **Chronic** injury of the glomerulus.
  - Many causes
- Basic clinical pattern
  - Proteinuria (>3.5 gm)
  - High serum lipids
  - Lipiduria
  - Low serum albumen
  - Edema

Chronic Renal Failure

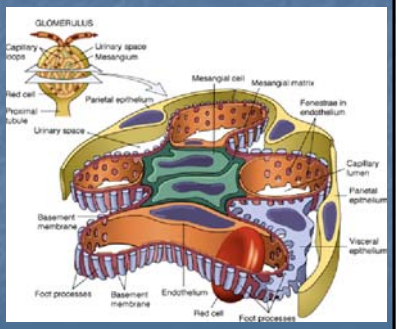
- Many causes
- Progressive loss of renal function.
  - Anemia
  - Bleeding
  - Increased infections
  - Accumulation of nitrogen wastes
    - Pericarditis
    - Uremic frost



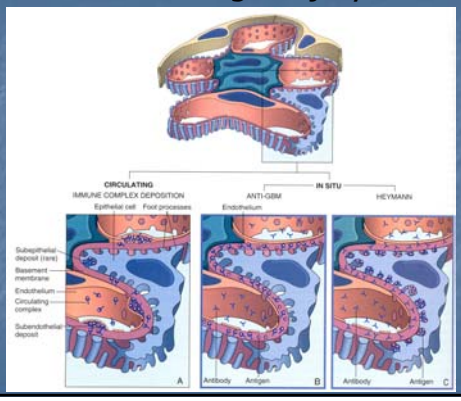


Glomerulonephritis General Features

- Mesangial cell proliferation
- Leukocyte infiltration
- BM thickening
  - Regular (linear)
  - Irregular (lumpy)

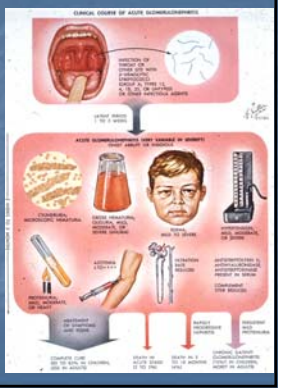


Immunologic Injury



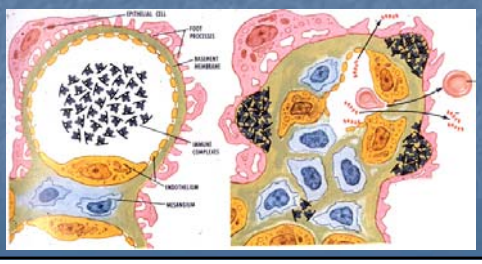
Acute Glomerulonephritis

- Follows Streptoccocal infection
- Antigen-antibody complexes lodge beneath the foot processes.
- Elicit a flaming inflammatory reaction
  - Complement deposited
- Huge holes in BM
- Nephritic syndrome



Acute Glomerulonephritis

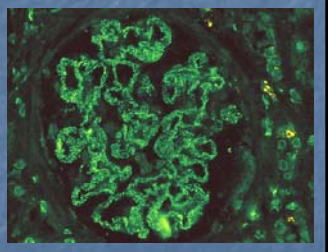
- Large number of immune complexes all at once
- Collect under foot processes because of charge
- Fix C′
- Focal destruction of BM
- Leakage of RBCs



Acute Glomerulonephritis

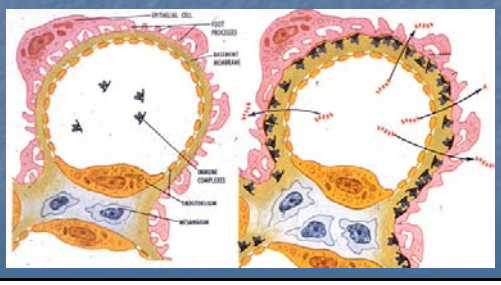
Acute Glomerulonephritis

- Anti-human IgG labeled with fluorescence.
- Identifies the immune complexes
- Granular pattern
  - Irregular clumps
  - Fix C′
  - Membrane damage



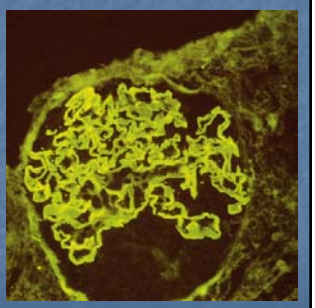
Membranous Glomerulonephritis

- Slow accumulation of Ag-Ab complexes
- Small holes, but numerous
- Tremendous protein loss



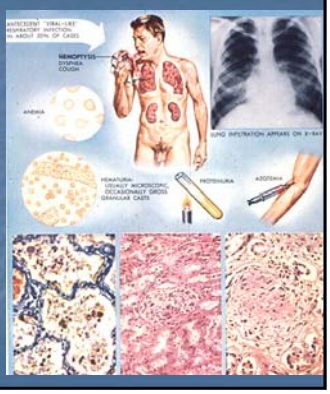
Membranous Glomerulonephritis

- Anti-human IgG labeled with fluorescence.
- Identifies the immune complexes
- Linear pattern
  - Smooth contours
  - Smaller holes
  - Protein loss
  - No RBC loss



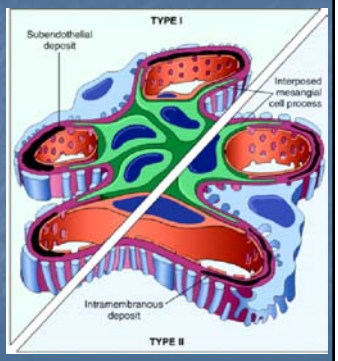
Goodpasture's Syndrome

- Antibodies specifically against BM
- Different from immune complex disease.
- Starts as a pulmonary infection (virus).
- Make antibodies against pulmonary BM
- Cross reacts with glomerular BM



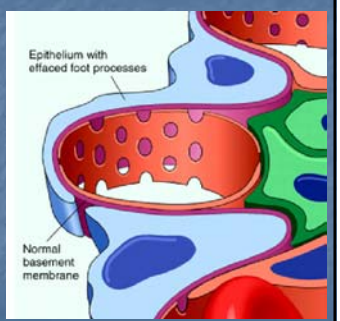
Membranoproliferative Glomerulonephritis

- Hybrid appearance
- Split BM
  - Train track
- C′ deposition
  - Alternate pathway
- Several types based on what starts it

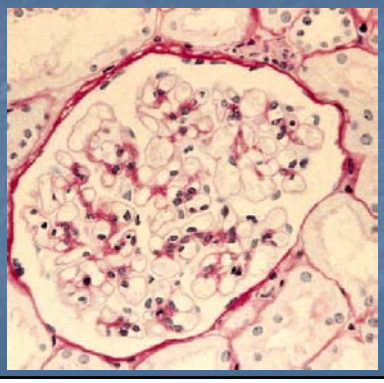


Minimal Change Glomerulonephritis

- Foot process disease
- Children 2-6 yrs
- Follows viral infection
- T-cell mediated?
- Tremendous loss of protein (nephrotic)
- Steroids helpful

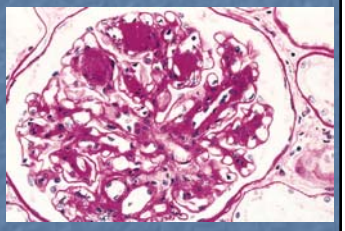


Minimal Change Glomerulonephritis



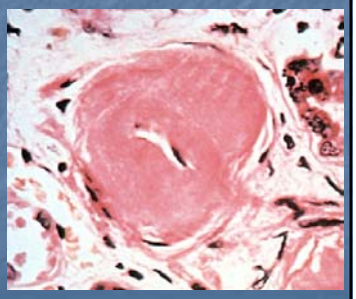
Diabetic Nephropathy

- Diabetes is a small vessel disease.
- Arterioles
- All parts of the kidney are involved.
- Glomerulus most significantly
  - Kimmelstiel-Wilson
  - Non-enzymatic glycosylation of proteins



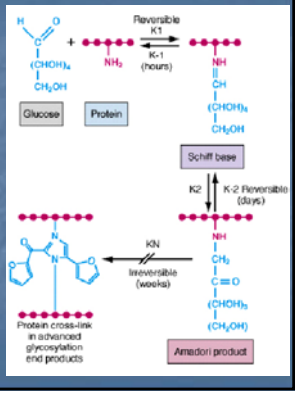
Diabetes is a Vascular Disease

- Atherosclerosis
  - Accelerated
- Arterioles ->
  - Retinal blindness
  - Gangrene
  - Renal failure
  - Neuropathy



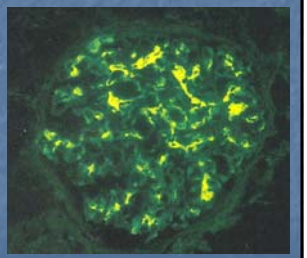
Non-Enzymatic Glycosylation

- Glucose sticks to, and alters, all sorts of proteins.
- No way of getting rid of the modified protein.
- BMs especially
- Small vessels narrow
- Glomerular BM
  - Thickens
  - Becomes inefficient
  - Loss of protein
  - Renal failure



IgA Nephropathy

- Mesangial deposits of IgA antibodies.
- Mid 20's
- Multiple episodes of hematuria.
- More common than once thought
- Transplant

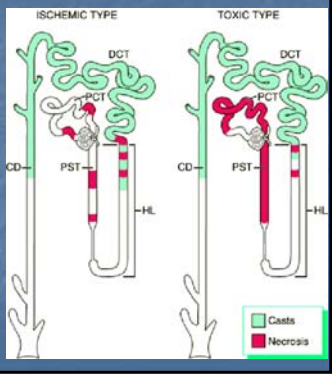


Tubular and Interstitial Disease

- Acute tubular necrosis
  - Pure tubular cell condition
  - Ischemia or toxic
- Interstitial (Pyelonephritis)
  - Toxic
  - Infectious
  - Autoimmune (medications)

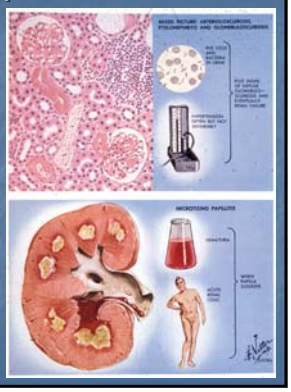
Acute Tubular Necrosis (ATN)

- Ischemic or toxic death of epithelial cells.
- Dead epithelial cells fall off the tubular BM.
- They clog the tubules.
- No urine output.
- Loss of concentrating gradient.



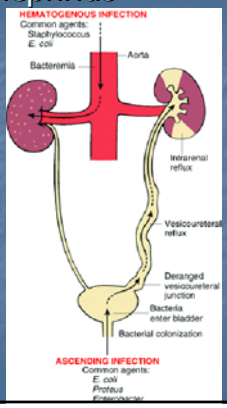
Pyelonephritis

- Inflammation of the interstitial tissue.
  - Infectious
  - Toxic
  - Immunologic
- Acute pyelonephritis.
  - Bacteria ascend from the urinary bladder.
  - Gram neg rods
  - Blood, pus and casts in the urine.
- These folks are sick.



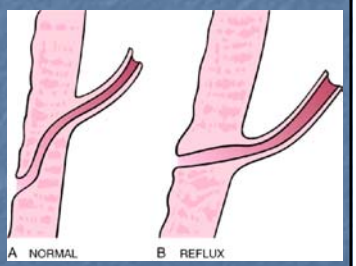
Bacterial Pyelonephritis

- Actually two ways
  - Blood borne
  - Ascend from bladder
- Direct infection of renal tissue.
- Predisposing factors
  - Ureteral reflux
  - Lower urinary tract obstruction
  - Diabetes
  - Vascular disease



Ureteral Implant Angle

- Lack of sphincter action.
- Reflux
- Bugs go upstream
- Congenital
- Problems for children
- Surgically correctable

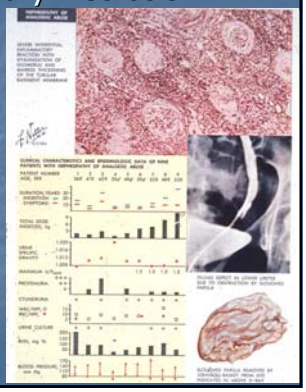


Chronic Pyelonephritis

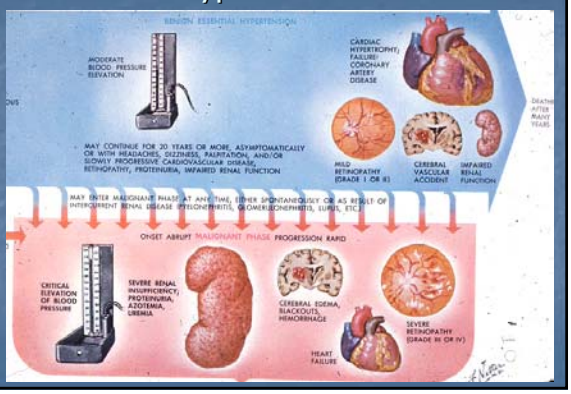
- Vascular insufficiency.
  - Arteriolar problem
- Chronic inflammation
  - Round cells
  - Tissue destruction
  - Fibrosis
- Diabetes
- Hypertension
- Repeat infections
- 'Thyroidization'

Renal Papillary Necrosis

- Death of the papillae
- Slough and obstruct ureter
- Inflammatory and/or vascular causes
  - Diabetes
  - Analgesic nephropathy
  - Chronic pyelonephritis

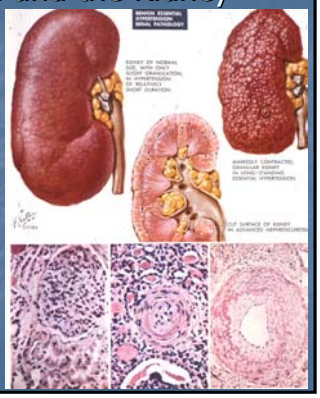


Hypertension



Hypertension and the Kidney

- Arteriolar changes
  - Onion skinning
  - Loss of luminal size
  - Reduced blood flow
  - Release of renin
  - Higher blood pressure
- Chronic pyelonephritis
- In time renal failure

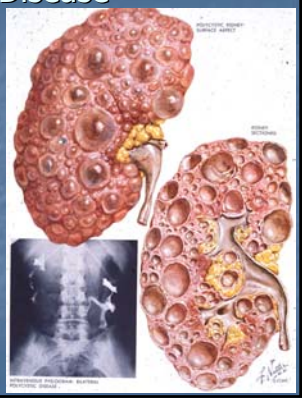


Additional Vascular Problems

- Diabetes (small vessel disease)
- Clotting related
- Emboli
- Sickle cell disease

Cystic Disease

- Polycystic renal disease
- Growth of tubular epithelium causes cyst formation.
- Cysts accumulate fluid and squeeze the rest of the kidney out of existence.
- Adult and juvenile forms

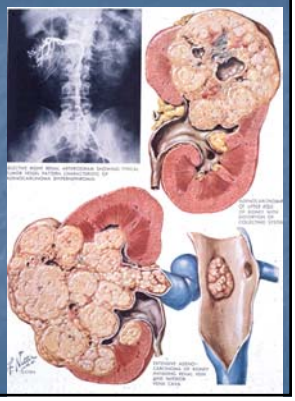


Tumors of the kidney

- Benign vs. malignant
- Primary vs. metastatic

Renal Cell Carcinoma

- Arises from tubular epithelium
- Likes to spread by way of blood vessels.
- Widely metastatic
- Painless hematuria
- Golden yellow with areas of necrosis.



Wilm's Tumor

- Childhood tumor
- Embryonic appearing tissue
- Two cell types
  - Stromal element
  - Little tubules

Lower Urinary Tract

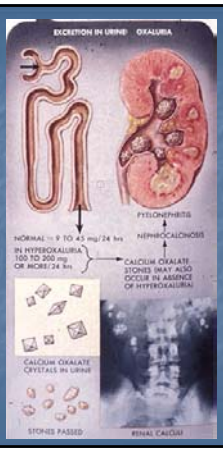
- Infections
- Stones
- Cancer

Bladder Infections

- Very common
- Host bugs
  - E. coli
  - Other gram negatives
- Urethral trauma
- Catheterization
  - Paraplegics especially

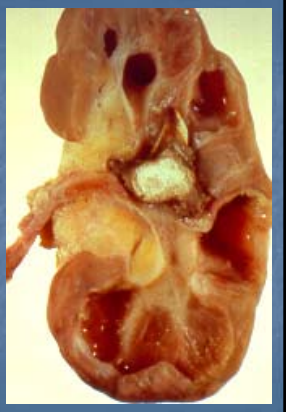
Kidney Stones

- Most are formed of oxalate crystals.
- Contributing factors
  - Dehydration
  - High protein diet
  - Genetics
- Very painful
  - Ureteral dilation



Kidney Stones

- Large calculus
- Hydronephrotic kidney



Papillary Transition Cell Carcinoma

- Transition cell origin
- Tobacco
- Industrial chemicals
- Hematuria

Papillary Transition Cell Carcinoma