www.poultryprotein.com

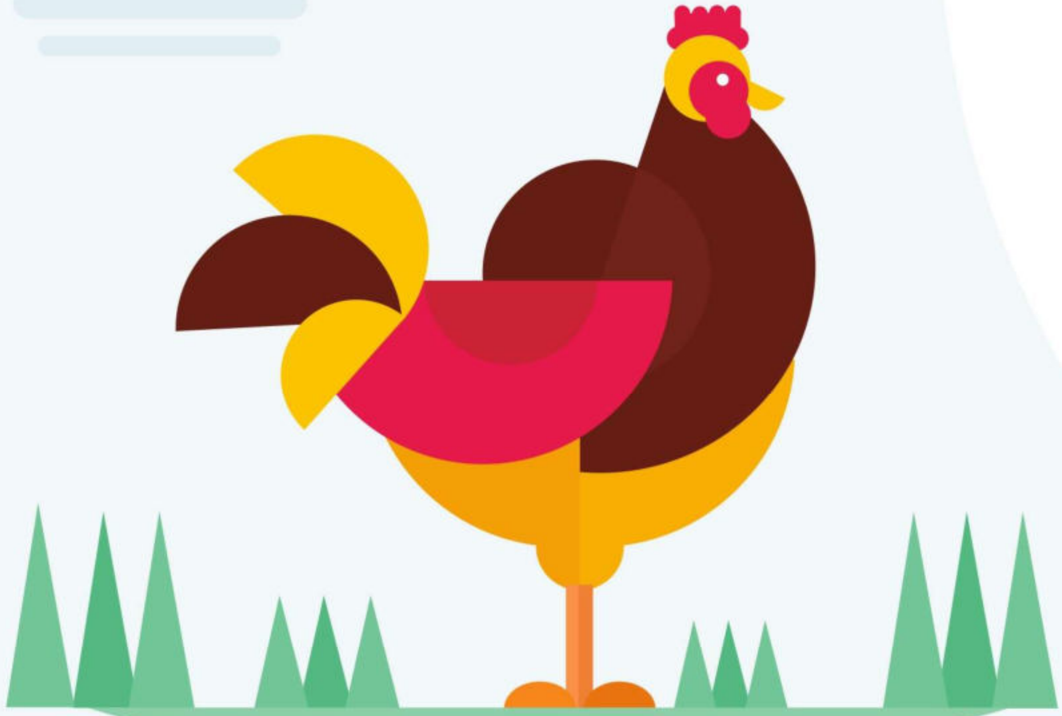
www.poultryrecipes.co.in

16th Edition POULTRY INDIA

16th Poultry

Knowledge Day

26 NOVEMBER



SHAPING THE FUTURE

OF INDIAN POULTRY SECTOR

www.poultryindia.co.in

Avian Influenza: Strategies for Prevention & Control

Chindr@gmail.com

Singapore

Outlines

- Introduction
- Virus Biology & AIV Current Status
- Epidemiology & Transmission
- Disease, Pathology & Diagnosis
- Control & Prevention Strategies
- Human Infections
- Epilogue

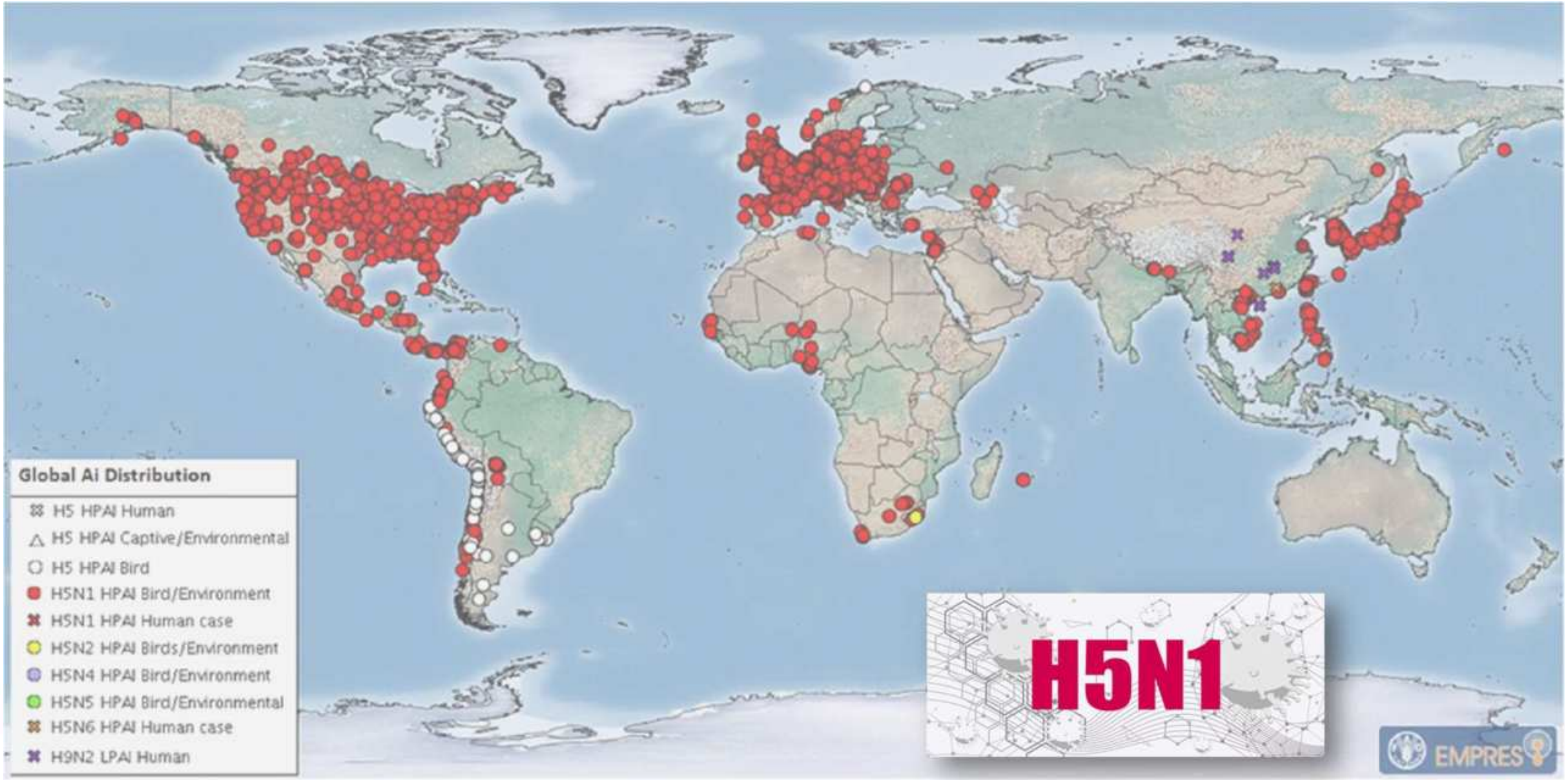
Asian Top 5 Poultry Health Issues

Ranking	Malaysia	Philippines	Thailand	Japan	China	Korea	Vietnam	India	Indonesia
1	ND	AI (H5)	ND	AI (H5)	AI (H7)	AI (H5)	AI (H5)	ABR & Removal	Gut Health
2	IB	ABR & Removal	ABR & Removal	ABR & Removal	Salmon	IB	ND	AI (H9)	AI (H9)
3	Salmon	ND	IB	FAdV	IB	EYP	IB	*MG*	ND
4	*MG*	*MG*	Salmon	Breast muscle myopathy	*MG/MS*	Salmon	NE/GD	Salmon	NE/GD
5	FAdv	Gut Health	APV	APV	RSS	Cocci	Gut Health	Gut Health	IB

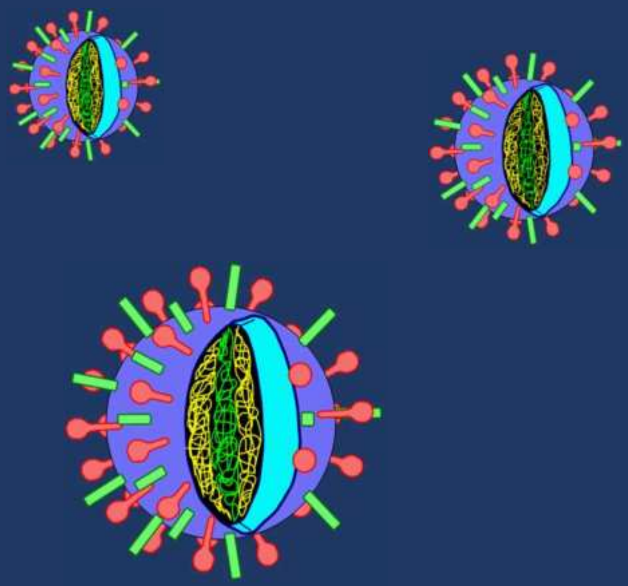
ABR = Antibiotic Resistance, **NE** = Necrotic enteritis, **GD** = Gangrenous dermatitis, **EYP** = Egg Yolk PeritoAPVnitis , **Salmon** = Salmonellosis, **ND** = Newcastle disease, **AI** = Avian Influenza, **IB** = Infectious bronchitis, ***MG/MS*** = Mycoplasma, **FAdV** = Fowl adenovirus, **APV** = Avian metapneumovirus

Data Source/references: Breeding Companies, OIE, Industry Veterinarians

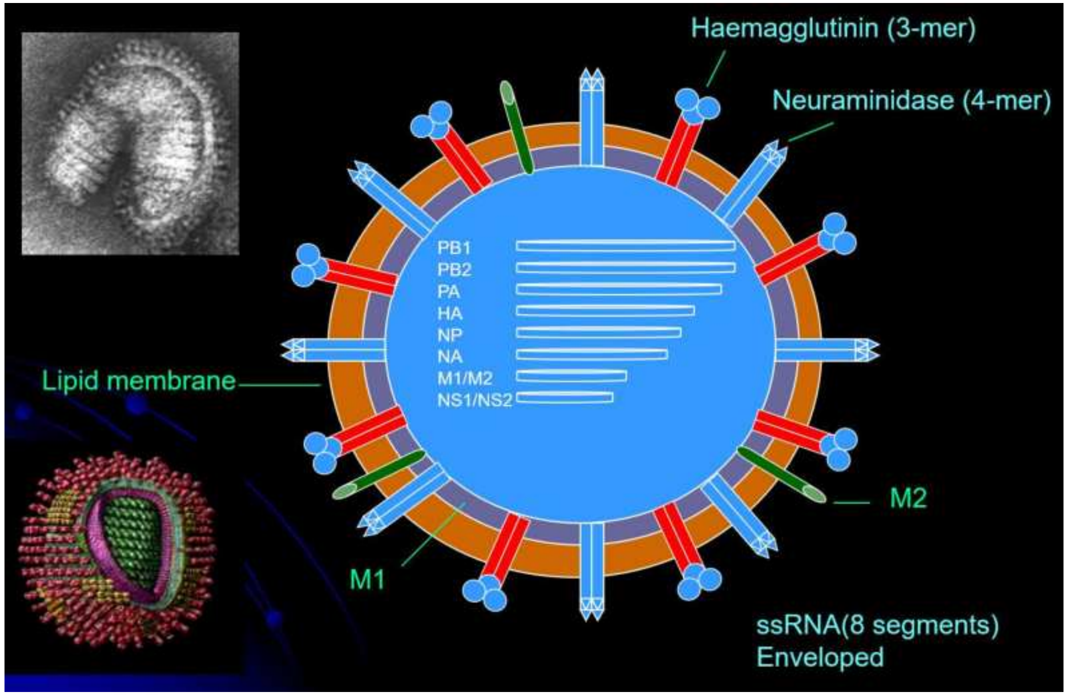
Global AI Situation: January 2022 – March 2023



Virus Biology & AIV Status



Avian Influenza Viruses



Surface Antigen Subtype

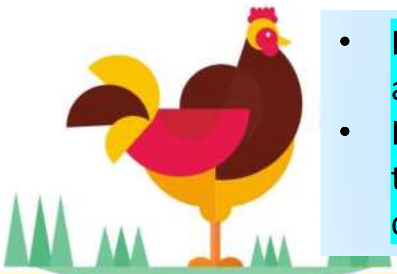
Haemagglutinin:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Human	●	●	●												
Equine			●				●								
Swine	●		●												
Avian	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

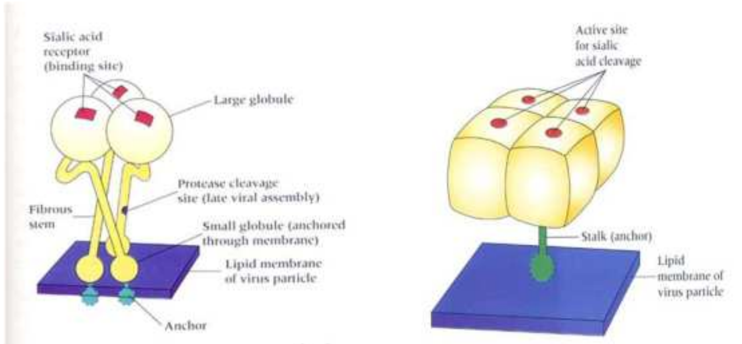
H16 (17 + 18)

Neuraminidase:

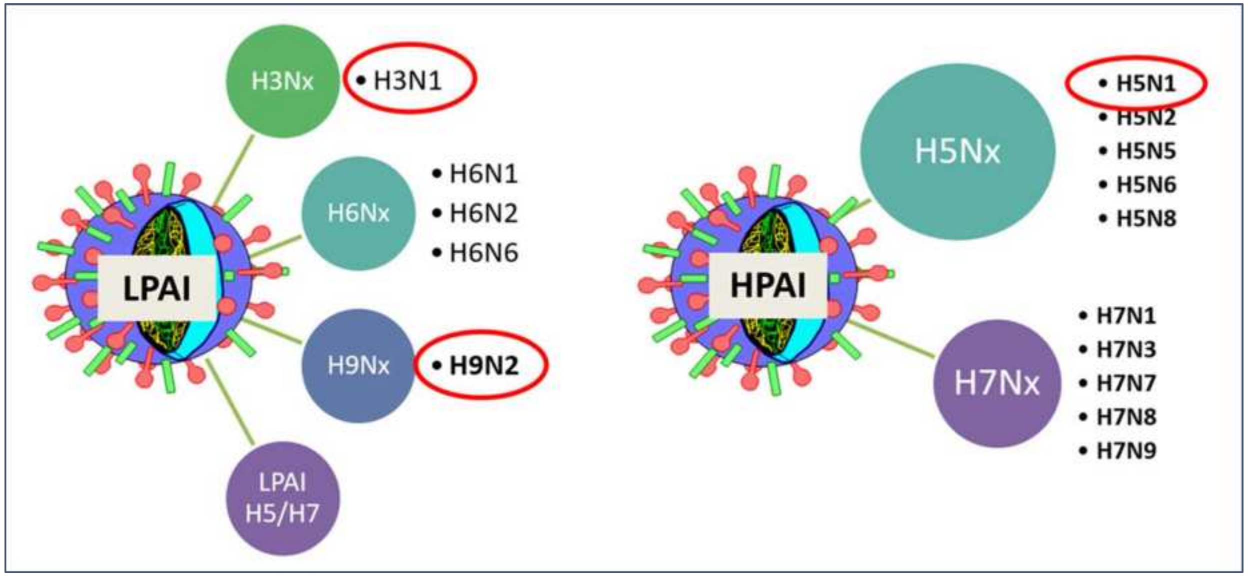
	1	2	3	4	5	6	7	8	9
Human	●	●							
Equine							●	●	
Swine	●	●							
Avian	●	●	●	●	●	●	●	●	●



- Potentially there is possible Combination from H and N = 144
- H and N are important in virus entry & exit from the host cell & interaction between virus & host cells

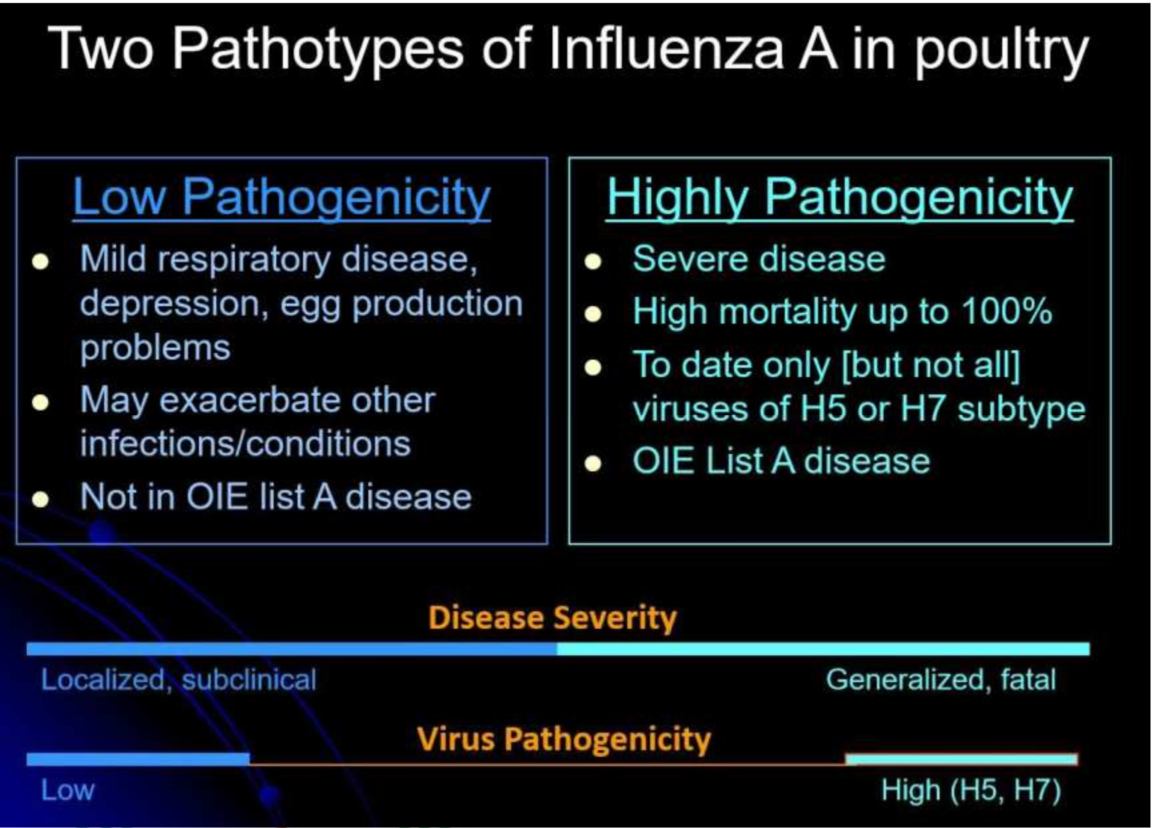


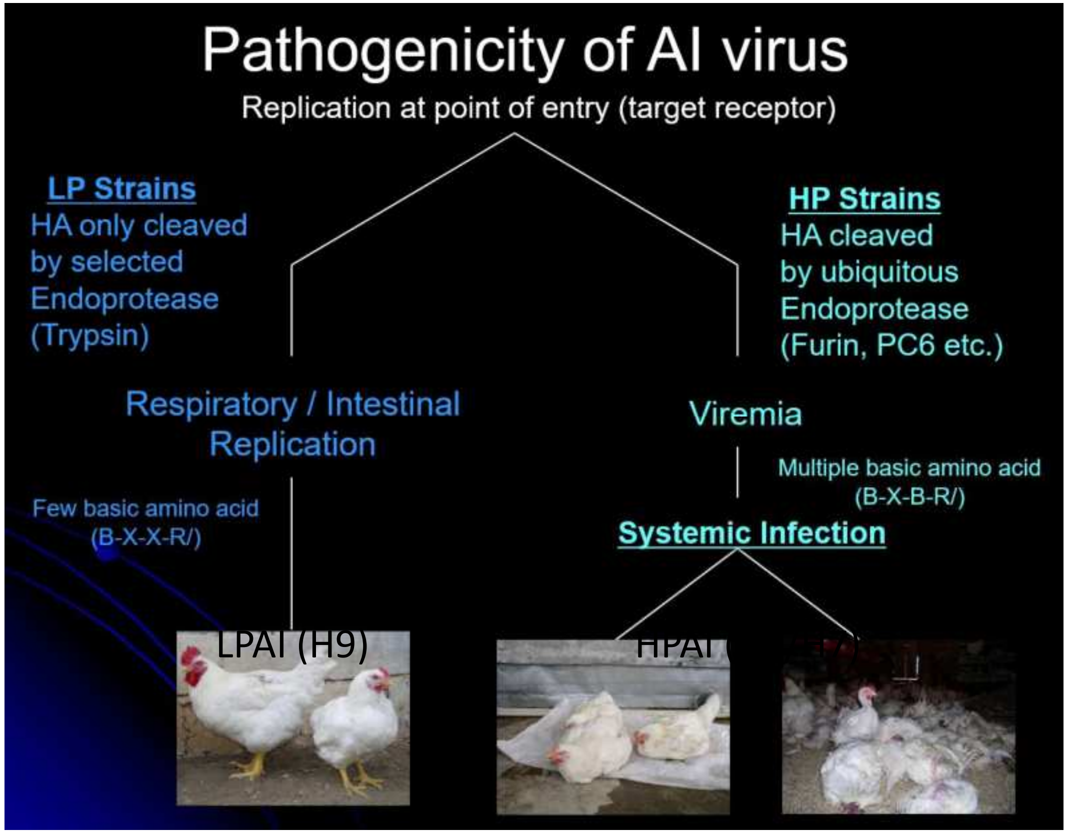
Important Avian Influenza Viruses



Virus / Host & sialic acid	H5N1	H7N9	H9N2
 α-2,3-Gal	Mild / Moderate	Mild	Mild
 α-2,3-Gal	Severe	Mild	Mild / Moderate
 α-2,3-Gal α-2,6-Gal	Moderate	Mild	Mild
 α-2,6-Gal	Severe	Moderate / Severe	Mild / Moderate
 α-2,6-Gal	Severe	Severe	Mild / Moderate

AIV Pathotypes & Virus Pathogenicity





HPAI Asia Situation

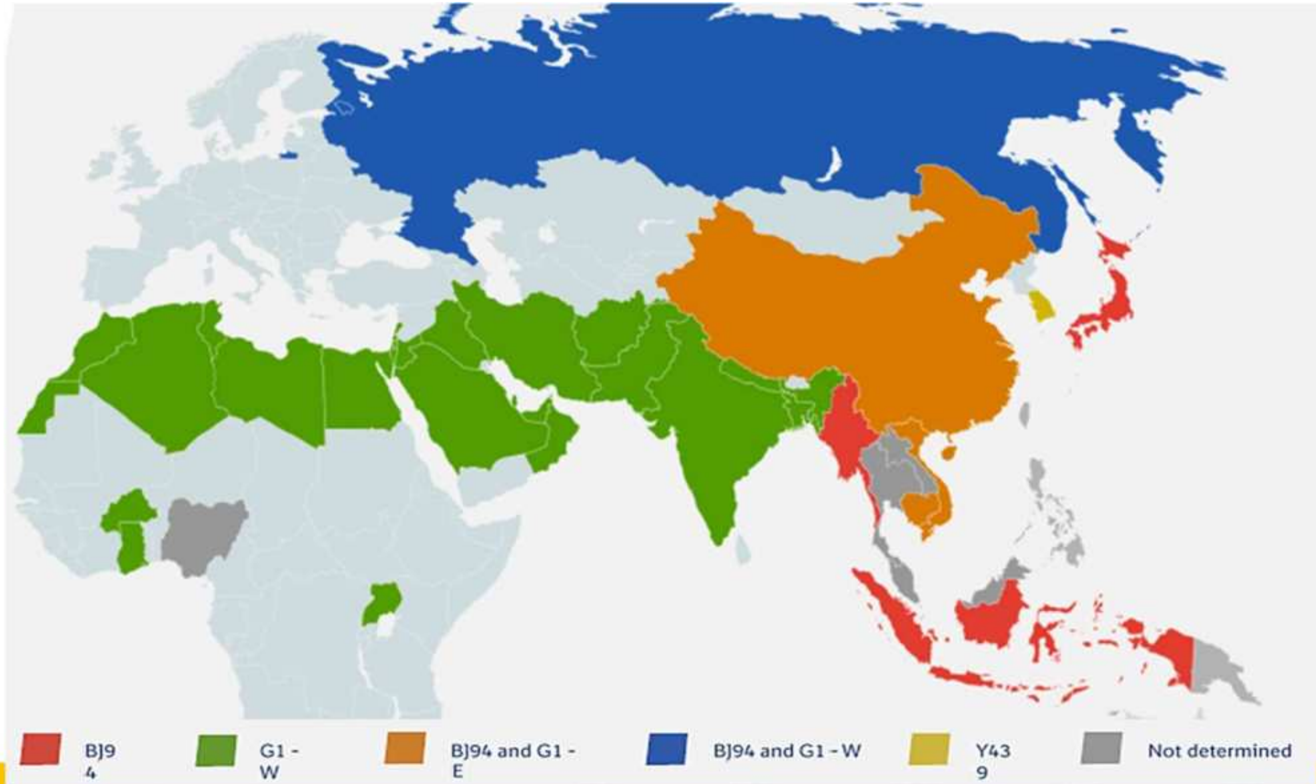
- **Currently H5N1 Clade 2.3.4.4b Viruses dominate Globally (> 77 countries)**
- Domestic bird outbreaks: not reported from endemic countries

Australia	H7N9, H7N8, H7N3
China	H7N9
South Africa,	H7N6
Mexico	H7N3
Germany	H7N5
Mozambique	H7 (N untyped)

Munir Iqbal (2024)

Global AI (H9N2) Status

- AI subtype **H9N2** is endemic in many bird species in Asia & the Middle East. Virus has occasionally crossing species barrier to mammals including human beings.
- H9 subtype viruses are **NOT Notifiable** to **OIE**: possible under-reporting on actual field situations.

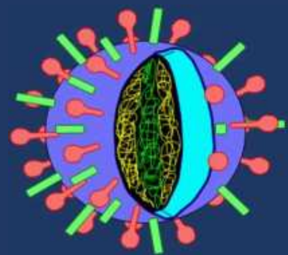


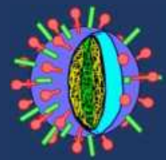
Three stable HA lineages:

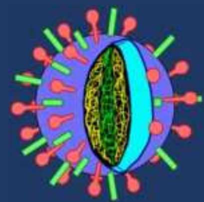
- **G1-W**
- Group A
- Group B
- Group C
- Group D
- **Beijing (BJ94/Y280)**
- **Korean-like (Y439)**
- **Few studies on Antigenicity**

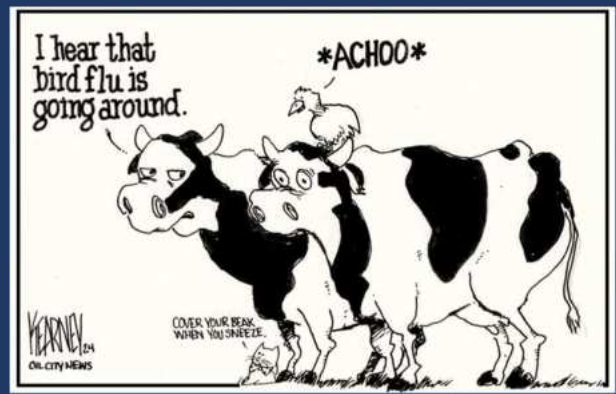
Peacock *et al.*, *Viruses* (2019)

Epidemiology & Transmission









Avian Influenza Virus : The Hosts

AIV can infect a variety of Domestic & Wild Avian Species (including chickens, turkeys, ducks, domestic geese, quail, pheasants, psittassines, gulls, shorebirds, emu & others). The clinical manifestation of infection ranges from asymptomatic infection to rapidly fatal disease

Aquatic birds, particularly Ducks, Shore Birds & considered the Natural Reservoirs
These waterfowl generally do not develop disease when infected with AI viruses. Recently, investigators in Asia have shown that asymptomatically infected domestic ducks are shedding more H5N1 to domestic poultry (references: FAO/OIE/WHO 2004)

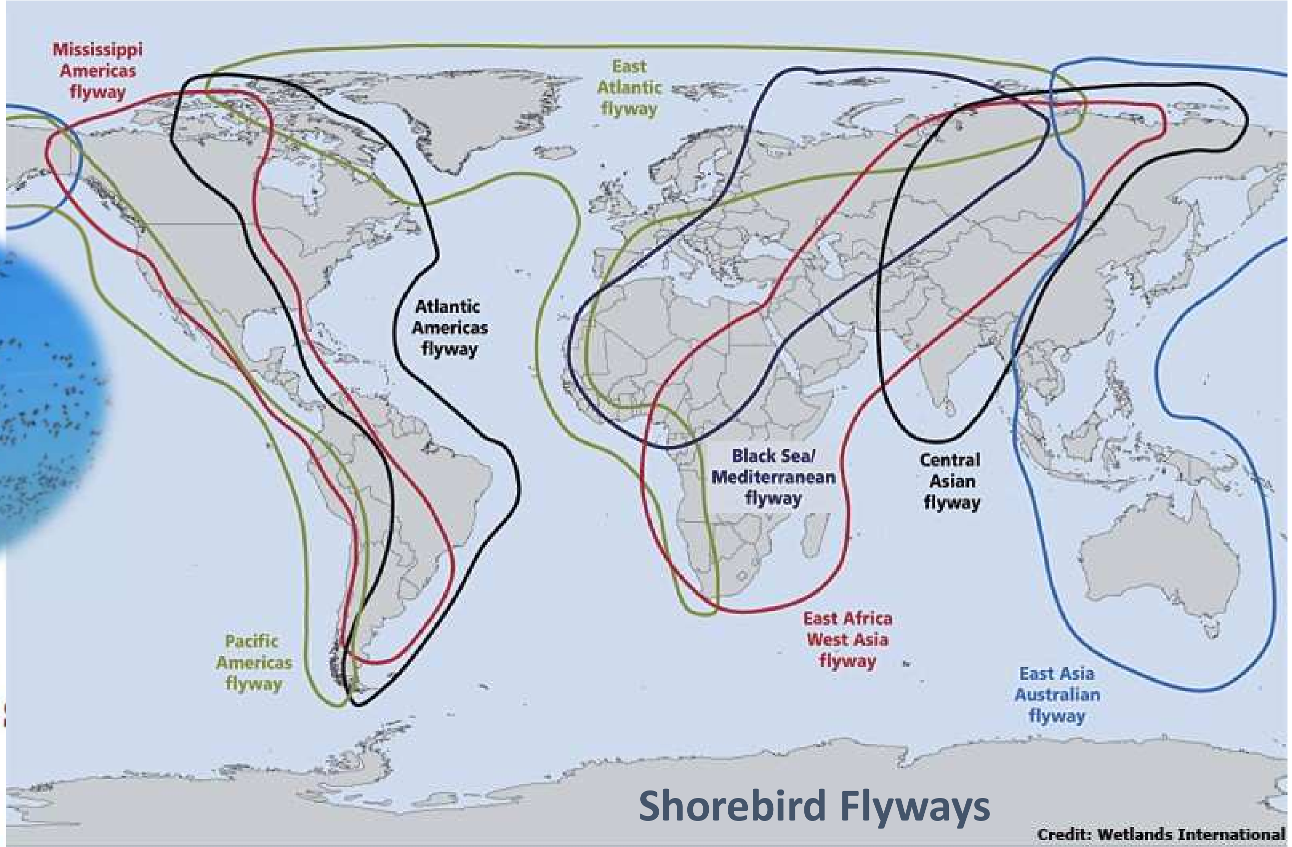
16th Poultry Knowledge Day 26 NOVEMBER

Influenza A viruses have been isolated from Free-living birds of the following Families

16th Edition POULTRY INDIA

- Very Diverse
- Very Diverse
- High prevale
  infection on
  basis

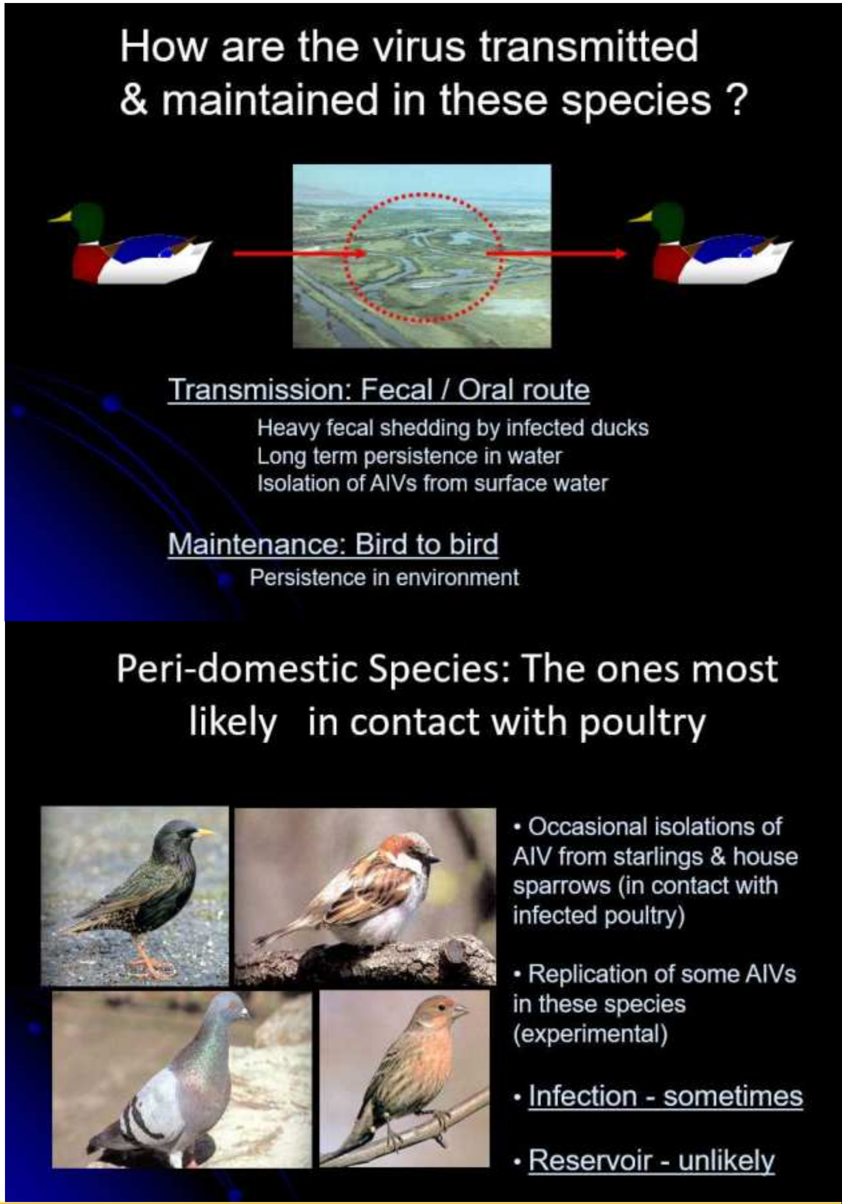
Recent Evidences support the Theory that H5N1 being Spread by Migrating Wild Fowls



Shorebird Flyways

AIV Virus Transmission

- ➢ Routes of bird-to-bird transmission include :
  - Airborne transmission if birds are in close proximity
  - Direct contact with contaminated respiratory secretions or fecal material
- ➢ Vertical transmission is not known to occur (possible cross contamination in hatchery)
- ➢ Other factors (spread within & between flocks) :
  - Broken contaminated eggs in incubators infecting healthy chicks
  - Movement of infected birds between flock. Movement of formites e.g. contaminated equipment, egg flats, feed trucks, clothing & shoes of employee
  - Contact with infected wild birds & waterfowl
  - Fecal contamination of drinking water
  - Garbage flies



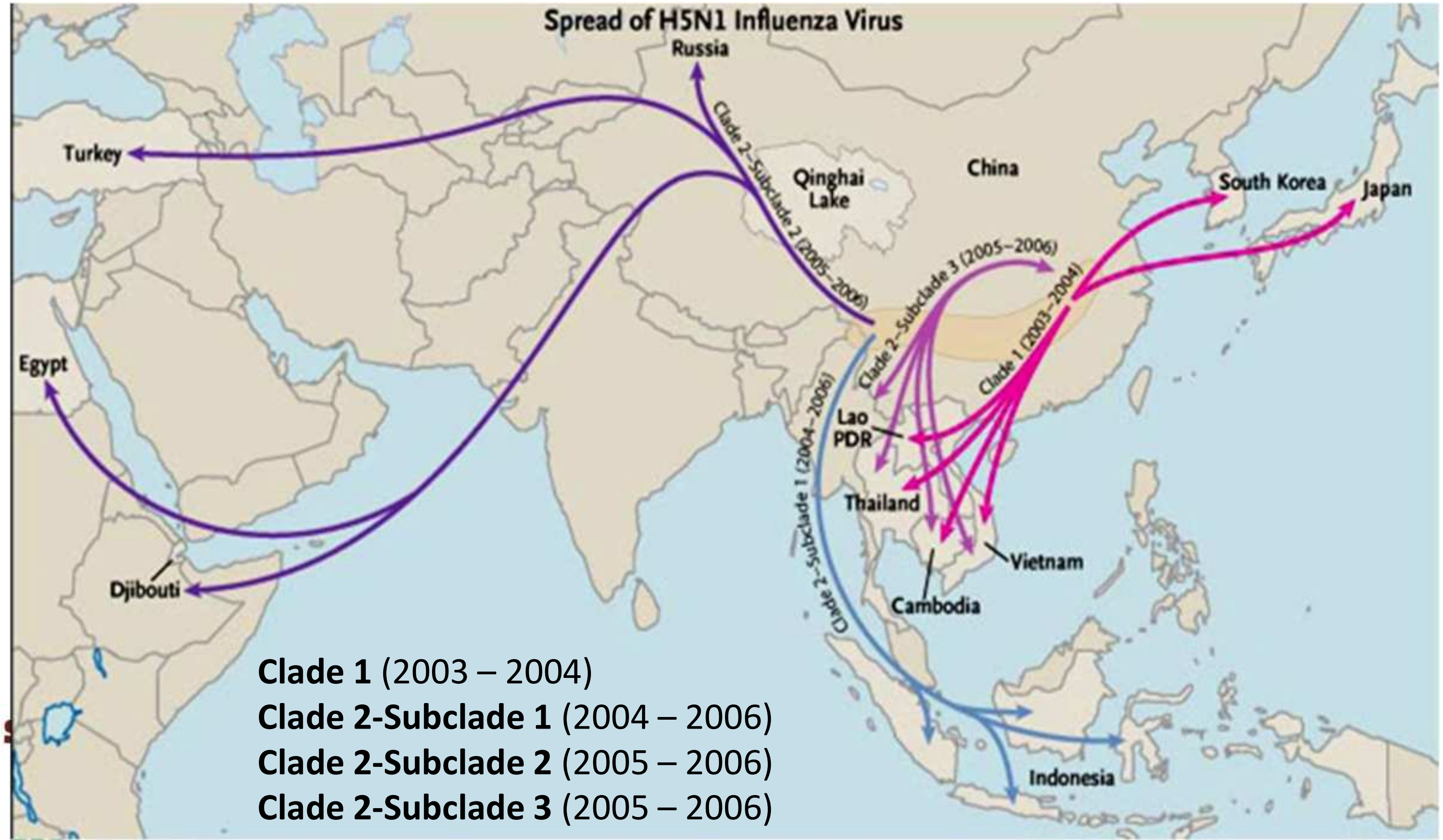
16th Poultry Knowledge Day 26 NOVEMBER

AIV in Commercial Ducks

- Alexander (1982) reported a 53% isolation rate from pools of cloacal swabs taken from ducks at slaughter
- Shortridge (1982) reported a 6% isolation rate from individual ducks in Hong Kong
- WHO (2005) reported 76% ducks & 21% chicken tested positive for H5N1 in Mekong Delta, South Vietnam

SHAPING THE FUTURE OF INDIAN POULTRY SECTOR

Early Spread of HPAI (H5N1) in Asia



Clade 1 (2003 – 2004)
Clade 2-Subclade 1 (2004 – 2006)
Clade 2-Subclade 2 (2005 – 2006)
Clade 2-Subclade 3 (2005 – 2006)

Epidemiology of 2024 H5N1 Avian Infleunza Outbreaks

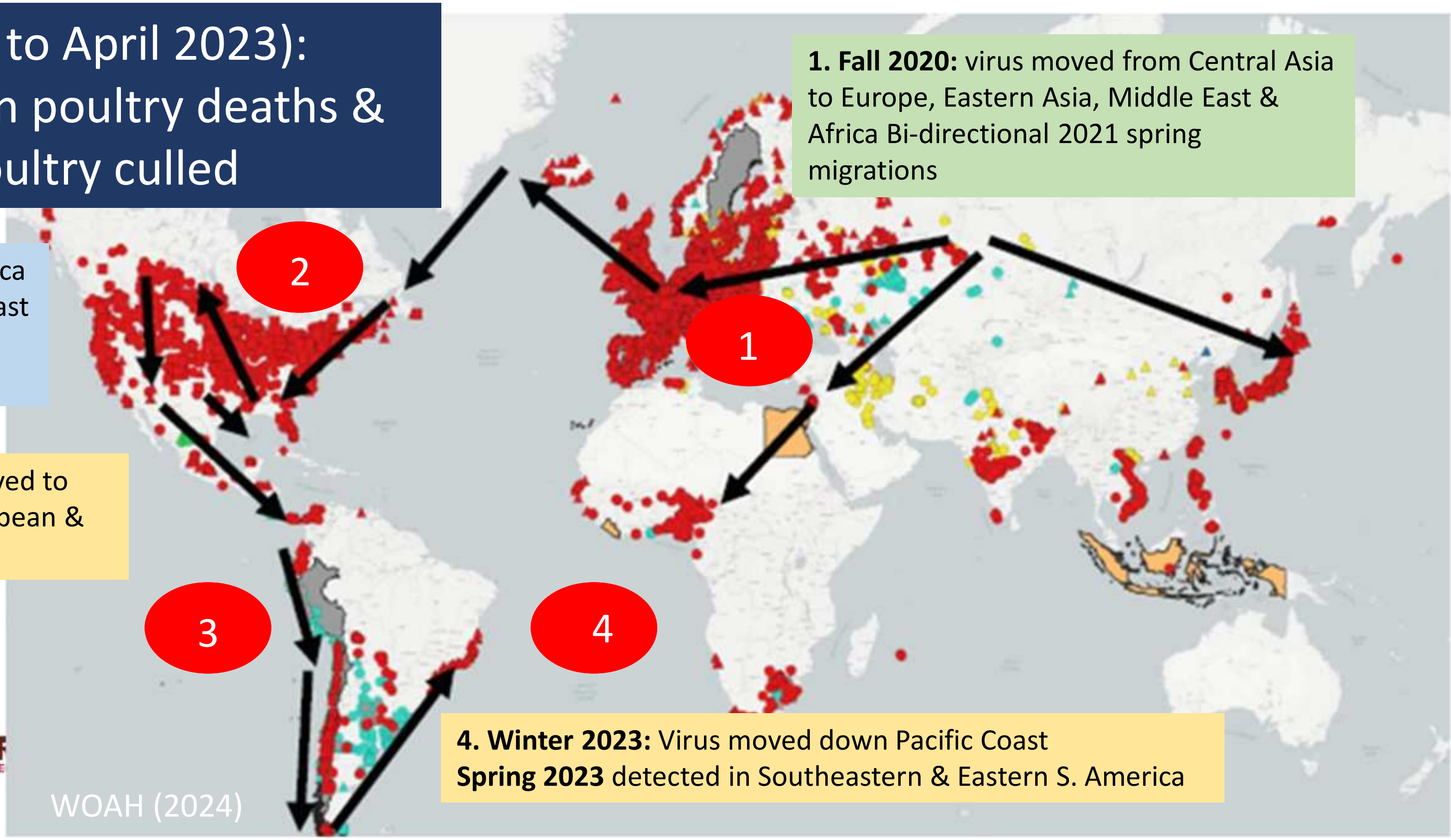
- During winter of 2020-2021, a new genotype of highly-pathogenic H5N1 avian influenza A virus emerged in Europe, comprising a (reassortant between the epizootic HP clade 2.3.4.4b H5N8 & local LP wildfowl strains).
- This new genotype caused record levels of infections in farmed poultry throughout Europe and quickly traveled, via waterfowl flyways, into North America, Africa and East Asia
- In following seasons, this panzootic genotype underwent further reassortment with local LP avian strains from waterfowl or seabirds - in Europe, North America & beyond; generating a diverse range of genotypes. One of these North American reassortant genotypes then entered South America and most recently, Antarctica

16th Poultry Knowledge Day 26 NOVEMBER

16th Edition POULTRY INDIA

Recent Spread of $H5N_X$ (Gs/GD Euroasian lineage) HPAI Virus (2.3.4.4b Clade)

Global (July 2020 to April 2023):
7515 cases, 14 million poultry deaths & 254 million poultry culled



1. Fall 2020: virus moved from Central Asia to Europe, Eastern Asia, Middle East & Africa Bi-directional 2021 spring migrations

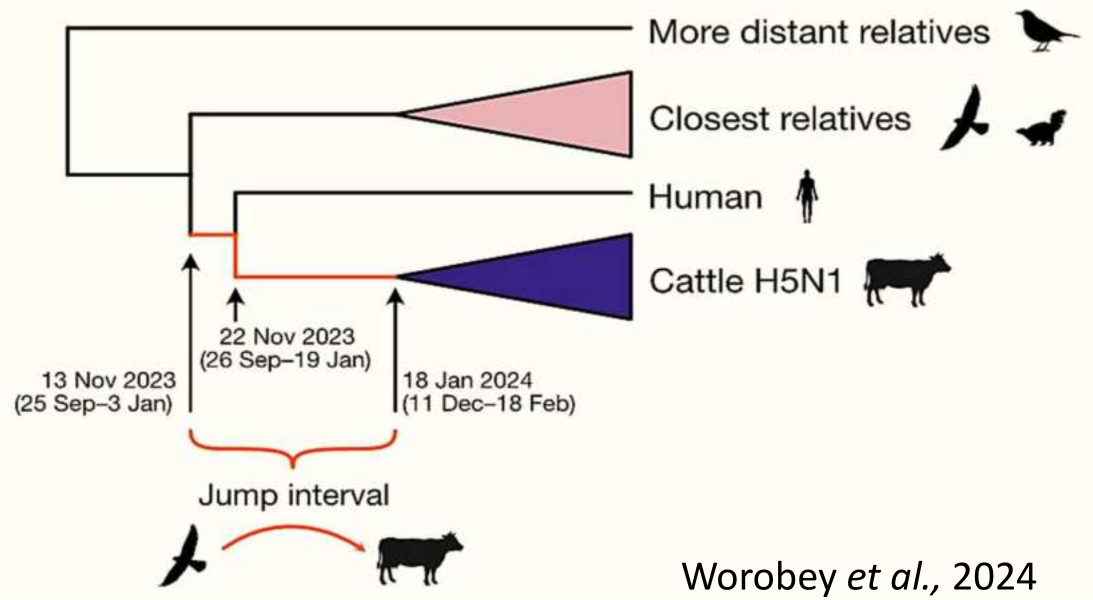
2. Fall 2021: Virus moved to N. America
- **Winter 2022** move down East Coast
- **Spring 2022** Northward
- **Late Summer 2022** Southward

3. Fall 2022: Virus moved to Central America, Carribean & Northern S. America

4. Winter 2023: Virus moved down Pacific Coast
Spring 2023 detected in Southeastern & Eastern S. America

Spillover of HPAI H5N1 virus to Dairy Cattle

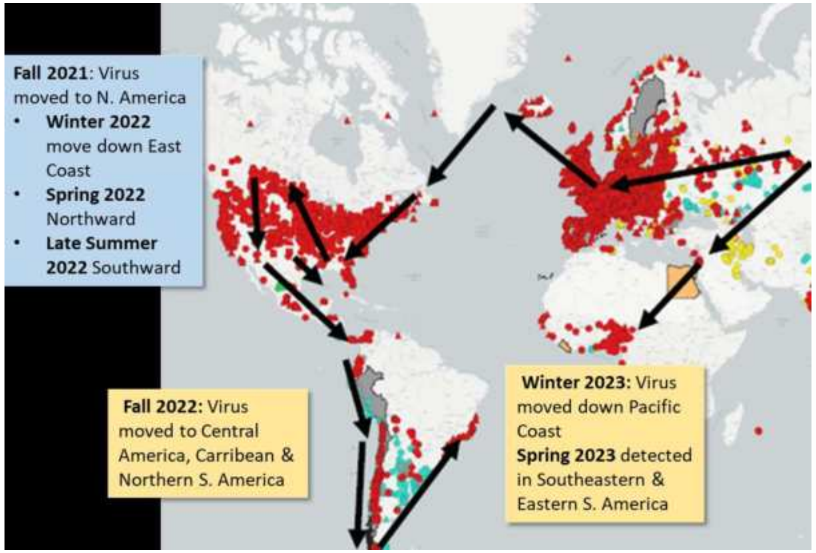
Cow Flu: H5N1 Clade 2.3.4.4b (2024)

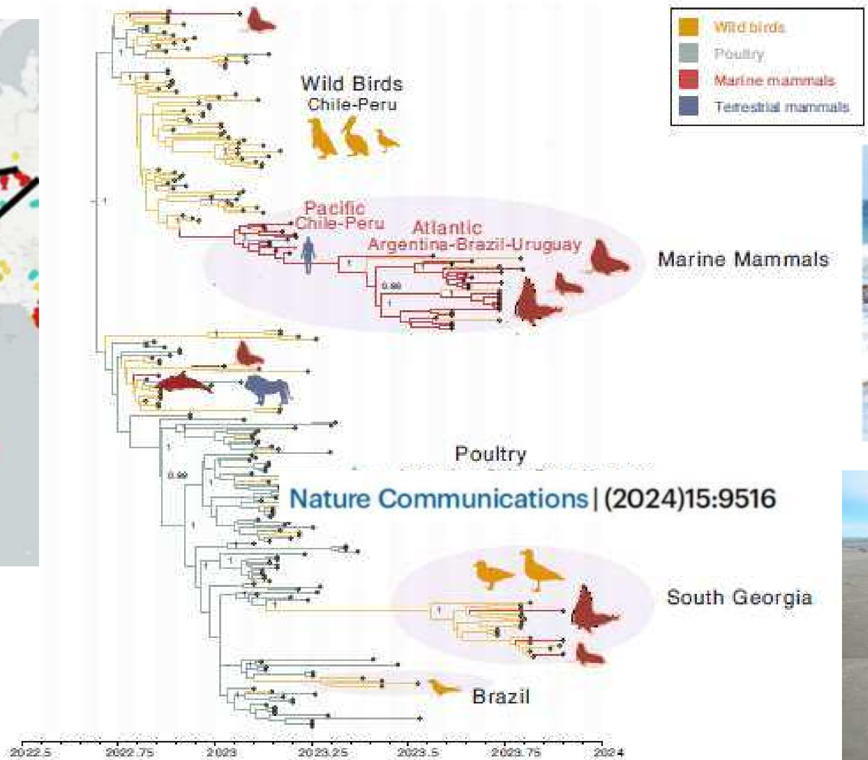


Worobey *et al.,* 2024

Schematic depicting the phylogenetic relationships between the HA segment of the viral genomes in different host species & when H5N1 likely spilled over into cattle

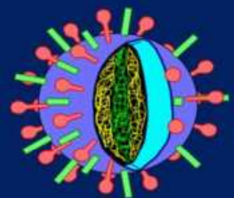
Virus Expansion to Marine Animals

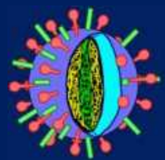


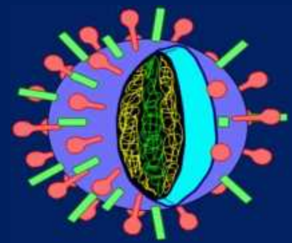


Uhart *et al.,* Nature Communications (2024)

Pathology & Diagnosis







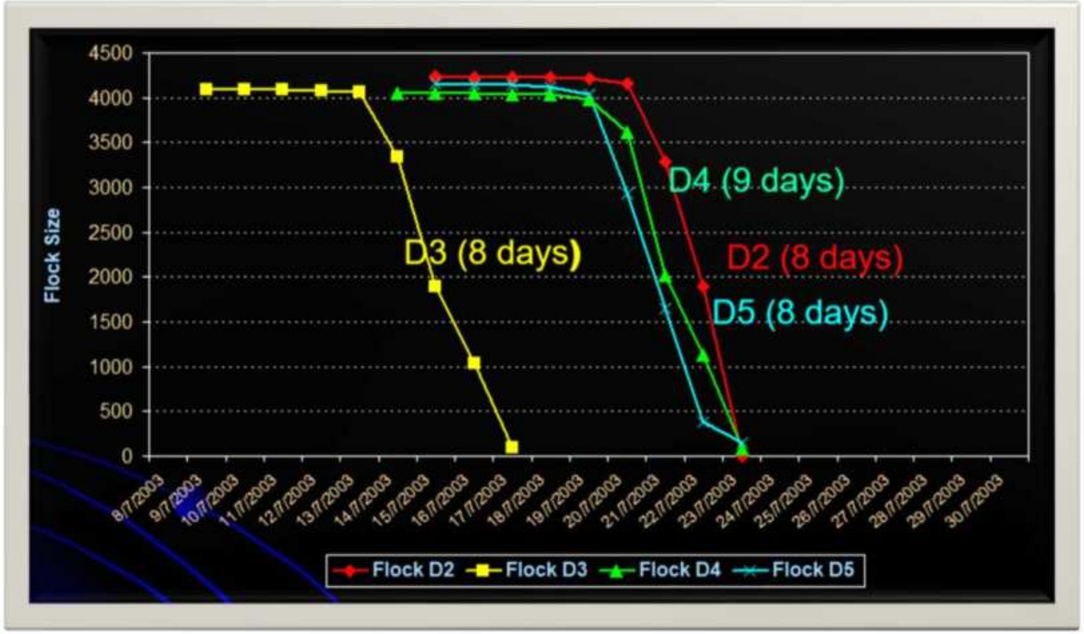
Highly Pathogenic Avian Influenza (HPAI)

Clinical Signs:

Sudden, high mortality (up to 100%)

Other Signs:

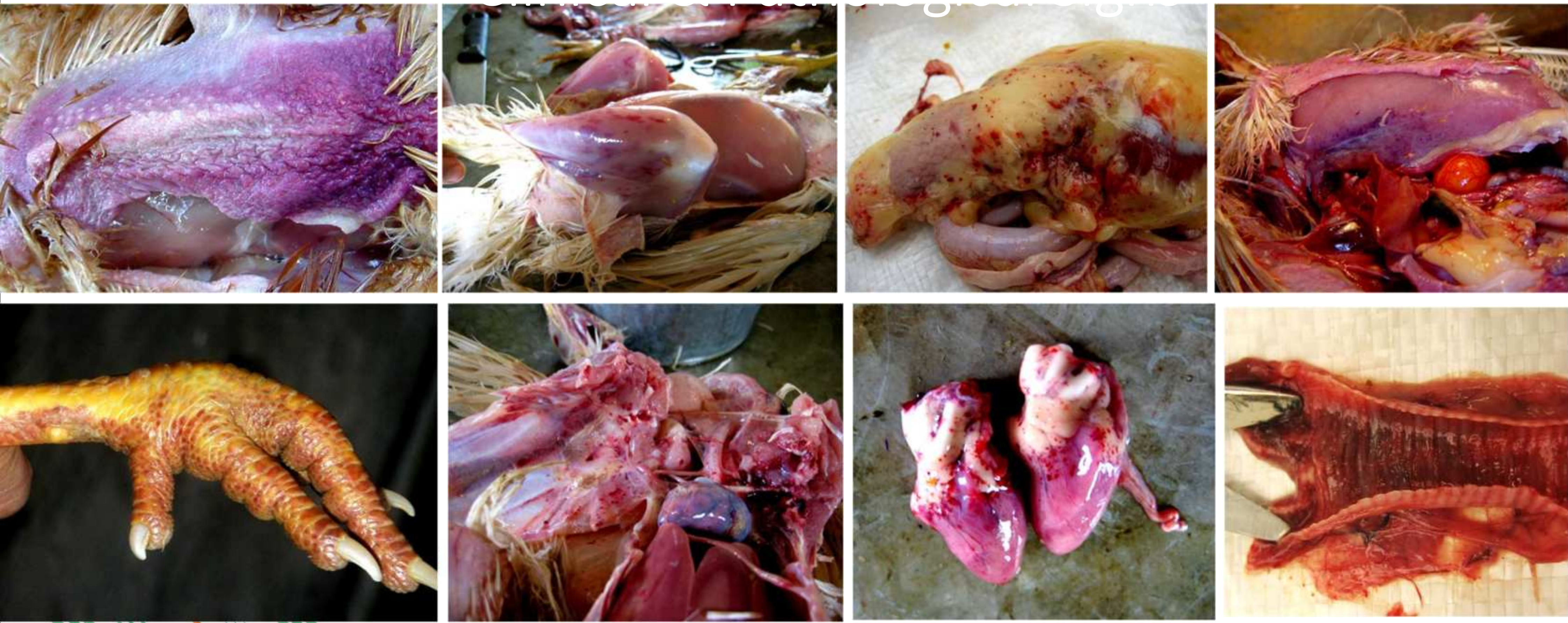
cessation of egg-laying, respiratory, excessive lacrimation, oedema of head, subcutaneous haemorrhage. Diarrhoea, neurological signs.



SHAPING THE FUTURE OF INDIAN POULTRY SECTOR

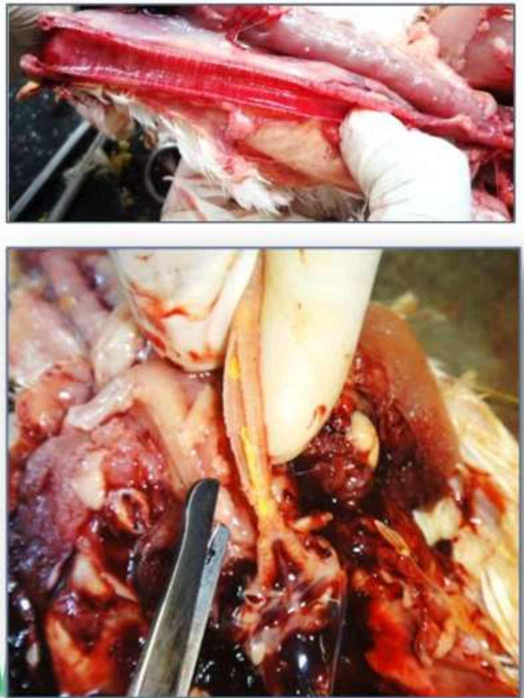
HPAI: Clinical Signs & Pathology

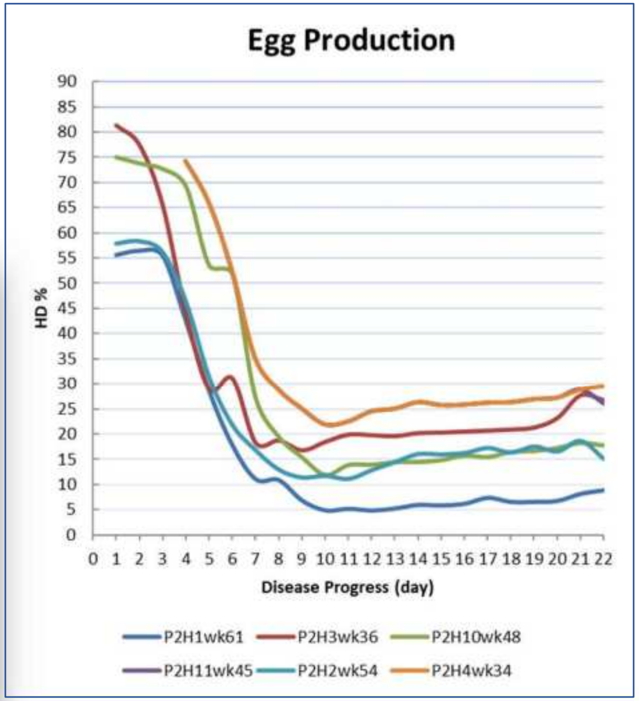
HPAI: Clinical Signs & Pathology

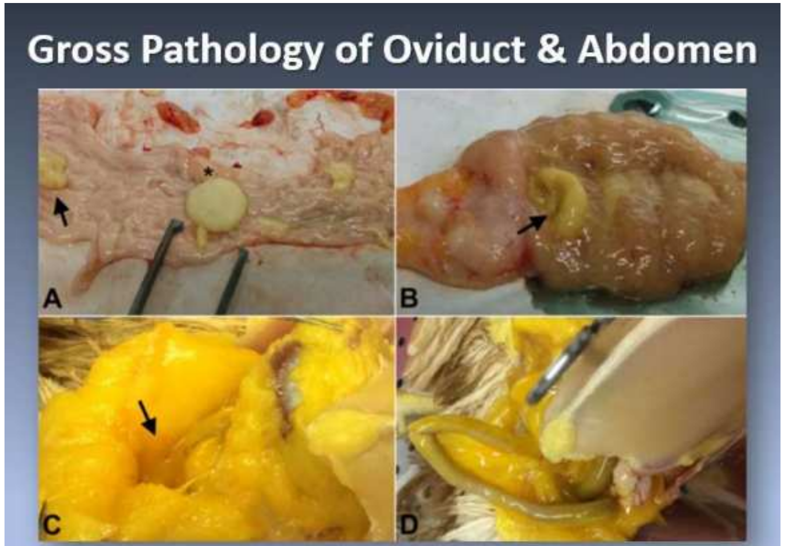


LPAI H9N2 in Poultry

- Virus is spread & disseminated via air sacs & serosal route to oviduct.
- Course of infection: loss of appetite, reduced feed intake & egg production drop (transient yolk follicle atresia, acute necrotic inflammation of oviduct: permanent low egg production with quality issues).
- **H9N2** is Self-limiting disease, affected birds recover after 2 weeks. Mortality observed more in older birds (> 55 wks) or birds with complicated secondary pathogens.





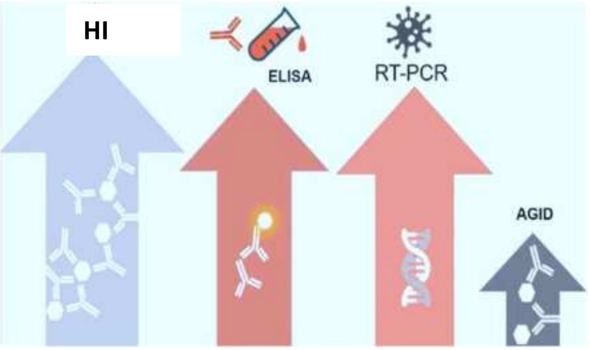


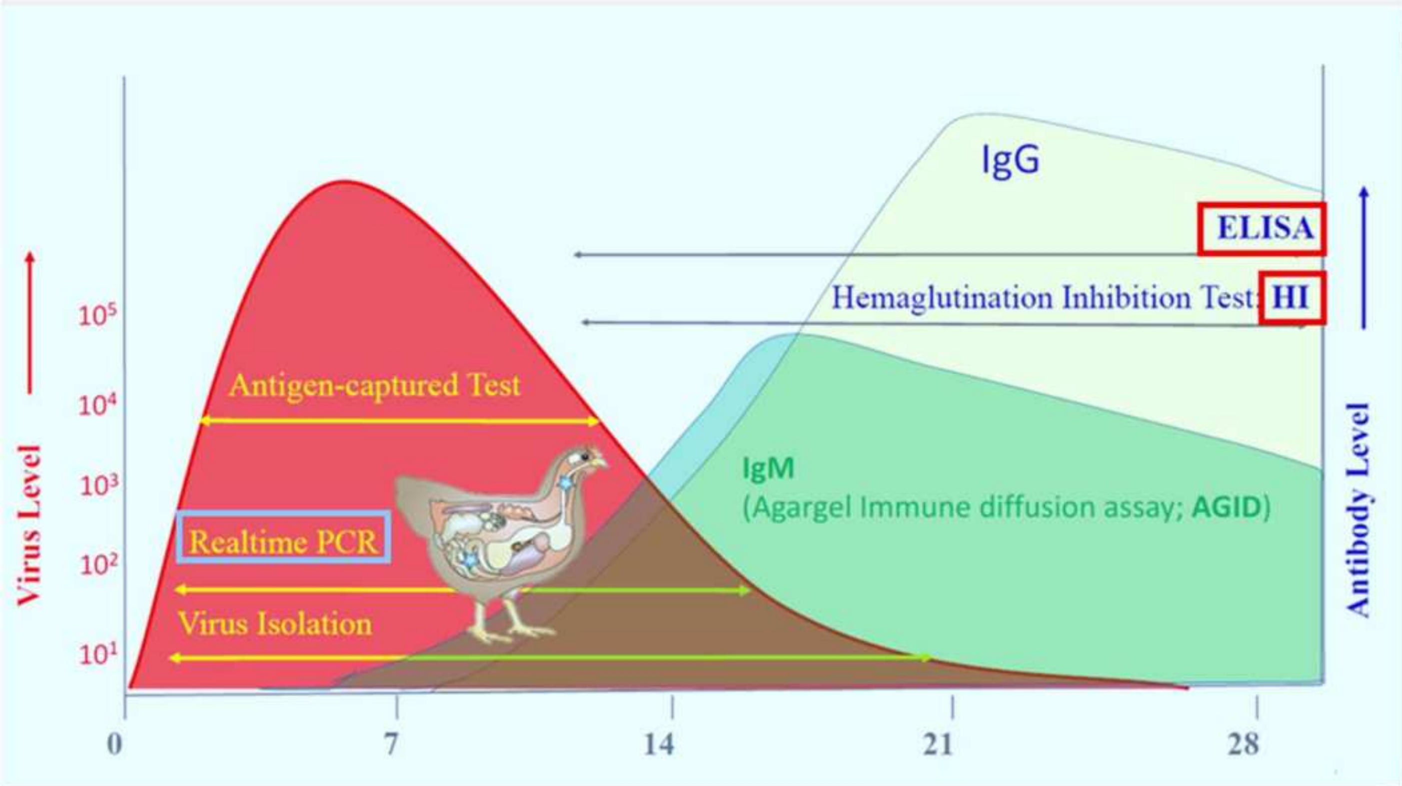
A. Magnum collected from on day 4 pi with defective egg & a fibrinous clot are indicative by an * & an Arrow. **B.** Uterus collected on day 6 pi. Arrow indicates mucus & fibrin. **C.D.** Egg yolk material in the abdomen necropsied on day 18 (C) & 80 pi. (D). (Bofante *et al.*, 2018)

16th Poultry Knowledge Day 26 November

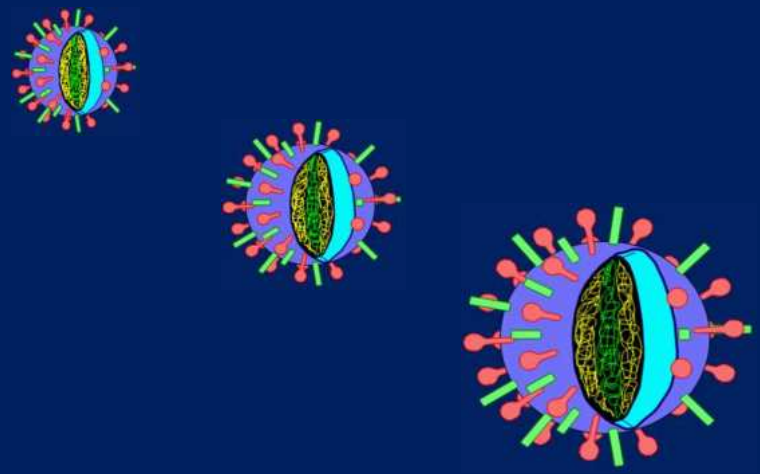
AIV Diagnostics: Serology & Molecular Methods

16th Edition Poultry India

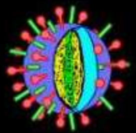


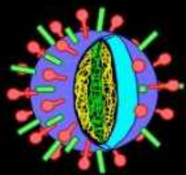


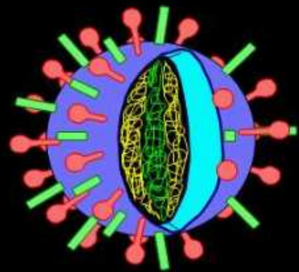
Disease Control
& Prevention Strategy



Disease Control & Prevention Strategy



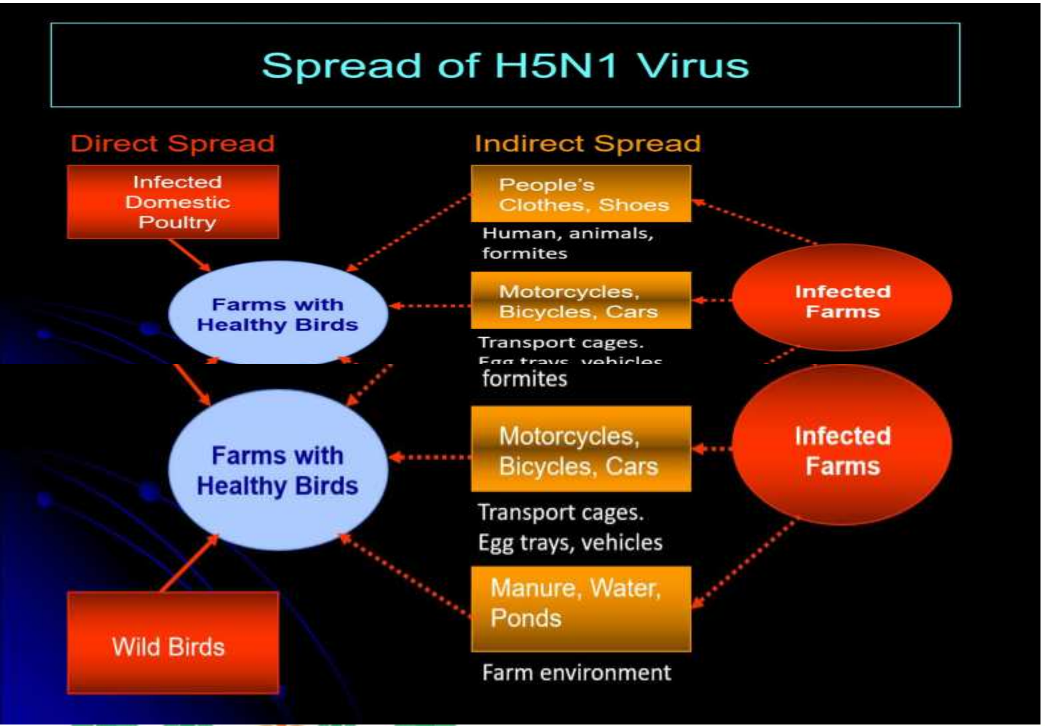




Containment of HPAI Spread

- Quarantine of area and infected premises
- Restrict movement of birds, product & manure
- Move by Permit only
- Strict Monitoring of Dead bird disposal
- Increased Biosecurity
- Surveillance of all poultry in a 3-5 mile area

Avian Influenza Control Measures



Avian Influenza Control Measures

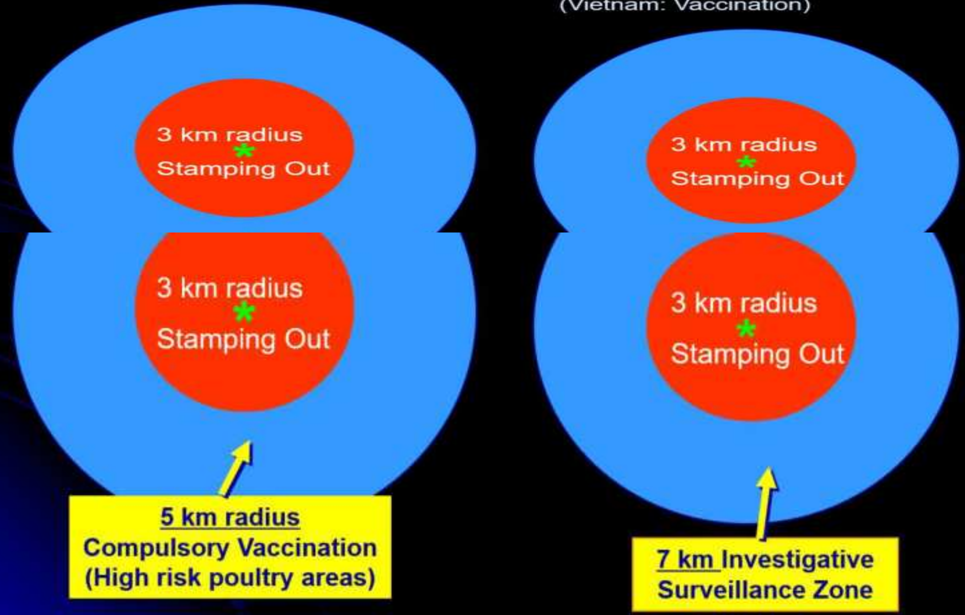
Control Measures during Outbreaks (Emergency Situation)

- Rapid destruction ("Culling" or "Stamping Out") of all infected or exposed birds
- Proper disposal of carcass
- Quarantine & rigorous disinfection of farm with disinfectant e.g. formalin, iodine compounds

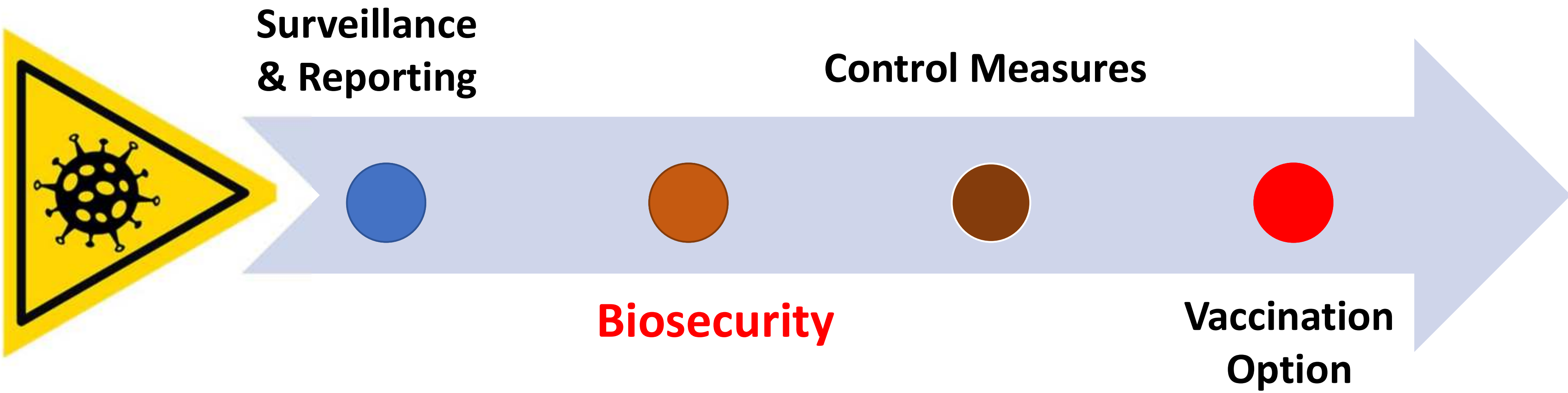
HPAI Control Strategies in Asian Countries

China : Combinations of culling & vaccination measures

Veitnam, Thailand, Cambodia : Combinations of Culling & Surveillance (Vietnam: Vaccination)



Control Measures of Avian Influenza



SHAPING THE FUTURE OF INDIAN POULTRY SECTOR

- Bio-security
- Stamping-out infected and at-risk flocks (sporadic infections)
- Vaccination

Control of Avian Influenza
Surveillance & Reporting

Early Detection is the Key to Control AIV Spread

1. Routine Submission of Eggs or Blood to Lab for testing
   - Broilers/turkeys – 10 blood samples per flock at slaughter
   - Layers/breeders – 30 eggs per month
2. Routine Submission to Lab for diagnosis of any Disease Problems
3. Training of local poultry industry of Danger of Avian Influenza
   - Prevent introduction through good biosecurity
   - Recognition of the disease
   - Testing for avian influenza

Control of Avian Influenza

Biosecurity: Cleaning & Disinfection

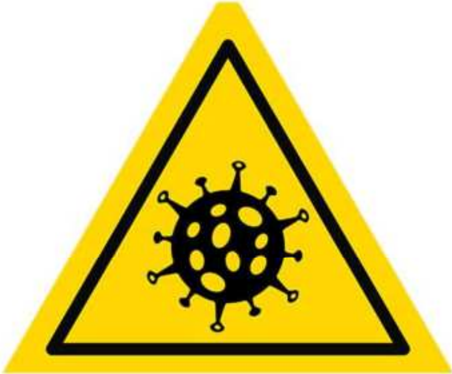
SHAPING THE FUTURE OF INDIAN POULTRY SECTOR

Control of Avian Influenza

Biosecurity - Biosecurity – Biosecurity

We know where the virus comes from

- Wild water fowl
- Live bird markets/Sunday markets
- Backyard flocks/Mixed farming
- Pet birds
- Other infected commercial poultry flocks



Biosecurity: AI Virus Inactivation

1. AIV are not very hardy, killed or inactivated by heat, drying, UV light & common chemical disinfectants e.g. sodium hypochlorite, phenolic compounds, quarternary ammonium compounds, iodine compounds, formalin & other aldehydes.
2. AIV inactivated within 6 days with field manure at an ambient temp (approx. 15^{o}C) condition (Lu *et al*., 2003).
3. AIV (H7N2) loss infectivity in 24 hrs under 30 – 37^{o}C & less than a week under 15 – 20^{o}C temperatures (Lu *at al.,*2003).

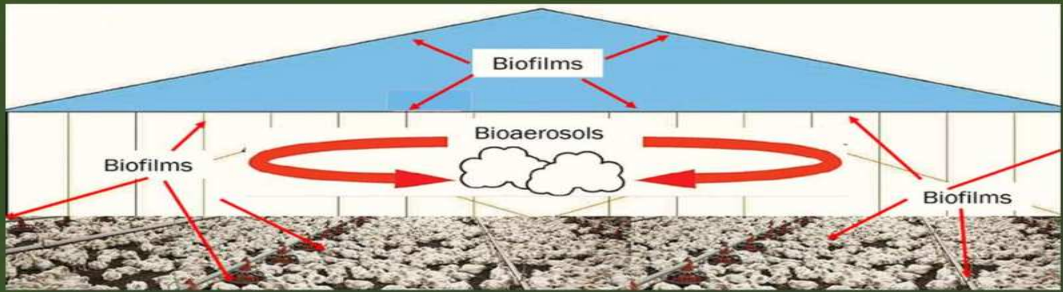
Effect of One hour Exposure of Different Disinfectants on the ability to inactivate AIV

- All **<u>5 disinfectants are effective at inactivating</u>** AIV @ recommended concentrations.
- **<u>Only the Chlorine & Peroxygen compounds</u> damaged the RNA** (could not be detected by RT-PCR).

Disinfectant/dilution	1/10	1/100	1/256	1/1000
Sodium hypochlorite*	NT[A]/(-)[B]	(-)[C]/(+)	(-)/(+)	
Phenolic		NT/(+)	(-)/(+)	(-)/(+)
Lysol		NT/(+)	(-)/(+)	(-)/(+)
Quaternary ammonia		NT/(+)	(-)/(+)	(+)/(+)
Peroxygen compound*		NT/(-)	(-)/(-)	(-)/(+)
Peroxygen Compound (10 day old)		NT/(+)	(+)/(+)	(+)/(+)

[A]NT = not tested. [B](-) = negative for RT-PCR. [C](-) = negative by virus (Suarez *et al.*, 2003)

Environmental Challenges : Biofilms



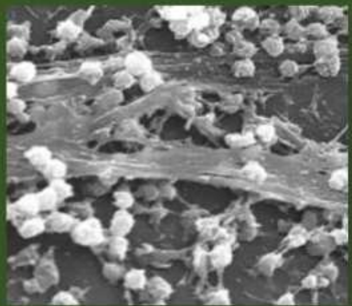
Temperature, Relative Humidity, Air Flow

Source: C.M. Wathes (2004)	Typical Concentration	Inhaled burden/day
Inhalable dust	7 mg/m³	7.7 mg
Respirable dust	0.8 mg/m³	0.88 mg
Inhalable endotoxin	1600 ng/m³	1.8 mg
Respirable endotoxin	80 ng/m³	0.09 mg
Bacteria	5×10^6 c.f.u./m³	5.5×10^6 c.f.u.
Fungi	1.6×10^5 c.f.u./m³	1.8×10^5 c.f.u
Ammonia	17 ppm	13 mg

Calculated assuming a minute volume of 760 ml for a 1.6 kg broiler chicken

- Biofilms are the most common form of microbial populations in poultry facilities
- Almost all pathogens are able to form Biofilm (facilitated by Quorum Sensing)
- Biofilms in poultry units are common in flocks with Chronic Respiratory Tract

Calculated assuming a minute volume of 760 ml for a 1.6 kg broiler chicken



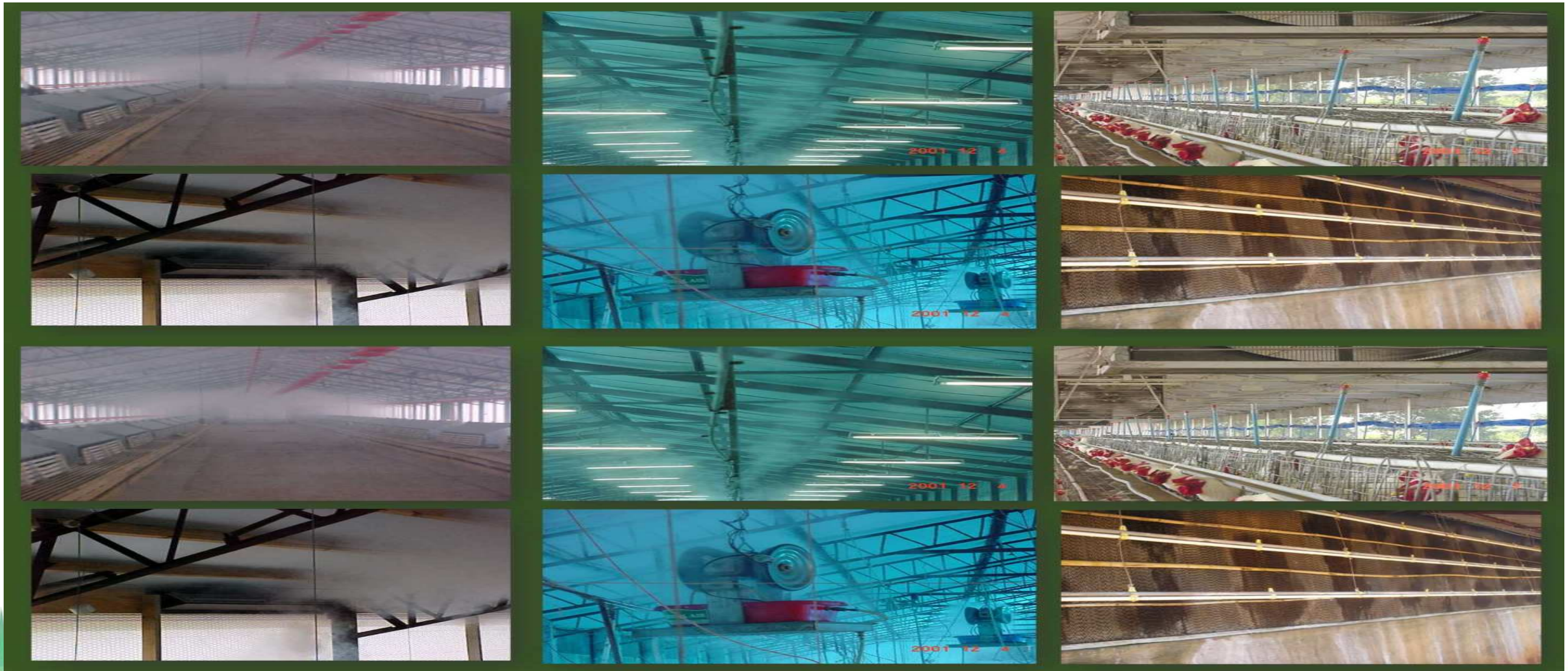
- Biofilms are the most common form of microbial populations in poultry facilities
- Almost all pathogens are able to form Biofilm (facilitated by Quorum Sensing)
- Biofilms in poultry units are common in flocks with Chronic Respiratory Tract infections (Pasteurella, Mycoplasma...)
- Biofilms development in poultry facilities can be due to:
  - Oral medication or nutrient supplement via drinking water
  - Sub MIC concentrations of antibiotics/disinfectant stimulate Biofilm formation

16th Poultry Knowledge Day 26 November

16th Edition Poultry India

New Idea in Air Sanitation: In-housing Fogging & Disinfection

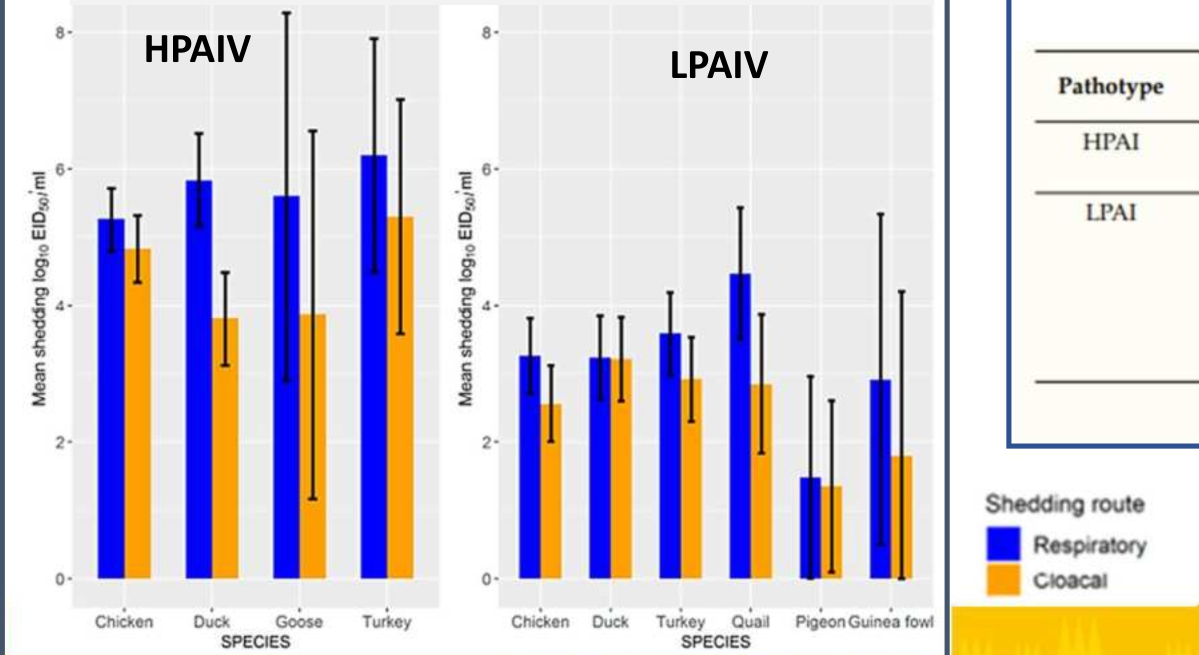
Contaminated air is one way that diseases and viruses like HPAI can be transmitted into a facility



Avian Influenza Virus Shedding

- Avian influenza viruses are shed in the saliva, mucous, feces, & respiratory secretions of infected birds
- The virus can also be found in the body fluids of other infected animals, such as cow milk
- LPAI viruses can be shed in asymptomatically infected or minimally affected flocks

Mean shedding (log_{10} EID_{50}/mL) in respiratory & cloacal swabs



An Indication of AIV shedding length in days in multiple poultry species

Pathotype	Poultry Species	Length of Respiratory Virus Shedding (Days)		Length of Cloacal Virus Shedding (Days)	
HPAI	Chicken	2.6	(1.1–6.5)	2.5	(1.0–6.2)
	Duck	6.9	(2.8–17.1)	6.6	(2.7–16.3)
LPAI	Chicken	6.2	(0.8–17.8)	5.5	(0.7–15.7)
	Duck	5.3	(0.7–15.3)	8.2	(1.0–23.3)
	Turkey	10.0	(1.3–28.7)	14.1	(1.8–40.2)
	Guinea fowl	3.3	(0.4–9.4)	3.3	(0.4–9.4)
	Pigeon	3.6	(0.4–10.2)	2.8	(0.3–8.0)
	Quail	NA		6.9	(0.9–19.8)

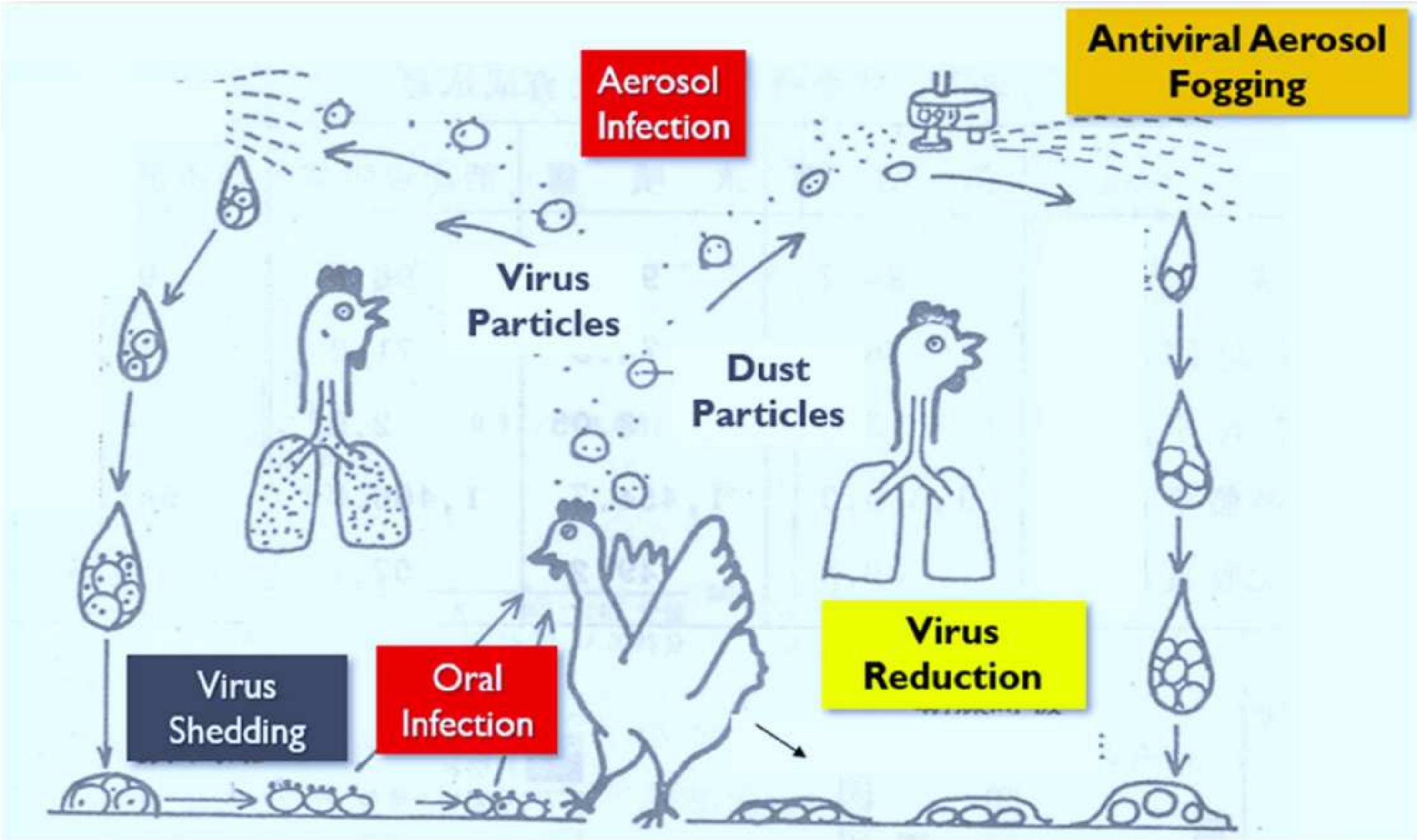
NA = not applicable.

Germeraad *et al*., (2019)

Reduce Virus Shedding & Contamination by Aerosol Fogging

House & Environment Decontamination

- Washing with surfactant, disinfectant spraying, thermal fogging…
- Consider Foaming disinfection in severe outbreak case
- Continuous use of water sanitizer



16th Poultry Knowledge Day 26 NOVEMBER

Application of Foggers

16th Edition POULTRY INDIA

Fogger Cooling System	Description
Low Pressure Fogging	100 – 200 psi (7 – 14 bar), droplet sizes > 30 microns may cause wet litter at high humidity
High Pressure Fogging	400 – 600 psi (28 – 41 bar), droplet sizes of 10 – 15 microns minimal residual moisture giving extended humidity range
Fogger + Cooling Pads	Air is drawn through water-soaked filter (pad) by tunnel ventilation + Foggers inside house

High Pressure Fogging
of 10 – 15 microns minimal residual moisture giving extended humidity range

Environmental Fogging

"Fog" Machines

- especially for disinfecting
- works on the basis of combustion & pressure (heat)
- use: 1.5 - 1.7 ltr/ 100m³
- dosage Formalin 100%
  Peroxides 20 -25 %

Peroxides 20 -25 %

Microaerolized H_2O_2 on Bacterial & Viral Poultry Pathogens

Efficacy of Vaporized H_2O_2 against Exotic Animal Viruses (Heckert *et al.*, 1997)

TABLE 2. Titers of several different exotic animal viruses, suspended in liquid or dried onto a glass or steel surface, before and after exposure to VPHP gas

Virus	Titer (mean ± SD, log_{10}/ml) of virus[a] in: Liquid suspension, No VPHP, Out of box, Glass	Liquid suspension, No VPHP, Out of box, Steel	Liquid suspension, No VPHP, In box, glass	Liquid suspension, VPHP, in box, glass	Dried state, No VPHP, Out of box, Glass	Dried state, No VPHP, Out of box, Steel	Dried state, No VPHP, In box, Glass	Dried state, No VPHP, In box, Steel	Dried state, VPHP, in box, Glass	Dried state, VPHP, in box, Steel
AIV	ND	ND	4.5[b]	0	5.68 ± 0.14	5.68 ± 0.14	2.60 ± 0.14	2.91 ± 0.63	0 ± 0.0	0 ± 0.0
ASFV	6.73 ± 0.8	6.35 ± 0.58	5.96 ± 1.06	<1[c]	5.89 ± 0.29	6.05 ± 0.25	0.06 ± 0.04	0.06 ± 0.01	<1	<1
BTV	4.43 ± 0.14	4.35 ± 0.14	4.39 ± 0.18	<1	4.43 ± 0.14	4.55 ± 0.25	1.32 ± 0.72	1.31 ± 0.8	<1	<1
HCV-CC	6.55 ± 0.25	6.85 ± 0.14	6.0[b]	<1	58.5 ± 0.14	5.74 ± 0.29	0 ± 0.0	0 ± 0.0	<1	<1
HCV-WB	6.99 ± 0.29	6.74 ± 0.29	5.64 ± 0.18	5.5 ± 0.0	6.8 ± 0.25	6.86 ± 0.43	4.3 ± 0.25	3.81 ± 0.8	4.18 ± 0.14	4.35 ± 0.14
NDV	ND	ND	8.25[b]	0 ± 0.0	9.14 ± 0.29	8.5 ± 0.0	6.5 ± 0.0	6.1 ± 0.14	0 ± 0.0	0 ± 0.0
PRV	6.95 ± 0.38	7.24 ± 0.29	6.75 ± 0.0	<1	6.1 ± 0.14	6.1 ± 0.14	4.35 ± 0.14	4.43 ± 0.14	<1	<1
SVDV	7.8 ± 0.25	8.18 ± 0.14	7.75[b]	<1	7.7 ± 0.38	8.01 ± 0.38	0 ± 0.0	0 ± 0.0	<1	<1
VEV	7.7 ± 0.38	8.0 ± 0.0	2.0 ± 0.0	<1	2.26 ± 0.38	2.55 ± 0.25	0.1 ± 0.0	0.1 ± 0.0	<1	<1
VSV-CC	5.04 ± 1.15	5.99 ± 0.29	4.75[b]	<1	3.04 ± 1.5	4.55 ± 0.25	0 ± 0.0	0 ± 0.0	<1	<1
VSV-AF	6.86 ± 0.43	7.01 ± 0.38	7.75[b]	<1	5.24 ± 0.52	4.34 ± 0.66	3.68 ± 0.14	3.89 ± 0.29	<1	<1

[a] AIV, avian influenza virus; ASFV, African swine fever virus; BTV, bluetongue virus; HCV-CC, hog cholera virus in cell culture medium; HCV-WB, hog cholera virus in whole blood; NDV, Newcastle disease virus; PRV, pseudoroabies virus; SVDV, swine vesicular disease virus; VEV, vesicular exanthema virus; VSV-CC, vesicular stomatitis virus in cell culture medium; VSV-AF, vesicular stomatitis virus in allantoic fluid. Out of box, samples not placed in decontamination chamber; in box, samples placed in decontamination chamber; ND, not done.

[b] Not replicated.

[c] Sample could not be assayed at a dilution of less than 1/10 because of toxicity in the assay system at lower dilutions.

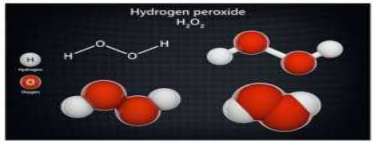
VPHP = vapor-phase of hydrogen peroxide)

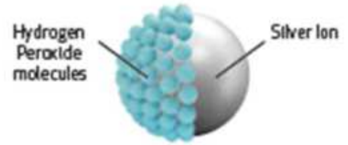
Silver Stabilized Hydrogen Peroxide

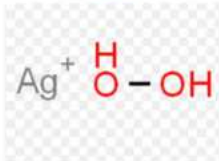
- **Silver stabilized H_2O_2** and is a very effective, multipurpose disinfectant & work effectively across wide pH range.
- Silver combines with H_2O_2 to enhance stability & to boost performance to clean effectively with short contact time (almost 20X more powerful). A potent Biofilm remover!
- It works as bactericidal, fungicidal & also against viruses and it works effectively in cold water (does not require any heat to inactivate).

short contact time (almost 20X more powerful). A potent Biofilm remover!
- It works as bactericidal, fungicidal & also against viruses and it works effectively in cold water (does not require any heat to inactivate).

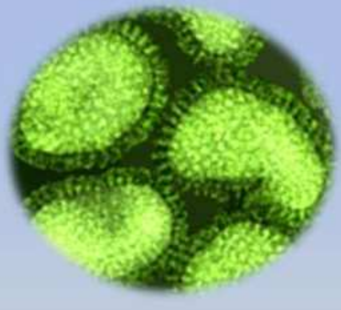
- It is safe, colorless liquid with no smell or taints and is Non-carcinogenic.







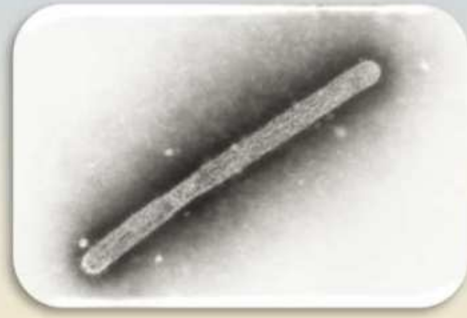
HPAI/LPAI Prevention Approach



3.Vaccination

Triangle of
HPAI & LPAI
Control

2. Management
Practice GMP

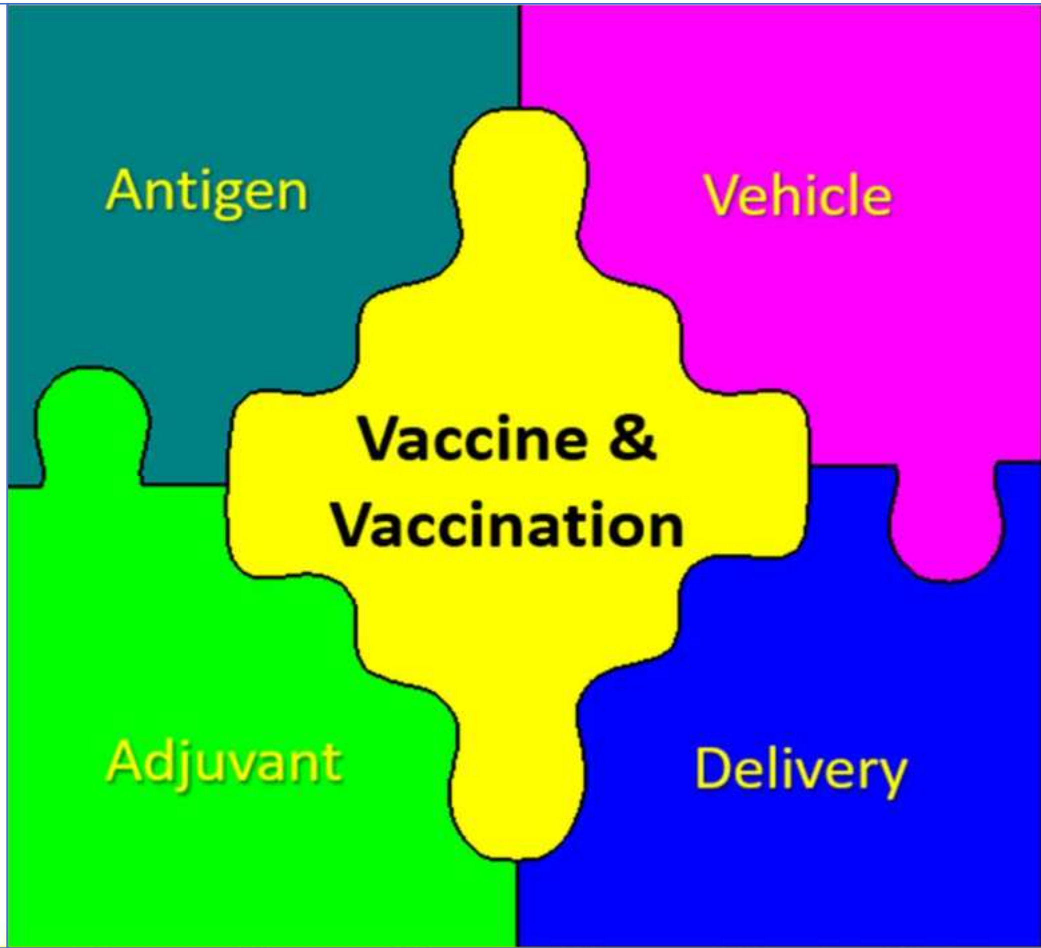


1.Biosecurity

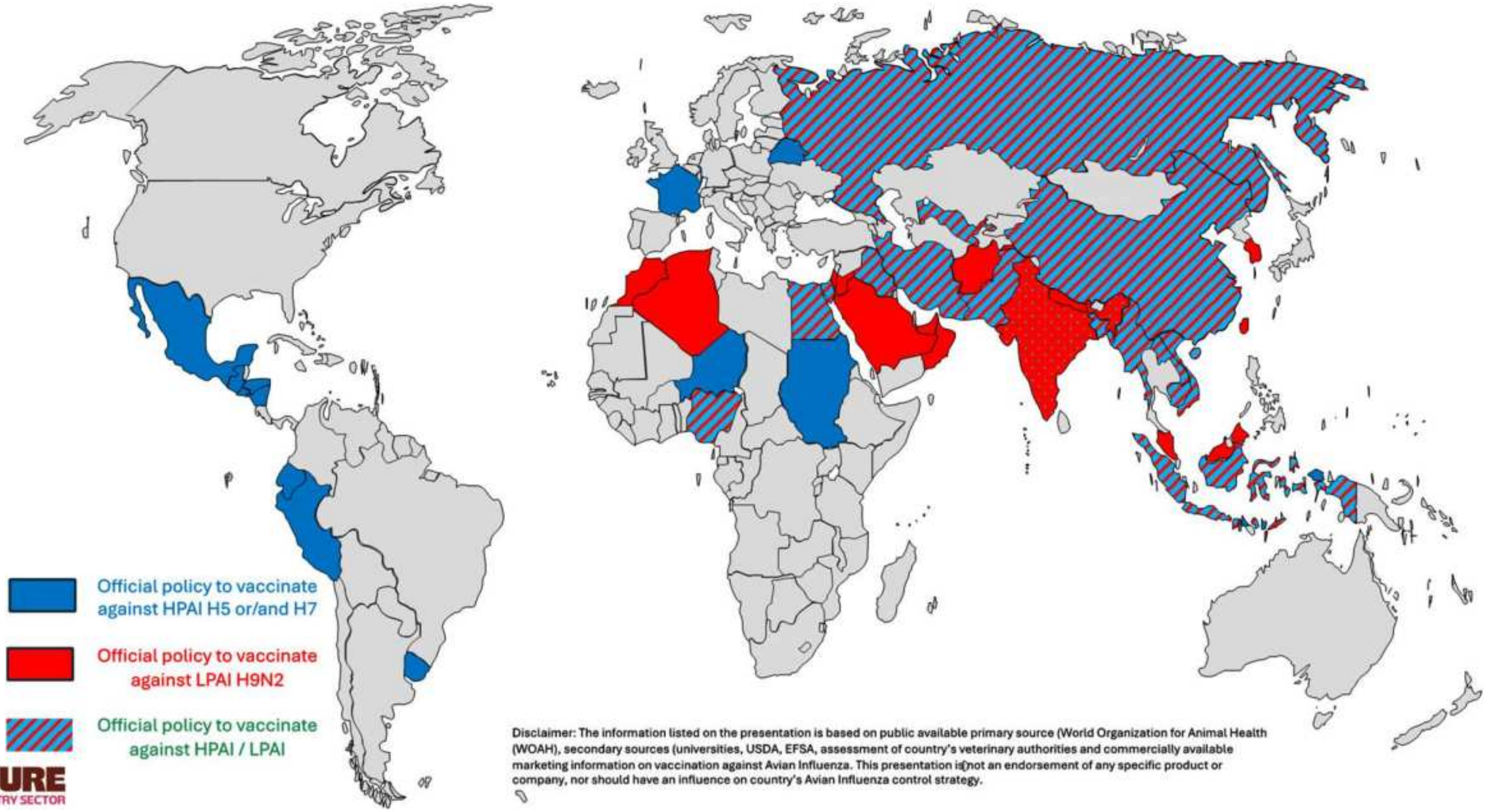
Use of AI Vaccines

What We Want? Objectives

- Increase immunity against AIV.
- **Prevent mortality,reduce symptoms**
- and economic losses.
- **Reduce shedding and spreading of AIV,** if infected.
- It <u>does not prevent infection</u> = **No Sterile Immunity**
- **Vaccination** against Avian Influenza is: **<u>to control the diseases, not to eradicate the virus</u>**



Countries officially vaccinating against LPAI & HPAI

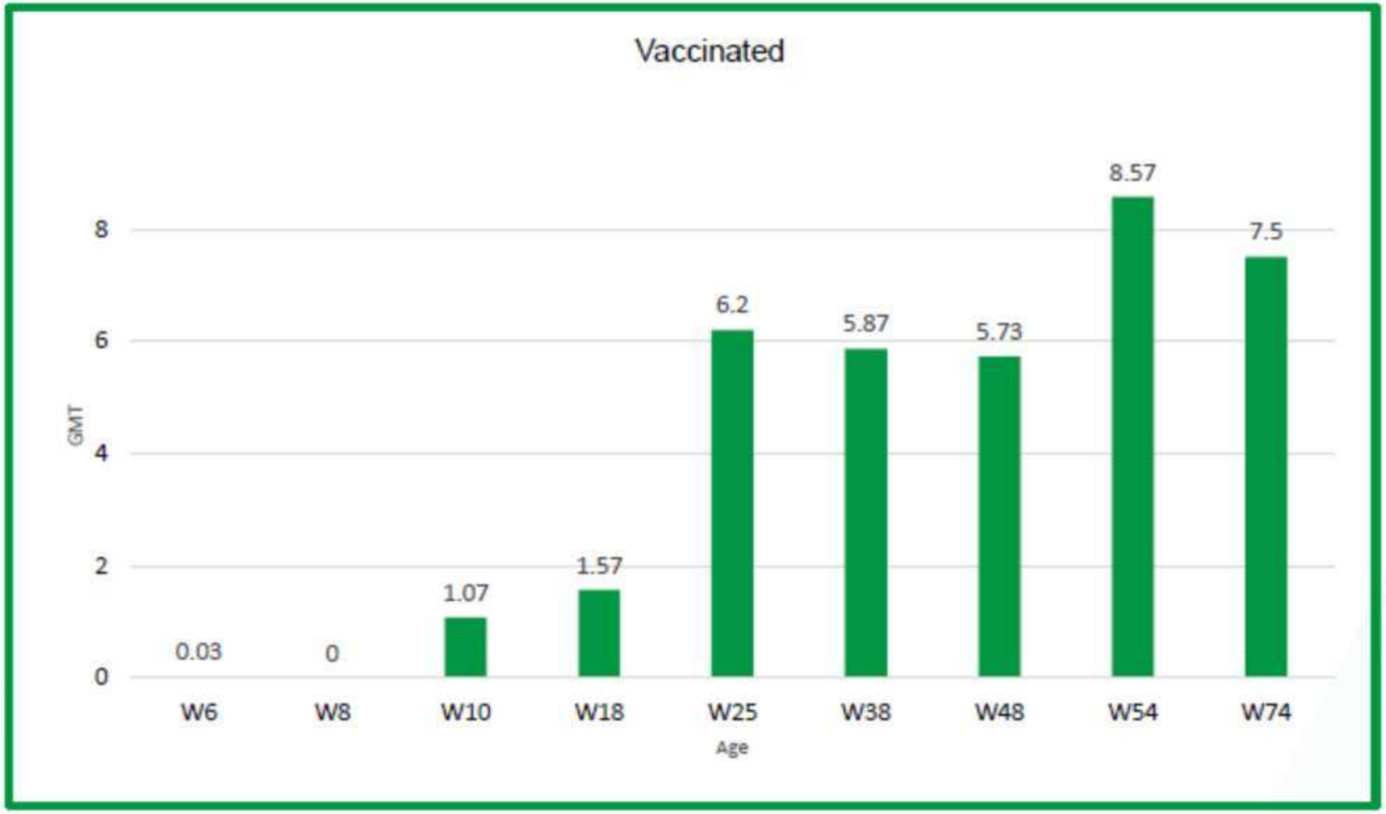


Disclaimer: The information listed on the presentation is based on public available primary source (World Organization for Animal Health (WOAH), secondary sources (universities, USDA, EFSA, assessment of country's veterinary authorities and commercially available marketing information on vaccination against Avian Influenza. This presentation is not an endorsement of any specific product or company, nor should have an influence on country's Avian Influenza control strategy.

Avian Influenza Poultry Vaccines

- ✓ **Inactivated "Whole virus" vaccines**
- ✓ **Inactivated "Reverse Genetic" vaccines**
- ✓ **Recombinant vaccines**
  - Baculovirus as the vector
  - Poxvirus as the vector
  - Newcastle Disease virus as the vector
  - Herpesvirus of Turkey (HVT) as vector

Example: Inactivated "Whole Virus" Vaccine Response (H9 HI titers)



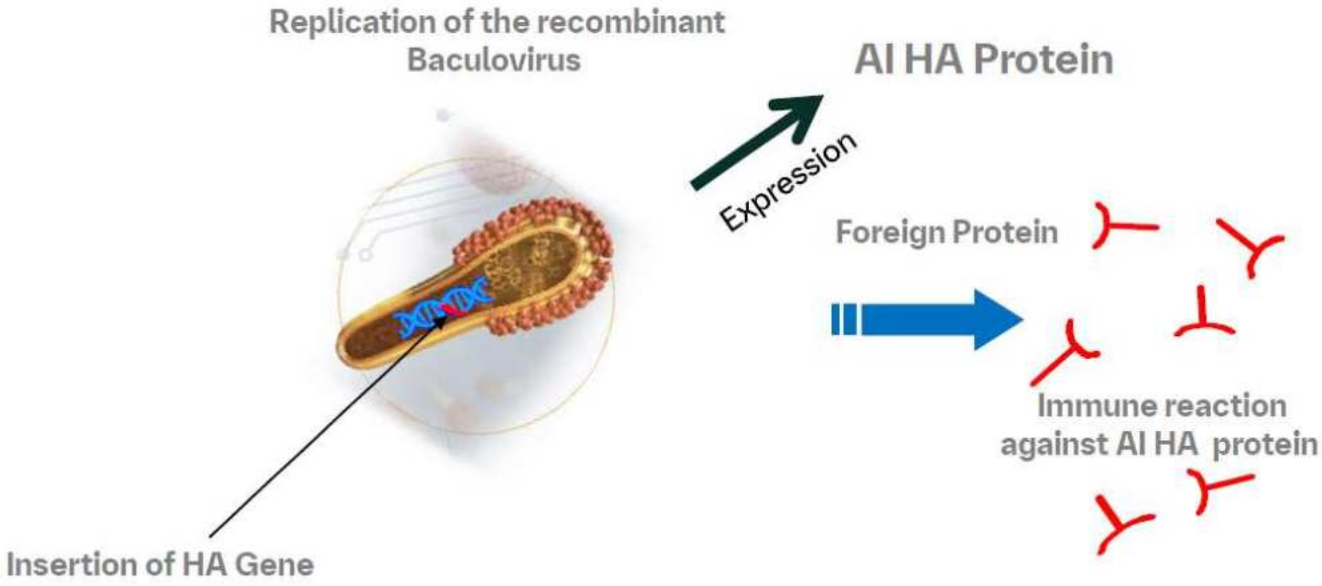
Vaccination	Age
1st dose	W5
2nd dose	W14
3rd dose	W45

Good seroconversion seen after 2 doses of vaccine administrated

Example: Inactivated Recombinant Vaccine against AIV H5 (B.E.S.T. Technology)

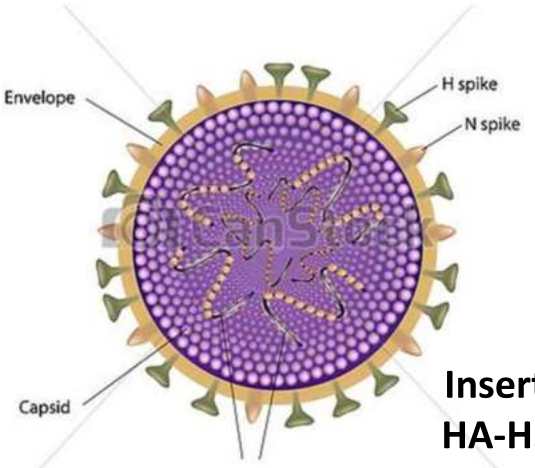
Baculovirus Expression System Technology B.E.S.T.

Antigen was expressed in insect cells after infection with a recombinant baculovirus encoding for inserted sequence



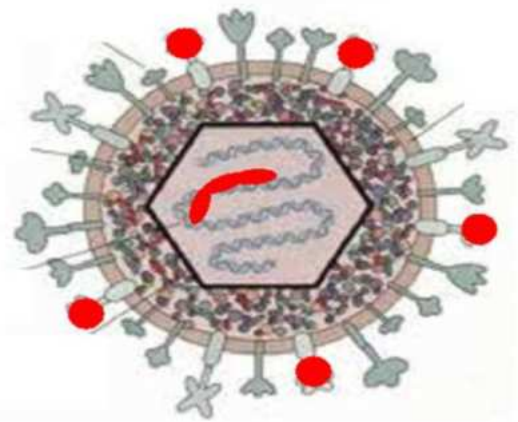
Stephane Lemiere (2024)

Example: HVT-vectored H5 Vaccine



Insertion of HA-H5 gene

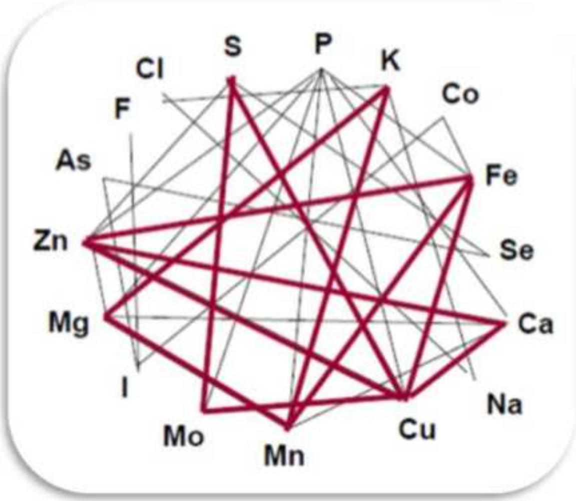
HVT (Marek's Disease Virus)



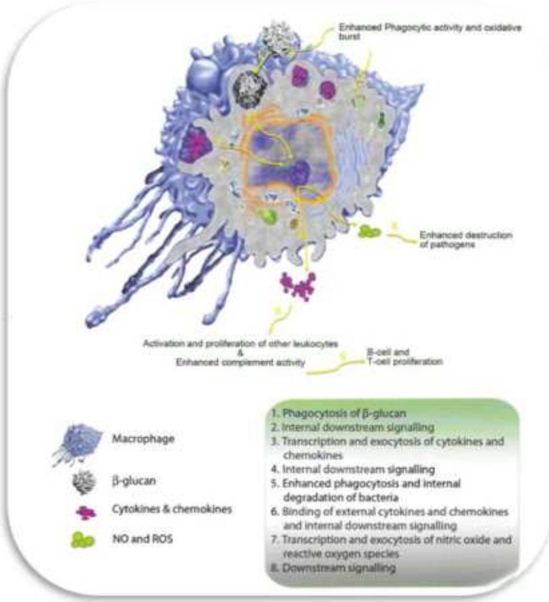
SHAPING THE FUTURE OF INDIAN POULTRY SECTOR

- HVT-H5 vaccine was constructed by inserting a recombinant HA-H5 gene into the genome of HVT FC126.
- The recombinant HA-H5 was derived from a compilation of HPAI H5N1, clade 2.2, 2005 strains (GenBank: MW310457).

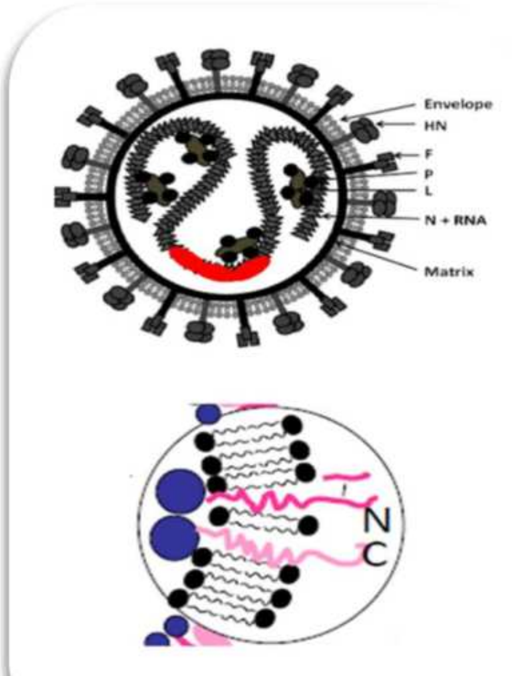
Recent Focus on Avian Immune System under Virus Challenge Situation



Nutrient Uplift & Consider Micro-nutrient Support



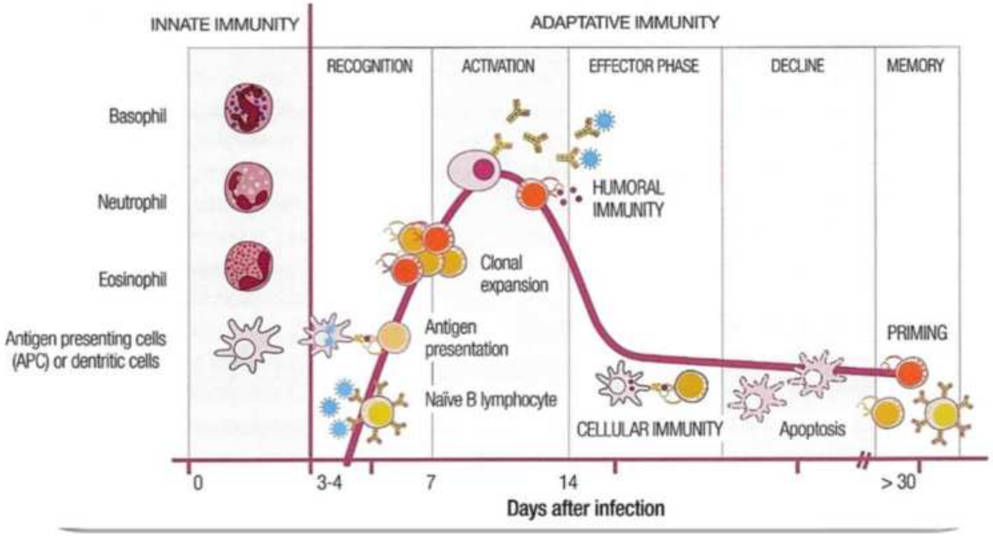
Apply Immune Modulating Agents



Rupture of Virus Envelope

Feed Sanitation & Water Hygiene

Role of Cell-mediated Immunity in Support of Inactivated Vaccination

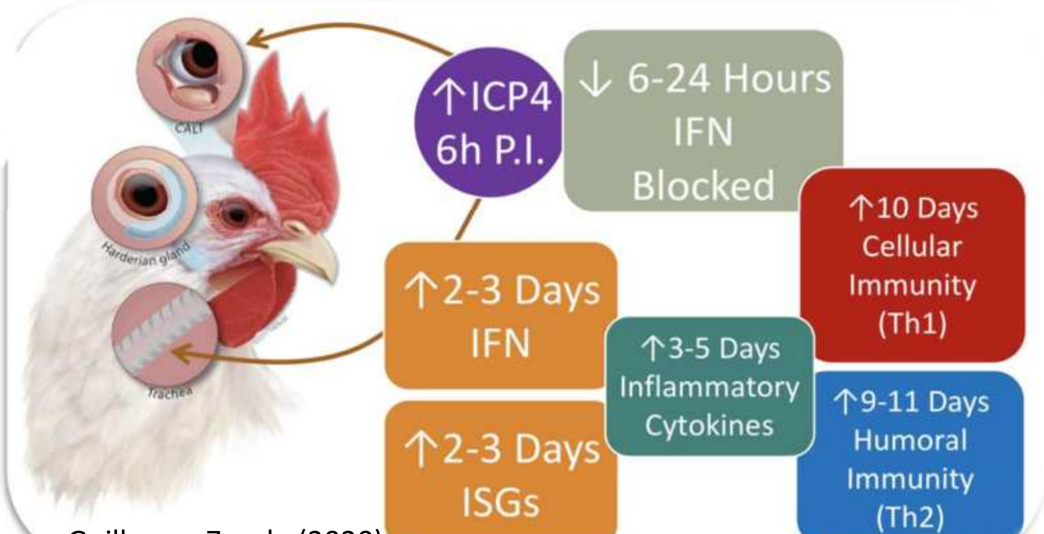


Thiery van den Berg (2014)

Type of Immunity		Killed Vaccines
Local Immunity	Humoral (Ab IgA)	No
	Cell-mediated (CTLs)	No
Systemic Immunity	**Humoral (Ab IgY, IgM)**	Yes
	Cell-mediated (CTLs)	No

Head-associated Lymphoid Tissues are important secondary tissues in the fight against Respiratory Pathogens

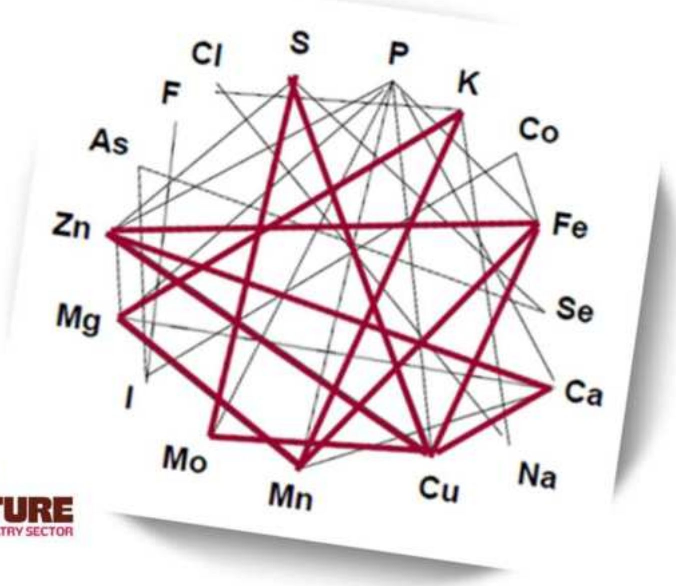
- **CALT** (Conjunctiva)
- **HALT** (Hardenian gland)
- **NALT** (Nasal)
- **TALT** (Trachea)



Guillermo Zavala (2020)

Use of Antioxidants, Probitoics, Immuno-modulators, Organic Minerals & Vitamins …

<u>Example: Organic Zinc & Selenium</u> reduce symptoms of vaccination stress by supporting the Immune system



Zinc
- Skin/gut integrity, Keratin formation, Lymphocyte & SOD production. Glutathione production

Manganese
- Macrophage killing ability, Steriodogenesis
- Chondroitin sulfate production

Copper
- Neutrophil activation, Cross-linking collagen, Lysyl oxidase

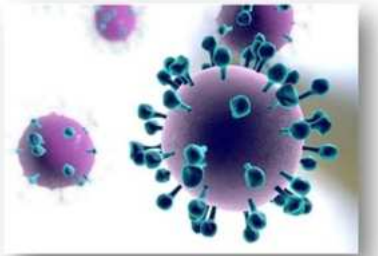
Selenium
- Cellular protection

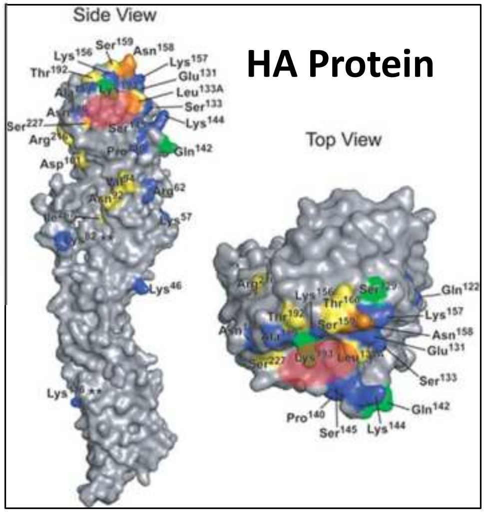
Chromium
- Insulin sensitivity

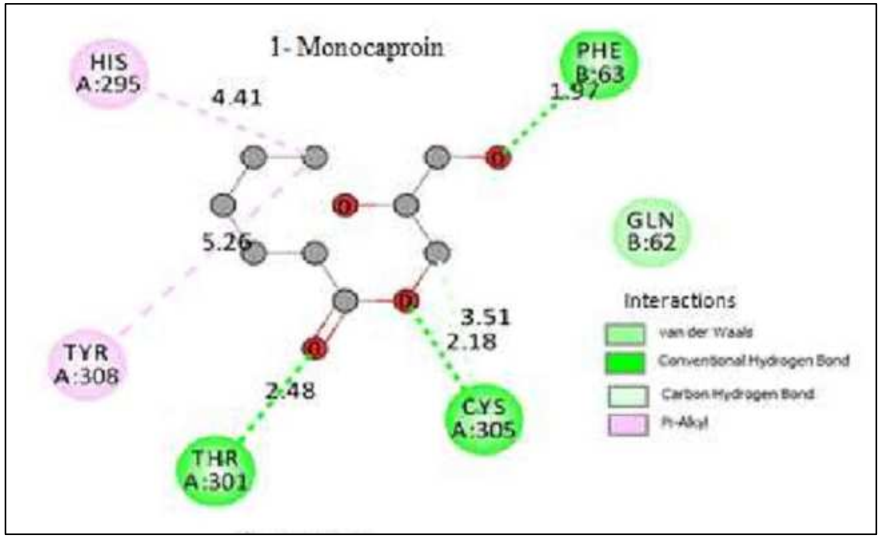
Iodine
- Metabolic rate

Virucidal Effect of Medium Chain Fatty Acids

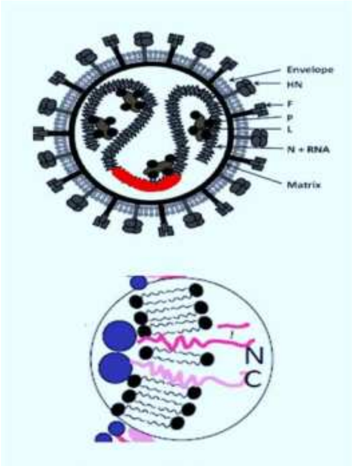
- **HA & N** plays a vital role in the attachment and release of AIV during infection: HA in virus envelope plays a critical role in viral binding, fusion & entry processes.
- **1-Monocaprin*** docks with H5N1 HA (5 amino acids) of Avian influenza virus, exhibiting inhibitory effects against H5N1 HA (Maheswaran & Revathi, 2017) .





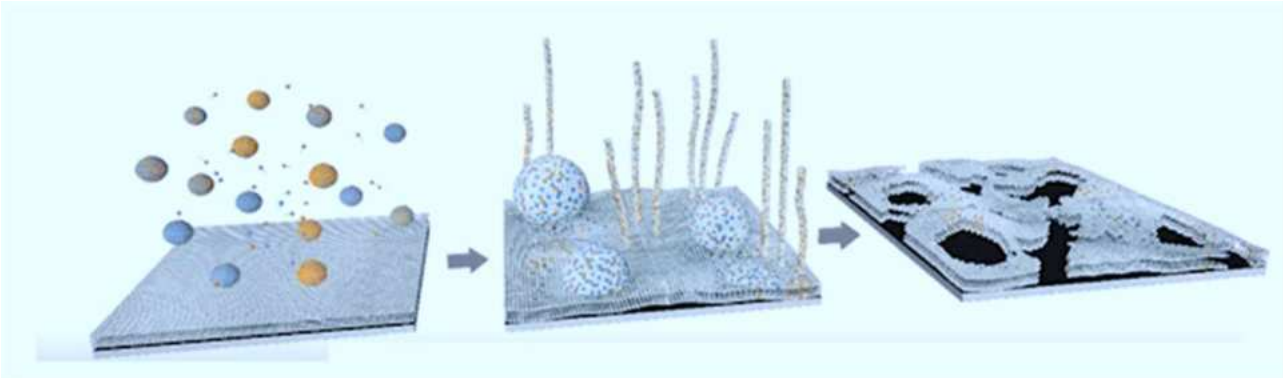


Antiviral Effect of Medium Chain Fatty Acid (MCFA) Application through Feed/drinking water



Rupture of Virus Envelope

- Michelles from **MCFA (Caprylic acid, Monocaprylin)** interact with virus membranes, causing buds or tubules formation which will rupture, leaving holes in the membrane, killing microbial pathogens & inactivating virus particles.
- Supplementation of MCFA Caprylic acid through feed or water could kill the virus in live birds.
- MCFA & MCMG are potent antimicrobials & antiviral with anti-inflammatory & growth promoting effects on recovery Pullets/Layers.

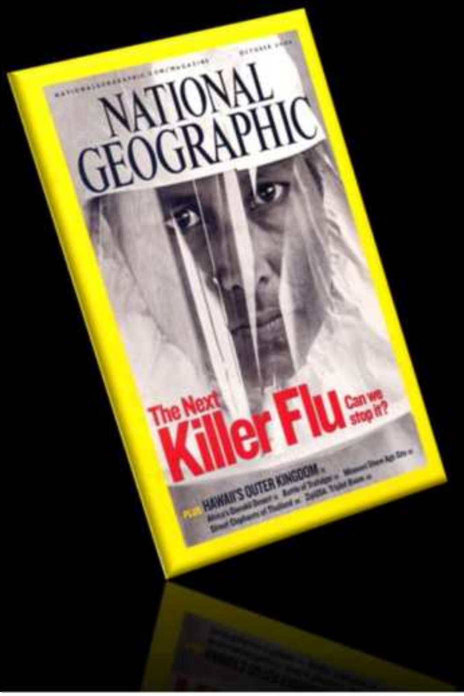


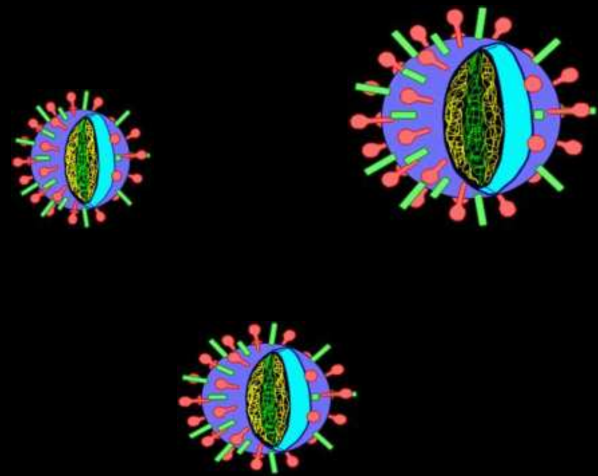
Guidelines & Application of Control Policies for Avian Influenza

H5/H7 virus Pathogenicity	Index Case Flock	Evidence of Spread to Industrial Sector	Population Density in area	Policy
HPAI/LPAI	Backyard	No	High/Low	Stamping out
HPAI/LPAI	Backyard	Yes	Low	Stamping out
			High	Vaccination
HPAI/LPAI	Industrial	No	High/Low	Stamping out
HPAI/LPAI	Industrial	Yes	Low	Stamping out
			High	Vaccination

After Capua & Marangon (2003)

Human Infection



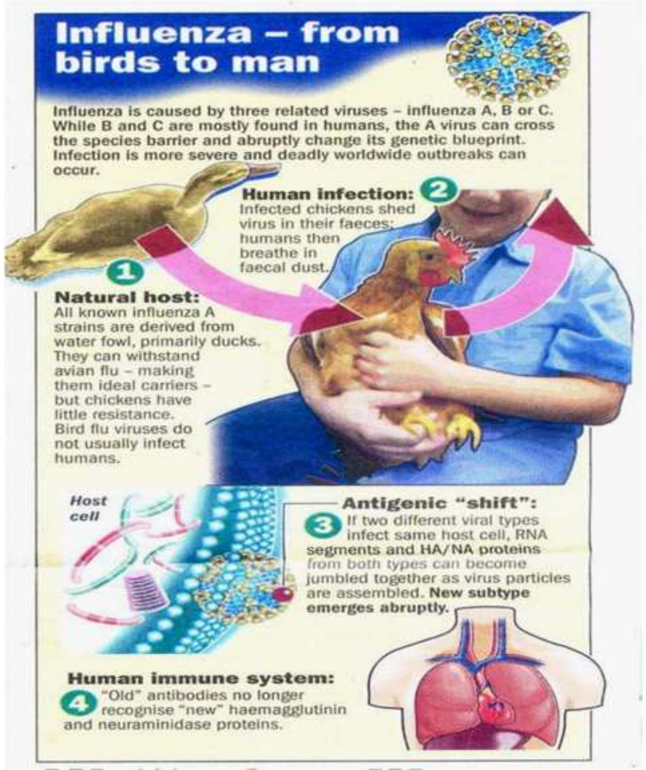


Zoonotic Disease

South China Morning Post 20th June 2005

16th Poultry Knowledge Day 26 NOVEMBER

Bird Flu Virus Infection in Humans



Influenza A H5

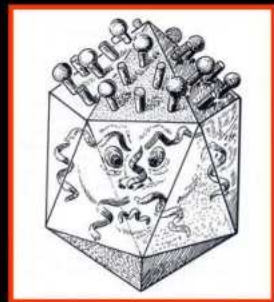
- Potentially of 9 different subtypes
- Can be highly pathogenic or low pathogenic
- H5 infection have been documented among humans, sometimes causing severe illness & death

Influenza A H9

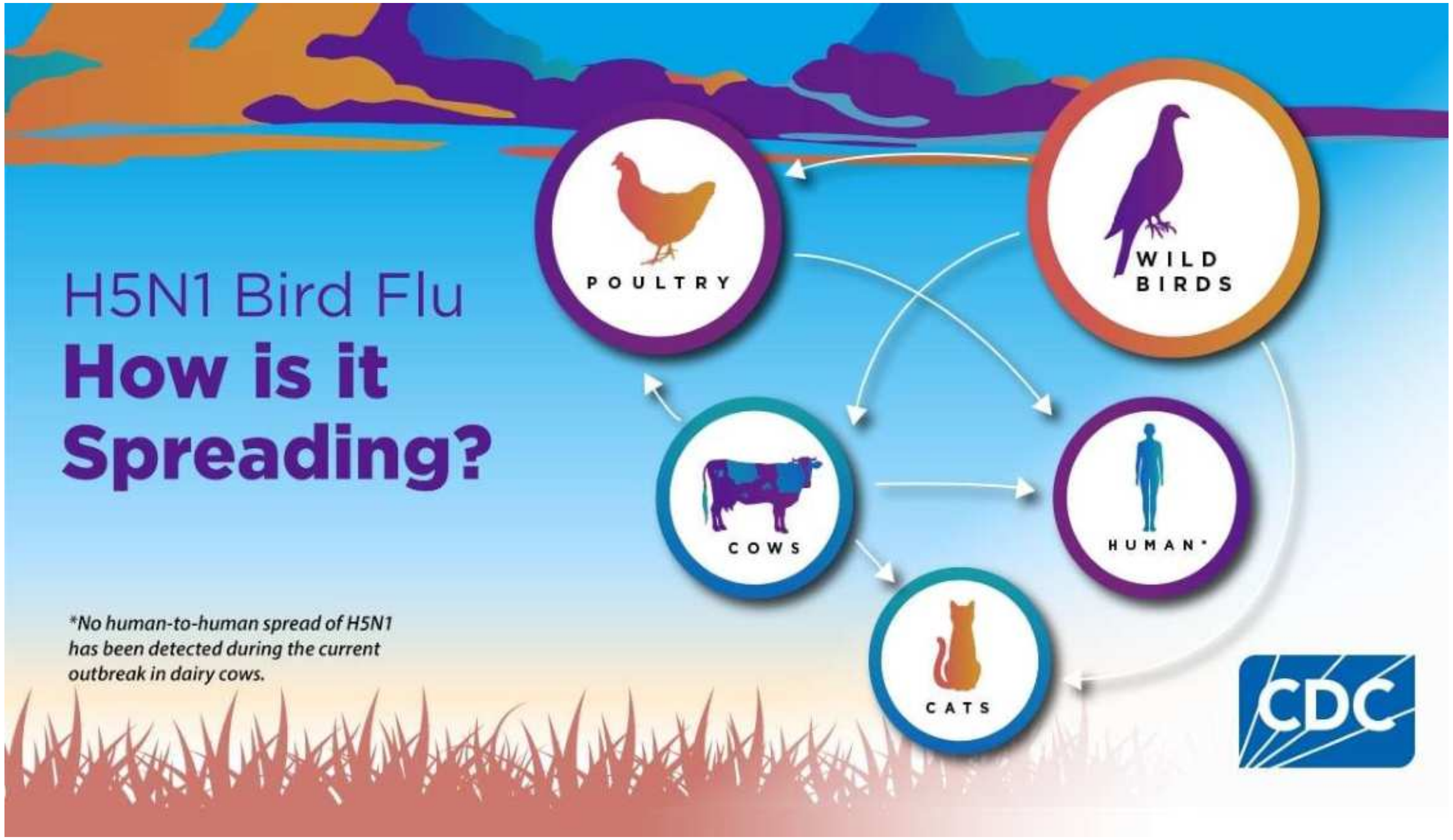
- Potentially 9 different subtypes
- Documented only in low pathogenic form
- H9 infections in humans have been confirmed

Influenza A H7

- Potentially 9 different subtypes
- Can be highly pathogenic or low pathogenic
- H7 infection in human is rare, but can occur any persons who have close contact with infected birds, symptoms may include conjunctivitis/ or upper respiratory symptom



Bird Flu Virus Infection in Humans

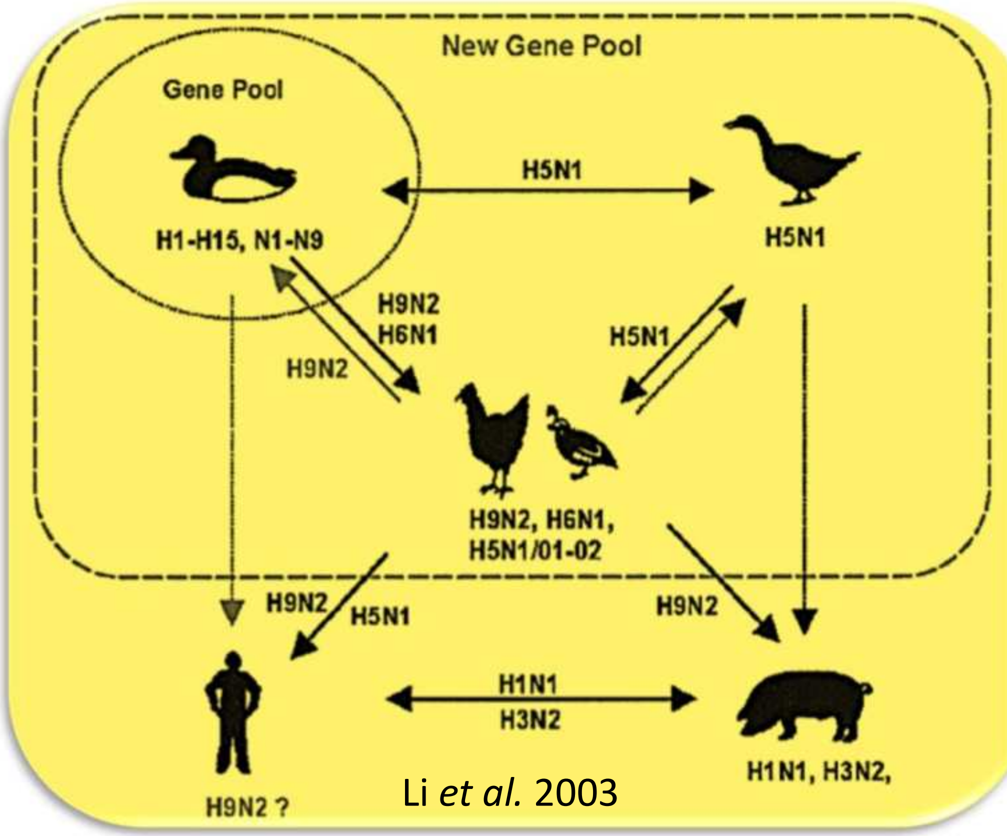


SHAPING THE FUTURE OF INDIAN POULTRY SECTOR

Zoonotic Potential of H9 Subtypes

Properties which may influence zoonotic transmission

	H5	H9
Worldwide interface	✓	✓✓
α2-6 receptor binding	x	✓
Signature residues for human transmission	✓	✓
Natural transmission to pigs	x	✓
Respiratory transmission	x	✓



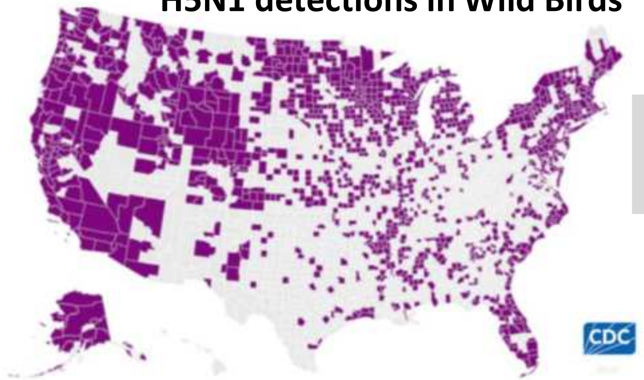
Li *et al.* 2003

16th Poultry Knowledge Day 26 NOVEMBER

US Bird Flu Virus Infection in Humans

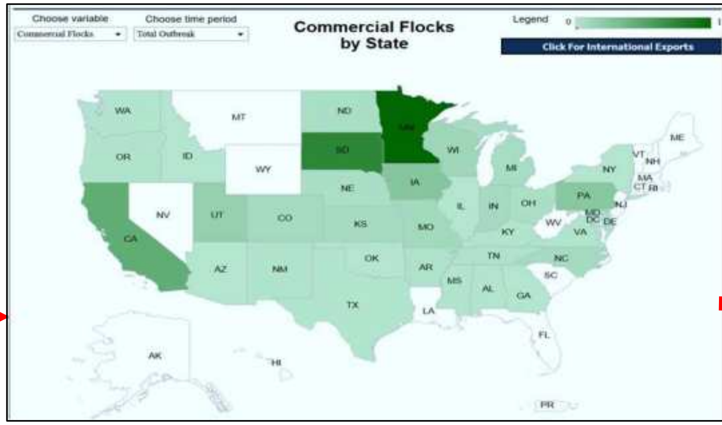
16th Edition POULTRY INDIA

H5N1 detections in Wild Birds



- Case detected **10,563**
- Counties affected 1,185

November 12, 2024



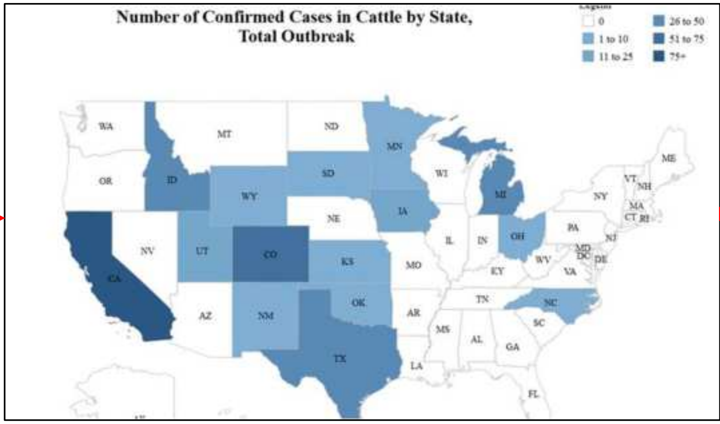
Since February 2022 Outbreak

- **108.41 million** birds have been affected
- Total 1,218 flocks in 48 States
- 533 flocks Commercial & 685 flock Backyard

November 15, 2024

- Total Outbreak in Cattle **549** confirmed in 15 States

July 03, 2024



SHAPING THE FUTURE OF INDIAN POULTRY SECTOR

Confirmed Total Reported Human Cases

State	Cattle	Poultry	Unknown	State Total
California	27	0	0	27
Colorado	1	9	0	10
Michigan	2	0	0	2
Missouri	0	0	1	1
Oregon	0	1	0	1
Texas	1	0	0	1
Washington	0	11	0	11
Source Total	31	21	1	53

NOVEMBER 18, 2024

Failure to control H5N1 among American livestock could have global consequences. The US response appears inadequate and slow, with too few genomic sequences of H5N1 cases in farm animals made publicly available for scientific review, says the writer. PHOTO: REUTERS

The world is watching the US deal with bird flu, and it is scary

The US needs to reassure the world it has the outbreak under control.

Tulio de Oliveira

As a virus scientist in South Africa, I've been watching with dread as H5N1 bird flu spreads among animals in the United States. The pathogen poses a serious pandemic threat and has been detected in more than 500 dairy herds in 15 states – which is probably an undercount. And yet, the US response appears inadequate and slow, with too few genomic sequences of H5N1 cases in farm animals made publicly available for scientific review.

Failure to control H5N1 among American livestock could have global consequences, and this demands urgent attention. The US has done little to reassure the world that it has the outbreak contained.

The recent infection of a pig at a farm in Oregon is especially concerning, as pigs are known to be "mixing bowls" for influenza viruses. Pigs can be infected by both avian and human influenza viruses, creating a risk for the viruses to exchange genetic material and potentially speed up adaptation for human transmission. The H1N1 pandemic in 2009 was created and spread initially by pigs.

Beyond the risks to its own citizens (there are more than 45 cases of people in the US getting the virus in 2024), America should remember that the country where a pandemic emerges can be accused of not doing enough to control it. We still hear how China did not do enough to stop the Covid-19 pandemic. None of us would want a new pandemic labelled the "American virus", as this could be very damaging for the US' reputation and economy.

The US should learn from how the Global South responds to infectious diseases. Those of us working in the region have a good track record of responding to epidemics and emerging pandemics, and can help the US identify new virus strains and offer insights into how to control H5N1. This knowledge has not come easily or without suffering; it has developed from decades of dealing with deadly diseases. We've learnt one simple lesson: You need to learn about your enemy as quickly as possible in order to fight it.

Beyond the risks to its own citizens (there are more than 45 cases of people in the US getting the virus in 2024), America should remember that the country where a pandemic emerges can be accused of not doing enough to control it. We still hear how China did not do enough to stop the Covid-19 pandemic. None of us would want a new pandemic labelled the "American virus", as this could be very damaging for the US' reputation and economy.

We did this during the Covid-19 pandemic. In November 2021, my colleagues and I, and others in Botswana, discovered the Omicron variant. We quickly and publicly warned the world that it could rapidly spread. This kind of transparency is not always easy because it can come at large economic cost. For example, after we shared our Omicron discovery, countries around the world imposed travel bans on South Africa ahead of December holidays, spurring backlash. Our team received death threats, and we needed security for our labs. One estimate suggests South Africa lost US$63 million (S$84.4 million) in cancelled bookings from December to March.

But it was the right thing to do.

That's why it's so frustrating that genomic sequences of H5N1 animal cases in the US are not quickly made available. Sharing genomes of virus samples immediately is crucial for understanding the threat and giving the world time to prepare, including developing antivirals and vaccines. Rwanda, for example, was recently hold

so many times. Countries need to continue to support one another; we need an international scientific and medical force that can work together to respond to new epidemics and potential pandemics, including diagnosing and genetically analysing every single sample of H5N1.

I understand that it's not easy to persuade businesses, such as the meat and dairy industries, to allow the testing of all of their animals and staff, and to make that data public quickly. But I also know that in the end, doing so protects lives, lessens economic damage and creates a safer world.

The world cannot afford to gamble with this virus, letting it spread in animals and hoping it never sparks a serious outbreak – or crossing our fingers that its effects won't be serious in people. Time will tell. I hope we are not watching the start of a new pandemic unfold, with both the American and the international communities burying our heads in the sand rather than confronting potential danger.

NYTIMES

Dr Tulio de Oliveira is the director of the Centre for Epidemic Response and Innovation at Stellenbosch University in South Africa and associate professor of global health at the University of Washington. He has received numerous awards for his work on virus genomics.

Beyond the risks to its own citizens (there are more than 45 cases of people in the US getting the virus in 2024), America should remember that the country where a pandemic emerges can be accused of not doing enough to control it. We still hear how China did not do enough to stop the Covid-19 pandemic. None of us would want a new pandemic labelled the "American virus", as this could be very damaging for the US' reputation and economy.

The US needs to reassure the world it has the outbreak under control.

16th Poultry Knowledge Day 26 NOVEMBER

Human Exposure to H5 Avian Influenza near Migratory Shorebird Habitats

16th Edition POULTRY INDIA

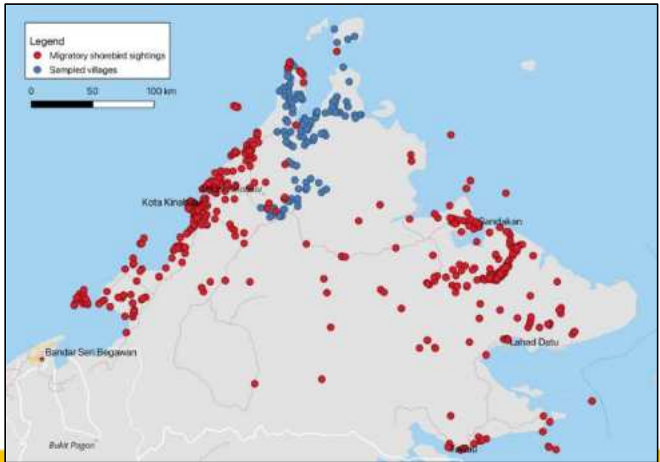
Article
https://doi.org/10.1038/s41467-024-53058-y

Serological analysis in humans in Malaysian Borneo suggests prior exposure to H5 avian influenza near migratory shorebird habitats

Received: 6 March 2024
Accepted: 25 September 2024
Published online: 17 October 2024
Check for updates

Hannah Klim[1], Timothy William[2,3,4], Jack Mellors[1], Caolann Brady[1], Giri S. Rajahram[4], Tock H. Chua[5,6], Helena Brazal Monzó[7], Jecelyn Leslie John[8], Kelly da Costa[9], Mohammad Saffree Jeffree[10], Nigel J. Temperton[9], Tom Tipton[1], Craig P. Thompson[11], Kamruddin Ahmed[8,12,13], Chris J. Drakeley[7], Miles W. Carroll[1] & Kimberly M. Fornace[7,14]

Cases of H5 highly pathogenic avian influenzas (HPAI) are on the rise. Although mammalian spillover events are rare, H5N1 viruses have an estimated mortality rate in humans of 60%. No human cases of H5 infection have been reported in Malaysian Borneo, but HPAI has circulated in poultry and migratory avian species transiting through the region. Recent deforestation in coastal habitats in Malaysian Borneo may increase the proximity between humans and migratory birds. We hypothesise that higher rates of human-animal contact, caused by this habitat destruction, will increase the likelihood of potential zoonotic spillover events. In 2015, an environmentally stratified cross-sectional survey was conducted collecting geolocated questionnaire data in 10,100 individuals. A serological survey of these individuals reveals evidence of H5 neutralisation that persisted following depletion of seasonal H1/H3 HA binding antibodies from the plasma. The presence of these antibodies suggests that some individuals living near migratory sites may have been exposed to H5 HA. There is a spatial and environmental overlap between individuals displaying high H5 HA binding and the distribution of migratory birds. We have developed a novel surveillance approach including both spatial and serological data to detect potential spillover events, highlighting the urgent need to study cross-species pathogen transmission in migratory zones.

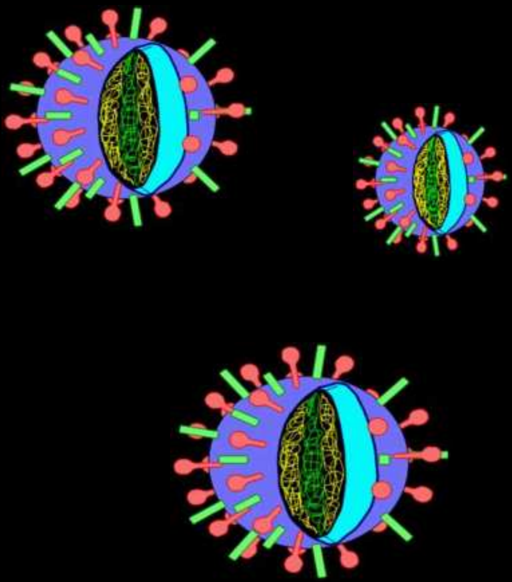


Bird Flu H5N1 Treatment in Human

1. There is No Effective Treatment for HPAI in Poultry
2. Drug Treatment possible in Human Cases

- Amantadine, Rimantadine used, resistance development quickly (Webster 1985)
- Newer analoques of Sialic acid (GG167, 4-guanidineNeu5AC2en) effective in animal models (Hayden *et al*.,1992)
- Current available antiviral drugs : Oseltamivir, Zanamivir ….

Epilogue

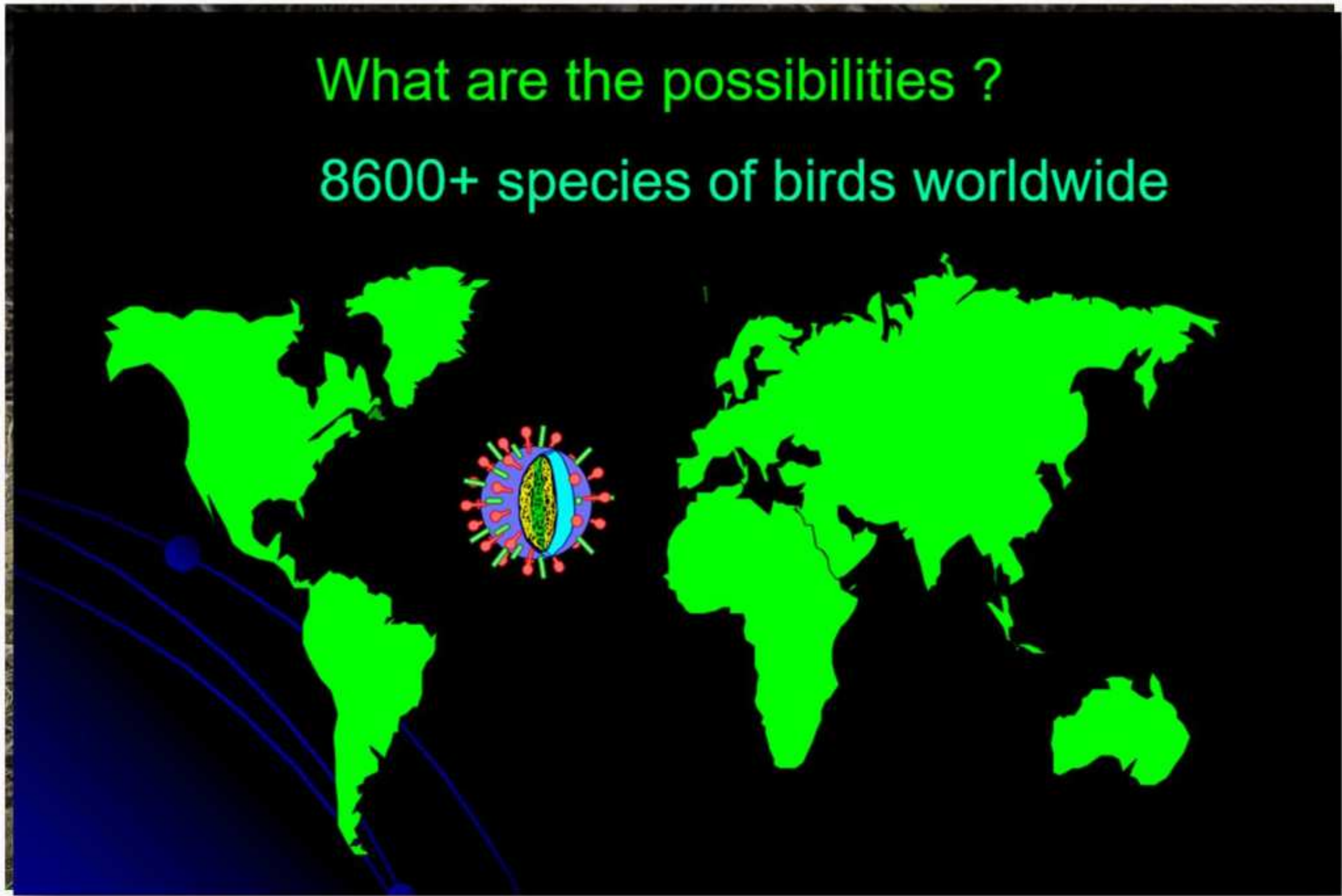


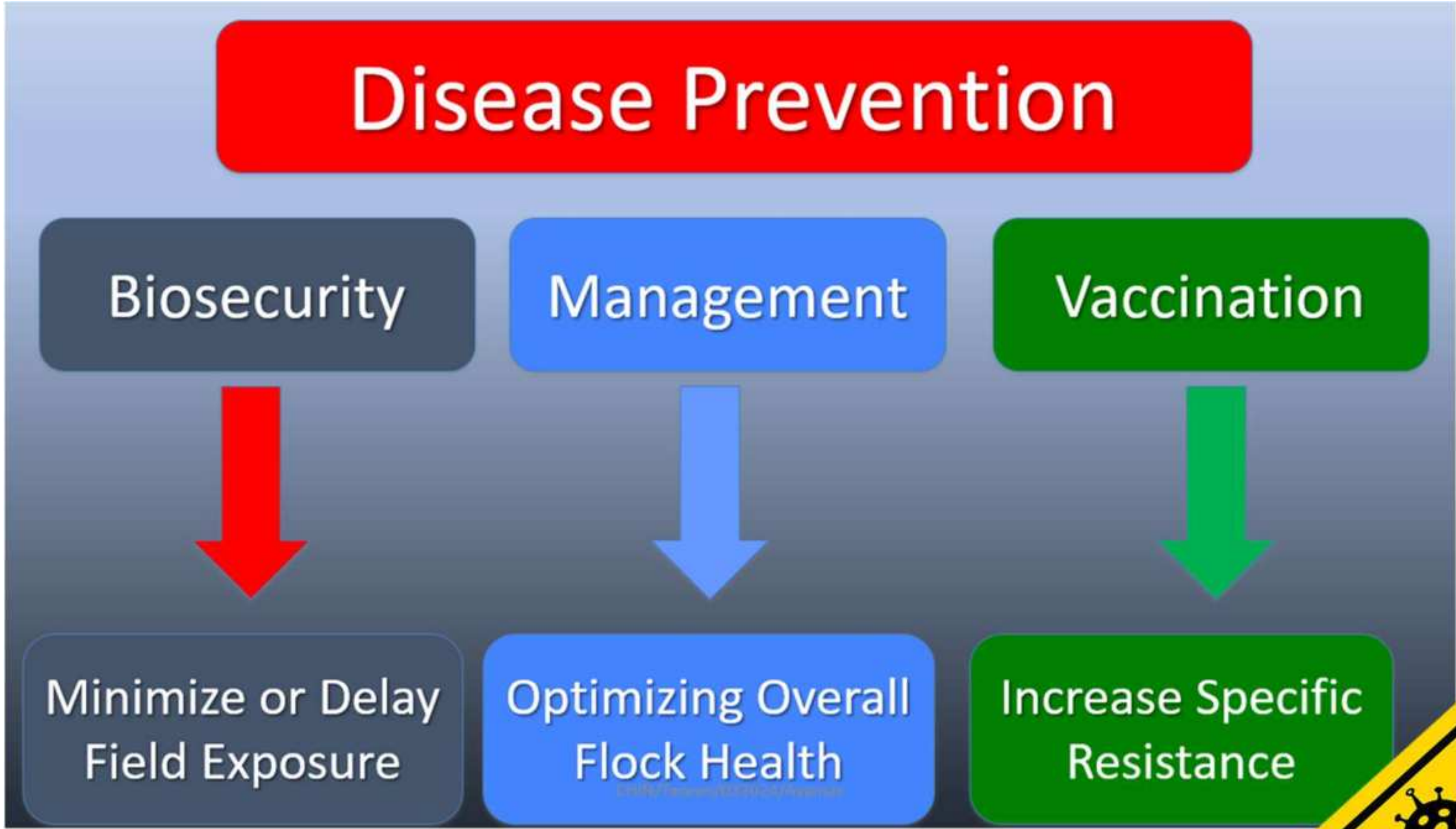
DEFEND THE FLOCK

16th Poultry Knowledge Day 26 NOVEMBER

16th Edition POULTRY INDIA

Avian Host & Avian Reservoir





SHAPING THE FUTURE OF INDIAN POULTRY SECTOR

Biosecurity - Biosecurity – Biosecurity

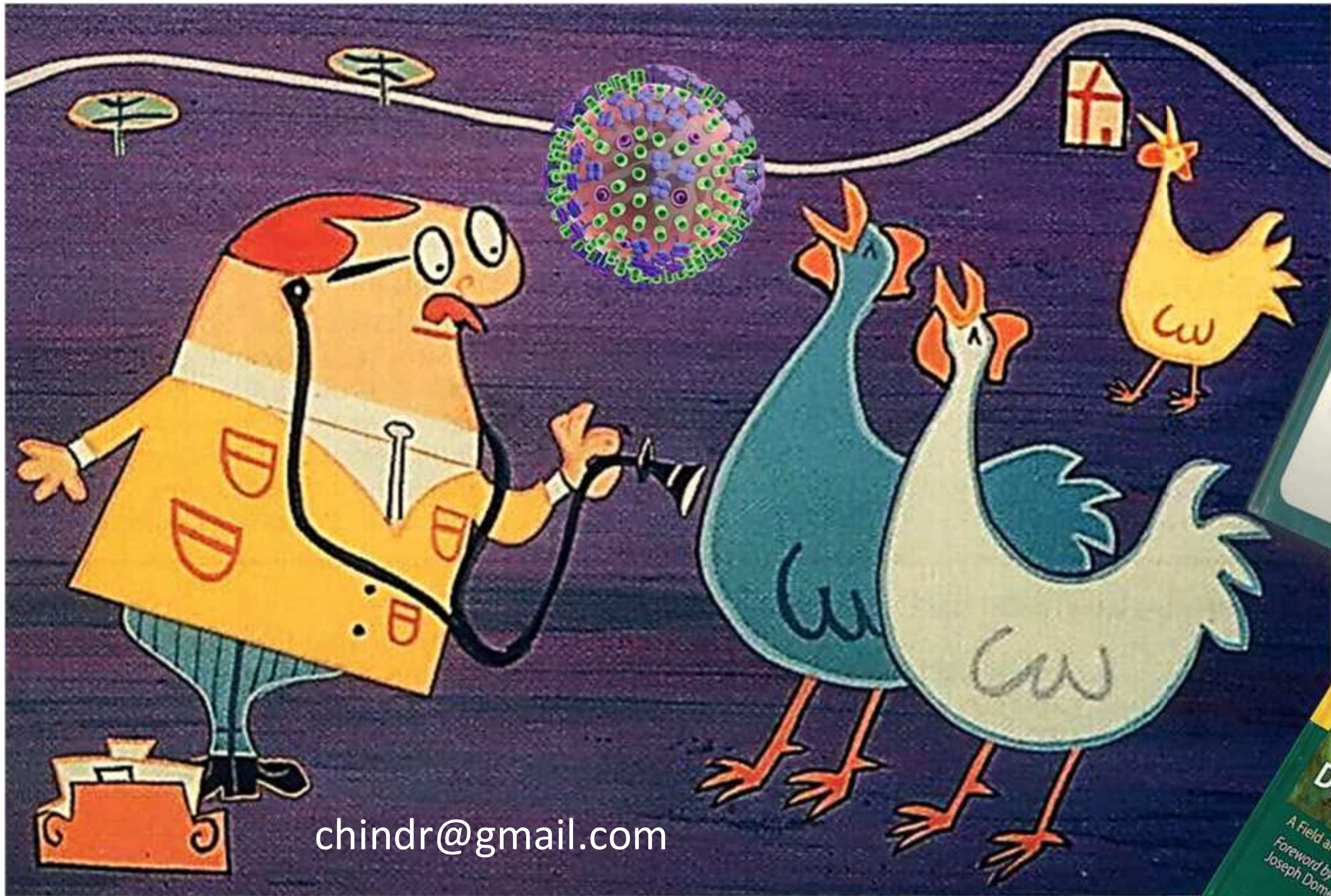
16th Poultry Knowledge Day 26 NOVEMBER

Take Home Message

16th Edition POULTRY INDIA

- **Natural reservoirs of AIV infection are abundant & will not go away**
- **Disease surveillance & Early Detection** is the key to Control AIV Spread
- **Enhanced Biosecurity** & **Change of Farming Practice** are the best long term Strategy to Prevent AIV infection
- **Vaccination Strategy** (in addition to Mass Culling method) will be more effective to stop the rapid spread
- **Industry & Public Sector Corporation** is vital for Successful Control & Eradication
- A need of **Transparency & Openness** in Disease Information Exchange & Reporting
- Need for a **Global Approach in AI Control Strategy**

SHAPING THE FUTURE OF INDIAN POULTRY SECTOR



SHAPING THE FUTURE
OF INDIAN POULTRY SECTOR