

Chapter-five

The Urinary System pathology

By

Muluken Yayeh (DVM, MSc., Assist.proff.)

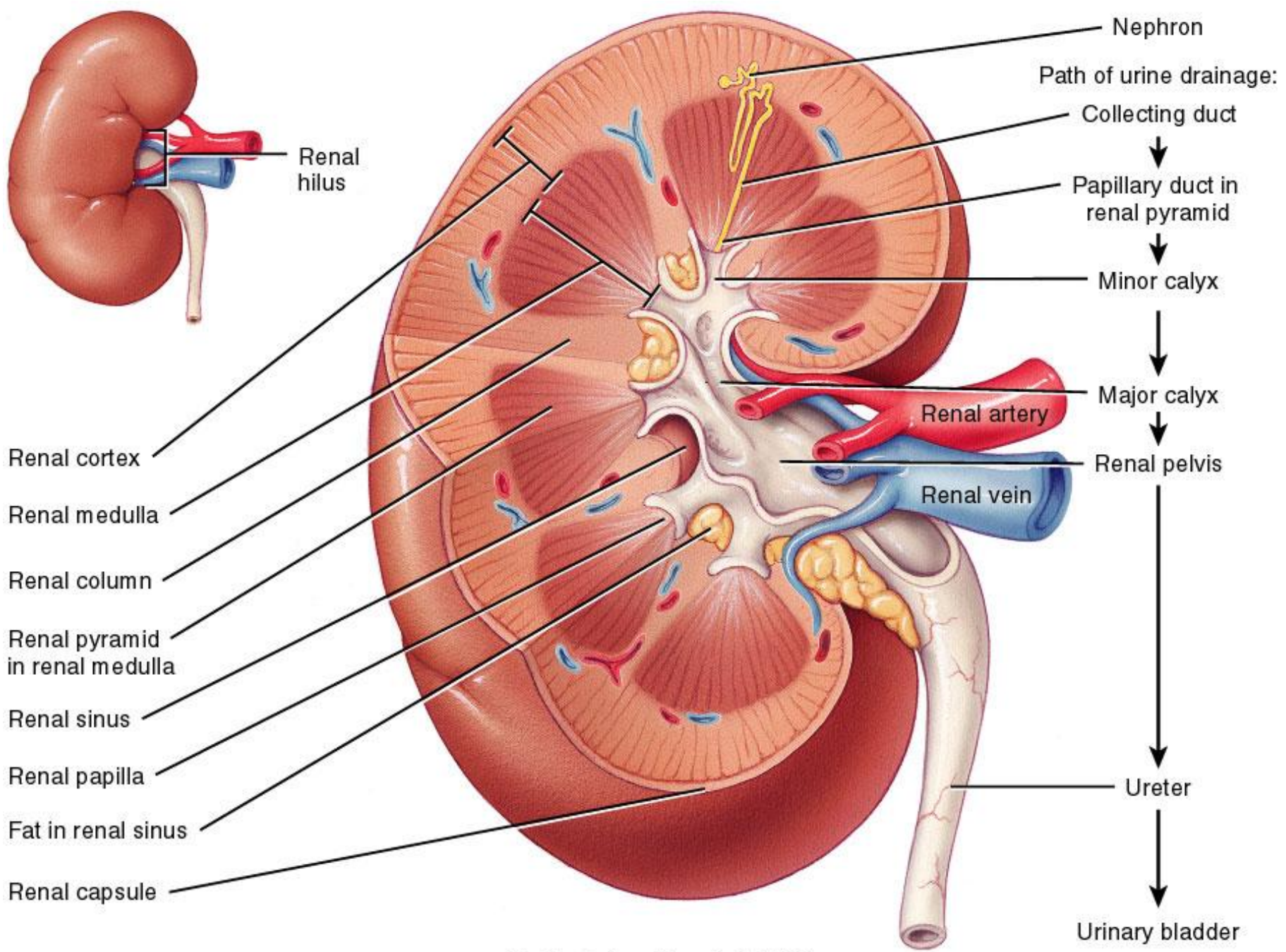
Learning objectives

- To outline the renal system;
- To describe the structure and function of nephron, processes of urine formation;
- To describe briefly the processes of urine formation;
- To describe the renin-angiotensin system;
- To describe the regulation of potassium, calcium and pH.

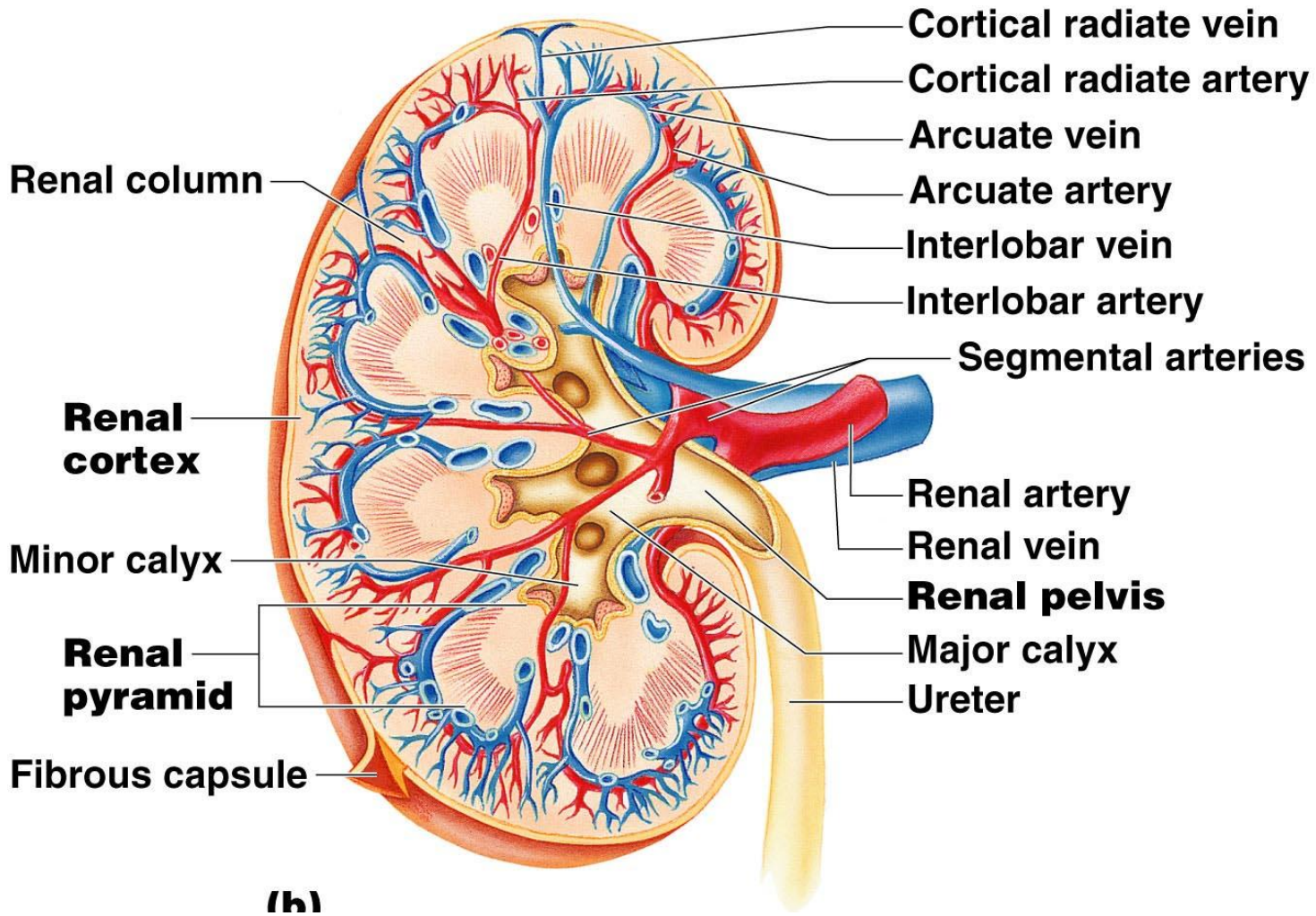
Mammalian renal system I

KIDNEY

- paired organs in abdominal cavity
- held firmly by peritoneum
- embedded in fat
- solid, dark red & bean shape
- below stomach
- renal artery vs renal vein



(a) Frontal section of right kidney



- Renal Artery
- Segmental Arteries
- Interlobar Arteries
- Arcuate Arteries
- Cortical Radiate Arteries
- Afferent Arterioles
- Glomerular Capillaries
- Efferent Arterioles
- Peritubular Capillaries
- Cortical Radiate Vein
- Arcuate Veins
- Interlobar Veins
- Renal Veins

NORMAL STRUCTURE OF KIDNEYS

- Colour
 - Reddish brown (normal)/ Yellow in cats
- Normal location
 - Sublumbar
- Normal shape
 - Bean shaped
- Normal surface
 - smooth unlobulated / monolobular – canine
- Histological consideration
 - No tissue is found between the tubules

Coverings of the Kidneys

- Renal capsule
- Surrounds each kidney
- Adipose capsule
- Surrounds the kidney
- Provides protection to the kidney
- Helps keep the kidney in its correct location

Functions of kidney

- Excretion
 - ~ remove nitrogenous waste i.e. urea, salts, water, heat, toxic substance
- Osmoregulation
 - ~ controlling amount of water in body
 - ~ maintain osmotic potential

Mammalian renal system II

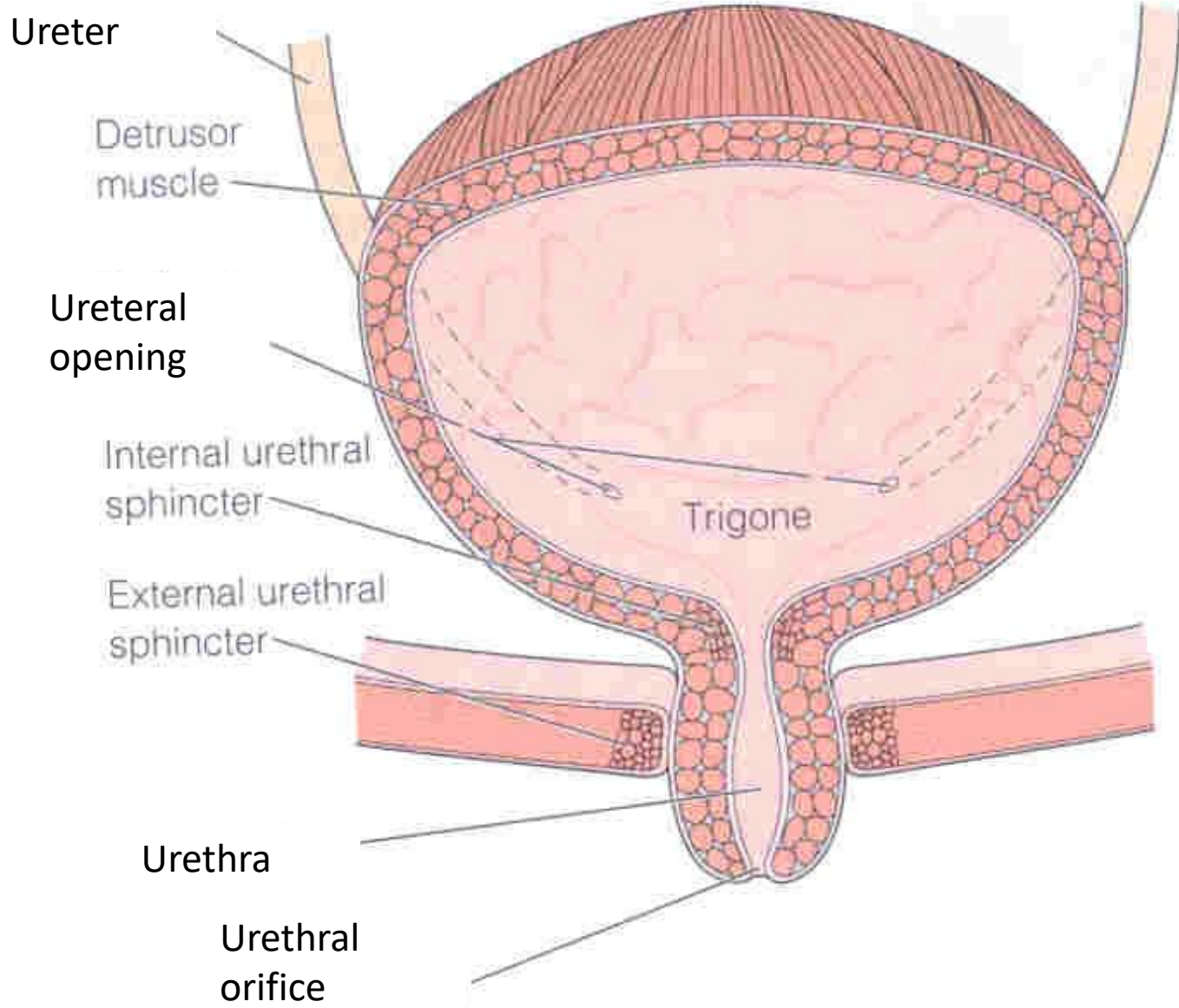
URETERS

- narrow tubes
- passing urine from kidneys to bladder
- valves ⇒ prevent back flow of urine
 - ⇒ stop bacteria from going into kidney

Mammalian renal system III

URINARY BLADDER

- muscular bag
- stores urine temporarily
- 300 cm³ of urine → sensation of urination
- contraction of bladder + relaxation of sphincter muscle ⇒ forces urine out

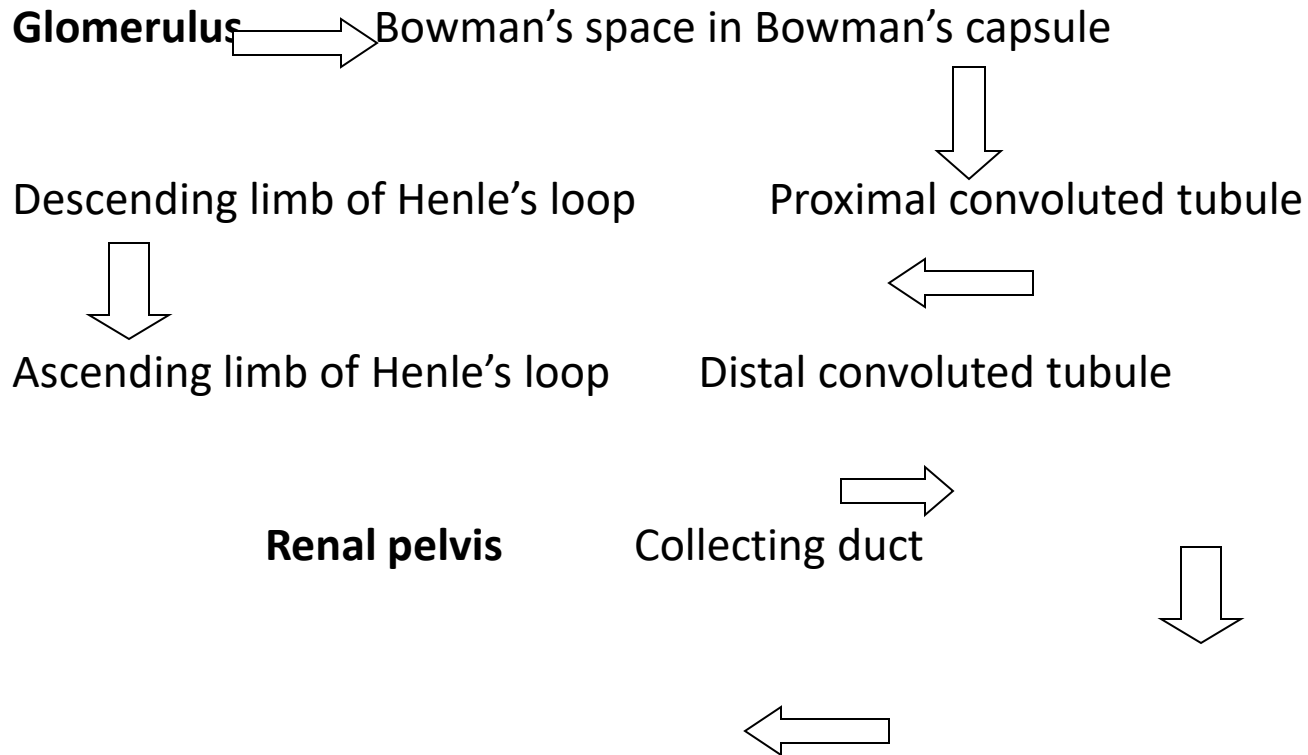


Mammalian renal system IV

URETHRA

- muscular tube
- carries ONLY URINE in female
- carries URINE & SEMEN in male

FLOW OF GLOMERULAR FILTRATE



NEPHRON

☺ 1,000,000 nephrons / kidney

➤ structural & functional units

➤ *Cortical nephron*

~ in cortex, short Loop of Henle, osmoregulation under NORMAL condition

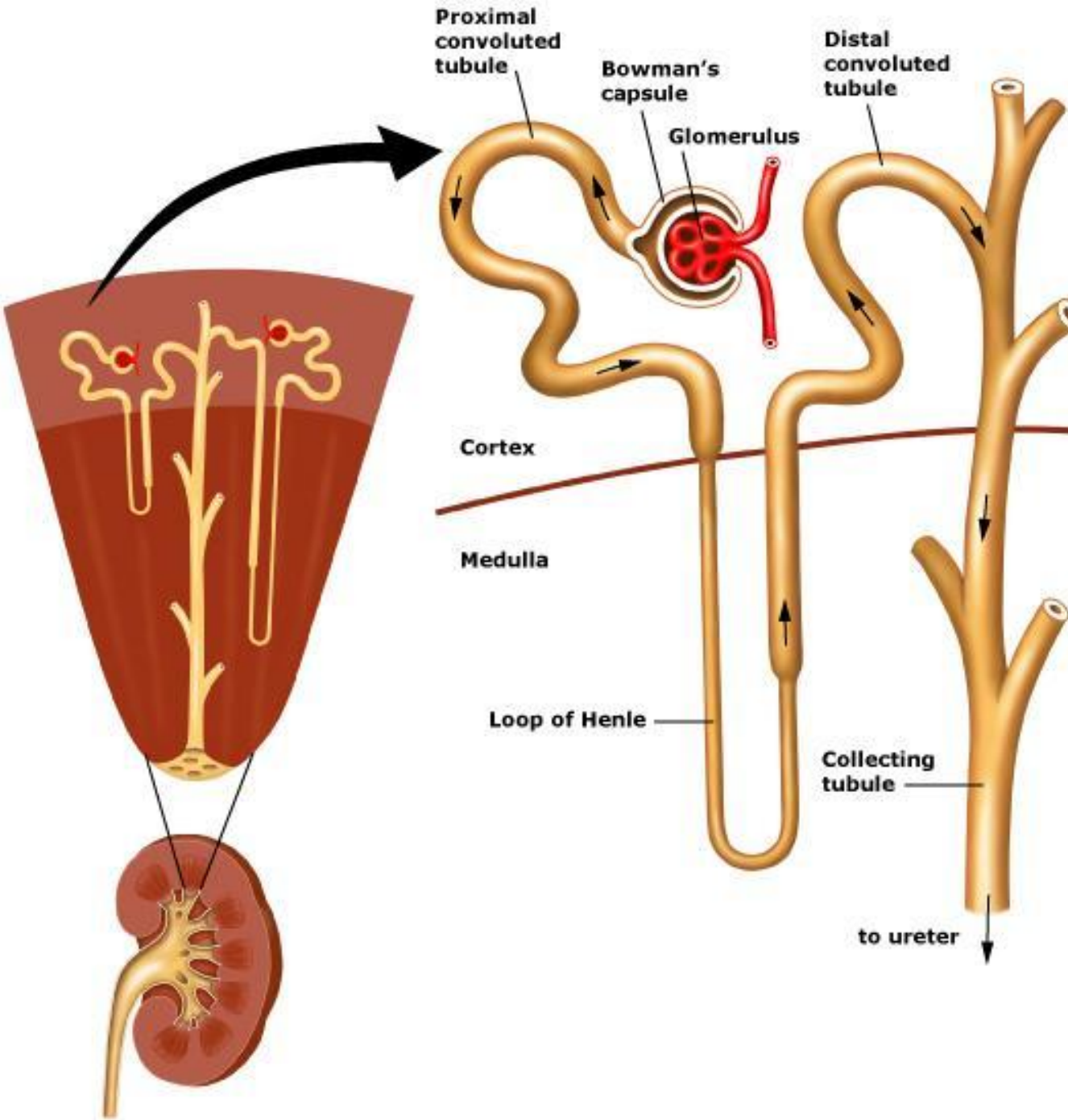
➤ *Juxtamedullary nephron*

~ at junction of cortex & medulla, long Loop of Henle, osmoregulation when SHORT OF WATER

Nephron

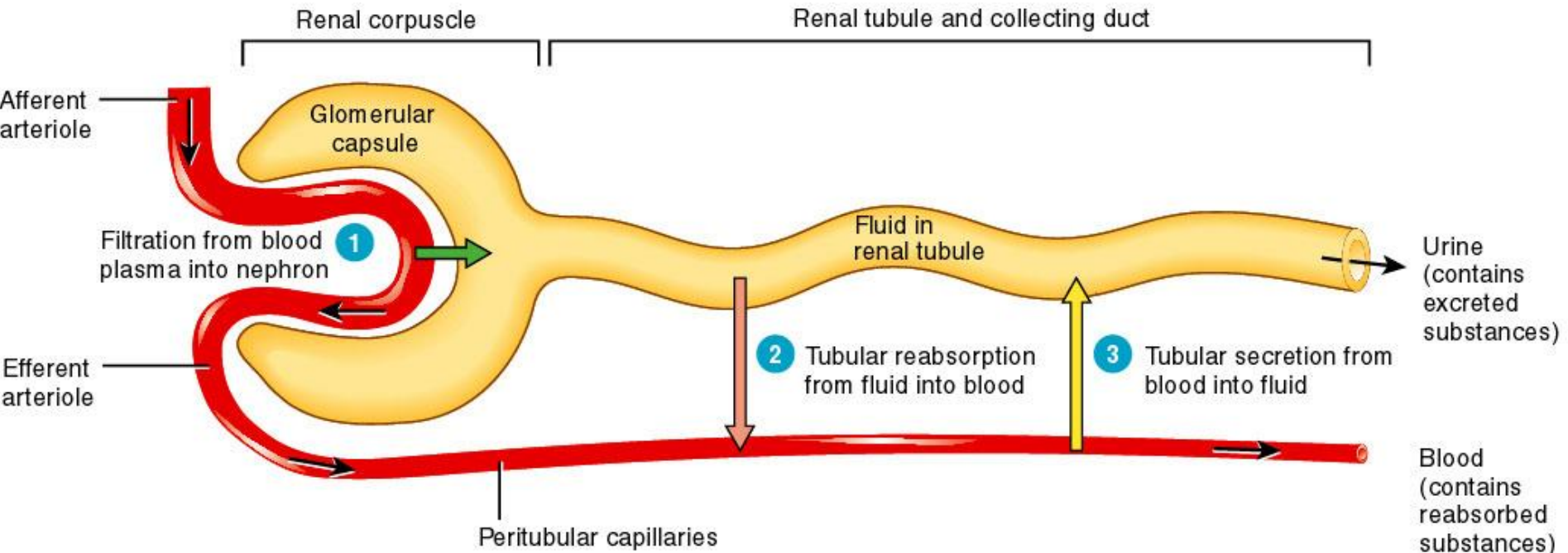
- Renal corpuscle
 - ➔ Glomerulus: knot of blood capillaries
 - ➔ Bowman's capsule
- Proximal convoluted tubule
- Descending limb of loop of Henle
- Ascending limb of loop of Henle
- Distal convoluted tubule
- Collecting duct

Nephron



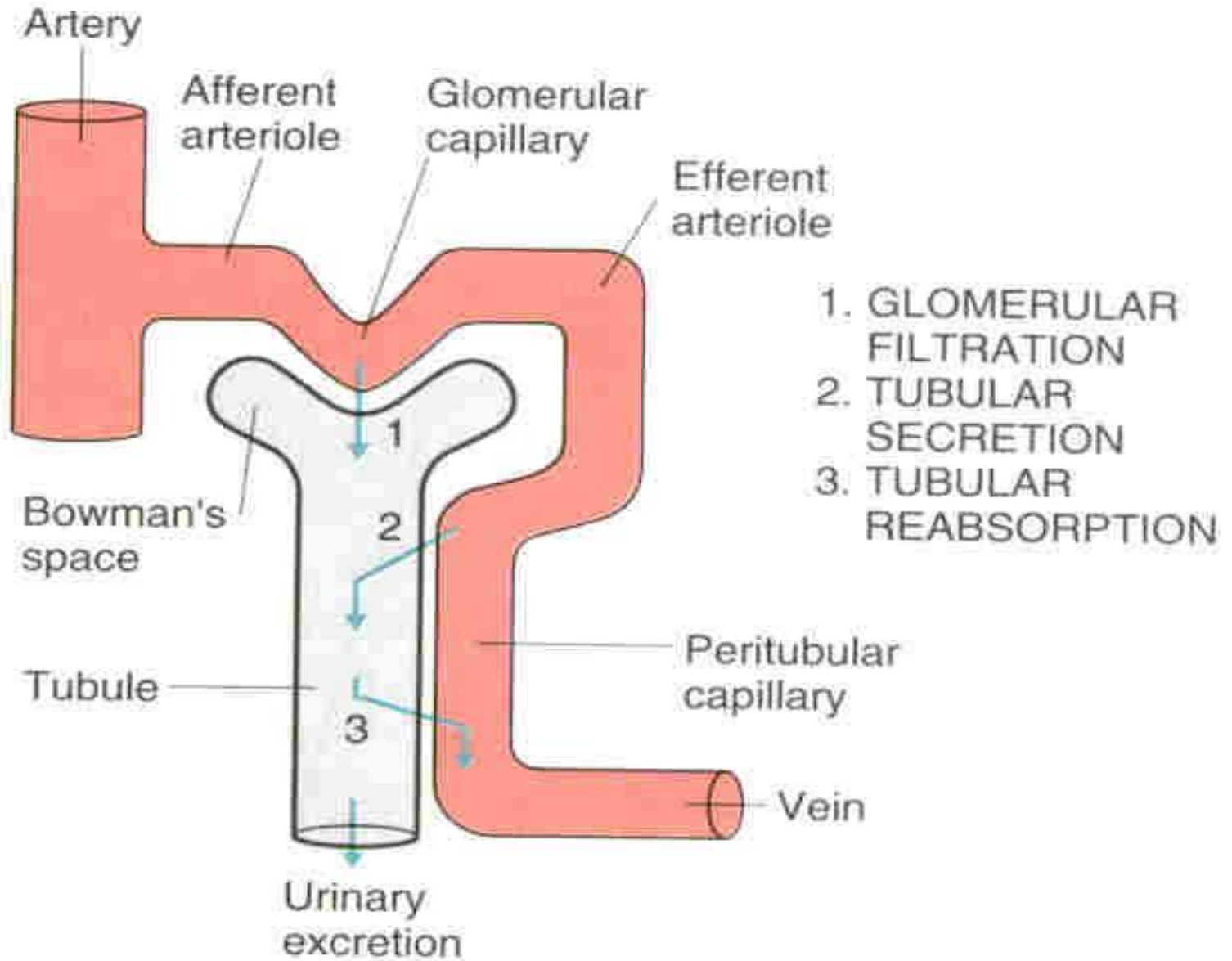
Nephron's functions:

1. glomerular filtration
2. tubular reabsorption
3. tubular secretion



Urine Formation

- Pressure filtration
(ultrafiltration)
- Reabsorption
- Tubular secretion



Ultrafiltration

- Occur at Malpighian body
- Glomerular filtrate: all substances in blood except RBCs & plasma protein

↳ **Blood pressure:**

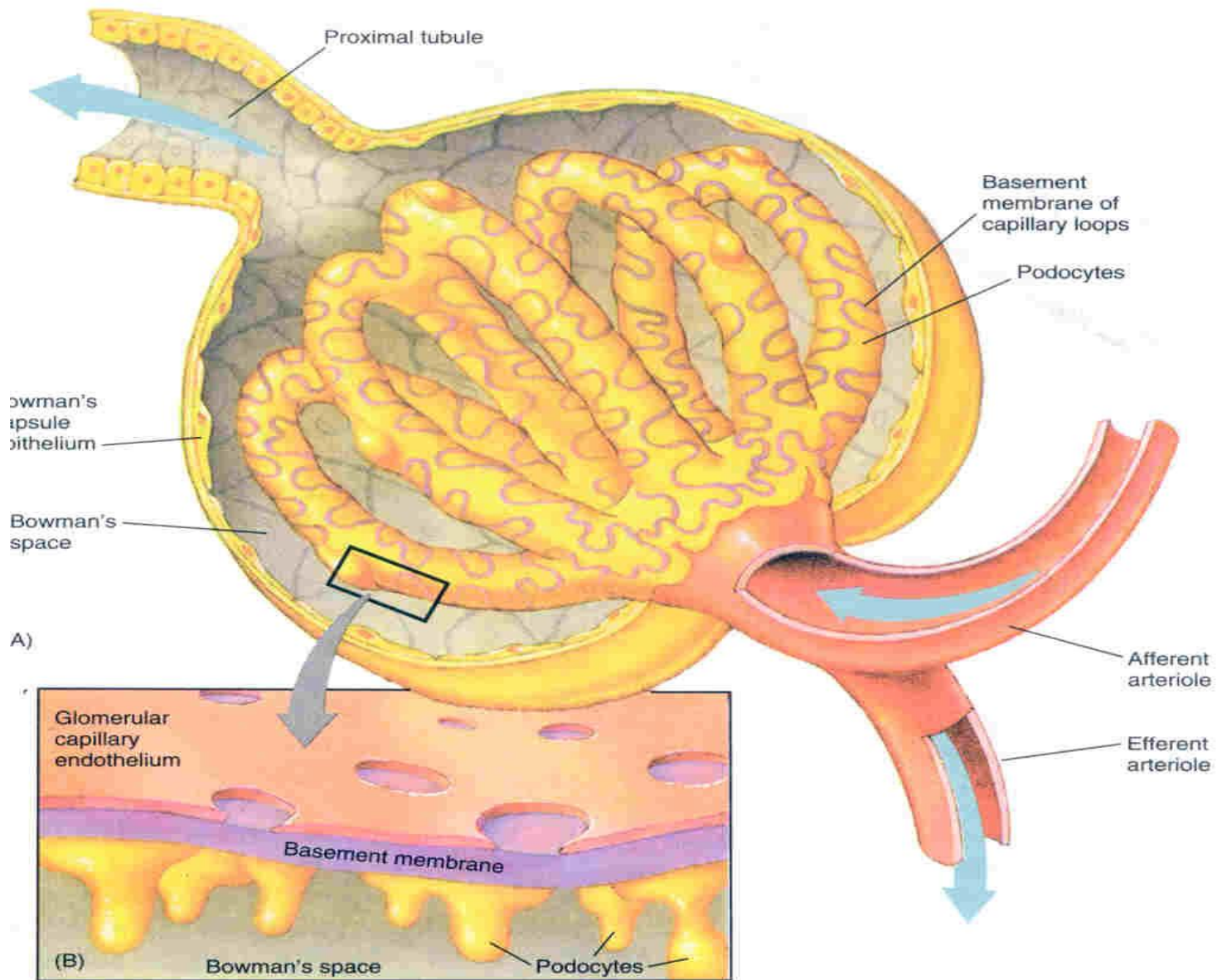
Diameter of afferent arteriole > Diameter of efferent arteriole

↳ **Glomerular filtrate rate**

180l/ day

↳ **Adaptation**

large area, great pressure, thin ,membrane



Reabsorption

- **99%** of the glomerular filtrate are reabsorbed
- matter reabsorbed:
 - **all glucose, amino acid**
 - **mineral salts**
 - **other useful substances**
- **⇒ SELECTIVE REABSORPTION**
- **Method of reabsorption**
 - **➤ diffusion** **➤ active transport**

Sites of reabsorption

① Proximal convoluted tubule

~ major site of reabsorption (80%)

~ microvilli \Rightarrow \uparrow surface area

~ numerous mitochondria

~ surrounded by peritubular capillaries

Sites of reabsorption

② Loop of Henle

- ~ conserve water in terrestrial mammal
- ~ creates & maintain an increasing osmotic gradient in the medulla
- ~ \uparrow Na^+ in medulla \Rightarrow vigorous osmotic extraction of water from collecting ducts \Rightarrow hypertonic urine

Sites of reabsorption

③ Vasa recta

~ narrow capillaries situated close to loop of Henle

~ freely permeable to ions, urea & water

~ *Counter current exchanger system*

Sites of reabsorption

④ Distal convoluted tubule

~ fine control of salt, water & pH balance of the blood

⑤ Collecting duct

~ water is extracted by osmosis \Rightarrow \uparrow conc. \Rightarrow hypertonic urine

Tubular secretion

- Takes place in distal convoluted tubule
- absorption of unnecessary: ammonia, potassium & drug from capillary network & secrete them into lumen of tubule

Regulation of urine composition

- Anti-diuretic hormone(ADH)
- Aldosterone
- Renin-angiotensin system

Potassium content

- most abundant intracellular ion
- reabsorbed by proximal convoluted tubule & loop of Henle, secreted by collecting ducts
- $\downarrow K \Rightarrow \downarrow$ secretion
- *aldosterone* \uparrow secretion of K

Calcium content

- \downarrow Ca \Rightarrow \uparrow excitability of nerve & muscle cell membranes \Rightarrow hypocalcemic tetany
- \uparrow Ca \Rightarrow cardiac arrhythmias
- most reabsorbed, no secretion

pH level

- Metabolic reactions are highly sensitive to H^+
- Sources of H^+ gain or loss
 - ⊗ Gain ~ from CO_2 , metabolism of protein etc,
loss of CO_3^{2-} in diarrhea & urine
 - ⊗ Loss ~ in vomitus & urine

5.1. Congenital anomalies of the kidney and the urinary tract

ANOMALIES OF KIDNEYS

1. Ectopic kidney

Location

Inguinal region

Pelvic cavity

Occurrence

Pigs and dogs

Sequelae

o Ureteral obstruction leads to secondary hydronephrosis

2. Fused kidneys

Fused kidneys look like horse shoe

3. Persistent Lobuation of kidneys

Normal in foetal life

Occurrence

Dogs, sheep and swine

- **Renal Agenesis**

- Renal agenesis means absence of one or both the kidneys

- **Renal Aplasia**

- It is usually found at necropsy

- It is seen in beagle and Doberman breeds of dogs

- If unilateral, the condition is compatible with life

- If bilateral it is usually incompatible with life.

- **Renal Hypoplasia**

- **Definition**

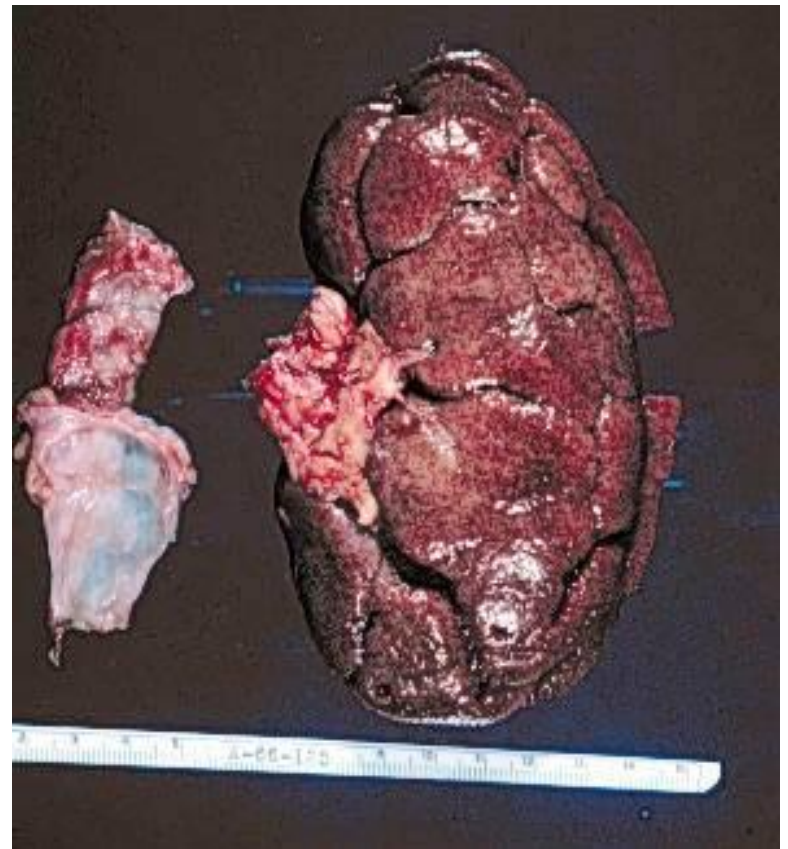
- Renal hypoplasia means that the affected kidney is smaller and the unaffected
- kidney shows compensatory hypertrophy.
- Criteria for considering the kidneys are hypoplastic include absence of acquired
- disease, 50% reduction in size, 1/3 rd reduction in mass and reduced number of
- glomeruli (5-12 glomeruli / LPF normal: 30-35)

Occurrence

- o Cattle, pigs and foals

Sequelae

If unilateral, the other kidney undergoes compensatory hypertrophy



- Duplication of kidneys

Three kidneys may be seen

Occurrence - Pigs

- **Renal Cysts**

Common congenital defect seen in calf, pigs, lambs, cat, dog and foal.

Etiology

- o Tubular obstruction
- o Weak tubular basement membrane

Pathogenesis

- o Cysts in kidneys arise due to lack of continuity between the nephron and collecting ducts and so urine formed in the nephron is not evacuated but collected to form the cyst.

Gross pathology

- o The kidneys may contain one or more cysts. Kidneys with many cysts are known as congenital polycystic kidney.

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- Ureteral Aplasia

Occurrence

Rare

Ureter empties into urethra / vagina, neck of bladder, prostate or vasdeference.

- Persistent (Patent) Urachus

Occurrence: Foals

Signs: Dribbling of urine

Sequelae: Cystitis

FACTORS AFFECTING RENAL FUNCTION

- Extrarenal Factors Interfering Kidney Function
 - Hemoconcentration
 - Low blood pressure
 - Obstruction to flow of urine
- Intrarenal Factors Interfering Kidney Function
 - Injury to glomeruli
 - Injury to tubules
 - Alteration in blood supply

ERRORS IN RENAL FUNCTION

- **Proteinuria**

Definition

- o Proteinuria means presence of protein (mainly albumin) in urine. The resultant hypoproteinemia causes renal edema.

Etiology

- o Increased permeability of glomerular capillaries
- o Amyloidosis
- o Tubular injury -Nephrosis
- o Renal infarction
- o Nephritis - Glomerulonephritis
- o Congestive heart failure

- **Glycosuria**

Definition

- o Glycosuria means presence of glucose in urine.

Etiology

- o Diabetes mellitus
- o Enterotoxaemia
- o Intravenous injection of large quantities of dextrose
- o Injection of ACTH
- o Rabies

- **Ketonuria**

Definition

- o Ketonuria means presence of ketone bodies in urine.

Etiology

- o Diabetes mellitus
- o Acetonemia / Ketosis of cattle
- o Pregnancy toxemia in ewes
- o Starvation

- **Anuria**

Definition

- o Anuria means absence of urine formation

Etiology

- o Glomerulonephritis
- o Tubular degeneration
- o Extensive destruction of tubular epithelium
- o Urinary obstruction
- o Extreme dehydration
- o Decreased blood pressure

- *Pathogenesis*

- o In glomerulonephritis, there is swelling of capillary endothelium and infiltration

- of inflammatory cells. These changes cause compression of capillaries of

- glomeruli and so blood flow through them is blocked. So urine is not filtered.

- o In tubular degeneration, fatty changes and cloudy swelling of tubular epithelial cells cause increase in pressure within the kidneys which compresses the blood vessels.
- o In urinary obstruction, the stagnated urine causes back pressure to the kidneys which in turn opposes the filtration pressure and thus the formation of urine.
- o In Extensive destruction of tubular epithelium, the filtered urine passes through the tubules in to the lymphatics and veins.

- **Oliguria**

Definition

- o Oliguria means reduced excretion of urine

Etiology

- o Glomerulonephritis
- o Tubular degeneration
- o Urinary obstruction
- o Extreme dehydration
- o Decreased blood pressure

- **Polyuria**

Definition

- o Polyuria means excessive passage of urine

Etiology

- o Diabetes mellitus
- o Diabetes insipidus
- o Tubular degeneration
- o Chronic interstitial nephritis
- o Hypercalcemia
- o Hypomagnesemia

- **Pyuria**

Definition

- o Pyuria means presence of pus in urine

Etiology

- o Suppurative inflammation of kidneys or urinary passage

- **Hematuria**

Definition

- o Hematuria means presence of blood in urine

Etiology

- o Trauma / Calculi
- o Chemicals – Phenol, turpentine
- o Septicemia – Haemorrhagic septicemia, anthrax
- o Parasites – *Dioctophyma renale*
- o Inflammatory reaction - acute nephritis, pyelonephritis, cystitis and urethritis
- o Renal infarction

- o Chronic bovine hematuria
- o Neoplasm – carcinoma of bladder or kidneys

Signs

- o Urine is coloured red

Pathogenesis

- o Hematuria is due to haemorrhage from any part of urinary system – from glomeruli to urethra

- **Haemoglobinuria**

Definition

- o Haemoglobinuria means presence of haemoglobin in urine

Etiology

- o Haemoglobinemia is seen in babesiosis, leptospirosis and infection by Clostridium and Streptococci
- o Chemicals – Chronic copper poisoning and potassium chlorate poisoning
- o Post parturient haemoglobinuria in cattle

Signs

- o Urine is brown or coffee coloured

- *Pathogenesis*

- o Here the red blood cells are lysed and so haemoglobin diffuses out and enters the glomerular filter.

- o The red blood cells can not be sedimented upon standing of urine.

CIRCULATORY DISTURBANCES

- **Hyperemia**

 - Etiology*

 - o Active hyperemia is seen in

 - o Acute – Nephritis

- **Septicemia**

 - Bacterial intoxication

 - Gross pathology*

 - o The kidneys may be slightly enlarged

 - o Cut surface – Ooze blood

- **Congestion**

 - Etiology*

 - o Hypostatic
 - o Generalized passive congestion
 - o Medullary congestion – Prominent

- **Edema**

 - Occurrence*

 - o As the capsule is inelastic and the parenchyma is firm, edema of kidney is not common.

 - Etiology*

 - o Inflammatory edema may be seen in acute interstitial nephritis

- **Haemorrhage**

Etiology

- o Vasculitis
- o Vascular necrosis
- o Direct trauma to kidney

- **Petechiae**

- o Cortical surface

- Etiology*

- o Seen in

- Swine fever

- African swine fever

- Swine erysipelas

- Streptococcosis

- Salmonellosis

- **Ecchymoses**

Etiology - Herpes virus infection in neonatal puppies

- **Extravasations**

Etiology

- o Direct trauma
- o Bleeding disorders – Hemophilia, disseminated intravascular coagulation

- **Infarct**

- Etiology*

- o Cows

- Thrombosis of the uterine veins after parturition

- Corynebacterium pyogenes and Streptococcal infection*

- o Pig

- Erysipelas infection

- Occurrence*

- o Very common in cattle especially cows

- o Anaemic (Pale) type is common

- *Gross pathology*
- o The infarcts are wedge shaped with the base towards the cortex and the apex towards the medulla or pelvis.

Sequelae

o If the condition is not septic, the infarct will be healed by scar tissue formation and the surface will be pitted.

UREMIA

Definition

- Uremia is a toxaemic syndrome resulting from renal insufficiency
- This is due to toxic action by-retained non-protein nitrogenous substances (NPN) Substances in blood (Azotemia) and partly to acidosis. The NPN substances include urea, creatine, uric acid and ammonia.

Occurrence

- Common – Nearly 5 % of all dogs examined at autopsy have some kind of uremia
- This is more common in males than in females in all species of animals

Etiology

Pre-Renal

- o Here waste products of protein catabolism are retained in the blood which may occur in the following conditions.
- o Low Blood Pressure: Decreased glomerular filtration may occur in trauma, shock, intestinal haemorrhage and severe dehydration.
- o Increased protein catabolism – High protein intake and followed by rapid breakdown of proteins, gangrene, diabetes mellitus, fever, large infarcts
- o In conditions like vomiting, diarrhea, excessive sweating and intestinal obstruction, there is salt deficiency, dehydration and electrolyte imbalance

Renal

- o Decreased glomerular filtration occurs in glomerulonephritis and extensive amyloidosis
- o Decreased tubular resorption occurs in toxic tubular nephrosis and chronic interstitial nephritis
- o Decreased tubular secretion - Hyperkalemia → Acidosis
- o Toxic tubular necrosis
- o Decreased detoxifying mechanism

Post-Renal

o The urinary tract may be obstructed by calculi, post inflammatory strictures, carcinoma of bladder, prostatic enlargements and expanding pressure by tumours over the urinary passage.

Urinary tract obstruction



Retention of urine



Decreased glomerular filtration



Anuria

Signs

- Polyuria leading to polydipsia
- Anuria
- Icterus

Clinical pathology

- Blood urea level is elevated which is a good index of the toxaemia that develops in
- uremic conditions
- Elevation of other NPN substances – uric acid, creatine, ammonia
- Elevation of amino acids in blood
- Elevation of sulphates and phosphates of potassium and chlorides
Decreased calcium level

Gross pathology

- Mouth – Ulcers
- Stomach – Ulcers
- Haemorrhagic gastroenteritis (Excretion gastritis)
- Serosa contains deposits of calcium urates and urea
- Anaemia / Icterus
- Parathyroids – Enlarged
- Skeleton especially of head and jaw–The bones are every soft, pliable and can be bent
- (Hence the bones called rubber nose, rubber jaw)
- Pericardial fluid – Increased and contains fibrin
- Enlarged left ventricle
- Lungs – Edematous

Histopathology

- Left auricle – Endocardium – Necrotic
- Aorta / pulmonary artery – Intima up to initial few centimeters undergoes necrosis →
- Necrotic area becomes fibrosed → Calcification
- Left ventricle – myocardial fibres → Hypertrophic
- Arteriole & capillaries shows medial hypertrophy
- Liver – Degenerative changes
- Neuronal injury by toxic materials in blood

- Bone marrow – suppression of hemopoiesis
- Bones - Resorption of bone by osteoclasts
- Parathyroids - Hyperplastic
- Metastatic calcification
 - o Gastric mucosa
 - o Larynx
 - o Trachea
 - o Lungs
 - o Visceral pleura
- Kidney: Nephritis
- The deposits of calcium urates and urea on serous membranes and joints cause
- inflammation and pain.

POSTMORTEM CHANGES

Postmortem changes in the kidneys include greyish or blackish discolouration, distortion and softening to pulpiness.

URINARY SYSTEM-II

NEPHROSIS

Definition

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

Toxic nephrosis

Etiology

o Toxic nephrosis may be due to inorganic, organic and endogeneous substances. Here the toxins are conveyed to the kidneys by way of blood.

Inorganic origin

- o Salts of mercury (Mercuric perchloride - fungicide) acts as cumulative toxicity. This is common in cattle, horses and swine. Mortality is high
- o Potassium dichromate, copper sulphate, bismuth bisulphate, cadmium, arsenic and phosphorus

Gross pathology

- o Kidney: Size: Enlarged
- o Colour: pale
- o Cut surface: Bulges

Histopathology

- o Kidney – Tubule
- o Proximal tubular epithelium desquamated or show coagulative necrosis
- o Calcium is deposited in the luminal debris, necrotic epithelium and basement membrane
- o Lumen contains granular or hyaline casts
- o Moderate dilatation of the lumen of the tubules
- o Intertubular tissue contains edema fluid and lymphocytic infiltration If death does not occur within a week, regeneration of the tubular epithelium occurs. The new cells are flat and dark staining. By the third week regeneration is complete

NEPHROCALCINOSIS

- Here calcium is deposited as calcium phosphates or carbonates

Gross pathology

- o Kidney shows white streaks or spots
- o Three types of disturbances of calcium metabolism are met with.
 - o Dystrophic calcification
 - o Calcium casts
 - o Deposition of calcium in interstitial tissue

NEPHRITIS AND NEOPLASMS

Definition

- o Inflammation of kidney is called nephritis

Nephritis is classified as follows

- o Suppurative Nephritis
- o Non-Suppurative Nephritis
- o Specific Nephritis

Suppurative nephritis is classified as follows

- o Pyaemic nephritis
- o Pyelonephritis

Pyaeamic nephritis

- o *Synonym*
- o Embolic nephritis

o *Etiology*

- Haematogenous origin– *E. coli, Staphylococci, Streptococci, Corynebacterium and Shigella*

Gross pathology

o Kidney

Cortex may contain numerous tiny round abscesses In medulla, the abscesses are elongated All the abscesses are of the same size, being of same age

o *Histopathology*

o Bacterial emboli may be seen in small blood vessels (glomeruli or intertubular capillaries)of kidney

o Around blood vessels leucocytic infiltration may be seen

Sequelae

o Pyaemic nephritis might lead to death

Pyelonephritis

oDefinition

Inflammation of pelvis and the adjacent parenchyma of kidney is called pyelonephritis.

Occurrence

o Met within cows but may also be found in sheep and swine.

Predisposing factor

o Stasis of urine

Signs

- o Haematuria / pyuria

Gross pathology

- Urinary bladder – Enlarged
- Ureters – Distended; Wall is thickened and their mucosa is roughened
- Pelvis is widely dilated with pus and contains triple phosphates
- Calyces are widely dilated and filled with purulent material containing calcium particles. The walls are red and ulcerated
- Papillae are either absent or dirty grey in appearance with erosions and a zone of hyperemia around
- Kidney- Beneath the capsule on the cortex is many tiny abscesses. In the medulla gray streaks may be found in the early stages

Histopathology

- o Pelvis - The epithelial lining of the pelvis may be necrosed and there may be leucocytic infiltration underneath and renal pyramid is infiltrated with neutrophils and a few lymphocytes. They may be found as a streak among the tubules in the medullary region.
- o Glomerular loops and Bowman's capsule are filled with leucocytes and bacteria
- o Tubules may contain cell casts and bacteria

- o The walls of collecting tubules and interstitial tissue may be necrosed which may be demarcated from the healthy area by a zone of leucocytes and hyperemia

Sequelae

- o Pyelonephritis might lead to death

NON-SUPPURATIVE NEPHRITIS

Non-suppurative nephritis is classified as follows

- o Interstitial nephritis
- o Tubular nephritis
- o Glomerulonephritis

Interstitial nephritis

- o *Occurrence*

- Most common in older male dogs

- Sometimes observed in horses, swine, sheep and cattle

- This is usually found at autopsy in normal looking animals

GLOMERULONEPHRITIS

Definition

- o It is the inflammation of the kidneys involving primarily the glomeruli.

Occurrence

- o The condition is not common in animals as in man
- o It is sometimes noticed in dogs, cats, swine, horses and mink

Etiology

- o Horses used for antisera production suffer from this disorder.
- o It is seen as a sequel to bacterial and viral diseases elsewhere in the body- Focal glomerulonephritis is seen in acute septicemic infections such as acute swine

Pathogenesis

- o Glomerulonephritis is due to antigen-antibody reaction to a foreign protein. The antigen-antibody complex gets deposited and damages the glomerular capillaries.
- o Based on the course glomerulonephritis is classified as follows
 - o Acute glomerulonephritis
 - o Subacute glomerulonephritis
 - o Chronic glomerulonephritis

Congenital abnormalities of the kidney and urinary tract

- Occur in 1 out of 500 newborns, and constitute approximately 20-30% of all anomalies identified in the prenatal period.
- Account for one third of all anomalies detected by routine fetal ultrasonography.
- CAKUT has a major role in renal failure, and there is increasing evidence that certain abnormalities predispose to the development of hypertension and cardiovascular disease in adult life.

- CAKUT is the cause of 40% of childhood end-stage renal failure.
- Acquired glomerulonephritis and congenital nephrotic syndromes, respectively, accounted for just 18% and 8% of cases, with other diseases being rare (nephronophthisis, 5%; cystinosis, 3%; polycystic kidney diseases [PKDs], 3%).

- 10% of individuals have urinary tract malformations, although many are asymptomatic
- 15% of congenital urogenital anomalies are secondary to an underlying chromosomal disorder
- In children, 20% of chronic renal failure is due to renal dysplasia or hypoplasia
- In adults, 10% of chronic renal failure is due to adult polycystic kidney disease

The spectrum of diseases encompassed by the term "CAKUT" is wide, including:

1-fetal kidney anomalies (renal malformations)

- renal agenesis (renal aplasia)
- renal hypoplasia
- multicystic dysplastic kidneys (renal dysplasias) (MRDs)

2-fetal ureteric anomalies

- megaureter
- ureteropelvic junction obstruction (UPJO)
- ureterovesical junction obstruction
- ureterovesical junction incompetence
- duplex kidneys/ureters (renal duplications)

3-fetal vesical anomalies (anomalies of the bladder)

4-fetal urethral anomalies



- These are normal term infant kidneys. Note the presence of fetal lobulations and the smooth cortical surfaces with some attached adipose tissue.

- These fetal kidneys (from a gestation estimated at 25 weeks in the second trimester) demonstrate a normal cut surface. Note the pelvis and the calyces. Note the well-defined corticomedullary junctions.

Renal Agenesis

- Complete absence of one or both kidneys.
- Renal agenesis is thought to result from a lack of induction of the metanephric blastema by the ureteral bud
- Bilateral agenesis is incompatible with life and is associated with pulmonary hypoplasia and limb defects
- Unilateral renal agenesis is uncommon, not fatal
- Compensatory hypertrophy in other kidney may cause glomerulosclerosis in adults.



associated with Klinefelter's (47, XXY) syndrome
Arrows indicate adrenal glands;
there is no kidney under the
adrenal glands

Renal Hypoplasia

- Failure of kidney to develop to normal size without scarring
- Usually unilateral, with a reduced number of pyramids (6 or less)
- **Oligomeganephronia:** a type of hypoplasia with a small kidney but hypertrophied nephrons



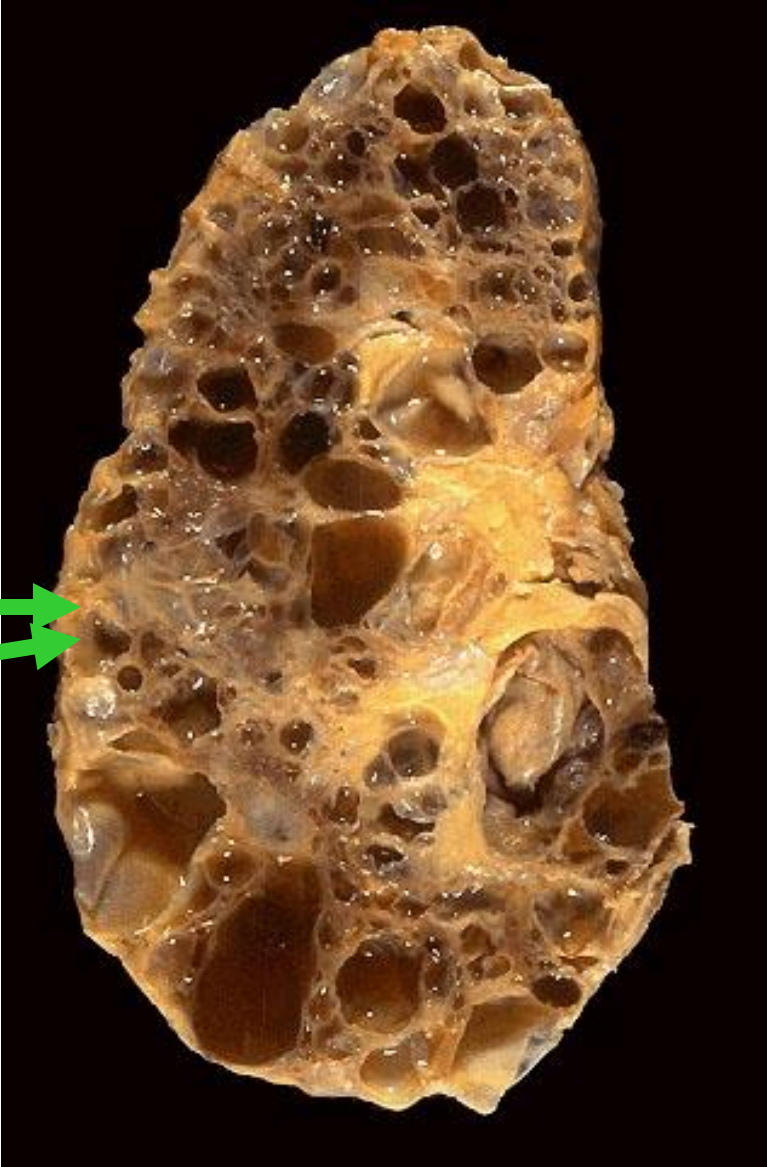
Horseshoe kidney

- 1/500 autopsies, 90% are fused at lower pole
- Associated with obstruction

Polycystic Kidney Disease

- Autosomal dominant
- Autosomal recessive

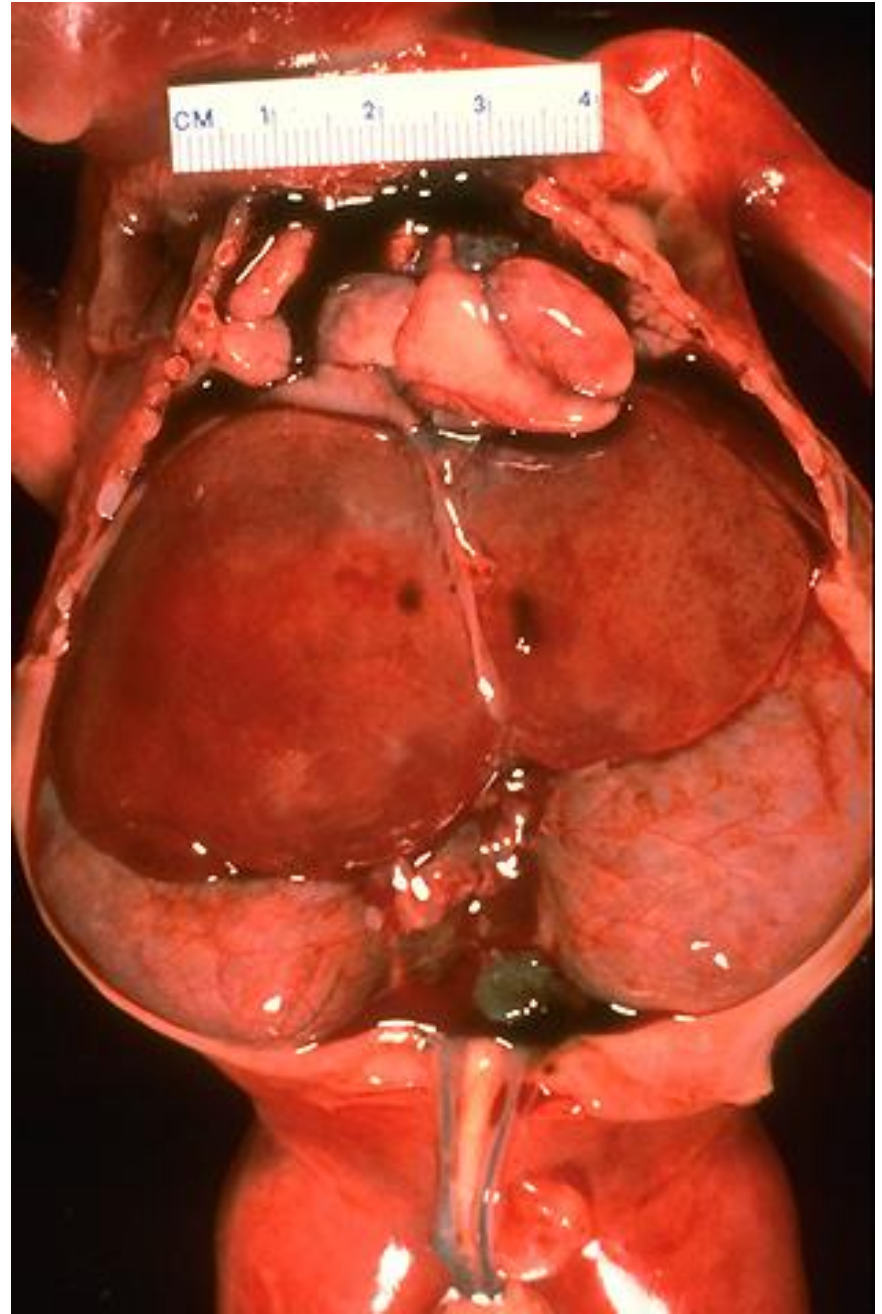
(You may hear more about this subject during your cystic renal diseases lecture)



Kidney with autosomal recessive polycystic kidney disease

- The cysts are fairly small but uniformly distributed throughout the parenchyma so that the disease is usually symmetrical in appearance, with both kidneys markedly enlarged.
- The recurrence risk for this disease is, of course, 25% because of the autosomal recessive inheritance pattern.
- Affected babies usually do not survive long.
- This disorder is linked to an abnormal fibrocystin protein produced by the *PKHD1* gene.

- Infantile type/autosomal recessive polycystic kidney disease (ARPKD).



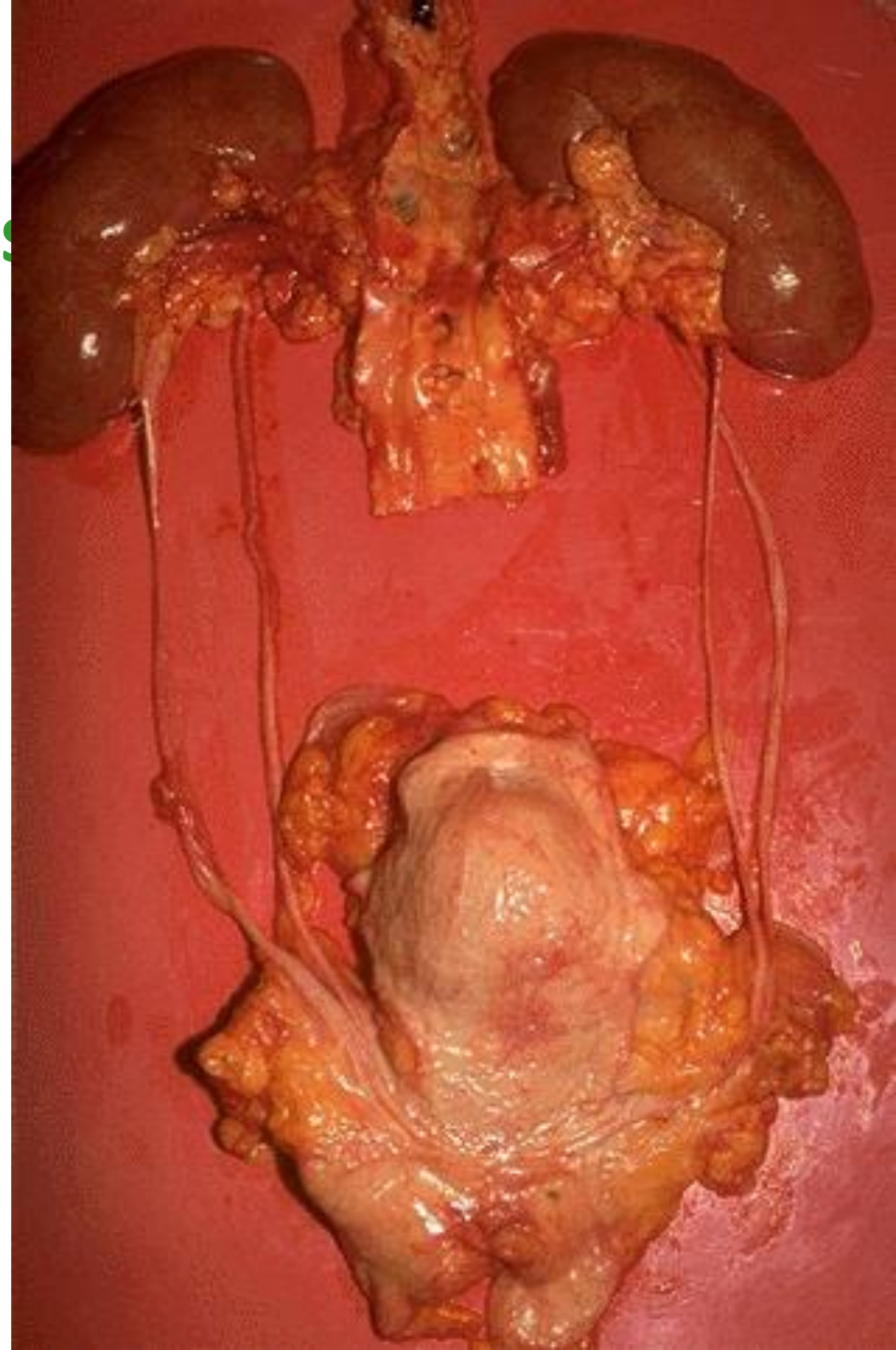
MULTICYSTIC DYSPLASTIC KIDNEY.

- This condition must be distinguished from ARPKD because it occurs only sporadically and not with a defined inheritance pattern, though it is more common than ARPKD.
- The cysts of multicystic renal dysplasia are larger and more variably sized than those of ARPKD.
- Often, multicystic renal dysplasia is unilateral. If bilateral, it is often asymmetric. If bilateral, oligohydramnios and its complications can ensue, just as with ARPKD.



Duplication of ureters

- Occurs in <1% of individuals
- Usually asymptomatic; may be associated with obstruction



Congenital anomalies of Bladder

Arteriovenous malformation:

- By definition, direct communication is present between arterioles and venules
- Very rare in bladder; more common in CNS, intestine, lung, extremities
- May cause massive hematuria

Cloacogenic bladder

- Also called **persistent cloaca**
- Defined as confluence of rectum, vagina and urethra into a single common chamber
- A surgical challenge to achieve bowel and bladder control and normal sexual function
- Occurs in 1/20,000 births, only in girls

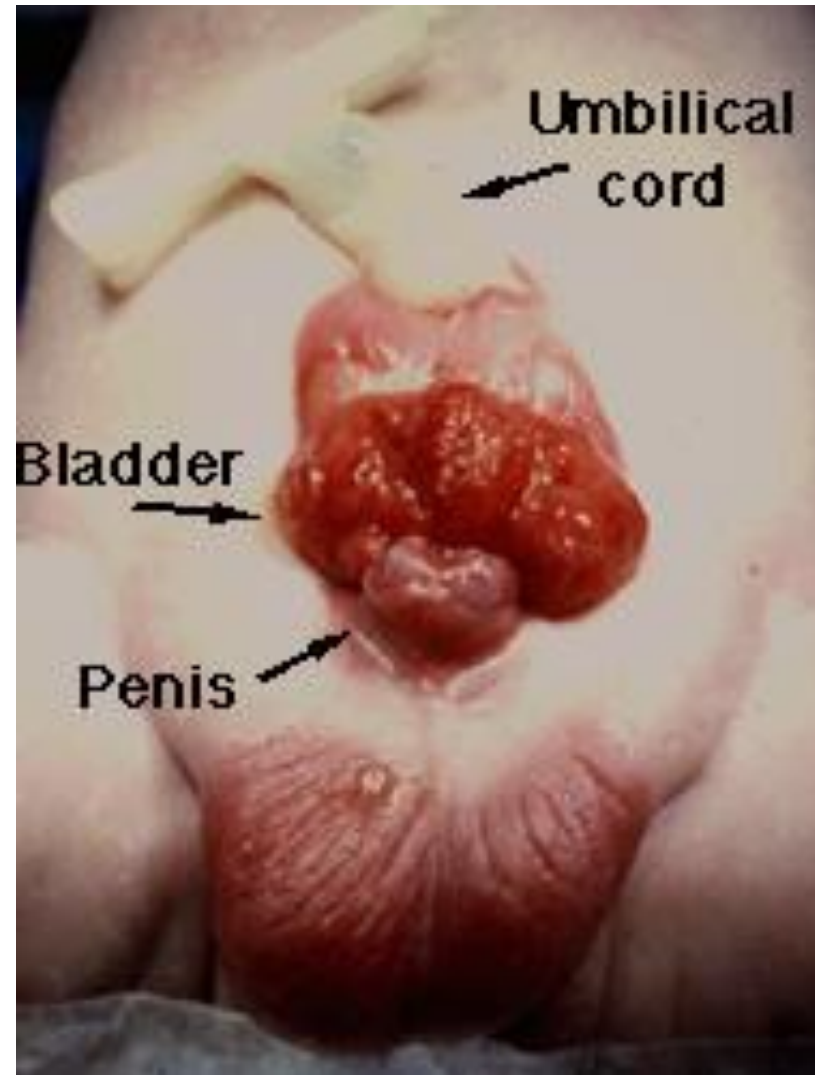
Duplication of bladder

- Bladder is separated into compartments
- Either double bladder, septal bladder or hourglass bladder
- Incomplete emptying causes urinary tract infections

Exstrophy of Bladder

- Developmental failure in lower abdominal wall or anterior wall of bladder due to failure of cloacal membrane to properly differentiate; bladder communicates with body surface or lies as an opened sac
- Associated with glandular metaplasia and adenocarcinoma (<10% of exstrophied bladders) or squamous metaplasia and squamous cell carcinoma (~7% of patients)
- Also associated with infections and ulceration

- This male infant was born with bladder exstrophy.
- The bladder mucosa is everted and lies on the abdomen. Both ureteric orifices lie on the exstrophic bladder.
- Notice that the penis is shortened and that there is no urethral meatus.
- His urethra is actually a plate of deep red mucosa lying on the dorsal penis. This is called **epispadias**.



- **Hypoplasia of Bladder**

- Normal but small bladder, seen in Potter syndrome

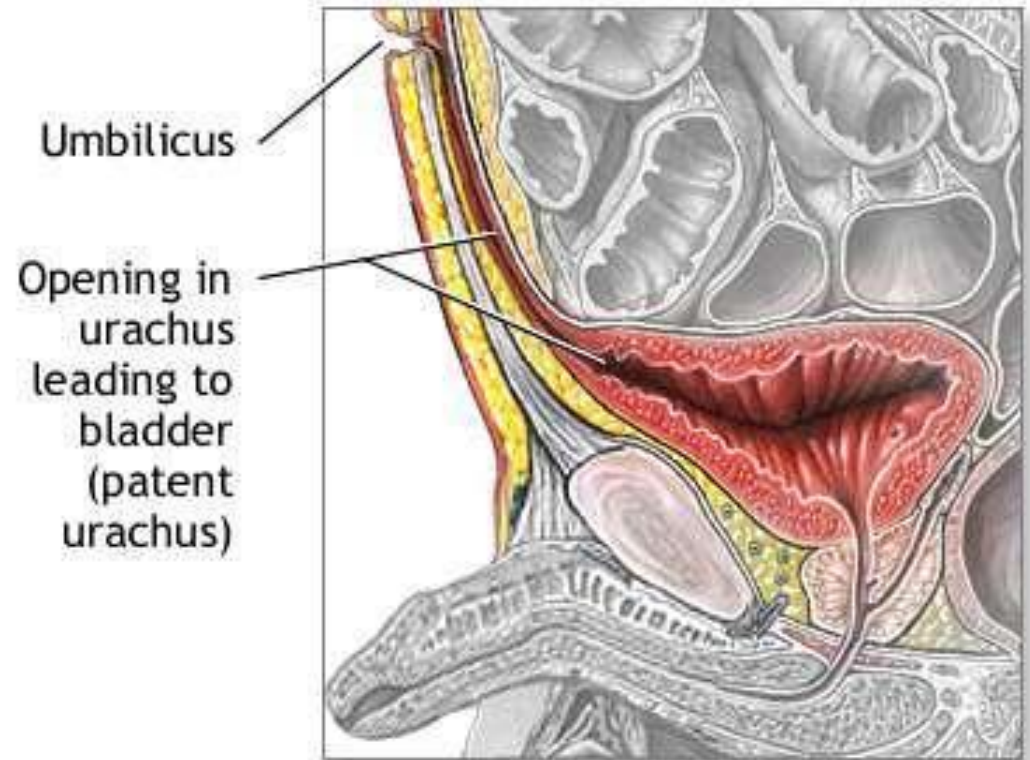
- **Hyperplasia of Bladder**

- Boys only
- Structurally and functionally abnormal bladder, shaped like cone, heart or cloverleaf
- Does not empty completely
- Associated with obstruction at urethral outlet but normal histology

Urachal Remnants

- Urachus is a 5 cm vestigial structure connecting dome of bladder and umbilicus; in fetus, connects bladder dome with allantois (embryonic diverticulum of hindgut, vessels are precursors to those in umbilical cord)
- After birth, it becomes median umbilical ligament
- Arises from superior urogenital sinus
- In midline or posterior bladder wall; fragmentation occurs post-partum when bladder descends into pelvis
- Urachal remnants seen at autopsy in 50% of fetuses, 33% of adults
- Associated with urachal cysts, sinus, fistula, diverticulum, infections, adenocarcinoma of bladder; also urothelial carcinoma, villous adenoma, squamous cell carcinoma

Patent urachus



- Also called persistent urachus
- Rare; leads to urination through umbilicus
- May be associated with infections

The End...

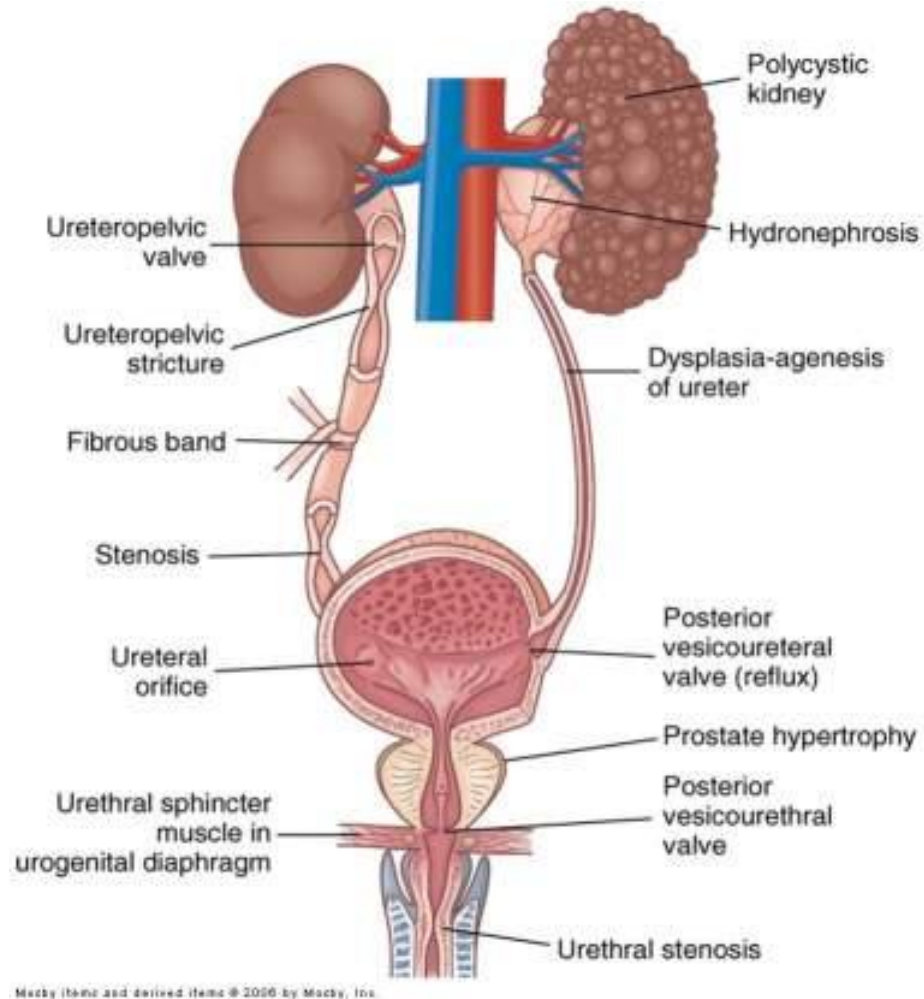
Urinary Tract Obstruction

- A urinary tract obstruction is defined as a blockage of urine flow with the urinary tract
 - The obstruction can be caused by an anatomic or functional defect
 - Obstructive uropathy
 - Severity based on:
 - Location
 - Completeness
 - Involvement of one or both upper urinary tracts
 - Duration
 - Cause

Urinary Tract Obstruction

- Hydroureter
- Hydronephrosis
- Tubulointerstitial fibrosis
- Apoptosis

Urinary Tract Obstruction



Urinary Tract Obstruction

- Compensatory hypertrophy
 - Obligatory growth
 - Compensatory growth
- Postobstructive diuresis
- Low bladder wall compliance

Upper Urinary Tract Obstruction

- Kidney stones
 - Calculi or urinary stones
 - Masses of crystals, protein, or other substances that form within and may obstruct the urinary tract
 - Risk factors
 - Gender, race, geographic location, seasonal factors, fluid intake, diet, and occupation
 - Kidney stones are classified according to the minerals comprising the stones

Kidney Stones

- Supersaturation of one or more salts
 - Presence of a salt in a higher concentration than the volume able to dissolve the salt
- Precipitation of a salt from liquid to solid state
 - Temperature and pH
- Growth into a stone via crystallization or aggregation

Kidney Stones

- Other factors affecting stone formation
 - Crystal growth-inhibiting substances
 - Particle retention
 - Matrix
- Stones
 - Calcium oxalate or calcium phosphate
 - Struvite stones
 - Cystinuric stones
 - Uric acid stones
 - Indinavir

Kidney Stones

- Manifestation
 - Renal colic
- Evaluation
 - Stone analysis
 - Intravenous pyelogram
 - Spiral abdominal CT
- Treatment
 - Stone removal

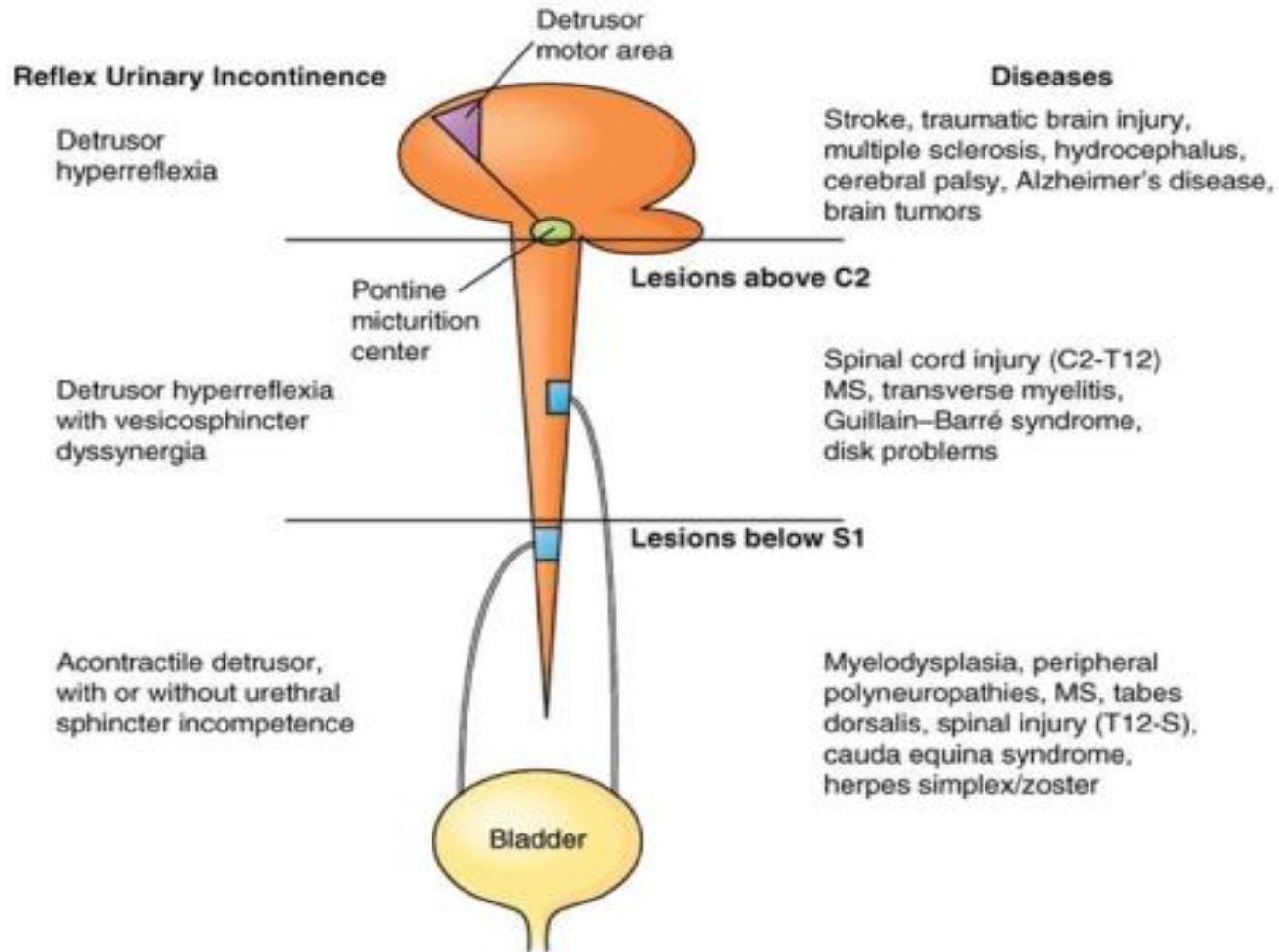
Lower Urinary Tract Obstruction

- Bladder neck dyssynergia
- Prostate enlargement
- Urethral stricture
- Severe pelvic organ prolapse

Lower Urinary Tract Obstruction

- Neurogenic bladder
 - Neurogenic detrusor overactivity
 - Detrusor sphincter dyssynergia
 - Obstruction
 - Low bladder wall compliance

Neurogenic Bladder



(Adapted from Doughty DB: Urinary and fecal incontinence. In Doughty DB, editor: *Urinary and fecal incontinence: nursing management*, ed 2, St Louis, 2000, Mosby.)

Tumors

- Renal tumors
 - Renal adenomas
 - Renal cell carcinoma
- Bladder tumors
 - Papillary tumors
 - Nonpapillary tumors
 - Metastasis to lymph nodes, liver, bone, and lungs

Urinary Tract Infection (UTI)

- UTI is inflammation of the urinary epithelium following invasion and colonization by some pathogen within the urinary tract
- Complicated UTI
- Uncomplicated UTI
- Persistent UTI

Urinary Tract Infection (UTI)

- Most common pathogens
 - *Escherichia coli*
 - *Staphylococcus saprophyticus*
 - *Enterobacter* spp
- Virulence of uropathogens
 - Host defense mechanisms

Urinary Tract Infection (UTI)

- Cystitis
 - Cystitis is an inflammation of the bladder
 - Manifestations
 - Frequency, dysuria, urgency, and lower abdominal and/or suprapubic pain
 - Treatment
 - Antimicrobial therapy, increased fluid intake, avoidance of bladder irritants, and urinary analgesics

Urinary Tract Infection (UTI)

- Pyelonephritis
 - Acute pyelonephritis
 - Acute infection of the ureter, renal pelvis, and/or renal parenchyma
 - Chronic pyelonephritis
 - Persistent or recurring episodes of acute pyelonephritis
 - Risk of chronic pyelonephritis increases in individuals with renal infections and some type of obstructive pathologic condition

Glomerular Disorders

- The glomerulopathies are disorders that directly affect the glomerulus
- Urinary sediment changes
 - Nephrotic sediment
 - Nephritic sediment
 - Sediment of chronic glomerular disease

Glomerular Disorders

- Glomerular disease demonstrates a sudden or insidious onset of hypertension, edema, and an elevated blood urea nitrogen (BUN)
- Decreased glomerular filtration rate
 - Elevated plasma creatinine, urea, and reduced creatinine clearance
- Glomerular damage causes a decreased glomerular membrane surface area, glomerular capillary blood flow, and blood hydrostatic pressure

Glomerular Disorders

- Increased glomerular capillary permeability and loss of negative ionic charge barrier result in passage of plasma proteins into the urine
- Resulting hypoalbuminemia encourages plasma fluid to move into the interstitial spaces
 - Edema

Glomerular Disorders

- Glomerulonephritis
 - Inflammation of the glomerulus
 - Immunologic abnormalities (most common)
 - Drugs or toxins
 - Vascular disorders
 - Systemic diseases
 - Viral causes

Glomerulonephritis

- Mechanisms of injury
 - Deposition of circulating soluble antigen-antibody complexes, often with complement fragments
 - Formation of antibodies against the glomerular basement membrane
 - Streptococcal release of neuramidase

Glomerulonephritis

Glomerulonephritis

- Acute poststreptococcal glomerulonephritis
- IgA nephropathy (Berger disease)
- Crescentic glomerulonephritis
- Antiglomerular basement membrane disease (Goodpasture syndrome)
- Chronic glomerulonephritis

Glomerulonephritis

Nephrotic Syndrome

- Excretion of 3.5 g or more of protein in the urine per day
- The protein excretion is due to glomerular injury
- Findings
 - Hypoalbuminemia, edema, hyperlipidemia, and lipiduria

Nephrotic Syndrome

- Membranous glomerulonephritis
- Focal and segmental glomerulosclerosis
- Minimal change disease (lipoid nephrosis)

Nephrotic Syndrome

Renal Dysfunction

- Renal insufficiency
- Renal failure
- End-stage renal failure
- Uremia
- Azotemia

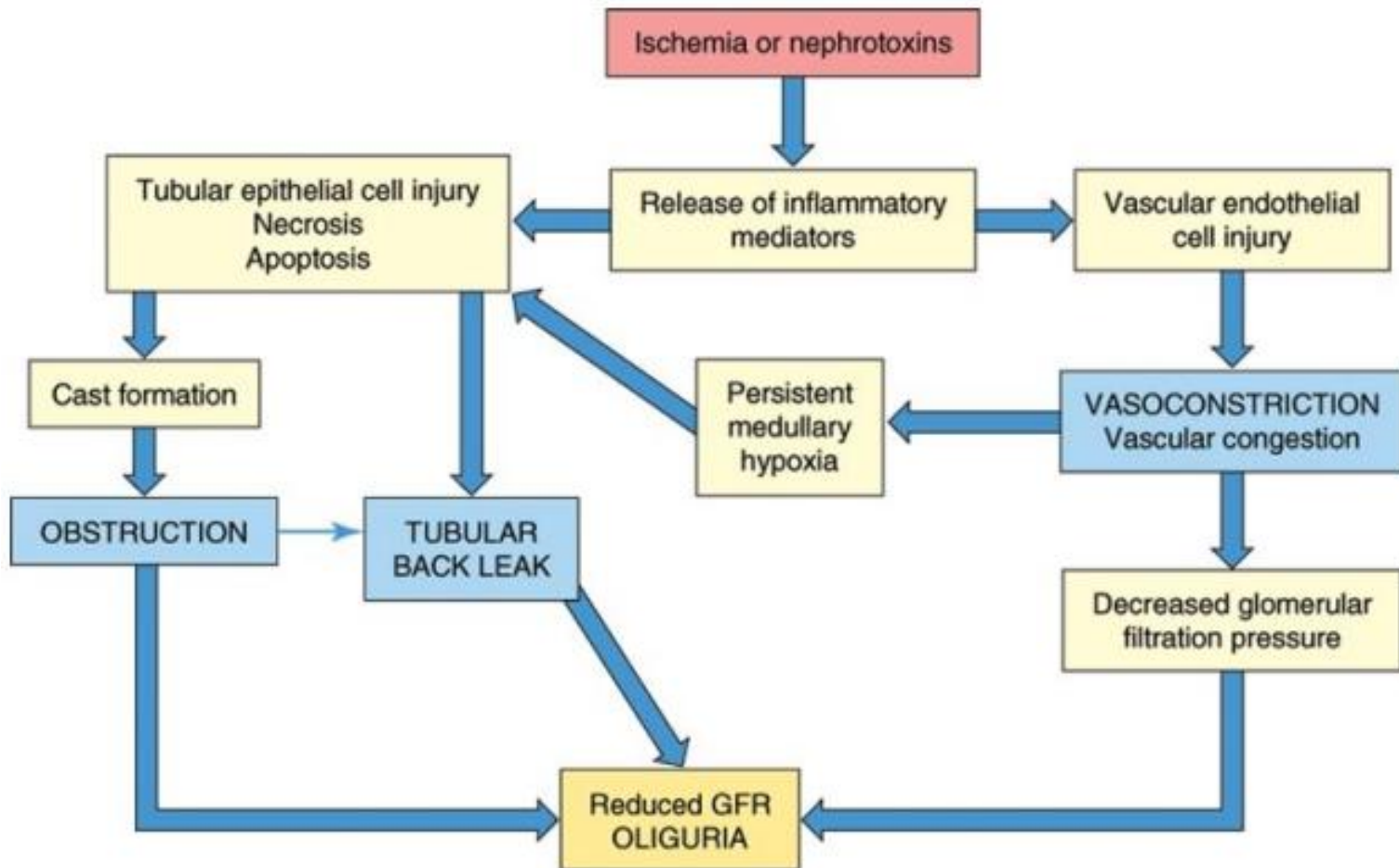
Acute Renal Failure (ARF)

- Prerenal acute renal failure
 - Most common cause of ARF
 - Caused by impaired renal blood flow
 - GFR declines due to the decrease in filtration pressure

Acute Renal Failure (ARF)

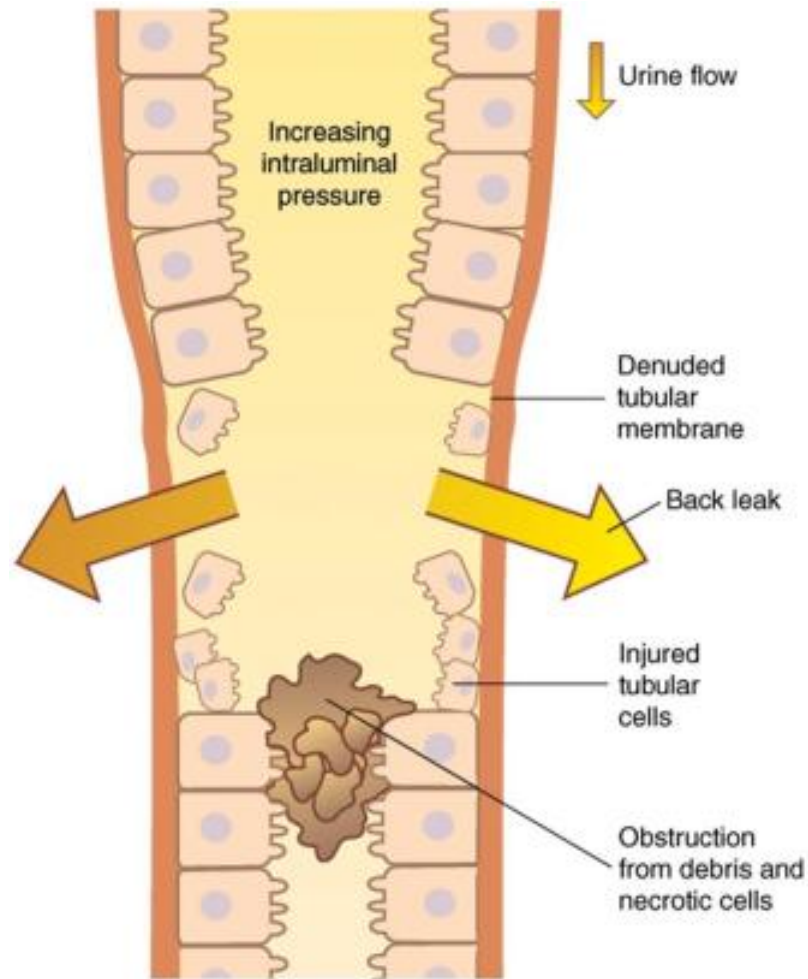
- Intrarenal acute renal failure
 - Acute tubular necrosis (ATN) is the most common cause of intrarenal renal failure
 - Postischemic
 - Nephrotoxic
- Postrenal acute renal failure
 - Occurs with urinary tract obstructions that affect the kidneys bilaterally

Acute Renal Failure (ARF)



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Acute Renal Failure (ARF)



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Acute Renal Failure (ARF)

- Initiation phase
- Maintenance phase
- Recovery phase

Chronic renal failure (CRF)

- Occurs when compensatory mechanisms of the diseased kidneys are no longer able to maintain the EXCRETORY, REGULATORY, and ENDOCRINE functions of the kidneys
- Resultant retention of nitrogenous solutes, derangements of fluid, electrolyte and acid-base balance, and failure of hormone production constitute CRF

Causes of CRF in dogs

- Chronic tubulointerstitial nephritis of unknown cause
- Chronic pyelonephritis
- Chronic glomerulonephritis
- Amyloidosis
- Familial renal diseases
- Hypercalcemic nephropathy
- Chronic obstruction (hydronephrosis)
- Sequel to acute renal disease (e.g., leptospirosis)

CRF may affect 0.5 to 1.0% of the geriatric canine population

Causes of CRF in cats

- Chronic tubulointerstitial nephritis of unknown cause
- Chronic pyelonephritis
- Chronic glomerulonephritis
- Amyloidosis (familial in Abyssinians)
- Polycystic kidney disease (familial in Persians)
- Chronic obstruction (hydronephrosis)
- Sequel to acute renal disease
- Neoplasia (e.g. renal lymphoma)
- Granulomatous interstitial nephritis due to FIP

CRF may affect 1.0 to 3.0% of the geriatric feline population

Causes of CRF in large animals

- Horse

- Chronic glomerulonephritis
- Chronic interstitial nephritis of unknown cause
- Chronic pyelonephritis
- Amyloidosis

- Cow

- Chronic pyelonephritis
- Chronic interstitial nephritis of unknown cause
- Amyloidosis
- Renal infarction due to sepsis
- Renal vein thrombosis
- Leptospirosis
- Renal lymphoma

CHAPTER 7

MALE REPRODUCTIVE SYSTEM

PATHOLOGY

**Dr. Muluken Yayeh (DVM, MSc., Assistant professor of
veterinary pathology)**

Learning objectives

- To know about pathology of male reproductive system.

INTRODUCTION

- The male reproductive system consists of the testes (singular: testis), epididymides (singular: epididymis), prostate and associated tubular structures.
- The morphological and functional competence of the testis and epididymis is under the regulatory control of androgens.
- Mammalian spermatozoa leave the testis for the epididymis and vas deferens. Initially the sperm are immobile and incapable of fertilization.

INTRODUCTION...

- Factors that advance sperm maturity are present in seminal plasma derived from the accessory sex glands.
- The testes perform two major functions that are largely complementary: **the production of sperm** and **the secretion of steroid hormones** (like testosterone).
- The steroid hormones influence the physiologic state of accessory ducts and glands and condition the appearance of the secondary sex characteristics, i.e. the male phenotype.

INTRODUCTION...

- In most mammals, the testes normally descend into the scrotum shortly **before or after birth** and remain permanently in that position.
- The temperature within the scrotum is approximately **2-4°C** lower than that of the abdomen.
- Both the interstitial cells (Leydig cells) and the germinal epithelium are dependent upon lower temperatures for maximum activity.

INTRODUCTION...

- Elevated temperature impairs enzyme systems of the mammalian testes and adversely affects spermatogenesis.
- The pampiniform plexus is a thermoregulator for testicular function and is essential for regulated optimal sperm proliferation.

INTRODUCTION...

INTRODUCTION...

INTRODUCTION...

- **Tunica vaginalis**: This is an extension of the peritoneum into the scrotal sac so anything that affects the peritoneum can affect the tunic vaginalis. Peritonitis can extend down into the scrotum.
- When the tunica vaginalis fills with fluid, it is called **hydrocoele**. Also, because this cavity is continuous with the peritoneum, herniation of abdominal viscera, especially intestines, can happen in the tunica vaginalis.

CRYPTORCHIDISM

- ❖ Retention of testes in the abdominal cavity is called **cryptorchidism**.

Occurrence

- Cryptorchidism is more often seen in horses and swine.

Etiology

- In horses, it is hereditary and caused by a sex- linked dominant factor.

CRYPTORCHIDISM...

- In this case as the abdominal cavity temperature is higher than the scrotal temperature, the testes do not develop normally. Hence, spermatogenesis is arrested.

Clinical signs

- Cryptorchidism may be unilateral or bilateral.
- The horses with this condition sometimes have increased sexual urge and become vicious and difficult to control.

CRYPTORCHIDISM...

Gross pathology

- Testes – small and softer

Histopathology

- The Leydig cells may be normal or hyperplastic.
- The seminiferous tubules lack spermatogenic activity
- The interstitial space has more fibrous tissue

CRYPTORCHIDISM...

CRYPTORCHIDISM...

Sequelae

- If the cryptorchidism is bilateral, the affected animal will be sterile.
- Dogs: Sometimes tumours like seminoma and sertoli cell tumour develop.

HYPOPLASIA OF TESTES

Occurrence

- Hypoplasia of testes is seen in all animals, But it is of greater economic importance in bulls.

Etiology

- In Swedish Highland cattle, it is hereditary.
- Hormonal disturbances
- Vitamin deficiencies
- Some poisons

Gross pathology

- Hypoplastic testes is small and harder

HYPOPLASIA OF TESTES...

Histopathology

- Severe condition
 - o The seminiferous tubules are narrowed and have only one layer of cells which do not show mitotic activity (cessation of spermatogenesis)
 - o The basement membrane is thick and hyalinized
 - o Peritubular connective tissue is increased (Hence the testes is harder)
 - o Leydig cells may be increased in number

Mild condition

- o Varying degrees of spermatogenesis is found and some show giant Spermatids.

CONGESTION IN TESTIS

- Congestion of testis may be seen in heat stroke or systemic infections

CONGESTION IN TESTIS...

HYDROCELE

Definition

- **Hydrocele** is a condition in which clear serous fluid accumulates in the tunica vaginalis.

Etiology

- This condition may be seen along with generalized edema or ascites
- Trauma (Here the fluid may be **turbid** or **blood stained**)

HAEMATOCELE

Definition

- Hematocele means presence of blood in the tunica vaginalis

Etiology

- Trauma
- Haemoperitoneum
- Leptospirosis
- Infectious canine hepatitis

Gross pathology

- Haemolysed blood is seen in the tunica vaginalis in leptospirosis and infectious canine hepatitis.

TESTICULAR DEGENERATION

Definition

- Degeneration of the seminiferous epithelium

Introduction

- This is the commonest type of bull infertility encountered

Occurrence

- Testicular degeneration may be unilateral or bilateral

Predisposing factors

- Failure of thermoregulation due to excess scrotal fat, short cremaster muscle, scrotal / inguinal hernia, periorchitis, edema of scrotum and dermatitis.

TESTICULAR DEGENERATION...

Etiology

- **Physical – Excessive** heat, freezing temperature, trauma, haematoma and laceration of scrotum and radiation
- **Localised / systemic** infection causing fever, toxemia, orchitis, inflammatory changes of tunica vaginalis, scrotum and epididymitis.
- Vascular lesion caused by torsion of testes, spermatic cord compression, testicular biopsy, inflammation of testicular artery (seen in horses caused by migrating strongyl larvae)
- **Artery – thrombus**, hyalinization in arteries lead to testicular degeneration

TESTICULAR DEGENERATION...

- **Obstructive lesion** in the head of epididymis interferes with the flow of spermatozoa and testicular tubular secretions. The back pressure cause degeneration of germinal layers of the seminiferous tubules.
- **Nutritional deficiency** of vitamin - A, phosphorus, protein and energy
- **Toxic substances** like arsenic, metals, cadmium chloride and naphthalene
- **Hormonal imbalance** of FSH and LH and improper administration of hormones
- Auto immunization with auto / isologus spermatozoal materials

TESTICULAR DEGENERATION...

Pathogenesis

- Avitaminosis causes testicular degeneration through inhibition of release of gonodotrophins.
- Cadmium chloride causes lesions in the vascular endothelium resulting in thrombosis
- Radiation affects highly sensitive spermatogonia-B and late spermatogonia –A.
- The testicular degeneration caused by highly chlorinated naphthalene is generally reversible.

TESTICULAR DEGENERATION...

Signs - Clinical Pathology

- *Semen*
 - o Density : Poor
 - o Count : Low
 - o Motility : Less
- Abnormal sperms increase to **30 -50 %**. Head abnormalities like detached heads, variation in size and shape of heads are common.
- Presence of proximal protoplasmic droplets, looped middle piece and tail, tight coils of middle piece and tail are other abnormalities encountered

TESTICULAR DEGENERATION...

Gross Pathology

- Tunica albugenia – Thick, wrinkled
- *Testes* Size may be normal or smaller
 - o Soft and flabby
 - o Do not bulge on cut surface
- *Chronic cases*
 - o Testes - size is smaller; Consistency: Firm
 - o In necrotic area calcium deposits appear as yellowish white flakes.

TESTICULAR DEGENERATION...

Histopathology

- Histological changes vary with severity and stage of degeneration
- The degenerative changes may not involve the tubules uniformly
- The entire length of some tubules may be affected, while in others only partial
- Tunica albuginea is condensed, thick and wrinkled.

TESTICULAR DEGENERATION...

Seminiferous tubules

- o Tubules collapsed, degenerated and degenerated tubules may contain calcium deposits.
- o In acute degeneration deposition of calcium is observed in the connective tissue.
- o Germinal epithelium is denuded leaving the basement membrane exposed
- o In early stages of degeneration, failure of maturation of spermatozoa and degeneration of spermatids occurs. Later spermatids undergo necrosis. Some of these give rise to multinucleate phagocytic giant cells.

TESTICULAR DEGENERATION...

TESTICULAR DEGENERATION...

TESTICULAR DEGENERATION...

- Spermatogonial cells – Cytoplasm is vacuolated;
Nucleus is pyknotic

TESTICULAR DEGENERATION...

- Lastly even the very resistant sertoli cells may be denuded. The tubules then collapse and are replaced by connective tissue
- In the lumen of stenotic tubules, large polyhedral and binucleate cells with granular eosinophilic cytoplasm are observed.

TESTICULAR DEGENERATION...

- These cells are thought to arise from the altered spermatogonia with an unusual capacity to survival.
- In addition, stagnation of spermatozoa and tubular secretions, fragmentation of basement membrane occurs
- Contact of degenerated sperms with the connective tissue causes granulomatous reaction

TESTICULAR DEGENERATION...

Chronic case

- o Sometime tubules are replaced by dense hyaline connective tissue
- o Basement membrane – Thick and hyalinized
- o Interstitial tissue is increased

ORCHITIS

- Inflammation of testis is called orchitis

Introduction

- Since the testes is located compactly in the tunica albuginea, a tough fibroelastic membrane, swelling of the testes to any appreciable degree does not occur.

Occurrence

- Orchitis occurs more frequently in sheep, cattle and swine.

Etiology

- Trauma – This is more common in rams as they have pendulous testes.
- Bacteria – The infection may extend from the lower part i.e. epididymis or may be haematogenous.

ORCHITIS...

The most common bacteria causing orchitis are

- o *Brucella abortus* in bulls
- o *Brucella suis* in boars
- o *Corynebacterium pyogenes*, *Corynebacterium ovis* and *Pasteurella pseudotuberculosis rodentium* in rams
- o *Salmonella abortus equi* in donkeys and stallions
- o *Pseudomonas mallei* in stallions
- o *Mycobacterium tuberculosis*

ORCHITIS...

Clinical signs

Brucella abortus in bulls

- o It is an acute condition
- o The scrotum is swollen, hot and painful
 - Chronic cases
- o Testes is shrunken and hard

ORCHITIS....

Gross pathology

- Inflammatory exudate may accumulate in the tunica vaginalis and scrotum which is responsible for the swelling of the scrotum. The exudate is fibrino purulent and sometimes haemorrhagic.
- Adhesion of the parietal and visceral layers of tunica vaginalis may occur.
- Due to pressure by the exudate and the action of the pathogen, necrosis of the testes occurs with suppuration and abscess formation
- Abscesses may open out on the scrotum

ORCHITIS...

Histopathology

- There is microcyst formation
- Seminiferous epithelium show degeneration and desquamation
- Interstitial tissue is infiltrated with lymphocytes, macrophages and plasma cells
- In suppurative orchitis, there will be a suppurative area filled with neutrophilic exudate.

ORCHITIS....

- The bacteria can be seen in large numbers in the epithelial cells and necrotic areas

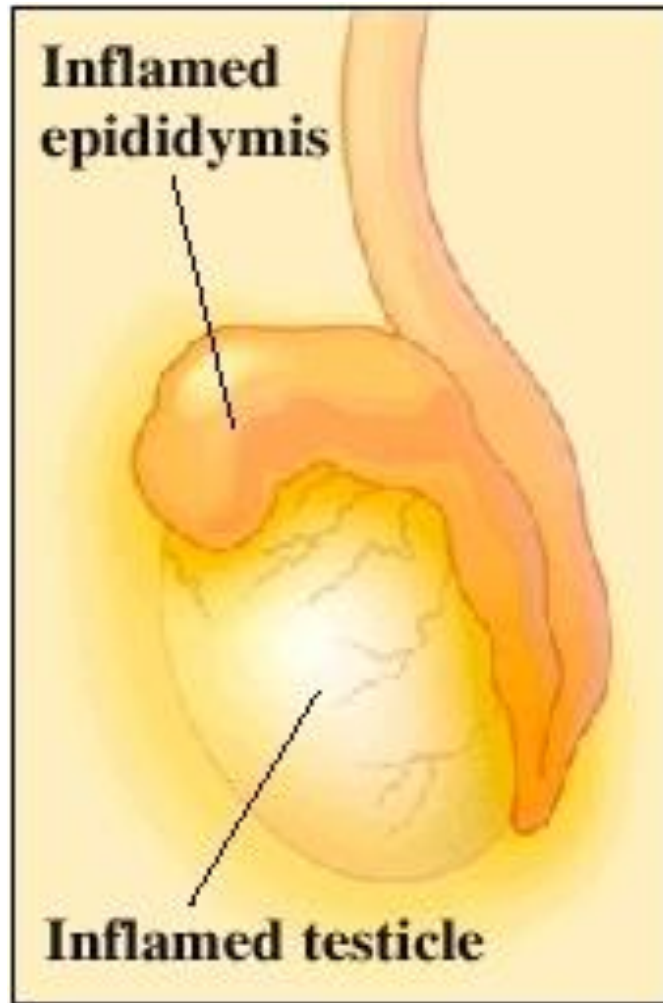
Chronic cases

- o Tubules and intertubular connective tissue contain **military granulomas**
- o Tubular epithelium shows **degenerative changes** and **atrophy**
- o Interstitial tissue has more amount of **fibrous tissue**

Sequelae

- In many cases an accompanying epididymitis is present

ORCHITIS....



EPIDIDYMITIS

Definition

- Inflammation of the epididymis is called epididymitis.

Etiology

- It is usually seen along with orchitis – orchitis may extend into epididymitis
- Bacteria – *Brucella ovis* in rams

EPIDIDYMITIS...

Gross pathology

- In the chronic stage, the epididymis enlarged 3- 4 times and becomes hard
- **Occlusion** of the lumen by the **debris** and **exudate** results in **spermatocyst** formation.
- If the cyst ruptures into tunica vaginalis, a dense adhesion takes place involving the visceral and parietal layers
- No lesion may be seen in testes

EPIDIDYMITIS...

Histopathology

- Usually the tail of epididymis is affected
- Granuloma is formed
- The organism incites an inflammatory reaction at the site of its localization with edema, infiltration with lymphocytes and macrophages. Later neutrophils arrive at the site.

EPIDIDYMITIS...

- The epithelium shows papillary hyperplasia and later hydropic degeneration
- The interstitial tissue shows increased fibrous tissue
 - If there is rupture of spermatocyst, the tunica vaginalis has a foreign body reaction

Sequelae

- Due to stasis of sperms, secondary degenerative changes with calcification may occur in the seminiferous tubules.

PATHOLOGY OF SPERMATIC CORD

Funiculitis

Definition

- o Inflammation of the spermatic cord is called funiculitis

Occurrence

- o Common in pigs due to contamination of the castrated wound

Etiology

- o Physical injury caused during castration
- o Contamination of the castrated wound with bacteria -

Staphylococcus aureus

Funiculitis...

Types

- o Acute and necrotizing in pigs
- o Chronic (Scirrhus cord) in horses and cattle

Histopathology

- o There is excessive formation of granulation tissue at the site of castration wound.
- o Abscesses with thick walls may be present in this tissue (Botriomycosis). Centre has granules (colonies of bacteria) surrounded by zone of club and inflammatory cells (Leucocytic infiltration).

Funiculitis...

- In the horse, testes and spermatic cord has verminous granulomas caused by larvae of *Strongylus spp* may be found occasionally.

PATHOLOGY OF SEMINAL VESICLE

Growth Disturbances

Segmental aplasia of ampulla and seminal vesicles

- o This usually occurs in association with segmental defects of the epididymis.

Duplication of seminal vesicles

- o It may occur unilaterally or bilaterally

Seminal Vesiculitis

Definition

- o Inflammation of the seminal vesicle is called **seminal vesiculitis**

Introduction

- o If it occurs in bulls used for artificial insemination, it is of serious concern as the pathogenic organisms can be transmitted to a wide population.

Occurrence

- o Rare.

Seminal Vesiculitis...

Etiology

- o Bacteria – *Brucella abortus*, *Corynebacterium pyogenes* and *Mycoplasma*

Gross pathology

o Seminal vesicle

- In most of the acute stages it is enlarged and tender on palpation. There is a tendency for loss of lobulation.

Seminal Vesiculitis...

- If it is not enlarged, massage the vesicles and stripping of the ampullae will force the inflammatory cells into the urethra and the exudate will drib from the penis.
- Semen collected following this procedure has marked increase in leucocytes and there may be clumping of the exudate and the sample will have the appearance of the curdled milk.

Seminal Vesiculitis...

Histopathology

o Acute stage

- Alveoli and interstitial tissue are infiltrated with neutrophils

o Chronic stage

- Interstitial tissue is infiltrated with lymphocytes, plasma cells and macrophages.

PATHOLOGY OF PROSTATE

Hyperplasia / Hypertrophy of prostate

Animals affected

- Dogs

Occurrence

- Dogs above five years old and house-bred are commonly affected

Etiology

- Urinary retention in household dogs
- Increased testosterone level in dogs

Hyperplasia / Hypertrophy of prostate...

Clinical signs

- Due to pressure on the rectum by the enlarged prostate constipation may be produced.
- Difficulty in micturition is attributed not to the pressure on or narrowing of urethral lumen, but to paresis of the bladder resulting from pressure of the enlarged gland on the parasympathetic nerves.

Hyperplasia / Hypertrophy of prostate...

Gross pathology

- Prostate
 - o Enlarged and sometimes the bilobed appearance of the gland is lost
 - o The surface may be smooth, nodular or cystic

Hyperplasia / Hypertrophy of prostate...

Histopathology

- The microscopic picture resembles that of hyperplastic adenoma
- Acinar cells are increased both in number and size.
- The epithelium is tall and is frequently thrown into folds as papillary projections into the lumen.

Hyperplasia / Hypertrophy of prostate...

- Some acini may be cystic with increased amount of secretion which presses upon the epithelium, flattening it.
- The interlobular connective tissue may be increased.
- There is always infiltration of lymphocytes and plasma cells in the interstitial tissue.
- Bladder may show compensatory muscular hypertrophy.

Hyperplasia / Hypertrophy of prostate...



Normal Prostate



Enlarged Prostate

PATHOLOGY OF PENIS AND PREPUCE

Definition

- Inflammation of glans penis is called balanitis
- Inflammation of the prepuce is called posthitis
Usually both occur together as balanoposthitis
- Occurrence
- In the dog, it is common condition.

balanoposthitis

Etiology

- In the dog, the cause may be trauma or bacteria.
- In other animals, balanoposthitis is associated with various organisms including *Pseudomonas aeruginosa*; *Corynebacterium pyogenes* and *C.renale*.
- This condition is also met with in bulls that cross cow suffering from “Infectious pustular vulvovaginitis”:

balanoposthitis

Gross pathology

- There is **catarrhal exudate**
- Mucosal **lymph follicles** may be enlarged.
- In the bulls (known as **infectious pustular balanoposthitis**) pustules form on the preputial lining and glans penis, giving them a granular appearance. Infection does not extend into urethra.
- **Edema** of penis and prepuce may cause paraphimosis.

Histopathology

- There is catarrhal exudate with infiltration of leucocytes into the degenerated epithelium.

Phimosis

Definition

- o It is a condition in which the penis cannot be extended from the **prepuce**, due to inflammatory swelling.

Paraphimosis

Definition

- o It is a condition in which **extended penis** due to inflammatory enlargement, cannot be withdrawn into the prepuce.

Neoplasms

- In the bull, transmissible fibro papilloma is encountered. These are multiple and cauliflowerlike.
- In the horse squamous cell carcinoma may be wet with
- In the dog transmissible venereal tumor is common.

Thank you

FEMALE REPRODUCTIVE SYSTEM-I PATHOLOGY

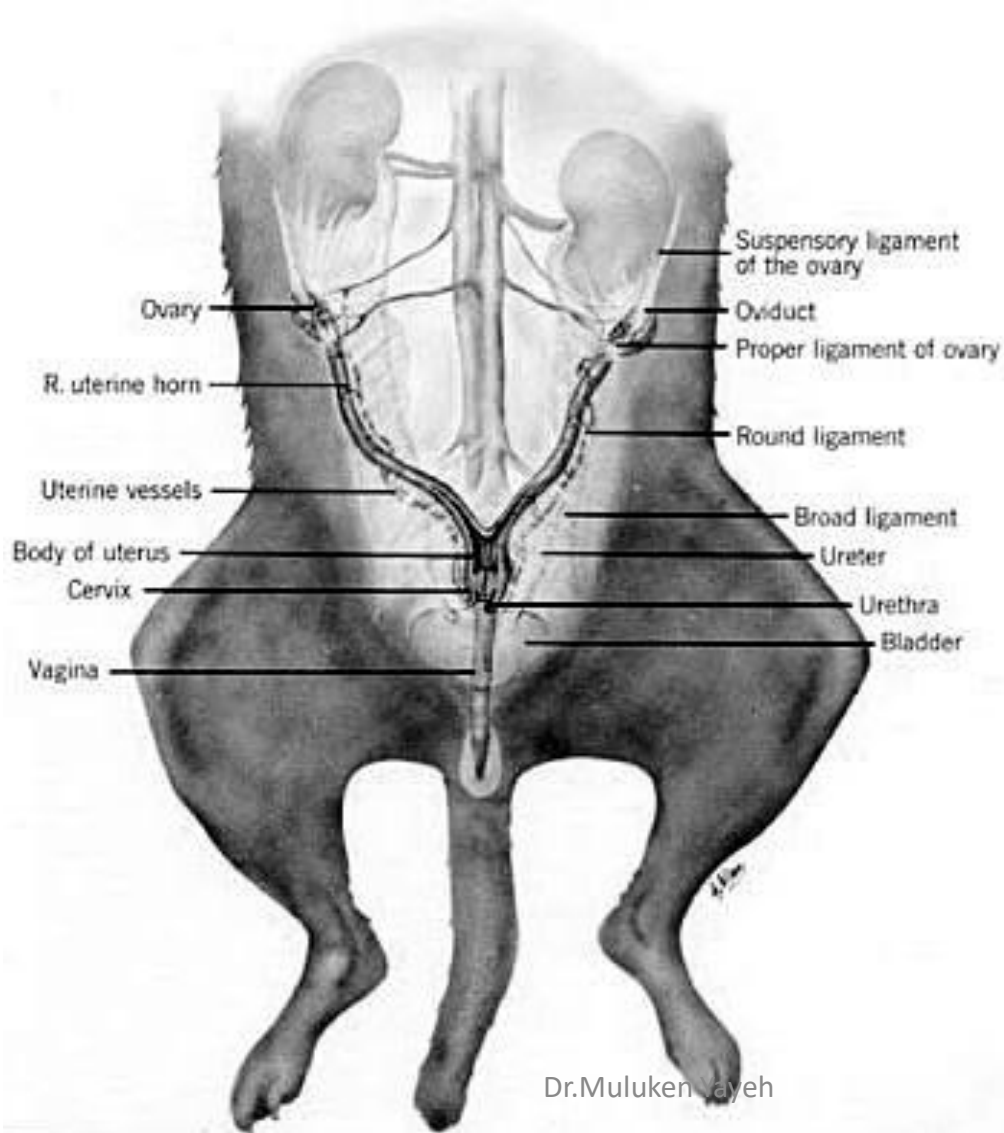
Learning objectives

- ❖ To know about developmental anomalies of the reproductive system and pathology of the ovary.

INTRODUCTION....

- The reproductive system in veterinary medicine is fairly complicated.
- The differences in the reproductive system between the sexes and among species are complex.
- The temporal and physiologic features of the reproductive cycle vary greatly among species. And, with pregnancy,
- No other organ system goes through as many dramatic changes in a short period of time.

INTRODUCTION



INTRODUCTION...

- At a minimum, the reproductive system consists of the gonads (testes or ovaries), and a duct system to the external environment.
- The gonads produce the gametes (sperm or ova) needed for sexual reproduction.
- The duct system varies in function depending on sex and species.

INTRODUCTION...

- There are 3 different components to sexual differentiation:
 1. **Chromosomal sex** (=genetic sex) is normally determined at fertilization by the formation of either an XY or XX zygote. XX are genetic females and XY are genetic males.

INTRODUCTION...

- 2. Gonadal sex** means - does the embryo take those rudimentary non-gender gonads and turn them into testes or ovaries
- The Y chromosome has an SRY (Sex-Determining Region on the Y chromosome) gene that codes for Testis-Determining Factor (TDF) and that is what urges the primordial genderless gonad to become a testis.
 - Without TDF that primordial sex-less gonad eventually goes female (ovary).

3. Phenotypic sex - does it LOOK like a male or a female? Phenotypic sex is determined by the male gonad (or absence there).

- Testicular tissue secretes **Müllerian duct inhibitory substance (MIS)** that causes the Müllerian ducts to regress and the **Wolffian ducts** to continue development, into the vas deferens and epididymis.
- Then testosterone from the Leydig cells of the testis helps with all the other features of being male. Without testes **producing MIS or testosterone**, the Müllerian ducts continue to develop into uterus and oviducts and the Wolffian ducts regress.

DEVELOPMENTAL ANOMALIES

FREEMARTIN

Definition

- The bovine freemartin is a genetic female born cotwin with a normal male with which it has exchanged whole blood.

Pathogenesis

- The structural modifications of female genitalia are under the influence of **androgenic hormones** produced by the male foetus.

FREEMARTIN...

Gross pathology

- The gonads are undifferentiated.
- The mullerian duct system is not differentiated fully.
- Ovaries are small.
- There are usually portions of tubular system.
- The uterus is small and incomplete.
- The cervix is usually absent.
- The vagina is fairly developed

FREEMARTIN...

- The clitoris is quite prominent.
- ❖ One feature of the reproductive tract, which is very useful in distinguishing this condition from severe cases of aplasia of Mullerian ducts is the presence of seminal vesicles.

FREEMARTIN...

Histopathology

- The histologic appearance of the gonad is one of a quite undifferentiated structure.
- There are small tubular structures resembling primitive seminiferous tubules with lining cells similar to the sertoli cells.

FREEMARTIN...

- In the freemartin which is allowed to live the age of one or more years, the interstitial cells develop and resemble luteal cells in the ovary or Leydig cells of the testis.
- In the older animals, these develop into multiple large masses of orange or tan colored masses which resemble both interstitial cell tumor or corpora lutea on gross examination.
- Most freemartins do not develop ovarian follicles.

FREEMARTIN...

- The seminal vesicles are usually small and have abundant fibrous stroma.
- The epithelium resembles that of seminal vesicles of a castrated bull.
- Endometrial glands are present and produce fluid resulting in cystic distension of vestigial remnants.

INTER SEXES

Definition

- The intersex is an individual with congenital abnormality, where the diagnosis of the sex is confused.

Occurrence

- Intersexes are common in pigs but not to the same degree as in goats. In bovines, intersex seems to be a rare condition.

INTER SEXES...

Types

- Intersexes may be of two types
 - **True hermaphrodites** in which gonads of both sexes are present
 - **Pseudo-hermaphrodites** have gonads of only one sex but has reproductive organs with some characteristics of the opposite sex.
- Such animals are classified as male and female pseudohermaphrodites depending on the gonads present.

UTERUS DIDELPHYS

- Uterus didelphys is the occurrence of two cervix with two uterine bodies and a single or double vagina.
- It occurs due to failure of mullarian ducts to fuse at their distal end.
- The failure of fusion may affect only cervix and there is two cervix which is termed as **cervix bifida**.

PHYSIOLOGICAL CONSIDERATIONS

- The ovary is under the control of anterior pituitary through two hormones, Follicle Stimulating hormone (FSH, and the Luteinising hormone (L H).
- Hence any pituitary endocrine disturbance affecting the gonadotropin levels affect the ovaries also

- Placenta also elaborates certain hormones which have considerable effect on the ovarian function.
- Ovary produces two hormones, estrogen and progesterone, which have very important functions on the development of tubular female genital organs and control of estrus cycles.

APLASIA OR ABSENCE OF OVARIES

- Aplasia or absence of ovaries is occasionally seen, especially in swine and sheep.

Hypoplasia of the ovary

Occurrence

- o Both ovaries may be affected, or sometimes only a single ovary or a part of the ovary may be affected.

Etiology

- o In the Swedish highland breed of cattle, hypoplasia is determined to have been caused by a single recessive autosomal gene.

Pathogenesis

- o Hypoplasia of the ovary occurs due to the failure of migration of primordial germ cells from the yolk sac to the developing gonad during embryonic stage.
- o Thus the ovary becomes devoid of germinal epithelium, which is the precursor for the follicular system.

Gross pathology

- o The ovaries are small and rudimentary in the form of a thin band with wrinkled rough and irregular surface similar to that of new born calves.

Histopathology

- o Tunica albuginea is thick and covered by low cuboidal epithelium.
- o Follicles are completely absent.
- o In ovarian hypoplasia, the ovary consists of predominantly medullary tissue.
- o The stroma is dense and made up of thick fibrous tissue with several anovular cords of Type I and Type II, blood vessels and rete tubules.

Hemorrhage

- Hemorrhage in the ovary occurs in the following conditions
 - ❖ During ovulation
 - ❖ While enucleating corpus luteum manually in the cow

CONGESTION OF OVARY

- Congestion of ovary may be seen in heat storke and systemic infections.

OOPHORITIS

Definition

- Oophoritis means inflammation of the ovary caused by trauma and infection

Occurrence

- It is rare in animals.

Ethiology

- Mycobacterium tuberculosis
- Herpes virus

Pathogenesis

- It is usually the result of an ascending infection from the oviduct or uterus.

OOPHORITIS...

Macroscopic and microscopic features

- Hard nodular lesions in ovary, encapsulated with fibrous tissue
- Granuloma of tuberculosis through hematogenous infection
- Infiltration of lymphocytes leading to lymphofollicular reaction in follicles

CYSTIC OVARIES

Etiology

- Endocrine disturbance is the main cause

Occurrence

- Cysts of the ovary are more frequent in the cows, sows and mares.
- Cysts are found in high milk yielding cows more frequently

CYSTIC OVARIES...

Macroscopic and microscopic features

- Presence of cyst in the ovaries
- Hormonal imbalance of animals leads to sterility, continuous estrus, nymphomania due to follicular cyst
- ❖ **Lutein cysts** may cause pyometra leading to pseudopregnancy
- ❖ **Follicular cyst**
 - Ova absent several layers of granulosa or a single layer of epithelium
 - Many follicular cysts are present
 - Lutein cysts covered by fat containing granulosa cell

REPRODUCTIVE SYSTEM-II

Learning objectives

- To know about Pathology of oviduct and Uterus-I

PATHOLOGY OF THE FALLOPIAN TUBES

Occurrence

- The diseases of the fallopian tubes (oviducts) are not common in animals.

Sequelae

- Affections of the oviduct are of importance since the ovum is transported to the uterus via these tubes and any disease of the tubes, therefore, will interfere with pregnancy and reproduction.

Malformations

- Absence of fallopian tubes or segmental aplasia may be met with.
- Accessory tubes, reduplication of the tubes are other malformations seen.
- These conditions are more important in the cow and sow.

HYDROSALPINX

Definition

- Hydrosalpinx denotes a cystic dilatation of a part of the oviduct, containing clear fluid.

Occurrence

- Hydrosalpinx is more important in the cow and sow.
- It may affect one or both the tubes.

Etiology

- This condition arises due to some obstruction in the oviduct and is usually a result of salpingitis in which, occlusion of the lumen may arise.

SALPINGITIS

- Salpingitis is the inflammation of oviduct or fallopian tube characterized by congestion, catarrhal or purulent exudates leading to distended lumen.

Introduction

- This is the most common disease of the oviduct and is usually not diagnosed while the animal is alive.
- This is of great economic importance since salpingitis is one of the causes of sterility.

SALPINGITIS....

Etiology

- The organisms that are incriminated in causing salpingitis are
 - o *Streptococcus viridans*
 - o *Staphylococcus aureus*
 - o *Mycobacterium tuberculosis and*
 - o *Brucella suis.*

SALPINGITIS...

Epizootiology

- The organisms may enter the oviduct
 - By way of the blood stream – in generalised infection as in tuberculosis.
 - Through the ostium abdominale – spread of peritonitis (descending)
 - Through the ostium uterinum – extension of endometritis (ascending)
- Sometimes irritants may be introduced by uterine insufflations or surgical operations.

SALPINGITIS...

Macroscopic and microscopic features.

- Congestion abscess formation
- Distention of oviduct lumen due to accumulation of serous exudate which is known as hydrosalpinx.
- Accumulation of pus in the oviduct is termed as pyosalpinx
- Fibrosis and hardness
- Occlusion of lumen due to inflammatory exudates resulting in sterility

SALPINGITIS...

- Inflammatory exudates is toxic to ova as well as sperms leading to sterility
- Suppurative inflammation
- Infiltration of neutrophils, macrophages and lymphocytes
- Proliferation of fibrous tissue
- Debris of desquamated cells

SALPINGITIS...

Sequelae

- The mucosa of the fallopian tubes does not possess much of regenerative capacity and so when once the epithelium is lost it is not substituted.

Sterility occurs in salpingitis for the following reasons:

- o The exudate or proliferating cells may occlude the lumen of the tubes.
- o The inflammatory exudate is toxic to the spermatozoa, causing their death.
- o The ciliated epithelium and contractile muscle necessary for transport of ovum is destroyed, preventing the movement of the ova to the uterus.
- o Fibrosis in chronic salpingitis may cause occlusive stenosis.

PYOSALPINX

- ❖ Pyosalpinx is an acute or chronic suppurative inflammation of the oviduct.

Etiology

- It occurs in suppurative salpingitis, which is usually a sequel to suppurative metritis.

Pathogenesis

- Pus accumulates in some segments of the tube due to occlusion of the lumen in certain places by inspissated exudate or inflammatory thickening or by chronic granulation tissue.

PYOSALPINX...

Histopathology

- The wall of the oviduct is infiltrated by neutrophils, lymphocytes and plasma cells which are also found in the exudate that collects in the lumen
- Metaplasia of the epithelium to squamous variety is common.

Sequelae

- Pyosalpinx invariably ends in sterility.

RUPTURE OF THE UTERUS

Etiology

- Rupture of the uterus may occur during parturition due to violent contractions or due to obstetrical manipulation during dystocia.
- Rupture may occur in prolonged dystocia and torsion due to weakening of the wall.
- Another rare cause may be over distension of the uterus with introduced fluids.

RUPTURE OF THE UTERUS.....

Sequelae

- Rupture may involve only the mucosa in which case healing will occur.
- If the whole wall of the uterus is involved, death may supervene, due to hemorrhage (or)
- inflammation of the uterus spreading to the peritoneum (or) entry of the placenta into the abdominal cavity.

MALPOSITIONS

Torsion of the uterus

- This condition is seen in all species, but is most common in cattle. Cattle have a well developed intercornual (between the two horns) ligament so when one horn twists, the whole uterus twists.
- It is most often secondary to pregnancy, hydrometra, or pyometra,

Torsion of the uterus...

- Multiparous species without an intercornual ligament (dog, cat) may have only one horn or part of a horn twist.

Gross pathology

- o The veins of the broad ligament and ovarian ligaments are compressed while acute hyperemia occurs in the arterie

MALPOSITIONS...

Sequelae

- o As the cervix is tightly closed in the twist, parturition cannot take place unless the disorder is corrected.
- o Minor twists are self corrected.
- o The uterus is liable to rupture easily in this condition as the walls become weakened and friable.
- o If the condition is not corrected the dam will die of gangrene, sepsis and peritonitis.

PROLAPSE OF THE UTERUS

Occurrence

- o Prolapse of the uterus through the vulva is most common in the cows, but may also be seen in other animals.

Etiology

- o It may be due to strong uterine contractions for expelling the fetus, the placenta or the exudate.

PROLAPSE OF THE UTERUS...

Predisposing causes

- o Forced traction during dystocia, post-parturient hypocalcemia and retained placenta are the predisposing causes.

Gross lesions

- o The prolapsed uterus may be enlarged, edematous, congested and haemorrhagic

PROLAPSE OF THE UTERUS...

Prolapsed uterus



Total uterine prolapse - Cow

PROLAPSE OF THE UTERUS...



PROLAPSE OF THE UTERUS...

Sequelae

- o The sequelae are similar to those found in intussusceptions viz. acute congestion, hemorrhage, necrosis, infection, gangrene and death
- o Sows and poultry may injure everted uterus.

CIRCULATORY DISTURBANCE

Hyperemia and edema of the endometrium

- Physiological hyperemia and edema of the endometrium are found during estrus.
- Acute hyperemia is present in metritis.
- Chronic general venous congestion is found with cardiac and pulmonary lesions hindering normal blood flow through these organs.

CIRCULATORY DISTURBANCE...

Hemorrhage

Physiological

- o Haemorrhage occurs during estrus, analogous to the menstrual discharge.
- o This is more often found in heifers and bitches.
- o The source of the blood is capillaries of the endometrium.
- o Ecchymoses on the serosa and musculature are normal in heifers during estrus.

CIRCULATORY DISTURBANCE...

Pathological

- o Hemorrhage can occur during parturition and dystocia. One of the common causes is manual intervention in dystocia when rupture of the uterus with hemorrhage may take place.
- o Hemorrhage from the arteries of the broad ligament, especially in the sow, is a surgical hazard during cesarean operation, if too much traction is applied on the uterus.

CIRCULATORY DISTURBANCE...

- o Torsion of the uterus as well as prolapse may be responsible for hemorrhages.
- o Lastly, massive hemorrhages may be met with in cattle in sweet clover poisoning.
- o In dogs metrorrhagia may be the result of hormonal disturbances. There may be severe lowering of FSH.

Thrombosis of the uterine vein

- Thrombosis of the uterine vein may be observed in septic metritis, torsion or prolapse.
- The affected veins are dilated and tortuous and do not collapse at death.

DISTURBANCES OF GROWTH OF UTERUS...

Atrophy of uterus

Etiology

- o Atrophy of the uterus may occur in the following conditions
 - ❖ Senility
 - ❖ Oophorectomy after a normal full growth of uterus is attained.
 - ❖ Hypopituitarism due to
 - ❖ wasting disease
 - ❖ primary lesion of the pituitary.

Hypoplasia of uterus

Etiology

- o Hypoplasia may be observed in
 - ❖ Nutritional deficiency
 - ❖ oophorectomised young animals

Gross pathology

- o The uteri of affected animals may not attain full size.

Hyperplasia of uterus

Synonym

- o It is also known as cystic hyperplasia of the endometrium.

Occurrence

- o Hyperplasia of the endometrium is observed in all species of animals but is more often met with in the dog.

Etiology

- o Hyperplasia of endometrium occurs due to increased estrogen or progesterone secretion.

Hyperplasia of uterus...

Gross pathology

o Macroscopically

- Endometrium of both the horns contains cysts of different sizes of microscopic to as big as 5 mm in diameter.
- The cysts may completely fill the lumen giving it a “swiss-cheese” appearance.
- They contain clear fluid

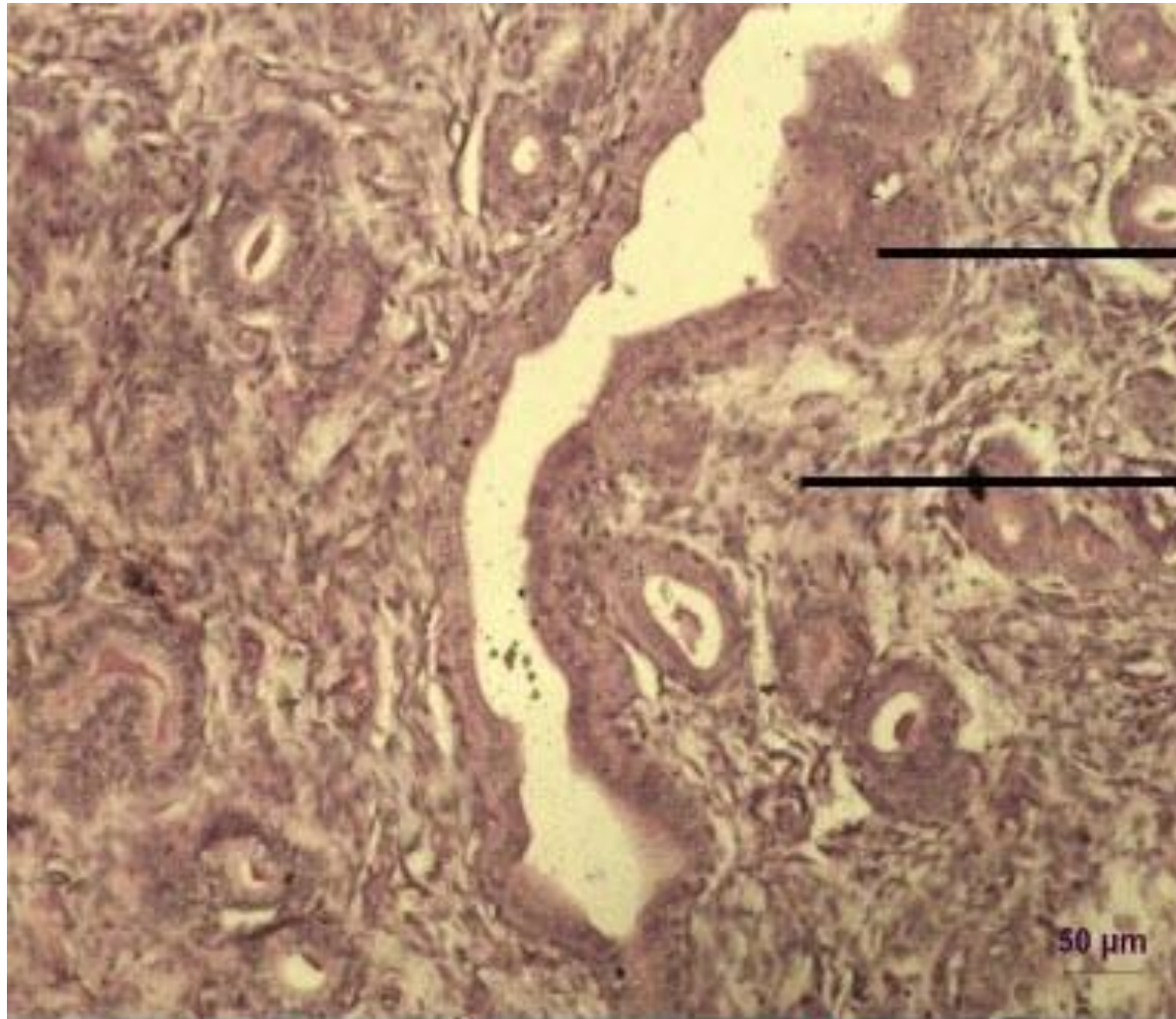
Hyperplasia of uterus...

Histopathology

o Microscopically,

- The endometrium may show thickening due to polypoid proliferation.
- Hyperplasia may involve the surface epithelium or glandular apithelium.

Hyperplasia of uterus...



Hyperplastic epithelium

Endometrium

50 μm

Hyperplasia of uterus...

- No inflammatory changes may be present in the uncomplicated cases but only cyst formation of the glands which are increased in number and irregularly distributed unlike the normal orderly arrangement may be seen.
- The cysts contain a single layer of epithelium enclosing clear watery fluid.
- In some animals, there may be plasma cell infiltration of the lamina propria.
- In those animals in which infection has taken place, there will be neutrophilic infiltration of the lamina propria

Hyperplasia of uterus...

Clinical features

- o Abnormal uterine bleeding.
- o Disturbances in estrus cycle
 - irregularity
 - longer or short duration
 - diminished or enhanced characteristics of the different phases.
- o Sterility
- o Abortion
- o Prolonged lactation
- o Development of secondary infection, characterized by high leucocytic count with a shift to the left.

THANK YOU !!

REPRODUCTIVE SYSTEM-III

Learning objectives

- To know about pathology of uterus-II, cervix, vagina and vulva

INFLAMMATION OF THE UTERUS

- If the inflammation is restricted to the endometrium of the uterus alone then the condition is known as **endometritis**.
- On the other hand, if the whole thickness of the wall is involved **metritis** is the term used.
- Metritis is inflammation of the uterus and is found in all animals.
- Inflammation of the serosa is known as **perimetritis** .

METERITIS

- **Meteritis** is inflammation of uterus characterized by suppurative exudate, hemorrhage and necrosis of uterus
- Depending upon the virulence and nature of the organisms, metritis may be **acute catarrhal**, **acute suppurative** and **chronic suppurative**.
- More severe forms of inflammation invariably involve all the layers of the wall

Macroscopic and microscopic features

- Congestion, catarrhal or purulent exudates
- Hemorrhage
- Enlargement ,oedema
- Oozing out pus from uterus on pressure
- Seropurulent exudates in uterine wall
- Infiltration of macrophages and lymphocytes
- Desquamation of lining epithelium

Etiology

- *Actinomyces pyogenes*
- *E.coli*
- Staphylococci
- Streptococci
- *Tricomonas Foetus*
- *Camphylobacter foetus*

ENDOMETRITIS

Endometritis is the inflammation of endometrium, the mucosa of uterus . It may be catarrhal or purulent and may occur after metritis

Etiology

- Tricomonas foetus
- Campylobacter foetus
- Staphylococci
- Streptococci
- Organism that enters in uterus as a result of coitus, artificial insemination or as iatrogenic infections
- Strong chemicals/medicines administered in uterus

Macroscopic and microscopic features

- Catarrhal discharge from uterus containing desquamated cells
- Sterility due to toxic environment of uterus to sperms
- Congestion
- Moderate infiltration of lymphocytes, plasma cells, and neutrophils in mucosa

MUCOMETRA / HYDROMETRA

- The two conditions are considered together as the difference is probably only in physical
- properties and depends on the degree of hydration of mucin, which in turn may be related to the relative activity of estrogenic hormone.

Gross pathology

- The accumulation of thin or viscid fluid in the uterus is concurrent with the development of
- endometrial hyperplasia or is proximal to an obstruction of the lumen of the uterus, cervix or vagina.
- In the first instance the amount of the fluid may be several liters and the greater the volume of the fluid the less viscous it is. Small amounts of mucin give the mucosal surface a gummy stickiness.

- In the second instance, that of obstruction to the lumen, the volume of fluid depends on the site of obstruction. The fluid is slightly cloudy and watery.
- In cows with cystic ovaries, the large volume of fluid is usually associated with functional cysts of the follicles.

Sequelae

- An abnormally long and tortuous cervix may result in a form of mucometra caused by the retention of uterine secretion.
- Animals with mucometra are sterile.

- If affected uterus becomes infected, an difficult pyometra results.

Histopathology

- Microscopically,
 - The endometrium is thin and lined by a single layer of cuboidal to low columnar cells.
 - The uterine glands are reduced in number.
 - The endometrial stroma is edematous.

MUMMIFICATION OF FETUS

Aborted fetus becomes shrunken with dried and wrinkled skin

Occurrence

Mummification of a dead fetus is seen occasionally in any, but usually in multiparous species and most commonly in the cow.

- In the mare it is typically one of twin fetuses which is mummified.

Pathogenesis

- A prerequisite for mummification is the absence of infection unlike in maceration.
- The fluids are reabsorbed and the membranes become closely applied to the desiccated fetus.
- The time required for complete mummification depends on the size of the fetus but probably requires as long as 6 to 8 months.

Gross pathology

- The whole fetus becomes brown or black and rather leathery, moist on the surface with sticky mucus without odour.

Sequelae

- In uniparous animals, the mummified fetus is usually retained indefinitely or if aborted may only be delivered into vagina.
- In the case of multiparous animals, it may be delivered along with viable fetuses.
- Animals which had and recovered from mummified fetus usually breed normally on subsequent occasion.

Mummification => “Dried up”



MACERATION OF FETUS

- If the foetus *in utero* is infected it may be softened by the toxic products liberated by the infecting organisms, then it is called as maceration of foetus.

Pathogenesis

- Maceration of foetus depends on the presence of infection in the uterus

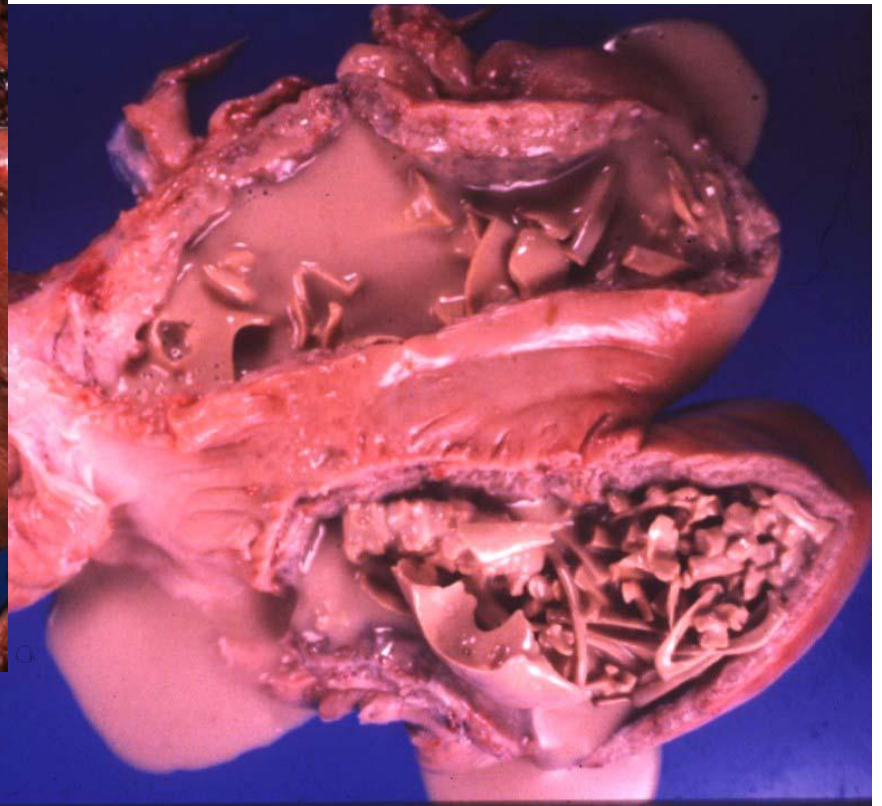
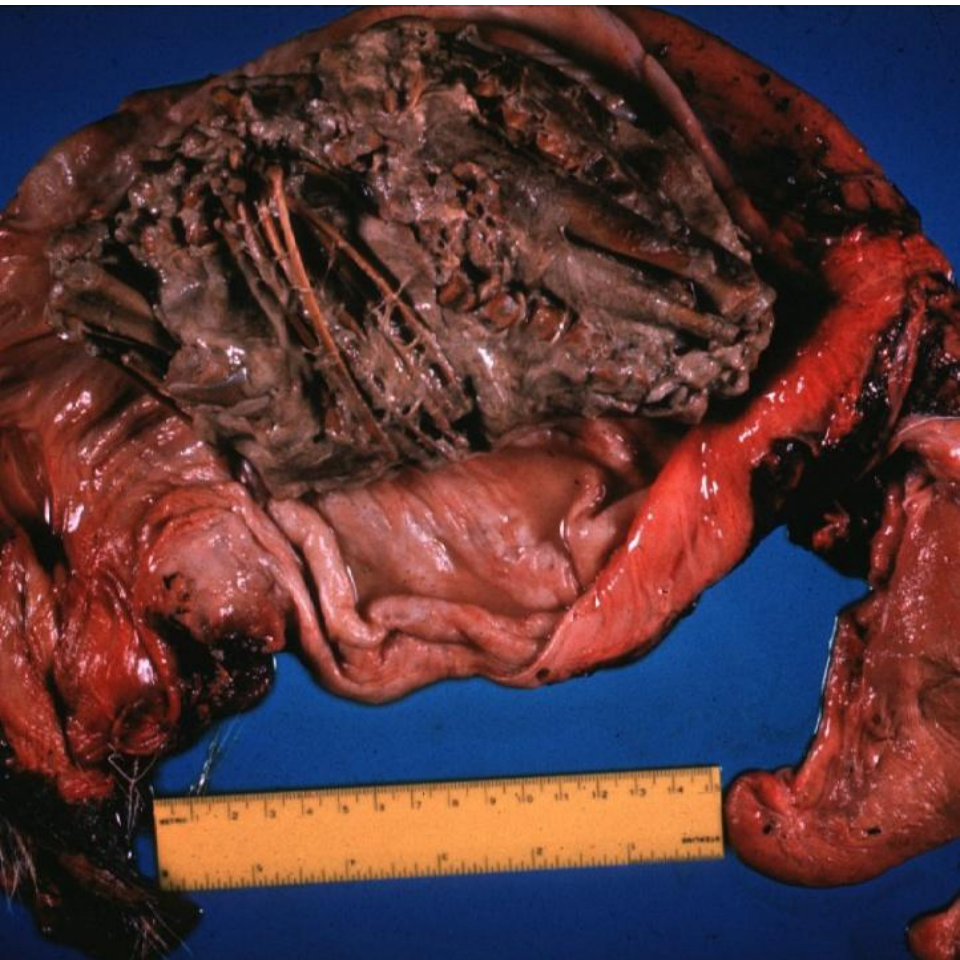
Sequelae

- If the early embryo succumb to uterine or embryonic infection maceration is usually followed by resorption from the uterus or expulsion along with a small amount of purulent discharge.
- If the fetus is about three months, complete foetal maceration does not occur and bones resist maceration. These may be discharged or be retained in the pus of pyometra indefinitely, often near the cervix

Histopathology

- Advanced uterine lesions accompany the macerated foetus.
- The uterine wall is thickened and the reaction within it varies from the acute exudative
- inflammation of pyometra to more or less complete sclerosis and replacement by granulation tissue in long standing cases.

Maceration => “Chewed up”



NEOPLASMS OF THE UTERUS

- In the domestic animals neoplasms are not common
- The most common uterine tumor is the lymphosarcoma, a local manifestation of a generalized condition. In the uterus the neoplastic cells may aggregate as nodules or may diffusely infiltrate the organ.

MALFORMATIONS

- Malformations occur more frequently in the cervix than in other parts of the reproductive tract.

Duplication of cervix/cervix bifida/

- Varying degrees of persistence of the median wall of the Mullerian ducts which are destined to develop into cervix result in the formation of a complete or partial duplication of cervix.
- Incomplete double cervix occurs much more frequently than a complete duplication and usually involves the portion of the cervix adjacent to vagina

Sequelae

- o In the case of both incomplete and complete double cervix, if the insemination is done pregnancy may occur but it may result in dystocia.

Absence of external os

- Absence of external os may be commonly encountered.
- In this case, the expulsion of uterine secretions cannot occur resulting in accumulation of fluids in uterine horns leading to hydrometra.

Double external os

- o This is the presence of a dorso-ventral band adjacent to external cervical os giving an impression as though two cervical openings are there.

Etiology

- o This condition is inherited and conditioned by a single recessive gene with low penetrance.

Sequelae

- o It may not interfere with conception or pregnancy but may cause dystocia occasionally.
- o The fetal membranes may be caught on this dorso-ventral band.

Hypoplasia of cervix

- o The cervix will be very small and there may be deficiency in number of cervical rings.

Sequelae

- o Hypoplastic cervix is usually defective in protecting the uterus against bacterial invasion from vagina.

Tortuosity of cervical canal

o Here the cervix may be kinked or tortuous.

Sequelae

- o In the S-shaped kink of cervix, insemination pipette cannot be inserted into cervix.
- o Extreme degrees of tortuosity of the cervical canal may cause of infertility in heifers.

Cervical dilatation and diverticula

Definition

- o Dilatation and diverticula usually occur in heifers at the level of third and fourth cervical rings.

Sequelae

- o The cervical canal is usually very small anterior to the defect so it is difficult to insert insemination pipette.
- o With age tenacious mucus tends to accumulate in the area of the defects.

Prolapse of cervical rings

Definition

- o Here the first and sometimes the second cervical rings protrude into the vagina.

Occurrence

- o It is a condition which usually develops with age

Etiology

- o Repeated parturition.

○ Lacerations and hemorrhages which occur during parturition

Sequela

○ It results in the formation of excess fibrous stromal tissue, enlargement of cervical rings, vascular defects and occasionally squamous metaplasia of the affected rings.

CERVICITIS

Definition

- It is the inflammation of the cervix

Etiology

The causes include

o Mechanical injuries

during parturition

copulation and

phooka – criminal stimulation of the vagina or os for higher milk yield.

- Diseases of uterus and vagina: Cervicitis, always occurs whenever metritis or vaginitis is present, since cervix is located between these two.
- The cervicitis normally follows abnormal parturition such as abortion, premature birth, dystocia, retained placenta, post partum metritis, and vaginitis.
- The organisms responsible for cervicitis are the same as those of metritis.

DEVELOPMENTAL ABNORMALITIES

Double vagina

- It is due to persistent median septum along the vaginal passage.
- Median vertical bands
- Median vertical bands connecting the floor with the roof of vagina at the hymenal border is more common.

DEVELOPMENTAL ABNORMALITIES

RUPTURE OF VAGINA

Etiology

- Rupture of vagina may occur during parturition or during coitus (especially in sows).
- Sequelae
 - Infection of the rupture may lead to abscess, gangrene and peritonitis

VAGINITIS AND VULVITIS

Etiology

- Causes include physical trauma, chemical, nutritional deficiencies, bacterial and viral agents that are the same as for metritis and abortion.

Gross pathology

- Appearances are similar to those of inflammations of other mucous membranes.

Granula Vaginitis

Synonym

- o It is otherwise called nodular venereal disease.

Etiology

- o The causative agent is not clearly established, many organisms have been listed: hemophilus, pleomorphic rods and viruses.

Occurrence

- o The incidence of the disease is highest in naturally served herds.

VESICULAR VENEREAL DISEASE

Synonyms

- Vesicular vaginitis
- Coital exanthema

Etiology

- The cause is supposed to be a virus, which is considered to be the same causing infectious bovine rhinotracheitis and infectious keratoconjunctivitis in cattle, an epitheliotropic virus.

Transmission

- This is a highly contagious disease, frequently transmitted by coitus.

VAGINITIS AND VULVITIS

Clinical signs

- Early fever may be seen during viremic phase.
- Within 24 hours of infection, there is mucopurulent discharge from the vagina.

Clinical pathology

- Leucopenia may be seen during viremic phase.

VAGINITIS AND VULVITIS

Gross pathology

- The vaginovulval mucosa is covered with thick mucus.
- Starting with hyperemia, hemorrhages may be observed later in the submucosal lymphoid follicles.
- Pustules may be found in the vagina and vulva over the lymphoid follicles.

VAGINITIS AND VULVITIS

Histopathology

- The epithelial cells undergo hydropic degeneration
Acidophilic intranuclear inclusion bodies are found in the epithelial cells, since the virus is epitheliotropic.
- Neutrophilic infiltration is present near these lesions.
- In the lamina propria, infiltration by lymphocytes and plasma cells may be found together with edema and hyperemia.

Sequelae

- Recovery is the rule with transient immunity. Resolution occurs in about 8 days.
- Rupture of these lesions results in ulceration.
- Extension of infection to cervix and uterus results in cervicitis and metritis

SPECIFIC BOVINE VENEREAL EPIDIDYMITIS AND VAGINITIS (EPIVAG)

Introduction

- It is a chronic viral disease of cattle, transmitted by coitus and is found in Africa.

Clinical signs

- The disease is characterized by mucopurulent vaginal discharges in females.
- In the bulls the disease causes swelling of epididymis.

Sequelae

- Permanent adhesions of fallopian tubes may occur

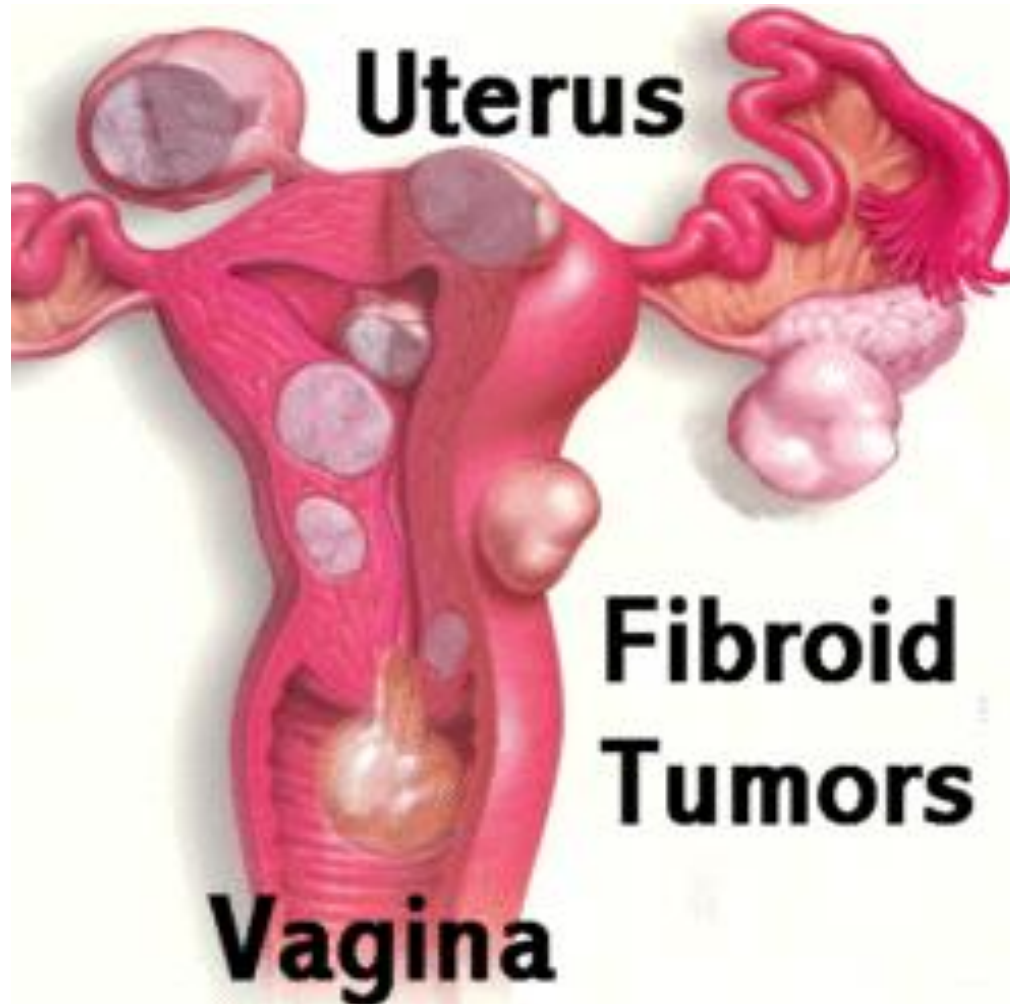
TUMOURS OF VAGINA

- Fibromas may be found, which may be soft or hard, pedunculated or sessile.
- Leiomyomas are also seen. Some have fair amount of collagen fibres when they are known as
- fibromyomas. These are comparatively harder than the pure leiomyomas.
- Transmissible venereal tumor of the bitch is frequently seen in the vagina.

Leiomyoma:

- This is a benign smooth muscle tumor that occurs in all animal species but is most common in the dog. They are also common in women where they are called “fibroid

Leiomyoma:



Leiomyosarcomas:

These are the malignant version of the leiomyoma.

- Like the leiomyoma, they can occur in the uterus, cervix, or vagina.
- They are less common than their benign counterpart.

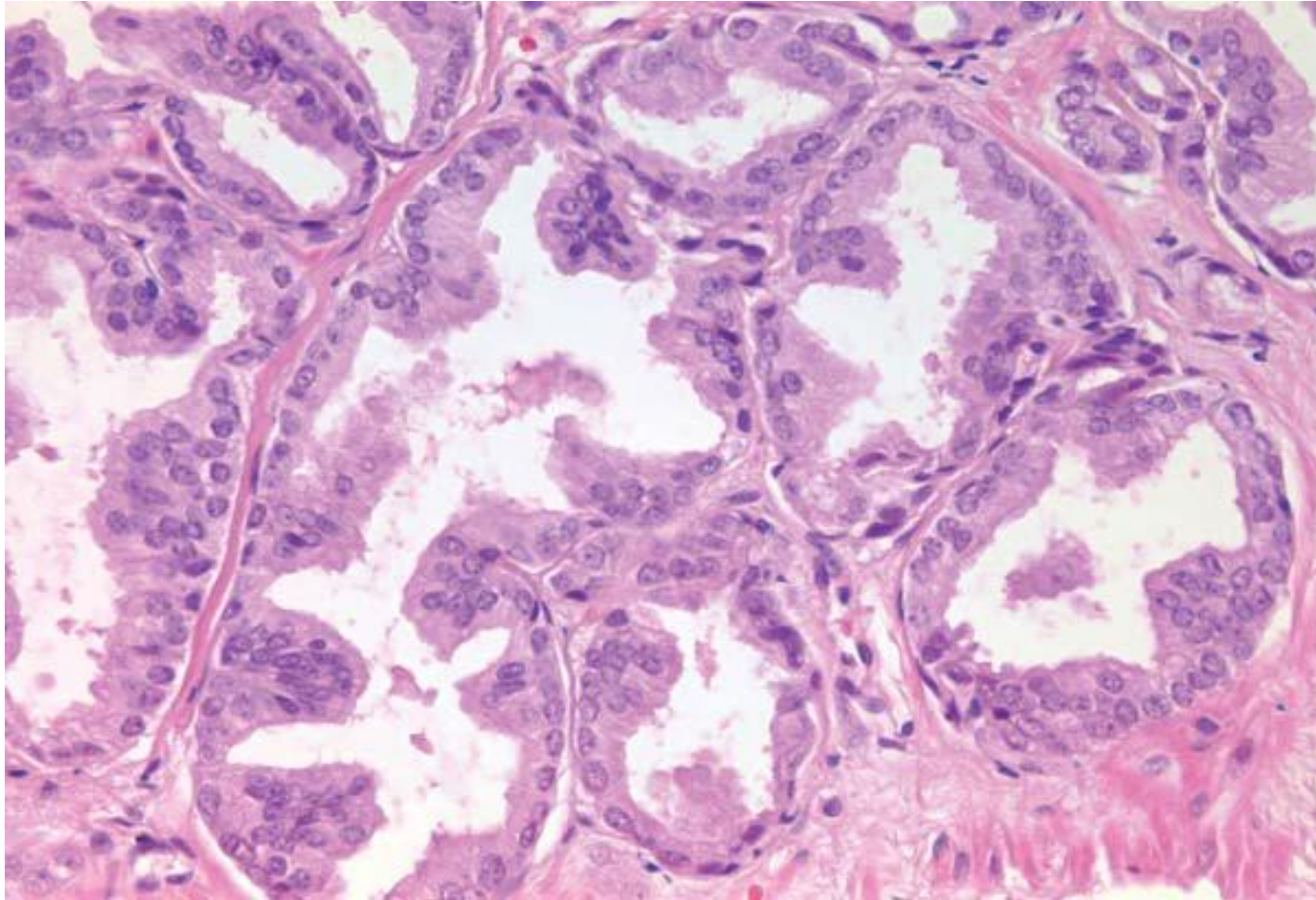
Fibropapilloma

- This tumor affects the vulva of young cows. They are caused by infection with bovine papillomavirus.
- The masses are sessile and round to cauliflower like, basically “warts”. Most masses regress in 1 to 6 months.

Uterine adenocarcinoma

- These tumors can occur in all species, but are particularly common in old domestic rabbits and chickens.
- This tumor can spread hematogenously to the lymph nodes and lung. It can also spread by implantation (carcinomatosis) to the peritoneum.
- Carcinomatosis results in lymphatic blockage since the peritoneum is often covered with tumor tissue, impairing resorption of fluid, so animals will develop severe ascites.

Uterine adenocarcinoma...



Lymphosarcoma

- This is the most common uterine neoplasm in the cow.
- Probably also the most common neoplasm in cows, period. It can be part of multicentric bovine lymphosarcoma or of primary uterine origin

Vulvar squamous cell carcinoma

- Similar to sunlight induced squamous cell carcinoma at other sites (periocular), squamous cell carcinomas of the vulva are most often seen in cows, horses, and ewes.
- They are typically locally aggressive, but are slow to metastasize to regional lymph node

Transmissible venereal tumor:

- This is a transmissible tumor that can be seen in all canidae including dogs, jackals, foxes, and coyotes.
- TVTs are macrophage origin tumors with an abnormal chromosome number, i.e., different from the regular dog number of chromosomes.

Transmissible venereal tumor...

- It is transmitted by close contact including sexual, from one host to another. Clinically, there are one or more expansive, and often ulcerated and friable masses.
- The neoplasm normally regresses over several months and this regression is associated with T lymphocyte infiltrates so presumably the immune system eventually recognizes the cells as foreign and kicks them out.

Transmissible venereal tumor...



THANK YOU!!!

ABORTION PATHOLOGY

Dr. Muluken Yayeh (DVM, MSc. Assistant professor of veterinary pathology)
University of Gondar
E-mail:muluken.yayeh@uog.edu.et

Learning objectives

- **To know about pathology of abortion**

ABORTION

- Abortion is the expulsion of dead embryo or fetus before attaining normal gestation.
- There are two other terms related to abortion
 - ❖ Stillbirth
 - ❖ Premature birth
- Stillbirth is defined as expulsion of dead fetus on its full maturity
- Premature birth is a birth of a live fetus before attaining full gestation period.

ABORTION...

Etiology

- Brucellosis (*Brucella abortus*, *B. melitensis*, *B. ovis*)
- *Campylobacter foetus*
- *Salmonella abortus equi-mares*
- Equine herpes virus-1-cattle
- *Chlamydia psittaci*
- *Trichomonas foetus*
- *Listeria monocytogenes*(*listeria ivanovi*)

ABORTION...

- *Leptospira* spp
- *Mycobacterium tuberculosis*
- *Toxoplasma gondi*
- *Mycoplasma mycoides*
- Fungi-*Aspergillus* spp.,
- Toxins/poisons

Pathogenesis

- Abortion is mostly due to infection of the fetus, placenta or the uterus since these conditions cause death of the fetus.
- A dead fetus is a foreign body and so is expelled from the uterus.

BRUCELLOSIS

- Etiology
- *Brucella abortus*, *B. melitensis* and *B. suis* affect the cow, sheep goat and pig.
- *Brucella ovis* affects only the sheep.
- Bovine brucellosis
- The typical abortion occurs at about the 7th month of gestation in the cow.

BRUCELLOSIS...

Routes of infection

- o Alimentary canal – ingestion of feed or water contaminated by fetal membranes, fetus or uterine discharge.
- o vagina – by coitus or artificial insemination
- o conjunctiva
- o Skin
- o Contamination of healthy udder from an infected one during milking.

BRUCELOSIS....

Pathogenesis

- o The organism produces abortion in the following manner: The organism has special affinity for the pregnant endothelium.
- First placentitis is produced by the invading organism.
- Sero-purulent exudate accumulates between the endometrium and chorion.
- Edema and infiltration of the chorion by macrophage, lymphocytes and plasman cells occurs.
- Necrosis and hyalinization of chorio-allantois.

BRUCELOSIS...

- Thus the membranes become separated from the uterine endometrium.
- Fetus dies.
- disconnection of blood supply to fetus.
- Dead fetus is a foreign body and so expelled (abortion). A few weeks after
- abortion or parturition, the organism can no longer be detected in the uterus

BRUCELOSIS...

Milder cases

- In milder cases, a live fetus may be born, which is usually weak and may succumb soon after.

Chronic cases

- In the chronic cases, there is fibrotic adhesion of the placenta to the endometrium resulting in
- retention of placenta. In these cases, calves may be born alive.

BRUCELOSIS...

Gross pathology

- o In the aborted fetus may be found croupous or catarrhal pneumonia edema of the pericardium, umbilical cord and skin
- serosanguineous exudate in the serous cavities
- suppurative or hemorrhagic gastro-enteritis

BRUCELOSIS...

Histopathology

- o Hyperplasia of lymph nodes and spleen are prominent lesions.
- Diagnosis
- o Brucellosis is usually diagnosed with Rose bengal plate agglutination test using the coloured antigen

BRUCELLOSIS...

o Cultural examination

Brucellosis of swine

- Coital infection is more frequent. Abortion occurs between the 2nd and 3rd months of pregnancy.

- *Gross pathology*

o Serosanguineous exudate in the serous cavities and subcutis

o Fetal membrane show yellowish grey mucopurulent exudate

Brucellosis in dogs

- *Etiology*

o *Brucella canis* causes abortion in dogs.

BRUCELLOSIS...

Transmission

- o This is a highly infectious disease
- o Transmission may be by contact, through infective discharges or by venereal transfer.
- *Clinical signs*
 - o In bitches, abortion occurs between the 7th and 9th weeks of gestation.

BRUCELLOSIS....

Histopathology

- o In male dogs, epididymitis and testicular atrophy may occur.

Sequelae

- o In male dogs, complete sterility may result.

BRUCELLOSIS...

Ovine Brucellosis

- *Etiology*

- o Ovine brucellosis is caused by *Brucella ovis*

- Routes of infection*

- o Infection is probably by ingestion.

- Pathogenesis*

- o In ewes abortion occurs due to placentitis.

- o In rams after an initial bacteremia and mild systemic reaction, the organisms localize in the epididymis and cause sterility

BRUCELLOSIS....

Clinical signs

- o In ewes abortion may occur in late pregnancy or still births may also result.
- *Clinical pathology*
- o Semen is of poor quality and contains leucocytes and brucellae.
- *Gross pathology*
- o Ram
- There may be acute inflammation of the scrotum with edema.
- The condition may become chronic with enlargement of epididymis, thickening of the scrotum and atrophy of testes.

BRUCELLOSIS....

o Ewe

- There is purulent exudate on the placenta and edema of allantois.
- There may be elevated, firm, yellowish-white plaques in the inter-cotyledonary areas
- The cotyledons are enlarged and edematous.

Brucella melitensis abortion in goats

- *Routes of infection*
 - o Infection is by ingestion

BRUCELLOSIS....

Clinical signs

- o Abortion may occur, but sometimes live kids may be born.

Pathogenesis

- o In the goats an acute systemic reaction develops and later localization of the organisms in the placenta causes placentitis and thus abortion results.

Sequelae

- o After abortion the uterine infection persists for over 5 months and the mammary glands remain infected for many years.
- o In some cases, spontaneous recovery may occur.
- o Viable kids are infected and infection persists in a latent form and at maturity clinical symptoms are manifested.

VIBRIOSIS

Occurrence

Vibrio abortion occurs in cows and sheep

Routes of infection

- Infection is by ingestion in sheep
- In cows, through coitus or artificial insemination infection occur

VIBRIOSIS...

Pathogenesis

- The pathogenesis of abortion is similar to that of brucellosis, the initial lesion being a placentitis followed by exudation, necrosis, vasculitis, separation of the placenta from the endometrium, death of the fetus and abortion.

Clinical signs

- In the cow abortion occurs between the 5th and 7th months of pregnancy
- In the sheep, abortion occurs at 2nd month of pregnancy

VIBRIOSIS...

Histopathology

- *Vibrio* causes acute catarrhal endometritis, cervicitis and vaginitis.

Fetus

- o In the fetus, edema of the subcutis, serofibrinous pleurisy, peritonitis and pericarditis may be found.
- o Fatty degeneration of the liver and kidney
- o Hemorrhages in the renal cortex.

Sequelae

- Infection causes repeat breeding.

TRICHOMONIASIS

Etiology

- It is caused by *Trichomonas fetus*.

Transmission

- It is transmitted to the cow through coitus

Epizootiology

- The bull harbours the flagellate in the mucous membrane of the penis, terminal portion of urethra and prepuce.

TRICHOMONIASIS...

Pathogenesis

- In the cow, within three days after infection, vulvitis and vaginitis develop, from where infection spreads producing cervicitis, endometritis and placentitis.
- There is copious grayish-white thin exudate and abortion will occur within about 16 weeks of pregnancy.
- Sometimes the dead fetus may be macerated in the exudate. Or the fluid may be absorbed (if not infected by other bacteria) and the fetus may be mummified.
- In chronic infection with fibrosis, placenta may be retained

TRICHOMONIASIS...

Sequelae

- If pyogenic organisms invade the uterus (*Corynebacterium, Staphylococci and Streptococci*), pyometra will result.
- Infection causes repeat breeding.

LISTERIOSIS

Etiology

- Listeriosis is caused by *Listeria monocytogenes*.

Occurrence

- Listeriosis causes abortion in cattle and sheep.

Pathogenesis

- Listeriosis primarily affects the brain.
- It may sometimes infect the pregnant uterus and the organisms become septicemic in the fetus and cause its death.

LISTERIOSIS...

- Abortions usually occur during the last trimester of pregnancy.

Gross pathology

Fetus

o The fetus shows

- hemorrhage in the kidneys
- anasarca
- areas of necrosis and granulomas in the liver, spleen, lungs and kidneys
- catarrhal gastro-enteritis
- cardiac vegetations and
- hemopericardium.

EPIZOOTIC BOVINE ABORTION

Etiology

- A virus of the family psittacosis lymphogranuloma group is found to cause abortion in cows and ewes (in sheep it is called enzootic abortion).

Epizootiology

- An arthropod vector is important in transmission.

Pathogenesis

- The virus causes death of the fetus.
- It injures the vascular endothelium of the fetus

EPIZOOTIC BOVINE ABORTION...

Clinical signs

- In an out break 75% of affected animals may abort.
- Abortion occurs during the last trimester.

Gross pathology

- *Fetus*
 - o Lesions in the fetus are
 - Skin at the groin shows erythematous patches.
 - Petechiae found on the skin.
 - Subcutaneous edema

EPIZOOTIC BOVINE ABORTION...

Hemorrhages on the conjunctiva, on the mucosa of ventral surface of the tongue and on the tracheal mucosa.

- Body cavities are filled with serosanguineous fluid.
- Petechiae found on the internal organs.
- The **pathognomonic lesions** are found in the liver which is enlarged, friable, pale red to reddish-orange in color and has a coarsely granular surface (due to chronic venous congestion).

EPIZOOTIC BOVINE ABORTION...

Histopathology

- *Fetus*
 - o The characteristic lesion found in all the organs is a focal inflammation consisting of neutrophils, lymphocytes and macro-phages.
 - o The liver may show chronic venous congestion (dilatation of the central vein and sinusoids and consequent pressure on the hepatic cells causing necrosis) or granulomatous lesions in the hepatic capsule, in the portal triads or in the adventitia of the central veins.

EPIZOOTIC BOVINE ABORTION

- o Meningitis and focal encephalitis
- o Infiltration of the adventitia of meningeal and parenchyma cells of the brain by pleomorphic mononuclear cells, arranged concentrically is a characteristic appearance.

LEPTOSPIROSIS IN CATTLE

Etiology

- In cattle various strains of leptospira produce abortion

Pathogenesis

- Abortion is due to fetal death.

Clinical signs

- Leptospira causes abortion after 6th month of pregnancy

LEPTOSPIROSIS IN CATTLE...

Gross pathology

- *Fetal membranes*
 - o The placenta is avascular with collapsed blood vessels.
 - o Cotyledons are atonic, yellow-brown in color and leathery.
- *Fetus*
 - o In the fetus, edema of the subcutis, peritoneum, umbilical cord and pericardium are seen.

LEPTOSPIROSIS IN CATTLE...

Histopathology

- Focal interstitial nephritis with round-cell infiltration, glomerulo-nephritis, and infiltration of eosinophils into the cortex.
- Round-cell infiltration into the periportal tissue of the liver.

ABORTION IN MARES BY SALMONELLA ABORTUS EQUI

Clinical signs

- Abortions occur late in pregnancy.

Gross pathology

- The organisms produce a purulent hemorrhagic placentitis.
- Allanto-chorion is edematous and exhibits necrosed areas with a wall of hemorrhagic reaction separating it from the surrounding tissue.

Sequelae

- Infection is followed by development of immunity.

EQUINE VIRAL ABORTION

Etiology

- Equine viral abortion is caused by
 - o (1) Equine rhinopneumonitis virus
 - o (2) Equine viral arteritis

Equine rhinopneumonitis virus (Equine influenza)

Clinical signs

- o Abortion occurs in the 9th or 10th month.

Gross pathology

- o The fetus shows edema of the subcutis

EQUINE VIRAL ABORTION...

- Jaundice
 - o The lungs are heavy and voluminous (edema of the lungs).
 - o Liver shows focal necrotic areas. Visible under the capsule are grayish-white foci. Such necrotic areas are seen in the spleen and lung also.
 - o Petechiae are found throughout the body.

EQUINE VIRAL ABORTION...

Histopathology

- o Bronchial and alveolar epithelial cells show acidophilic intranuclear inclusions Equine viral arteritis

Pathogenesis

- o The virus of equine arteritis brings about the death of the fetus.

Gross pathology

- o The fetus shows hemorrhages in the splenic capsule and respiratory mucosa.

INFECTIOUS BOVINE RHINOTRACHEITIS

Etiology

- Abortion in cows may be caused by the IBR virus when the animal suffers from respiratory affection caused by this virus.
- Vaccination of cows with the IBR virus vaccine also brings on abortion.

INFECTIOUS BOVINE RHINOTRACHEITIS...

Clinical signs

- Abortion occurs during the last trimester of pregnancy.
- No symptoms are noticed prior to abortion.
- There may be history of vaccination by IBR vaccine or of a respiratory affection. Fetus is
- usually decomposed when aborted since abortion occurs only 24 to 36 hours after its death.

Gross pathology

- Serous cavities contain serosanguineous fluid.
- There is edema of lungs and placenta.
- Fetus shows petechiae on the heart.

INFECTIOUS BOVINE RHINOTRACHEITIS...

Histopathology

- There is focal necrotizing hepatitis and placentitis.
- Renal cortex shows hemorrhagic necrosis.

Diagnosis

- By clinical signs
- Affected animals are serologically positive
- Virus isolation from cotyledons.

MYCOTIC ABORTION IN CATTLE AND SHEEP

Etiology

- Abortion in cattle may occur due to infection by fungi of the following species. *Aspergillus*, *Absidia*, *Mucor* and *Rhizopus*.

Pathogenesis

- The infection is a secondary one, the primary lesions being in the lungs, abomasums (ulcers) and the intestines.
- Infection is through the blood stream.
- Separation of the placenta from the cotyledons causes death of the fetus.

MYCOTIC ABORTION IN CATTLE AND SHEEP...

Clinical signs

- Abortion in affected cows occurs during the later half of the gestation period between 6th and 8th months.
- Placenta is retained.

Gross pathology

MYCOTIC ABORTION IN CATTLE AND SHEEP

- Infection occurs first in the placentomes which show necrotic plaques and the fungus can be demonstrated in these locations.
- In the cow, the chorion-allantois is thick and leathery.
- The fetus may show circumscribed grayish plaques on the skin resembling ring worm lesions

MYCOTIC ABORTION

MYCOTIC ABORTION IN CATTLE AND SHEEP...

Histopathology

- The typical lesion consists of focal collection of inflammatory cells with macrophages predominating.
- Extensive necrosis of the placentomes
- In the uterine wall, the intercaruncular areas show red patches covered in places by a thin yellowish-grey pseudomembrane.

ABORTION BY OTHER CAUSES

- Abortion may occur in infections by various organisms which first produce metritis followed by placentitis and abortion or birth of weak fetus.

ABORTION BY OTHER CAUSES...

The following are noteworthy

o *Cattle*

- *Salmonella sp*
- *Corynebacterium pyogenes*
- *Streptococci*
- *Stapylococci*
- *M. tuberculosis*
- *Actinobacillus*
- *Pasteurella*

ABORTION BY OTHER CAUSES

o *Mares*

- *Streptococcus zooepidemicus*
- *Klebsiella genitalium*
- *Shigella equirulis*
- *E. coli*

o *Ewes*

- Virus of ovine abortion
- *Salmonella abortus ovis*

ABORTION BY OTHER CAUSES

- Poisoning by ergot
 - o Ergot being an produces violent contractions of the uterine muscle resulting in abortion.
- Neutralization of the effect of progesterone by estrogens
 - o Progesterone maintains pregnancy while estrogen terminates it by inducing uterine contraction

ABORTION BY OTHER CAUSES

Histopathology

- Focal interstitial nephritis with round-cell infiltration, glomerulo-nephritis, and infiltration of eosinophils into the cortex.
- Round-cell infiltration into the periportal tissue of the liver.

ABORTION BY OTHER CAUSES

- Hereditary predisposition.
- Torsion of the umbilical cord (rare).
- Traumatic injury to the placenta (very rare).

REPRODUCTIVE SYSTEM-V

Learning objectives

- To know about mastitis in domestic animals, abnormal eggs and abnormal location of eggs.

MASTITIS (MAMMITIS)

Definition

- Mastitis or inflammation of the udder

Introduction

- All domestic animals suffer from this condition, but it is in the cow that mastitis is of importance because of the economical loss the owner may suffer.

Etiology

- Mastitis may be caused by trauma of various kinds.
- The most common causes are the infectious agents.

MASTITIS (MAMMITIS)...

Bovine Mastitis

- The bacteria that have been found to cause mastitis, are *Streptococcus agalactiae*:
- *Streptococcus dysagalactiae*; *Staphylococcus aureus* and *albus*; *Corynebacterium pyogenes*; *E.*
- *coli*; *Pseudomonas aeruginosa*, *Pasteurella multocida*; *Brucella abortus*; *Mycobacterium*
- *tuberculosis*; *Actinomyces bovis*; *Actinobacillus lignieresii*; *Nocardia*; *Mycoplasma* and
- *Cryptococcus neoformans*.

MASTITIS (MAMMITIS)...

- *Staphylococcus aureus* has been found to be the major cause of mastitis in cows.
- In India, *Staphylococcus aureus* and *pyogenes* have been isolated from large number of
- mastitis cases. In some herds, on the other hand, gram negative organisms (*E. coli* and
- *Aerobacter aerogenes*) have been isolated.

PATHOLOGY OF STREPTOCOCCUS MASTITIS

- When once udder becomes infected with *Streptococcus agalactiae*, it never becomes free of this organism.
- Though some kind of equilibrium develops between the udder and the organism, at times acute exacerbations may occur when the organisms multiply and increase in great numbers.
- In a herd all cows are not equally affected.

MASTITIS (MAMMITIS)...

Routes of infection

- The route of infection appears to be through the teat canal.
- Wounds that occur in cow pox or those caused by suckling calves facilitate infection.
- Source of infection
- Contaminated cups of milking machines, milkers hands and farm utensils are other sources of infection.

MASTITIS (MAMMITIS)....

Resistance to infection

- The teat canal is lined by the same type of epithelium that covers the teat, but this epithelium
- secretes a type of smegma (rich in fatty acids) and this inhibits the streptococci.

Pathogenesis

- Milk being a good medium for the growth of bacteria infection is much more serious in a lactating udder than in a dry one.
- The acute systemic symptoms are due to the action of the bacterial toxins that diffuse into the general circulation.

MASTITIS (MAMMITIS)..

The development of mastitis can be described under three phases

- o The invasion phase in which the bacteria are able to enter the teat orifice and be present in the teat canal and cistern.
- o The infection phase in which the organisms are able to overcome the resistance and multiply
- o The inflammatory phase in which the organisms invade the udder.

MASTITIS (MAMMITIS)...

Gross pathology

- One or more quarters may be affected.
- The gland is swollen and slightly hard.
- The secretion may be serous or may contain floccules and sometimes it may be purulent also.
- On section of gland, the silky pink color of normal udder is lost but is red or white. Lobulation is distinct.
- When fibrosis has set in it can easily be seen surrounding the lobules and the ducts.

MASTITIS (MAMMITIS) ...

Histopathology

- Streptococci are numerous in the ducts
- The epithelium of the acini becomes vacuolated and desquamated.
- When the streptococci invade the epithelium of the ducts inflammation results and due to the rapid development of the granulation tissue beneath the epithelium it is thrown into folds of polypoid thickening.
- The organisms may penetrate the interstitial tissue and cause edema and infiltration by neutrophils which destroy some of the organisms.

- Poisoning by ergot
 - Ergot being an produces violent contractions of the uterine muscle resulting in abortion.
- Neutralization of the effect of progesterone by estrogens
 - Progesterone maintains pregnancy while estrogen terminates it by inducing uterine contraction

Poisons

- o Chlorinated naphthalenes (which are anti-vitamin A and so may produce metaplasia of the uterine epithelium, infection and separation of the placenta)
- o Purgatives
- o Nitrates through ingestion of plants containing large quantities of this chemical

Faulty nutrition of the mother

- o Deficiencies of minerals and vitamins may lead to abortion.
- Vaccination of mother during pregnancy against bacterial and viral diseases.
- Severe and acute septicemic diseases of the mother
- o Abortion may frequently occur in leptospirosis, dourine, viral diarrhoea, hog cholera, erysipelas and infectious rhino-tracheitis.

- Hereditary predisposition.
- Torsion of the umbilical cord (rare).
- Traumatic injury to the placenta (very rare).

REPRODUCTIVE SYSTEM-V

Learning objectives

- To know about mastitis in domestic animals, abnormal eggs and abnormal location of eggs.

MASTITIS (MAMMITIS)

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- *Aerobacter aerogenes*) have been isolated.

MASTITIS IN EWES

Etiology

- The organisms responsible for mastitis in ewes are *Staphylococcus aureus*, *Pasteurella hemolytica*, *Corynebacterium pyogenes*, *Streptococci* and *Coliforms*.
- *Staphylococcus aureus* produces a more acute disease than in the cow.
- Mastitis caused by other organisms is less severe than that produced by *Staphylococcus aureus*.

Macroscopic and microscopic features of mastitis

- Terminal atrophy or shrunken quarter
- Gangren formation . In sheep udder assumes blue color and so the condition is called “**blue bag**”.
- Congestion ,hamorrhage
- Infiltration of neutrophils, macrophages, lymphocytes
- Necrosis of alveolar epithelium, hyperplasia of epithelium lining

Macroscopic and microscopic features of mastitis

- Proliferation of fibrous tissue
- Increase in WBC count in milk (more than 100/ml of milk)
- Edema of udder
- Flakes (coagulated milk proteins)
- Blood mixed milk
- Watery dirty gray or dark colour milk in animals , which are in dry period caused by actinomyces pyogenes and is known as “summer mastitis”

CHAPTER-8
NERVOUS SYSTEM PATHOLOGY
**Muluken Yayeh (DVM, MSc., Assist. professor of
veterinary pathology)**

Learning objectives

- To know the functional disturbances of brain, reaction of nervous tissue to injury, congenital
- anomalies of nervous system and disturbances of circulation affecting the brain and spinal cord.

Nervous System

Central Nervous System (CNS)

Brain & Spinal cord

Peripheral Nervous System (PNS)

- Spinal and cranial nerves

- Meninges Outer covering of connective tissue
 - ...Dura – dense collagenous tissue
- Middle - loose connective tissue strands and blood vessels
 - .Arachnoid
- Inner – contiguous with the brain (external surface of brain) . pia

Cerbro-spinal fluid (CSF)

- Surrounds brain and spinal cord
- Protects the brain
- Allows exchange of substances between the blood and the brain

- Brain

Cerebrum

- 2 hemispheres connected by the corpus collosum

Cerebellum

Brainstem

- Midbrain
- Pons
- Medulla oblongata

FUNCTIONAL DISTURBANCES

Loss of consciousness

- It results from the effect of various toxic agents upon the brain.

Coma

- o Complete loss of consciousness is called coma.
- o Nervous depression results from pressure upon the brain tumor, or even collection of fluid within the ventricles.

Clinical signs

- o In this condition, the animal lies outstretched and motionless, its reflexes are gone, the pupils are dilated, respiration is slow and irregular, heart beat weak, and skin cool.

FUNCTIONAL DISTURBANCES...

Sequelae

- o It usually ends fatally.

Nervous depression

- Nervous depression results from pressure upon the brain as in the case of haemorrhage within the cranial cavity, brain tumour or collection of fluid within the ventricles.

Etiology

- o Equine encephalomyelitis

FUNCTIONAL DISTURBANCES...

Clinical signs

- o There is loss of feeling, sleepiness, and muscular in-coordination.

Nervous excitement

- o Nervous excitement results from congestion and inflammation of the brain and its coverings.

Etiology

- o Rabies

Clinical signs

- o There is delirium, mania and convulsion

NEUROMUSCULAR DISTURBANCES

Disturbances in nervous functions also affect muscles in two ways.

- In the first case there is increased muscular activity (spasm) and in the other loss of muscular contractility (paralysis and paresis).

Spasms

- In muscle spasms there are sudden, violent involuntary contractions.
- They may be continuous (tonic spasms) or intermittent (clonic spasms).

NEUROMUSCULAR DISTURBANCES

Tremor

- When the spasms are mild and are confined to groups of muscles, they are called tremors .

Etiology

- o Epidemic tremor (avian encephalomyelitis) of chicks

NEUROMUSCULAR DISTURBANCES

Convulsions

- If the muscle spasms are widespread and involve the whole body, including the limbs, they are called convulsions.

Etiology

- o They are often seen in puppies infested with ascarids.

NEUROMUSCULAR DISTURBANCES

Epilepsy

- When tonic and clonic spasms alternate, and are accompanied by loss of consciousness, they are termed epilepsy.

Paralysis

- There is complete immobility of a muscle

Paresis

- Paresis means incomplete loss of motion
- The underlying cause is the defective innervations of the muscle. The defect may lie in the motor centers or in the conduction paths. It prevents the flow of motor impulses and immobility result.

NEUROMUSCULAR DISTURBANCES...

Hemiplegia

- Hemiplegia is the paralysis arising in the brain cortex and in the peripheral nerves and is unilateral.

Paraplegia

- A bilateral paralysis of the posterior parts of the body and hind limbs resulting from injury to the spinal cord is called paraplegia.

REACTION OF NERVOUS TISSUE TO INJURY

Paths of infection

- Infection may reach the CNS by way of the blood stream or the lymph stream or it may pass along the axis cylinders of motor or sensory nerves.

Neurones

- Degenerate neurons are normally found in healthy brain but more so in the young animals.
- Since autolysis occurs very early after death in the nervous system it is essential to know how to distinguish between autolytic and degenerative changes.
- The following are the changes noticed postmortem

DEGENERATION

- o Imbibition of large amounts of fluid giving a spongy, wet appearance to the tissue
- o Neurons and glia shrink, leaving a clear space between the cell and the surrounding parenchyma
- o shrinkage and condensation of the nucleus (Postmortem pyknosis)
- o Fragmentation, fading and disappearance of the nucleus and cytoplasm and Nissl granules
- o Axis cylinders, which are normally unstained, take stain diffusely.

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DEGENERATION

Etiology

- The neurons being highly specialized are easily susceptible to injury by hypoxia or toxic materials.
- The following are some of the causes that bring about the degenerative changes in the neurons

DEGENERATION...

In organic salts: lead, arsenic.

- o Organic: Anesthetic agents.

- o Metabolic: Toxic products of uremia.

- o Infectious agents: neurotropic viruses.

- o Nutritional deficiency: Deficiency of B1, Copper, Cobalt

DEGENERATION...

- o Vascular: Ischemia causing anoxia
- o Effects of vaccination: Allergic encephalitis occurs after vaccination with vaccines containing brain tissue.
- o Toxic agents
 - In liver disease, toxic agents, exogenous or endogenous are not detoxified and so these pass on to the brain and produce degenerative changes.
 - Mercury, *lathyrus* and *chlorinated hydrocarbons poisoning*.

DEGENERATION...

Lesions

- When a neuron is destroyed, it cannot be replaced.
- When the nervous system is sick and fails to perform its functions, the structural changes may be of three types.
 - o Macroscopic alterations.
 - o Microscopic alternations, or
 - o The changes may be of a biochemical nature, and nothing may be visible even

REACTION OF GLIAL CELLS TO INJURY

microscopically.

Astrocytes

- Astrocytes are star shaped, are the supporting cells found throughout the central nervous system.
- These cells react to injury and proliferate and this process is known as “ gliosis ”, which may be uniformly diffuse or may be focal.

REACTION OF GLIAL CELLS TO INJURY

- When nervous tissue is destroyed, repair does not take place by fibrosis. The fibrous tissue
- from the adventitia of the blood vessels may repair sometimes. But, if a cavity arises due to
- softening and absorption of the brain, it is not filled in but a cyst is formed with a thin fibrous capsule around which the astrocytes proliferate.

REACTION OF GLIAL CELLS TO INJURY

Oligodendroglia

- Oligodendroglia are the cells containing dark round nuclei and are found mostly in the white matter, in long rows between the fibers.
- They may also be found in small numbers as satellite cells around the nerves and blood vessels.
- The cells invade the dead neurons and engulf them (neuronophagia).

REACTION OF GLIAL CELLS TO INJURY

Microglia

- Microglial cells are the phagocytes of the central nervous system and are found in both white and gray matter.
- With ordinary stains, only their oval dark nuclei are noticed. Their branching cytoplasmic processes require special stains to be seen.
- Microglia is amoeboid and phagocytic and become hypertrophied and proliferates. Hypertrophied cells that engulf the dead tissue are rounded and the cytoplasm is foamy containing lipids and are called “ **Gitter cells** ” (from Gitter –Zellen, German), “Compound granular corpuscles” or “fat granule cells”.

REACTION OF GLIAL CELLS TO INJURY

The meninges

- The coverings of the central nervous system consist of the dura and pia-arachnoid.
- The dura in the cranium is attached to the cranial periosteum, in the spinal column it is separated widely from the vertebral periosteum.
- Pia closely follows the brain and is separated from the arachnoid by the subarachnoid space. The space contains the cerebrospinal fluid and has the spongy network of the arachnoid trabeculae.
- The meninges are composed of cells that are mesodermal in origin. Their reaction to injury is by inflammation and fibrosis.

REACTION OF GLIAL CELLS TO INJURY

Blood vessels

- The blood vessels of the brain have some peculiarities. These are
 - o The arterioles and venules are very thin walled, devoid of elastic and muscular tissue.
 - o Veins do not have valves

REACTION OF GLIAL CELLS TO INJURY

- It is in this perivascular space that the cells accumulate and give rise to “ perivascular cuffing ”.
- Depending on the nature of the pathogen, the cells vary. In bacterial infections of the brain, inflammatory exudates collect in the space of Virchow-Robin.

REACTION OF GLIAL CELLS TO INJURY

Blood- brain barrier

- Histologically, the blood brain barrier is composed of the vascular endothelium of blood vessels,
- The blood- brain barrier is essentially a defense mechanism against noxious agents.
- The brain effectively prevents a wide variety of toxic substances of large molecules from reaching the brain.

REACTION OF GLIAL CELLS TO INJURY

- It successfully prevents the entry of most bacteria and viruses from the circulating blood into the brain.
- It is only when certain toxic substances, including bacteria and viruses, break down the barrier that they are able to enter into the brain tissue and set up the infection, or induce other pathological changes.

Cerebrospinal fluid

Cerebrospinal fluid is found in the ventricles, spinal cord and the subarachnoid plexus in the lateral ventricles.

- In infections, C.S.F may show considerable changes. It may become cloudy or even bloody and the globulin content may be very high.

CONGENITAL ANOMALIES

Anencephaly is the absence of most of the brain, and is seen in most animal species

- **Acrania** is the complete failure of cranial development
- **Amyelia** is the absence of spinal cord.
- **Cranioschisis** is congenital fissure of the cranium
- **Encephalocele** is the protrusion of meninges, alone or with part of the brain through a defect in the cranium.
- **Microcephaly** is the presence of an abnormally small brain.

CONGENITAL ANOMALIES

- **Meningocele** is hernia of the meninges, which protrude through an opening of the skull or spinal column.
- **Rachicele** is hernia of the spinal cord.
- **Spina bifida** is a congenital defect in walls of spinal canal caused by lack of union between the laminae of the vertebrae. Through this defect the spinal cord may herniate.

HEMORRHAGE

Petechiae

- Petechiae are common in acute septicemic diseases (Anthrax, Hemorrhagic septicemia, Hog cholera, Leptospirosis) or in infections by pyogenic organisms.
- These also occur after thrombosis or in degeneration of the vessel walls or in general hemorrhagic diseases as in bracken fern poisoning.
- Hyperemia of the brain and meninges together with petechial hemorrhage and edema are found in the following conditions

HEMORRHAGE....

- o Electrocution,
- o Lightning stroke and
- o Sunstroke

Rupture of an artery

- Rupture of an artery will give rise to large areas of hemorrhage with clots causing **apoplexy**.
- Rupture may occur in injuries – automobile accidents, gun-shot wounds, diseases of wall of blood vessels (atheroma) with hypertension as in arteriosclerosis, chronic-nephritis, bursting of an aneurysm as in parasitic aneurysm in horses.

HEMORRHAGE....

Clinical signs

- The first symptom in cerebral hemorrhage is shock, later passing on to coma and terminating in death.
- Animals that survive the first shock suffer from some degree of paralysis due to pressure on and damage to neurons.

Gross pathology

- Hemorrhages may be found subdurally or epidurally

- They may also occur in the substance of the brain.
- When hemorrhage is present in the ventricles, the cerebrospinal fluid may be blood tinged.
- The blood clot in the brain first contracts separating the serum which is absorbed. The clot that remains is liquefied and a cyst is formed with a clear fluid – the “ **apoplectic cyst** ”.

Histopathology

- The capsule of the apoplectic cyst is formed by the neuroglia.

EDEMA OF BRAIN

Edema of brain may be focal caused by local lesions such as

- o Trauma accompanied by hemorrhage and laceration
- o Cerebral and meningeal hemorrhages
- o Meningitis
- o Focal necrosis
- o Neoplasms

Generalised edema of brain

Generalised edema of brain may be found in

- o Causes that give rise to general edema of the body
- o Enterotoxemia caused by *Clostridium welchii*
- o Viral encephalitis
- o Salt poisoning in pigs
- o Poisoning by Lead, organic mercury compounds
- o Sunstroke
- o Shock
- o Diffuse meningitis

Gross pathology

- Macroscopically

- o The brain appears more moist and heavy.
- o The gyri are widened while the sulci are narrowed.
- o Swollen gyri that press against the skull appear flattened.
- o On section, the gray matter appears wider while the internal white matter is softer. The ventricles appear narrowed.

Histopathology

Microscopically

- o The white and gray matter appears to have a loose texture and the interfibrillar space is widened.
- o Neurones and glia appear swollen.
- o Edematous fluid accumulating around the perivascular space widens these areas.

HYDROCEPHALUS

Definition

- Hydrocephalus is a condition in which there is abnormal accumulation of cerebrospinal fluid in and around the brain.

Etiology

- In animals this is a congenital condition due to some error in development, obstructing the pathways of fluid passage.
- Vitamin A deficiency during intrauterine life may cause internal hydrocephalus in calves and pigs.

Types

- If the accumulation is in the ventricles, the condition is called internal hydrocephalus.
- But if fluid accumulation occurs in the sub-dural space or pia-arachnoid, it is called **external hydrocephalus.**

Gross pathology

- o Due to pressure of the accumulating fluid the ventricles dilate and the adjoining nerve tissue atrophies.

Sequelae

- o If hydrocephalus develops before the cranial sutures fuse, the cranial bone may grow to a large size.
- o The cranium is greatly enlarged causing foetal dystocia.

Gross pathology

- o The accumulated fluid exerts pressure on the surface of the brain.
- o So there is a general atrophy of the brain and widening of the sulci between the convolutions.

Sequelae

- o The result of hydrocephalus is pressure atrophy of the surrounding nervous tissue causing depression, in-coordination, ataxia and death.

CONGESTION OF BRAIN

- Congestion of brain may be seen in heat stroke, poisoning (nervous) and systemic infections.



NERVOUS SYSTEM-II

Learning objectives

- To know the disturbances in growth, disturbances in cell metabolism, traumatic injury to the nervous system, necrosis, gangrene, inflammation – terminology of inflammation affecting the nervous system and types of inflammation.

DISTURBANCES IN GROWTH

Aplasia

- Aplasia of portions of the brain and spinal cord are observed in young animals.

Hypoplasia

- This is relatively more common than aplasia.

Etiology

- o Hypoplasia is seen in congenital posterior paralysis in calves and swine, spastic paresis in cattle.

DISTURBANCES IN GROWTH

Cerebellar hypoplasia

- This anomaly is seen in calves and cats mostly but may also be found in other animals. In the Jersey calves and cats, this defect is inherited.
- Cerebellar hypoplasia was encountered in calves born of cows which were affected with virus diarrhoea-Mucosal Disease while pregnant. Similarly modified hog cholera virus causes, cerebellar hypoplasia in the fetal pig.
- It is also reported in dogs, lambs and goats.

DISTURBANCES IN GROWTH

Gross pathology

- o At necropsy, cerebellum may be found to be rudimentary or even absent.

Histopathology

- o Microscopically, molecular and granular layers are reduced in size.

Sequelae

- o Animals may usually die shortly after birth.
- o Animals that survive for a short while, show locomotor disturbance and incoordination.

DISTURBANCES IN GROWTH

Hypertrophy

- This may result from increase in size of the glial cells, microglia showing the greatest degree of hypertrophy.
- The neuron does not increase in size.

Hyperplasia

- This results from an increase in the number of glial cells. Glia, especially the microglia, increases in number in case of hypoxia.
- Hyperplasia of the neurons does not occur.

DISTURBANCES IN GROWTH

Metaplasia

- This does not occur in the nervous tissue proper.
- It may occur in the connective tissue of the meninges and blood vessels, in which case cartilage and bone may be found.

Atrophy

- Atrophy of the cerebrum may occur in hydrocephalus.
- Pressure atrophy may also occur in the vicinity of tumors, abscesses, haematocysts and depression fractures of the skull

DISTURBANCES IN CELL METABOLISM

Cloudy swelling

Etiology

- o The neurons and the glia undergo cloudy swelling as a result of hypoxia produced by toxic substances or infectious agents.

Histopathology

- o The cells become larger, cellular outline more round and cellular structures indistinct.

Fatty degeneration

- This appears as fat droplets in the cytoplasm of the neurons.

DISTURBANCES IN CELL METABOLISM

Hydropic degeneration

- It is a continuation of cloudy swelling. In this droplets of edematous fluid are observed in the cytoplasm of the neurons and glia.

Amyloid infiltration

- This is uncommon in the central nervous system of most domestic animals.

Glycogen infiltration

- This does not occur in the central nervous system.

DISTURBANCES IN CELL METABOLISM

Pigmentation

- In cattle and sheep, melanin is most frequently encountered in the pia mater of the anterior one-fourth of the brain.
- Focal areas of melanin may be found in other portions of the meninges and even within the brain and spinal cord.

Calcification

- This is most commonly found in meninges than in the brain and spinal cord proper.
- It occurs in the presence of dead tissue and faulty circulation, examples being abscesses, infarcts, parasitic lesions, sites of old hemorrhage and in necrotic neurons.

TRAUMATIC INJURY TO THE NERVOUS SYSTEM

- The brain being soft, is susceptible to shock that emanates from impact, especially from fast moving objects.
- A sudden blow on the cranium may result in fracture of the cranial bones which may not be depressed.
- Fracture of the skull causes considerable damage to the meninges and brain. Hemorrhage may occur and nerve fibres disrupted.

TRAUMATIC INJURY TO THE NERVOUS SYSTEM

- Hemorrhage aggravates the condition by pressure of the accumulated blood on the brain tissue.
- On the other hand a blow on the vertebral column results in fracture or dislocation.

Concussion

- Concussion occurs when the skull receives a sharp blunt blow suddenly, not accompanied by fracture.

TRAUMATIC INJURY TO THE NERVOUS SYSTEM

Gross pathology

- o Lesion consists of small hemorrhage in the brain and under the skin at the site of injury.

Sequelae

- o There is loss of consciousness.
- o The condition is not fatal. Recovery is the rule.

Laceration

- In this condition there is discontinuity of the tissue and usually occurs in automobile accidents.
- **Blunt objects** may cause laceration and a contre coup laceration occurs on the brain on the side opposite to that on which the injury is struck.
- This is due to striking of the brain on the skull on the opposite side, since normally the brain is smaller than the cranium and is slightly movable. In such places hemorrhages are common.

Penetrating wounds

- Penetrating wounds, usually caused by gun-shot wounds, are followed by severe hemorrhage.
- Fractures are also common in such injuries. Penetrating wounds are usually followed by secondary infections and are fatal.

NECROSIS

Coagulative necrosis

- This involves the neurons and the glia.

Etiology

- o The causes are severe injury to the cells brought about by hypoxia, chemical poisons, bacterial toxins and viruses.

Gross pathology

- o No changes are seen macroscopically.

NECROSIS

Histopathology

- o the cells are swollen and become more globular in shape.
- o The cytoplasm stains more intensely with eosin.
- o The Nissl substances may eventually disappear (chromatolysis or tigrolysis).
- o The nucleus shows pyknosis, karyorrhexis, or karyolysis.
- o Microglia accumulates around the necrotic neurons, the process being known as **satellitosis**. When the microglia phagocytose the necrotic neuron, the process is called **neuronophagia**.

NECROSIS

Liquefactive necrosis

- Necrosis of the brain is almost always liquefactive in nature.

Etiology

- o Infarction is one of the common causes of liquefactive necrosis.
- o It may also occur when the central nervous system is invaded by pyogenic bacteria.
- o Encephalomalacia is commonly seen in the following conditions

Pathogenesis

- o This is the most common type of necrosis encountered in the brain and spinal cord compared to coagulative and caseous type because the **nervous tissue contains little coagulable albuminous material** but is rich in lipoids.
- o When necrosis occurs in the nervous system, the autolytic enzymes released from lysosomes of the dead cells cause disintegration of myelin into a liquid mass that consists mainly of **lipoid**.

- The lysosomal enzymes released from neutrophils induce liquefaction of myelin, neuroglia and other structures, and is known as encephalomalacia .
- Softening of gray matter is known as **poliomalacia** and that of white matter **leucomalacia** .

Histopathology

- o The lesions seen are thickening of blood vessels, endothelial hyperplasia and liquefaction of brain substance.
- Astroglia proliferate and surround the area of encapsulation. The involved tissue undergoes liquefaction and a serous fluid is present.

GANGRENE

- This could occur if the brain is invaded by saprophytic microorganisms, as in the case of traumatic injuries of the skull or as septic emboli from areas of gangrene in the lungs.

INFLAMMATION

- Terminology of inflammation affecting the nervous system
- **Encephalitis** – is inflammation of the brain.
- **Myelitis** – is inflammation of the spinal cord.
- **Encephalomyelitis** – is inflammation of the brain and spinal cord.
- **Meningitis** – is inflammation of the meninges.
- **Pachymeningitis** - is inflammation of the dura matter.
- **Leptomeningitis** – is inflammation of the pia matter

Meningoencephalomyelitis – is inflammation of the meninges, brain and the spinal cord.

- **Poliomyelitis** – is inflammation of gray matter in the spinal cord.
 - Since there are no mucous membranes, catarrhal inflammation does not occur.
 - Serous inflammation also probably does not occur: If it does it resembles edema.
 - Hemorrhagic exudates are rarely met with and fibrinous inflammation is limited practically to the meninges.

❖ Purulent, lymphocytic and proliferative inflammations are the types which are regularly encountered in the central nervous system.

Types of inflammation

- *Fibrinous encephalitis, myelitis and meningitis*
 - These are seen in cattle and sheep during *Pasteurella infection of the central nervous system*.
 - They are characterized by cardinal signs of inflammation and increased fibrin content in the sub-arachnoid and Virchow-Robin space.

Suppurative (purulent) encephalitis, myelitis and meningitis

- o These are observed in all species of animals.

Routes of infection

- o By direct extension from suppurative conditions of the middle ear, nasal passage or from meninges.
- o Through blood stream (in septicemic disease) and lymphatic vessels accompanying nerves (Listeriosis).
- o Infection of penetrating wounds of the skull.
- o Suppurative myelitis will result due to infection of the wound made while docking the tail.

Etiology

- o The pyogenic organisms responsible are Staphylococci, Streptococci, Corynebacterium, Pasteurella, Listeria and pleuroneumonia like organisms.

Gross pathology

- o There are the usual cardinal signs of inflammation.
- o The principal constituent of the exudates is pus.
- o The inflammation may be focal or diffuse.

Histopathology

- o The lesions may be microscopic and consists of focal collection of neutrophils and lymphocytes.
- o The abscesses do not have well developed capsules as mesodermal cells that form it are few. Astroglia proliferate and form a poorly defined capsule around the cerebral abscess.

Sequelae

- o The accumulation of pus causes pressure and destruction of the local tissue.
- o If an important area is involved, severe effects follow.

LISTERIOSIS (LISTERELLOSIS)

- This is the most frequent cause of a purulent reaction in the brain of farm animals.
- Infection by *Listeria monocytogenes* produces *suppurative meningoencephalomyelitis* in cattle, sheep and goats.
- The disease is characterized by the presence of multiple microabscesses which contain the organisms.

NERVOUS SYSTEM-III

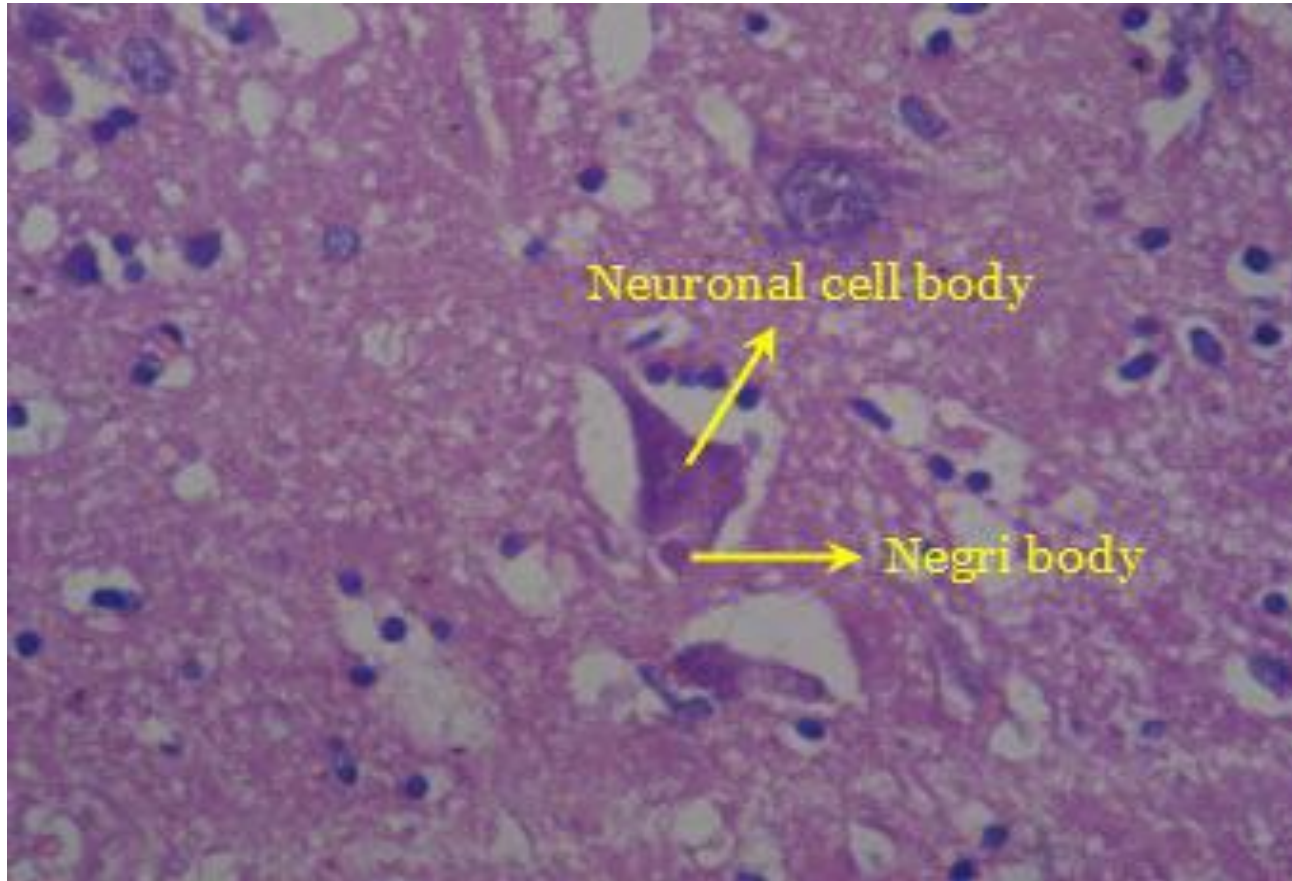
Learning objectives

- To know the specific inflammations of brain and spinal cord, pathology of meninges, spinal cord, peripheral nerves and neoplasms affecting the nervous system.

SPECIFIC INFLAMMATIONS OF BRAIN AND SPINAL CORD

Rabies

- It is an acute viral disease of domestic animals characterized by a very severe lymphocytic inflammation of nervous system.
- There is diffuse and severe meningoencephalomyelitis.
- A characteristic feature of the disease is the presence of intracytoplasmic inclusion bodies in the cells of the hippocampus and cerebellum.



Pseudorabies

- It is an infectious viral disease of cattle, pigs, dogs and cats.
- In pigs, there is a diffuse lymphocytic meningoencephalomyelitis which does not seem to occur in cattle.

Hog cholera (swine fever) encephalitis

- In hog cholera 80 to 90 per cent of the animals suffer from an acute diffuse lymphocytic
- meningoencephalomyelitis.

Canine distemper encephalitis

- The virus of canine distemper also produces a typical diffuse lymphocytic meningoencephalomyelitis.
- However, not all the affected dogs develop lesions in the central nervous system.

Infectious viral equine encephalomyelitis

- This is an acute viral disease of horses and mules and is also characterized by a typical diffuse lymphocytic meningoencephalomyelitis.
- It terminates fatally in about 50 percent of the cases.

Borna disease

- This is an acute diffuse viral meningoencephalomyelitis of the horses that occur in Europe, especially in Germany.
- It has not been reported in India.

Louping ill

- This is an acute diffuse viral lymphocytic meningoencephalomyelitis of sheep in Scotland,
- England and Ireland.

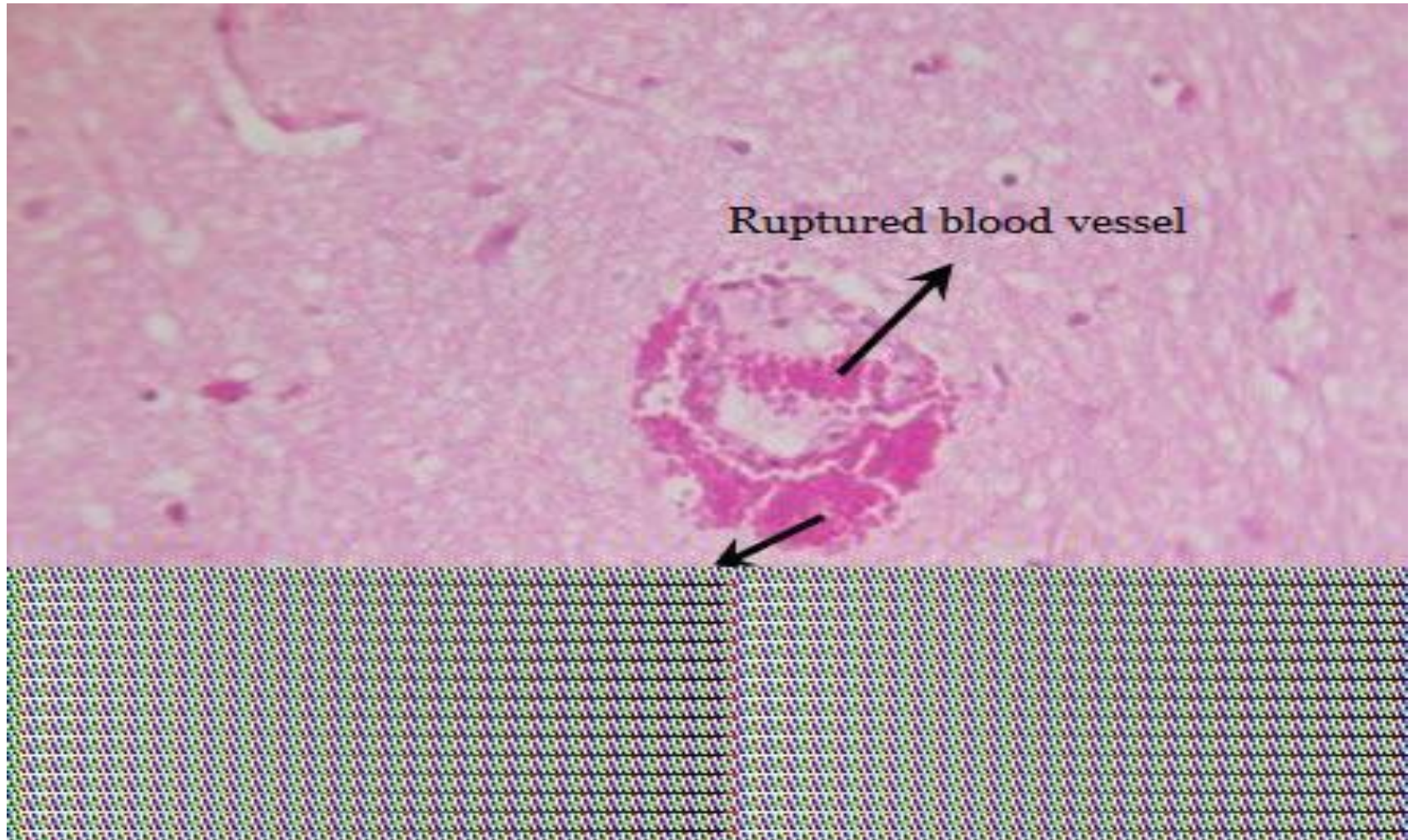
Tuberculosis meningoencephalomyelitis

- The lesion in the central nervous system consists of a central area of caseous necrosis which may be partially calcified.
- This indicates that generalized tuberculosis is present.

Enterotoxaemia

- In enterotoxaemia of sheep, there is perivascular edema and haemorrhage.

Enterotoxaemia



MYIASIS

- *Hypoderma bovis* larvae may be found in the fat of the vertebral canal in cattle. At times they may invade the spinal cord or the brain.
- The larvae of *Oestrus ovis* have also been reported to invade the brain.

CESTODIASIS

- Tapeworm cysts are found in the central nervous system of the domestic animals.

Etiology

- Cysts of *Multiceps multiceps*, *Taenia pisiformis* and *Tanenia echinococcus*.

Pathogenesis

- The ova of these tapeworms are ingested by the animal. In the intestine, the hexacant embryo comes out, pierces the intestine, and is carried by blood stream to various places in the body.
- Some of the larvae, particularly those of *Multiceps multiceps*, reach the brain where they encyst

Gross pathology

- The path of migration of the larvae in the brain is macroscopically visible as red streaks due to the presence of hemorrhage.

GID OR STURDY

- The larval stage of *Multiceps multiceps*, a dog tapeworm is known as *coenurus cerebralis* .
- It causes, a rather uncommon disease of the central nervous system of sheep, known as “ gid ”or “ sturdy ”.

Clinical signs

- The symptoms depend on whether the bladder worms are located in the brain or spinal cord.
- Cysts usually affect the lumbar portion of the spinal cord, which results in in-coordination and paralysis of the posterior extremities.
- In acute diffuse lymphocytic meningoencephalomyelitis, the animal dies.

Gross pathology

- In both brain and spinal cord, they form cysts reaching 50 mm in diameter or more. Each cyst is filled with clear fluid and contains even up to 500 scolices.
- As the cyst enlarges there is pressure atrophy of the surrounding nervous tissue. So the convolutions may be flattened and cortex becomes thinned. Even the cranial bones may be
- subjected to pressure atrophy and some may be punctured even.

Histopathology

- In severe infection, an acute diffuse lymphocytic meningoencephalomyelitis is produced.
- The chronic irritation induces a chronic lymphocytic meningitis, encephalitis, or myelitis, depending on the location of the parasite.

Sequelae

- Death of the larvae will result in calcification of the cysts.

NEMATODIASIS

Various nematode larvae are found in the central nervous system. Strongyle larvae are found in the horses. The larvae of ascarids, strongyloides, hookworms and microfilaria of *Dirofilaria immitis* may be found in the capillaries or in the nervous tissue of the brain, spinal cord or meninges. Their lesions are characterized by a chronic lymphocytic inflammation.

NEMATODIASIS

Gross pathology

- Macroscopically, lesions are found in the brain and spinal cord and the severity depends on the number of the parasites present.
- Narrow tortuous tracks of hemorrhage and softening may be found denoting the path taken by the parasite

NEMATODIASIS

Histopathology

- o The lesions consist of a central space surrounded by a degenerated and necrotic tissue.
- o The necrosis is liquefactive in type.
- o Hemorrhages may be present in this area.
- o Due to damage by the larvae the axis cylinders in the affected area are swollen and degenerated and appear enlarged and fragmented.
- o The myelin sheath becomes swollen and distorted, accompanied by glial proliferation.
- o Lymphocytes, eosinophils and microglia infiltrate around the area.

NEMATODIASIS

- o Perivascular cuffing of nearby vessels is observed.
- o The larvae may not be visible in these lesions as they might wander off.
- o Careful microscopic examination of the tissue and cerebrospinal fluid is necessary to see the larvae.

Sequelae

- The causes may terminate fatally, or recovery may follow.

TOXOPLASMOSIS

- *Toxoplasma gondi* , a protozoan parasite is found in the central nervous system of domesticated animals.
- Lesions consist of a central area of coagulative necrosis, surrounded by microglia and
- neutrophils. There is also lymphocytic meningitis, lymphocytic perivascular cuffing, and gliosis.

ALLERGIC ENCEPHALITIS

- This sometimes occurs in dogs following rabies vaccination.
- It occurs 2 to 3 weeks after vaccination.
- There is motor paralysis of one or more limbs, which may later involve most of the body.
- It is characterized by a lymphocytic meningoencephalomyelitis.
- Death is the usual outcome.

EPILEPSY

Epilepsy is a sudden brief (petit mal) or prolonged (grand mal), loss of consciousness usually preceded by convulsions.

Types

- *Symptomatic epilepsy*
 - o It may occur in animals due to organic brain lesions such as neoplasms or inflammation or trauma; disturbances in brain metabolism due to visceral pathology or metabolic diseases or poisons; cerebrospinal nematodiasis; verminous infestations or profound toxemias.

True or Idiopathic epilepsy

- o It is an inherited condition in Brown Swiss cattle and Cocker spaniels.
- o The inheritance is through a recessive factor.
- o Between attacks the animals are preferably well and the condition persists for life.

Clinical signs

- A true grand mal epileptiform seizure is manifested by an early period of alertness, followed by a state of tetany, which gives way after a few seconds to a clonic convulsion with padding,

- The temperature may be elevated or normal.
- The pulse is frequent and respiration rate is increased.
- The blood, cerebrospinal fluid and urine are normal.
- The attacks are always recurrent and the animals are normal in the intervening periods.

SWAYBACK OR ENZOOTIC ATAXIA

- The disease is seen in new born lambs in certain parts of the world.

Etiology

- Swayback is attributed to a deficiency of copper.
- The ewes which are maintained on a copper deficient diet or grazed on lands with molybdenum-rich grasses may manifest anemia and produce “steely” wool. Lambs of such ewes show demyelination and suffer from “swayback”.

Clinical signs

- The symptoms noticed are severe ataxia, locomotor disturbance, paralysis and inability to walk.
- Affected animals may be blind and so are unable to move.
- Death may also be due to broncho-pneumonia.

Gross pathology

- Lesions are not prominent in mild cases. But in severe cases, cavities containing gelatinous material may be found in the white matter due to liquefactive necrosis with secondary
- internal hydrocephalus.
- The lesions are bilaterally symmetrical.
- Flattening of cranial bones occurs due to cystic degeneration and increased intracranial pressure.

Histopathology

- Diffuse symmetrical destruction of the white matter in the cerebrum is noticed, which is
- liquefactive necrosis.
- There is destruction of descending myelinated tracts.
- Gitter cells are numerous in the area.
- There is reduction in the cytochrome oxidase activity of neurons.

MENINGITIS

- Inflammation of the meninges is called meningitis.

Pachymeningitis

- o Inflammation of the dura mater is called pachymeningitis

Etiology

- The inflammation of the dura mater is usually secondary to infection of the middle ear or adjacent bone.
- o It may be suppurative or non-suppurative

- .o In the suppurative variety which is more common, local abscesses may be found on the dura and the peridural spaces.
- o Subsequently chronic fibrosis may develop when the dura is thickened with local adhesions.
- o Infection may spread to the arachnoid causing leptomenigitis.

Leptomeningitis

- o Leptomeningitis is the inflammation of the pia-arachnoid.
- o When associated with inflammation of the brain, which is usually the case, the condition is known as meningoencephalitis.

Etiology

- o Leptomeningitis may be suppurative or non-suppurative.
- o The causes are

Leptomeningitis

- Mechanical injuries – fractures
- Extension from adjacent tissues – as in viral encephalitis (swine fever, rabies etc)
- Bacterial infection from neighboring areas
- *Mycobacterium tuberculosis and Cryptococcus.*

Leptomeningitis

Pathogenesis

- o Due to the movement of the C.S.F, the inflammation is usually diffuse.
- o The causative organisms grow on the surface of the pia-arachnoid and in its spaces.
- o Injury to the blood vessels is responsible for the inflammatory exudates.

Leptomeningitis

Gross pathology

- o Hyperemia is severe in meningitis.
- o In suppurative meningitis, the exudate which is yellow or greenish accumulates in the pia-arachnoid space.
- o Pus may also be found in the spinal fluid. When it accumulates in the lateral ventricles, the convolutions tend to be flattened.
- o Due to gravity the inflammatory fluid collects at the base of the brain.

Leptomeningitis

Histopathology

- o Suppurative inflammation is characterized by the infiltration of neutrophils while mononuclears (lymphocytes and macrophages) predominate in the non-suppurative

Variety Diagnosis

- o Examination of the spinal fluid collected from a lumbar puncture gives, valuable information as to the nature of infection.

PATHOLOGY OF SPINAL CORD

Myelitis

Definition

- Myelitis is inflammation of the spinal cord.
- Usually myelitis is found along with encephalitis when the condition is known as encephalomyelitis.

Types

- Myelitis may be suppurative or non-suppurative and the lesions are comparable to those of the brain.

Etiology

- Sometimes non-suppurative myelitis may occur without any attributable cause. In such cases trauma (automobile accidents) are believed to be the cause.
- Fractures of spinal column and protrusion of intervertebral disc may be other causes.

Gross pathology

- Macroscopically, there may be congestion of the pia, petechiae on and inside the spinal cord and in advanced cases, softening of the nervous tissue

Histopathology

- Congestion, infiltration by inflammatory cells and degenerative changes of the nerve cells are seen.
- The nerve cells are swollen.
- Nissl substance disappears and the nucleus assumes an eccentric position.
- Degenerative changes of the nerve fibres are also observed.

PATHOLOGY OF THE PERIPHERAL NERVES

Degeneration

Types

- o When a nerve cell undergoes degeneration due to the action of an irritant, the degenerative process also affects the nerve fibre of that cell. This is known as **descending degeneration** .
- o Degeneration can also begin in the nerve fibre and progress towards the nerve cell (**ascending degeneration**).

PATHOLOGY OF THE PERIPHERAL NERVES

Histopathology

- o Microscopically, both axis cylinder and myelin sheath are simultaneously involved (total degeneration).
- o Loss of the myelin substance is called demyelination.
- o When a nerve fibre (axon gets severed from cell body, the distal part of the nerve fibre undergoes characteristic degenerative changes known as Wallerian degeneration .

PATHOLOGY OF THE PERIPHERAL NERVES

Regeneration

- Nerve fibres in the central nervous system cannot regenerate as it is lacking a sheath of Schwann, but the peripheral nerves regenerate fairly rapidly.
- In a degenerated nerve fibre there are also attempts at repair.
- Repair in a nerve fibre is a prolonged process and it requires 10 to 12 months for complete healing.
- Schwann cells play a leading role in the healing of nerves.

Neuritis

o Neuritis is inflammation of the peripheral nerve.

Etiology

o Trauma

o Viruses – Marek’s disease, Ranikhet disease.

o Toxins – bacterial mostly. Neuritis occurs in infectious diseases as in strangles, protozoal – dourine, viral - rabies and distemper.

o Chemical poisons – lead, mercury, arsenic, alcohol

o Nutritional deficiency – deficiency of the members of vitamin B group.

o Allergic factors.

Neuritis

Gross pathology

- o More often no naked eye changes are noticed.
- o The nerve may be swollen, reddened, soft or flabby.

Histopathology

- o Microscopically, inflammation of the nerves is usually accompanied by degenerative changes.
- o Degenerative changes even leading to Wallerian degeneration are found.
- o Edema and infiltration by inflammatory cells of interstitial connective tissue can be seen.
- o The exudates may be serous (serous neuritis) or purulent (purulent neuritis). The latter variety may destroy the nerve completely.

NEOPLASMS AFFECTING THE NERVOUS SYSTEM

Primary tumors

- Primary tumors of the brain and spinal cord are rare. However, tumors of the central nervous system are most common in dogs and least common in the pig and sheep.
- Primary tumors include those of the neuroglia (gliomas, astrocytoma, oligodendroglioma), nerve cell and fibres (neuromas), ganglion cells (ganglioneuroma), ependymal cells (ependymomas) and of meninges (meningiomas).

- The brain tumors are of limited malignancy, metastases not occurring elsewhere. Pressure on the brain by the developing neoplasms produces various symptoms depending upon the part of the brain involved and the functional disturbances in turn are dependent on the neurons of the part which are responsible for them. Death is the invariable outcome.

Secondary tumors

- Central nervous system is also prone to secondary tumors, which are metastatic, their primary sites being the lung or some other organ.

POSTMORTEN CHANGES IN THE BRAIN

- Post mortem changes in the brain include hypostatic congestion and softening of the brain.

Quiz

1. Necrosis of brain is known as

- A). Encephalomalacia
- B). Polioencephalomalacia
- C). Myelomalacia
- D). None

2. Removal of dead neurons through microglial cells is known as

- A). Satellitosis
- B). Neuronophagia
- C). Perivascular cuffing
- D). None

3. Which one is the most common type of necrosis in the brain

- A). Coagulative necrosis
- B). Fat necrosis
- c). Caseous necrosis
- D). Liquefactive necrosis

Thank you

CHAPTER-9
SKELETAL SYSTEM
PATHOLOGY
BY
Dr. MULUKEN YAYEH

Learning objectives

❖ To know about pathology of bone.

NORMAL BONE FORMATION

Bone cells

- Bone has three types of cells. These are as follows
 - **Osteocytes** are the ordinary bone cells that are found in the lacunae. These are old cells that cannot divide.
 - **Osteoblasts** are bone producing mesodermal cells and line the deep layer of periosteum, the endosteum and the Haversian canals.

NORMAL BONE FORMATION...

- These cells like fibroblasts have great power of proliferation and produce alkaline phosphatase.
- **Osteoblasts** secrete precursors of collagen and mucopolysaccharides.
- The latter act as the cement substance and in this is embedded collagen. These form the matrix of the bone called osteoid.

NORMAL BONE FORMATION...

o **Osteoclasts** are the phagocytes of bone and are multinucleated. Foreign body giant cells can be formed from them.

These are under the control of **parathyroid** and under its influence remove bone.

NORMAL BONE FORMATION...

Normal calcification

- The cartilage cells nearest the diaphysis become degenerated and calcified.
- Then the capillaries nearby invade and corrode the cartilage, on the remnant trabeculae of which the osteoblasts arrive and form the organic matrix, the osteoid, over which calcium salts are deposited.

NORMAL BONE FORMATION...

Various factors which govern bone formation

- **Proteins:** Sufficient amount of protein must be fed for the formation of the ground substance osteiod.
- **Minerals:** sufficient amount of calcium and phosphorus must be supplied in the food in correct proportion and the intestinal tract must be healthy and of correct pH for their absorption.
- Normally, the Ca : P ratio in food should be 2:1.
- **Vitamins:** Vitamins A, D and C control bone formation.

NORMAL BONE FORMATION...

- o **Vitamin A** deficiency produces inanition and growth rate is retarded. It is concerned with the metabolism of endothelial cells and so is required for the proliferation of endothelial cells of the capillaries, for their transformation into osteoblasts and for the
 - erosion and removal of the calcified cartilage.
- o **Vitamin D** controls absorption and utilization of calcium and phosphorus.
- o **Vitamin C** controls the formation of osteoblasts and so controls deposition of osteoid.

NORMAL BONE FORMATION...

- **Alkaline phosphatase:** *The alkaline phosphatase found in bone is formed by the osteoblasts.*
- This enzyme splits the organic phosphate compounds liberating excess of phosphate which upsets the local calcium phosphate balance leading to the precipitation of calcium salts.
- It is in this manner that mineralization of the osteoid (the organic matrix of the bone) takes place

NORMAL BONE FORMATION...

Endocrines

- Parathyroid controls calcium and phosphorus metabolism.
 - It increases the phosphate diuresis and
 - It produces hypercalcemia through its action on the osteoclasts which withdraw calcium from the bone.

NORMAL BONE FORMATION...

o **Anterior Pituitary**

- The growth hormone influences the growth of connective tissue especially bones.
- Gigantism occurs when there is increased secretion of growth hormone and the bony growth is enormous.

NORMAL BONE FORMATION...

o Thyroid

- Thyroxin controls the metabolism of **carbohydrates** and **fats** and so energy production is under its control. Indirectly therefore, bone formation is influenced by the thyroid as energy production is controlled by it.
- In hypothyroidism, there is retardation of endochondral bone formation and
- osteoporosis which occurs due to negative metabolism balance

NORMAL BONE FORMATION...

- Gonads and Adrenal cortex
- Bone, growing and mature is affected by estrogens and androgens.
- These hormones accelerate the epiphyseal closure and maturation of the bone.
- In deficiency of these hormones, there is disproportionate elongation of immature lone bones.

ANOMALIES AND ABNORMALITIES OF BONE

- The following terms indicate certain anomalies and abnormalities in the skeletal system.
- **Amelia** Absence of limbs. The scapula and pelvic girdle may be intact or rudimentary.
- **Brachia** Absence of anterior limbs.

ANOMALIES AND ABNORMALITIES OF BONE

- **Apodia** Absence of posterior limbs.
- **Micromelia** All parts of limbs are present but are of smaller size.
- **Perodactyly** Absence of all toes in a limb.

ANOMALIES AND ABNORMALITIES OF BONE

- **Brachydactylism** - Abnormal shortening of toes.
- **Polydactylism** - Presence of more number of digits; seen in horse and pig.
- **Syndactylism** - Fusion of toes seen in cattle and pigs.
- **Prognathism** - Having a long jaw; pig-mouth condition in horse
- **Brachygnathism** - Having a short jaw; parror-mouth in horse.

ANOMALIES AND ABNORMALITIES OF BONE

- **Kyphosis** Abnormal dorsal curvature with prominence of spine (hump back) is called kyphosis. It is rare in animals.
- **Lordosis** It is the curvature of the spine with a ventral convexity due to heavy loads or heavy abdominal organs; terminal parts of the thoracic spine and the lumbar spine are involved.
- The spinous processes rub against each other and so periostic osteophytes develop.

ANOMALIES AND ABNORMALITIES OF BONE

- **Scoliosis** Abnormal lateral curvature of the spinal column is called scoliosis. It may be congenital and sometimes inherited. It may be due to disease of bones like achondroplasia, osteodystrophy.
- **Torticollis** - This is twisting of the neck with an unnatural position of the head.

ANOMALIES AND ABNORMALITIES OF BONE

- **Osteodystrophy** It denotes disturbance in the growth of bone. Osteodystrophies may be acquired or congenital.
- It may be due to Lack of minerals and vitamins (Rickets and osteomalacia etc.)
- Excessive hormones- gigantism acromegaly, osteoporosis.

RICKETS

- ❖ Rickets is failure of adequate deposition of calcium in bones of growing animals caused by deficiency of calcium and vitamin D .
- ❖ characterized by bending of limbs, enlargement of ends of long bones and skeletal deformities.

Etiology

- Vitamin D deficiency
- Calcium deficiency
- Deficiency of phosphorus

RICKETS

Macroscopic and microscopic features

- Bending of legs, bow legs
- Pot belly
- Enlarged costochondral articulation
- Softening of bones

RICKETS

- Increase in proliferating cartilage adjacent to the area of ossification and its disorderly arrangement.
 - Disorderly penetration of cartilage by blood vessels
 - Increased area of uncalcified osteoid tissue
 - Fibrosis of marrow

RICKETS

Pathogenesis

The essential defects in rickets are

- o The cartilage cells are resistant to degeneration and are not calcified.
- o The blood vessels fail to invade and corrode the cartilage.
- o On the persistent and growing cartilage, there is overgrowth of the osteoid.
- o The osteoid is not calcified.
- o In the osteochondral zone, fibrous tissue proliferates.

FIBROUS OSTEODYSTROPHY

- ❖ “Bran disease”
- ❖ Fibrous osteodystrophy occurs as excessive action of parathyroid hormone on bones
- ❖ characterized by bone resorption with replacement by fibrous tissue, increased osteoid formation which does not get sufficient minerals for deposition and formation of cysts

FIBROUS OSTEODYSTROPHY

Etiology

- Hyperparathyroidism
- Dietary deficiency of calcium or excess of phosphorus
- Vitamin-D deficiency
- Excessive bran feeding (feeding miller)

Macroscopic and microscopic features

- Lack of calcification in bone
- Resorption of calcium from bone, fibrosis
- Bone becomes soft, flexible and deformed
- Rubbery jaw due to involvement of facial bones
“Big Head”.
- Fibrous tissue hyperplasia in bones.
 - Bone tissue is replaced by fibroblasts, with osteoclastic giant cells lining the remaining bone *tissue*

OSTEOMALACIA

- Osteomatacia is also known as *adult rickets*.
- It occurs in bone of adults caused by deficiency of vitamin D and calcium and characterized by softening of bones.

Etiology

- Vitamin-D deficiency
- Calcium-phosphorus ratio disturbance

Macroscopic and microscopic features

- Softening of bones
 - Irregular diffuse thickening of bones
- Bone deformities
 - Increase in osteoid tissue with failure of calcification
 - Increase in osteoclastic activity

OSTEOPOROSIS

- Osteoporosis is atrophy of bones caused by possibly hormonal imbalance and characterized by inadequate deposition of calcium, brittleness of bones due to its increased porosity. “there is reduction in the bony matrix”.

Etiology

- Hormonal imbalance
- Vitamin C deficiency
- Copper deficiency

Macroscopic and microscopic features

- Inadequate calcium deposition
- Bone becomes brittle and porous
- Increased fragility of bones
- Widening of Haversian canals
- Increased activity of osteoclasts
- Decrease in zona compacta and thickness of bone trabeculae

OSTEOPETROSIS

- Osteopetrosis is enlargement of bone caused by fluorosis or avian leukosis virus and characterized by increase in bony tissue. It is also known as *marble bone disease*.

Etiology

- Avian leukosis virus of retroviridae family
- Fluorosis

Macroscopic and microscopic features

- Enlargement of bone towards outside and inside.
- Reduced marrow cavity
- Bone becomes brittle, marbelling of bones.
- Cartilage is also calcified, surrounded by osteoid tissue.

OSTEOMYELITIS

- Osteomyelitis is the inflammation of bone with bone marrow caused by trauma and pyogenic bacteria and characterized by destruction, replacement and excessive growth of new bone adjacent to the infected part.

Etiology

- Hematogenous infection
- Direct infection through trauma/ fracture
- *Actinomyces pyogenes*, *A. bovis*
- *Staphylococcus aureus*

OSTEOMYELITIS

- *Pseudomonas aeruginosa*

Macroscopic and microscopic features

- Metastatic abscess in bone marrow
- Excessive growth of bone in adjacent area.
- Exostosis or endostosis.
- Infiltration of neutrophils
- Proliferation of osteoid tissue
- Demonstration of bacteria in pus

BONE FRACTURE AND REPAIR

- ❖ Fracture is the break in the continuity of bone due to trauma.
- ❖ A fracture may be simple or compound depending on the severity of trauma.
- ❖ Healing of fracture occurs by reunion of the broken ends of bone through development and proliferation of fibroblasts, angioblasts, osteoid tissue and infiltration of calcium salts.

BONE FRACTURE AND REPAIR

Etiology

- Trauma
- Accidents-automobile accidents.

Macroscopic and microscopic features

- Fracture can be identified by break in bones:
- Healing of fracture is characterized by development of callus at the site of reunion of break ends of bone.

BONE FRACTURE AND REPAIR

- Proliferation of fibroblasts, angioblasts and metaplasia of connective tissue to osteoid tissue.
- Areas of calcification in osteoid tissue
- This fibrovascular tissue is strong enough to keep the two broken ends together and is known as a soft tissue callus . (Callus, Latin for a hard substance).

PULMONARY OSTEOARTHROPATHY

- Pulmonary osteoarthropathy is a rare disease of dog, sheep, cat, horse, and lion caused by prolonged anoxia and characterized by cough, dyspnea, respiratory disturbances and formation of new bone leading to thickening and deformity of limbs.

PULMONARY OSTEOARTHROPATHY...

Etiology

- Prolonged anoxia
- Toxaemia

Macroscopic and microscopic features

- Pneumonia
- New bone formation just beneath the periosteum in long bones.
- The proliferation of bone is irregular leading to rough surface

PULMONARY OSTEOARTHROPATHY...

- Bone becomes enlarged twice to its normal size.
 - Heart worms in case of dogs.
 - Bronchogenic carcinoma
 - Granulomatous lesions of tuberculosis
 - Chronic bronchiectasis
 - Hyperplasia of osteoid tissue with no indication of any kind of neoplastic growth in bones.

SPONDYLITIS

- Spondylitis is the inflammation of vertebrae caused by bacterial fungi and characterized by caseation, intraosseous abscess formation granulomatous lesions and Fibrosis.
- Etiology
 - *Brucella abortus, Br. ovis, Br. melitensis*
 - *Actinornyces bovis*
 - *Coccidioidornyces* sp.

SPONDYLITIS

Macroscopic and microscopic features

- Intraosseous abscess
- Granuloma encapsulated by fibrous tissue involving one or two adjacent vertebrae.
- Local enlargement of bone.
- Granulomatous lesions with caseation
- Proliferation of osteoid tissue
- Infiltration of neutrophils in intraosseous abscess.

PATHOLOGY OF JOINTS

ARTHRITIS

- ❖ Arthritis is the inflammation of joint caused by bacteria, virus, chlamydia, mycoplasma and immune complexes and characterized by serous, fibrinous, purulent or ankylosing lesions in joints.

ARTHRITIS

Pathology of Joints

- Normally, the young cartilage is whiter and translucent. As it ages it becomes opaque,
- yellowish and less and less elastic.

Definition

Inflammation of the joint is called arthritis.

Terminology

- **Inflammation** of hip joint is called Coxitis
- Inflammation of stifle joint is called gonitis

ARTHRITIS

Etiology

- Bacteria- *E. coil*, *Erysipeias rhusicpathae*, *Streptococcus* sp., *Shige lla* sp. *Corynebacterium avis*, *Brucelia* sp.
- Mycoplasma- *Mycoplasma mycoides*, *Mycopiasma sinoviae*
- Virus- Reovirus (Tenosynovitis in birds)
- Antigen antibody complexes
- Trauma

Macroscopic and microscopic features

- Swelling of joints with increase in synovial fluid.
- Difficulty in movement
- In chronic cases fusion of two bony processes leaving no joint (ankylosing)
- Synovial fluid diminishes, becomes dirty, thick in chronic illness
- Presence of increased number of leucocytes in synovial fluid
- Serous fibrinous or purulent exudates in joints
- Thickening of synovial memberane
- Presence of plasma cells and immature complaxes in synovial fluid.

THANK YOU

Chapter-10
PATHOLOGY OF MUSCLES
by
Dr. Muluken Yayeh

Learning objectives

To know about pathology of muscles.

DISEASES OF SKELETAL MUSCLE

Atrophy of skeletal muscle

Etiology

- *Senility*
- *Disuse.*
- *Starvation*
- *Atrophy of wasting diseases, cachexia and malnutrition*
- *Pressure*
- *Denervation*

Gross pathology

- The muscle which is normally pink, loses this color and turns pale, grey or brown.
- It is firmer due to replacement by fibrous tissue.
- Due to uneven atrophy of different muscles, disfigurement may occur.
- Skeleton becomes prominent

The size of the muscle fibres is reduced.

- Sarcoplasm may become so reduced and in some places may even disappear, that the sarcolemmal nuclei become prominent.
- There may be deposition of “wear and tear” pigments at the poles of nuclei giving the muscle a brown color-brown atrophy
- The cell nuclei may proliferate and fill the empty sheath.

AZOTURIA

Synonym

- Equine myoglobinuria; Monday-morning sickness; Paralytica hemogloburia

Definition

- Azoturia literally means “nitrogen in the urine.”

Clinical signs

- Azoturia is found to occur suddenly in horses going to work after complete rest for a few days but maintained on full work-rations.
- The animals suddenly stop; sweat, shiver and show great suffering from pain in the lumbar regions
- The affected muscles are those of gluteal, lumbar and femoral regions and are swollen and board-like. Soon the animal passes coffee colored dark-brown or black urine since it contains large amount of myoglobin.

AZOTURIA

Animals lie down and soon die.

- Those that survive are weak and it takes a long time for them to recover and for the atrophied muscles to regain their normal state.

Clinical pathology

- Urine shows granular reddish casts and few hyaline casts

Gross pathology

- The affected muscles are swollen, pale and have increased amount of interstitial fluid.

AZOTURIA

- Necrosed muscle liberates myoglobin which is excreted in the urine.
- Large masses of myoglobin in the urine appear to produce renal blockade, renal ischemia and lower nephron nephrosis where in the epithelium of the distal convoluted tubules as well as
- that of Henle's loops are degenerated some of which become necrosed and desquamated.
- This condition causes degenerative changes in the tubules and so anuria and fatal uremia results
- Death is due to renal insufficiency leading to uremia.

Macroscopic and microscopic features

- Hardening of muscle just like wood
- Urine is dark brown with *myoglobin-myoglobinuria*
- Tonic spasms in muscles
- Atrophy of affected muscles in chronic cases
- Necrosis of muscle fibers
- Edema
- Hyaline degeneration.
- Invasion of sarcolemma by macrophages and lymphocytes
- Degeneration and necrosis of tubular epithelium in kidneys.

WHITE MUSCLE DISEASE

❖ Stiff-lamb disease

Extensive coagulative necrosis of muscles is observed in calves possibly due to deficiency of vitamin E during 6 month of age.

Etiology

- Vitamin E deficiency
- Selenium deficiency
- Stress

MYOSITIS

Definition

- Inflammation of the muscle is called myositis.

Types

- This may be acute or chronic.

Etiology

- The routes of infection and causes are
 - o Trauma
 - o By direct extension from lesions of neighbouring arthritis, osteitis or periostitis
 - o In pyemia, hematogenously
 - o By parasitic infection.

MYOSITIS

Macroscopic and microscopic features

- Colour of muscle becomes pale pink, yellowish red, grey or white.
- Muscle becomes dry, inelastic and firm.
- Urine is brown/ red or chocolate brown in colour because of myoglobin.
- Coagulative necrosis of muscles.
- In some muscle cells, cloudy swelling can be observed.
- Neutrophils, macrophages, lymphocytes and eosinophils may present.
- Calcium may be deposited in necrosed areas.

ACUTE MYOSITIS

- ❖ Acute myositis is the acute inflammation of skeletal muscles characterized by the presence of serous, fibrinous or haemorrhagic exudates.

Etiology

- Trauma
- Vitamin E/ Selenium deficiency
- *Clostridium chauvoci*, the cause of black leg in cattle

ACUTE MYOSITIS

Macroscopic and microscopic features

- Muscles become extremely moist.
- Colour becomes red, consistency is firm and tense.
- Swelling and accumulation of gas in muscles, crepitating sound on palpation

ACUTE MYOSITIS

- Muscle dark red/ black with gas mixed exudates.
- Presence of serous, fibrinous and/or haemorrhagic exudate.
- Infiltration of neutrophils, macrophages, lymphocytes, etc.
- Degenerative and necrotic changes in muscles.
- Presence of Gram positive rods in exudate.

HEMORRHAGIC MYOSITIS

- Haemorrhagic myositis is characterized by the presence of large amount of blood and inflammation in muscles. It may occur due to trauma and muscle rupture.

Etiology

- Trauma
- Clostridial infections

HEMORRHAGIC MYOSITIS

Macroscopic and microscopic features

- Area becomes red/ cyanotic.
- On cut, large amount of blood comes out from muscles.
- On touch, the affected area is hard and painful to touch.
- Regional lymphnodes may become enlarged and swollen.
- Extravasation of blood in between the myofibrils.
- Infiltration of neutrophils, macrophages and lymphocytes in connective tissue between the muscle cells.

CHRONIC MYOSITIS

inflammation of muscle is characterized by necrosis, calcification and proliferation of fibrous connective tissue.

- In case of tuberculosis and pseudotuberculosis, there are multiple, focal nodules containing caseation and fibrous capsule.

CHRONIC MYOSITIS

Etiology

- *Mycobacterium tuberculosis*
- *Corynebacterium pseudotuberculosis*
- *Trichinella* spp. infection
- *Sarcosporidia* spp. infection

Macroscopic features

Muscles become hard to touch

Nodules can be seen.

- On cut the lesions of caseation and calcification observed.
- Caseative necrosis, infiltration of macrophages, lymphocytes and proliferation of fibrous tissue.
- Calcification can also be observed.
- In cases of pseudotuberculosis infiltration of neutrophils is seen.
- Extensive infiltration of eosinophils in sarcoporidia infection.

PARASITIC MYOSITIS

- The following parasites are found to infect the muscles of animals.

- Toxoplasma-protozoal

Trichinella spiralis

- o This is found in man, pig and other animals.
- o The larvae are encysted in many muscles, especially those of diaphragm, intercostals muscles and tongue.
- o The cysts are parallel to the muscle fibres which undergo granular degeneration of the sarcoplasm.
- o Intense infiltration by eosinophils, plasma cells, histiocytes and lymphocytes occurs
- o Sarcolemmal nuclei proliferate

Sarcosporidiosis

- o The sarcosporidia are present in the skeletal and cardiac muscle of all species of animals.
- o No specific disease has been attributed to these parasites.
- o Though light infections cause no perceptible symptoms, heavy infections may be responsible for lameness, weakness, paralysis, emaciation and sometimes even death.
- o Parasitised muscle fibres are destroyed by the parasite and the adjacent cells undergo pressure atrophy.

Cysticercus

infects the muscles of pig.

- The muscles of the shoulder, neck, diaphragm, tongue, intercostals, abdominal and cardiac muscles are affected.
- Heavy infection may result in fatal anemia and