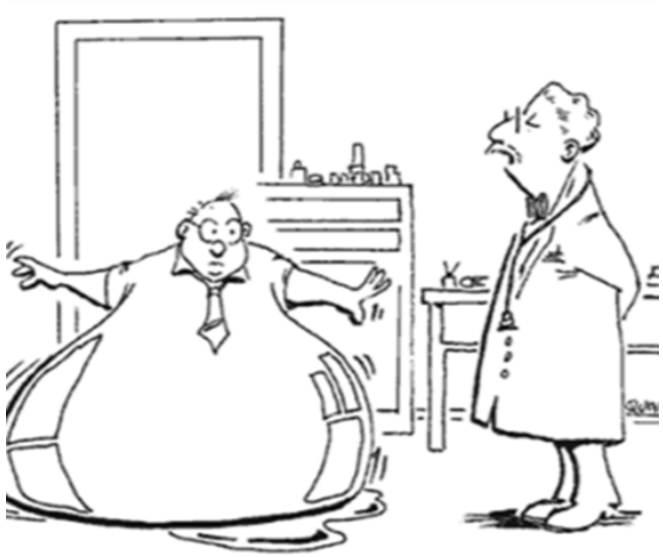
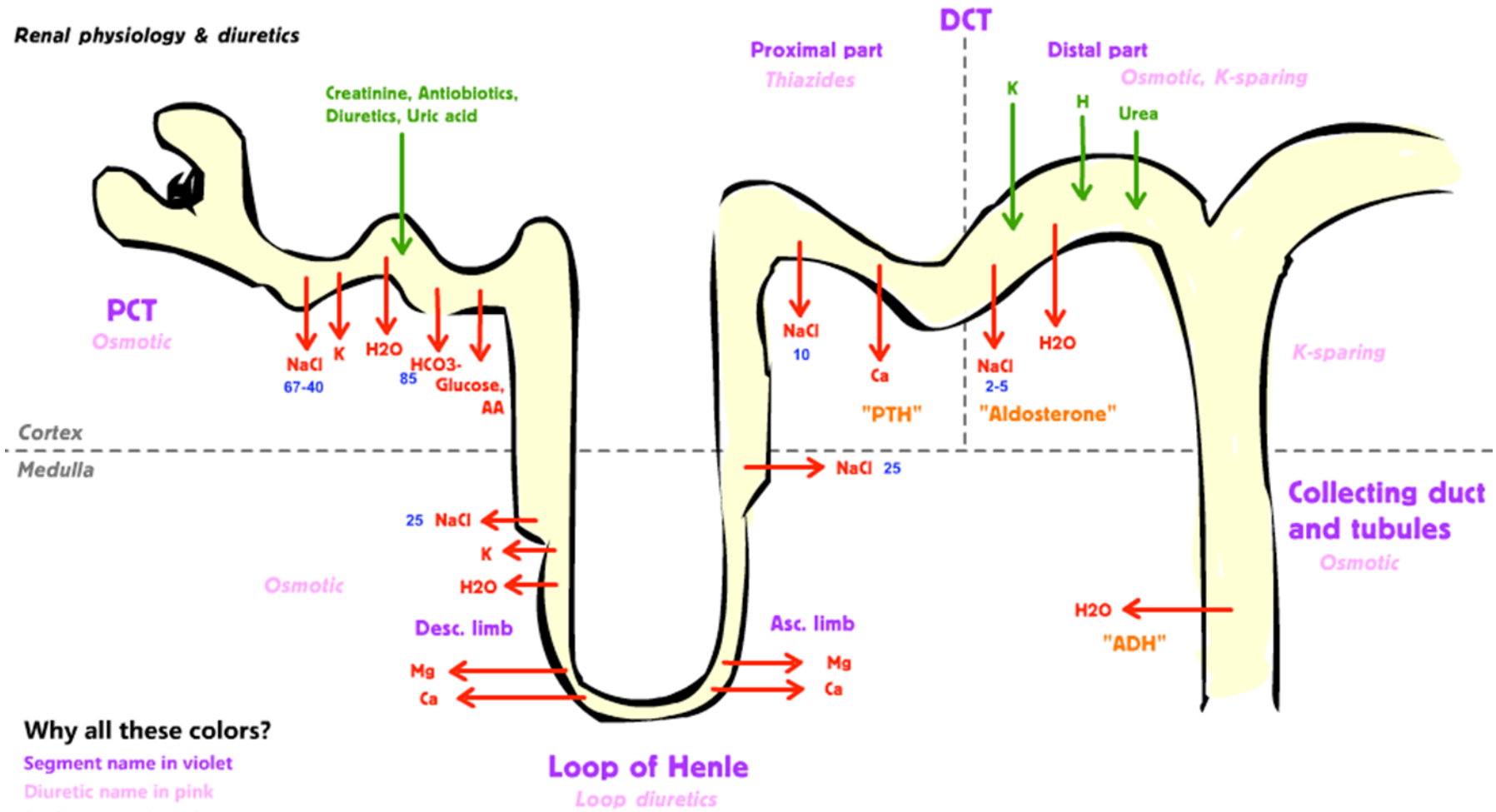


Alterations of Renal & Urinary Tract Function in Children

Tracy L. Brewer, DNP, RNC-OB, CLC©



Why all these colors?

Segment name in violet

Diuretic name in pink

Reabsorption in red

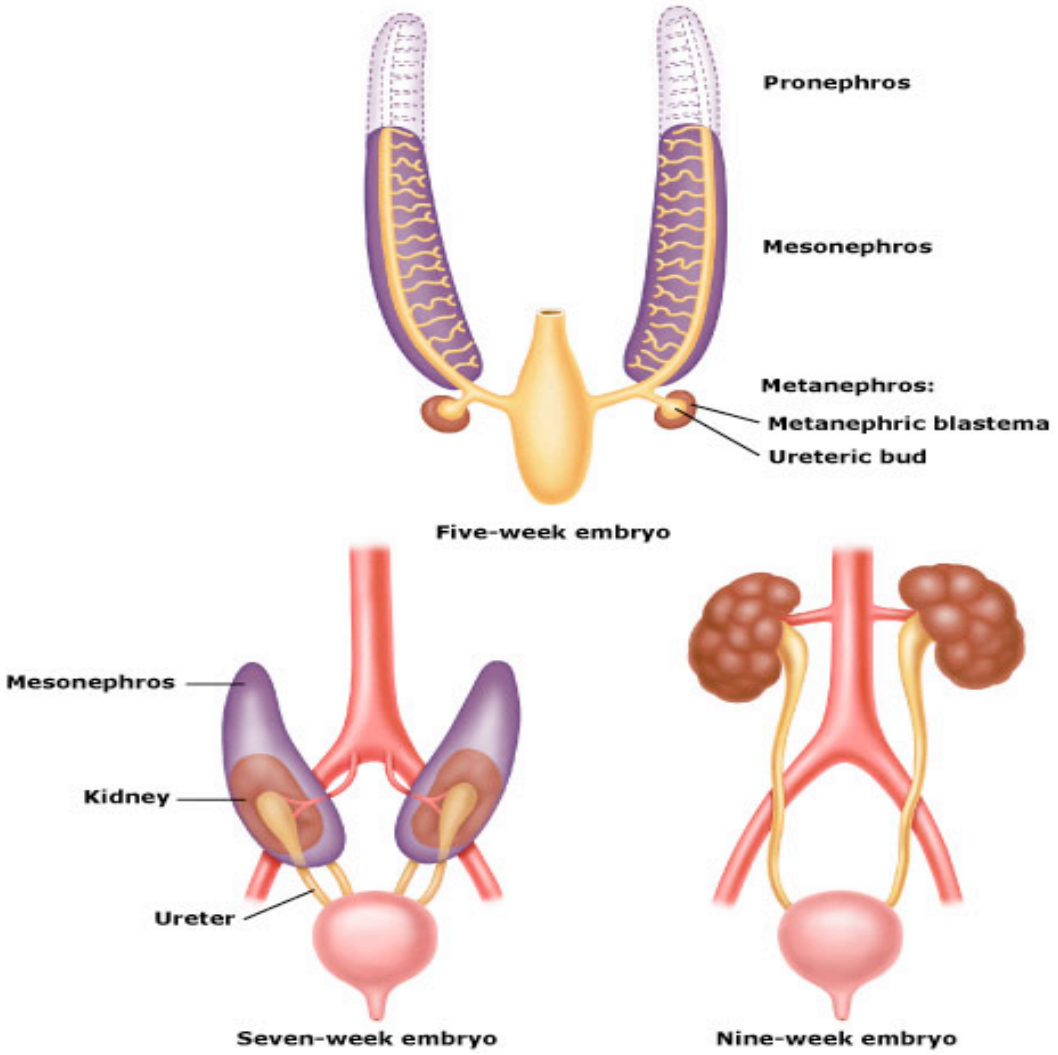
Secretion in green

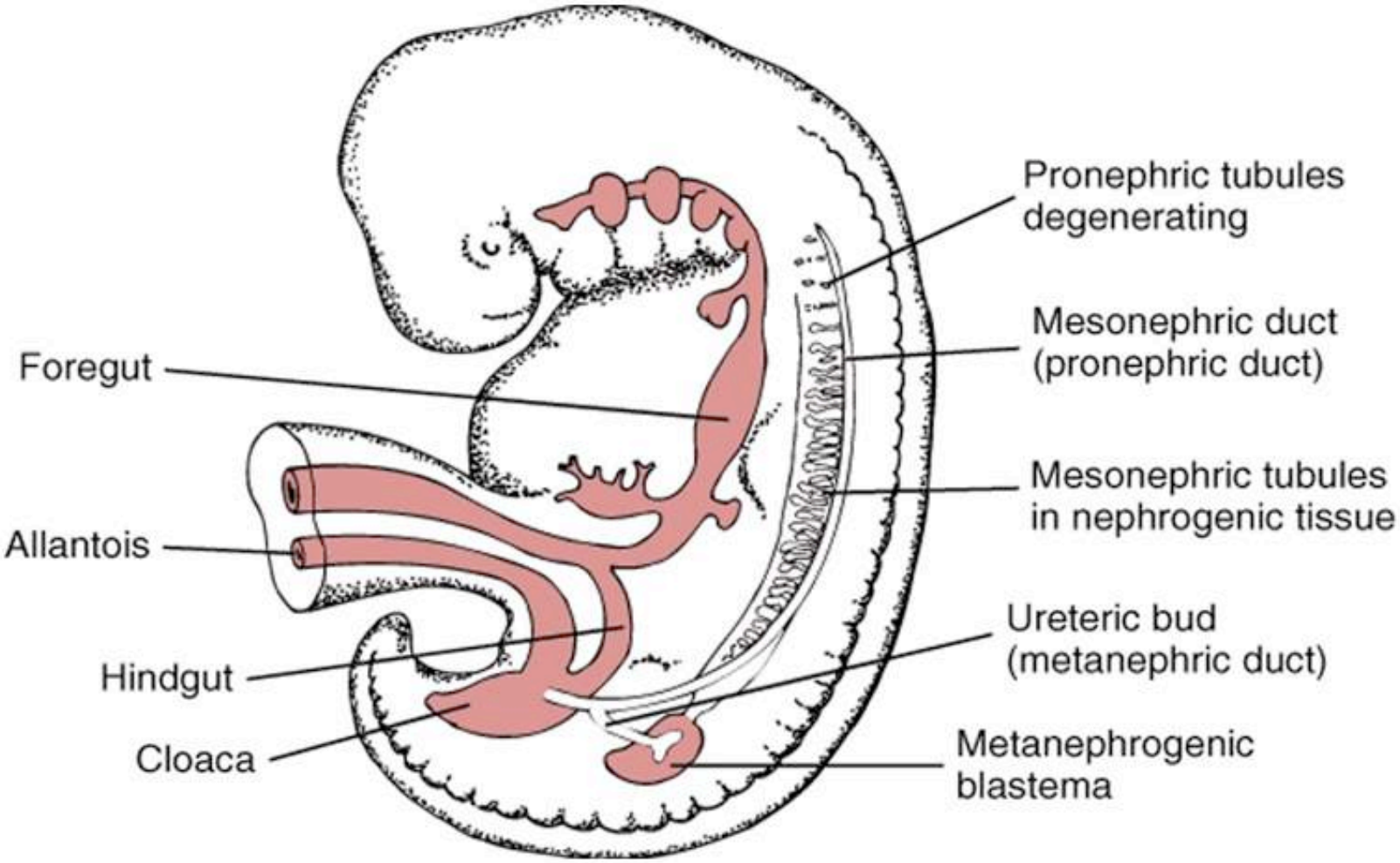
Percentage in blue

Hormone in orange

Kidney embryology

- Pronephros
- Mesonephros
- Metanephros





(From Netter F, Shapter R, Yonkman F, editors: *The ciba collection of medical illustrations,* vol 6, *Kidneys, ureters, and urinary bladder,* Summit, NJ, 1973, Ciba Pharmaceutical Corporation.)

Fluid and Electrolyte Balance

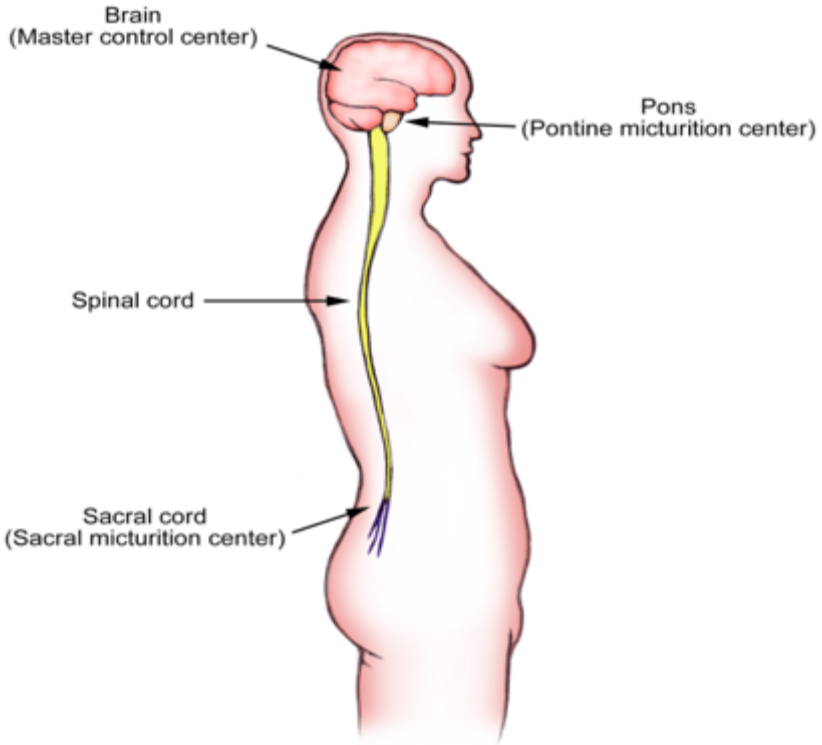
- Blood flow to the kidney in a newborn is primarily to the medullary nephrons
- Due to the short loops of Henle in the medullary nephrons, an infant produces more dilute urine
- Infants are in a high anabolic state, so their urea excretion is low
  - Urea is required to establish the concentration gradient in the medulla

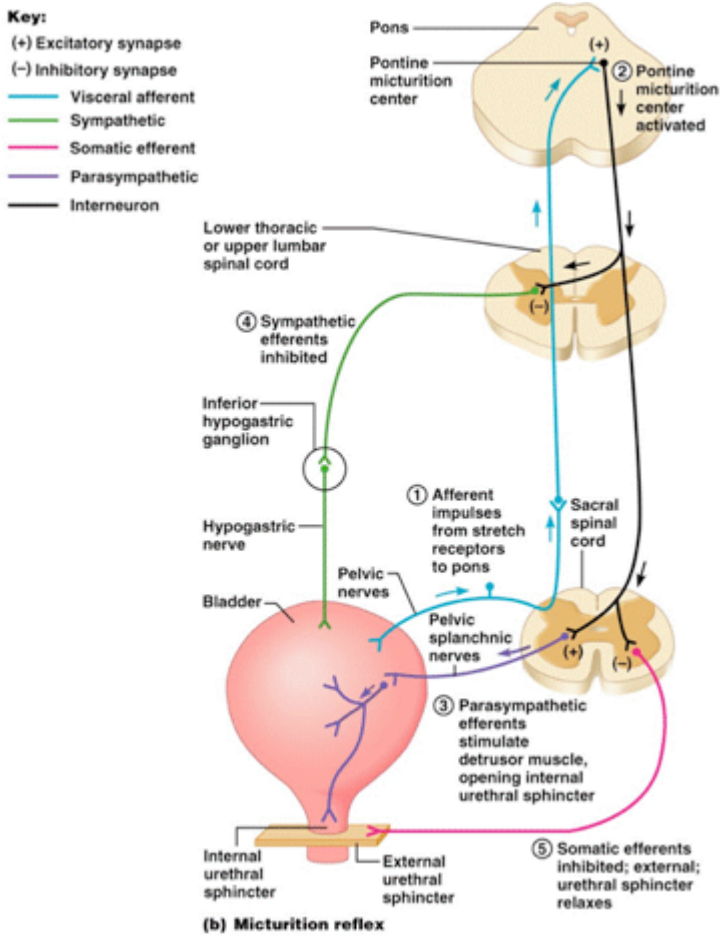
Fluid and Electrolyte Balance

- Infants have a narrow chemical safety margin due to high hydrogen ion concentration, low osmotic pressure, and limited ability to regulate their internal environment

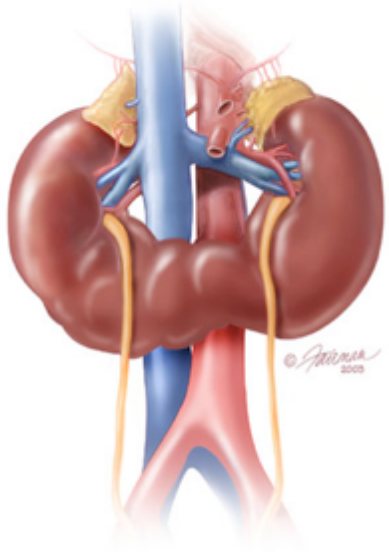
- Diarrhea, infection, fasting, and poor feeding can rapidly lead to severe acidosis and fluid imbalance

Micturition

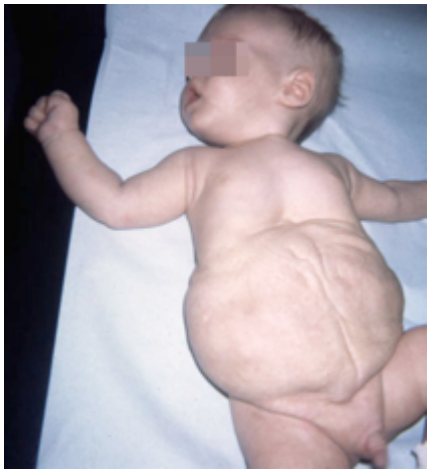




Structural abnormalities

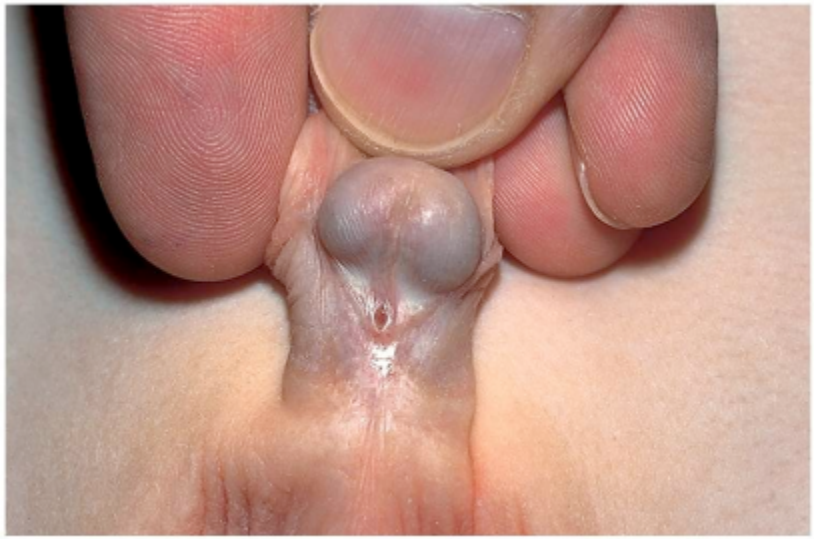


- Occur in 10 to 15% of population
- Fusion of kidney
  - Horseshoe Kidney
    - 1:600 births
    - Asymptomatic
- Congenital anomalies associated with urinary tract malformations
  - Chromosomal disorders, Trisomy 13 & 18
  - Prune-belly syndrome
  - Imperforate anus or genital deviation
    - VATER Syndrome
  - Anomalies of spinal cord
  - Wilms tumor
  - Congenital ascites
  - Cystic disease of the liver
  - Family History of renal disease

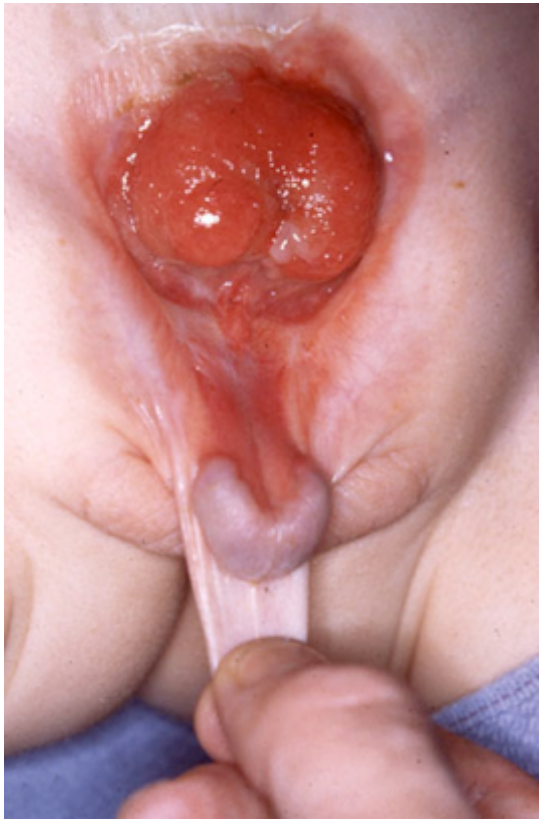


Structural abnormalities

- Hypospadias
  - Urethral meatus is located on the ventral side of the penis
- Epispadias
  - Urethral opening is on the dorsal surface of the penis
    - Twice as many boys as girls suffer from this defect

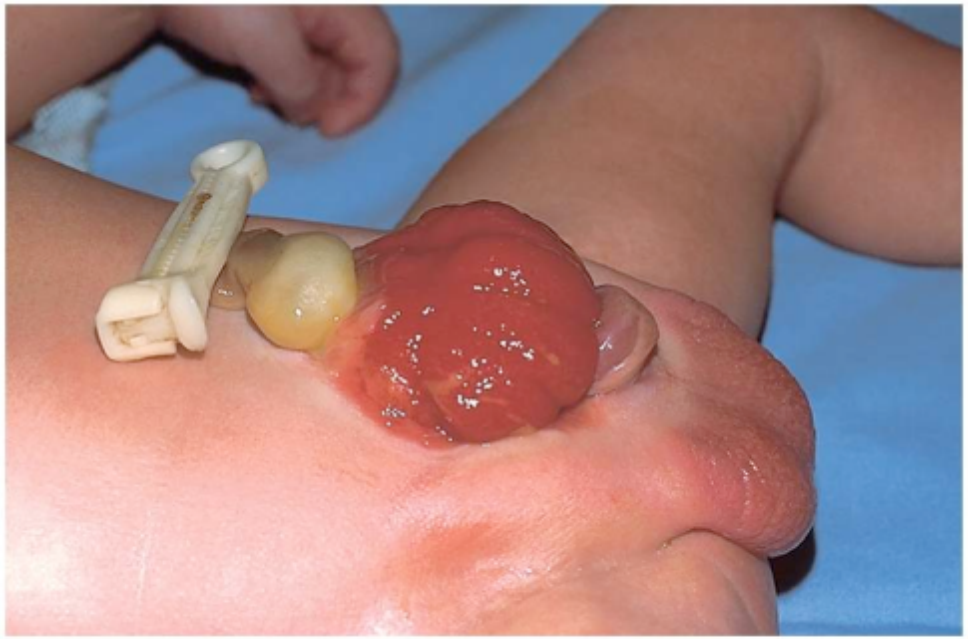


(Courtesy H. Gil Rushton, MD, Children's National Medical Center, Washington, DC; from Hockenberry MJ et al: *Whaley and Wong's nursing care of infants and children*, ed 7, St Louis, 2003, Mosby.)

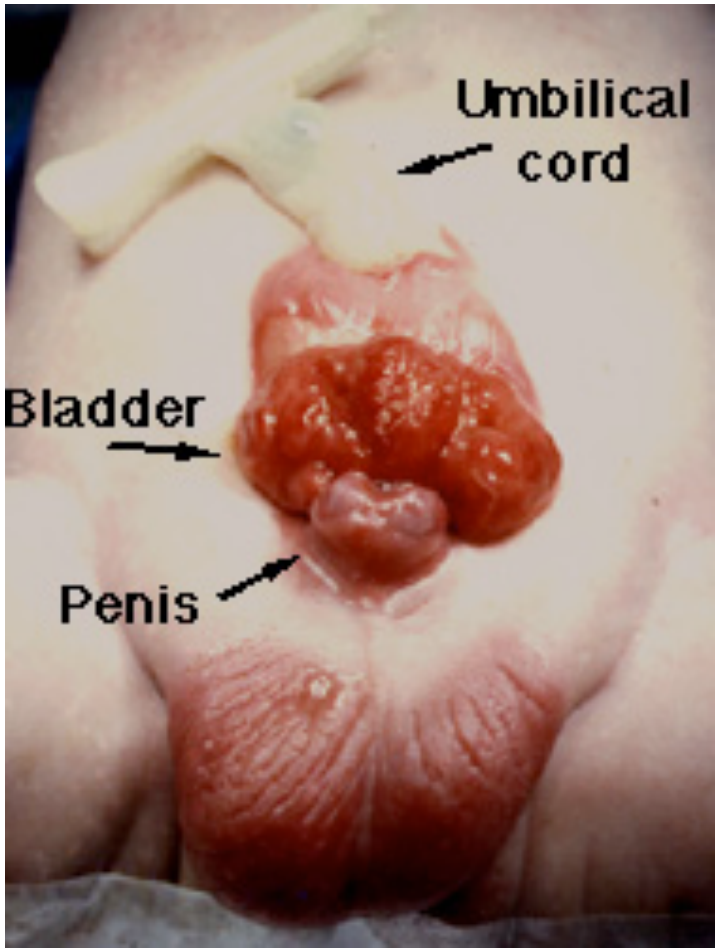


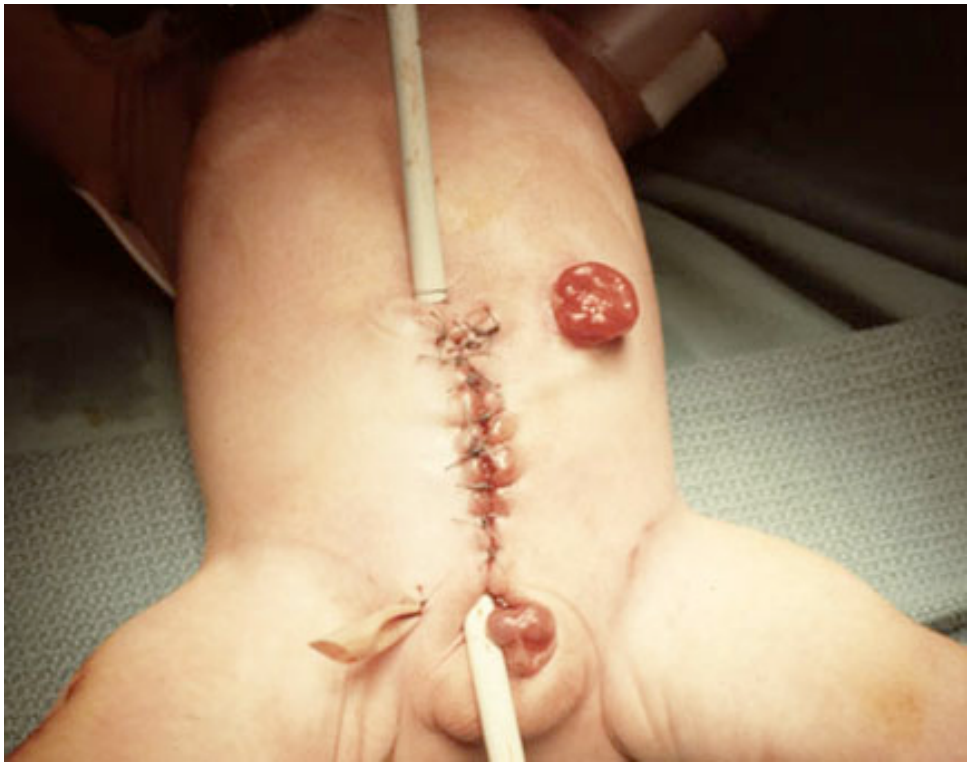
Exstrophy of the bladder

- Extensive congenital anomaly in which the lower urinary tract is exposed directly to the surface of the body



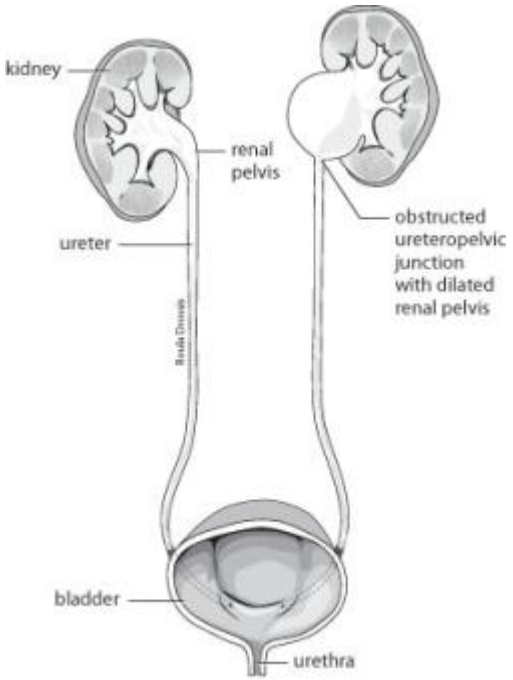
(Courtesy H. Gil Rushton, MD, Children's National Medical Center, Washington, DC; from Hockenberry MJ et al: *Whaley and Wong's nursing care of infants and children*, ed 7, St Louis, 2003, Mosby.)


Umbilical
cord
Bladder
Penis

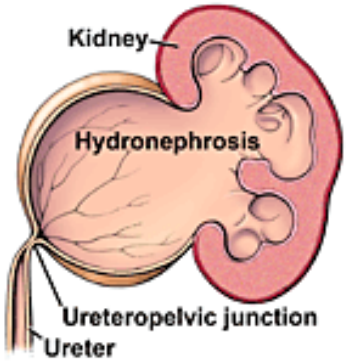


Ureteropelivic Junction (UPJ) Obstruction

- Blockage of the tapered point where the renal pelvis transitions into the ureter
  - Most common cause of hydronephrosis in neonates
- Secondary UPJ
  - Kinking or scarring from high-grade vesicoureteral reflux

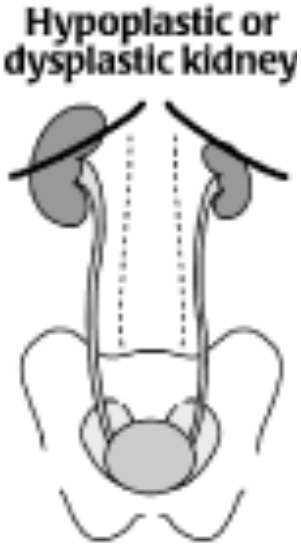


Ureteropelvic Junction Obstruction



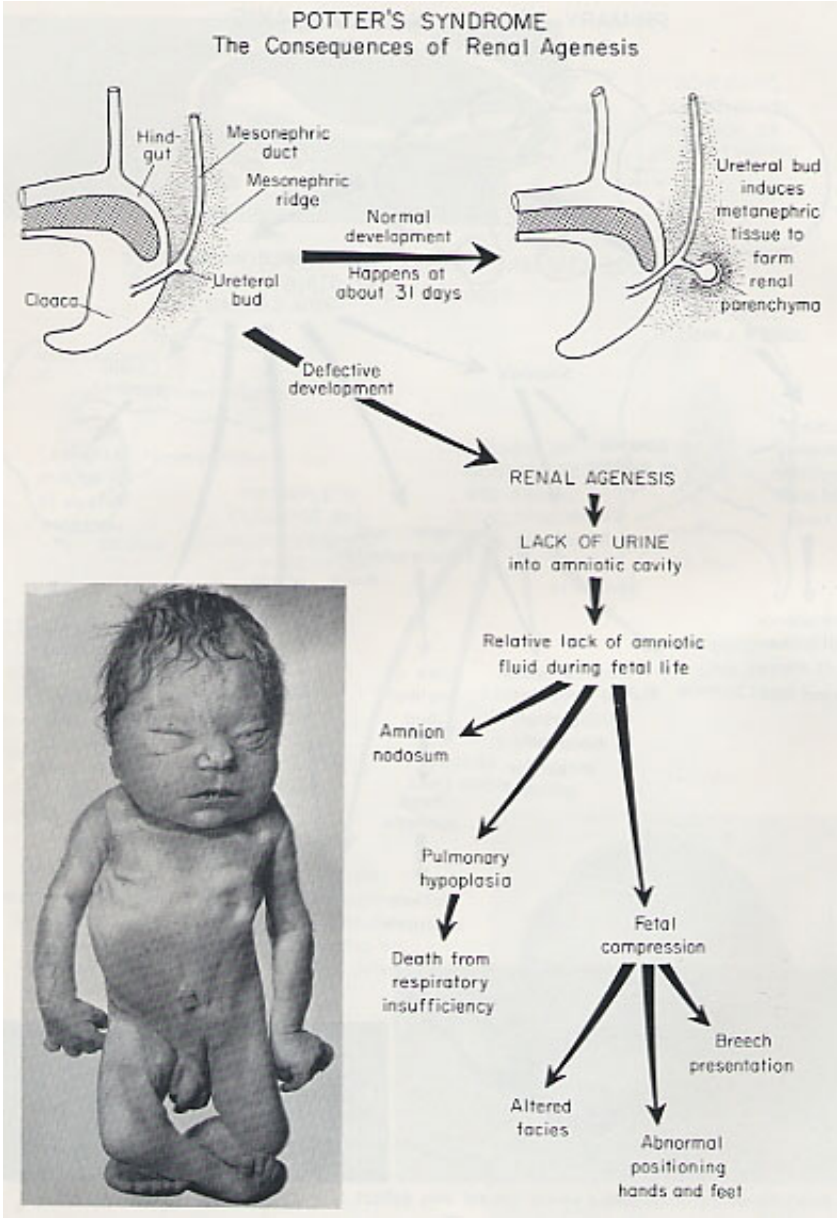
Hypoplastic or Dysplastic Kidneys

- Hypoplastic kidney
  - Very small normal kidney
  - Can be congenital or acquired due to renal vein thrombosis, which occurs in setting of severe dehydration/ diarrheal illnesses.
- Renal dysplasia
  - lack or abnormal differentiation of renal tissues
  - Functional or organic obstruction of the collecting system and may begin before birth
- Bilateral hypoplastic or dysplastic kidneys common cause of ESRD



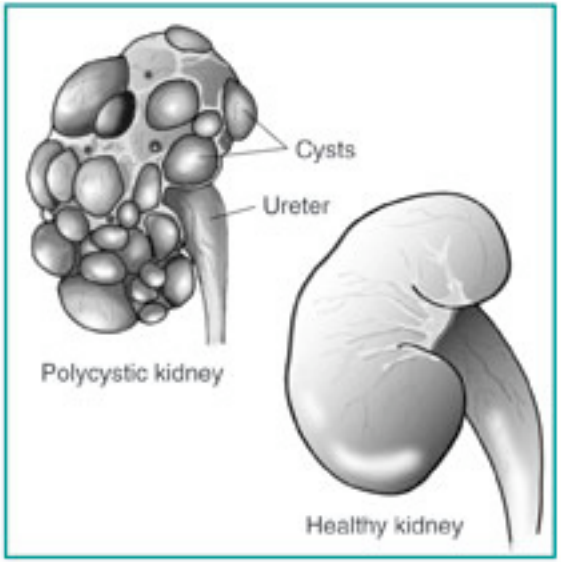
Renal Agenesis

- Renal agenesis
  - Potter Syndrome
    - Oligohydramnios



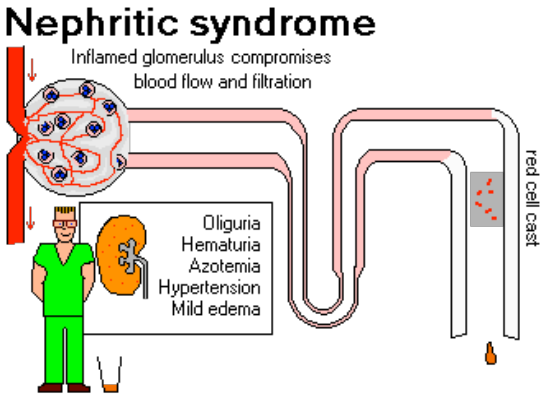
Polycystic kidneys

- Autosomal dominant inherited disorder
  - 1:1000 live births
  - Mutations to 2 genes in adults:
    - *PKD-1* (chromosome 16)
    - *PKD-2* (chromosome 4)
- Autosomal recessive disorder
  - Mutations to the short arm of chromosome 6 (*ARPKD* gene)
  - Other organs with cysts:
    - Pancreas
    - Liver

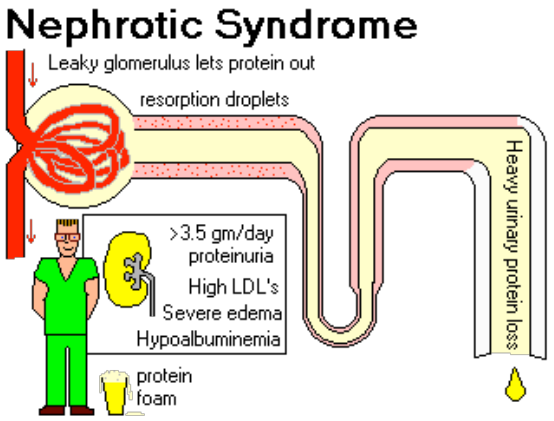


Glomerular diseases

- Nephritic diseases
  - Hematuria
  - Oliguria
  - Azotemia
  - Hypertension



- Nephrotic diseases
  - Massive proteinuria
  - Hypoalbuminemia
  - Edema
  - Hyperlipidemia/hyperlipiduria



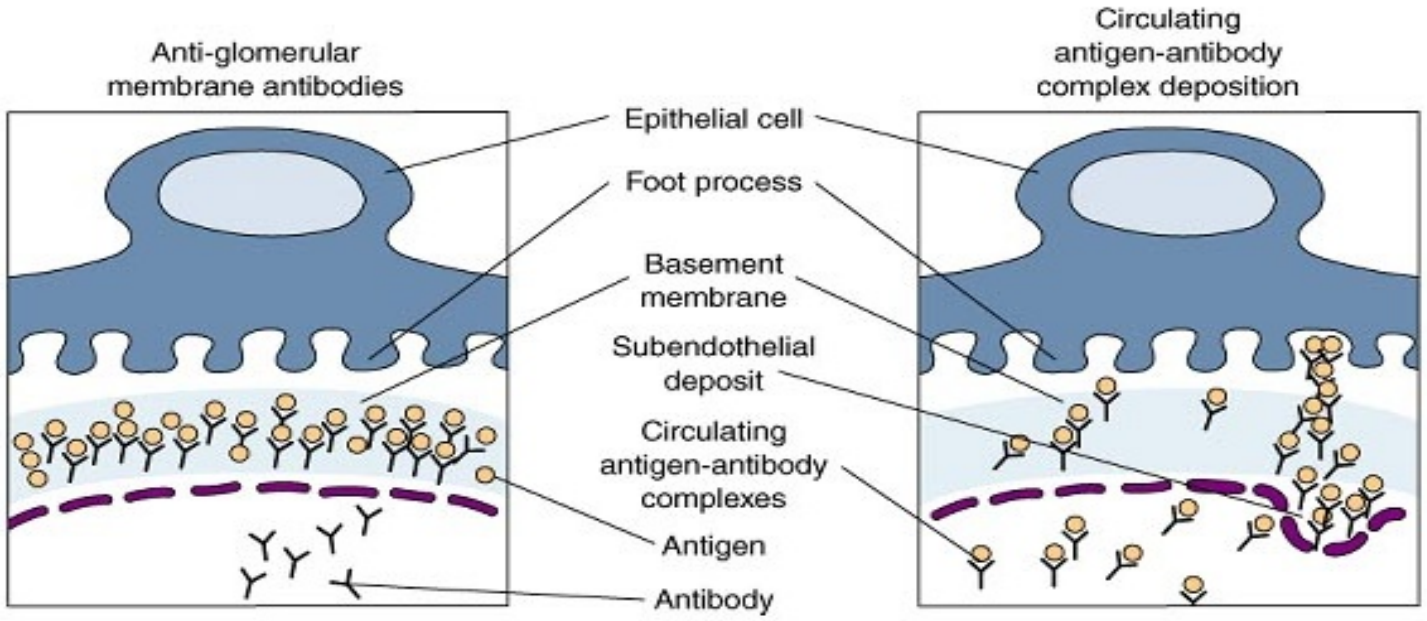
Glomerulonephritis

- Acute poststreptococcal glomerulonephritis (PSGN)
  - PSGN occurs after a throat or skin infection with certain strains of group A β-hemolytic streptococci
  - The patient experiences a sudden onset of hematuria, edema, hypertension, and renal insufficiency
  - Antigen-antibody complexes and complement are deposited in the glomerulus
  - The immune complexes initiate inflammation and glomerular injury

Glomerulonephritis

Pathogenesis

- Antibody reaction with antigens in the glomerulus
- Entrapment of antigen-antibody complexes



Pathogenesis

Streptococcal infection (group A β hemolytic)

↓

antigen-antibody reaction

↓

formation of antigen-antibody complexes

↓

entrapment in the glomerular basement membrane

↓

Proliferation of the endothelial and mesangial cells of the glomerulus

↓

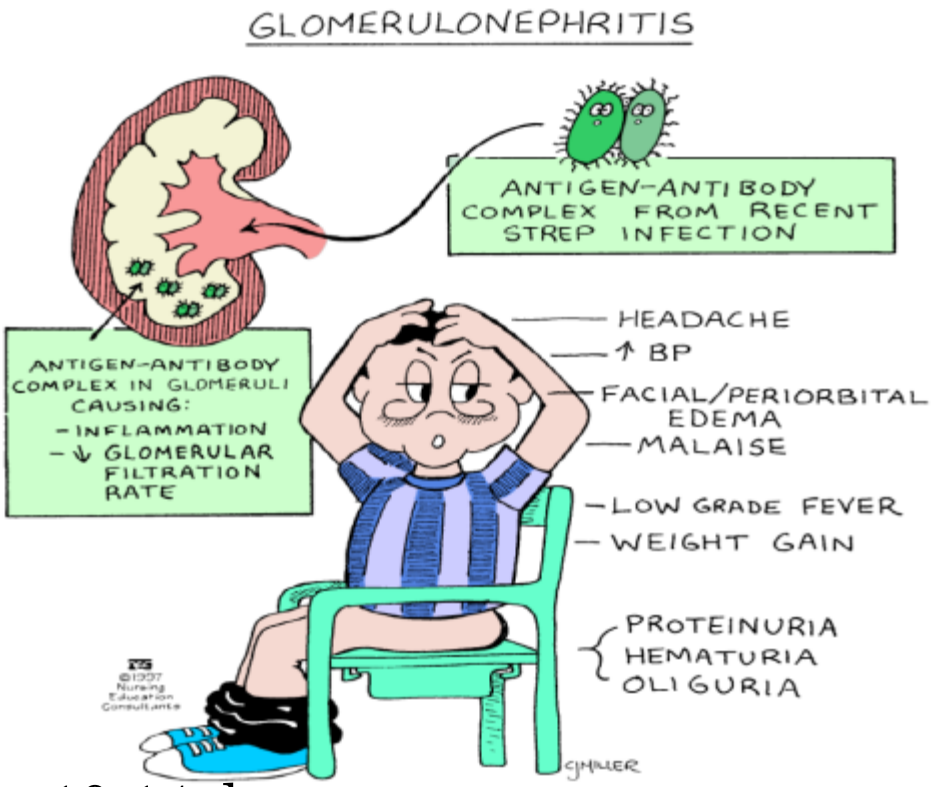
Swelling of the glomerular-capsule membrane

↓

Increased porosity of the membrane to plasma proteins and RBC's

Manifestations

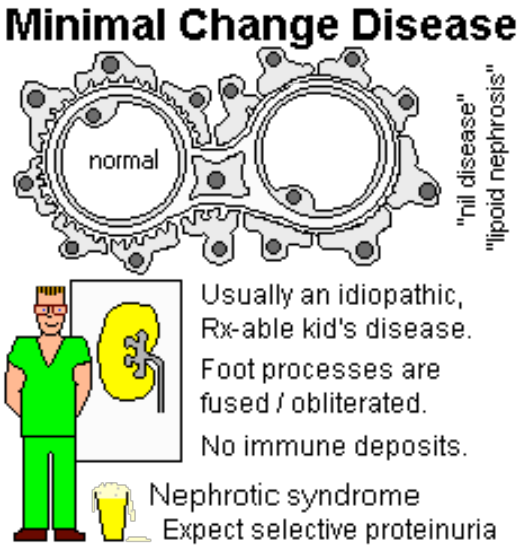
- Oliguria
- Azotemia (↑BUN/CR)
- Proteinuria (varies)
- Hematuria
  - Cola colored urine
- Edema
- Hypertension



- Clinical Course
  - Symptoms resolution in 10-14 days
  - Possible residual proteinuria
- Diagnostics
  - Antistreptolysin-O nonspecific, anti DNA-ase B
  - Decreased serum complement

Nephrotic syndrome

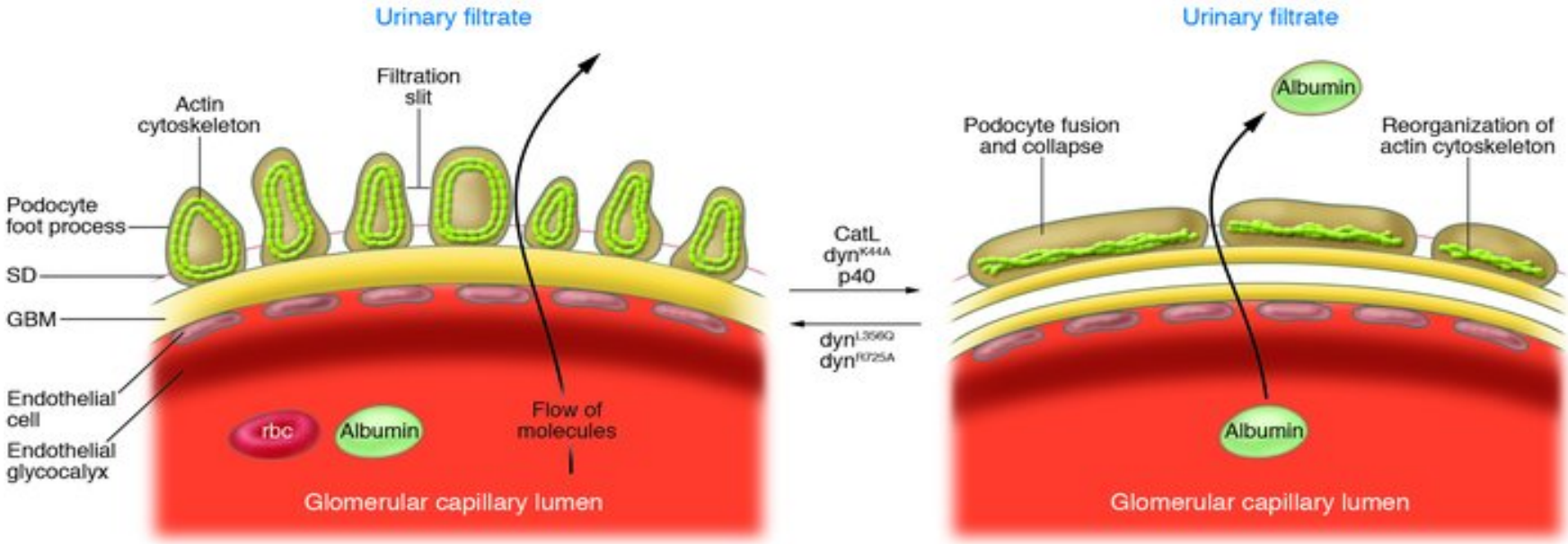
- Condition that describes complex symptoms:
  - Proteinuria
  - Hypoproteinemia
  - Hyperlipidemia
  - Edema
  - Transient hypertension and hematuria can occur



- Most common causes are idiopathic
- Minimal change nephropathy: 85%
- Focal segmental glomerulosclerosis (FSGS): 15%

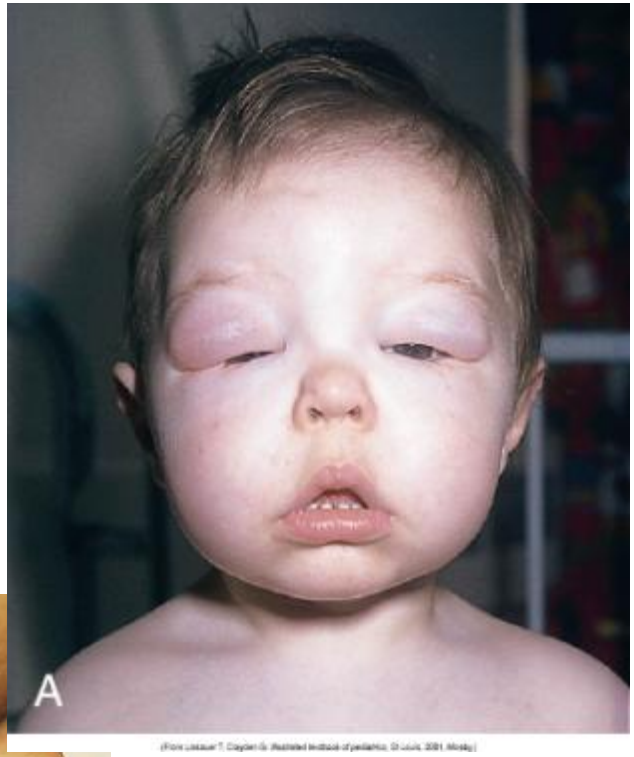
Pathogenesis

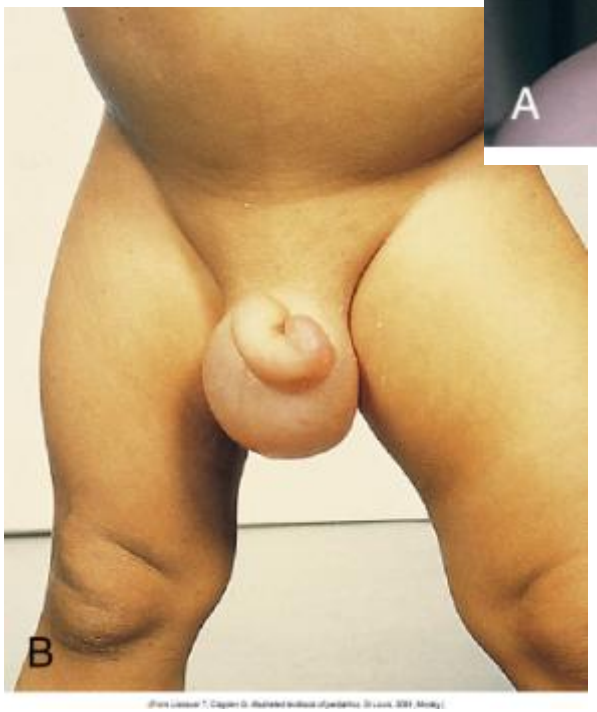
- Etiology: unknown
- Increased glomerular permeability
  - Abnormal circulating T cells that injure the epithelial cells of the glomerulus
  - Fusion of epithelial cell podocyte



Manifestations

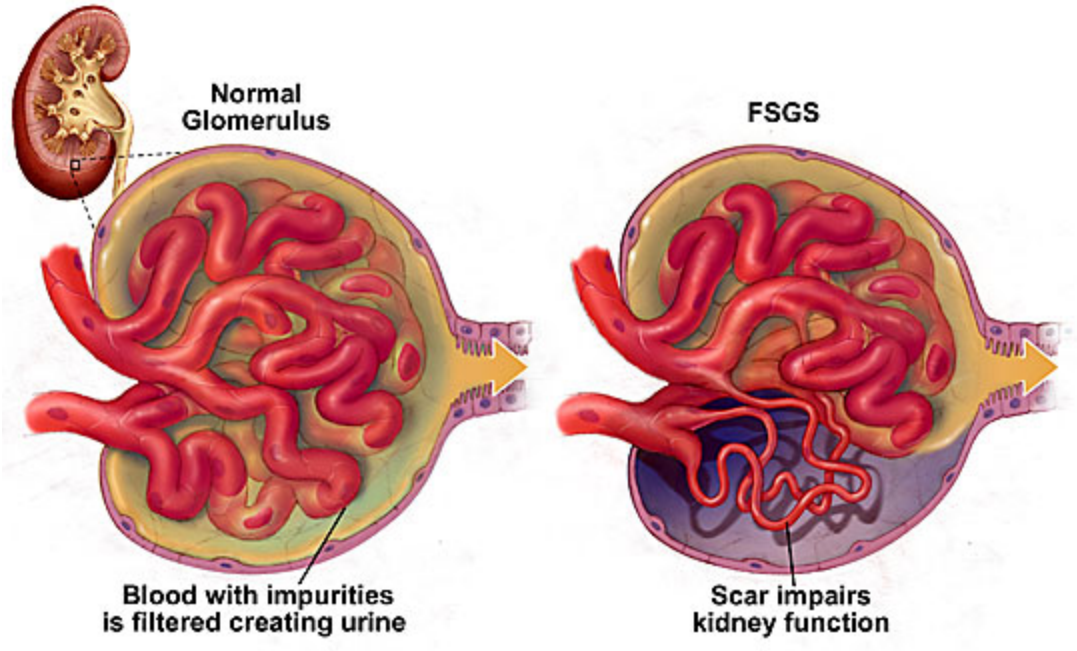
- Severe edema
- Hypertension
- Sequela
  - Pulmonary edema
  - Pleural effusion
  - Ascites
  - Hyperlipidemia
  - infection





Focal Segmental Glomerulosclerosis

- 15% of children with nephrotic syndrome
- Pathogenesis:
  - Thinning or deletion of epithelial podocytes
  - Increasing pore size
  - Proteinuria



Hemolytic-uremic syndrome

- HUS is the most common cause of acute renal failure in children
- There is an association of HUS with bacterial and viral agents
  - *Escherichia coli O157:H7*
- The bacterial toxin from *E. coli damages red cells and endothelial cells*
- The endothelial lining of the glomerulus becomes swollen and occluded with fibrin clots

Pathogenesis

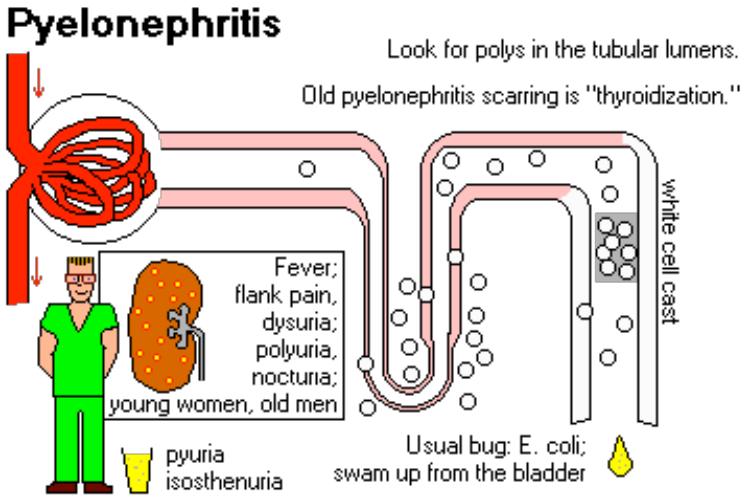
- Vertoxin from Ecoli is absorbed from the intestines and damages RBCs and endothelial cells.
- Endothelial lining of the glomerular arterioles becomes swollen and occluded with platelets and fibrin clots
- Decreased GFR with hematuria and proteinuria
- Narrowed vessels damage RBCs as they pass through, these damaged cells are removed by the spleen causing acute hemolytic anemia
- Thrombocytopenia
  - Thrombotic thrombocytopenic purpura

Manifestations

- Preceded by URI or GI illness by 1-2 weeks
- Sudden onset
  - Pallor
    - Bruising/pupura
    - Irritability
    - Oliguria
  - Fever
  - Vomiting & bloody diarrhea
  - CNS
    - Seizures
    - Lethargy
  - Renal failure

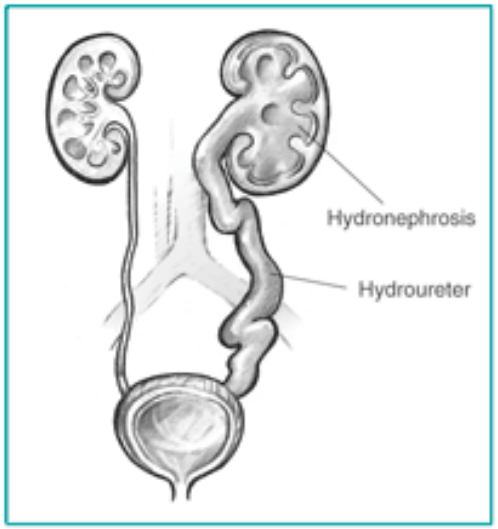
Urinary Tract Infections

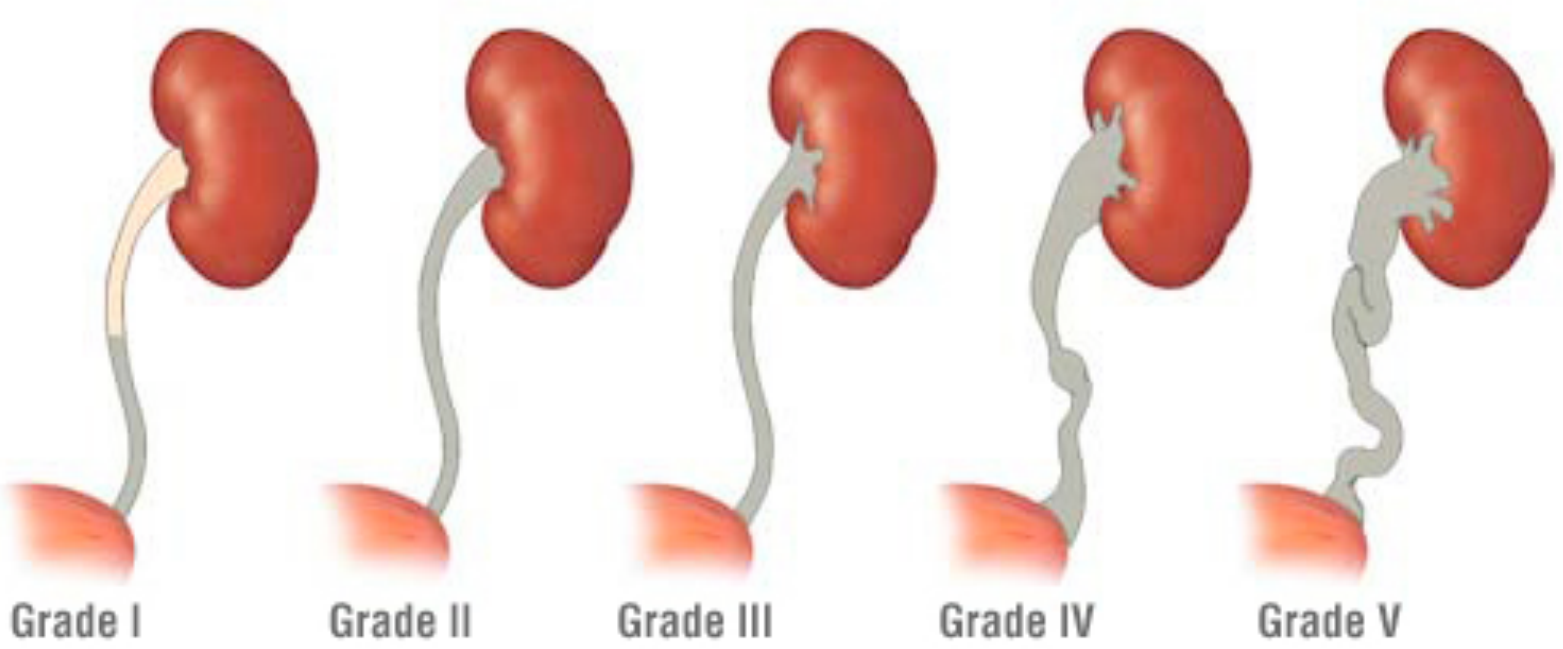
- Common bacterial infection in infants
  - UTIs are most common in 7-11 year: girls
  - E coli primary pathogen
- Cystitis: infection of the bladder
  - Mucosal inflammation & congestion
- Acute pylonephritis
  - Infection in the kidneys
    - Fever, chills, & flank/abdominal pain
- Diagnosis: history + Urine Culture
  - Treatment? Cranberry juice



Vesicoureteral Reflux (VUR)

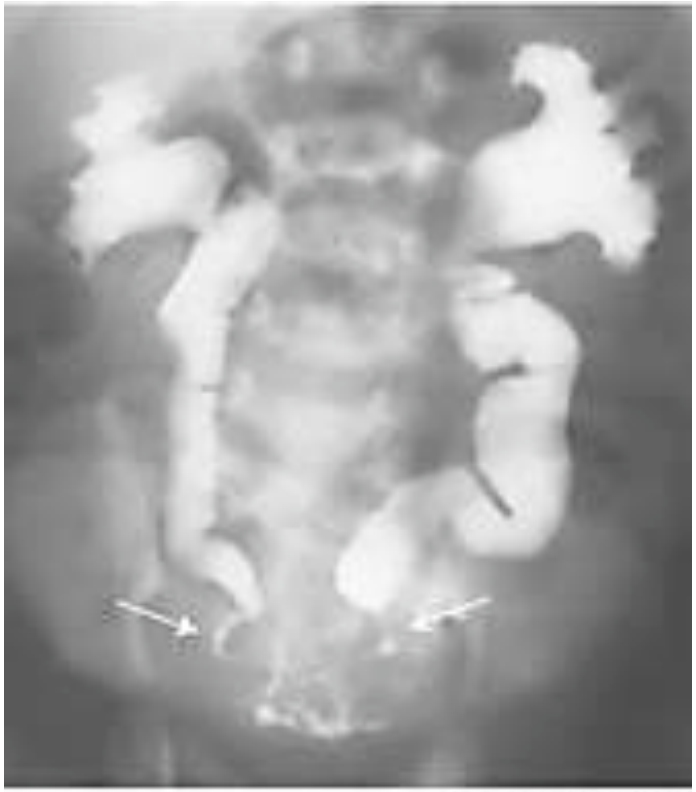
- Retrograde flow of urine from the bladder into the ureters
- Reflux encourages infected urine from the bladder to be swept up into the kidneys
- Leads to frequent pyelonephritis
- Caused by a congenital abnormality or ectopic insertion of the ureter into the bladder
- Diagnosed by a voiding cystourethrogram (VCUG) and an intravenous pyelogram (IVP)




Grade I
Grade II
Grade III
Grade IV
Grade V

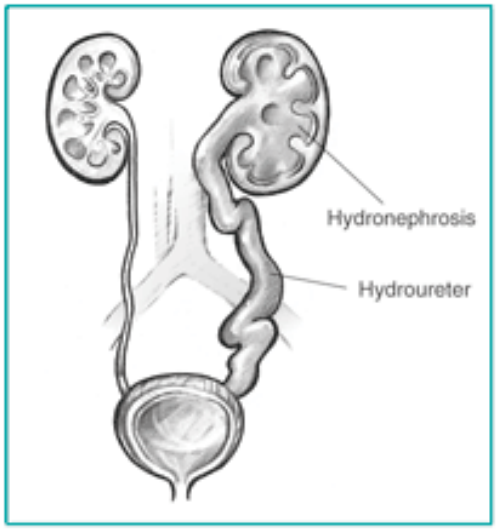
Voiding cystourethrogram (VCUG)

- Megaureter and vesicoureteral reflux. Postvoid image from a voiding cystourethrogram (VCUG) shows bilateral vesicoureteral reflux and bilateral ureterovesical junction obstruction caused by stenosis of the distal ureters (arrows).

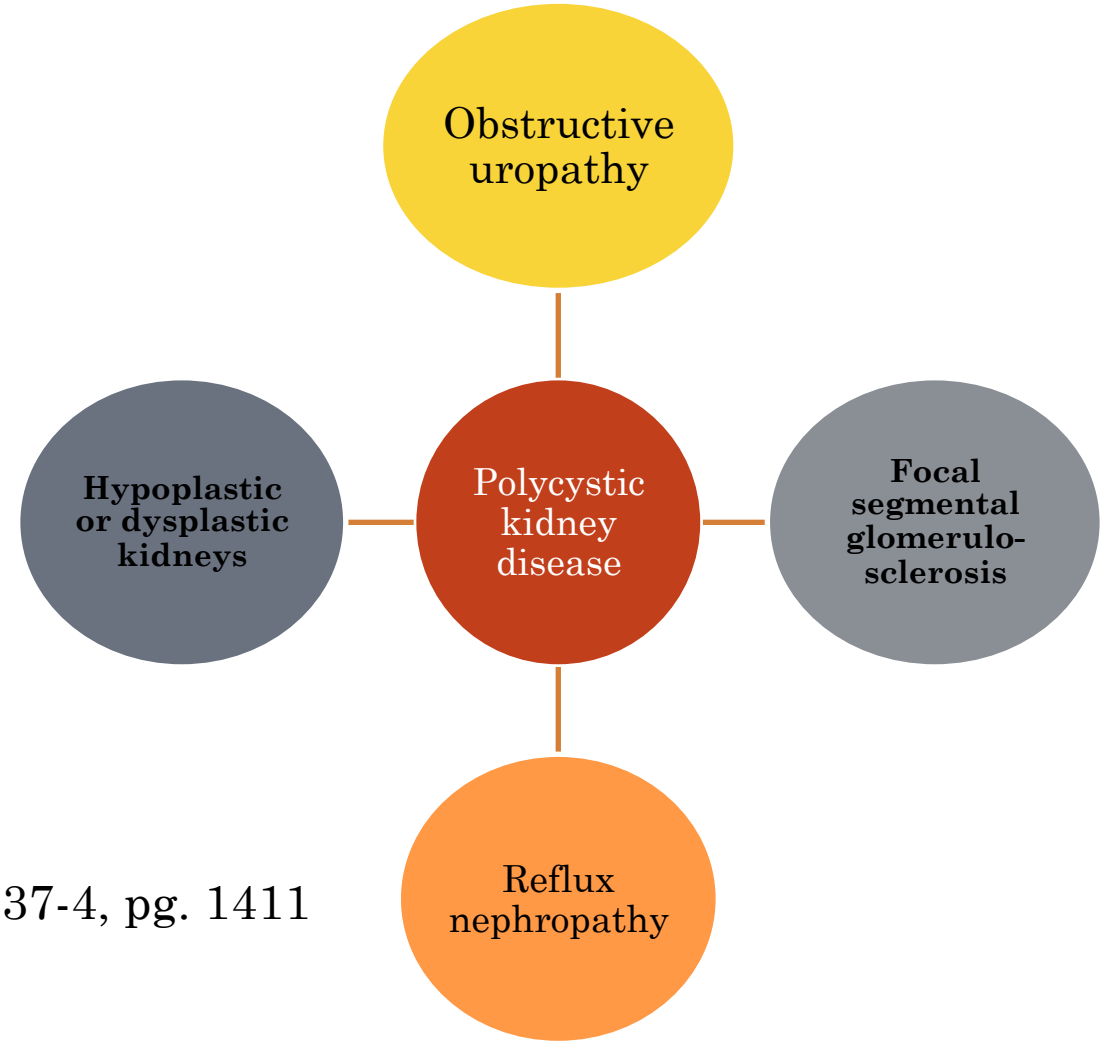


Vesicoureteral Reflux (VUR)

- Most common cause for hypertension
  - In teenage girls
- Leads to hypertension, proteinuria
  - And can lead to progressive renal failure in adults
- In adults, VUR is suggested by
  - Presence of duplicated ureter/ collecting system
  - Unilateral kidney stone formation or atrophy
- Treat by preventing infection/ treating bacteriuria, ACEi for high BP.



Chronic Renal Failure: Pediatrics



pRIFLE table 37-4, pg. 1411

Questions??