Coronaviridae

- Viruses are enveloped with a positive-sense, single-stranded, linear RNA molecule as genome.
- The term "corona" refers to the halo of spikes extending outwards from the envelope.
- These viruses infect the respiratory, gastrointestinal tracts and the CNS of many mammals, including humans, and birds.

Viral Characteristics

- Virions are enveloped (80 - 120 nm in diameter), with club-shaped surface spikes (about 20 nm from the envelope surface) that give the appearance of a crown .
- The nucleocapsid has helical symmetry. This feature is unique to the coronaviruses, as most positive- sense RNA viruses have icosahedral nucleocapsids.
- The spike protein is associated with attachment to target cells, which is usually species specific, and is antigenic.
- Coronaviruses replicate in the cytoplasm and bud into cytoplasmic vesicles from which the virions obtain the envelope.
- Coronaviruses have the largest genome of any RNA virus (26 - 32 kb in size).
- The genome is positive-sense ssRNA that is nonsegmented. The genome has a 5' cap and a 3' polyadenylated (poly A) tail.
- Coronaviruses have a high frequency of mutation and a high frequency of recombination, resulting in rapid strain formation within an individual.
- In the cytoplasm, the genomic RNA is copied to a complementary negative-sense RNA strand. This is used as the template for more genomic positive-sense RNA strands and for the formation of viral mRNAs of various sizes (all have a common 3' end), known as subgenomic RNAs. The production of subgenomic RNAs is characteristic of coronaviruses.
- These viruses can be propagated in cell culture but often with difficulty.
- They are labile in the environment.

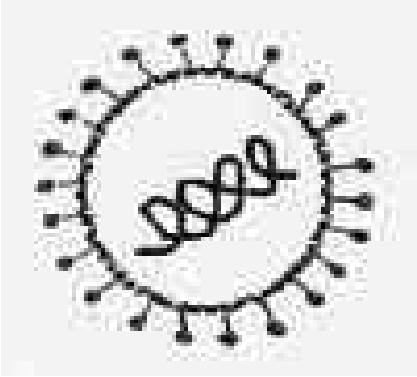

Figure 7 Coronaviridae (80 - 120 nm in diameter). Distinguishing features are the club-shaped surface spikes (about 20 nm from the envelope surface) that give the appearance of a crown and a nucleocapsid that has helical symmetry.

Classification
The family Coronaviridae has two genera;
Coronavirus and *Torovirus*.

The genus *Coronavirus* is divided into three groups on the basis of features such as presence or absence of a hemagglutinin-esterase (HE) protein and the number and arrangement of non-essential genes.

Important viruses in these genera are as follows:

- ***Coronavirus***
- Group 1
  - Porcine transmissible gastroenteritis virus
  - Porcine epidemic diarrhea virus
  - Feline infectious peritonitis virus
  - Canine coronavirus
- Group 2
  - Bovine coronavirus
  - Porcine hemagglutinating encephalomyelitis virus
- Group 3
  - Infectious bronchitis virus
  - Turkey coronavirus
- ***Torovirus***
  - Bovine torovirus (Breda virus-Iowa): Associated with severe diarrhea in neonatal calves.
  - Equine torovirus: Isolated from a horse with diarrhea in Switzerland, although it was probably not the etiological agent responsible for the disease. The isolate was antigenically related to bovine torovirus.

- Coronaviruses cause human respiratory infections, including the common cold and recently a disease called severe acute respiratory syndrome (SARS) that was first recognized in Asia in 2003.

Coronavirus
Transmissible Gastroenteritis
Cause

- Transmissible gastroenteritis virus.
- Only one antigenic type is known.
- The virus is serologically related to porcine respiratory coronavirus, canine coronavirus, and feline infectious peritonitis virus.
- The virus may remain viable on premises for up to three days.

Occurrence

- Although transmissible gastroenteritis (TGE) virus only causes serious disease in pigs; it can infect dogs subclinically.
- The disease is highly contagious and destructive and occurs frequently in swine worldwide.
- The majority of outbreaks occur during the colder months of the year.

Transmission

- The virus is present in feces and nasal secretions and may also be present in the milk of infected sows.
- Spread is by direct and indirect contact.

Clinical & Pathologic Features

- TGE is highly fatal to pigs less than 10 days old and usually spreads rapidly through the whole herd.
- Young pigs have a severe diarrhea with a watery, whitish or whitish-green stool. Vomiting is fairly common. Dehydration is especially marked, and deaths occur in 2 - 5 days after the onset of clinical signs.
- TGE virus selectively multiplies and destroys absorptive epithelial cells of the villi, giving rise to villous atrophy and impaired absorption (malabsorption).
- Disease in adult animals may include elevated temperature, poor appetite, mild diarrhea and depression. Vomiting may also occur in some animals.
- In herds where the virus is endemic, due to pre-existing immunity in most individuals, clinical signs are milder and mortality is relatively low. Clinical signs are often seen in these pigs during the post-weaning period when passive immunity has declined. Although clinical signs of respiratory infection are not common, the virus can be recovered from lung tissue. The virus has been shown to persist in the intestine of pigs for extended periods of time.

Diagnosis

Clinical specimens:

Portions of jejunum and ileum with contents.

- Because various other agents cause clinically similar gastroenteritis, confirmation of diagnosis by laboratory means is recommended.
- laboratory method most often used is the fluorescent antibody examination of cryostat sections or scrapings of affected intestine.

- The virus can be cultivated in cell cultures of swine origin, but may produce little or no discernible cytopathology.

Prevention

- Both live attenuated and killed vaccines are available for the immunization of sows prior to farrowing. Their value seems to depend on their capacity to produce colostral and colostrum-derived immunity.
- Stronger and long lasting immunity is achieved via natural infection, and one empirical procedure has been to feed infectious intestine and feces to pregnant sows about a month before farrowing.
- Application of strict sanitary measures to prevent spread to susceptible swine.

Infectious Bronchitis

Cause

- Infectious bronchitis virus.
- Neutralization tests in chicken embryos have shown there are many antigenic types of the virus. They are not related antigenically to other coronavirus species.

Occurrence

- This highly contagious disease of chickens occurs worldwide.

Transmission

- Virus is usually present in respiratory discharges
- By direct and indirect contact and aerosol.

Clinical & Pathologic Features

- Highly contagious disease of sudden onset and high morbidity.
- Most severe in chicks and young birds; older birds are susceptible, although the disease is mild.
- Mortality may be high in baby chicks infected with nephrotropic strains.

- The cardinal clinical signs are coughing and gasping.
- Egg-laying capacity of survivors may be permanently impaired; eggs may be misshapen, rough, and soft-shelled. Some strains of the virus are nephrotrophic and cause interstitial nephritis with sudden death.

Diagnosis

Clinical specimens:

Trachea, lungs, and kidneys.

- Virus can be cultivated in susceptible chicken embryos and in chicken epithelial cell cultures. Serotype identification is accomplished by virus neutralization tests with specific antisera.
- Changes in inoculated embryos are usually seen after several passages. They are characterized by death or dwarfing, curling of the embryo, and crystal urate deposits in the meso-nephrons.
- Fluorescent antibody tests on tracheal scrapings from infected birds have been used for rapid diagnosis.

Prevention

- Vaccination is practiced widely.
- A live attenuated virus is usually administered to birds at 1 - 2 weeks of age via drinking water with revaccination 3 - 4 weeks later, often with a killed vaccine injected subcutaneously.
- Since there are numerous types of virus, the vaccine used should include the appropriate type(s) for a given area.

Prions

- Prions are proteinaceous particles, devoid of nucleic acid, which are aetiologically implicated in fatal neurodegenerative diseases with long incubation periods. Neuropathological changes include vacuolation of both neurons and neuropil.

- No conventional infectious agents are currently implicated as aetiology in the transmissible spongiform encephalopathies (TSEs), a unique group of neurodegenerative diseases.

- TSEs are caused by unconventional infectious agents termed prions. Infectious agent are ’unconventional’ because

  i. they lack nucleic acid, unlike viruses and other microbial agents.

  ii. they are non-immunogenic and

  iii. are extremely resistant to inactivation by heating, exposure to chemicals and irradiation.

- ‘prions’ are thought to be derived from a native glycoprotein PrPc (cellular prion protein), associated with the plasma membrane of some cell types. Following exposure

to abnormal prion protein (PrPsc, scrapie prion protein), PrPc is altered post-translationally to a structure similar to that of the PrPsc. As more PrPc is converted to PrPsc, this protease-resistant molecule gradually accumulates, especially in the long-lived cells of CNS.

- Formation of PrPsc from PrPc in TSEs may be initiated following exposure to an external source of PrPsc, usually by ingestion.
- Rarely, random spontaneous conversion of native PrPc to PrPsc may initiate the process in an individual.
- A third mechanism which predisposes to configurational change in PrPc relates to mutation in the PrP gene, as occurs in the Gerstmann-Straussler-Scheinker syndrome in humans.

- PrP genes of infected animals determine the primary amino acid sequence of the prion protein in such animals.

- The resistance of some species to infection by prions derived from another species is termed the 'species barrier'. The barrier is attributed to differences between the amino acid sequences of the prion proteins in the two species. On initial transfer of PrPsc between specie, the incubation period tends to be relatively long. Subsequent transfer between members of the recipient species leads to shorter incubation periods. The presence of a 'species barrier' may explain the resistance of humans to infection with PrPsc derived from sheep with scrapie.

- Diseases attributed to prions occur sporadically and are significantly influenced by the genome of the affected animal. These slowly progressive neurodegenerative diseases, which are characterised by long incubation periods and spongiform changes in the brain, have been described in many animal species and in humans.

- Transmissible spongiform encephalopathies have been recognized in both ruminants and carnivores. In scrapie, there is convincing evidence for the importance of the genetic constitution of certain breeds of sheep in determining susceptibility to the disease.

Scrapie

- This is a fatal, neurological disease of adult sheep and goats.
- Transmission mode is yet unknown. Neurological signs develop predominantly in adult sheep between ages 3-4 yrs.
- Early clinical signs include restlessness or nervousness, particularly after sudden noise or movement.
- Pruritis may lead to loss of wool and body weight. Death results within six months of onset of clinical signs.

Diagnosis

- Primarily based on Clinical signs and histopathological examination of the CNS.
- Confirmatory tests include immunohistochemical staining for PrPsc, immunoblotting to detect proteinase-K-resistant PrPsc and electron micorscopy to detect scrapie-associated fibrils in detergent-treated extracts of brain.

Bovine spongiform encephalopathy

- A progressive, neurodegenerative disease of adult cattle, first reported in England in 1986.
- The disease has been reported in several more countries in animals imported from United Kingdom.
- Also, the disease has benn reported in some native cattle in a number of European countries, including Switzerland, Ireland, France and Portugal.

- The prion strain suspected to be causing bovine spongiform encephalopathy (BSE) is yet to be considered specie-specific.
- In 1996, a novel form of human prion disease, termed variant Creutzfeldt-jakob disease (vCJD) was again reported in UK.

- Molecular strain-typing studies and experimental transmission in transgenic and convectional mice have shown association between prion strains causing vCJB and BSE.

- BSE epidemic in UK was linked to the feeding contaminated meat-and-bone meal (MBM) prepare from slaughterhouse offal and fed as a protein dietary supplement to cattle. It has been postulated that the aetiology of scrapie crossed the specie barrier into cattle in the early 1980s, following changes in the rendering process which allowed survival of increased amount of scrapie PrP (PrPsc) in MBM.

- Mean incubation period of BSE is about 5years.

- Neurology signs, which are highly variable, include changes in behaviour and deficits in posture and movement. Ataxia, hypermetria and a tendency to fall become increasingly evident in the later stages of the disease.

- Bovine spongiform encephalopathy can be confirmed by histopathological examination of brain tissue and specific immunological confirmatory methods.

Acknowledegment

I wish to acknowledge the use of the book titled “Concise review of Veterinary Microbiology”. It is also recommended for this course.

1. Concise review of Veterinary Microbiology
   P.J. Quinn and B.K. Markey