CONGENITAL ANOMALIES of the INTESTINE I

- **Segmental Anomalies**
- **Stenosis** *(incomplete occlusion or narrowing of the lumen)*
  - **Atresia** *(complete occlusion of the lumen)*
    - Atresia coli
    - Atresia ilei
    - Atresia jejunni
    - Atresia ani
    - Atresia ani and recti
CONGENITAL ANOMALIES of the INTESTINE II

- Short colon (cats and dogs)
- Hypoplasia of the small intestine (foals)
- Congenital colonic agangliosis (foals)
- Persistent Meckel’s diverticulum (swine and horses)
- Intestinal diverticula
PERSISTENT MECKEL’S DIVERTICULUM

- Occurs mostly along the antimesenteric border of the lower small bowel.
- Mainly in swine and horses.
- Derived from the omphalomesenteric (vitelline) duct, which is the stalk of the yolk sac.
MISCELLANEOUS CONDITIONS OF THE INTESTINAL TRACT

- Intestinal Lipofuscinosis
- Muscular hypertrophy of the ileum (swine and horses)
- Diverticulosis of the small intestine
- Intestinal emphysema in pigs
- Rectal prolapse (swine, sheep and cattle)
Intestinal obstruction may be the sequel to a physical blockage of the lumen resulting from stenosis (narrowing, stricture) caused by an intrinsic lesion involving the intestinal wall, obturation (occlusion) by an intraluminal mass, or extrinsic compression.
1. STENOSIS AND OBTURATION

Segmental congenital anomalies of the intestine (stenosis and atresia)

Possible causes:

- Acquired stenosis (intramural abscesses, primary neoplasms and scarring following following ulceration)
- Foreign bodies
- Enteroliths*, phytobezoars*, trichobezoars*
- Parasites
- Impaction of the colon, by feces in dogs and cats
- Impaction of the ileum, by feces in horses
- Impaction of the cecum or colon in horses
- Gravel
Enteroliths (mineral concretions) were historically common in the colon of horses.

Mineral salts are deposited in concentric lamellae around a central nidus—a foreign body such as a nail, wire, stone, or particle of feed

Phytobezoars or fiber balls consist largely of plant fibers intermixed with phosphate salts, may be found especially in the colon of horses

Hairballs (trichobezoars) sometimes occur in dogs, cats, and ruminants; in ruminants they occur mostly in the forestomachs.
2. EXTRINSIC OBSTRUCTION

- TUMORS
- ADHESIONS
- ABDOMINAL FAT NECROSIS
- PEDICLES OF SOME TUMORS
- INCARCERATION IN HERNIAS
3. FUNCTIONAL OBSTRUCTION

Failure of the intestinal circular smooth muscle to contract blocks the peristaltic wave, causing **functional obstruction**, a clinical syndrome of pseudo obstruction in which there is no physical occlusion of the lumen of the impacted intestine.

- Paralytic ileus
- Pseudo-obstruction (neuromuscular dysfunction)
- Ganglioneuritis or neuronal hypocellularity
- Megacolon in Clydesdale foals-hypoganglionosis of the myenteric plexus
- *Grass sickness* in horses
- Feline dysautonomia or **Key-Gaskell syndrome**
- Intrinsic disease of intestinal smooth muscle (syndrome of intestinal sclerosis)
CLINICAL SYMPTOMS AND CIRCUMSTANCES LEADING TO DEATH IN INTESTINAL OBSTRUCTION

- Acute shock
- Endotoxemia
- Dehydration
- Tympany
- Ischemia
- Autointoxication
- Electrolyte imbalance
- Gastric and intestinal rupture
- Disseminated
- Paralytic ileus
DISPLACEMENTS OF THE INTESTINES

1. EVENTRATION

Displacement of a portion of the gut, usually the small intestine, outside the abdominal cavity.

- Congenital
  - Schistosomus reflexus
  - Patent umbilicus
  - Congenital diaphragmatic hernia

- Acquired (trauma)
2. CECAL AND COLONIC DILATION, TYMPANY AND TORSION

- In ruminants, cecal dilation and torsion
  - Occurs in animals fed High-concentrate rations
  - Has been associated with late gestation and ileus from other causes

Volatile fatty acids → Atony → Dilation → Rotation and torsion → Obstruction and cecal strangulation
In horses, cecal and colonic tympany

- Severe abdominal distension
- Compression of intra-abdominal organs
- Reduced cardiac return due to postcaval compression
- Reduced respiratory capacity due to compression of the diaphragm
- Severe pain
- Hypovolemia, acidosis, large bowel ruptures
- Laminitis (in recovered horses)

Clinically

- Readily fermentable carbohydrate
3. DISPLACEMENTS OF THE EQUINE COLON

- Right dorsal displacement of the colon
- Left dorsal displacement of the colon
- Colonic torsion and volvulus
4. INTERNAL HERNIA

- Herniation through a natural foramen
  (foramen of Winslow)
- Omental hernia
- Mesenteric hernia
- Pelvic hernia
- Hernia spatii renolienalis
4. EXTERNAL HERNIA

- Ventral hernia of the abdominal wall
- Umbilical hernia
- Parietal hernia
- Inguinal hernia
- Scrotal hernia
- Femoral hernias
- Perineal hernias
- Diaphragmatic hernias
INTESTINAL ISCHEMIA AND INFARCTION

1. VENOUS INFARCTION

- Displacements of intestine
- Torsion of the long axis of the mesentery
- Volvulus
- Invagination (Intussusception)
- Cecal inversion and cecocolic intussusception in the horse
- Segmental ischemic necrosis of the small colon
INVAGINATION (INTUSSUSCEPTION)

• Telescoping of intestine one portion into another.

• Linear foreign bodies, heavy parasitism, previous intestinal surgery, enteritis, and intramural lesions such as abscesses and tumors may be associated.

• Common in dogs, most frequently ileocolic.

• Venous infarction of the intussusceptum. Edema, congestion, necrosis and gangrene may develop.
2. ARTERIAL THROMBOEMBOLISM

- *Mannhemia* spp (*Pasteurella* spp) septicemia in lambs
- *Histophilus somni* bacteremia in cattle
- Endoarteritis, mainly at the root of the cranial mesenteric circulation, caused by migrating larvae of *Strongylus vulgaris*
3. REDUCED PERFUSION

- Hypovolemic states (hemorrhagic shock in the dog, cat and possibly other species)
- Disseminated intravascular coagulation (DIC-dogs)
- Hepatic disease and portal hypertension (dogs)
- Hypotensive shock due to heart failure
- Verminous endoarteritis (horses)
- Acute acorn poisoning in the horse
- Mercury poisoning (horse)
- Nonsteroidal anti-inflammatory drugs (horses and dogs)
  - Phenylbutazone (horse)
  - Flunixin meglumine (horse/dog)
THE CONSEQUENCES OF ISCHEMIC LESIONS

- Strangulation, volvulus and similar lesions
  → Physical obstruction + Ileus

- Reduced arterial perfusion or thromboembolism
  → Functional obstruction + Ileus

- Effusion of tissue fluid and blood into the lumen, proliferation of anaerobes occurs in the lumen of the ischemic area with accumulation of gas
  → Gangrene + Rupture of ischemic gut

- Toxin production by anaerobes (*Clostridia*)
  → Circulatory failure

- Absorption of endotoxin
  → Septic peritonitis

- Transmural invasion by enteric bacteria
MALASSIMILATION and PROTEIN-LOSING SYNDROMES

- **LYMPHANGIECTASIA**

  - Common in dogs.
  - Most common cause of malassimilation and protein-losing enteropathy.
  - Associated with a syndrome characterized by:
    - Chronic diarrhea
    - Hypoproteinemia (Peripheral edema, ascites, hydrothorax)
    - Lymphopenia
    - Hypocalcemia
    - Hypocholesterolemia
    - Dilation of the lacteals, and often lymphatics of the submucosa, muscularis, serosa, and mesentery
- **CHRONIC INFLAMMATORY DISEASES**
  - Lymphocytic-Plasmacytic enteritis
  - Eosinophilic gastroenteritis in dogs
  - Eosinophilic granuloma
  - Eosinophilic enteritis in cats
  - Chronic eosinophilic enteritis in horses
  - Granulomatous enteritis
    - Paratuberculosis (Johne’s disease)
    - *Histoplasma* enteritis
    - Transmural granulomatous enteritis in dogs and cats
    - Idiopathic granulomatous enteritis in horses

- **AMYLOIDOSIS**
TYPHLOCOLITIS IN DOGS

- Glucocorticoid administration
- Functional adrenal cortical tumors
- Trauma
- Surgery involving the spinal cord

- Indomethacin (analgesic/experimentally → Ulcerative colitis)
- Uremia (necrotizing colitis/ulceration/perforation)
- Canine intestinal hemorrhage syndrome (Clostridial, C. difficile)
- *Clostridium difficile* → Ulcerative colitis
- *Trichuris vulpis* → mild colitis, hemorrhagic typhlitis, typhlocolitis

Ulceration, perforation, Peritonitis, necrotizing colitis, typhlocolitis
COLITIS IN CATS

- Idiopathic mucosal colitis
- Feline panleukopenia virus
- Mycotic colitis (*Candida, Zygomycetes, Aspergillus* hemorrhagic ulcerative colitis)
- Necrotic colitis
- Feline leukemia virus
- *Bacillus piliformis* (mild colitis)
- *Salmonella typhimurium* (Transmural acute ulcerative colitis)
- Ulcerative colitis
- Granulomatous or pyogranulomatous foci (Regional enterocolitis-feline infectious peritonitis virus)
TYPHLOCOLITIS IN HORSES

- Acute colitis
- Salmonellosis
- Equine monocytic ehrlichiosis
- *Rhodococcus equi*
- Histoplasmosis
- *Larval cyathostomes*
- *Larval strongyles*
- *Anoplocephalid tapeworms*
- Ischemic mucosal lesions
- Phenylbutazone
- Right dorsal colitis
- Granulomatous and eosinophilic typhlocolitis
- *Tritrichomonas*
TYPHLOCOLITIS IN RUMINANTS

✓ CATTLE
✓ Salmonellosis
✓ Bovine viral diarrhea
✓ Rinderpest
✓ Coccidiosis
✓ CGB
✓ Adenoviral infection
✓ Winter dysentery
✓ Arsenic
✓ Heavy metals
✓ Oak or acorn poisoning
✓ Trichuriasis (rarely/calves/hemorrhagic mucosal typhlitis)
✓ Johne’s disease (Granulomatous typhlocolitis)

Acute to subacute fibrinohemorrhagic typhlocolitis (over 2-3 months of age)

Acute fibrinohemorrhagic typhlocolitis
SHEEP

- Bluetongue
- Peste des petits ruminants

- Heavy metals intoxication
- Salmonellosis
- Trichuriasis
- Coccidiosis

- Cl. perfringens type D enterotoxemia (goats)

Hemorrhagic

Hemorrhagic typhlocolitis

Fibrinohemorrhagic enteritis

Mucohemorrhagic typhlitis/typhlocolitis

Hemorrhagic ileotyphlocolitis

Fibrinohemorrhagic typhlocolitis
VIRAL DISEASES OF INTESTINE

- ADENOVIRAL ENTERITIS
- ENTERIC CORONAVIRUS INFECTION
- ROTAVIRUS INFECTION
- DISTEMPER

- PARVOVIRAL ENTERITIS
  - Feline panleukopenia
  - Canine parvovirus 2 infection
  - Canine minute virus
  - Bovine parvovirus infection

- HERPESVIRUS INFECTION
  - Canine herpesvirus infection
  - Equine herpesvirus infection
  - Aujeszky disease
ADENOVIRAL ENTERITIS

**CATTLE** (10 serotypes)
✓ 1-8 → pneumoenteritis complex

**SHEEP** (6 serotypes)
✓ S. 1,2,3 → isolated from feces of normal sheep and lambs with enteritis and pneumoenteritis
✓ S. 4,5,6 → respiratoric diseases

**PORCINE** (4 serotypes)
✓ Asymptomatic infections
✓ Isolated from feces of normal pigs

**EQUINE** (2 serotypes)
✓ S.1 → subclinical/upper respiratory infection + duodenal villus atrophy
✓ S.2 → Foals with diarrhea

**DOGS**
S.1 → Infectious hepatitis + diarrhea
S.2 → Upper respiratory tract infections
BOVINE ADENO VIRUSES

- Occur sporadically in 1-8 week-old calves and in feedlot animals.
- Fever, diarrhoea, dehydration, congested mucous membranes.
- Necrotic areas and ulcers in the forestomach and abomasum.
- The intestinal lesions vary from slight distention with excessive fluid to severe multifocal or diffuse necrosis, which may be covered by a pseudodiphtheritic membrane.
- Congested and hemorrhagic colon
ENTERIC CORONOVIRAL INFECTIONS

CATTLE

- Common cause of diarrhea, alone or in combination with Rotavirus and Cryptosporidium in neonatal calves.
- At autopsy, affected animals have the nonspecific lesions of undifferentiated neonatal calf diarrhea.
- Rarely, mild fibrinonecrotic typhlocolitis is recognized.
- Mesenteric lymph nodes may be enlarged and wet.
- Microscopically villus atrophy in combination with mild colitis is typical.

✓ Respiratory tract infection in calves
✓ Winter dysentery
ENTERIC CORONOVIRAL INFECTIONS

SWINE

- Hemagglutinating encephalomyelitis virus causes vomiting and wasting disease in suckling piglets
- Transmissible gastroenteritis virus
- Porcine epidemic diarrhea virus (Coronavirus 777)

DOGS

CATS

SHEEP

FOALS

Diarrhea

Syndromes of acutediarrheal disease in all age groups and chronic diarrhea and runting in weaned pigs
PARVOVIRAL ENTERITIS

- Genus parvovirus (Feline panleukopenia virus and Canine parvovirus 2)
- Replicates in tissues with a high mitotic rate (Enteric epithelium, hematopoietic and lymphoid tissue)
Parvoviral Enteritis

- Clinical symptoms: Diarrhea (bloody), Dehydration and electrolyte depletion, vomition, anemia,..

- Infection of the fetus during late prenatal life by FPV causes anomalies of the central nervous system, mainly hypoplasia of the cerebellum.

- Infection of proliferating cardiac myocytes in young puppies with CPV-2 results in nonsuppurative myocarditis.

- Fibrinous and hemorrhagic enteritis.
• Necrosis and dilation of crypts of Lieberkuhn.
• Villous atrophy occurs secondary to crypt cell destruction.
• Basophilic intranuclear inclusion bodies in enterocytes and lymphocytes early in infection.
• Lymphocytolysis in follicles of lymph nodes, thymic cortex and splenic white pulp, and Peyer’s patches
CANINE DISTEMPER

- Morbillivirus
- Alimentary system, respiratory system, nervous system and skin.

- Alimentary system:
  - Diarrhea
  - Catarrhal gastroenteritis
  - hyperaemia
  - Intracytoplasmic/intranuclear inclusion bodies.
BACTERIAL DISEASES OF THE INTESTINE

ESCHERICHIA COLI

1. Enterotoxigenic colibacillosis (LT “heat-Labile” and ST “heat-stable” toxins)

2. Enteropathogenic colibacillosis
   - Entero-adherent *E. coli* (villus atrophy + enteritis)
   - Verotoxin-producing *E. coli* (diarrhea)
   - Enterohemorrhagic *E. coli* (hemorrhagic enterocolitis)
3. Edema disease of Swine  
   (Hemolytic *E. coli*)  
   Postweaning *E. coli* enteritis  
   (Hemolytic *E. coli*)

4. Enteroinvasive *E. coli* [humans and certain other species]

5. Septicemic colibacillosis  
   Peracute septicemic and endotoxemia  
   Subacute  
   Chronic  
   Joints/meninges/eye
PREDISPOSITION TO INFECTION

- Reduced transfer or absorption of maternal colostral immunoglobulin
- Intercurrent disease
- Debilitation
THE PORTAL OF ENTRY OF *E. coli*

- Navel in the neonate
- Upper respiratory tract
- Tonsil
- Intestine
- Nasopharyngeal route
The clinical and pathologic syndromes of salmonellosis typically vary from localized enterocolitis to septicemia; abortion may also occur, with or without obvious systemic disease.

Stressors are often implicated in Salmonellosis.

The ability to attach, invade, and penetrate enterocytes is crucial to virulence, and the first step in the development of salmonellosis.

Exotoxins lead to the degeneration and necrosis of enterocytes; endotoxins lead to thrombosis of mucosal venules and vascular lesions.
The virulence of *C. perfringens* is attributable to its capacity to produce up to 4 toxins (alpha, beta, epsilon, and iota) which are used to classify this microorganism into 5 toxinotypes, designated A-E.

- **Alpha toxin**: is a lecithinase that acts on cell membranes, producing hemolysis or necrosis of cells-major toxin of Type A.
- **Beta toxin**: Necrotizing and paralyzing effect on the intestine-Type B and C.
- **Epsilon toxin**: Effects on brain and kidney. Type B and D.
- **Iota toxin**: Increases capillary permeability. Type E.
ENTERIC CLOSTRIDIAL INFECTIONS

- *Clostridium perfringens* type A
  - Gas gangrene
  - Food poisoning
  - Colitis in horses
  - Diarrhea in pigs and calves
  - Acute intravascular hemolysis in calves and lambs
• **Clostridium perfringens** Type B
  ✓ Lamb dysentery
  ✓ Dysentery in calves and foals

• **Clostridium perfringens** Type C
  ✓ “STRUCK” in adult sheep
  ✓ Enterotoxemia in feedlot cattle
  ✓ Enterotoxemia in lambs, calves, pigs and foals

• **Clostridium perfringens** Type D
  ✓ Enterotoxemia- “Pulpy kidney” disease in sheep and goats

• **Clostridium perfringens** Type E
  ✓ Enteritis in calves and rabbits
PARATUBERCULOSIS (JOHNE’S DISEASE)

- *Most common in domestic ruminants.*
- Incubation period is protracted and irregular. Cattle are 2 years of age or older.
- **Persistent diarrhea**, progressive weight loss, debilitation, and eventually death.
- **Malabsorption** and filtration secretion caused by the inflamed small intestinal mucosa overloads the capacity of the colon to resorb electrolytes and fluid.
- Major lesions are confined to the *ileum, colon and lymph nodes*, the infection is generalized.
Gross lesions:

Lesions are usually best developed in the lower ileum and upper large intestine.

Diffuse thickening of the mucosa

Mucosal thickening is due to accumulation of predominantly macrophages, as well as edema fluid, in the mucosa and submucosa.

The ileocecal and mesenteric lymph nodes are enlarged, pale, and edematous.

Lymphangitis is common, and the lymphatic vessels can often be traced as thickened cords from the intestinal serosa through the mesentery to the mesenteric nodes.
Microscopic lesions:

- **Transmural granulomatous enteritis and lymphangitis.**
- **Macrophages** in the lamina propria, submucosa, muscular layers or the serosa of the intestine.
- **Epithelioid macrophages** and **Langhans-type multinucleated giant cells.**
- **Granulomatous lymphangitis** is one of the most consistent changes, and inflammatory cells can be observed along the lacteal vessels of villi, or in the submucosa.
MYCOTIC DISEASES OF THE INTESTINE

INTESTINAL PHYCOMYCOSIS and ASPERGILLOSIS

✓ Aspergillus spp. \( \rightarrow \) ASPERGILLOSIS

✓ Zygomycetes
  \[ \begin{align*}
  & Absidia \\
  & Mucor \quad \rightarrow \quad MUCORMYCOSIS \\
  & Rhizopus
  \end{align*} \]

✓ Oomycete \( \rightarrow \) Pythium spp. \( \rightarrow \) PYTHIOSIS “ = OOMYCOSIS”

✓ Entomophthoracetes
  \[ \begin{align*}
  & Basidiobolus \\
  & Conidiobolus \quad \rightarrow \quad ENTOMOPHTHOROMYCOSIS
  \end{align*} \]
CANDIDIASIS

- *Candida albicans*
- *Candida tropicalis*

INTESTINAL HISTOPLASMOSIS

- *Histoplasma capsulatum*
PARASITIC DISEASES OF THE INTESTINE

- ECHINOCOCCOSIS (HYDATIDOSIS)
  
  - *Echinococcus granulosus*
  - *E. multilocularis*
  - *E. oligarthus*
  - *E. vogeli*

- *E. granulosus granulosus*
  (Intermediate host ruminants and humans)

- *E. granulosus equinus*
Hydatid cysts

- Hydatid cysts are usually spherical, turgid and fluid-filled.
- The lining of fertile cysts is studded with small granular brood capsules which contain protoscolices; “hydatid sand” comprised of free brood capsules and protoscolices is in the fluid.
EQUINE STRONGYLOSIDIS

- Members of the family Strongylidae are common nematode parasites of the cecum and colon in horses.
  - *Strongylus vulgaris*
  - *Strongylus edentatus*
  - *Strongylus equinus*
Larval forms cause *endoarteritis* in the mesenteric circulation.

- Forming nodules ~5-8 mm in diameter
- Necrotic debris, neutrophils, some eosinophils and macrophages
- Obstructive thrombotic lesions
- Aneurisma
PROTOZOAL ENTERITIS

- GIARDIASIS
  - Giardia duodenalis

- AMOEBIASIS
  - Entamoeba histolytica

- BALANTIDIASIS
  - Balantidium coli
COCCIDIOSIS

- **Cattle**: *Eimeria zuernii* / *E. bovis* / *E. ellipsoidalis* / *E. auburnensis*

- **Sheep**: *E. ovinoidalis*/*E. ahsata*/*E. bakuensis* *

- **Goats**: *E. ninakohlyakimovae* / *E. christiensenii*/*E. arloingi*/*E. caprina*

- **Horses**: *E. leuckarti*

- **Swine**: *E. scabra* / *E. debliecki* / *E. spinosa*

- **Dogs**: *Isospora canis* / *I. burrowski* / *I. neorivolta* / *I. ohioensis*

- **Cats**: *I. felis* / *I. rivolta*
- **CRYPTOSPORIDIOSIS**
  - *Cryptosporidium muris / C. parvum*

- **TOXOPLASMOsis**
  - *Toxoplasma gondii*

- **NEOSPOROSIS**
  - *Neospora caninum*

- **HAMMONDIASIS**
  - *Hammondia hammondi*
Sarcocystis

- Final host (dogs)
  - Sarcocystis cruzi (S. bovicanis)
  - S. tenella (S. ovicanis)
  - S. capracaanis
  - S. meischerianana (S. porcicanis)
  - S. bertrami
  - S. equicanis
  - S. faeri
• **Final host (cats)**
  - *S. hirsuta (S. bovifelis)*
  - *S. gigantea (S. ovifelis)*
  - *S. porcifelis*

• **Final host (humans)**
  - *S. bovihominis*
  - *S. porcihominis*

**Final hosts:** Dogs, cats, wild carnivores and humans

**Intermediate host:** Ruminants, swine and horses.