**Specific virus families**

**Poxviridae**

Pox viruses are largest and most complex of all viruses, that replicate entirely in the cytoplasm of infected cells. Pox DNA viruses which usually produce proliferative focal skin lesions and are occasionally fatal when they generalize.

**Classification**

This family infect a wide range of hosts, and are divided into two subfamilies:

a- *Chordopoxvirinae,* infected vertebrates. There are 10 recognised genera in this subfamily.

b- *Entomopoxvirinae*, infected insects. There are 3 genera in this subfamily.

*Chordopoxvirinae* are divided into the following genera:-

**The Genera of the subfamily *Chordopoxvirinae***

|  |  |
| --- | --- |
| Genera | Member |
| Orthopox  | (Smallpox virus (variola), vaccinia virus, Cow pox, Camel pox, buffalo pox, rabbit pox. |
| Parapox | Orf (contagious ecthyma), bovine papular stomatitis (Pseudocowpox, Milker’s nodules) |
| Capripox  | Sheep pox, goat pox, lumpy skin disease |
| Suipox | Swine pox virus |
| Avipox | Fowl pox, pigeon pox, turkey pox, canary pox, and other birds |
| Leporipox | Myxoma virus, rabbit (shope) fibroma virus, |
| Molluscipox  | Molluscum contagiosum virus |
| Yatapox  | Yaba monkey tumor poxvirus |
| Cervidpox |  |
| Crocodylipox |  |

**Subfamily Entomopoxvirinae includes:**

**1-Alphaentomopoxvirus**

**2- Betaentomopoxvirus**

**3- Gammaentomopoxvirus**

**General properties of pox viruses:**

1- There are 10 genera

2- Most genera, Brick shape virion 300 x 240 x 100 nm irregular arrangement of tubules on outer membrane.

3. Complex structure with core, lateral bodies, outer membrane and sometimes envelope like orthopoxvirus whereas parapoxvirus are not.

4. Linear ds DNA genome, 130 kbp (parapoxvirus), 165-210kbp (orthopoxvirus), 280 kbp (Avipoxvirus), noninfectious encodes over 100 genes, including DNA dependent RNA transcriptase.

5. Cytoplasmic replication, enveloped viruses released by exocytosis, non-enveloped particles released by cell lysis.

6. Up to 30 different structural proteins have been identified as well as carbohydrate , copper, flavin, biotin, four enzyme included DNA and RNA polymerase.

7- Host range varies by specific virus; zoonoses is common, but small pox only infect human.

**Physical-Chemical properties**

Para, Capri and Leporipox viruses are ether sensitive, but otherwise all pox viruses are stable and very resistance to temperature change particularly in dry condition.

They last month or years in dust.

**Cultivation and cytopathic effect**

Most pox viruses grow in host cell lines and on CAM, where they produce nodular lesions and on CAM where they produce nodular lesion. Pocks, CPE consist of ballooning cells with intracytoplasmic and rarely intranucleus bodies. CPE in tissue culture is not readily seen by light microscopy, although Orthopox viruses may cause syncytial formation.

**Antigenic Differentiation**

Morphological features are sufficient to distinguish between Ortho, Para and Capripox genera. Agar gel diffusion (AGDP) precipitation and viral neutralization (VN) will also identify genera, although the AGDP indicates that some antigens are shared. Differences between isolates are most consistently demonstrated by restraction endonuclease analysis (RE). Cross reaction between viruses are valiable.

**RE:-** **(Restriction endonucleases are enzymes that cleave the sugar-phosphate backbone of DNA).**

**Trasmission:**

Poxviruses are most commonly spread by direct contact. In the case of small pox, the virus is found in lesions in the upper respiratory tract, which can be transmitted to others droplet secretions, and in skin lesions.

**Tissue Tropism (Pathogenesis of the virus)**

Access is frequently by local **trauma** of squamous epithelium. **Primary replication** is followed **by viraemia** and multiple skin eruptions. The proliferation ballooning and final necrosis of infected cells in the stratum spinosum give rise to the classical scouerce of lesions then spread of the virus.

 More rarely virus will replicate in the viscera giving rise to multiple lesions which are often fatal, e.g. Sheep pox, Leporipox.

**Immune response and host defenses**

Infection by a poxvirus results in CMI. People who are infected with small –pox are generally immune to the disease for the rest of their lives.

**ORTHOPOXVIRUSES**

genus of viruses of the subfamily [Chordopoxvirinae](http://medical-dictionary.thefreedictionary.com/Chordopoxvirinae) (family [Poxviridae](http://medical-dictionary.thefreedictionary.com/Poxviridae)) thatcause generalized infections with a rash in  mammals, including [cowpox](http://medical-dictionary.thefreedictionary.com/virus), [monkeypox](http://medical-dictionary.thefreedictionary.com/virus),  Smallpox virus (variola), vaccinia virus, Camel pox, buffalo pox and rabbit pox

**Host**

Cattle, Man and Cats, group morphology (brick- shaped). Major cross-reaction is with variola (smallpox in man) and vaccinia (which is probably a laboratory recombinant of Cow pox.

**Cowpox**: Is an infectious disease caused by the cowpox virus. The virus, part of the orthopoxvirus family, is so closely related to the *vaccinia* virus that the two are often spoken of interchangeably. The virus is zoonotic, meaning that it is transferable between species, such as from animal to human. The transferral of the disease was first observed in dairymaids who touched the udders of infected cows and consequently developed the signature pustules on their hands

 **Smallpox:** was an infectious disease unique to humans, caused by either of two virus variants, variola major and variola minor. Smallpox is believed to have emerged in human populations about 10,000 BC. The earliest physical evidence of it is probably the pustular rash on the mummified body of Pharaoh Ramses V of Egypt

**Transmission**

Occurs through inhalation of airborne variola virus, usually droplets expressed from the oral, nasal, or pharangeal mucosa of an infected person. It is transmitted from person to another primarily through prolonged face-to-face contact with an infected person, the virus can cross the placenta, but the incidence of congenital smallpox is relatively low.

**Pathogenesis and clinical signs**

Trauma results in local replication. Viraemia follows in 3-7 days then 1 cm size foci swell to papules, flatten to vesicles, develop a central depression, erode and scab within a further 5-10 days. Lesion may heal or be followed by an orbit of secondary smaller vesicle, or become secondarily infected with bacteria.

Cats develop focal pustules on the legs or head, lesion are occasionally more widespread and may involve lungs and pleura.

**Immunity and Epidemiology**

Cattle develop neutralizing antibodies which pass to calves in colostrums. Spread is by direct contact within a milking herd. In general, once an outbreak has occurred recurrence is unlikely for several years. However, individuals may suffer repeated episodes in the presence of antibody. Dairymen may develop localized lesions on the hand forearm and face; lesions are usually self-limiting but occasionally generalize in adults.

**Diagnosis**

1-Rapid spread of the lesions through a herd is suggestive of pox virus.

2- Microscopically, poxvirus produce characteristic cytoplasmic inclusion, however all orthopoxvirus exhibit identical brick-shaped virions by EM.

3- Definitive laboratory identification involved growing the virus on CAM and check for pock lesions.

 4- Strains may be characterized by PCR.

5- Serology tests and ELISA.

**Prevention &Control**

Improve herd management, hygiene. Outbreaks are usually self-limiting. The condition is too rare too justify.

In 1796 Edwared Jenner, discover that immunity to smallpox would be produced by inoculation a person with material from a cowpox lesion. EJ called this material as a vaccine.

The cowpox virus used for smallpox vaccination was replaced by vaccinia virus. Vaccinia is in the same family as cowpox and variola but is genetically distinct from both. The origin of vaccinia virus is not known. The current formulation of smallpox vaccine is a live virus preparation of infectious vaccinia virus.

**Genus PARAPOX**

**1- Pseudocowpox:** Is a worldwide disease of cattle. Symptoms include ring or horseshoe shaped scabs on the teats, which usually heal within six weeks,  lesions may also develop on the muzzles and in the mouths of nursing calves. Spread is by fomites, including hands, calves' mouths, and milking machines.

HOST:- Cattle and Man

Virus:- Parapox morphology **oval** in shape, Grows only on bovine cells.

The virus serologically cross reacts with Orf and Bovine popular stomatitis.

**Pathogenesis and clinical signs**

Asfor cowpox. In pseudocowpox the lesions are larger, show moreproliferation and rarely vesiculate, but horse-shoe shaped scabs form which secondary lesions may develop 11-14 days later.

The raised lesions are usually painless. Recurrence is not common. In man they form papules within (five days) (milker’s nodules).

**Immunity and Epidemiology**

Out breaks occur in herds and are a problem in lactating cattle. Low levels of circulating neutralizing antibody develop.

**Diagnosis**

The nature of the lesions is suggestive. The virus will not grown on CAM, but will replicate in bovine mono layers. Biopsies will show the tipical intracytoplasmic inclusion bodies. There may also be sufficient virus to make direct examination by EM.

**Control**

It is usually self limiting. Poor immunity and persistence of virus make vaccination ineffective.

**2- Bovine Papular Stomatitis**

Is a disease caused by a virus of the family *Poxviridae* and the genus *Parapoxvirus*. It occurs worldwide in young cattle, it usually occurs before the age of two years, possibly as a sequel to suckling teats of infected cows and subsequent spread within a group by aerosol and by licking. Symptoms include reddish, raised, sometimes ulcerative lesions on the lips, muzzle, and in the mouth.Reinfection is possible because of the short duration of immunity. Clinically, the disease is mild, but its importance lies in the need to differentiate it from foot-and-mouth disease.

**3- ORF:** Is an exanthemous diseasecaused by a parapox virus  and occurring primarily in sheep and goats. It is also known as**contagious pustular dermatitis**,  **contagious ecthyma.**

Orf is a zoonotic disease, meaning humans can contract this disorder through direct contact with infected sheep and goats or with fomites carrying the orf virus. It causes a purulent-appearing papule locally and generally no systemic symptoms. Infected locations can include the finger, hand, arm, face and even the penis (by infection from the hand during urination ). Consequently it is important to observe good personal hygiene and to wear gloves when treating infected animals.

**HOST:**- Sheep, Goats, many other animals and man.

Virus:- Morphology is similar to other parapoxviruses.

The virus grows in bovine and sheep cells particularly testis cells

Cross-react with milker’s nodule virus and bovine papular stomatitis virus.

**Pathogenesis and clinical signs**

Trauma leads to the development of lesions in non-woolled parts of the dermis i.e. lips, muzzle, ears, interdigital cleft, udder, venereal lesions are also record.

The lesions are proliferative, raised and often coalesce to form scabbed papilloma-like masses. The vesicular shape is not marked.

Incubation in 5-10 days, while the lesions may heal in 10 days or take several weeks. In man papules develop (usually in hands) within 5 days, but regress spontaneously.

**Immunity and Epidemiology**

Orf is often a recurrent problem on specific premises lambs being affected year after year. Low or negligible levels of neutralizing antibodies develop after infection although AGDP antibodies and CF antibodies have been described. The disease occurs worldwide.

**Diagnosis**

The lesions are pathognomic. Virus may be isolated or detected by CF or ACDP in samples from early lesions.

**Control**

Vaccine consist of 1% spension of a fresh sucab (live virus in 50% glycerol) applied by scarfication on the inside of the thigh at 1 ml at 3 months of ages. Ewes should be vaccinated annually behind the shoulder. A reaction occurs within 7 days. All susceptible animals must be vaccinated.

**Genus CAPRIPOX**

**1-Sheep and goat poxvirus**(SGP): Is an acute to chronic disease of sheep and goats characterized by generalized pox lesions throughout the skin and mucous membranes, a persistent fever, lymphadenitis, and often a focal viral pneumonia with lesions distributed uniformly throughout the lungs, caused byCapripox , one of the largest viruses (170-260 nm by 300-450 nm). They grow in sheep and goat cells, and have been adapted and attenuated in eggs. Goat pox and Lumpy skin disease (LSD) virus of cattle share common antigens with sheep pox. The virus(SGP) is closely related to the virus that causes lumpy skin disease; SGP virus and LSD virus cannot be distinguished serologically. The viruses are thought to have prolonged survival in the environment; they can remain infectious for up to six months in sheep pens and may also be found on the wool or hair for as three months after infection.

**Transmission**

Sheep and goat poxvirus are usually transmitted by close contact. Inhalation of aerosols containing virus, and contact through abraded skin by fomites or direct contact, are the natural means of transmission. Stable flies may transmit the viruses mechanically, although this is uncommon. Infectious virus is found in all secretions, excretions, and the scabs from skin lesions.

**Pathogenesis and Clinical Signs**

All ages of sheep and goats can be affected; however, disease is more sever in young animals.

Trauma results in local replication- but pox often fatal with visceral as well as dermal lesions.

An incubation period of 4-8 days is followed by pyrexia and dermal odema in association with vesicles.

Focal lesions may be found in lungs, trachea, kidney and alimentary tract epithelium. There is also a lympadentis. There is a necrotizing vasculitis and replication in connective tissue cells. Animals mat die at this stage (5-50%) or succumb later to secondary infection, or recover within 3-4 weeks.

**Immunity and Epidemiology**

Recoverd animals are immune. Passive immunity is conferred via colostrums. It is prevalent in Asia, the Middle East, Africa and Mediterranean countries. It is highly infections, airborn-spread being common, with prolonged survival off the host (6 months plus).

**Diagnosis**

Sheep or goat pox should be suspected in animals with the characterstic full-thickness skin lesions, fever, and lymphadenitis.

Laboratory procedure for diagnosis of sheep and goat pox include observation of the virus by EM (morphology is characteristic) and virus isolation, identification is by immunofluorescence.

Viral antigens can be detected by agar gel immunodiffusion (AGID) or ELISA.

**Prevention**

The most likely manner for SGP to enter a new area is by introduction of infected animals. Restrictions on the movement of animals and animal products (meat, hair, wool, and hides) are essential to prevent introduction of SGP. Wool, hair, and hides must be subjected to suitable decontamination procedures before entry into non endemic areas. Infection results in good immunity.

**Treatment &Control**

Annual vaccination is recommended. A varity of live vaccines exist.

A-Glycerol suspension of scab into the dermis of tail using experimental cases as virus source.

B-Freeze dried avianised strains are used in Russia and China, inoculated into the tail.

C-Tissue culture attenuated vaccines (liveare also now available

**3- Lumpy skin diseases (LSD):** Is a disease caused by a virus of the family *Poxviridae .* It mainly affects cattl , but has also been seen in , giraffes, African buffalo,  Lumpy skin disease was first seen as an epidemic inZambia in 1929, and since then has affected cattle throughout Africa, including the countries South Africa, Egypt and Sudan . It is

spread by biting insects.

Lumpyskin disease has an incubation period of two to four weeks.Symptoms include fever, discharge from the eyes and nose, nodular, necrotic skin lesions, edema of the limbs, and swollen lymph nodes. Morbidity can be very high but mortality is low. The disease can be easily confused in its early stages with pseudo-lumpy skin disease. Two vaccines are available, one a live attenuated version of the Neethling virus, the other a live attenuated version of the sheep pox virus.

**Host: -** Cattle; possibly sheep and goats.

**Virus:** Similar to sheep and goat pox virus.

**Pathogenesis and clinical signs**

The pathogenesis is similar to sheep and goat pox without internal lesions or mortality except that the multiple focal skin lesions (2-3 cm2) and the enlarged superficial lymph nodes are more obvious. The skin lesions develop 4-41 days after pregnant animals may abort. Rcoverd animals are solidly immune although the lesions may take 2-3 months to resolve.

**Immunity and epidemiology**

Recovery and immunity are associated with viral neutralizing antibodies (VN)

Recovery and immunity are associated with viral neutralizing antibodies (VN) which persist for several years. Although the morbidity except that the multiple focal skin lesions 92-3 cm2) and the enlarged superficial lymph nodes are more obvious. The skin lesions develop 4-14 days after an initial pyrexia; subcutaneous odema occurs and pregnant animals may abort. Recovered animals may take 2-3 months to resolve.

**Diagnosis**

As for sheep and goat pox.

**Control**

Egg-passaged live virus vaccines confirm protection with antibody persist up to 3 years.

**Genus LEPORIPOX**

**Myxomavirus (Myxomatosis)**

It is pox virus disease of rabbits, characterized by the formation of gelatinous nodule subcutaneously that appeared within 2-3 days post infection. Mecanical transmission was recorded through mosquitoes and fleas. Virus may spread directly by contact or aerosol. Virus remains infectious for several months in vector.

**Genus AVIPOX**

**Fowl pox**

is the worldwide disease of poultry caused by viruses of the family *Poxvirida*  and the genus *Avipoxvirus.* The viruses causing fowl pox are distinct from one another but antigenically similar, possible hosts including chickens, turkeys, quail, canaries, pigeons, and many other species of birds. There are two forms of the disease. The first is spread by biting insects (especially mosquitoes) and wound contamination and causes lesions on the comb, wattles, and beak. Birds affected by this form usually recover within a few weeks. The second form is spread by inhalation of the virus and causes a diphtheritic membrane to form in the mouth, pharynx, larynx, and sometimes the trachea. The prognosis for this form is poor

Host:- most poultry with slight strain differences, fowl, turkey , pigeon and canary strains.

Virus:- Round large virions 280-330 nm, Grows on CAM.

**Pathogenesis and Clinical signs**

Local trauma and replication result in virimia and secondry localization in the comb, wattle, commissure of the beak, feet and vent. The head form only causes anorexia, loss of weight and fall in the egg production. A diphtueritic form involves lesions on the tongue sometimes spreads to traches and lungs.

**Immunity and Epidemiology**

Immunity in recovered birds is long lasting. Spread within a flock is relatively slow and insidious. Mechanical spread by mosquitoes, ticks and lice is recorded as well as direct spread.

**Diagnosis**

Lesions, the diphtheritic form has to be differentiate from other respiratory pathogens or deficiency of vitamin A. Pox infected tissue will produce classical pox lesions on CAM; virus may detected by AGDP; inclusion bodies are seen in infected tissue.

 **Control**

Live pigeon pox virus given by scarification (through wing web) produce reasonable immunity and little reaction. It may be used at 2-3 weeks old and again at 10-15 week old. Cell culture attenuated turkey virus vaccines have also successfully used.

 GENUS LEPORIPOXVIRUS

It is a pox virus disease of rabbits. Characterized by the formation of gelatinous nodules subcutaneously that appeared within 2-3 days post infection.

Mechanical spread was recorded through mosquitoes and fleas. Virus may spread directly by contact or aerosol. Viruses remain infectious for several months in vectors.