
بسم الله الرحمن الرحيم

Special Virology 355

Lecture Series IV

Family: Coronaviridae

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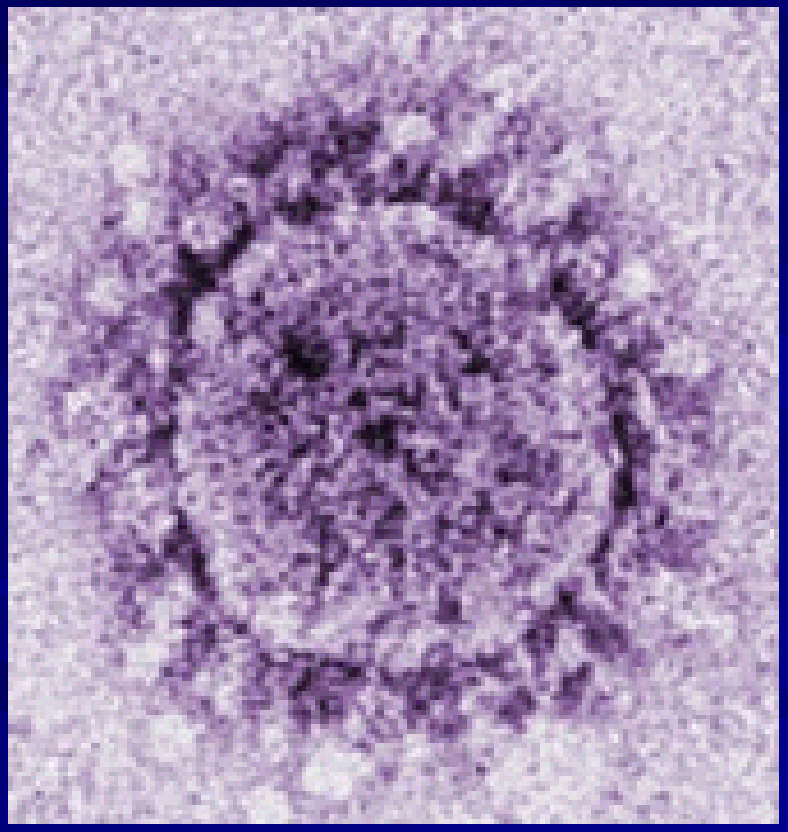
Introduction

- Coronaviruses induce a variety of diseases like:
  - Respiratory disease (human, chicken and rats)
  - Gastroenteritis (cattle, pigs, dogs, equine and mice)
  - Encephalomyelitis (pigs and mice)
  - Hepatitis (mice)
  - Myocarditis (rabbits)
  - Peritonitis (cats)
  - Nephritis (chicken)
- In humans, they cause common cold (229E, OC43, NL63, HKU-1) and severe respiratory syndrome (SARS, MERS).

The name "Corona" means crown, which represent the crown-shaped appearance of surface projections (similar to solar corona).



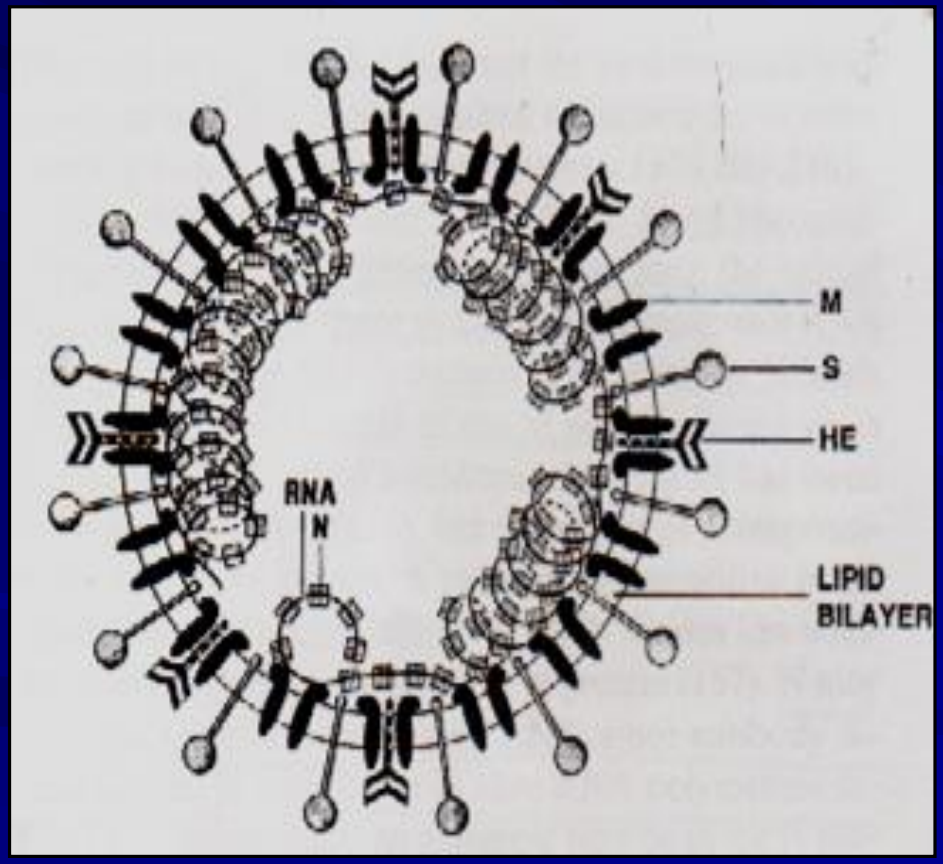
Taxonomy

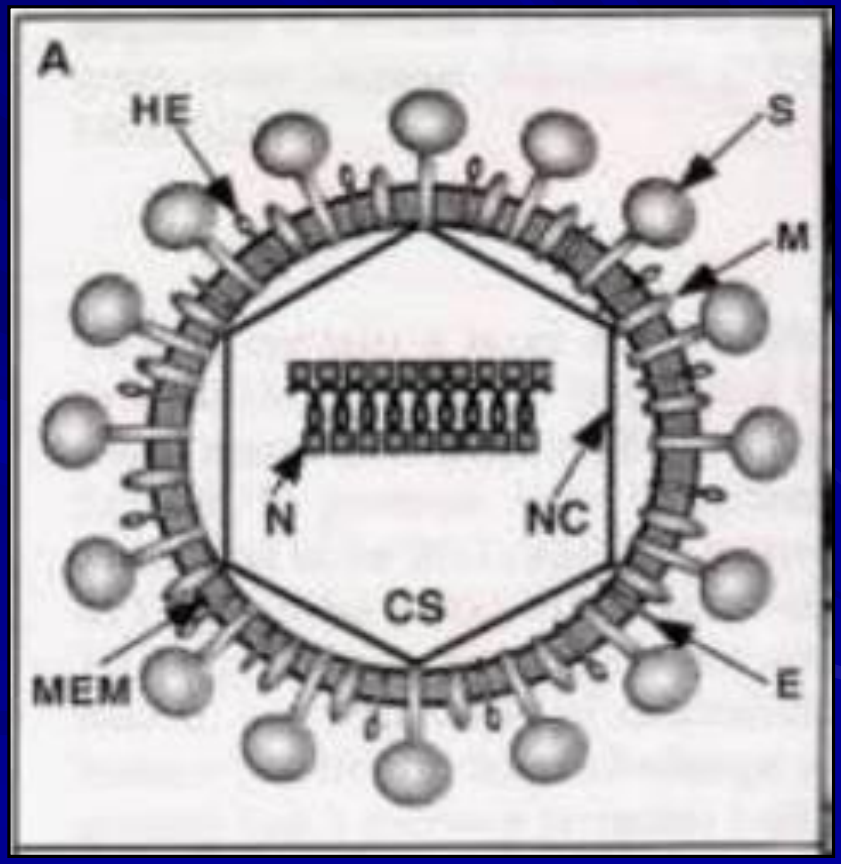
- Order: Nidovirales (nidus = nest) …. 3 suborders
- Suborder: Cornidovirineae …. 1 family
- Family: Coronaviridae
  - Subfamily: Letovirinae (Frogs)
  - Subfamily: Orthocoronavirinae
- Subfamily: Orthocoronavirinae
  - Genus: Alphacoronavirus
  - Genus: Betacoronavirus
  - Genus: Gammacoronavirus
  - Genus: Deltacoronavirus

Genus	Virus Species	Host	Disease
Alphacoronavirus	- Alphacoronavirus 1 - Porcine epidemic diarrhea virus - Human coronavirus 229E - Human coronavirus NL63	Pig Pig Human Human	Enteritis Enteritis Respiratory disease Respiratory disease
Betacoronavirus	- Murine coronavirus - Betacoronavirus 1 - Human coronavirus HKU - SARS coronavirus - MERS coronavirus	Rodents Cattle, pig, human Human Human Human	Hepatitis, enteritis, Encephalomyelitis Respiratory disease, enteritis Respiratory disease Respiratory disease Respiratory disease
Gammacoronavirus	Avian coronavirus (IBV)	Chicken Turkey	Respiratory disease nephritis
Deltacoronavirus	A group of avian coronaviruses	Birds	Different disease forms

General properties

I. Morphology

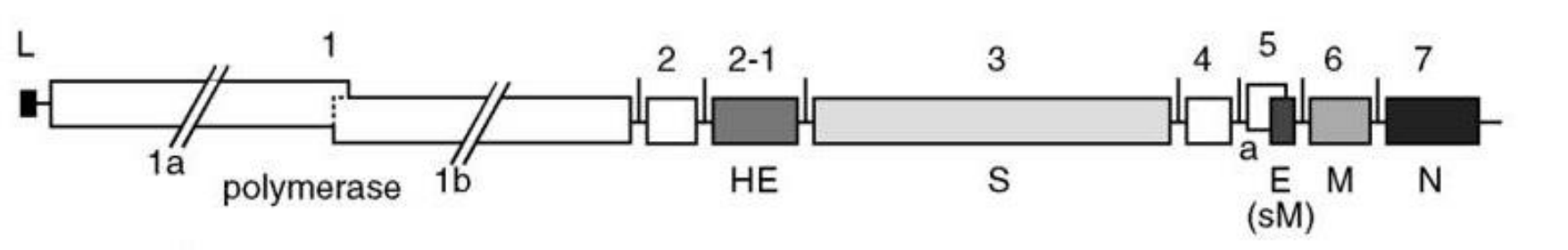




- Enveloped viruses
- Pleomorphic (mostly spherical)
- Medium-sized (80-220 nm in diameter)
- Envelope carries large club-shaped projections (peplomers or spikes) of 20 nm long
- Some coronaviruses (Betacoronaviruses) have a second layer of shorter peplomers; 5 nm long (HE protein)
- Internal core comprises from:
  - ✓ Helical nucleocapsid (enclose the viral genome).
  - ✓ Spherical core shell (possibly icosahedral) 65 nm diameter

II. Genome

- Single-stranded RNA (Positive-sense) – Infectious
- Linear – Single molecule (non-segmented)
- Largest viral RNA genome (27.6 – 31 kb)
- Organized in 6-7 regions (each contain one or more ORF)
- Encodes for 7-10 proteins (4-5 structural)
- 5` end: Capped - Leader sequence of 65-98 nucleotides
- 3` end: Pseudoknob and poly A tail



III. Proteins

1) Nucleocapsid (N) protein:

- Phosphoprotein
- Binds to viral genome to form helical nucleocapsid (Protects genome from environmental conditions)
- Plays an important role in regulation of RNA synthesis, transcription and budding

2) Integral membrane (M) protein:

- Glycoprotein
- A short triple-spanning transmembrane protein
- responsible for virus assembly and budding

III. Proteins

3) Spike (S) protein:

- Glycoprotein
- Forms the club shape projections of the envelope
- Present in one of two forms:

  Uncleaved form (Alphacoronavirus)

  Two cleavage products: S1 and S2 (other genera)
- Functions:

  a) Binding to cell receptors (viral attachment)

  b) Cell fusion (Penetration, cell-to-cell spread)

  c) Haemagglutination and haemadsorption

  d) Induction of humoral and cellular immunity

III. Proteins

4) Haemagglutinin-esterase (HE) protein:

- Glycoprotein found ONLY in Betacoronaviruses
- Envelope protein forms the shorter projections
- Functions:

  a) Binding to cell receptors (viral attachment)

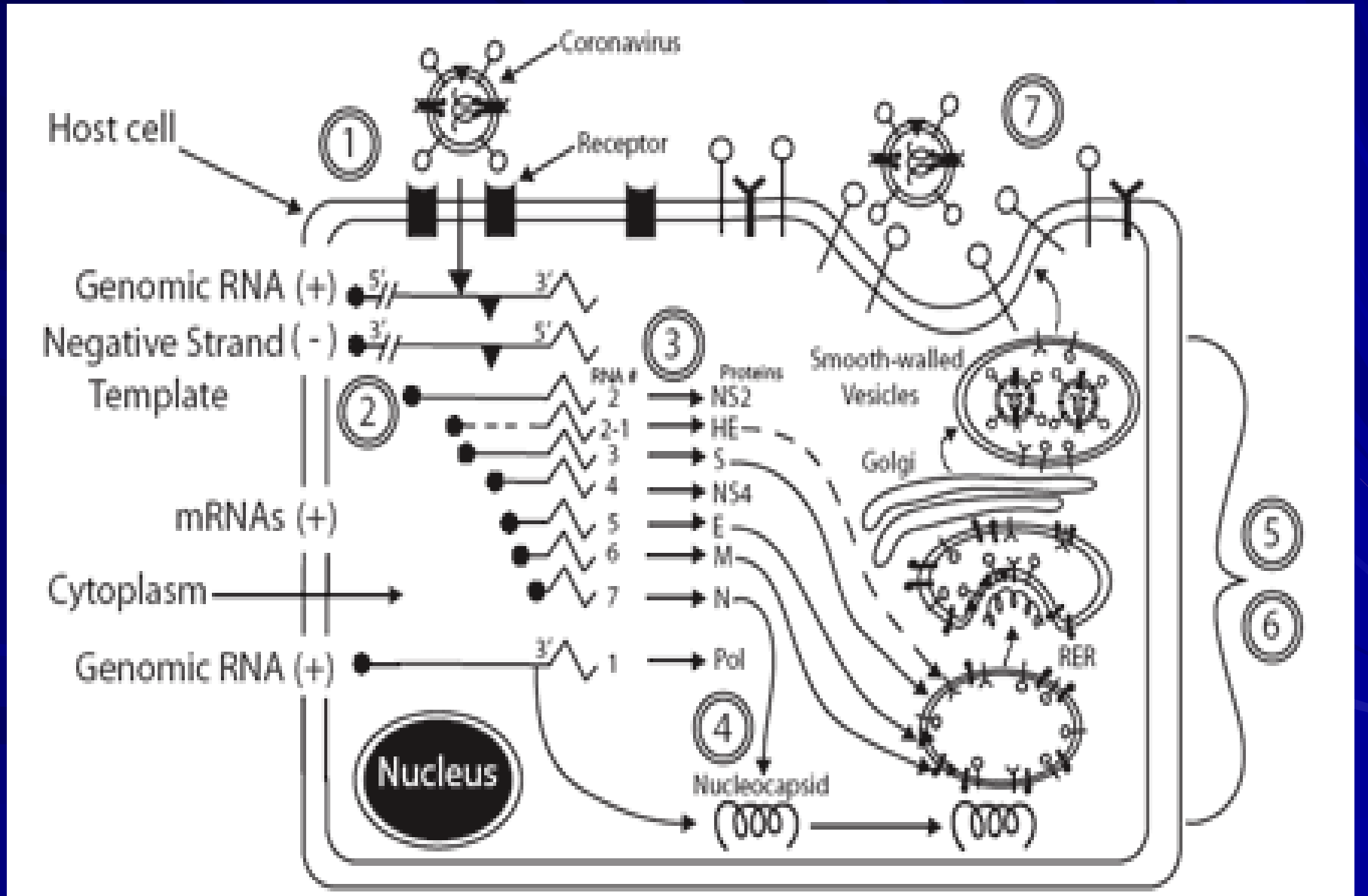
  b) HA and haemadsorption

  c) Receptor destruction (virus release and elution)

5) Envelope (E) protein:

- Small protein linked to the virus envelope
- Plays a role in virus assembly

IV. Replication



Bovine Coronavirus

Hosts:

- Mostly affect cattle
- Reports of bovine-like coronavirus in buffalo, camel, llama, alpaca, deer, giraffe, wild goat, bison, musk oxen, and antelopes.
- A single report of accidental infection in humans.

Virus Properties:

- Haemagglutinate adult chicken and murine RBCs.
- Heat labile (Destroyed at 50˚C for 1 hr)
- Stable at low pH values (up to 3)
- Sensitive to lipid solvents, formalin, oxidizing agents

Bovine Coronavirus

Diagnosis:

Clinical Diagnosis

- Neonatal Calf diarrhea: 3-21 days old
  - Yellow diarrhea for 3-6 days
  - Calves often dull and loss appetite
  - Fever and dehydration that may lead to death
- Winter Dysentery: Pregnant and lactating cows
  - Profuse watery diarrhea (usually sudden & bloody)
  - Dramatic decrease in milk production
  - Depression and anorexia
- Respiratory tract infection: Young and feedlot calves
  - Upper respiratory signs (rhinitis, sneezing, cough)

Bovine Coronavirus

Diagnosis:

Laboratory Diagnosis

- Samples: Feces – Intestinal content – Nasal swab - Serum
- Virus detection: Electron microscopy – HA followed by HI - Immunofluorescence – Antigen capture ELISA
- Detection of viral RNA: RT-PCR – Sequencing
- Virus isolation: Difficult – HRT-18 cell line or primary bovine cells (gut or tracheal organ culture)
- Sero-diagnosis: for antibody detection using HI, ELISA, IFA or VNT.

Bovine Coronavirus

Immunity and Vaccines:

- Protection is mediated by the presence of adequate level of specific antibodies in the gut lumen.
- Consumption of colostrum and milk from immune dams provides a continuous supply of antibodies.
- Two vaccination methods are used :

  1- Oral vaccination of newly-born calves with live attenuated virus vaccine (Mostly failed).

  2- Vaccination of pregnant cows with inactivated vaccine to increase the antibody level in colostrum and milk. Two doses: 6-8 weeks and 2-3 weeks before calving.

Infectious Bronchitis

Hosts:

- IB is primarily a disease of chicken
- All ages are susceptible (more severe in young ages).
- It has no human health significance

Virus Properties:

- Haemagglutinate chicken RBCs (after treatment with phospholipase C)
- Heat labile (Destroyed at 56˚C for 15 min)
- Sensitivity at pH 3 differs from strain to another
- Sensitive to lipid solvents, formalin, and common disinfectants.

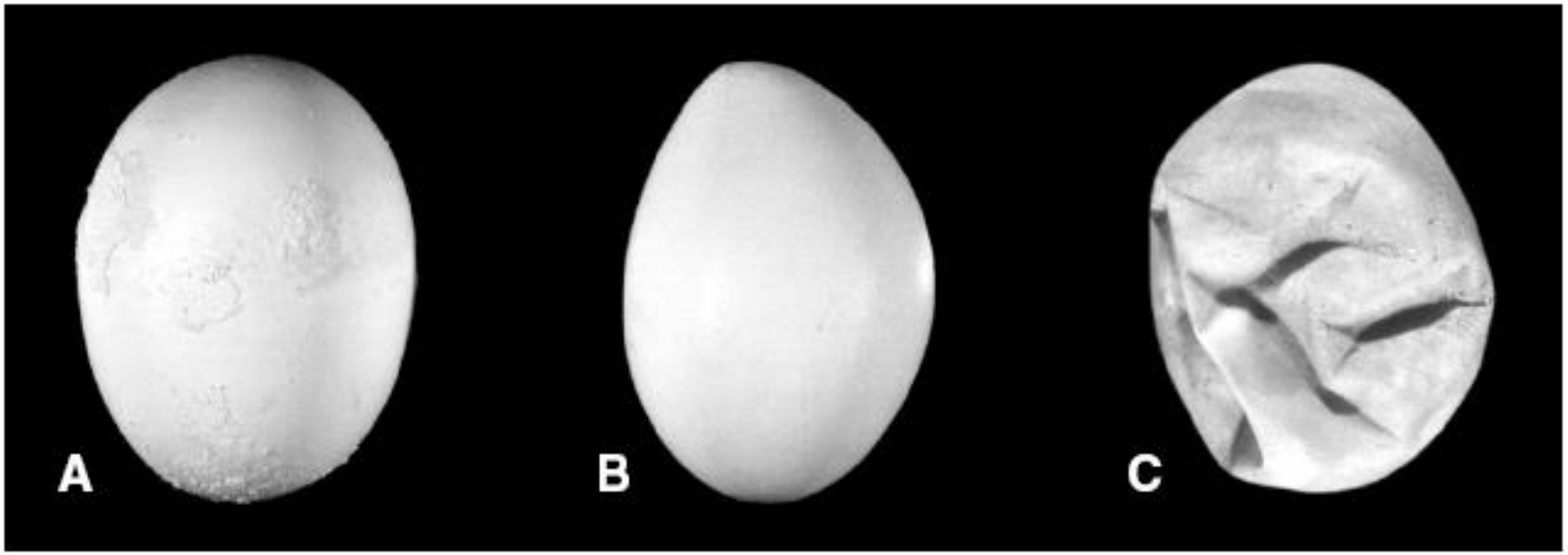
Infectious Bronchitis

Diagnosis:

Clinical Diagnosis

- Incubation period: 18-36 hours
- Young chicks:
  - Respiratory signs (Gasping, cough, sneezing).
  - Depression, ruffled feather and wet eye.
  - Reduction in feed conversion and weight gain.
  - Swollen sinuses (occasionally).
  - Facial swelling, airsaculitis (in severe cases).
  - Morbidity up to 100% and mortality 0-82%.
  - Some strains affect the kidney and cause high mortalities due to kidney failure.

- Layers and Breeders:
  - Decrease in egg production (up to 70%)
  - Decline in egg shell quality.
  - Permanent damage of the oviduct in the immature females may occurs (result in limited egg production over the production stage)



Rough Shell Deformed Shell Soft Shell

Infectious Bronchitis

Diagnosis:

Laboratory Diagnosis

- Samples: Tracheal or cloacal swab – lung – kidney – oviduct – coecal tonsils
- Virus detection: Immunofluorescence –Antigen capture ELISA – Immunoperoxidase – HA followed by HI
- Detection of viral RNA: RT-PCR – Sequencing
- Virus isolation: ECE (Intra-allantoic); curling and dwarfism of the embryos
- Sero-diagnosis: for antibody detection using ELISA, IFA, HI, VNT

Curling and dwarfism

Infectious Bronchitis

Immunity and Vaccines:

Modified Live Vaccines

- From avirulent strains or by serial passages in ECEs.
- Massachusetts serotype vaccines (e.g. M41 and H120) are commonly used.
- Broilers - initial vaccination of layers & breeders.
- Given at 7-10 days of life, repeated at 4 weeks.
- Administration:

  Individually (eye drop, intranasal or intratracheal).

  Mass (coarse spray, aerosol and drinking water).
- Combinations of IBV & NDV are used frequently.

Infectious Bronchitis

Immunity and Vaccines:

Inactivated Oil-Emulsion Vaccines

- Usually given after priming with live virus.
- Before the point of laying in layers and breeders.
- Administration: I.M or S.C injection.
- May be given in combination with other inactivated vaccines.