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## Adenoviridae

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This family consists of double-stranded DNA viruses with an icosahedral nucleocapsid. They have been recovered from many mammalian and avian species. Many are found in the respiratory tract and infections are often persistent. Only a small number cause significant veterinary diseases.

### **Viral Characteristics**

- Non-enveloped, viruses with icosahedral symmetry containing a single, linear molecule of double-stranded DNA.
- The capsid consists of capsomeres (called *hexons*) and 12 vertex capsomeres (called *pentons*). These are the only viruses with a fiber (the fiber antigen) protruding from each of the 12 pentons (see Fig. 13-1).
- The fiber is the structure of attachment to host cells and is also a type specific hemagglutinin.
- The hexon of mammalian adenoviruses contains a cross-reacting group antigen.
- The fiber antigen attaches to a specific cell receptor and initiates replication.
- The dsDNA encodes approximately 30 proteins. Viral DNA replication, mRNA transcription and virion assembly occur in the nucleus, utilizing both host and virus-encoded factors. This results in the formation of basophilic and / or acidophilic intranuclear inclusions.
- Many adenoviruses agglutinate red cells of various animal species and some are capable of malignant transformation in tissue culture cell and oncogenesis when inoculated into laboratory animals.
- They are resistant to trypsin and lipid solvents, and moderately resistant on premises.

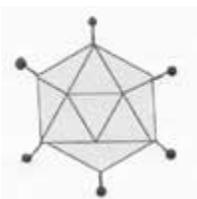


Figure 13-1. Adenoviridae (70 - 90 nm). Note the fiber proteins protruding from the vertices of the 12 pentons. - To view this image in full size go to the IVIS website at [www.ivis.org](http://www.ivis.org) . -

## **Classification**

This family originally consisted of only two genera, Mastadenovirus, which infect mammals, and Aviadenovirus, which infect birds. There are also several as yet unassigned and recently assigned viruses in the family.

### Mastadenovirus

This genus consists of 20 virus species that infect mammals including canine, equine, bovine, ovine and porcine adenoviruses. All 20 species share a common antigen. Important diseases are infectious canine hepatitis, canine adenovirus 2 infection, and equine adenovirus A infection.

### Aviadenovirus

This genus includes the viruses of inclusion body hepatitis, quail bronchitis, marble spleen disease and a number of adenoviruses of poultry and birds that are not associated with significant diseases. Members of the genus share a common antigen.

### Previously Unassigned Adenoviruses

Included in this category are the viruses that have recently (2002) been placed in the genera Atadenovirus and Siadenovirus. These viruses include the egg drop syndrome virus (Atadenovirus), turkey hemorrhagic enteritis (Siadenovirus), adenoviral splenomegaly of chickens (Atadenovirus) and ovine adenovirus 287 (Atadenovirus; of research interest, but of no disease significance) and some bovine adenovirus types 4 to 8 (Atadenovirus).

## **Mastadenovirus**

### **Infectious Canine Hepatitis**

#### Cause

Canine adenovirus 1. The DNA sequence of this virus has been determined.

#### Occurrence

Dogs younger than one year of age are most often affected. The virus also infects wild and captive foxes causing encephalitis, and wolves, coyotes and bears. Other carnivores may sustain subclinical infections. The disease occurs commonly worldwide, but is uncommon where vaccination is practiced.

#### Transmission

Infection is by inhalation and ingestion. Spread is by direct and indirect contact.

#### Pathogenesis

The virus replicates initially in tonsils and Peyer's patches producing a viremia with secondary localization and replication in the liver and kidney.

#### Clinical & Pathologic Features

Clinical signs include depression, fever, vomiting, diarrhea, and discharges from the nose and eyes. Because of a tendency to bleed, hematomas may be seen in the mouth. The principal tissue changes involve the endothelium and hepatic cells. Damaged endothelium results in widespread petechial hemorrhages. The liver may be enlarged or normal in size, but usually is mottled because of focal areas of necrosis. Microscopically, the most significant changes are found in the liver, where centrilobular necrosis is noted and typical adenoviral inclusion bodies are observed in Kupffer cells and parenchymal cells. Circulating immune complexes in the glomeruli may result in glomerulonephritis. Recovered dogs may develop a transient corneal opacity ("blue eye") as a result of local immune complex deposition. Recovery from infectious canine hepatitis (ICH) results in lasting immunity.

#### Diagnosis

- Clinical specimens: liver, spleen, kidney, blood, urine, nasal swabs and paired serum samples.
- Diagnosis of ICH is usually made on the basis of clinical signs and gross and microscopic lesions including the presence of basophilic inclusions in hepatocytes, endothelial cells, and Kupffer cells.
- The virus can be demonstrated in frozen liver sections by immunofluorescence.
- The virus can be cultivated in cell cultures of canine origin. The liver has been reported to be less suitable for virus recovery than other vital organs.
- A rising titer of antibodies employing hemagglutination inhibition or virus neutralization are supportive of a diagnosis.

#### Prevention

- Modified live and killed vaccines are used, often in combination with parvovirus and canine distemper antigens. Modified live vaccines induce a longer lasting immunity, but a small percentage of vaccinated dogs may develop ocular or renal lesions.
- These core canine vaccines were traditionally administered annually but are now, depending on the type of vaccine,

often given less frequently.

### **Canine Adenovirus 2 Infection**

This virus causes an infection of the respiratory tract that is usually unapparent or mild. It has been implicated as one of the causes, not the most important, of the common widespread disease kennel cough or infectious canine laryngotracheitis, which is associated with kennels and animal hospitals. The etiology of kennel cough is complex. Canine parainfluenza 2 and Bordetella bronchiseptica seem to play major roles. Spread is mainly by direct and indirect contact. Ordinarily attempts are not made to isolate canine adenovirus 2. A diagnosis of kennel cough is usually based on clinical signs and history. Canine adenovirus 2 can be cultivated in cell cultures of canine origin, producing characteristic CPE. Virus identification is accomplished by virus neutralization with specific antiserum and/or by immunofluorescence assay.

### **Equine Adenovirus A Infection**

#### Cause

Equine adenovirus A (EAV-A); also referred to as equine adenovirus 1.

#### Occurrence

This adenovirus infection occurs in horses worldwide.

#### Transmission

The principal mode of infection is by aerosol droplets. Entrance to the host occurs through the upper respiratory mucosa or conjunctiva.

#### Clinical & Pathologic Features

The virus causes only subclinical or mild upper respiratory tract infections in most horses. However, in Arabian foals, from which most isolates have been recovered, the infection is characterized by progressive pneumonia and subsequent death. The severity of the infection in Arabian foals is related to a combined immunodeficiency resulting from a genetic defect.

#### Diagnosis

- Clinical specimens: nasal and ocular swabs, and lung tissue.
- Finding typical intranuclear inclusion bodies in conjunctival scrapings and tissue sections of lung and various other tissues are diagnostically significant. However, care must be taken in evaluating conjunctival scrapings, as inclusion bodies produced by slow-herpesviruses generally are indistinguishable from those produced by EAV-A.
- The virus can be propagated in cell cultures of equine kidney producing typical adenovirus cytopathic effects, including large intranuclear inclusions.

#### Prevention

Because of the ubiquity of the virus it is difficult to avoid infection.

### **Bovine, Ovine and Porcine Adenoviruses**

Strains of adenoviruses occur in these species causing subclinical infections and only occasionally associated with mild enteric and respiratory disease.

### **Aviadenovirus**

#### **Inclusion Body Hepatitis**

#### Cause

A number of serotypes of aviadenoviruses have been implicated.

#### Occurrence

The disease, which most often affects young chickens, occurs infrequently worldwide.

#### Transmission

Aviadenoviruses are transmitted horizontally and vertically.

#### Clinical & Pathologic Features

Infected chickens may appear anemic and weak but other characteristic clinical signs are absent. The mortality is low in the uncomplicated disease, but as high as 30% in birds that are immunosuppressed as a result of concurrent infection with the chicken anemia virus or the virus of infectious bursal disease. The liver of affected chickens is enlarged and pale and frequently with hemorrhages throughout. Microscopically there is evidence of diffuse hepatitis with intranuclear eosinophilic inclusion bodies in hepatocytes. Anemia and icterus involving the musculature and subcutaneous tissues may be noted. It is not certain that all the tissue changes seen in the disease can be attributed to aviadenovirus infection alone.

### Diagnosis

- Clinical specimens: Sick, live birds are preferred.
- This is usually based on macroscopic liver lesions and microscopic examination of characteristic intranuclear inclusion bodies in hepatocytes.
- The virus can be propagated on the chorioallantoic membrane of chicken embryos or in avian kidney cell cultures and identified by the virus neutralization test, but these procedures are expensive and seldom performed. Because of the widespread distribution of adenoviruses in chickens, isolation of virus is not necessarily meaningful.

### **Quail Bronchitis**

#### Cause

Caused by quail bronchitis virus. It is indistinguishable from the chicken adenovirus CELO (chicken embryo lethal orphan) virus. CELO (fowl adenovirus 1) virus is widespread in chickens but is not associated with disease.

#### Occurrence

This important disease of domestic and wild bobwhite quail occurs worldwide.

#### Transmission

Infected quail shed virus in respiratory secretions and feces. Spread is via the egg and by direct and indirect contact.

#### Clinical Features

Quail bronchitis is an acute, highly contagious disease of quail under four weeks of age. Signs of the disease are sneezing, coughing, and tracheal rales. Mortality is usually about 50%, but may reach 100%.

#### Diagnosis

- Clinical specimens: whole birds killed in extremis.
- A presumptive diagnosis is made on the basis of clinical signs and high mortality.
- Histopathologic lesions of tracheitis and bronchitis with intranuclear inclusions are supportive.
- Confirmation requires isolation of the virus in cell cultures of chicken embryonic liver or kidney, or by the inoculation of chicken embryos via the yolk sac. Several passages may be necessary before the virus causes death of embryos. Dead embryos usually have necrotic foci in the liver and urate accumulation in the mesonephrons. The virus is identified by neutralization tests.

#### Prevention

- There are no commercial vaccines available.
- Prevention is best accomplished by strict measures to prevent introduction of the virus.

### **Atadenovirus**

#### **Egg Drop Syndrome**

#### Cause

Duck adenovirus 1.

#### Occurrence

Egg drop syndrome (EDS) is common and worldwide in distribution. It occurs most frequently in broiler chicken breeder flocks 5 - 6 weeks of age.

#### Transmission

It is mainly transmitted vertically through the egg. The virus is shed in the feces and spread can be by contaminated water and fomites. Sporadic outbreaks have been attributed to wild birds contaminating water.

#### Clinical & Pathologic Features

Infected birds appear healthy. Egg production is variably depressed and abnormal eggs are produced. Shells of the latter may be absent, thin, underpigmented and rough surfaced. Outbreaks last 4 to 10 weeks. Among the effects noted are inactive ovaries, atrophied oviducts, edema of the uterus, exudates in the cell gland and intranuclear inclusions in tissue of the cell gland.

#### Diagnosis

- Loss of egg production with abnormal eggshells suggest EDS.
- Clinical specimens: eggs and reproductive tissues including the shell gland.
- Virus can be cultivated in duck and goose embryonated eggs (preferred) and also in duck kidney or fibroblast cell lines. The presence of virus is indicated by hemagglutination of avian red cells.
- Diagnosis is made with the hemagglutination inhibition test. It is used to screen flocks but negative tests do not indicate that birds are necessarily free of infection.

### Prevention

- Replacement birds should be from uninfected flocks.
- An oil adjuvant inactivated vaccine provides immunity for a year.
- Good hygiene to prevent lateral spread particularly from infected egg contamination.

## **Siadenovirus**

### **Turkey Hemorrhagic Enteritis**

#### Cause

An adenovirus (turkey adenovirus 3). This group has recently been classified in the genus Siadenovirus. The agents of hemorrhagic enteritis, marble spleen disease, and adenoviral splenomegaly of chickens are a closely related group of avian adenoviruses that share a common group specific antigen.

#### Occurrence

The disease occurs frequently throughout the world and is responsible for great economic loss annually in the United States.

#### Transmission

The virus is present in the feces and infection is by ingestion with direct and indirect spread.

#### Clinical & Pathologic Features

The disease occurs most often in young turkey poults 4 - 16 weeks of age. It is sudden in onset and characterized by bloody diarrhea, depression, and death. Affected layers may produce thin and soft-shelled eggs. The principal lesion is the hemorrhagic enteritis. The spleen may be enlarged and mottled, resembling marble spleen disease of pheasants and adenoviral splenomegaly of chickens. Similar microscopic changes, including intranuclear inclusions are seen in the three diseases. The mortality may be as little as 1%, or may exceed 60%.

#### Diagnosis

- Clinical specimens: intestine and spleen.
- The disease is usually diagnosed clinically and by gross and microscopic lesions. The finding of typical inclusion bodies (poults examined early in the course of the disease are preferred) is significant.

#### Prevention

- A commercially available tissue culture products and crude splenic preparations containing mildly pathogenic isolates are used in vaccination of flocks.
- Appropriate antibiotic therapy to prevent secondary colisepticemia is advised.

### **Marble Spleen Disease**

This disease of pheasants is caused by pheasant adenovirus 1 of the genus Aviadenovirus, which closely resembles the virus of hemorrhagic enteritis of turkeys. It is an acute and fatal infection of ring neck pheasants. Among the few clinical signs are depression, bloody droppings, and sudden death. Grayish-tan, mottled, and enlarged spleens are characteristic. Intranuclear inclusions are seen in the reticuloendothelial cells of affected tissue.

### **Adenoviral Splenomegaly of Chickens**

This name refers to the enlarged mottled spleen that results from the experimental inoculation of a virus that is identical or closely related to the turkey hemorrhagic enteritis virus.

### **Glossary**

Combined Immunodeficiency: Total absence T and B lymphocytes; an autosomal recessive inheritance pattern. In EAV-A, the combined immunodeficiency is characterized by progressive EAV-A bronchopneumonia, and pathology in a wide variety of organs and tissues, including the gastrointestinal tract, liver, pancreas and bladder.

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