

Introduction and discovering of viruses

1- the viruses discovered coincidence during a world **Adolf Meyer** in 1883, research on the mosaic tobacco leaves, had identified to the present of minutes is smaller than the bacteria causing the disease.

2- followed by Russian scientist **Dmitri Ivanovsky** the year 1892, who managed the liquidation of sap of infected tobacco leaves using filters a not allow bacteria to pass through, and wipe the leaves is infected with filters noted hit. And is the first to called the virus name, which means in **Latin poison** .which is .a simple and small molecules in size.

3-The first virus infects vertebrates discovered a **foot and mouth virus** disease virus in 1898, all of the world **Loeffler and Frosch** world and the world **koch**.

4-**Reed and the world Carol** discovered the first virus infects a human virus, yellow fever virus.

Virology: the science which deals with study of viruses as causative agents of very important diseases that occurs in human, animals, plants and other living organisms (insects, bacteria,...).

Viruses: They are the smallest and simplest form of life on earth, which can replicate only in living susceptible cells. Viruses consist of:

1. A nucleic acid genome either DNA or RNA.
2. A protein coat (capsid) that enclosed the genome.
3. In some cases a lipid membrane (envelope).

Virion: a complete infectious virus particle that consists of an RNA or DNA core with protein coat with external envelopes

General characters of viruses:

1. Virus particles are very small in size; they are between 20-500 nm (nanometer)
In diameter. $1 \text{ nm} = 1/1000 \text{ } \mu\text{m}$, $1 \text{ } \mu\text{m} = 1/1000 \text{ mm}$.
2. Viruses are obligatory intra cellular microorganisms.
3. Multiply inside the cells by replicating their genomes which either DNA or RNA, but not both.
4. The virus does not contain any organelles (ribosome's, t RNA, metabolic enzymes, etc), but they depend on infected cells to provide all their needed organelles.
5. Virus does not affect with antibiotics.
6. Most viruses sensitive to interferon.
7. Viruses cannot grow on artificial media, but only in living cells (specific host, Lab. Animals, chicken embryonated eggs & tissue culture).
8. Some viruses cause latent infection.
9. Viruses cannot be seen by ordinary microscope, but only by Electron Microscope (EM).

The chemical composition of viruses

- 1-all viruses contain only one type of nucleic acid (NA), either DNA or RNA but not both
- 2--A protective coat of protein(capsid)
- 3-some viruses may contain lipids & carbohydrates.(membrane)

❖ Structure of viral nucleic acids:

Genetic information is stored as the following:

1. Double stranded DNA cells (animal, plants, bacteria and some viruses).
2. Single-stranded DNA in other viruses (phage x 174).

3. Single stranded RNA (myxovirus).
4. Double-stranded RNA (reoviruses).

How we can differentiated between DNA and RNA?

1. By DNA ase or RNA ase
2. Between double and single stranded NA; by acridine orange stain, which is yellowish green in double stranded and red orange in single stranded.

Chemical composition of nucleic acid:-

NA chain is composed of basic units called nucleotides each of which consist of:

1. Nitrogenous base: ring compound containing nitrogen and carbon.
2. Molecule of a 5-carbon pentose sugar which is either ribose RNA ribose (RNA) or deoxyribose (DNA).
3. Molecule of phosphoric acid which links the base to the pentose sugar. There are four kinds of nucleotides (bases) in **DNA**: Guanine, Adenine, Cytocine, and Thymine.

In the **RNA** molecules the bases are guanine, adenine, cytocine and uracil.

Viral proteins:

Protein coat which encloses the viral genome called **capsid** which consists of **protomers** that accumulated to give pentan or hexan forms producing the **capsomers** which protect the viral NA and have surface characters acts to attach the virus on host cells then penetration, also it contains antigenic determinants.

Viral envelope:

Most viruses contain envelope or membrane surrounding the virus so they called **enveloped** viruses, others have no envelope and they called **naked** viruses. Enveloped viruses contain lipids like orthomyxo and paramyxo viruses, these viruses will become

sensitive to organic solvents (ether, alcohol, chloroform), these characters used in newly isolated virus classification. Also **viral membrane** contains **glycolipids or glycoprotein** which appears as projections from the envelope called **spikes or peplomers**.

Viral shape structure

Nucleocapsid is the arrangement between the viral nucleic acid genome with the capsid, this connection controlled by specific NA genetic information leading to different types of symmetry. **Accordingly viruses** can be classified into four symmetry structures.

1. Helical symmetry.
2. Cubical symmetry.
3. Binal symmetry.
4. Complex symmetry.

1. Helical symmetry:-

This form can be seen in RNA viruses, that the capsomers surrounded the N.A in spiral or helical manner to give helical symmetry which may be seen naked (TMV) or enveloped in ND & Rinderpest viruses. When the tubular nucleocapsid presented in coil form and surrounded by lipoprotein envelope containing peplomers which is glycoprotein projections (also called spikes) which represent haemagglutinins and neuraminidases but in rabies virus the capsid is straight and surrounded by lipoprotein membrane to give the bullet shape.

2. Cubical symmetry:-

Many RNA and DNA animal viruses the virus particles have **hexagonal outlines with 20 equilateral triangular faces**, i.e. icosahedrons, but when these viruses studied by negative stain using phosphotungstic acid which can penetrate even through the finest contours of the viral surface. Many viruses appear to be faceted and each face forms an

equilateral triangle consisting of angular arrangement of protein subunits as capsomers. There are generally 20 equilateral triangular faces.

3. Binal symmetry

This type of symmetry show both **icosahedral (cubical) and helical symmetry**, but within the same virion like bacteriophage, when the head is cubical and the tail is helical.

4. Complex symmetry

Most animal viruses show either helical or cubical symmetry but pox viruses have exceptional and their ultra structure appears to be complex. Some pox viruses are **brick-shaped**, while others are ovoid and the DNA is contained in nucleoid, shaped like a **biconcave disc and surrounded by one or more membranes**. Negative staining shows that the virion contains a surface layer of hollow tube like fibrils which may give the particles a striated appearance. In some species of pox viruses e.g. or virus, the thread appears to be continuous and is arranged in a cross or **figure-eight pattern across the surface of the virion giving it the characteristic ball of wool appearance**.

Genetics & Evolution of Viruses

Mutation: - spontaneous and random errors in the copying of viral N.A. which can occur during the replication of viruses, leading to change in nucleic acid sequence to produce mutant when differ somewhat than original organism. Mutant rate in RNA viruses are **higher than DNA viruses** although some RNA viruses such as those of mumps in man and Newcastle disease in poultry are remarkably stable over many years, but others like influenza A are labile and show tendency to variation in some their properties, leading to producing new pandemics. Some times virus mutation may lead to loss of virulence still immunogenic which called attenuated viruses like vaccinia which is mutant of variola, then it can be used is vaccine against small pox in human. **There are some viruses properties may change through mutation:-**

1. Loss of virulence.
2. Increase rate of reproduction.
3. Extension of natural host range.
4. Altered haemagglutination activity and changes of antigenic structure, plaque size, morphology or resistance to heat.

Viral recombination:- the transfer of genetic material between closely related viruses infecting the same cell, e.g. Sheep pox and Goat pox virus, then new recombinant virus will produced with genome contain new genetic information.

The alteration of genetic information in recombinant may result from:-

1. **Intramolecular recombination:** usually occurs in DNA viruses and involved dissociation and re-establishment of covalent bonds within the nucleic acid .
2. **Copy-choice recombination:** usually occurs between positive sense single stranded RNA viruses. e.g. Picorna , Corona, and Toga viruses .
3. **Reassortment:** occurs randomly in RNA viruses with segmented genome e.g. Orthomyxo viruses (influenza), Reo viruses and Bunya viruses. Viral cell interactions. When an intact of infectious virus particles makes contacts with a susceptible host cell may develop a number of reactions at the cell surface lead to release of the enetic material at the virus within the cell. This is immediately followed by a series of biosynthetic processes lead to formation of new virus like e.g.

1. **Defective virus:-** viruses that have lost ability to perform any one of the essential steps required for successful replication.
2. **Incomplete virus:-** abnormal viruses produced due to inoculation of high titer virus solution in limited number of host susceptible cells like inoculums containing a high rating of infective units to cells this called Von Magnus phenomena. That the produced viruses without nucleic acid e.g. influenza virus.

Interferon

Soluble substance produced by living cells of many different types in cell cultures, embryonated eggs, in lab. Animals when infected by some animal viruses either DNA or RNA and can inhibit multiplication of active virus e.g. influenza virus.

Characteristics of interferon molecules:-

1. It is small protein without nucleic acid.
2. Low molecular weight of about 25- 45000 Dalton.
3. Thermo stable at 4 C° and resist heating at 50 C° for 1 hour.
4. Interferon is active through a wide range of pH values (2-12).
5. It is relatively non-toxic, weakly antigenic and cannot be neutralized by the specific antiserum.
6. Inactivated by proteolytic enzymes such as trypsin.
7. Not affected with RNase & DNase.
8. Interferon specific to animal species but not to viruses species i.e.: it acts against a wide variety of viruses.

Replication of Viruses

Viruses can multiply only in active host cells, the replicate cycle of viruses can be divided into number of stages:

1. **Attachment to surface receptors on the susceptible host cell.**
2. **Penetration and uncoating.**
- 3-**Formation of messenger RNA**
- 4-**Formation of new genomes**
- 5-**Formation of new protein (translation)**
- 6-**Assembly.**
- 7- **Release.**
- 8- **Latency .**

1-Attachment: the virus meets and then binds to a cell surface receptor.

2-Penetration and uncoating: :- the process where by the viral genome is released in a form suitable for transcription.e.g.

a-In enveloped viruses: nucleocapsid is discharged directly into the cytoplasm, transcription can usually proceed without complex uncoating.

b. In non- enveloped virus uncoating may results from lysosomal proteolytic enzymes activity.

3-Formation of messenger RNA: Viruses have their own **polymerase proteins** which force the cell to make a huge amount of **viral mRNA and also nucleic acid.**

DNA viruses make mRNA in the cell nucleus.

RNA virus make mRNA in the cytoplasm.

4- Formation of new genomes which may be aided by early proteins which are **either viral polymerases**, see above, or **promoting cell division** to provide new cells for the madly dividing viruses.

5- Formation of new protein is always on the **host cell ribosomes**. Early proteins are viral enzymes e.g. **polymerases** (see above) or **viral growth factors** which

stimulate cell division to provide new host cells for virus.Late proteins are the structural proteins e.g. capsids and spikes .

6-Assembly. Nucleocapsid of DNA viruses are assembled the nucleus. Nucleocapsid of RNA viruses are assembled the nucleus. The notable exception is the DNA poxviruses which assemble the cytoplasm. Nucleocapsid 'factories' can be seen as inclusion bodies by light microscopy. Glycoprotein spikes insert into the cell-surface plasma membrane.

7- Release. Release of many particles at once when the cell dies and then bursts. Or each enveloped virus particle gradually buds from the cell surface.

8- Latency - certain viruses, the herpes and retro's, form \pm DNA during replication and this can remain latent in the nucleus for years but then become reactivated to make new particles during immunosuppression.

Viral vaccines and anti viral drugs:-

A **vaccine**:- is a biological preparation that provides active [acquired immunity](#) to a particular [disease](#). A vaccine typically contains an agent that resembles a disease-causing micro-organism and is often made from weakened or killed forms of the microbe, its toxins or one of its surface proteins. Vaccines can be [prophylactic](#) or [therapeutic](#) (e.g., [vaccines against cancer](#)).

advantages of veterinary vaccines:-

- 1- **Safety**: A vaccine should not cause disease, and side effects should be minimal.
- 2- **Effectiveness**: Vaccinated animals should be protected from illness due to the pathogen. Ideally, appropriate innate, cellular and humoral responses should be evoked by the vaccine, and long term immunity.
- 3- **Practical Issues**: The vaccine should be stable (for storage) .
- 4- Control of zoonotic diseases.
- 5- Control of exotic diseases of animals and people.
- 6- Reduction of the need for antibiotics.

Types of Vaccines:-

- 1- [Live, attenuated vaccines](#)
- 2- [Inactivated vaccines](#) (killed vaccine)
- 3- [Subunit vaccines](#)
- 4- [Toxoid vaccines](#)
- 5- [DNA vaccines](#)
- 6- [Recombinant vector vaccines](#).

1- Attenuated Live Vaccines: vaccines contain live, [attenuated](#) microorganisms. Many of these are active [viruses](#) that have been cultivated under conditions that disable their virulent properties, and become less dangerous organisms to produce a broad immune response. Although most attenuated vaccines are viral, some are bacterial in nature. Examples include the viral diseases [yellow fever](#), [measles](#), [rubella](#), and [mumps](#), and the bacterial disease [typhoid](#)..

advantages Attenuated Live Virus Vaccines:-

- 1- they are effective at stimulating both the **humeral and cellular immune system**.
- 2- **long-term immunity**.
- 3- they can induce **secretary immunity**.

2- Killed Viral Vaccines:

vaccines contain inactivated virus, but previously virulent, micro-organisms that have been destroyed with chemicals, heat, radiation, or antibiotics without destroying the antigenicity of the virus. Examples are [influenza](#), [cholera](#), [hepatitis A](#), and [rabies](#).

killed virus vaccines are often administered along with an **adjuvant**, which induces an inflammatory response and can stimulate the cellular immune system.

Advantages Killed Viral Vaccines:

stable, and usually safe since no live virus is present.

Table 1: General Comparison of Killed Versus Live, Attenuated Vaccines.

Feature	killed	Live
no. of doses	single	multiple
need for adjuvant	no	yes
Duration of immunity	less	many years
antibody response	IgG,	IgA IgG
CMI	poor	good
Reversion to virulence	possible not	possible

3-Subunit vaccines: viral proteins or groups of proteins are used. These proteins can be purified directly from viral particles. However this is expensive, since it is difficult to prepare virus in large enough quantities for protein purification, and potentially dangerous since there is the possibility of contaminating virulent virus. An alternative method is to use **recombinant** proteins produced in either procaryotic or eucaryotic (yeast, insect, animal) cells. **The viral proteins that are chosen for this type of vaccine should be immunogenic (ie, good antigens) and should also induce neutralizing or protective antibodies. This method of immunization has many of the same advantages and disadvantages as the killed virus vaccine.**

3-Recombinant Vaccine: In this approach, a gene encoding a major viral antigen (that is a target for neutralizing Ab) is inserted (cloned) into another, non-virulent viral **vector** so that the cloned gene is expressed and the protein produced during viral infection. Animals are then infected with the recombinant virus, and mount an immune response (both **humoral ,cellular and induce secretory immunity**) against the introduced antigen.

4-DNA- Based Vaccines: In this approach, genes (DNA) encoding specific viral proteins are injected into an animal (either in muscle or skin). The DNA is then taken up by cells, where it is transcribed into mRNA which is then translated to give rise to the viral protein. This protein is expressed on the surface of cells, either alone or in association with MHC molecules. It is recognized as a foreign molecule by the immune system, and elicits an immune response.

This approach has several advantages, including the following:

- 1- no infectious agent. 2 long term immunity. 3- strong **cellular immune response**.
- 4- Once a gene is cloned, DNA is inexpensive to make and is stable, so the vaccines should be **inexpensive**.
- 5- No adjuvant is required.

5-Toxoid Vaccines

For bacteria that secrete toxins, or harmful chemicals, a toxoid vaccine might be the answer. These vaccines are used when a bacterial toxin is the main cause of illness.

Scientists have found that they can inactivate toxins by treating them with formalin, a solution of formaldehyde and sterilized water. Such “detoxified” toxins, called toxoids, are safe for use in vaccines.

Anti-viral Drugs:

The goal of anti-viral drug development is to identify drugs that inhibit viral replication without harming the animal host. Theoretically, anti-viral drugs could be developed that affect/inhibit any stage of a virus life cycle

- A- **Penetration and Uncoating**. Develop drugs that will inhibit virus binding to its receptor, or uncoating of the virus inside the cell. An example would be using soluble receptor to block the cellular binding sites on the virus. [Amantadine](#) and [rimantadine](#) have been introduced to combat influenza. These agents act on penetration and uncoating.
- b- **Transcription/Translation** (gene expression): **Antisense oligonucleotides** could be used to block translation (these are oligos that are complementary to the viral mRNAs so that they can bind to them and inhibit their translation and/or cause their degradation). **-interferon** could be used to block both viral transcription and translation, since it induces an "anti-viral state" [acyclovir](#), [lamivudine](#), [caliciviruses](#)
- c- **Assembly and Release**: Protease inhibitors can be developed to prevent the final maturation of viral proteins in viruses that use a polyprotein expression strategy. [Rifampicin](#) and [Tamiflu](#)

Laboratory diagnosis of viral infections:-

In the diagnostic laboratory [virus](#) infections are confirmed by several methods that include:

- 1-Growth of the virus in a [cell culture](#) from a specimen taken from the patient.
- 2-Detection of virus-specific antibodies in the blood.(IgM and IgG)
- 3-Detection of virus antigens([ELISA](#) in tissues and fluids)
- 4-Detection of virus nucleic acids.([reverse transcriptase PCR](#) and [real time PCR](#))

5-Gene sequencing to characterise viral strains

6-Observation of virus particles by [electron microscopy](#).

7-[Hemagglutination assay](#).

Bacteriophages

a phage is a [virus](#) that infects and replicates within a [bacterium](#). Bacteriophages are composed of [proteins](#) that [encapsulate](#) a [DNA](#) or [RNA genome](#), and may have relatively simple or elaborate structures. Their genomes may encode [as few as four](#) genes, and as many as hundreds of [genes](#). Phages replicate within the bacterium following the injection of their genome into its [cytoplasm](#).

Effect of physical and chemical agents on viruses

1. Heat and cold.

Viral infectivity is generally destroyed by heating at 50-60 C⁰ for 30 mint., hours at 20 C⁰, days at 4 C⁰. Viruses can be preserved at -90 C⁰ or -196 C⁰ (liquid nitrogens).

2. PH

Viruses can be preserved at physiological PH (7.3).

3. Ether susceptibility :

Ether susceptibility can be used to distinguish viruses that possess an envelope from those that do not.

4. Detergents:

Non Anionic detergents solubilize lipid constituents of viral membranes. The viral proteins in the envelope are released. Anionic detergents also solubilize viral envelopes; in addition, they disrupt capsids into separated polypeptides.

5. Salts

Many viruses can be stabilized by salt in concentrations of 1 mol/L. e.g. MgCl₂, MgSO₄, Na₂SO₄.

6. Radiation

Ultraviolet, X-ray, and high-energy particles inactivate viruses.

7. Formaldehyde: Destroys viral infectivity by reacting with nucleic acid.

8. Antibiotics: Antibacterial antibiotics have no effect on viruses.

Classification of Animal Viruses:-

Animal viruses can be classified into two families according to the following characters:

A- Characters of viral nucleic acid (N.A):

1. Type of N.A if it is DNA or RNA.
2. Shape of N.A strand if it is ring or straight, single or double strand, segmented or not
3. Molecular weight (size & diameter of N.A).
4. Replication site of N.A if it is in the cytoplasm or nucleus of infected cells.
5. Presence of transcriptase enzyme.

B- Characters of viral capsid:

1. Shape & size of capsid.
2. Symmetry of capsid with N.A (Helical, Cubical, Binal, Complex).
3. Site of capsid assembly inside the infected cells.
4. Lipid solvent sensitivity.
5. Number of capsomeres which consisting the capsid.

According to all above characters recently animal viruses classified into two major groups which are RNA group & DNA group as following:

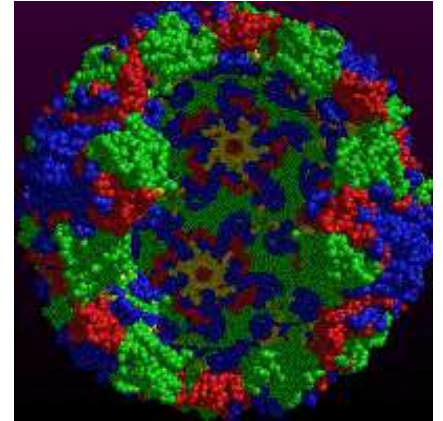
RNA Viruses families:

1. Picornaviridae
2. Orthomyxoviridae
3. Paramyxoviridae
4. Coronaviridae
5. Reoviridae
6. Retroviridae
7. Rhabdoviridae
8. Birnaviridae
9. Bornaviridae
10. Bunyaviridae
11. Togaviridae
12. Astroviridae
13. Arteriviridae
14. Caliciviridae
15. Flaviviridae

DNA Viruses families:

1. Herpesviridae
2. Poxviridae
3. Adenoviridae
4. Parvoviridae
5. apillomaviridae
6. Asfaviridae
7. Circoviridae.

RNA Viruses



1- Picornaviridae :- Pico = small in size.

General characters:

- virions are 18-30 nm in size.
- replicate in cytoplasm.
- resistant to many organic solvents (ether, chloroform).
- Non enveloped, positive-sense, single-stranded RNA viruses with cubical symmetry.
- Individual members differ in their susceptibility to pH change.

Reproductive Cycle of a Picornavirus in a Host Cell

a picornavirus virion attaches to a host cell. Uncoating occurs, and the virus' RNA is released into the cytoplasm of the host cell through a membrane channel. Virus replication occurs entirely in the cytoplasm. The host cell's transcription processes are shut off to a degree that varies with different picornaviruses, while the IRES helps to make sure the virus' transcription is left untouched. Replication occurs. RNA is packaged into preformed capsids. Release of the virus occurs when cell lysis occurs

Genera of Picornaviridae:

Viruses of veterinary importance in five genera of the family Picornaviridae:

1. **Aphthovirus:** causes **Foot and mouth disease** .

Foot-and-mouth:- disease is a highly contagious, viral disease of domestic cloven-hoofed and many wild animals characterized by erosions in the mucosa of the mouth and hooves. the virus causes a high fever for approximately two to six days, followed by [blisters](#) inside the mouth and on the feet that may rupture and cause [lameness](#).

Etiology:-Family Picornaviridae, genus Aphthovirus ,7 serological types: Type A , O, C, South African Territories (SAT) 1,South African Territories (SAT) 2,South African Territories (SAT) 3,and Asia 1.

Animal Transmission:

- 1-Respiratory aerosols.
- 2-Direct contact (Vesicular fluid and Ingestion of infected animal parts)
- 3-Indirect contact via fomites(Boots, hands, clothing).

Clinical Signs:

- 1-Incubation period: 2 to 14 days
- 2-Fever and vesicles.(Feet, mouth, nares, muzzle, teats, Progress to erosions
- 3-Lameness(reluctance to move, sloughing of hooves)
- 4-Abortion
- 5-Death in young animals

Diagnosis

- 1-Serum neutralization test
- 2-Complement fixation test
- 3-Enzyme-linked immunosorbent assay
- 4-Viral isolation
- 5-PCR

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2. Enterovirus:

a. Avian enterovirus cause avian encephalomyelitis and nephritis in chickens.

b. Bovine enteroviruses.

Most cattle show no clinical signs when infected with the virus. However [abortion](#), [stillbirth](#), [infertility](#), and neonatal mortality can occur following infection of the reproductive tract. Enteric signs include [diarrhea](#) and weight loss, and respiratory infection can produce a mucoid nasal discharge.

c. Swine vesicular disease virus.

3. **Cardiovirus:** Encephalomyocarditis in Rodents.

4. **Hepatovirus:** Avian encephalomyelitis-like virus.

5. **Teschovirus:** Porcine enterovirus (Talfan disease).

2-Orthomyxoviridae:- Orthomyxo = Classical mucous**General characters**

- a. Spherical or pleomorphic, nucleocapsid helical symmetry.
- b. 80-120 nm diameter .
- c. single-stranded RNA, segmented (eight molecules), negative sense.
- d. Replication occurs in the nucleus.
- e. Genome is segmented facilitating genetic reassortment.
- f. enveloped contains viral in influenza types A & B haemagglutinin (H), responsible for virus attachment and envelope fusion, and a neuraminidase (N) capable of cleaving viral receptors & promoting both entry of virus into cells & release of virions from infected cells.

Reproductive Cycle of an Orthomyxovirus in a Host Cell

It takes **about 6 hours for the replication of the orthomyxovirus**, killing the host cell in the process. **The virus attaches to the permissive cells via the hemagglutinin subunit, which binds to cell membrane glycolipids or glycoproteins containing N-acetylneuraminic acid, the receptor for virus adsorption. The virus is then engulfed by pinocytosis into endosomes. The acid environment of the endosome causes the virus envelope to fuse with the plasma membrane of the endosome, uncoating the nucleocapsid and releasing it into the cytoplasm. A trans membrane protein derived from the matrix gene (M2) forms an ion channel for protons to enter the virion and destabilize protein binding, allowing the nucleocapsid to be transported to the nucleus, where the genome is transcribed by viral enzymes to yield viral mRNA.. the virus cap sequences allow the viral mRNA to be transported to the cytoplasm, where it is translated by host ribosomes. The nucleocapsid is assembled in the nucleus.**

Virions acquire envelope hemagglutinin is subjected to proteolytic cleavage by host enzymes during budding. This process is necessary for the **released** particles to be infectious

Genera of Orthomyxoviridae:-

1. Influenza type A.

This type includes influenza A viruses of human and also widespread in animals, particularly aquatic birds, chickens, ducks, pigs, horses, and seals. Influenza type A is responsible for pandemic and for most cases of epidemic influenza (antigenically highly variable).

Epidemic:- is defined as an outbreak of a contagious disease that is rapid and widespread, affecting many individuals at the same time.

A pandemic:- is an epidemic that becomes so widespread that it affects a region, continent, or the world.

2. Influenza type B.

This type includes influenza B viruses which are mainly found in humans. Influenza type B may exhibit antigenic changes and sometimes causes epidemics.

2. Influenza type C.

This type includes influenza C viruses of human and swine. Influenza type C is antigenically stable.

Genetic variation in influenza viruses.

A. Events leading to different subtypes:-

Antigenic shift: Major antigenic changes in one or both surface glycoproteins (HA and/ or NA) in influenza A viruses. This due to :

- 1- Genetic reassortment of surface glycoprotein genes occurs between different strains of a given type (possibly involving animal strains).
- 2- Reemergence of strains. Every 10-40 years when a new subtype of influenza A appears, a pandemic results. This happened in :

1918 H1N1 (Spanish flu)

1957 H2N2 (Asian flu)

1968 H3N2 (Hong Kong flu)

1977 H1N1 (Russian flu).

B. Events leading to variation within subtypes:-

Antigenic drift: Minor antigenic changes due to accumulation of point mutations in the gene, resulting in amino acid changes in the protein. Sequence changes can alter antigenic site.

Avian influenza (AI)

Avian influenza (AI) viruses infect domestic poultry as well as pet, zoo, and wild birds. In domestic poultry, AI viruses are typically of **low pathogenicity (LP)**, causing **subclinical infections, respiratory disease, or drops in egg production**. However, a few AI viruses cause **severe systemic infections with high mortality**. This **highly pathogenic (HP)** form of the disease has historically been called **fowl plague**.

Etiology

AI viruses are type A orthomyxoviruses characterized by antigenically homologous nucleoprotein and matrix internal proteins, AI viruses are further divided into 16 hemagglutinin (H1-16) and 9 neuraminidase (N1-9) subtypes based on hemagglutinin inhibition and neuraminidase inhibition tests, respectively. Most AI viruses (H1-16 subtypes) are of low pathogenicity, but some of the H5 and H7 AI viruses are highly pathogenic for chickens, turkeys, and related gallinaceous domestic poultry.

Transmission:-

1-Fecal –oral route 2- water

Clinical Findings

Clinical signs, severity of disease, and mortality rates vary depending on AI virus strain and host species.

Low Pathogenicity Avian Influenza Viruses:

1-Sub clinical infection

2-respiratory signs such as sneezing, coughing, ocular and nasal discharge, and swollen infraorbital sinuses in poultry.

3-decreased egg production or fertility.

High Pathogenicity Avian Influenza Viruses:

1- HP AI viruses cause severe, systemic disease with high mortality in chickens, turkeys, and other gallinaceous poultry; mortality can be as high as 100% in a few days. **In peracute cases**, clinical signs or gross lesions may be lacking before death. However, in acute cases, lesions may include cyanosis and edema of the head, comb, wattle, and snood (turkey); edema and red discoloration of the shanks and feet due to subcutaneous ecchymotic hemorrhages; petechial hemorrhages on visceral organs and in muscles; and blood-tinged oral and nasal discharges. **In severely affected birds**, greenish diarrhea is common.

Swine flu (swine influenza)

Swine influenza is an acute, highly contagious, respiratory disease that results from infection with type A influenza virus.. Pigs are the principal hosts of classic swine influenza virus

Etiology

Swine influenza virus (SIV) is an orthomyxovirus of the influenza A group with hemagglutinating antigen H1 and neuraminidase antigen N1 (ie, H1N1). Recently, new subtypes of SIV have been reported (H3N2, H1N2, and H2N3). Influenza B and C viruses have been isolated from pigs but have not caused the classic disease.

Transmission

aerosolization and pig-to-pig contact.

Clinical Findings

A classic acute outbreak is characterized by sudden onset and rapid spread through the entire herd, often within 1–3 days. The main signs are depression, fever (to 108°F [42°C]), anorexia, coughing, dyspnea, weakness, prostration, and a mucous discharge from the eyes and nose. Mortality is generally 1%–4%. The overt course of the disease is usually 3–7 days in uncomplicated infections. Some increase abortions in late pregnancy.

Laboratory Diagnosis

- 1- Specimens: Nasal washings, gargles, and throat swabs.
- 2- Isolation:
 - a. Embryonated eggs
 - b. Primary monkey kidney cells:- Cell cultures can be tested for the presence of virus by hemadsorption 3-5 days after inoculation.

3-Identification: Viral isolates can be identified by hemagglutination inhibition test(HI).

4- Serology: Routine serodiagnostic tests in use are based on (HI) and ELISA.

5- Polymerase chain reaction (PCR).

Rapid tests based on detection of influenza RNA in clinical specimens using reverse-transcription polymerase chain reaction (RT-PCR) are preferred for diagnosis of influenza. RT-PCR is rapid (<1 day), sensitive, and specific.

Prevention (vaccines):

The different types of vaccines in use today for influenza included an annual vaccine available for influenza A and B typically two A strains and one B strain.

A-Inactivated-virus vaccines, are either whole virus, split or subunit (surface Ag preparations purified HA & NA) vaccines. These vaccines are administered intramuscularly.

B. Live-virus vaccines

A live attenuated, cold-adapted, temperature sensitive, trivalent influenza virus vaccine administered by nasal spray .

Treatment:-

Amantadine and rimantadine for systemic use in treatment and prophylaxis of influenza A (blocks viral uncoating). Resistant viruses emerge during therapy. Zanamivir (Relenza) and Oseltamivir (Tamiflu) NA inhibitors. These drugs are effective against both influenza A and B viruses.

3- Paramyxoviridae: - Paramyxo= along - side mucous

General characters:

- a. Large pleomorphic enveloped viruses (150 nm or more).
- b. Negative sense single –stranded RNA, (non segmented).
- c. Helical symmetrical nucleocapsid.
- d. Replicate in the cytoplasm.
- e. Genetically stable & not exhibit recombination but some antigenic variation may occurs through mutation

Genera of Paramyxoviridae:

1. Respiro virus: Bovine parainfluenza virus 3.
2. Morbillivirus : - Rinderpest virus.
3. Rubella virus : - Newcastle disease virus.-Avian parainfluenza virus.
4. Pneumovirus : Bovine respiratory syncytial virus.
5. Meta pneumovirus: Turkey rhinotracheitis virus.

Replication:-

Viral replication is cytoplasmic. Entry into the host cell is achieved by virus attaches to host cell. Replication follows the negative stranded RNA virus replication model. Negative stranded RNA virus transcription, using polymerase stuttering is the method of transcription. Translation takes place by leaky scanning, ribosomal shunting, and RNA termination-reinitiation. The virus assembly and releasing from the host cell by budding.

1- Bovine Parainfluenza-3 Virus(PI3)

Bovine parainfluenza-3 is a respiratory disease infected cattle population and usually only causes mid to subclinical disease. More importantly it can predispose an animal to secondary bacterial pneumonia.

Etiology:-

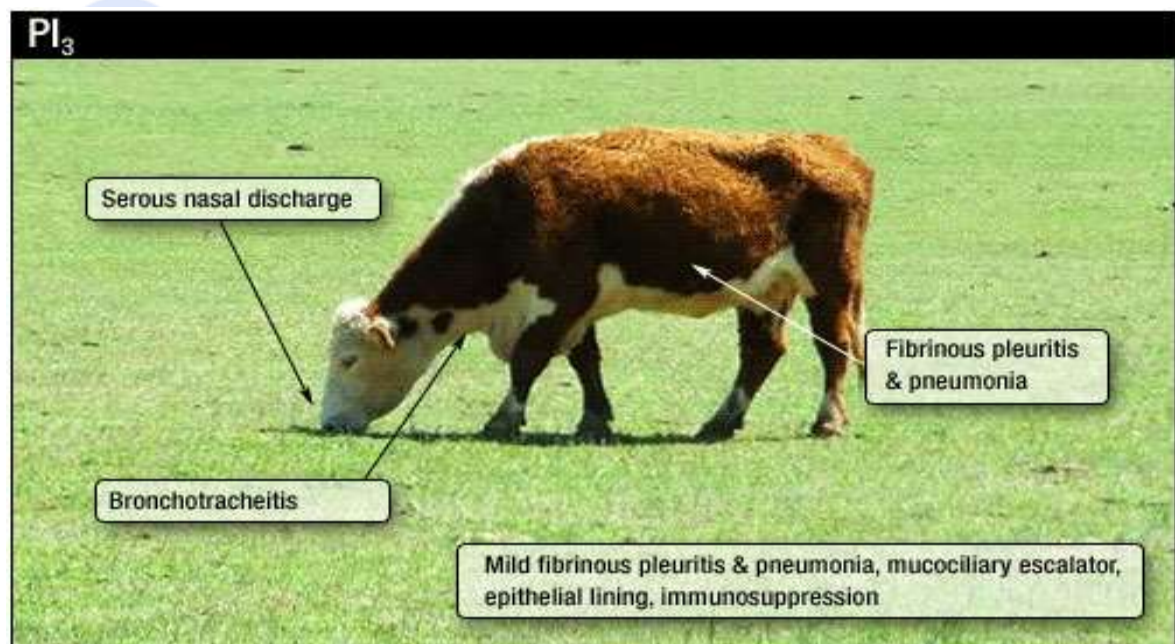
Parainfluenza-3 is classified as a RNA virus of the paramyxovirus .

Clinical Findings:-

1-The clinical signs of parainfluenza-3 include pyrexia (fever), cough, serous (watery) nasal and lacrimal discharge as well as increased rate of respiration and an increase breathing sounds.

2-Bronchotracheitis.

3-Fibrinous pleuritis and pneumonia.

**Diagnosis:-**

1-Clinical signs

2-Viral isolation.

3-ELISA test.

Treatment and Prevention (Vaccination):-

Prevention through vaccination is the best way to prevent any large impact of parainfluenza-3. Most vaccines are combined with other respiratory viruses, and is almost always combined with bovine herpesvirus 1 (bovine rhinotracheitis).

The vaccine is available in modified **live or inactivated through intramuscular** (IM) administration or temperature sensitive mutant strains for intranasal vaccination.

2-Rinderpest:-

Rinderpest was a disease of cloven-hoofed animals characterized by fever, necrosis and erosion in the stomatitis, gastroenteritis, tongue and infected oral mucosa, lymphoid necrosis, diarrhea with/ and blood and mucous. and high mortality.

Etiology

Rinderpest virus is a *Morbillivirus* .

Transmitted:-

1-direct contact.

2-drinking contamination water.

3-air

4-infected animals secreted ocular, nasal, oral and vaginal and feces secretion

Clinical Findings

After an incubation period of 3–15 days.

1-fever.

2-Necrosis and erosions in gastrointestinal tract.

3-ulcer, vesicles and erosions on the gums, buccal mucosa, and tongue. The hard and soft palates were often affected. The ocular nasal discharge became mucopurulent, and Diarrhea the final clinical sign, could be watery and bloody.

Diagnosis:-

- 1-clinical signs.**
- 2-Viral isolation.**
- 3-agar gel immunodiffusion test.**
- 3-ELISA.**
- 4-RT-PCR technique.**

3- Newcastle Disease in Poultry:-

Newcastle disease is an infection of domestic poultry and other bird species characterized by acute respiratory disease, depression, nervous manifestations, or diarrhea may be the predominant clinical form. Severity depends on the virulence of the infecting virus and host susceptibility. Occurrence of the disease is reportable and may result in trade restrictions.

Etiology

NDV, is an RNA virus caused by rubella virus. The virus classification isolates into one of three virulence groups by isolated chicken embryo and chicken inoculation as virulent (velogenic), moderately virulent (mesogenic), or of low virulence (lentogenic). Velogens and mesogens are now classified as virulent NDV (vNDV), the cause of Newcastle disease and reportable infection, whereas infections with lentogens, the low virulence NDV (loNDV) widely used as live vaccines, are not reportable.

Transmission

- 1-air.
- 2-respiratory discharges,
- 3-feces.
- 4-ingesting contaminated water or food.
- 5-contaminated equipment or litter

Clinical Findings

- 1-Onset is rapid, and signs appear throughout the flock within 2–12 days (average 5).
- 2-Observed signs depend on whether the infecting virus has a predilection for respiratory, digestive, or nervous systems.
- 3-Respiratory signs of gasping, coughing, sneezing, and rales predominate in infections with lNDV.
- 4-Nervous signs of tremors, paralyzed wings and legs, twisted necks, circling, clonic spasms, and complete paralysis may accompany, but usually follow, the respiratory signs in neurotropic velogenic disease. Nervous signs with diarrhea are typical in pigeons, and nervous signs are frequently seen in cormorants and exotic bird species. Respiratory signs with depression, watery greenish diarrhea, and swelling of the tissues of the head and neck are typical of the most virulent form of the disease, viscerotropic velogenic Newcastle disease, although nervous signs are often seen, especially in vaccinated poultry. Varying degrees of depression and inappetence are seen. Partial or complete cessation of egg production may occur.
- 5-Eggs may be abnormal in color, shape, or surface and have watery albumen. Mortality is variable but can be as high as 100% with vNDV infections.

Diagnosis

- 1-NDV can be isolated from oropharyngeal or cloacal swabs or tissues from infected birds by inoculation of the allantoic cavity of 9- to 11-day-old SPF embryonated chicken eggs.
- 2-hemagglutinating inhibited test.
- 3-PCR.
- 4-ELISA

Prevention:-

- 1-vaccines are used to prevent losses from sickness and death. **Live lentogenic vaccines, chiefly B1 and LaSota strains**, are widely used and typically administered to poultry by mass application in drinking water or by spray..

2-Oil-adjuvanted inactivated vaccines are also used after live vaccine

4- Bovine Respiratory Syncytial Virus

Bovine Respiratory Syncytial virus or BRSV is a common virus that affects cattle characterized by respiratory disease that can range in severity from being

fatal to the animal not even appearing ill. This virus is also important because it can predispose the animal to secondary infections.

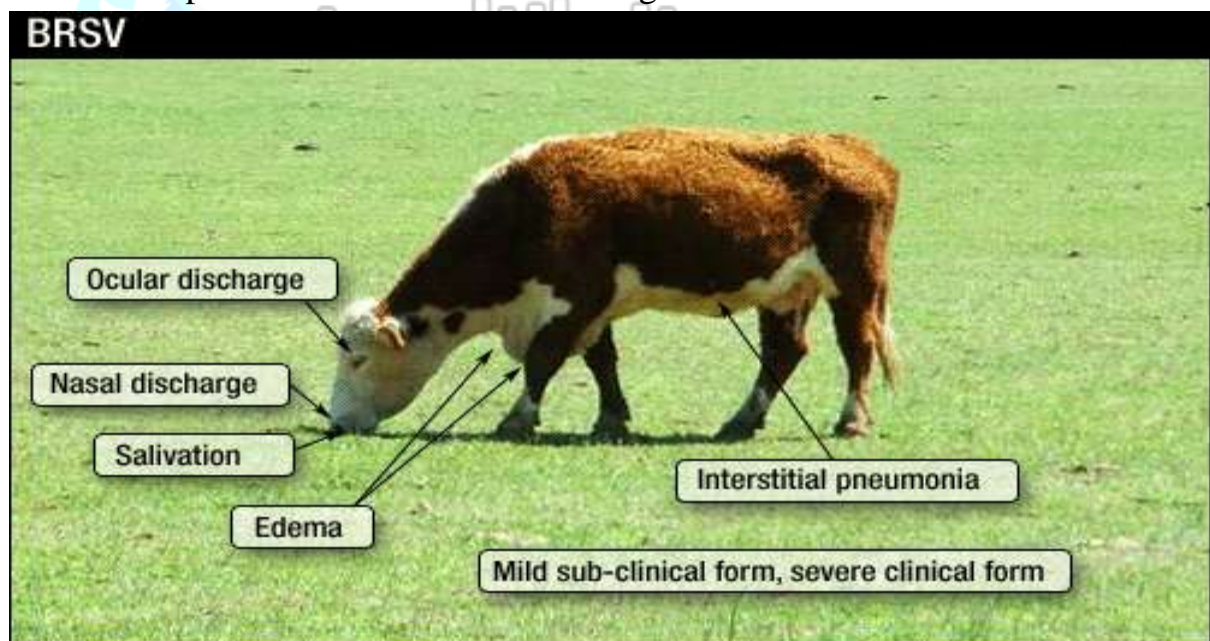
Etiology:- It is a RNA virus causes by pneumonia virus.

Transmission

1-nose to nose contact. 2-Direct contact.

Clinical Findings

Signs of an animal having this are: Difficulty breathing, fever, reduced feed intake and production and nasal discharge.



Diagnosis

1- clinical signs.

2-immunoperoxidase staining,

3-fluorescent antibodies, and enzyme immunoassay.

Treatment and Prevention

1-give antimicrobial drugs to prevent a secondary infection.

2-fluids may be beneficial if the animal is dehydrated due to the disease.

3-Vaccinations are also useful in preventing the disease if done properly.

4- Reoviridae Respiratory enteric orphan.**General characters:**

- a. Non-enveloped with double or triple layered capsid & icosahedral structure 60-80 nm in diameter.
- b. Segmented (10-12 segments) **double- stranded RNA**.
- c. Replicate in cytoplasm with intracytoplasmic inclusion bodies.
- d. Genetic reassortment readily takes place.
- e. Resistant to heat, organic solvents.

Genera of Reoviridae :

1. Orthoreovirus: cause arthritis & tenosynovitis in poultry.
2. Rotavirus : cause enteritis in neonatal farm animals.
3. Orbivirus: Arthropods- borne infections (Arbo), cause: African horse sickness in horses, Bluetongue disease in sheep, and in other domestic & wild ruminants.

Replication:-

Reovirus replication occurs in the cytoplasm. Viral attachment protein s1 binds to sialic acid and junction adhesion molecule (JAM) on host cell. Particles enter the cell via endocytosis and are partially uncoated in the endolysosome to form infectious subviral particles or ISVPs. This process is characterized by removal of outer capsid protein s3, proteolytic cleavage of the inner capsid proteins $\mu 1$ and conformational changes in s1. Early transcription of the segmented dsRNA genome by a viral polymerase occurs inside the ISVPs. These transcripts leave the core particle and are translated in the cytoplasm. RNA is transcribed ; negative-sense strands are used as templates for positive-sense strands. These (+) sense strands serve as late mRNAs and as templates for (-) sense strand synthesis. The capsid is assembled and the particles are released

1. Orthoreovirus: cause arthritis & tenosynovitis in poultry.

Avian orthoreovirus is a virus of the Reoviridae family and causes **most importantly arthritis and tenosynovitis** in poultry but can also be a cause of respiratory disease.

Transmission

- 1-fecal-oral route . 2-respiratory droplets.

Clinical Signs

- 1-Lameness is the principle sign of disease, and may be accompanied by swelling, haemorrhage, skin discolouration and refusal to move.
- 2-In severe cases, the **gastrocnemius** may rupture the bird .
- 3-Diarrhoea, dehydration and anorexia can also be caused by the virus . (malabsorption syndrome).
- 4-Neurological signs develop in severe cases..

Diagnosis

- 1- Clinical signs.
- 2- Virus can be isolated by cultured on chicken eggs and chicken embryo liver cell cultures.
- 3- electron microscopy and PCR.
- 4- Agar gel immunodiffusion and ELISA.

Treatment

Vaccination can be used in the face of an outbreak, **Live attenuated and inactivated vaccines** are available. **Attenuated vaccines are for use in young birds and inactivated for breeding hens**

3-Rotavirus : cause enteritis in neonatal farm animals.

Rotavirus in Calves - Rotaviral diarrhoea

Rotaviral diarrhoea is one of the main infections causing calves scour between five to fourteen days of age. Both the rotavirus, which is seen more often, and the coronavirus together make up over half of diarrhoea problems in calves .

Bovine rota virus entering the small intestine, the virus attacks the villi thus reducing the calf's ability to absorb material into the body effectively. This produces a concentration gradient and the change in water potential results in water loss from the epithelial cells and therefore from the body causing dehydration.

Transmission:-

- 1-oral contact with infected faeces.
- 2-Other sources of infection include re-infected cows which show no symptoms at all. These cows are able to shed the virus without the knowledge of the farmer.

Signs and Symptoms of the bovine rotavirus

- 1-**diarrhoea** which may have the appearance of water rather than normal faeces. The **diarrhoea is often yellow in color and blood and mucous may be present.**
- 2-The calf will appear depressed and be prevent to drink or feed.
- 3-As a result severe dehydration will occur.
- 4-Some calves may drool.

These symptoms are more commonly seen in **calves** between **four days and three weeks of age**. It is rarely symptomatic when the cow is older than a month old.

Diagnosis

- 1-clinical signs.2- ELISA.

Treatment and vaccination bovine rotavirus

- 1-The treatment plan usually consists of **replacing lost fluids and restoring the balance of the body's important electrolytes.**
- 2-administered intravenously or orally depending on whether the oral dehydration therapy works.
- 3-The infected animal must be **kept in a warm and dry area**, and **adequate amounts of colostrum** may be given to young calves to induce recovery.

4-The use of antibiotics in a presence of a secondary bacterial infection the antibiotics are administered.

cows may be administered the **vaccine** in the last one to three months of pregnancy.

3-African horse sickness:

African horse sickness (AHS) is an insect borne, viral disease of equine that is endemic Africa. It can be acute, subacute, or subclinical and is characterized by clinical signs and lesions associated with respiratory and circulatory impairment.

Etiology :-

AHS is caused by African horse sickness virus (AHSV) of the genus *Orbivirus* in the family Reoviridae. There are nine immunologically distinct serotypes of HSV.

Transmission

1-*Culicoides* spp are the principal vectors of all nine serotypes of AHSV is seen during warm, rainy seasons, which favor propagation of the vectors, and disappears when cold weather stops or significantly reduces vector activity.

2-transmitted between dogs by infected mosquitoes.

Clinical Findings :-

1-The acute respiratory form is characterized by an incubation period of 3–5 days, interlobular edema, and hydropericardium. Death occurs in ~1 wk.

2-A fever of 40°–40.5°C (104°–105°F) for 1–2 days is followed by dyspnea, spasmodic coughing, and dilated nostrils.

3-The animal stands with its legs apart and head extended.

4-The conjunctivae are congested, and the supraorbital fossae may be edematous.

5- Recovery is rare, and the animal dies of anoxia, congestive heart failure, or both.

Diagnosis:-

1-clinical signs. 2-ELISA. 3-PCR.

Vaccination.

1- Live vaccine. 2- inactivated and subunit vaccines

3- Bluetongue:-

Bluetongue disease is a non-contagious, insect-borne, viral disease of ruminants, mainly sheep and less frequently cattle, ^[1] goats, buffalo, deer, dromedaries, and antelope

Etiology

Bluetongue virus is the type-species of the genus Orbivirus in the family Reoviridae. There are at least 24 serotypes worldwide, although not all serotypes exist in any one geographic area.

Transmission

The virus is transmitted by the midge *Culicoides* spp.

Clinical signs:-

1-high fever.

2-excessive salivation, swelling of the face, lips and tongue and cyanosis of the tongue. gives the tongue its typical blue appearance.

3-Some animals also develop foot lesions, beginning with coronitis, with consequent lameness. In sheep, this can lead to knee-walking. In cattle, constant changing of position of the feet gives bluetongue the nickname **The Dancing Disease**. Torsion of the neck is observed in severely affected animals.

Diagnosis:- Clinical signs. 2- viral isolation. 3-ELISA. 4- PCR.

Vaccination and treatment.

1-There is no specific treatment for animals with bluetongue apart from rest, provision of soft food, and good husbandry.

2-Complicating and secondary infections should be treated appropriately during the recovery period.

3- Attenuated and inactivated vaccines

5-Retroviridae:-Reverse transcriptase

General characters:

- a. Labile enveloped RNA viruses 80-100 nm in diameter.
- b. Diploid containing two linear positive- sense strands of RNA.
- c. Most members of this family possessing a reverse transcriptase which transcribes Viral RNA to double-stranded DNA.
- d. Mutation and recombination occur with high frequency.

Replication:-

- (1). The first step of replication is the binding of the glycoprotein to the receptor protein of the host cell.
- (2). Once these have been bound, the cell membrane degrades and the RNA strands and enzymes enter the cell
- (3). Within the cell, reverse transcriptase creates a complementary strand of DNA from the retrovirus RNA and the RNA is degraded; this strand of DNA is known as cDNA
- (4). The cDNA is then replicated, and the two strands form a weak bond and enter the nucleus
- (5). Once in the nucleus, the DNA is integrated into the host cell's DNA with the help of integrase
- (6). This cell can either stay dormant, or RNA may be synthesized from the DNA and used to create the proteins for a new retrovirus

7). Ribosome units are used to transcribe the mRNA of the virus into the amino acid sequences which can be made into proteins in the rough endoplasmic reticulum. This step will also make viral enzymes and capsid proteins

(8). Viral RNA will be made in the nucleus. These pieces are then gathered together and are pinched off of the cell membrane as a new retrovirus

Genera of Retroviridae:

1. Alpha retrovirus causing- avian leucosis and avian sarcoma.
2. Beta retrovirus: mouse mammary tumor virus.
3. Gamma retrovirus: feline leukemia feline sarcoma.
4. Delta retrovirus: bovine leukemia.
5. Epsilon retrovirus: fish tumor virus.
6. :
 - a- Human immunodeficiency virus 1,2 HIV (AIDS)
 - b- Equine infectious anemia virus.
 - c- Feline immunodeficiency virus.
 - d- Bovine immunodeficiency virus.

1- avian leucosis

lymphoid leukosis has been the most common form of the leukosis/sarcoma group of diseases seen in chicken flocks.

Etiology

avian leukosis is caused by certain members of the leukosis/sarcoma group of avian retroviruses. viruses are divided into subgroups A, B, C, D, and J, on the basis of differences in their viral envelope glycoproteins, which determine antigenicity,

Transmission :-

1-Congenitally infected chickens fail to produce neutralizing antibodies and usually remain viremic for life.

2-Horizontal infection after hatching is also important, especially when chicks are exposed immediately after hatching to high doses of virus, eg, in feces of congenitally infected chicks or in contaminated vaccines. Horizontally infected chickens have a transient viremia followed by antibody production.

Clinical Findings

1-These may include in appetite, weakness, diarrhea, dehydration, and emaciation. Infected chickens become depressed before death.

2-Palpation often reveals an enlarged bursa and sometimes an enlarged liver. Infected birds may not necessarily develop tumors, but they may lay fewer eggs.

3-Diffuse or nodular lymphoid tumors are common in the liver, spleen, and bursa and are found occasionally in the kidneys, gonads, and mesentery

Diagnosis:

1-Clinical signs . 2-virus isolation and PCR . 3- ELISA kits.

2-bovine leukemia.

Bovine leukemia virus (BLV) :- Bovine immunodeficiency virus (BIV) is a retrovirus belonging to the Lentivirus genus. It is similar to the human immunodeficiency virus (HIV) and infects cattle. The cells primarily infected are lymphocytes and monocytes/macrophages.

Transmission

1- BIV is spread through exchange of bodily fluids.

2- Transmission via colostrum, milk, and in utero.

3- contaminated needles used in vaccinations

Clinical signs of bovine leukosis

enlargement of superficial lymph nodes, a digestive form, a cardiac form, a nervous form, a respiratory form, and others. Lymph node enlargement is often an early clinical sign.

diagnosis

1-clinical signs. 2-agar gel immunodiffusion, 3- ELISA and PCR. 4-Post-mortem findings are characteristic and include widespread white tumors in most organs.

Treatment and vaccine.

1-No apparent treatment is available for the disease.

2-attenuated provirus vaccine for bovine.

6. Birnaviridae:- Bi-RNA

General characters:

- a. Double stranded RNA icosahedral symmetry.
- b. Virions are 60 nm in diameter.
- c. Virions stable over a wide pH range and 60 C° for 1 hour, resistant to ether and chloroform.

Genera of Birnaviridae:

1. Avibirna virus: - infectious bursal disease (Gumboro).
2. Aquabirna virus: - infectious pancreatic necrosis in salmonids (fish).
3. Entomobirna virus: - infect insects.

1- infectious bursal disease (Gumboro).

Infectious bursal disease (IBD) is a viral disease infected domestic chickens. Characterized by present clinical or subclinical disease, but immune suppression and related secondary infections are typically seen. Severity of the immune suppression depends on the virulence of the infecting virus and age of the host.

Etiology .

IBD is caused by avibirnavirus (infectious bursal disease virus; IBDV) that is most readily isolated from the bursa of Fabricius but may be isolated from other organs.

Two serotypes of IBDV have been identified.

- 1- serotype 1 viruses cause disease in chickens and, within them, antigenic variation can exist between strains. Antigenic drift is largely responsible for this antigenic variation, but antigenic differences can also occur through genome homologous recombination.
- 2- Serotype 2 strains of the virus infect chickens and turkeys but have not caused clinical disease or immunosuppression in these hosts.

Transmission:-

- 1-feces .
- 2-transferred from house to house by fomites.

Clinical Findings

IBD is highly contagious; results of infection depend on age and breed of chicken and virulence of the virus.

1-Infections may be subclinical or clinical. Infections before 3 wk of age are usually subclinical. Chickens are most susceptible **to clinical disease at 3–6 wk of age** when immature B cells populate the bursa and maternal immunity has waned, but severe infections have occurred in Leghorn chickens up to 18 wk of age.

subclinical infections They cause severe, long-lasting immunosuppression due to destruction of immature lymphocytes in the bursa of Fabricius, thymus, and spleen. The humoral (B cell) immune response is most severely affected;

In clinical infections, onset of the disease occurs after an incubation of 3–4 days. Chickens may exhibit severe prostration, incoordination, watery diarrhea, and inflammation of the cloaca.

Diagnosis:-

1-clinical signs.

2-Viral isolation

3-PCR to identify the viral genome in bursa tissue.

4-titration of the virus and virus-neutralization assays.

Control

1-Live vaccines of chicken embryo can be administered by eye drop, drinking water, or SC routes at 1–21 days of age

2-oil-adjuvanted, inactivated vaccine.

7- Rhabdoviridae:- Rod**General characters:**

- a. Have characteristic rod shapes and bullet-shaped in vertebrates .
- b. enveloped RNA viruses with helical symmetry.
- c. virions size (100-430 nm).

- d. Stable in the pH range of 5- 10.
- e. Rapidly inactivated by heating at 56 C°.
- f. Sensitive to lipid solvents and UV light.

Genera of Rhabdoviridae:

1. Lyssavirus: Rabies virus .
2. Ephemero virus: Bovine ephemeral fever virus.
3. Vesiculovirus: vesicular stomatitis virus.

1- **rabies virus** is a neurotropic virus that causes rabies in humans and animals.

Transmission:-

- 1- Usually the bite or scratch of an infected animal, which introduces the virus through the skin or mucous membrane. .
- 2- Aerosol transmission from an infected animal, usually a bat.
- 3- Tissue transplants (such as corneas) from infected humans.

Clinical signs:-

most animals, the virus will spread through the nerves of the bitten animal towards the brain. The virus is relatively slow moving and the average time of incubation from exposure to brain involvement is between 3 to 8 weeks in dogs, 2 to 6 weeks in cats, and 3 to 6 weeks in people. However, incubation periods as long as 6 months in dogs and 12 months in people have been reported. After the virus reaches the brain it then will move to the salivary glands where it can be spread through a bite. After the virus reaches the brain the animal will show one, two, or all of the three different phases

1-Prodromal phase

The first is the prodromal phase and usually lasts for 2-3 days in dogs. Apprehension, nervousness, anxiety, solitude, and a fever may be noted. Friendly animals may become shy or irritable and may snap, whereas, aggressive animals may become affectionate and docile.

2-Furious phase

From the prodromal phase, animals may enter the furious stage; cats are particularly prone to developing this phase. The furious stage of the disease in dogs usually lasts for 1 to 7 days. Animals become restless and irritable and are hyperresponsive to auditory and visual stimuli. As they become more restless, they begin to roam and become more irritable and vicious. When caged, dogs may bite and attack their enclosures. Animals progress to become disoriented and then have seizures and eventually die.

3-Paralytic (dumb) phase

Animals may develop the paralytic phase either after the prodromal or furious stage. The paralytic phase usually develops within 2 to 4 days after the first signs are noted. Nerves affecting the head and throat are the first to be involved and animals may begin to salivate as a result of their inability to swallow. Deep labored breathing and a dropped jaw may result as the diaphragm and facial muscles become increasingly paralyzed. Animals may make a choking sound and many owners think that there is something lodged in the dog's throat. The animal will get weaker and eventually go into respiratory failure and die.

Diagnosis:

1-clinical signs.

2-microscopic examination.

3-blood samples

Treatment

There is no treatment. Vaccination is the best way to prevent infection

DNA Viruses

1- Herpesviridae: creeping

General characters:

1. Enveloped DNA viruses with icosahedral symmetry.
2. Replicate in nucleus, with intra nuclear inclusion bodies.
3. 120-200 nm diameter.
4. Latency is a common outcome of infection with these viruses.
5. This family contains more than 100 viruses which cause different diseases in human, birds, mammals, fish, amphibian & reptiles.

There are three subfamilies of veterinary importance:

Alpha herpesvirinae, Beta herpesvirinae, Gamma herpesvirinae which cause diseases of the respiratory, reproductive & nervous systems, in different animal species: e.g. Herpes infections of ruminants:

- a. Bovine herpes virus cause (infectious bovine rhinotracheitis (IBR).
- b. In poultry: a. infectious laryngo-tracheitis (ILT).- Marek's disease.- Duck plaque.
- c. Human Herpes simplex type 1 cause:- Fever blisters.- Chicken pox or varicella zoster or shingles.

Replication

Replication begins with the binding of the virion to the plasma membrane of the host cell and is followed by fusion of the virion envelope with the host cell membrane. The capsid and tegument are released into cytoplasm and are transported to the nucleus. Viral DNA is then released in the nucleus, followed by transcription, replication, and assembly of new capsids. Capsids egress from the nucleus and are released from the cell plasma membrane by exocytosis.

1-Infectious Bovine Rhinotracheitis (IBR):-

is a highly contagious, infectious disease that is caused by Bovine Herpesvirus-1 (BHV-1). In addition to causing respiratory disease, this virus can cause conjunctivitis, abortions, encephalitis, and generalized systemic infections.

Cause

IBR is caused by Bovine Herpesvirus-1 that is capable of attacking many different tissues in the body leading to a variety of clinical diseases.

Transmission:- secretions from the eye nose and reproductive organs.

Clinical signs:- clinical diseases caused by the virus can be grouped into:

- 1- respiratory tract infections
- 2- eye infections
- 3- abortions
- 4- genital infections
- 5- brain infections
- 6- generalized infections of newborn calves.

Diagnosis:-

- 1-Clinical signs.
- 2-Elisa test.

Treatment and Control

As with other viral diseases, there is no direct treatment for the infection. Antibiotic treatment of secondary infections may be necessary. The best way to control IBR is to vaccinate before a disease outbreak occurs (replicating or non-replicating vaccines) although there are fast acting intranasal vaccines that will confer short-lived immunity.

2-Infectious laryngotracheitis (ILT):- is an acute, highly contagious, herpesvirus infection of chickens .characterized by severe dyspnea, coughing, ,rales, nasal and ocular discharge, tracheitis, conjunctivitis, and mild rales.

Causes:-

The disease is caused by *Gallid herpesvirus I*, commonly known as infectious laryngotracheitis virus (ILTV).

Clinical Findings

- 1-In the acute form, gasping, coughing, rattling, and extension of the neck during inspiration, blood, mucus, yellow caseous exudates, or a hollow caseous cast in the trachea are seen 5–12 days after natural exposure.
- 2-Reduced productivity is a varying factor in laying flocks. Affected birds are anorectic and inactive.
- 3- The mouth and beak may be bloodstained from the tracheal exudate. Mortality varies but may reach 50% in adults and is usually due to occlusion of the trachea by hemorrhage or exudate.

Diagnosis:-

- 1- Clinical signs.
- 2-detection of viral DNA using virus-specific PCR assays.
- 3-Isolation and identification of the virus is done in chicken embryos or tissue culture .
- 4- microscopic examination of the trachea, intranuclear inclusion lesions produced by ILTV infection .

Control

- 1-. Vaccination is done with live attenuated vaccines
- 2-viral vector recombinant vaccines.

3-Marek's disease:- Marek's disease is one of the most ubiquitous avian infections; it is identified in chicken flocks worldwide. Every flock, except for those maintained under strict pathogen-free conditions, is presumed to be infected. Although clinical disease is not always apparent in infected flocks, a subclinical decrease in growth rate and egg production may be economically important.

Etiology

Marek's disease virus is a member of the genus *Mardivirus* within the subfamily Alphaherpesvirinae. Within the genus *Mardivirus* are three closely related species

previously designated as three serotypes of Marek's disease virus. Gallid herpesvirus 2 (MDV-1) represents all virulent Marek's disease virus strains and is further divided into pathotypes, designated as mild (m), virulent (v), very virulent (vv), and very virulent plus (vv+). Gallid herpesvirus 3 (MDV-2) and Meleagrid herpesvirus 1 (turkey herpesvirus, MDV-3) represent avirulent virus strains isolated from chickens and turkeys, respectively, and are commonly used as vaccines against Marek's disease.

Transmission

The route of infection is usually respiratory and the disease is highly contagious being spread by infective feather-follicle dander, fomites, etc. Infected birds remain viraemic for life. Vertical transmission is not considered to be important.

Signs

- Paralysis of legs, wings and neck.
- Loss of weight.
- Grey iris or irregular pupil.
- Vision impairment.
- Skin around feather follicles raised and roughened

Diagnosis

History, clinical signs, distribution of lesions, age affected, histopathology. Differentiate from Lymphoid leukosis, botulism, deficiency of thiamine, deficiency of Ca/Phosphorus/Vitamin D, especially at the start of lay.

Treatment and vaccines

None treatment. HVT & SB-1 & RISPENS trivalent Marek's disease vaccine contains serotype 1 (Rispens), serotype 2 (SB-1) and serotype 3 (turkey herpesvirus or HVT) Marek's disease viruses. This combination vaccine is recommended for use in chickens as an aid in the prevention of very virulent Marek's disease.

2- Poxviridae:**General characters:**

1. Largest viruses (220-450 nm x 140- 260 nm).
2. Complex symmetry, brick shaped viruses.
3. Enveloped DNA viruses replicate in cytoplasm.
4. Virions are stable at room temperature under dry conditions, but sensitive to heat, detergents, formaldehyde and oxidizing agents.
5. Skin lesions prominent feature.
6. Genetic recombination within genera results in extensive serological cross reaction and cross-protection.

Genera of Poxviridae:

- a. Orthopoxvirus: Vaccinia, cow pox , variola virus .
- b. Parapoxvirus: Orf virus, Bovine papular stomatitis virus, pseudo complex.
- c. Capripox virus : goat pox, sheep pox, lumpy skin disease virus.
- d. Avipoxvirus: Fowl pox virus, pigeon pox, Turkey pox.
- e. Suipox virus: Swinepox virus.
- f. Leporipox virus: Myxoma virus. (Rabbit)
- g. Entomopox virus: infect insects.

1-vaccinia virus, cowpox virus , variola virus

Despite the name, the reservoir hosts of cowpox virus are rodents, from which the virus occasionally spreads to domestic cats, cows, humans, and zoo animals.

The virus produces lesions on the teats and the contiguous parts of the udder of cows and is spread through herds by the process of milking.

2-Sheep pox, Goat pox, lumpy skin diseases virus :-

Sheep pox and goat pox are the most important of all pox diseases of domestic animals, causing high mortality in young animals and significant economic loss.

Eciology:- Capripox virus.

Transmission:

- 1-Virus particles are shed from skin lesions and in ocular and nasal discharges during the acute stages of the disease.
- 2-During an outbreak, the virus is probably transmitted between sheep by respiratory droplets.
- 3-There is also evidence that mechanical transmission by biting arthropods, such as stable flies, may be important.
- 4-Infection occurs through skin abrasions or by aerosol.

Clinical signs:-

- 1- incubation period of about one week,
- 2-infected animals develop fever,
- 3-edema of the eyelids, conjunctivitis and nasal discharge. Within a few days
- 4-macules which rapidly develop into papules appear on the skin and external mucous membranes.
- 5-Scabs form over necrotic papules.

Lumpy skin Disease virus (within genus Capripoxvirus).

Lumpy skin disease affects cattle breeds, characterized by fever, followed shortly by the development of nodular lesions in the skin that subsequently undergo necrosis

Clinical signs

- 1-The incubation period is up to 14 days.
- 2-persistent fever accompanied by lacrimation, nasal discharge and a drop in milk yield.
- 3- Superficial lymph nodes become enlarged and there is oedema of the limbs and dependent tissues.
- 4- skin nodules develop particularly on the head, neck, udder and perineum.
- 5-Nodules also develop on the mucous membranes of the mouth and nasal
- 6-Some skin lesions may develop into a central plug of necrotic tissue which sloughs producing a deep ulcer.
- 7-Secondary bacterial infection or myiasis can exacerbate the condition.
- 8- Recovery may take several months.
- 9-pregnant cows may abortion .

3-Diseases caused by members of the genus avipoxvirus

Fowlpox and Other Avian Poxvirus Diseases

Poxviruses that are related serologically to each other and specifically infect birds have been recovered from lesions found in all species of poultry and many species of wild birds. Viruses recovered from various species of birds are given names related to their hosts, such as fowl pox, canary pox, turkey pox, pigeon pox. The fowl pox virus is highly infectious for chickens and turkeys, rarely so for pigeons, and not at all for ducks and canaries, but turkey pox virus is virulent for ducks.

There are two forms of fowl pox, probably associated with different routes of infection.

1-The most common, which probably results from infection by **biting arthropods**, is characterized by **small papules on the comb, wattles, and around the beak**; lesions occasionally develop on the **legs and feet and around the cloaca**.

2-The second form of fowl pox is probably due to **droplet infection and involves infection of the mucous membranes of the mouth, pharynx, larynx, and sometimes the trachea**. This is often referred to as the **diphtheritic form of fowlpox** because the lesions result in a **necrotic pseudo-membrane, which can cause death by asphyxiation**.

4-Diseases caused by members of the genus para pox virus.

1-Orf (Contagious Pustular Dermatitis):-

Orf (contagious pustular dermatitis, scabby mouth) is an important disease in sheep and goats (especially in young lambs) caused by a para poxvirus

Transmitted through direct or indirect contact.

Clinical signs:-

The virus, which is epithelio tropic, produces proliferative wart-like lesions following entry through skin abrasions. The virus replicates in **epidermal keratinocytes** and infected cells release an **endothelial growth factor** which is implicated in epithelial cell proliferation.

1-Papular lesions progress to vesicles, pustules and eventually to scab formation. Lesion appear on the muzzle and lips gums tongue, The lesions can also affect the eyelids, feet, and the teats.

2- Infections caused by pseudo cow pox virus

Pseudocowpox, also known as **milker's nodule**, is caused by pseudocowpox virus, parapoxvirus with worldwide distribution. It is a common mild condition affecting the teats of lactating cows. Infection spreads slowly through **milking herds** with variation in the number of affected animals at any particular time.

Transmission

Occur by direct or indirect contact.

- 1-through teat cups and on milkers' hands.
- 2-mechanically by flies or when calves are being suckled.

3-Bovine papular stomatitis.

- 1-This mild viral disease of young cattle occurs worldwide.
- 2-Mature cattle are considered to be reservoirs of infection
- 3-It is caused by a parapoxvirus, bovine papular stomatitis virus,
- 4-is transmitted by direct or indirect contact
- 5-Affected calves commonly develop lesions in **the Oral cavity and on the muzzle.**
- 6-These lesions are characterized by **hyperaemic foci that develop** into papules
- 7-Affected animals usually recover within three weeks

Diagnosis of Poxviridae diseases

- 1-Diagnosis can often be made on clinical grounds.
- 2-Skin biopsies or postmortem specimens may be used for laboratory confirmation.
- 3-Eosinophilic intracytoplasmic inclusions may be demonstrable histologically in epidermal cells.
- 4-Electron microscopy can be used for the rapid identification of poxvirus

5-lesions. can be readily distinguished from parapoxviruses.

6-Virus may be isolated in lamb testis or kidney cell monolayers, chorioallantoic membrane,.....

7-Direct ELISA has been developed for to detection of virus antigen.

8-Nucleic acid probes can be used for diagnosis

9-PCR

10-Several serological methods including virus neutralization, Western blot analysis and the indirect fluorescent antibody test and indirect ELISA.

Treatment

1-There is no specific treatment.

2-Control of secondary infected in skin, on oral mucosa or on respiratory bacterial infection is desirable.

Control

A-In endemic areas, control is based on annual vaccination by:

1-Modified live vaccines

2-inactivated vaccines

3-subunit vaccine

B-control in reservoirs carriers (flies , rodent , wild animals, ...)

3- Adenoviridae: Gland

General characters:

1. Non enveloped, double-stranded DNA viruses.
2. Icosahedral symmetry, 70-90 nmin diameter.
3. Replicate in nuclei, forming intranuclear inclusion bodies.
4. Fibers project from twelve vertices of capsid.
5. Agglutinate rat or monkey RBCs
6. Resist freezing, mild acid & lipid solvents, 56C for 10 min.

Genera of Adenoviridae:-

1. Aviadenovirus: hydropericardium hepatitis syndrome (HHS), Egg drop syndrome in layers .
2. Mastadenovirus mammalian adenovirus which cause sever infections in dogs (infectious canine hepatitis .pulmonary infections in equine, which fatal in Arabian foals.

1-hydropericardium hepatitis syndrome (HHS):-

is an acute disease of young chickens associated with anemia, hemorrhagic disorders, and hydropericardium. It is a common disease in several countries, where broilers are severely affected, resulting in high mortality rates.

Etiology:-

The AAVs classified in the genus *Aviadenovirus* (formerly group I), are the etiologic agents of this condition. Although there are 12 different serotypes of AAV, these AAVs are capable of producing the disease without the immunosuppressive effects.

Transmission:-

1-Vertical transmission has been described in progeny from breeder flocks infected with AAV serotypes 4 and 8.

2- Horizontal transmission has also been demonstrated; young chicks in contact with infected chicks.

Clinical Findings:-

specific clinical signs, abrupt onset of mortality, lethargy, huddling with ruffled feathers, and yellow, mucoid droppings may be seen. The duration of the infection usually ranges from 9–14 days with morbidity of 10%–30% and a daily mortality of 3%–5%.

diagnosis

1-clinical signs.

2-Viral isolation.

3-restriction enzyme analysis, and PCR.

Treatment and Prevention

1-As with many other viral diseases, there is no treatment. Antibiotics may help prevent secondary bacterial infections. Sulfonamides are contraindicated if evidence of hematologic disease or immunosuppression is seen.

2-live and inactivated vaccines are used to control the syndrome.

2-Egg drop syndrome:-

is an aviadenovirus-induced disease characterized by the production of pale, soft-shelled, and shell-less eggs by apparently healthy laying hens. The disease in laying hens has commonly been called "egg drop syndrome," but the full name (egg drop syndrome '76 [EDS '76]) should be used to distinguish.

Etiology:-

EDS '76 is caused by a double-stranded DNA virus, duck adenovirus 1 (also known as EDSV), which belongs to the genus *Avai adenovirus*. The virus commonly infects both wild and domestic ducks and geese

Clinical Findings

1-pale-shelled eggs, quickly followed by production of soft-shelled and shell-less eggs. The thin-shelled and shell-less eggs are fragile, and the birds tend to eat them;

Diagnosis:

1-Clinical signs.

2-viral isolation.

3-A hemagglutination-inhibition test using fowl RBCs .

4-ELISA,

5-neutralization test can be used for confirmation.

6-The double immunodiffusion test also has been used. PCR-based tests.

Control:-

There is no treatment for EDS '76. Inactivated vaccines with oil adjuvant are available.

4- Parvoviridae:- small = picodna

General characters:

1. small (18-26 nm), non enveloped DNA viruses.
2. Icosahedral symmetry, single stranded DNA.
3. Replicate in the nucleus forming intra nuclear inclusion bodies.

4. Require rapidly- dividing cells for replication.
5. Resistant to heat 56C for more than 60 minutes also resistant to lipid solvents,pH (3-9).
6. Inactivated by formalin, Propiolacton, sodium hypochlorite.

Genera of Parvoviridae:

Parvovirus: cause of enteric & systemic disease in dogs & cats (Feline pan leukopenia or feline infectious enteritis).

1-Feline Panleukopenia(feline infectious enteritis):-

is a highly contagious, often fatal, viral disease of cats that is seen worldwide. Kittens are affected most severely. The causative parvovirus is very resistant; it can persist for 1 yr at room temperature in the environment.

Etiology:- Parvovirus

Transmission:-

Cats are infected oro nasally by exposure to infected animals, their feces, secretions, or contaminated fomites(eg, shoes, clothing).

Clinical Findings

1-Acute cases show fever (104°–107°F [40°–41.7°C]), depression, and anorexia after an incubation period of 2–7 days. Vomiting usually develops 1–2 days after the onset of fever; it is typically bilious and unrelated to eating. Diarrhea may begin a little later but is not always present. Extreme dehydration develops rapidly. Affected cats

Diagnosis

1-clinical signs

2-Total WBC counts <2,000 cells/ μ L are associated with a poorer prognosis.

3-immunochromatographic test kit intended for detection of fecal CPV antigen. However, fecal antigen is detectable only for a short time after infection. False-negative results are common.

Treatment and Prevention:-

1-Successful treatment of acute cases requires vigorous fluid therapy and supportive nursing care in the isolation unit.

2-IV fluid replacement and maintenance with a balanced isotonic crystalloid solution (eg, lactated Ringer's solution with calculated potassium supplementation). B vitamins should be added to the infusion, together with 5% glucose if hypoglycemia is suspected or proved.

3- Parenteral, broad-spectrum antibiotic therapy is indicated; however, nephrotoxic drugs (eg, gentamicin, amikacin) should be avoided until dehydration.

4-Recombinant feline interferon omega (rFeIFN; 1 MU/kg/day SC for 3 days) should be considered for use in the treatment of feline panleukopenia.

5-inactivated and modified live virus vaccines

5-Papillomaviridae

General characters:

1. Non-enveloped, circular double strand DNA viruses.
2. Icosahedral symmetry, 55 nm in diameter.
3. Replications in nucleus
4. Resistant to lipid- solvents, acids, 60°C for 30 minutes.

Genera of Papillomaviridae:

Contains one genus, Papillomavirus:

- a. Have not been cultured in vitro.
- b. Cause papilloma & fibropapilloma in domestic animals.

1-Bovine papillomavirus (BPV):-

is a group of [DNA viruses](#) of the family [Papillomaviridae](#) that are common in [cattle](#). Infection causes [warts](#) ([papillomas](#) and fibropapillomas) of the [skin](#) and [alimentary tract](#), and more rarely cancers of the alimentary tract and [urinary bladder](#). They are also thought to cause the skin tumour [equine sarcoid](#) in [horses](#) and [donkeys](#).

Types of papillomavirus

There are at least five strains of papillomavirus, each of which has a specific predilection **site on the cow.**

1-BPV type I:- causes wart like lesion on the nose, teats or penis and affect young cattle and will usually regress over time.

2-BPV type II:- causes warts all over the skin of the head and neck of young cattle and will usually regress over time.

3-BPV type III:- causes atypical warts which are smooth and white in appearance and occur mainly on the teats and udders of older cows.

4-BPV type IV causes papillomas in gut, especially the rumen, and bladder, as well as lesions on the eye. This particular systemic form can be referred to as **papillomatosis**. The papillomas caused by this strain can undergo malignant transformation to alimentary carcinomas,

5-BPV type V causes tiny warts on the teat

Transmission:-

infection is spread by direct contact from cow to cow or by indirect contact from fomites. With most strains, calves are most commonly affected.

Clinical Signs

In BPV type IV signs will be concurrent with the body system affected e.g. haematuria if in the bladder or diarrhoea and bloat if in the rumen.

On the skin, the virus will at first appear as small, smooth raised nodules in the characteristic regions, which will then enlarge. Some will become rough and cauliflower like in appearance, whilst others may become pedunculated. A characteristic feature of this disease is that the warts will regress spontaneously over a period no longer than one year.

Diagnosis

Lesions are characteristic in appearance and location along with the signalment of the animal are enough to make a presumptive diagnosis.

Treatment and Control

Often no treatment is required as spontaneous regression usually occurs. If the cow traumatises a wart then a short course of antibiotics or anti inflammatories may be used to aid its immediate relief. Any other treatment is only of cosmetic value and so is generally only performed by those wishing to show their cattle. Treatment of warts would include injection with lithium antimony thiomalate 6%, removal by cryosurgery or cold steel surgery.

Control measures are not usually necessary due to the mildness of the disease.

