

# **AVIAN INFLUENZA- A CURRENT PERSPECTIVE**

**PRESTAGE DEPT. OF POULTRY SCIENCE**

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# ECONOMIC IMPACT OF HPAI

- **COSTS INCURRED FROM:**
- **BORDER CONTROL AND PERMITTING TO EXCLUDE AI.**
- **PREPAREDNESS, TRAINING, INFRASTRUCTURE, R & D.**
- **OUTBREAK CONTROL AND ERADICATION**
  - GOVERNMENT SECTOR**
  - PRIVATE SECTOR**
  - CONSUMERS**
- **DISRUPTION IN TRADE OF BREEDING STOCK, CHICKS AND PRODUCTS**

# FINANCIAL IMPACT OF HPAI

- 1924 U.S. \$ 10 m (2000 VALUE)
- 1983 PA. \$ 110m (USDA-APHIS)  
\$ 25m (PRODUCERS)  
\$ 350m (CONSUMERS)
- 1999 ITALY \$ 600m
- 1985 Australia \$ 2m (SINGLE COMPLEX)

# HISTORY OF HPAI

- 1878 and 1894 Italy and other European countries (where recognized)
- 1901 Germany and neighboring nations, Chickens “Fowl plague”
- 1924 and 1929 U.S., Chickens (H7)
- 1959 Scotland, Chickens H5N1
- 1961 South Africa, Terns H5N3
- 1976 Australia Chickens H7N7
- 1983 U.S. (PA, MD) Chickens , Turkeys H5N2
- 1995 Pakistan, Chickens H7N3
- 1997 Hong Kong, Chickens etc. H5N1
- 1999 Italy, Chickens etc H7N1
- 2001 China and other Asian nations, Chickens etc H5N1
- 2003 Mexico, Chickens etc. H5N2

# RECENT HPAI OUTBREAKS

- 2003 Holland, Chickens H7N7
- 2012 Mexico, Chickens etc. H7N3
- 2013 Australia, Chickens H7N2
- 2014 Canada, (BC) Chickens etc. H5N2
- 2014 Russia, Chickens etc. H5N1
- 2014 India, Ducks and Chickens H5N8
- 2014 Korea, Japan, Ducks and chickens H5N8
- 2014 EU, Chickens, Turkeys and Ducks H5N8
- 2014 Taiwan, Ducks, Geese, Chickens H5N2 and H5N8 plus H5N3
- 2014 Canada, Chickens and Turkeys H5N2
- 2014/5 U.S. (OR, UT, WA, ID), wild birds, backyard flocks H5N2 & H5N8, H5N1
- 2015 Nigeria, Chickens H5N?
- 2015 Israel, Palestine, Bulgaria, Turkeys and Chickens, H5N1

# HUMAN HEALTH SIGNIFICANCE

- **MAMMALS GENERALLY REFRACTORY TO AVIAN STRAINS**
- **Asia H5N1 from 2003 onwards**
- **Holland H7N7 in 2003**
- **China H7N9 2013 onwards**
- **Egypt H5N1 mid 2000's onwards**
  
- **Mild cases (conjunctivitis )**
- **Severe cases (respiratory complications and death)**
- **Marked decline in egg and chicken consumption**

# CLOSE CONTACT WITH INFECTED FLOCKS RESULTED IN H5N1 INFECTION IN GENETICALLY PREDISPOSED HUMANS



**MOST OF THE 500 CASES OF HUMAN H5N9 AI INFECTION HAVE BEEN DOCUMENTED IN CHINA WITH HIGH FATALITY RATES**

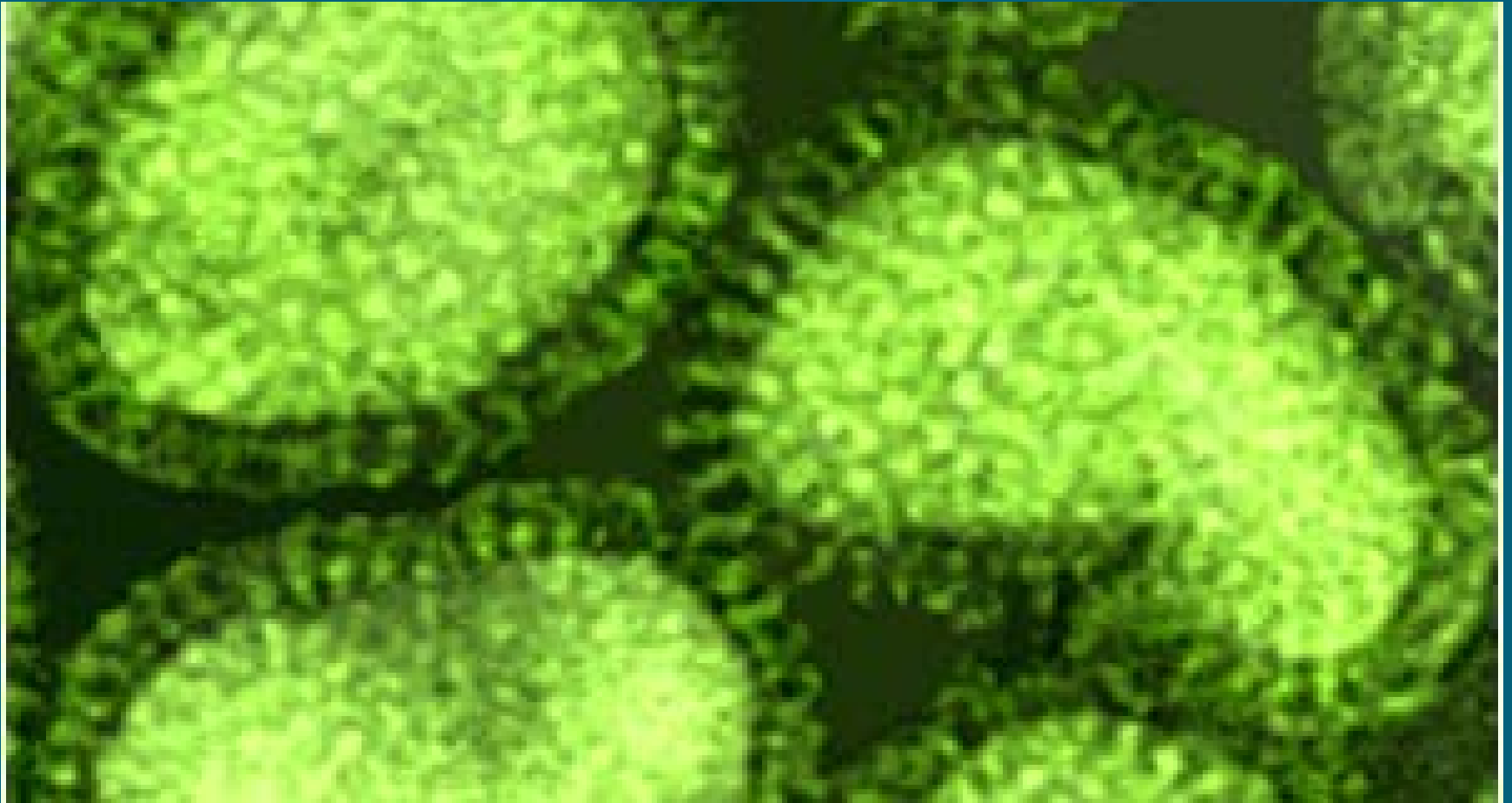




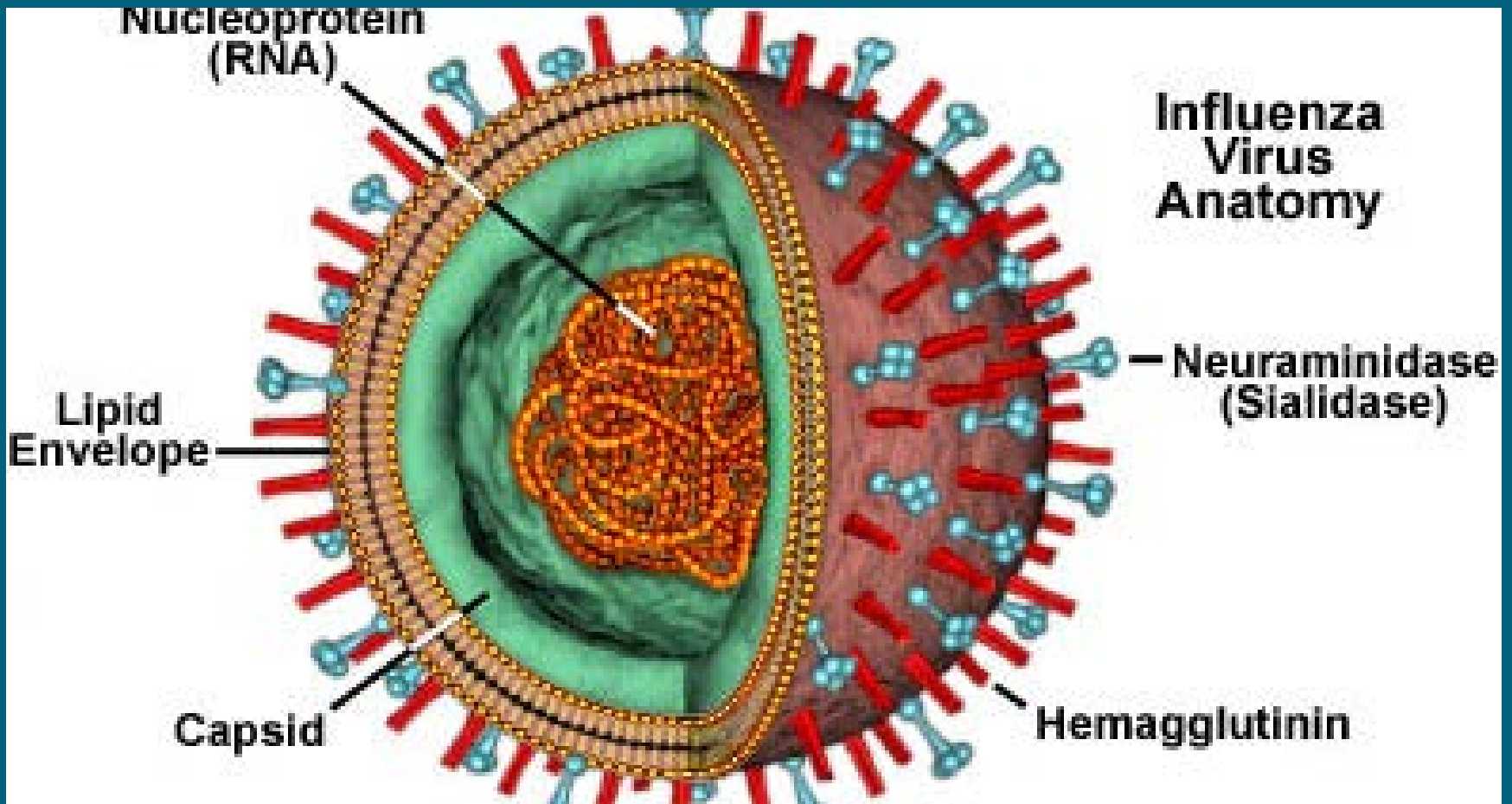
# AVIAN INFLUENZA VIRUS

- Family: Orthomyxoviridae
- Genus: Influenzavirus A
- RNA virus with enveloped virion, 80-120 nm
- Eight single RNA strands coding for:-
  - ❖ 1. PB 1 transcriptase
  - ❖ 2. PB 2 endonuclease
  - ❖ 3. PA RNA replication
  - ❖ 4. HA attachment, envelope fusion, neutralization
  - ❖ 5. NP vRNA synthesis
  - ❖ 6. NA virus elution,
  - ❖ 7. M 1 & 2 virus budding
  - ❖ 8. NS 1 & NS 2 translation of viral mRNA

# EM VIEW OF A1 ORTHOMYXOVIRUS SHOWING SURFACE HA AND NA GLYCOPROTEIN ANTIGENS



# STRUCTURE OF INFLUENZA VIRUS



# AVIAN INFLUENZA NOMENCLATURE

- **A / chicken/ Indonesia/ 4 / H7N8/09**
  - **A/ chicken /Pennsylvania/ 1370/83**
  - **15 HA (hemagglutinin) serotypes**
  - **9 NA (neuraminidase) serotypes**
- “Highly pathogenic avian influenza” H5 and H7**
- “Low pathogenic avian influenza” 13 other HAs**

# ANTIGENIC VARIATION

- **Surface HA and NA glycoproteins undergo frequent changes.**
- **Antigenic Drift**
  - Arises by point mutation. (vaccination pressure and population density?)
  - H5 and H7 strains of LPAI becoming HPAI
- **Antigenic Shift**
  - Arises from genetic reassortment

# SIGNIFICANCE OF VIRAL SHIFT REASSORTMENTS

- **A/goose/Taiwan/??/2015 H5N3**
- **Identified mid-January 2015**
- **H5 99% similar to 2014 H5N8 isolate involved in extensive outbreaks in S.Korea and Japan.**
- **N3 98% similar to 2010 H2N3 Taiwan isolate migratory ducks**
  - **2011 H1N3 Thailand isolate in waterfowl**
  - **2013 H5N3 Taiwan isolate migratory ducks**

# OIE CRITERIA FOR HPAI

- 1. AI isolate lethal to +6/8 5-week SPF chickens receiving 0.2 ml  $10^{-1}$  allantoic fluid iv.
- 2. Any H5 or H7 isolate with a preponderance of basic amino acids at the HA cleavage site.
- 3. Any isolate other than an H5 or H7 lethal to 1 to 5 chickens and can be grown in cell culture without trypsin

# SENSITIVITY OF AI VIRUS

- **Inactivated by:-**
- **solvents and detergents**
- **aldehydes (formalin and gluteraldehyde)\***
- **oxidizing agents (sodium hypochlorite 5%)\***
- **chemical disinfectants (phenolics, QACs)\***
- **\* ONLY if not protected by organic matter.**
  
- **AI virus can persist in liquid manure for 100 days in NE U.S winter**
- **in feces for 30 days at 4° F**
- **Susceptible to 90° F in “cleaned” houses for 1 week**



# Cycle of Avian Influenza Viruses in Animals & Humans



# ORIGIN OF AI VIRUS STRAINS

- Role of Asia in evolution of AI strains
- Migratory waterfowl to domestic waterfowl
- Spread to chickens and mixing in hogs and other mammalian hosts in rural locations.  
Reassortment events (“shifts”) occur to produce pandemic strains infecting humans. Can be induced under laboratory conditions.
- Endemic infection can lead to mutations (“drift”) when introduced into areas with high population density-LPAI to HPAI.

# COHABITATION OF DOMESTIC AND MIGRATORY WATERFOWL RESULTS IN TRANSMISSION AND DISSEMINATION OF HPAI



# DISSEMINATION OF AI

- **Intercontinental and international:**
  - **Migratory waterfowl and shore birds**
  - **Uncooked poultry products**
  - **Contaminated personnel**
- **Regional and local**
  - **Movement of live poultry (LBM systems)**
  - **Movement of contaminated personnel and equipment (fomites)**
  - **Virus entrained on dust particles in air.**
  - **Contaminated housing and waste**

# LIVE BIRD MARKETS IN ASIA ARE ARE A SOURCE OF AI VIRUS FOR CONSUMERS AND A RESERVOIR FOR POULTRY FLOCKS



# CLINICAL PRESENTATION OF HPAI

- **SHARP DROP IN WATER AND THEN FEED INTAKE**
- **CONCURRENT RAPID ASCENDING MORBIDITY**
- **RATE (10%; 40 % 80% CUMULATIVE ON SUCCESSIVE DAYS)**
- **LAYERS AND BREEDERS CEASE PRODUCTION (OVER 2 TO 3 DAYS , PRESENCE OF SHELL-LESS EGGS)**
- **SIMULTANEOUS RAPID ASCENT IN MORTALITY RATE (5%; 25%; 50% CUMULATIVE OVER SUCCESSIVE DAYS)**
- **TYPICAL SIGNS (PROSTRATION, RESPIRATORY DISTRESS, DIARRHEA, SWOLLEN CYANOTIC HEADS, SKIN HEMORRHAGES)**

**EXTENSIVE MORBIDITY IN FLOCK INFECTED WITH  
HPAI. RECUMBENCY, RESPIRATORY DISTRESS  
EVIDENT IN SMALL FLOCK**



# **RAPIDLY ASCENDING MORTALITY FOLLOWING HPAI INFECTION LEADS TO A “CARPET OF DEAD BIRDS”**





# CUTANEOUS LESIONS HPAI



# SWOLLEN WATTLES, NECROSIS OF COMB WITH HPAI



# CHARACTERISTIC SUBCUTANEOUS HEMORRHAGES ON THE SHANKS OCCUR FOLLOWING HPAI INFECTION



# LESIONS OF HPAI

- EDEMATOUS , HEMORRHAGIC AND NECROTIC CHANGES IN ADNEXA (SKIN, WATTLES, COMB, SHANKS)
- VISCERAL SEROSAL HEMORRHAGES
- FIBRINOUS PERITONITIS (NON-PERACUTE CASES)
- NOTE: GROSS LESIONS ARE NOT PATHOGNOMONIC. D/D INCLUDES vvND (END),
- COMBINATIONS OF vvIBD/ILT/LENTOGENIC ND

# DIAGNOSIS OF HPAI

- **VIRAL ISOLATION:**

- SPF CHICKEN EMBRYOS –ALLANTOIC ROUTE WITH HI
- ANTIGEN-CAPTURE ASSAY (DIRECTIGEN®)

- **VIRAL RNA:**

- PCR ASSAY

- **SEROLOGY:**

- HEMAGGLUTINATION INHIBITION
- AGAR-GEL WELL AGGLUTINATION
- ELISA

# ELISA AI ANTIBODY TEST KITS AVAILABLE COMMERCIALY



# PREVENTION AND CONTROL OF HPAI

- **EXOTIC TO NATION**

**EXCLUSION BY RESTRICTING IMPORTS**

**RAPID DIAGNOSIS AND ERADICATION**

**(QUARANTINE, COMPENSATION, SURVEILLANCE, FLOCK DEPLETION AND DISPOSAL)**

**REGIONAL CONTROL OF MOVEMENT**

**(REGIONALIZATION AND COMPARTMENTALIZATION)**

**FARM BIOSECURITY**

## **ENDEMIC TO NATION**

**REGIONALIZE AND RESTRICT INTERZONE MOVEMENT**

**VACCINATE, VACCINATE, VACCINATE**

**BIOSECURITY AS FAR AS PRACTICAL**

# MASS DEPLETION OF FLOCKS IMPOSES RISKS OF INFECTION FOR WORKERS AND ALSO PROBLEMS OF DISPOSAL





# VACCINATION AGAINST HPAI

- **INTRODUCTION OF AN EXOTIC INFECTION**
- **VACCINATION NOT RECOMMENDED.**
- **(PRESENCE OF ANTIBODIES PRECLUDE TRADE)**
  
- **PRESENCE OF ENDEMIC INFECTION**
- **INACTIVATED EMULSIONS (STABLE, HIGH ANTIGEN TITER)**
- **DIVA APPLIED IN ITALY H7N3 VACCINE AGAINST H7N1**
- **RECOMBINANT rHVT –H5 PRODUCT DEVELOPED (CEVA)**
- **NO LIVE ATTENUATED VACCINES!!!**
-

**I/M VACCINATION OF CHICKS WITH INACTIVATED EMULSION SUPPRESSES MORTALITY BUT DOES NOT ERADICATE INFECTION. LOW SHED RATE OF VIRUS FOLLOWING VACCINATION.**



# VACCINATION OF INDIVIDUAL HENS IN THE FACE OF INFECTION IS LABORIOUS



# TRADE CONSIDERATIONS

- **TO REGULATE TRADE, THE WTO (WORLD TRADE ORGANIZATION) RECOGNIZES STANDARDS DEVELOPED BY THE OIE (WORLD ORGANIZATION FOR ANIMAL HEALTH).**
- 
- **CANNOT BAN TRADE IF SAME DISEASE OCCURS IN IMPORTING NATION**
- 
- **ALL H5 AND H7 AND HIGH-PATH ISOLATES TO BE REPORTED TO OIE 1 DAY FOLLOWING CONFIRMATION. OTHER AI ISOLATES AT ANNUAL INTERVALS . BILATERAL AGREEMENTS EXIST BETWEEN NATIONS MANDATING DISCLOSURE OF LPAI**
- **SOME NATIONS (RUSSIA) USE AI AS AN EXCUSE FOR POLITICAL EMBARGOS**
- **MANY NATIONS (INDIA) USE AI TO PROTECT LOCAL PRODUCTION**

# QUESTIONS TO PONDER

1. CAN I APPLY THE BASICS OF AI VIRUS MOLECULAR BIOLOGY TO AN UNDERSTANDING OF THE DISEASE?
2. DO I UNDESTAND THE EPIDEMIOLOGY OF AI AND THE SIGNIFICANCE IN PREVENTION AND CONTROL?
3. AM I AWARE OF THE SOCIOECONOMIC IMPACT OF AI?
4. COULD I DEVELOP A PROGRAM TO ERADICATE EXOTIC AI?
5. COULD I APPLY THE PRINCIPLES ACQUIRED IN THIS REVIEW TO LIMIT INTRODUCTION AND DISSEMINATION OF AI?

**THANK YOU**

**QUESTIONS?**

**COMMENTS!**