

Pigmentary changes

- Following acute hemolytic crises, the kidneys may be **very dark, almost black**, as a consequence of concentrated hemoglobin.
- The gross lesion is commonly observed in hemolytic crisis of chronic copper poisoning *in sheep*.
- **Microscopically**, The hemoglobin appears as **fine red granules** in the epithelial cells of the tubules and as **red granular casts** in the lower nephron (especially the loop of Henle and collecting tubules).

Pigmentary changes

- Myoglobin casts are histologically indistinguishable from hemoglobin casts. The same histologic picture occurs following incompatible blood transfusions.
- Hemosiderosis occurs in the course of chronic hemolytic anemia and as residue from acute hemoglobinuric episodes. The pigment is found in epithelial cells of proximal tubules, where it is produced by the degradation of resorbed hemoglobin, and it may be sufficient to produce a distinctive brown coloration of the cortex.

Pigmentary changes

- *Lipofuscinosis* of the kidneys of **adult cattle** is the result of deposition of brown iron-free pigments with staining characteristics of lipofuscin. Pigmentation is also found in striated muscles; muscles takes a dark color.

Brown pigment deposition in the tubular epithelium. Brown pigment deposition occurs occasionally in the proximal tubular epithelium. The deposited pigments are considered to **be lipofuscin**.

Pigmentary changes

- Cloisonné kidney is a nonclinical pigmentary condition in goats.
- It is seen in Elaziğ region in our country.
- The renal cortices are uniformly brown or black, because of thickening and brown pigmentation of basement membranes restricted to the convoluted portions of the proximal tubules.
- The basement membrane thickening is the result of the deposition of ferritin and hemosiderin, which is presumably the result of repeated episodes of intravascular hemolysis.

Pigmentary changes

- *In congenital porphyria* of cattle, swine, and cats, the renal cortices are discolored brown.
- Histologically, the pigment is present in the tubular epithelium and interstitium, and the pigment is excreted in the urine.
- When exposed to light, the urine develops a **port-wine color** because of photic activation of porphyrins.
- Urine and tissues fluoresce blue-green in ultraviolet light.

Pigmentary changes

- **A green-yellow pigmentation** of swollen kidneys is common in **icterus** of hepatic origin and less notable in hemolytic icterus unless there is concomitant hepatic injury. It is described in **the section Hepatorenal syndromes**.
- **Olive-green coloration** of the renal cortex is common in newborn lambs, calves, and foals. The pigment is **bilirubin**, and its presence is probably because of immaturity of hepatic conjugating mechanisms.

Pigmentary changes in the kidney, extracted from Maxie et al.⁴ and Newman et al.⁶

Condition	Pigment	Gross lesion	Histologic lesion
Hemoglobinuric nephrosis (acute hemolytic crisis)	Hemoglobin	Dark red-brown to blue-black with radial streaks	Fine red granular speckling within epithelial cells or granular casts
Myoglobinuric nephrosis (acute rhabdomyolysis)	Myoglobin	Dark red-brown to blue-black with radial streaks	Fine red granular speckling within epithelial cells or granular casts
Hemosiderosis (chronic hemolytic anemia)	Hemosiderin	Brown discoloration of cortex	Pigment within the epithelial cells of proximal tubules
Cloisonné kidney (non- clinical condition)	Ferritin and hemosiderin	Brown to black renal cortices	Brown pigmentation of basement membrane, convoluted portions of proximal tubules
Lipofuscinosis	Brown iron-free pigments	Radial dark lines on the cut surface of cortex, sparing the medulla	Fine brown granules in epithelial cells of convoluted tubules

TUBULOINTERSTITIAL DISEASES

- This term comprises diseases that involve primarily the interstitium and tubules, and acknowledges that inflammatory and degenerative interstitial diseases almost always impair tubular function.

Hence;

interstitial nephritis and pyelonephritis

are classified as tubulointerstitial diseases.

TUBULOINTERSTITIAL DISEASES

- **Histology of Tubulointerstitial diseases** include interstitial inflammation, interstitial fibrosis, and tubular atrophy and degeneration.
- In tubulointerstitial diseases, **glomeruli and vessels** are affected secondary.
- Interstitial nephritis occurs mainly hematogenously and occurs in systemic diseases.
- However, the formation of **pyelonephritis** is mostly caused by the urinary tract.

TUBULOINTERSTITIAL DISEASES

- The hallmark of **glomerular disease** is **persistent proteinuria**, whereas **tubulointerstitial diseases** are more likely to demonstrate defects of concentrating ability or specific tubular defects of resorption or secretion.
- The end point of both classes of renal disease is decompensated **renal failure with isosthenuria and uremia.**

TUBULOINTERSTITIAL DISEASES

- **Nonsuppurative Interstitial Nephritis**
- **Suppurative Interstitial Nephritis**
- **Embolic Suppurative Nephritis**

Leptospirosis

- Leptospirosis is an important, complex spirochetal infection of animals and humans caused **by serovars of *Leptospira interrogans***.
- It is particularly important as a **cause of abortion and stillbirth in farm animals** but also causes **acute disease (septicemia, hepatitis, nephritis, meningitis)** in these and other animals.
- Leptospire are common in nature and are found in almost all parts of the world.

Leptospirosis

- The natural reservoir of pathogenic leptospires is the **proximal convoluted tubules** of the kidney and, in certain maintenance hosts, the **genital tract**.
- In maintenance hosts particularly, **Transmission** may be **direct**, that is, through **contact with urine, postabortion discharges, milk, or through venereal or transplacental transmission**.
- Infection of incidental hosts is often **indirect**, via **environmental contamination by urine of carrier animals**.
- Optimal conditions for survival of leptospire are moist, warm (optimal 28°C), and neutral or mildly alkalized.

Leptospirosis

- Under ideal conditions, leptospire may survive **weeks or months in stagnant water**.
- *Leptospirosis thus occurs especially in the autumn in temperate climates (“fall fever”), and in the winter in tropical climates.*
- In subclinical infections and disease-infected animals, microorganisms are excreted in the urine for a long time, so that such animals spread the infection to other animals.
- Leptospire penetrate exposed mucosal surfaces or watersoftened skin and disseminate throughout the body.
- Leptospiremia lasts up to 7 days.
- Organisms multiply especially well in the **liver, kidneys, lungs, placenta, udder, and cerebrospinal fluid**.

Leptospirosis

- Development of agglutinating and opsonizing antibody ~6 days after infection clears the organisms from most organs except immunologically privileged sites (i.e., proximal convoluted tubules of the kidney, cerebrospinal fluid, vitreous humor of the eye).
- Certain serovars can also survive in the genital tract of maintenance hosts.
- In the leptospiremic phase, infection may also lead to acute or subacute systemic disease.
- After leptospiremia has ceased, chronic disease can manifest as abortion, stillbirth, infertility, or recurrent uveitis.

Leptospirosis

- **Jaundice** is a common manifestation of acute disease (and might be the result of hemolysis from hemolysin production or because of toxic and/or ischemic hepatocellular injury.)
- **Clinically;** disease may be characterized by **fever, jaundice, hemolytic anemia, hemoglobinuria, pulmonary congestion,** or occasionally meningitis.
- **Postsepticemic localization of leptospire in the kidneys** is associated with focal or diffuse interstitial nephritis and acute, transient tubular injury.

Leptospirosis

- *The tissue samples must be very fresh and well fixed* for the determination of the agent.
- **Diagnosis** can be done by showing agents in blood, urine and organs, isolation and identification.

Leptospirosis / Cattle

- Species and serovars of major importance are *hardjo* type in Europe, *hardjo* and *pomona* type *kennewicki* in North America.
- The most *severe manifestation of acute infection* occurs in calves infected with incidental serovars, especially **pomona**.
- **Hemoglobinuria** is usually the first sign and may be transient (or takes 2-3 days).
- In fatal cases, the urine is a **port-wine color**.
- **Hematuria** from hemorrhage into renal tubules may lead to blood clots in the urinary tract.

Leptospirosis / Cattle

- There is fever, anemia, icterus, dyspnea because of pulmonary congestion, and occasionally meningitis.
- Albuminuria and bilirubinuria can be severe.
- In cows, agalactia with small quantities of discolored, viscous milk is also typical.
- Abortion may occur during the acute phase or several weeks later during convalescence. The fetus is frequently decomposed, indicating death some time before abortion.
- The most common form of the disease is a less severe, “**subacute**” form characterized in dairy cows in milk production with transient pyrexia.

Leptospirosis / Cattle

- In this “milk drop syndrome,” the milk has the consistency of colostrum, with thick clots and yellow discoloration, and the udder is soft.
- **The chronic form of the disease**, most commonly associated with serovars hardjo and pomona *in pregnant cows*, is seen as **abortion, stillbirth, or the birth of premature and weak infected calves.**
- **The postmortem appearance** of an animal that dies of acute leptospirosis is characterized by **mild icterus and severe anemia**. Ecchymoses may be **numerous on serous membranes and in the subcutis.**
- The lungs are pale and edematous.

Leptospirosis / Cattle

- The liver is enlarged, friable, pale tan-yellow, with or without hemorrhages and small zones of necrosis around central veins.
- But the zones of necrosis are not distinguished well.
- The kidneys are enlarged and dark in color during hemolytic crises.
- In the kidneys may have numerous small gray foci because of leptospiral interstitial nephritis.

Leptospirosis / Cattle

- *The histologic changes in most cases of bovine leptospirosis may be mild and nonspecific.*
- **The lungs** are edematous, there are thin network fibrin in some alveoli and lymphatic vessels in the septum.
- **In liver** → Zonal necrosis, mostly periacinar hepatocellular necrosis type, is seen (from anemia).
- **Kupffer cells** are increased in number and contain excessive amounts of hemosiderin.
- There is **diffuse** but **mild cellular infiltration** in the portal triads.
- In the uncommon infections, **necrosis in the liver and dissociation of hepatic cords** may occur.
- Depending on the stage of the infection and degree of hemolysis, **biliary canaliculi may contain bile plugs**.

Leptospirosis / Cattle

- **Kidney** → In acutely fatal disease, there are often marked degenerative changes in the epithelium of the cortical renal tubules.
- The changes vary in severity from acute cellular swelling to necrosis and desquamation.
- In acute disease, organisms can often be demonstrated by appropriate stains in the liver, in which they are partly intracellular, and in the kidneys, in which they occur in the tubular epithelium and frequently as clusters in the tubular lumen.

Leptospirosis / Cattle

- Aborted fetuses show no specific changes, although the organism can often be demonstrated in fetal tissues.
- The fetuses are sometimes **edematous**, and in many cases, there is advanced **autolysis or putrefaction** by the time the fetus is aborted.
- The placenta may show **mild placentitis**; there is a tendency for it to be unduly **retained**.

Pyelonephritis

- **Pyelonephritis** is inflammation of the pelvis and renal parenchyma, usually resulting from infection ascending from the lower urinary tract.
- **Pyonephrosis** denotes severe suppuration of the kidney in the presence of complete or nearly complete ureteral obstruction.
- The infected hydronephrotic kidney is converted to a sac of pus.
Suppuration may extend through the renal capsule during the course of pyelonephritis to produce a **perinephric abscess**.

Pyelonephritis

- The pathogenesis of pyelonephritis begins with establishment of infection in the lower urinary tract.
- Organisms involved in urinary tract infection are usually endogenous bacteria of the bowel and skin (such as *Escherichia coli*, *staphylococci*, *streptococci*, *Enterobacter*, *Proteus*, and *Pseudomonas*).
- More specific urinary pathogens, such as *Corynebacterium renale*, *C. cystitidis*, and *C. pilosum* in cattle, and *Actinobaculum (Eubacterium) suis* in pigs. *Mycoplasmas* are rarely involved in cattle. Infection can be mixed.

Pyelonephritis

- *Normal voiding of urine* helps maintain the sterility of the bladder. Once bacteria enter the bladder, they grow well in urine with low osmolality or alkaline pH.
- **Stasis of urine** is an important predisposing factor in the pathogenesis of **cystitis** and of **pyelonephritis**.
- **Urinary obstruction** can be caused by ureteral anomalies in young animals, kinked ureters in pigs, pregnancy, urolithiasis, and prostatic hypertrophy.
- *Females are predisposed to urinary tract infection* because of their short urethras, urethral trauma, and possibly because of hormonal effects.

Pyelonephritis

- Pyelonephritis is **often bilateral**, but may not always develop symmetrically.
- **Acute disease** is seen in more female pigs, **chronic pyelonephritis** is seen more common in cows and dogs.
- **Acute disease** typically begins **with necrosis and inflammation of papilla or renal crest** (“necrotizing papillitis”) in an irregular pattern. **Bacteria** may be abundant in the collecting ducts. Associated wedge-shaped areas of **parenchyma** are swollen, dark red, and firm. As the **hyperemia** subsides, **suppurative tubulointerstitial nephritis** and **tubular necrosis** develop in radially distributed wedges. Tubules are obliterated by **the inflammation**, and **neutrophils** cross the tubular basement membrane to enter the tubular lumen (tubulitis)

Parasitic lesions in the kidneys

- *Toxocara canis* larvae in dogs kidneys,
- *T. cati* and *T. canis* larvae make similar lesions in calves,
- *T. (Neoascaris) vitulorum* larvae in Bufalos ,
- *T. canis* in cats,
- *Stephanurus dentate* is a parasite that lives in the kidneys of pigs.

Parasitic lesions in the kidneys

- *Dioctophyma renale* is the giant kidney worm, the largest of parasitic nematodes. The worm is red and cylindrical. *D. renale* is usually found in dogs, mink, cats, and other fish-eating mammals, but has been reported in the pig, ox, and horse.
- *Pearsonema (Capillaria) plica* may be found in the lumen of the renal pelvis, ureter, or urinary bladder of dogs, foxes, and smaller carnivores.
- *Klossiella equi* is a sporozoan parasite of the kidney of the horse and its relatives, including the zebra, donkey, and burro. Infections are usually incidental.
- Granulomas may be found in the renal pelvis in *schistosomiasis* of cattle and sheep and larvae of *Setaria digitata* may produce granulomas in the bladder of cattle in Asia.
- *Halicephalobus gingivalis* (formerly *Micronema delectrix*) is a saprophagous nematode that produces granulomatous masses in the nasal cavity of horses and is occasionally responsible for cerebral vasculitis and granulomatous nephritis.

RENAL NEOPLASIA

❖ Renal adenoma

❖ Renal carcinoma

❖ Nephroblastoma

❖ Other tumors

- **Urothelial papilloma** and carcinoma of the renal pelvis are rare tumors, which occur in the dog, cat, cow, pig, and horse.
- **Primary mesenchymal tumors** of the kidney occur.
- **Benign cortical fibromas** also occur in older dogs.
- **Metastatic tumors** are common in the kidneys, and disseminated neoplasms of any type are likely to localize there, typically with bilateral involvement of the cortices.
- Renal involvement in **lymphoma** is common in those species in which the neoplasm is common. Peripelvic and periureteral lymphoma, which can cause hydronephrosis, is seen in cattle.

LOWER URINARY TRACT

- The lower urinary tract consists of **ureters, urinary bladder, and urethra.**
- Histologically, the bladder is an expanded ureter, lined by stratified urothelium ranging from 3-14 cells thick, depending on the species and degree of distension.

ANOMALIES OF THE LOWER URINARY TRACT

Ureters

- **Agensis, Duplication** and **Ureteral dysplasia** can be seen.
- **Urinary anomalies** may increase the tendency for urinary tract infections that may result in pyelonephritis and hydronephrosis.
- **Ectopic ureter** is the most important ureteral anomaly.
- Rather than terminating at the trigone of the bladder, the affected ureter may empty into the vas deferens, vesicular gland, or urethra of the male, or the bladder neck, urethra, or vagina of the female portant ureteral anomaly.
- Ectopic ureter is most common in dogs and is diagnosed up to 20 times more frequently in females than in males.

- Ectopia can be **unilateral or bilateral**.
- The defect is familial in **Siberian Huskies and Labrador Retrievers**.
- Certain dog breeds have a high risk for the defect, including the **Newfoundland, Labrador Retriever, West Highland White Terrier, Fox Terrier, and Miniature and Toy Poodles**.

ANOMALIES OF THE LOWER URINARY TRACT

Urinary bladder

- **Duplication of the urinary bladder** occurs rarely in dogs and causes dysuria, incontinence, and, less frequently, abdominal distension and cryptorchidism.
- **Patent or pervious urachus** is the most common malformation of the urinary bladder and is seen more often in foals than in other animals. Animals with this defect dribble urine from the umbilicus because the urachal lumen fails to close and is a channel between the apex of the bladder and the umbilicus.
- **Diverticula of the bladder** may be primary or acquired secondary to partial obstruction to urine outflow, or as the result of pressure changes exerted during normal contractions. **Calculi** may form in the diverticulum.

ANOMALIES OF THE LOWER URINARY TRACT

Urethra

- Urethral **agenesis**, **duplicated** urethra, **ectopic** urethra, and **imperforate** urethra occur rarely in dogs.
- **Hypospadias** is described with male genitalia (The urethra glans can be opened out of the ventral side of the penis instead of the tip of the penis).
- The most common urethral anomaly is **urethrorectal** or **rectovaginal fistula**.
- **In males**, the communication involves the pelvic urethra, and affected dogs urinate from the rectum.
- **In females**, the opening is in the vagina and may be associated with imperforate anus.
- These defects are reported in **dogs, cats, pigs, rabbits, alpacas, and foals**.

UROLITHIASIS

- **Urolithiasis** is the presence of calculi (uroliths or stones) in the urinary passages.
- **Calculi** are grossly visible aggregates of precipitated urinary solutes, urinary proteins, and proteinaceous debris.
- **Minerals** predominate in calculi, whereas matrix usually predominates in urethral plugs. Calculi typically have a central nidus, surrounded by concentric laminae, an outer shell, and surface crystals.
- *The diseases caused by uroliths* are among the most important urinary tract problems of domesticated animals.

UROLITHIASIS

- **Calculogenic material** must occur in urine in quantities sufficient to be precipitated.
- ❖ Sometimes this concentration is achieved because a **substance is metabolized in an unusual way**, as is uric acid in Dalmatian dogs.
- ❖ A substance may be processed abnormally by the kidney, (as is cystine in cystine stone-formers),
- ❖ It may be in abnormally high levels of a substance in the diet, (such as silicic acid in native pastures).
- Regardless of the type of calculus, **certain factors** are more or less important; these are:
 - ✓ **urinary pH**
 - ✓ **reduced water intake**
 - ✓ **Deficiency of vitamin A**

UROLITHIASIS

- In general, calculi are important in cattle, sheep, dogs (several breeds are predisposed to formation of calculi, namely, **Dachshunds, Dalmatians, Cocker Spaniels, Pekingese, Basset Hounds, Poodles, Schnauzers, and small terriers**), and cats, less important in horses, and unimportant in pigs.
- Calculi may form in any part of the urinary duct system, from the renal pelvis to the urethra.
- Some uroliths clearly originate in the lower urinary tract.

UROLITHIASIS

- Small calculi may be voided in the urine, but **impaction in the urethra is common in males.**
- **The common sites of urethral impaction** are the ischial arch, the sigmoid flexure of ruminants, the vermiform appendage of rams, the proximal end of the os penis in dogs, and anywhere along the urethra of **male cats.**
- At the point of obstruction, there is **pressure necrosis with ulceration** of the mucosa.
- Because urinary stasis favors bacterial growth, **acute hemorrhagic urethritis** develops and can ascend to the bladder and kidney.

UROLITHIASIS

- **Hydronephrosis** is not common with completely obstructive urethral calculi.
- **Rupture of the urethra with associated infection and acute cellulitis** terminates the condition fairly quickly.

UROLITHIASIS

- Silica calculi
- Struvite calculi
- Oxalate calculi
- Uric acid and urate calculi
- Cystine calculi
- Clover stones
- Xanthine calculi

INFLAMMATION OF THE LOWER URINARY TRACT

- Inflammation of the lower urinary tract centers **on involvement of the urinary bladder, that is, cystitis.**
- **Ureteritis is rare in the absence of cystitis,** and clinical urethritis in animals is usually associated with obstruction by a calculus from the bladder.
- Under normal circumstances, the bladder is resistant to infection, and bacteria are quickly eliminated by the normal flow of normal urine.

INFLAMMATION OF THE LOWER URINARY TRACT

Predisposition to urinary tract infection (UTI) occurs ;

- *when there is*
- *stagnation of urine*
- *because of obstruction, incomplete bladder emptying*
- *urothelial trauma*

Other risk factors for UTI include

- ✓ *catheterization,*
- ✓ *vaginoscopy,*
- ✓ *urinary incontinence,*
- ✓ *vaginitis, or*
- ✓ *administration of antibiotics or corticosteroids.*

INFLAMMATION OF THE LOWER URINARY TRACT

- Unlike human urine, which tends to be a good medium for bacterial growth, animal urine usually has antibacterial activity.
- This activity is related to urine pH and particularly to urine osmolality.
- In general, the further the pH is from the optimum range of 6-7, the less likely it is to support bacterial growth.

INFLAMMATION OF THE LOWER URINARY TRACT

□ Cystitis

Causes of Cystitis;

- They are usually bacteria that come through the urethra and are almost always microorganisms in the rectum flora.
- Bacteria involved in bladder infections in animals include *Escherichia coli*, *Proteus vulgaris*, *streptococci* and *staphylococci*.
- *Corynebacterium renale* group (*C. renale*, *c. Pilosum*, *C. cystitidis*) factors are important in cows.

INFLAMMATION OF THE LOWER URINARY TRACT

☐ Cystitis

Causes of Cystitis;

- *Eubacterium suis* is the main cause of **cystitis and pyelonephritis** in pigs and causes death in female pigs.
- *Mycoplasmas* occasionally occur in urinary tract infections in dogs and cattle.
- Urogenital infections leading to **prostatitis, orchitis, nephritis and cystitis** are seen in dogs with **blastomycosis**.
- **Aspergillus and Candida-related cystitis** were rarely observed in dogs and cats.

Enzootic Hematuria

- **Enzootic hematuria** is a **syndrome** in mature cattle characterized by *persistent hematuria and anemia*, and is associated with **hemorrhages or neoplasms** in the lower urinary tract.
- This disease is named "**hematuria vesicalis bovis**" and "**hematuria cancerogenes bovis**."
- The disease is not seen in cattle under two years of age.
- This syndrome can be seen **in all cattle breeds**.
- In >90% of cases, the hematuria originates from tumors of the urinary bladder.
- Outbreaks of the disease are reported in sheep.

Enzootic hematuria

- Enzootic hematuria occurs in **almost all parts of the world**, and especially in areas where the **bracken fern** (*Pteridium aquilinum*) is grown and endemic.
- In endemic areas, up to 90% of adult cattle may be affected.
- It is widely seen in our country in the Black Sea Region.
- *The syndrome is attributed to chronic ingestion of **bracken fern** and is reproducible experimentally.*
- It caused **small intestine and urinary bladder carcinomas** in rats and **urinary bladder tumors** in guinea pigs.
- It caused to lung adenomas and adenocarcinomas and lymphoblastic leukemia in mice.

Enzootic hematuria

- In natural cases, bracken fern should be taken **in small amounts** and **for a long time** in order to produce neoplasms in the bladder.
- Although the relationship of *bracken fern with enzootic hematuria* is certain, disease can be seen in areas where fern does not grow or there is no disease in the regions where fern is found.

Enzootic hematuria

- There are 2 subspecies of bracken fern: ***Pteridium aquilinum* subsp. *aquilinum*** and ***P. aquilinum* subsp. *caudatum***.
- *It is not* known whether all varieties are toxic.
- *P. revolutum*, a species of bracken fern common in South Asia, and *P. esculentum*, a bracken fern of Australia, also produce enzootic hematuria.

Enzootic hematuria

- It contains several toxic substances, including a *thiaminase*, **a variety of carcinogens** (quercetin, shikimic acid, prunasin, ptaquiloside, ptaquiloside Z, aquilide A, and **others**), and a “**bleeding factor**” of unknown structure.
- Acute poisoning occurs when ferns are taken in large quantities by cattle.
- This toxicity is **cumulative** and occurs within 1 to 2 months, and after this latent period, symptoms of acute poisoning are observed.
- The most important disorder in acute poisoning is in the bone marrow.
- Besides hematological disorders such as **thrombocytopenia, agranulocytosis, increased clotting time and anemia, bleeding in the mucosa of the nose and vagina, hematuri** are also formed. A few days before death, the body temperature is too high.

Enzootic hematuria

At necropsy,

- Hemorrhage and ulcers are found in subserosa of various organs and intestinal mucosa.
- Urine is often bloody.
- Periaciner necrosis is seen in liver.
- Hemorrhagic foci can be seen in various size (from lenti to pea) in mucosa of bladder. These foci may bleed quickly.
- The tumors in the bladder that die from acute poisoning are not formed.

Enzootic hematuria

- When ferns are taken in small amounts, acute poisoning symptoms are not observed in cattle.
- As a result of chronic intoxication, **bladder tumors** are formed and **hematuri** occurs.
- In long-term cases, the bladder mucosa has cauliflower appearance, wart-like or polypoid growth.

Enzootic hematuria

- Several types of epithelial and mesenchymal neoplasms may develop, including urothelial cell and squamous cell carcinoma, papilloma, adenoma, hemangioma, hemangiosarcoma, leiomyosarcoma, fibroma, and fibrosarcoma.
- Multiple tumors of more than one type may be present, and in >50% of affected cattle mixed **epithelial-mesenchymal neoplasms** develop.
- *Papillomas, fibromas, and hemangiomas with carcinomas are the most common types.*
- Malignant types may invade locally, and about 10% of epithelial malignancies metastasize to iliac nodes or lungs.

Enzootic hematuria

- **Chronic cystitis** usually accompanies the neoplastic changes.
- Epithelial neoplasms appear to develop from the hyperplastic and metaplastic (squamous and mucous) changes in the urothelium that often accompany the vascular lesions.

NEOPLASMS OF THE LOWER URINARY TRACT

- Neoplasia of the lower urinary tract is uncommon, but occurs most often in **dogs, cats, and cattle**.
- Tumors develop almost in the urinary bladder.

EPITHELIAL TUMORS OF URINARY BLADDER

- Papilloma - Adenoma
- Urothelial cell carcinomas- Squamous cell carcinomas-Adenocarcinomas

NEOPLASMS OF THE LOWER URINARY TRACT

- **Leiomyomas**
- **Rhabdomyosarcomas**
- **Hemangioma, hemangiosarcoma and hemangiopericytomas** were found in cattle. They constitute about 6% of primary tumors. They are usually associated with primary epithelial tumors. Vascular tumors are not very common in dogs and cats.
- **Fibromas** probably arise from subepithelial connective tissue, are usually solitary, and have a typical gross and microscopic appearance
- **Fibrosarcomas** are rare; they are likely to metastasize widely.