

Pathology of Urinary System

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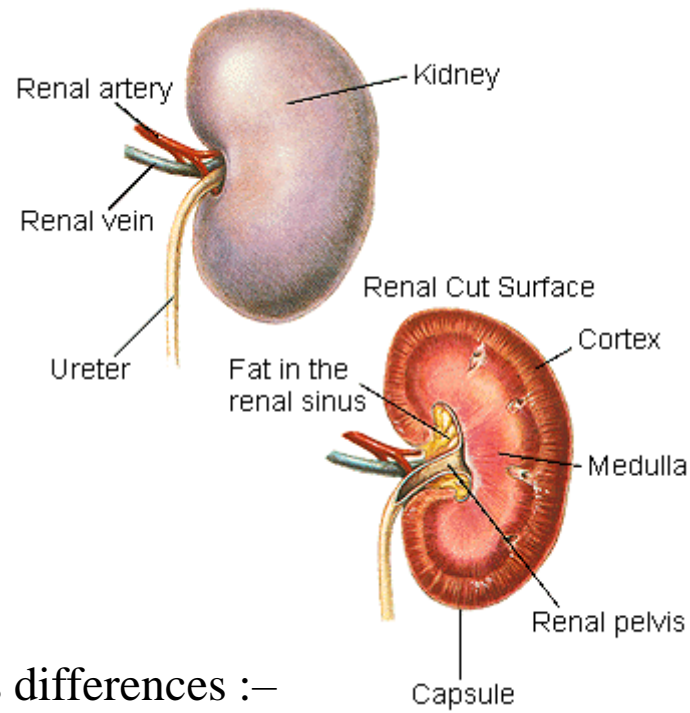
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GENERAL CONSIDERATIONS

- The urinary system plays an important role in the regulation and maintenance of fluid and electrolyte homeostasis in all higher forms of animal life.
- The organ primarily responsible for these activities is the kidney.
- It acts as an elaborate filtration-resorption device whose responsibilities include maintenance of a constant quality and quantity of plasma and tissue fluids and excretion of waste products.
- It is also involved in the production of such hormones as **erythropoietin, renin, and prostaglandin.**

- Abnormalities in the urinary system can occur in various forms, including anomalies in development, hereditary problems, circulatory disturbances, infections, toxicoses (**nephrotoxicoses**) and immune-mediated diseases.
- Grossly, kidneys are divided into three parts – cortex, medulla, and pelvis



And there are some species differences :-

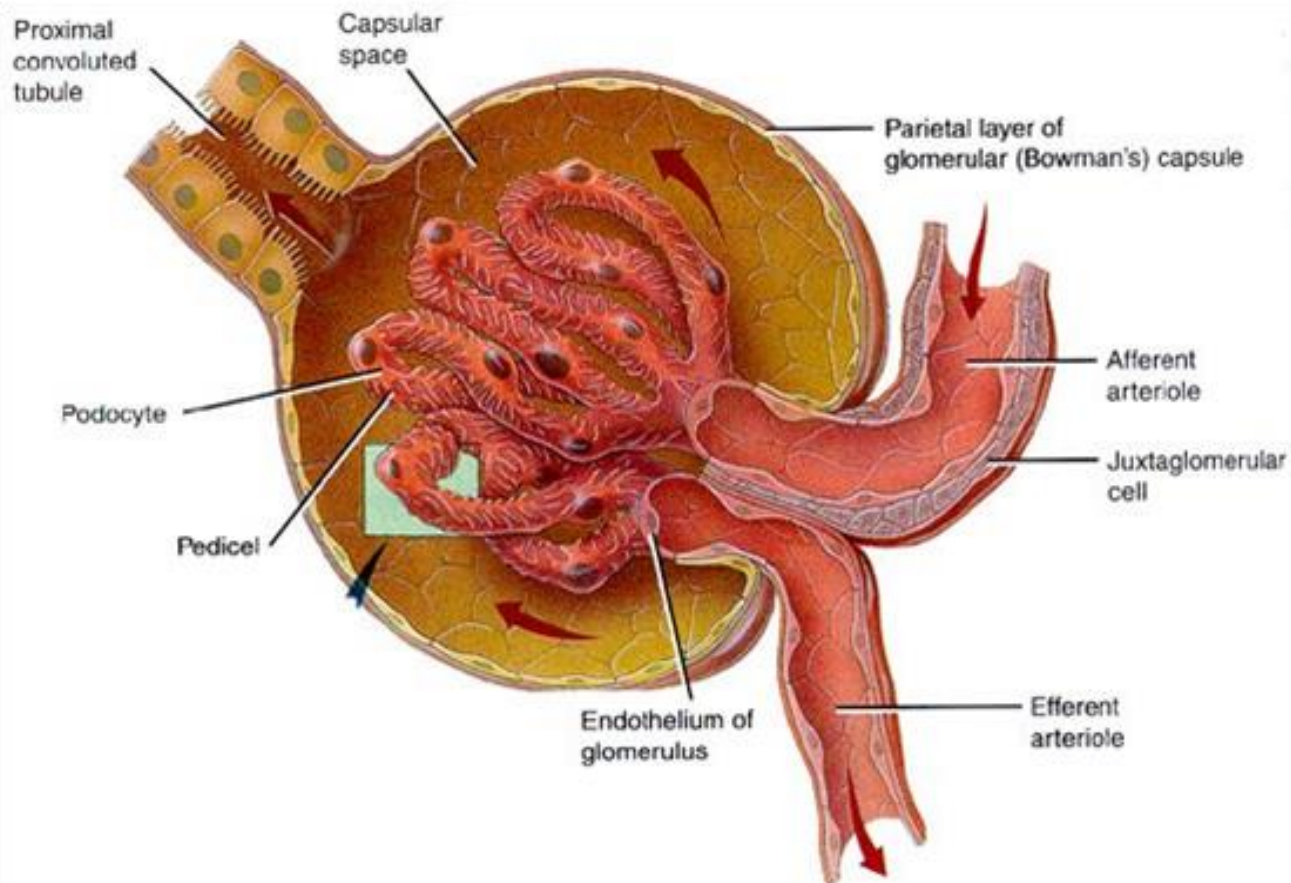


Cattle have kidneys that are composed of multiple lobes.



Horse kidneys have mucus glands in the pelvis, and so there is often a lot of mucus in this area.

- The nephron is the functional unit of the kidney, consisting of renal corpuscle (glomerulus and associated blood vessels), proximal convoluted tubule, loop of Henle, distal tubules, and collecting ducts.



• **GROSS EXAMINATION OF THE KIDNEY**

- The systematic gross examination of the kidney includes observation of its size, shape, color, and consistency.
- The kidneys are usually equal in size and are comparable in length to the length of three vertebrae.
- Enlargement of a kidney may occur due to excessive blood, edema fluid, fat or urine in the tubules or the renal pelvis or hypertrophy of the nephrons.
- Focal lesions in the kidney tend to cause distortions in the shape of the kidney, whereas generalized lesions usually do not.
- The normal renal color is brownish-red, except in mature cats, in which case they tend to be yellowish due to a high lipid content.

- The ratio of the thickness of the cortex to the medulla is usually **1:2 or 1:3**; however, the cortex is actually a far greater overall percentage of the kidney parenchyma. Removal of the capsule is essential in an examination of the kidney. It should pull away from the cortex with minimal resistance.

- *Reading Assignment*

- Anomalies of Development

- Aplasia or Agenesis
 - Hypoplasia of The Kidneys
 - Renal Dysplasia

Renal Failure and Associated Vocabulary

- Renal failure refers to the condition resulting from suboptimal renal function.
- **Azotemia/uremia** are characteristic features of renal failure and the symptoms include tiredness, nausea, vomiting, pruritis and twitching. Renal failure may develop acutely (**develops in minutes, hours, or a few days**), in which case it may be reversible.
- The body functions fine until more than 75% of renal function is lost (this means 75% of nephrons aren't working).
- At that point, it becomes “**end stage kidney disease**” and this can be started by glomerular, tubular, or interstitial problems.

- END STAGE KIDNEYS are **small, pitted and fibrotic**. This term is used because of the inability to differentiate antecedent cause, which may have been glomerular, tubular, vascular or interstitial.
- Renal failure with **azotemia and uremia** would be expected.



- **RETENTION OF EXCRETORY WASTES**

- **Azotemia** is defined as the presence of excessive urea or creatinine in the blood without clinical manifestation of renal disease.

- Azotemia may be due to several causes (Reading assignment)

- **Uremia** is the presence of urinary constituents in the blood AND the toxic condition produced by those constituents.

- Thus uremic animals would be azotemic AND have clinical signs or systemic lesions caused by the retained waste products.
 - Nausea and depression are common.

- **ABNORMAL URINE EXCRETION**

- **Anuria** is the absence of urine excretion.
- **Oligouria** is reduction in the amount of urine excreted. There are many causes, including dehydration.
- **Polyuria** is the passage of abnormally large amounts of urine.
- **Pollakiuria** is increased frequency of urination (the amount may be normal).
- **Dysuria** is painful or difficult urination.
- **Stranguria** is the slow and painful discharge of urine due to spasm of the urethra or bladder.

- **EXCRETION OF ABNORMAL SUBSTANCES**

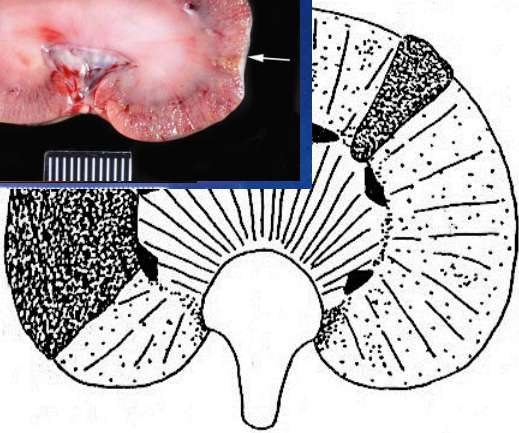
- **Proteinuria** is the presence of excess protein in the urine.
- **Glucosuria** is the presence of glucose in the urine.
- **Crystalluria** is the presence of crystals in the urine.
- **Pyuria** is neutrophils in the urine
- **Hemoglobinuria** is the presence of hemoglobin in the urine.
- **Myoglobinuria** is the presence of myoglobin in the urine, due to muscle damage.
- **Hematuria** is the presence of red blood cells in the urine.

- **RED URINE**

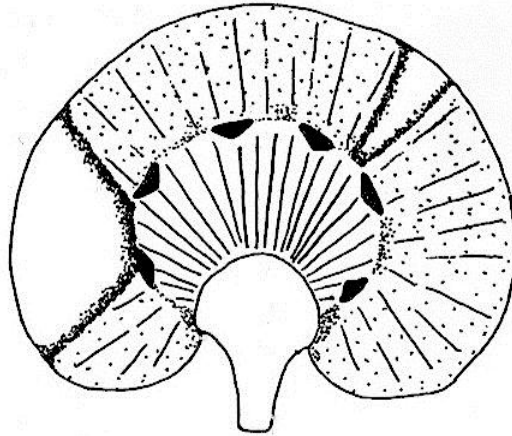
- Urine may be red due to: hemoglobin, myoglobin, or red blood cells. In addition, certain foods (e.g. beets), drugs and even chronic lead or mercury poisoning may result in red urine.

Circulatory Disturbances

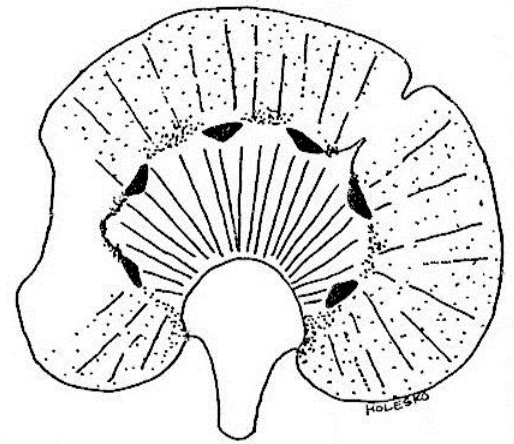
- There are two big problems that happen in the kidney relative to circulatory disorders.
- The first big circulatory problem in the kidney is **infarction**.
 - The arteries of the kidney are called “**end arteries**”, which means there is no collateral circulation.
 - Consequently, if there is a thrombotic or embolic problem in the animal, these arteries are likely to get infarcted, because with end arteries, there is no peripheral circulation.
 - Infarcts are **red** at first, then they become **white**, then they get replaced with fibrous tissue which **shrinks** the area and causes an **indentation**.



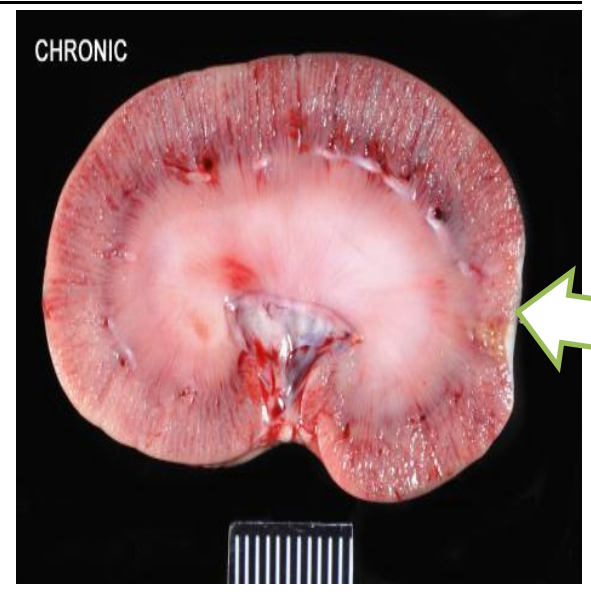
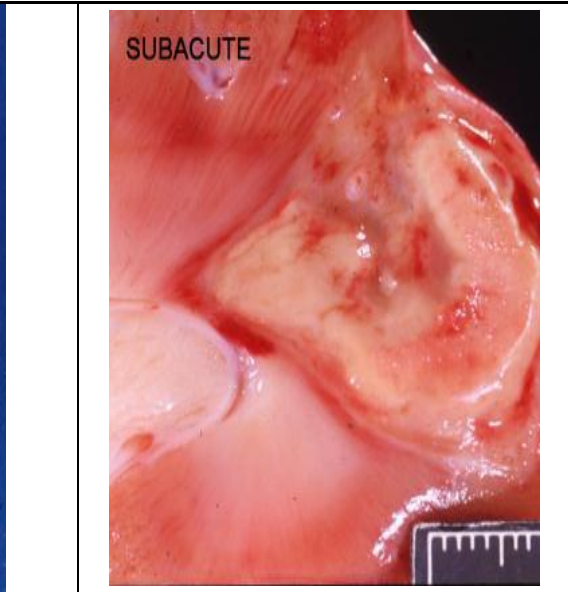
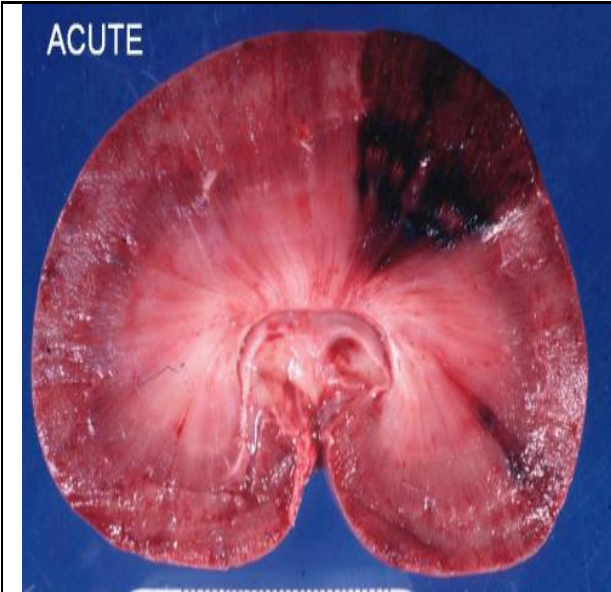
Acute



2-3 days



Chronic



- The second circulatory problem that happens in the kidney is that it is very susceptible to **hypoxia!**
 - So anytime there is very severe anemia or hypovolemic shock, the kidneys might just shut down entirely.
 - The proximal tubule cells will die if not constantly exposed to enough oxygen, and they never recover.
 - Necrosis of proximal tubules is called **NEPHROSIS** and will be covered more later.

- Nephrosis includes cloudy swelling, fatty degeneration and even necrosis of tubules.

Site of occurrence.

- Proximal convoluted tubule, Henle's loop and distal convoluted tubule are affected in descending order of occurrence

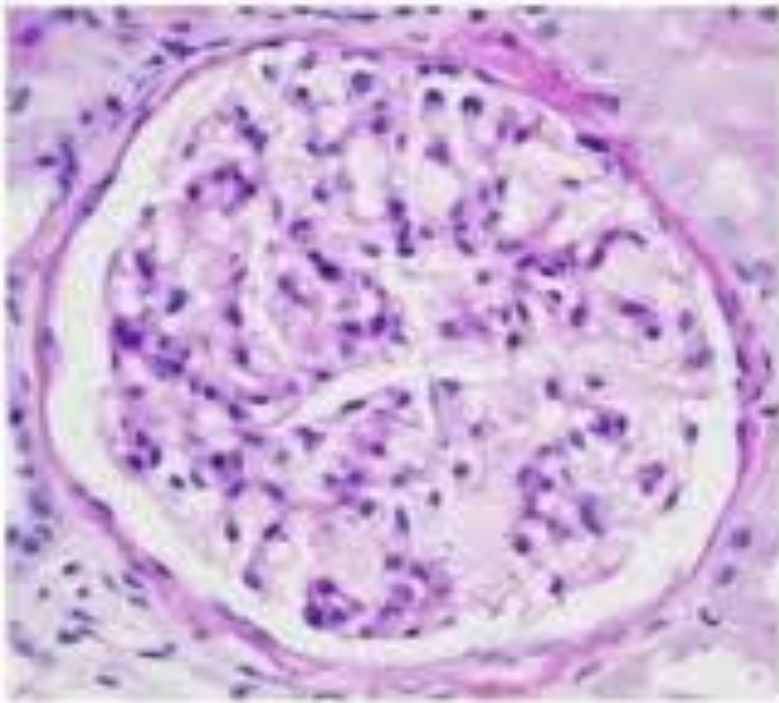
- **Reading Assignment (different type of nephrosis)**

- Toxic nephrosis (Oxalate nephrosis and Sulphonamide nephrosis)
- Anoxic Nephrosis

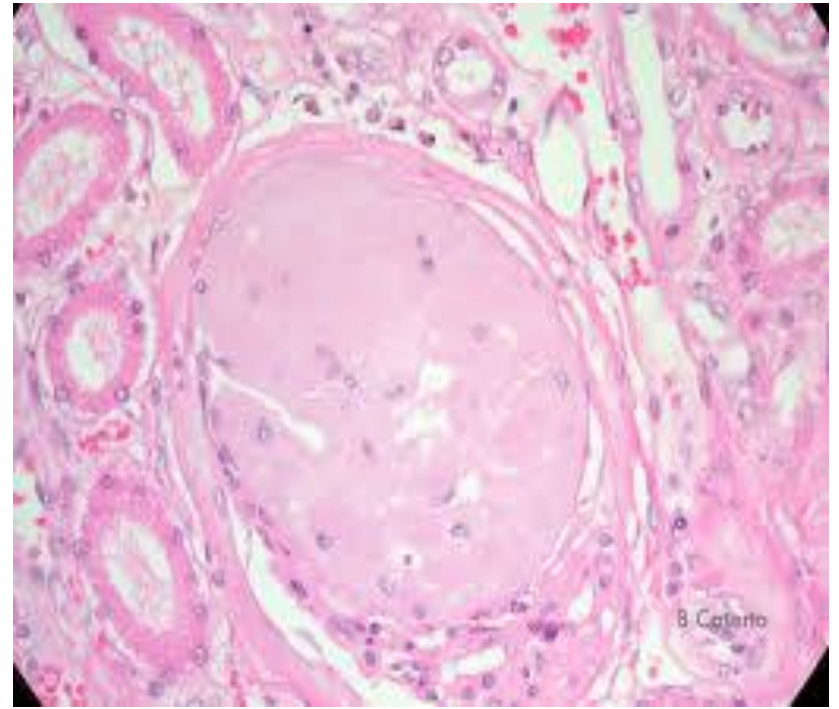
Glomerular diseases

- **AMYLOIDOSIS**
- Renal involvement is almost always a feature of systemic amyloidosis.
- Systemic amyloidosis develops secondarily to either chronic inflammation or to a B-cell dyscrasia and involves deposition of amyloid fibrillar proteins (derived from either serum amyloid associated proteins or immunoglobulin light chains) in various organs and tissues.
- Progressively worsening **renal insufficiency and proteinuria** are typical developments in cases of glomerular amyloidosis.
- Eventually, renal tubular disease develops followed by renal failure.

- In horses, systemic amyloidosis is seen most frequently in animals used for antiserum production.
- In other animals, most cases develop secondary to a chronic inflammatory disease.
- **Grossly**, affected kidneys are slightly enlarged and the cortical parenchyma tends to be pale and slightly firm in consistency.
- In cattle, affected kidneys are markedly enlarged and finely stippled due to the presence of pale spots (**affected glomeruli**) and grayish translucent spots (**dilated tubules**).
- **Histologically**, most of the glomeruli in affected kidneys are enlarged and their architecture is almost completely destroyed by accumulations of a finely granular or homogeneous, eosinophilic material (**amyloid**) in glomerular capillaries.

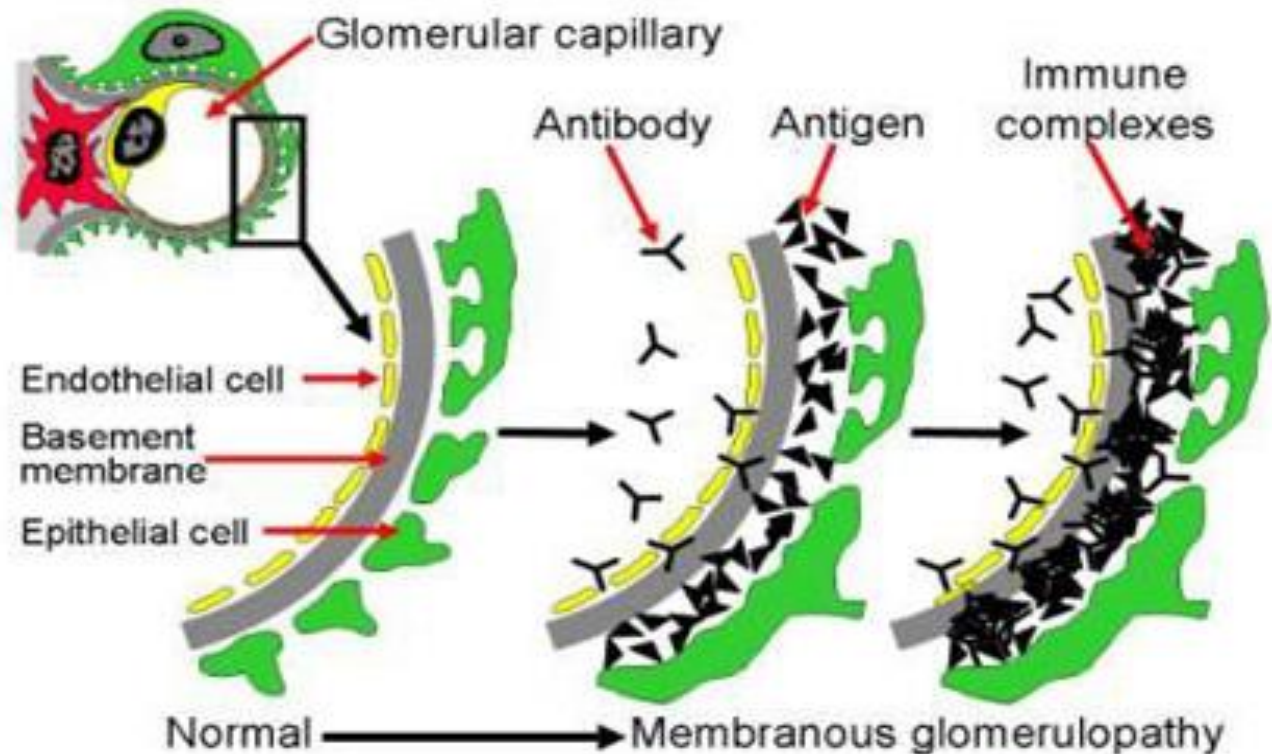


Normal glomerulus



Glomerulus filled with amyloid –
no filtration!

- **Immune complex glomerular disease:** If there is chronic antigen circulating and many antibodies produced, these form complexes that get deposited in the glomerular membranes.
- The result is similar to amyloid, filtration is screwed up, basically, there isn't any, and protein goes right through into the urine.



- **Acute infectious inflammation due to bacteria**, usually part of a bacterial septicemia, can settle in the glomerulus.
- Inflammation primarily of the glomerular tuft is called **glomerulonephritis**.
- **Grossly**, the kidneys are enlarged and pale and petechial hemorrhages tend to outline glomeruli.
- **Histologically**, there is enlargement of the glomerular tufts with increased numbers of endothelial cells filling the Bowman's spaces. In early stages, neutrophils appear in glomeruli but as the disease progresses, there is proliferation of epithelial cells in the visceral layer of the Bowman's capsule and adhesions often develop between the parietal and visceral layers.

- Unfortunately, there are not really any gross lesions with glomerular changes, so not common to do a gross morphologic diagnosis.
- **PROTEINURIA** is the hallmark of glomerular disease.
When the glomerulus is messed up, there is no filtering, and protein goes directly through the open door of the glomerulus and into the urine.
- As a result there is often hypoproteinemia and **edema** in many parts of the body.

DISEASES OF RENAL TUBULES

- The tubules are a very important part of the nephron and essential for maintaining the body's ionic balance and also ensuring that bad waste products get disposed.
- When tubules become necrotic, the term is NEPHROSIS.
- It is noted that renal tubules and the interstitium are closely related, and defects involving one tend to cause problems in the other.
- Tubular Necrosis (Reading assignment)
 - Examples of substances which cause nephrotoxic tubular necrosis in animals include: Organomercurials, Aminoglycosides, Tetracyclines, Sulfonamides etc...

- A characteristic of NEPHROSIS is finding CASTS of protein or cells in the urine:



- **PYELONEPHRITIS**

- Pyelonephritis refers to inflammation of the renal pelvis and renal parenchyma characterized by the formation of a purulent exudate in those areas.
- It usually develops from an ascending infection and is usually accompanied by ureteritis and cystitis.
- The most common pathogens are E. coli., staphylococci, streptococci, Enterobacter, Proteus, Pseudomonas, Corynebacterium renale, and Corynebacterium suis.
- These bacteria are carried up the urinary tract, retrograde to the flow of urine.



Pyelonephritis

- **HYDRONEPHROSIS**

- It refers to dilatation of the renal pelvis and calyces with progressive atrophy of the renal parenchyma and cystic enlargement of the kidneys.
- It is caused by some form of urinary tract obstruction.
- The pathogenesis involves persistence of glomerular filtration in spite of urinary tract obstruction.
- If the obstruction persists, the kidney parenchyma will eventually undergo complete degeneration and necrosis and will be replaced by fibrous connective tissue.

- **Grossly**, there is progressive dilatation of the renal calyces and pelvis and blunting of the papillae or medullary crests. In severe cases, this may progress to form a large unilocular or multilocular cyst from the affected kidney.
- **Histologically**, tubular dilatation is the most striking feature with damage occurring in the proximal regions of the nephron first. In severe cases, there is liquefactive necrosis in the medulla causing progressive reduction in the medullary parenchyma.

- **RENAL NEOPLASIA**

- Primary neoplasms of the kidney are **rare**.
- They include renal adenomas, renal carcinomas, nephroblastoma, transitional cell papilloma, transitional cell carcinoma, fibroma, fibrosarcoma, hemangioma, and hemangiosarcoma.

DISEASES OF THE LOWER URINARY TRACT

- **ANOMALIES**

- Persistent Urachus

- This is sometime seen in foals. Urachus is a tube that connects the bladder to the umbilicus in the foetus.
 - Just before birth, this is severed from the umbilical cord and becomes obliterated.
 - But in some instances, it is still patent after birth and said to be “pervious”.

- Diverticula of the Bladder

- **UROLITHIASIS**

- Urolithiasis is one of the most important urinary tract problems in domestic animals.
- It refers to the presence of calculi in the urinary passages.
- These calculi form by precipitation of urinary solutes and they may be found in any part of the urinary collecting system including the renal pelvis, the ureters, the urinary bladder, and the urethra.
- The calculi basically cause disease by obstructing flow in the urinary tract; however, they can be locally irritating and cause problems without causing obstruction.
- Urinary tract obstruction is common in male cats and is called **feline urologic syndrome (FUS)** or **BLOCKED CAT**.

- **INFLAMMATION OF THE LOWER URINARY TRACT**
 - Cystitis refers to inflammation of the bladder.
 - Infection of the bladder is rare and it usually develops subsequent to interference with urine flow or damage to urinary tract epithelium.
 - In bacterial infections, usually the pathogens can be traced to the rectal flora.
 - The more commonly isolated pathogens include E. Coli, Proteus vulgaris, streptococci, staphylococci, Corynebacterium renale (**in cattle**), and Corynebacterium suis (**in swine**).
 - Cystitis often leads to **ureteritis and urethritis** which are inflammation of the **ureters and urethra** respectively.

- *Some predisposing factors for cystitis include:*
 - Being a female – females have a shorter urethra so the bacteria don't have to travel as far!
 - Urine stagnation – animal is not urinating voluntarily and so urine builds up in the bladder. There is not the flushing action that cleans the urethra regularly.
 - Mucosa trauma – usually due to catheterization
 - Glucose in the urine – this occurs in diabetes, the bacteria do very well with extra glucose!

QUESTIONS

