Avian Influenza in cage-free systems

Fernando Carrasquer Puyal
DVM CEAV ECPVS Resident
Global Technical Service – Veterinary specialist
H&N International GmbH

It has not been an easy year with bird flu ...

REUTERS World Business Legal Markets Breakingviews Technology Investigations More

Europe

2 minute read · October 3, 2022 2:20 PM GMT+2 · Last Updated 3 months ago

Worst ever bird flu crisis in Europe raises risks for next season - EFSA

By Sybille De La Hamaide

Source: Reuters

Source: Euronews

Bloomberg Europe Edition Sign In Subscribe

Live Now Markets Economics Industries Technology Politics Wealth Pursuits Opinion Businessweek Equality Green CityLab Crypto More

Markets

US Avian Flu Outbreak Worst on Record With 50 Million Dead Birds

- Avian influenza contributed to 50.54 million birds killed
- Highly pathogenic virus prompted turkey, egg prices to soar

Source: Bloomberg

Colombia confirms 22 avian influenza outbreaks since Oct. 19

Outbreaks were identified in backyard flocks near wild birds

Source: Poultry World

NEWS EXPLAINER | 21 October 2022

Why is bird flu so bad right now?

The virus is running amok around the world. Possible explanations include an enhanced ability to replicate or infect more bird species.

Saima May Sidik

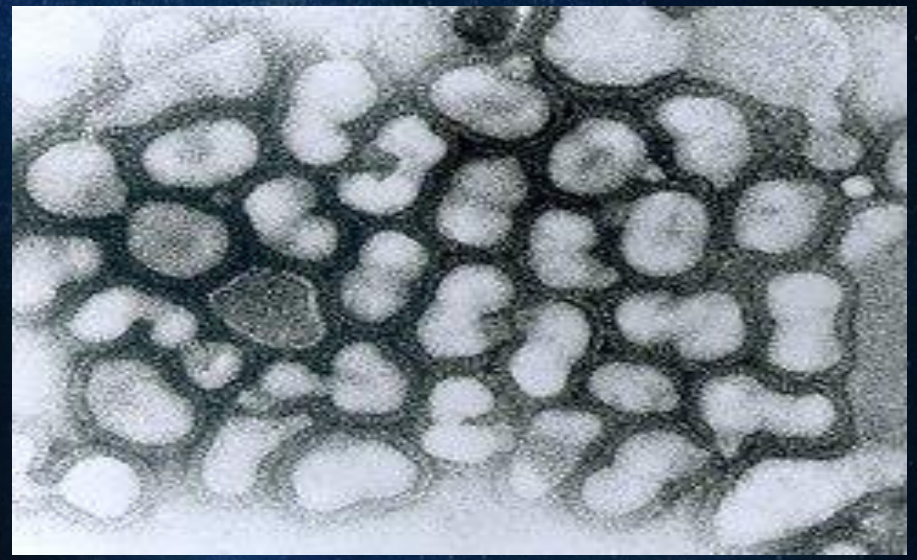
Source: Nature

Etiology

TAXONOMICAL CLASSIFICATION

- **Realm:** *Riboviria*
  - **Kingdom:** *Orthornavirae* Realm: *Riboviria*
    - **Phylum:** *Duplornaviricota* Kingdom: *Orthornavirae*
    - **Phylum:** *Kitrinoviricota* Kingdom: *Orthornavirae*
    - **Phylum:** *Lenarviricota* Kingdom: *Orthornavirae*
    - **Phylum:** *Negarnaviricota* Kingdom: *Orthornavirae*
      - **Subphylum:** *Haploviricotina* Phylum: *Negarnaviricota*
        - **Class:** *Chunqiuviricetes* Subphylum: *Haploviricotina*
        - **Class:** *Milneviricetes* Subphylum: *Haploviricotina*
        - **Class:** *Monjiviricetes* Subphylum: *Haploviricotina*
        - **Class:** *Yunchangviricetes* Subphylum: *Haploviricotina*
      - **Subphylum:** *Polyploviricotina* Phylum: *Negarnaviricota*
        - **Class:** *Ellioviricetes* Subphylum: *Polyploviricotina*
        - **Class:** *Insthoviricetes* Subphylum: *Polyploviricotina*
          - **Order:** *Articulavirales* Class: *Insthoviricetes*
            - **Family:** *Amnoonviridae* Order: *Articulavirales*
            - **Family:** *Orthomyxoviridae* Order: *Articulavirales*
              - **Genus:** *Alphainfluenzavirus* Family: *Orthomyxoviridae*
                - **Species:** *Alphainfluenzavirus influenzae* Genus: *Alphainfluenzavirus*
              - **Genus:** *Betainfluenzavirus* Family: *Orthomyxoviridae*
              - **Genus:** *Deltainfluenzavirus* Family: *Orthomyxoviridae*
              - **Genus:** *Gammainfluenzavirus* Family: *Orthomyxoviridae*
              - **Genus:** *Isavirus* Family: *Orthomyxoviridae*

ICTV

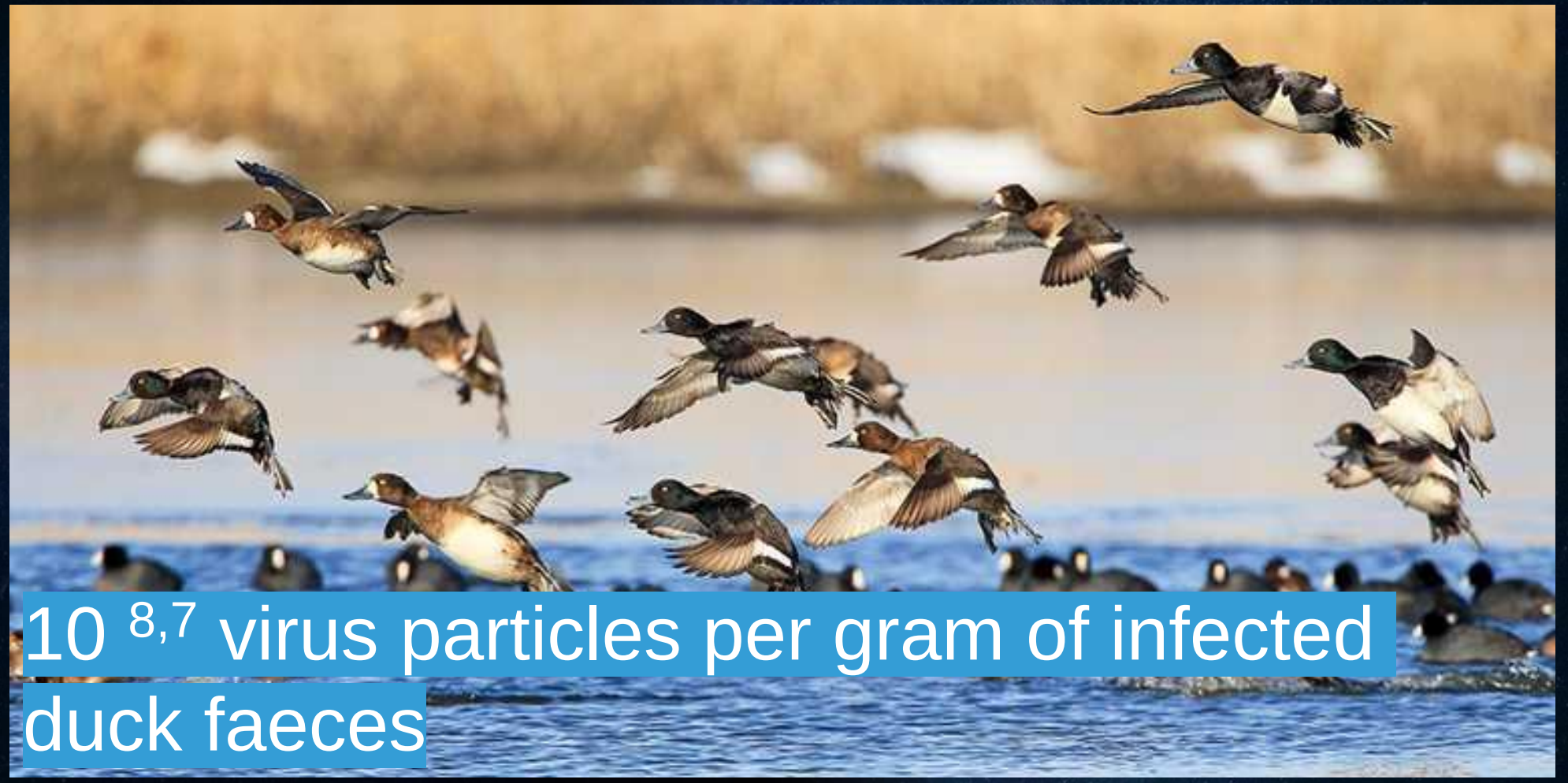


Picture: Wikipedia

Family: Orthomyxoviridae
Genus: Alphainfluenzavirus
Specie: Alphainfluenzavirus influenzae

Ecology

AIV RESERVOIR



$10^{8,7}$ virus particles per gram of infected duck faeces

Picture: Dean Pearson

Webster 1978

Ecology

AFFECTED BIRD FAMILIES

Anseriformes
Charadriiformes
Ciconiiformes
Galliformes
Passeriformes
Columbiformes
Falconiformes
Piciformes
Pelecaniformes
Procellariiformes
Podicipediformes
Gaviiformes
Gruiformes

60 % of known bird families (at least)

Pictures: Wikipedia

Ecology

INFLUENZA IN OTHER SPECIES

H3, H7

H10

H4, H7, H13

H5

H1 – H16

H1,H2,H3

(H7?)

H1,H2,H3
(H5, H7)

H5,H7,H9

(H5,H7)

Wahlgren 2011

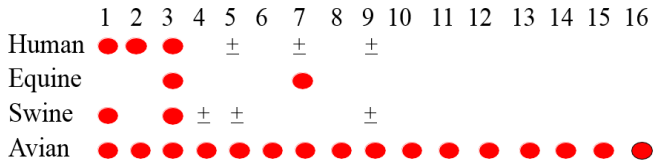
Picture: Wikipedia

Etiology

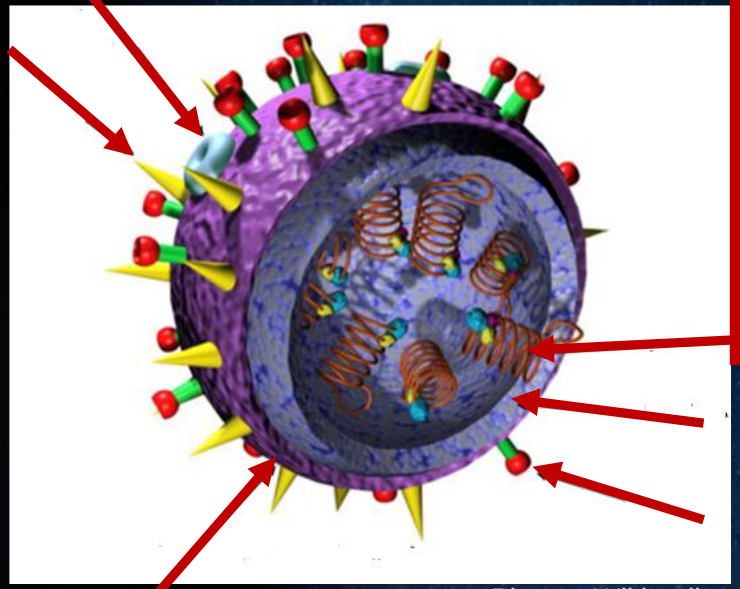
AIV STRUCTURE

M2 protein

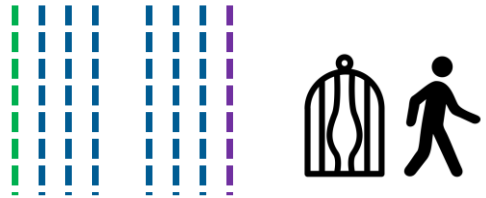
Hemagglutinin



Lipid envelope



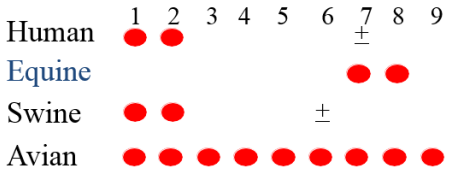
Picture: Wikipedia



Segmented RNA

M1 protein

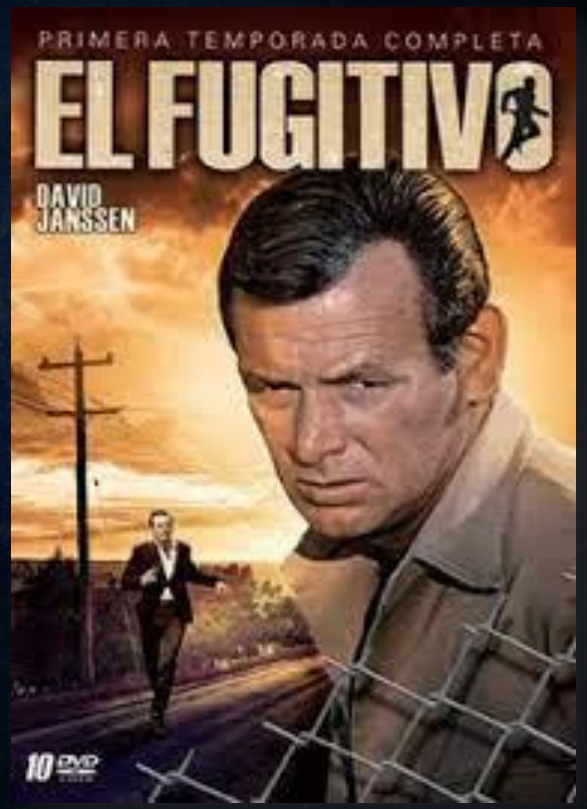
Neuraminidase

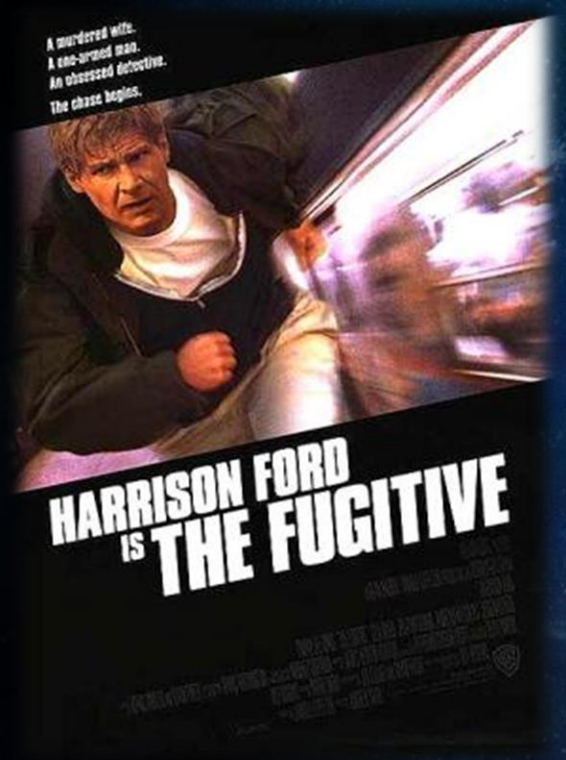


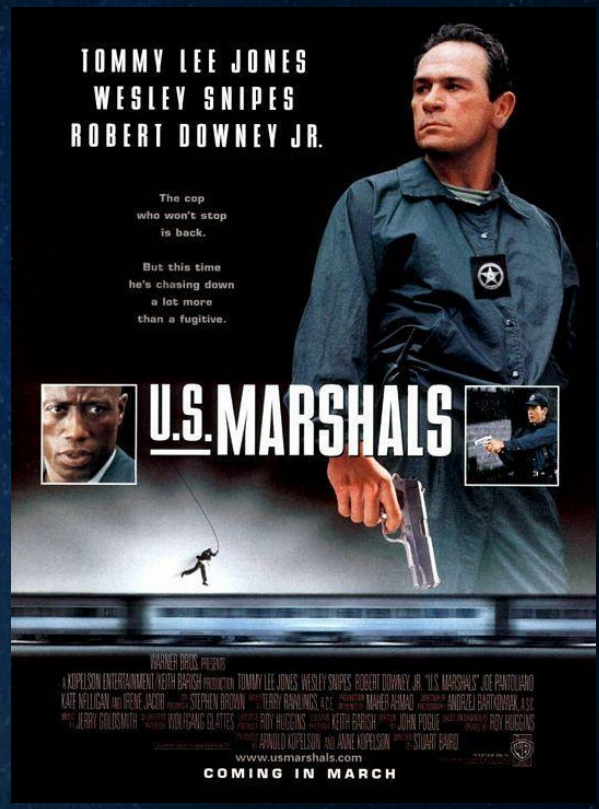
Ecology

AIV'S SURVIVAL STRATEGY

Always on the run!!!!



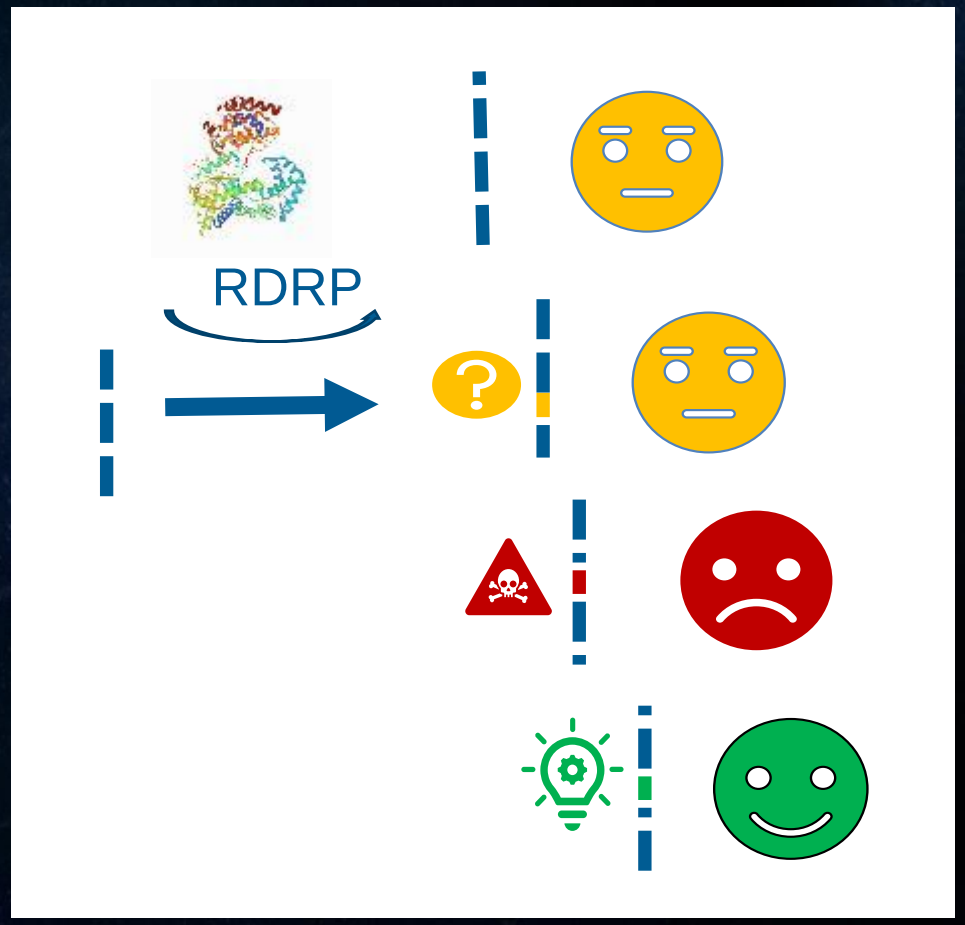




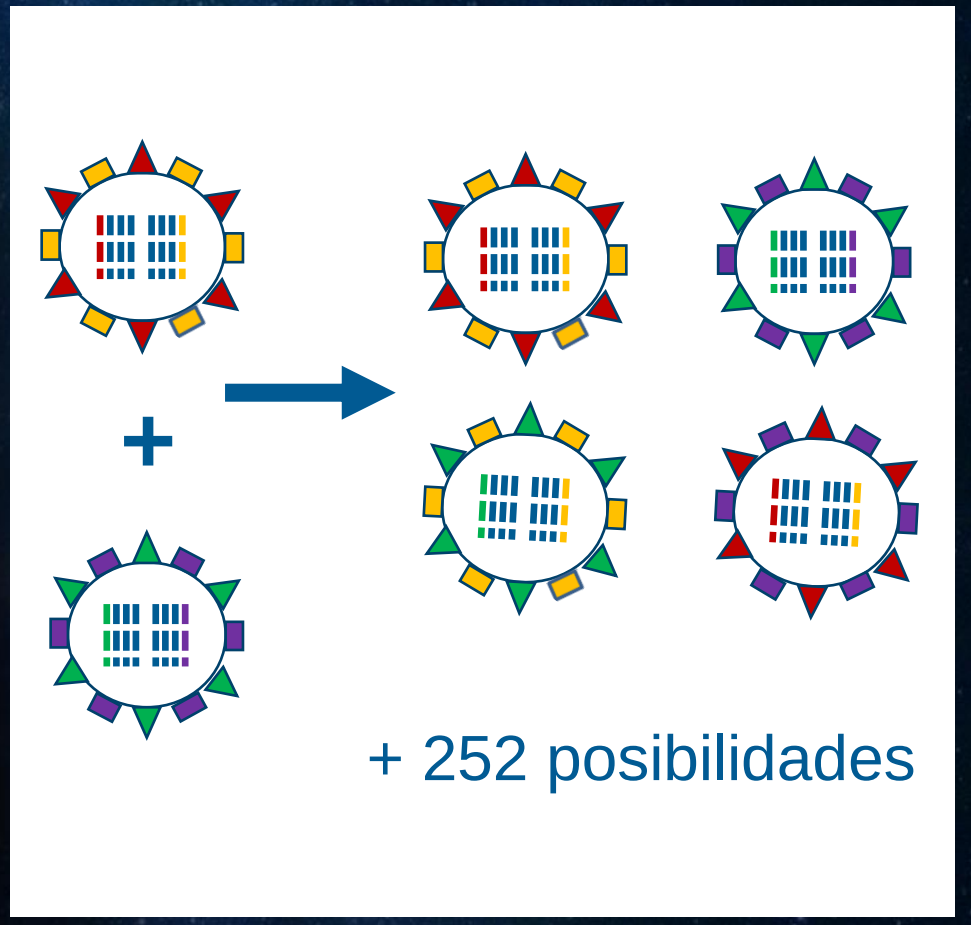
Ecology

A BREAKAWAY ARTIST ...

Antigenic drift



Antigenic shift



Etiology

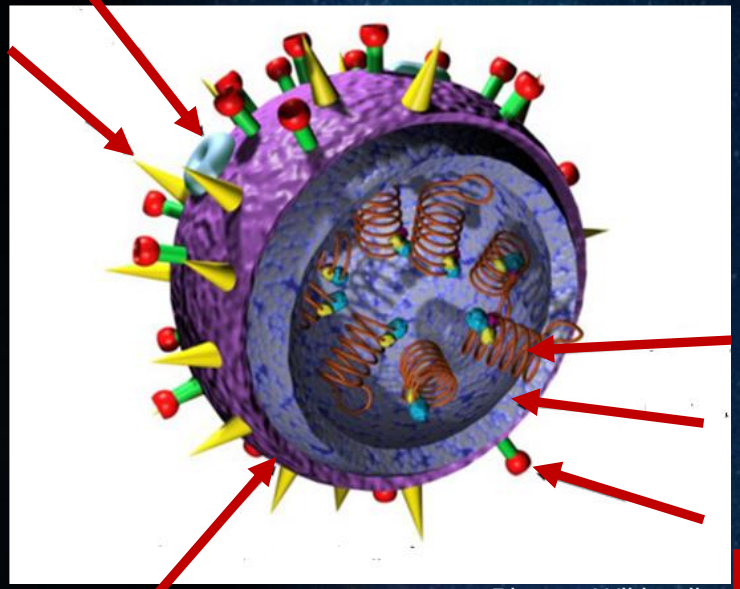
AIV STRUCTURE

M2 protein

Hemagglutinin

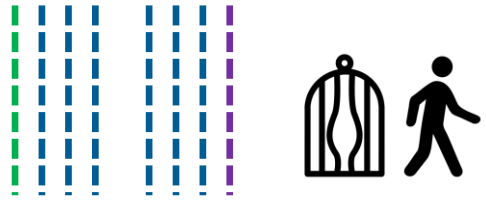
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Human	●	●	●		±		±		±							
Equine			●				●									
Swine	●		●	±	±				±							
Avian	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Lipid envelope



Picture: Wikipedia

Segmented RNA



M1 protein

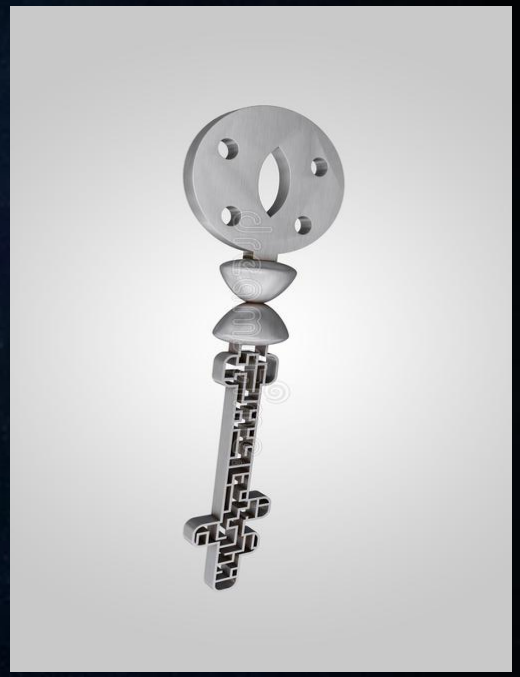
Neuraminidase

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

Pathogenesis

MAIN PROTEIN SURFACES

Hemagglutinin (H)



Picture: Wikipedia

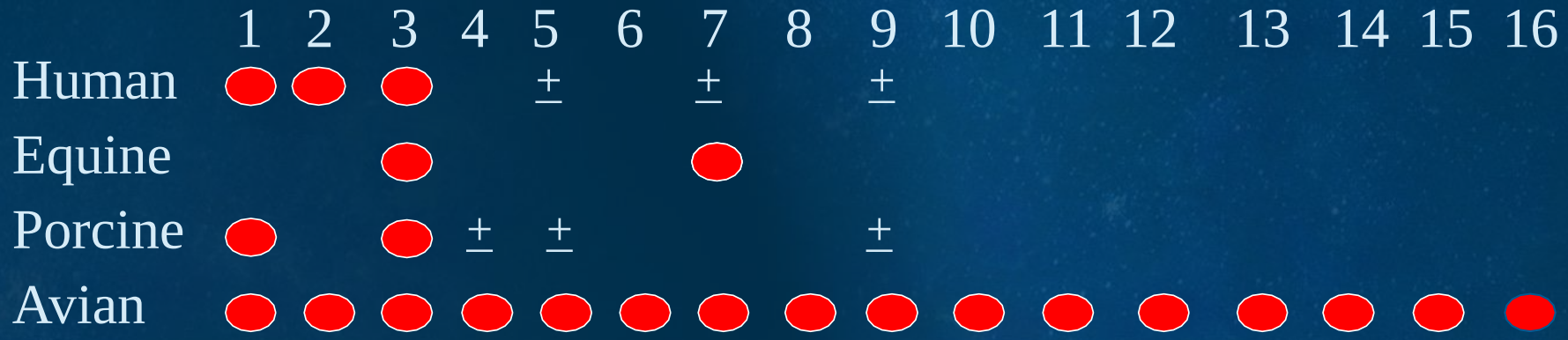
Neuraminidase (N)

Picture: Wikipedia

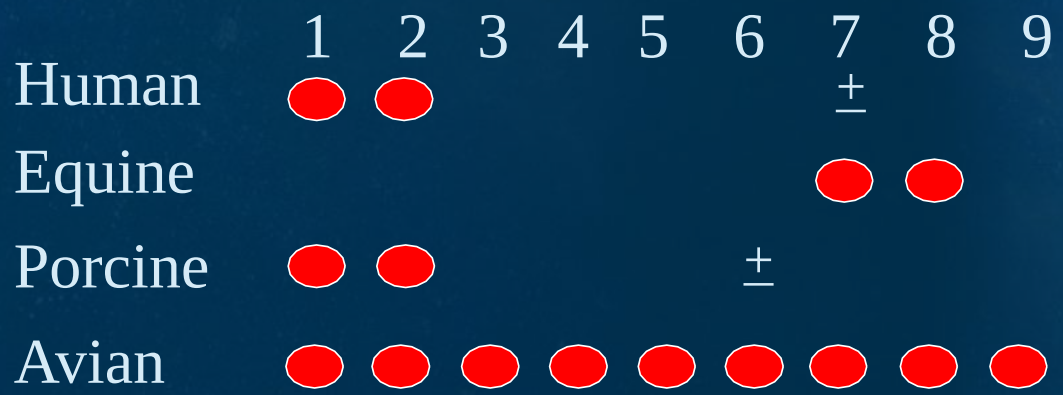
Pathogenesis

TYPES OF SURFACE ANTIGENS BY ANIMAL SPECIES

Hemagglutinin (H) subtypes:

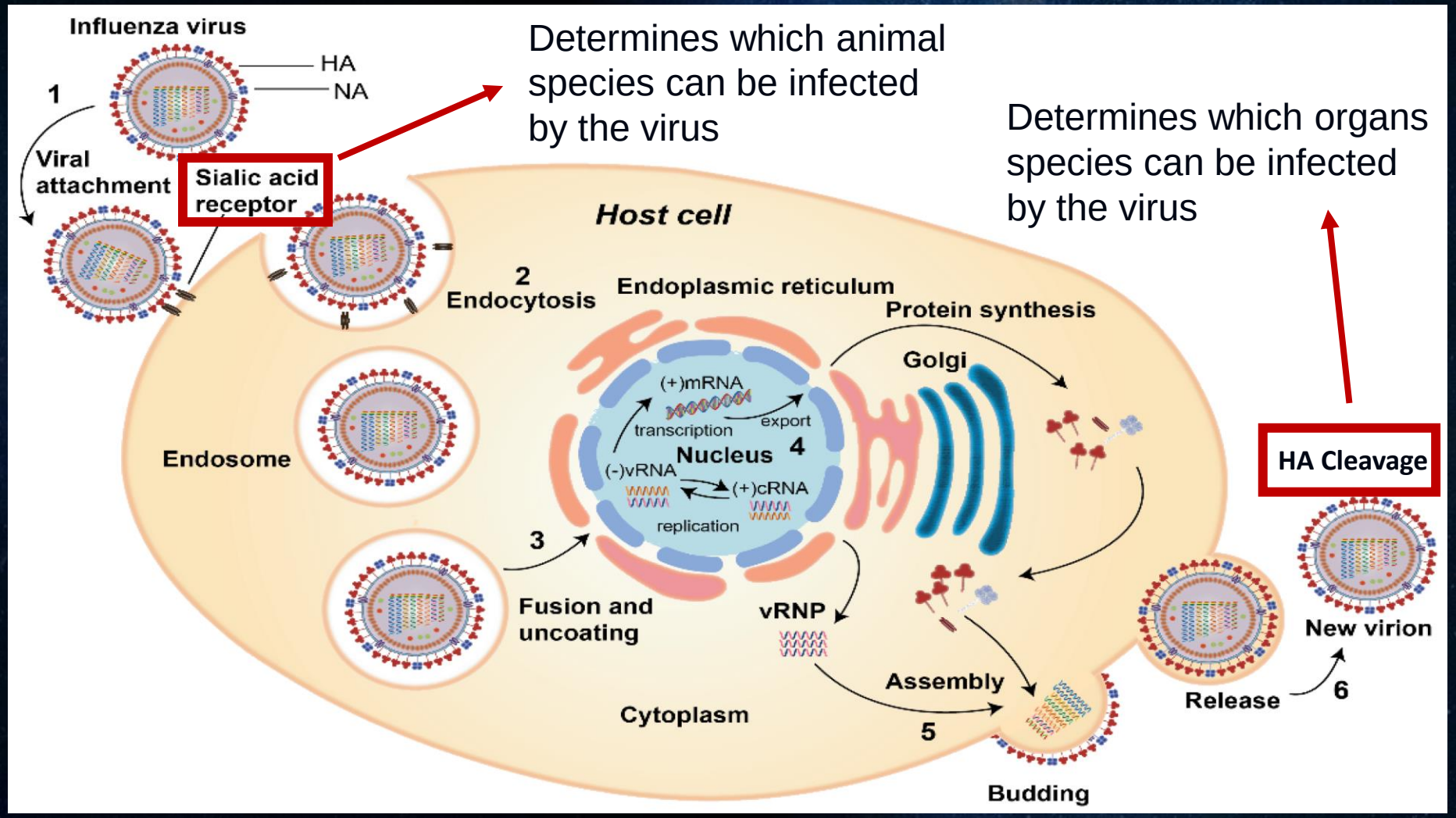


Neuraminidasa (N) Subtipos:



Pathogenesis

CELL INFECTION CYCLE



Determines which animal species can be infected by the virus

Determines which organs species can be infected by the virus

Determines

Dou 2017

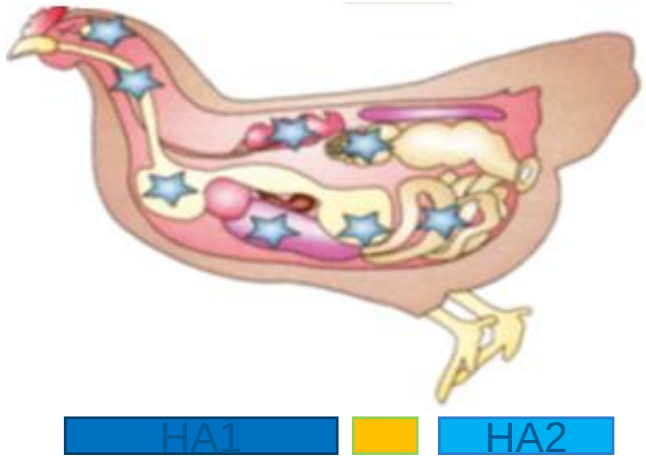
Pathogenesis

LPAI vs HPAI

Low Pathogenic Avian Influenza

Non OIE list
Mild respiratory disease
H1-H16

High Pathogenic Avian Influenza



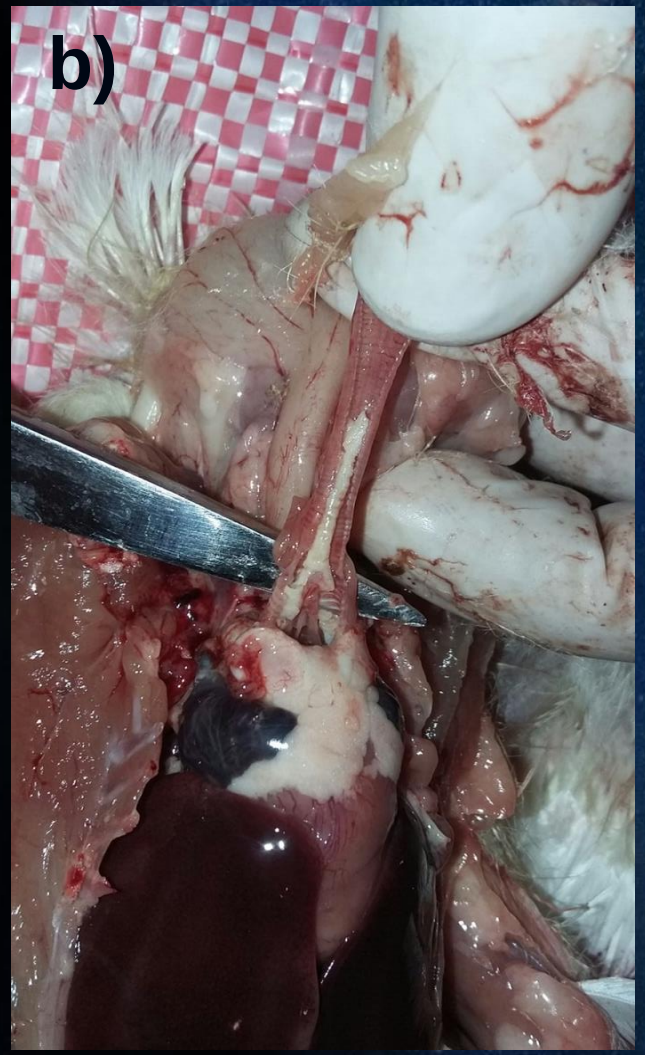
OIE list
High mortality
H5 or H7

LPAI H9N2 ??

Wahlgren 2011

Clinical signs & lesions

LPAI H9N2 LESIONS



(a) Fibrinous tracheitis with fibrinous plug in the trachea,
(b) tracheal bifurcation and
(c) fibrine in bronchi

Pictures:
M. Salek

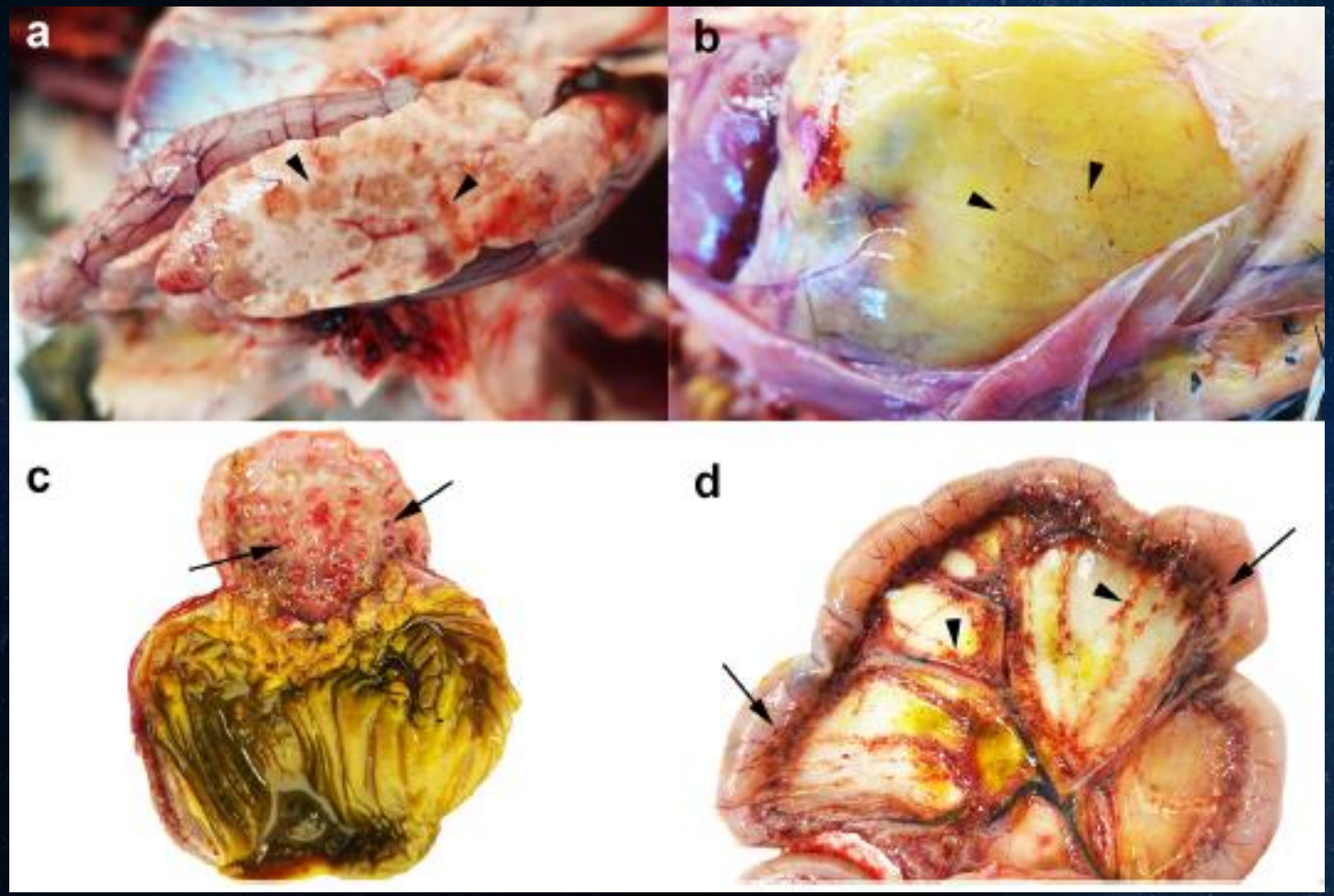
Clinical signs & lesions

WORLDWIDE DISTRIBUTION OF LPAI H9N2

Peacock 2019

Clinical signs & lesions

HPAI H5N1 LESIONS (CHICKENS)



(a) petechiae in the coelomic fat (c), haemorrhages in the proventricular mucosa (b) haemorrhages in the intestinal serosa and (d) in the mesentery

Fabian 2022

Clinical signs & lesions

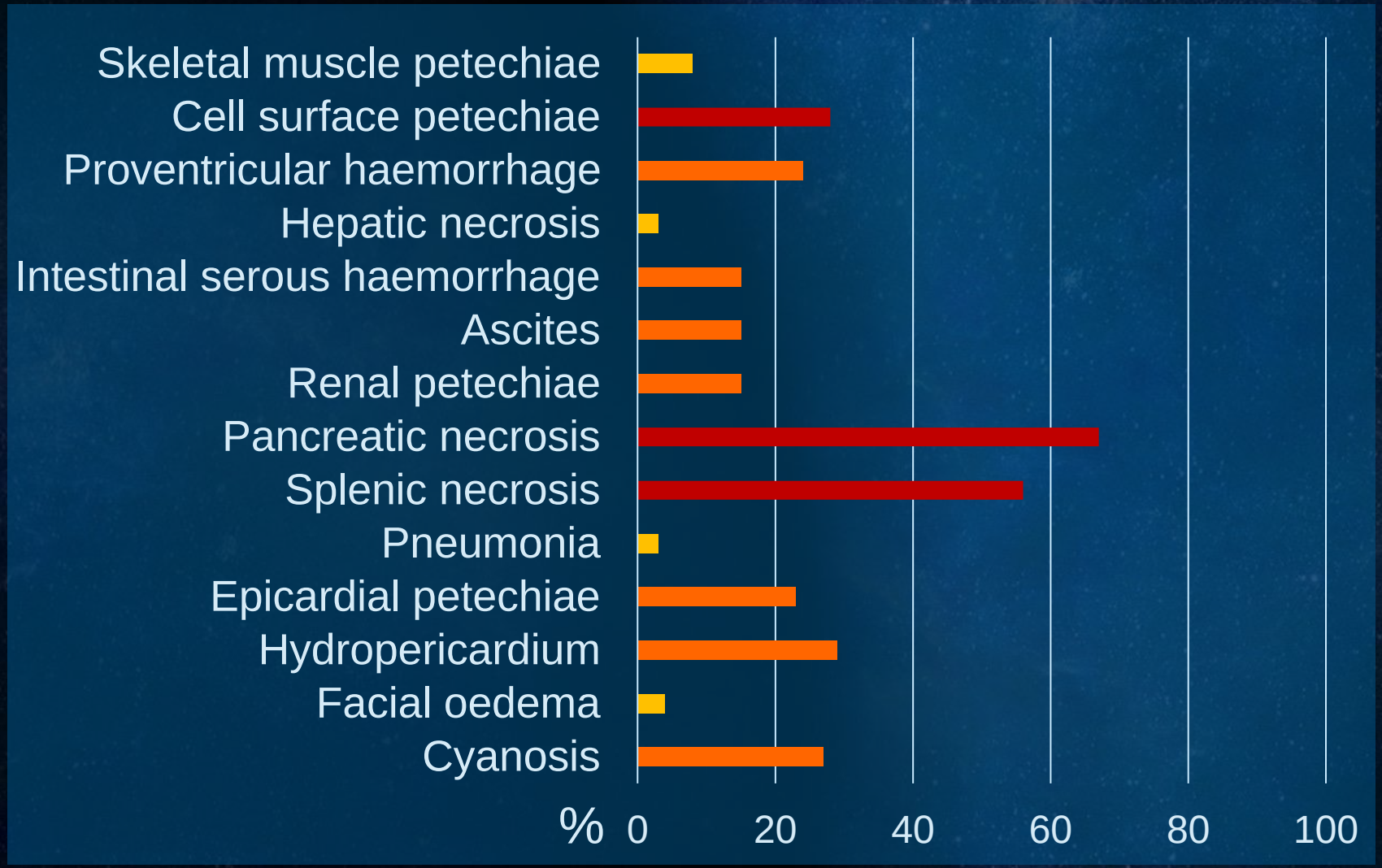
HPAI H5N1 LESIONS (TURKEYS)

(a) Intestinal serosal haemorrhage in the mesentery
(b) intestinal serosal haemorrhage
(c) haemorrhages in the proventricular mucosa
(d) haemorrhagic tracheitis

Pictures:
P. Catala

Clinical signs & lesions

GROSS LESION OBSERVED IN BIRDS WITH HPAI H5N1



UK
Gallus gallus
n=96

Fabian 2022

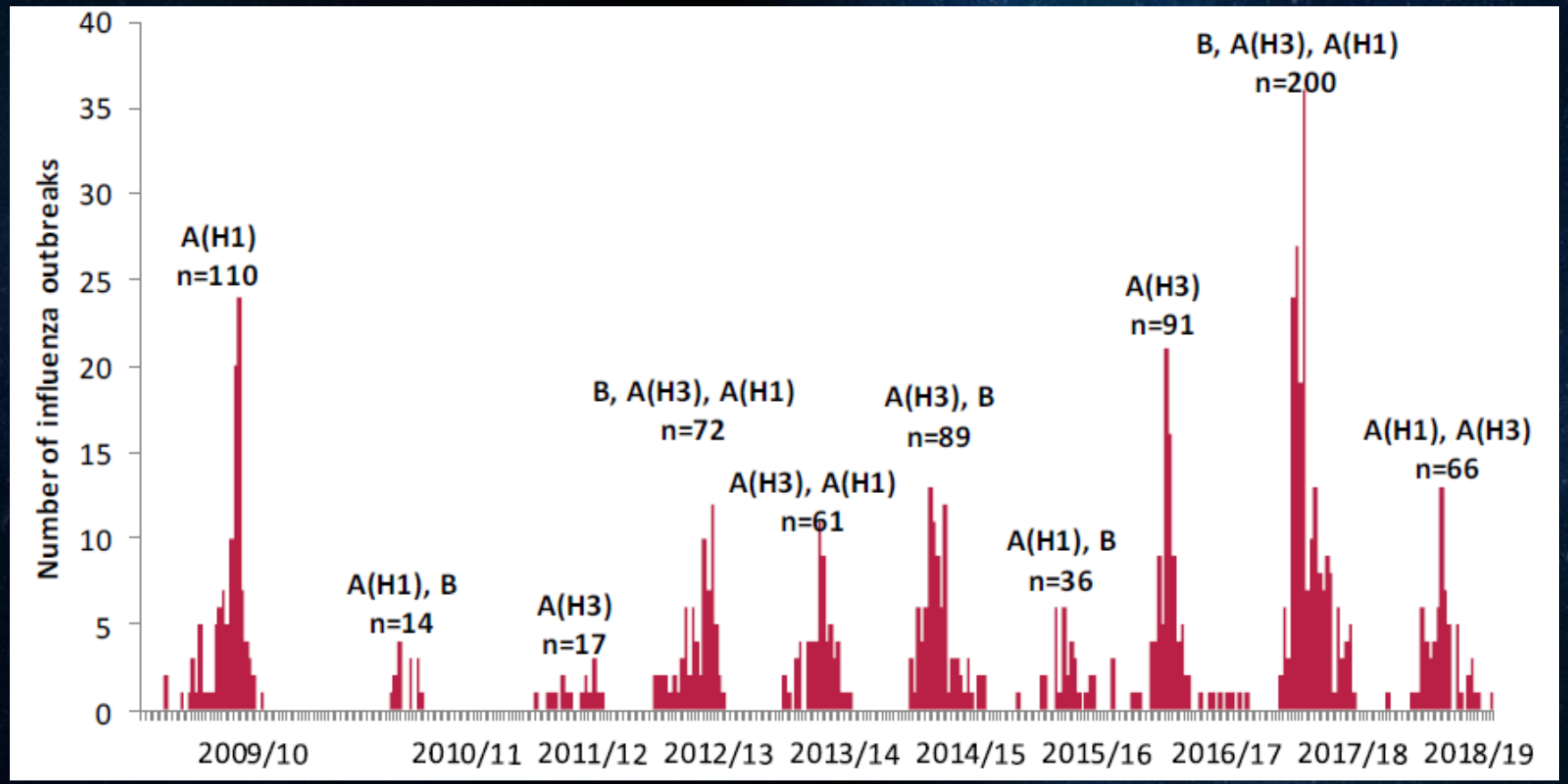
Is Avian influenza a zoonotic disease?

Picture:
Wikipedia

Flu in humans

SEASONAL FLU

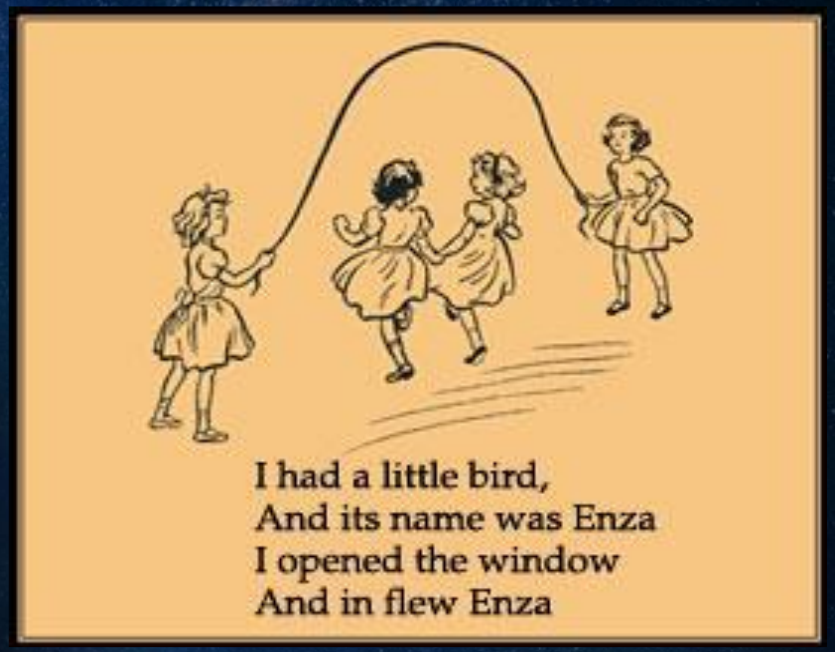
Every winter, H1 - (H2) - H3



Source: HSE

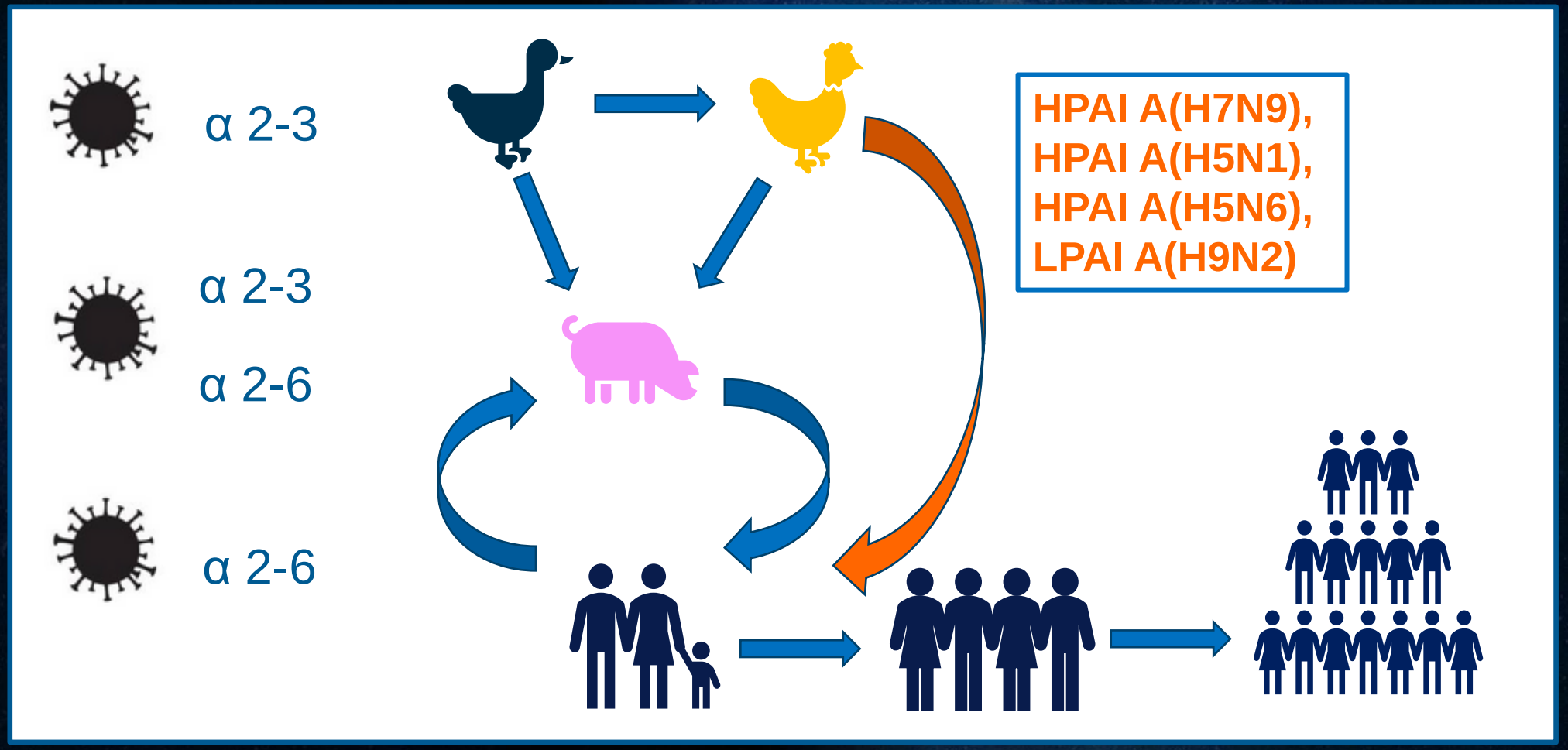
Flu in humans

PANDEMIC FLU



Flu in humans

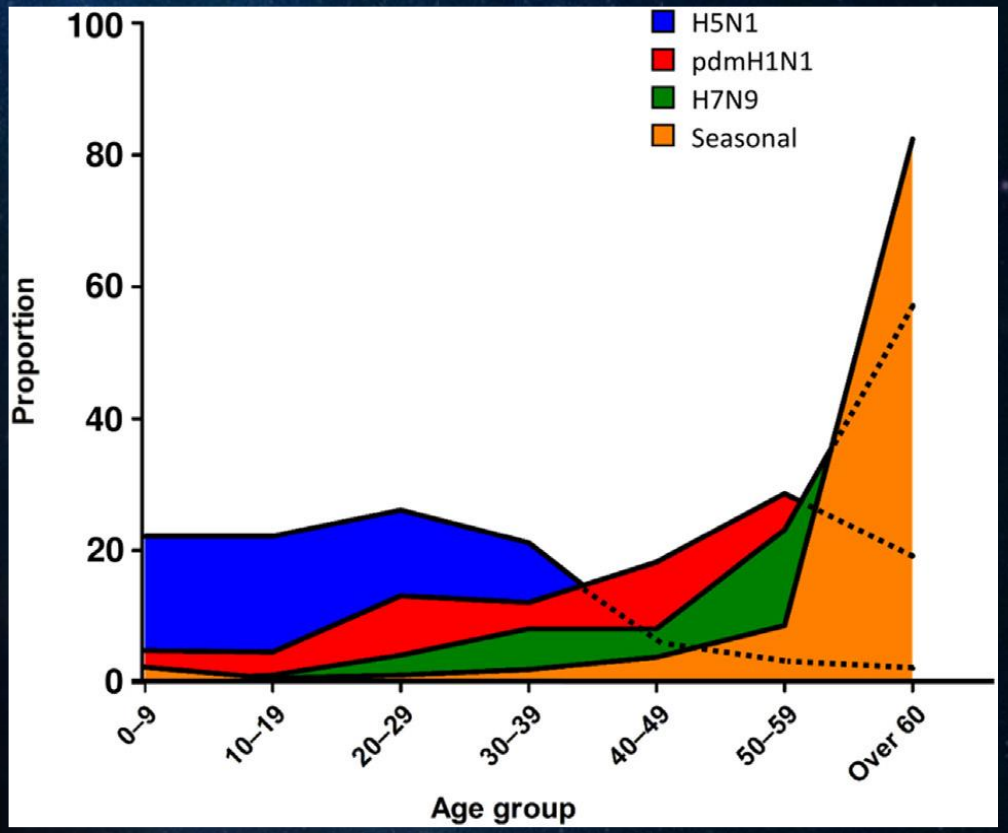
BIRD-TO-HUMAN TRANSMISSION OF INFLUENZA



Flu in humans

AVIAN FLU IN HUMANS

Host & sialic acid \ Virus	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



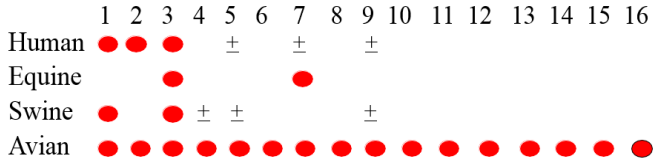
Horman 2019

Etiology

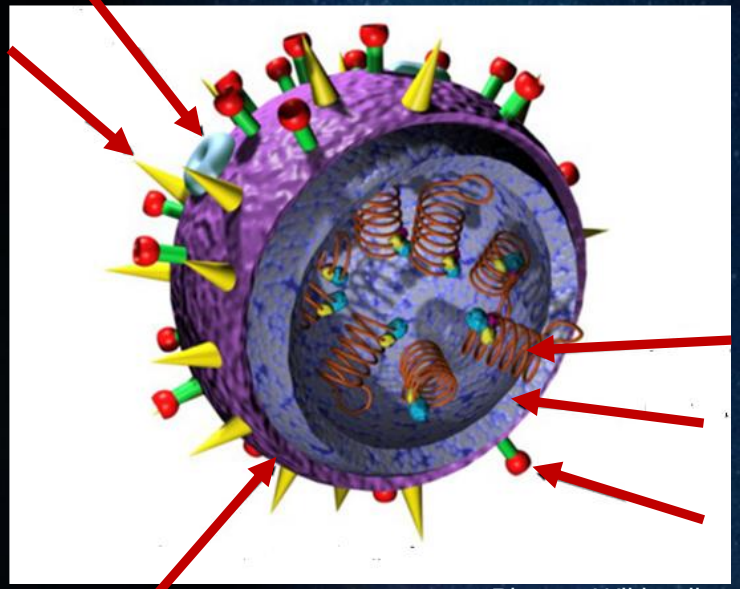
AIV STRUCTURE

M2 protein

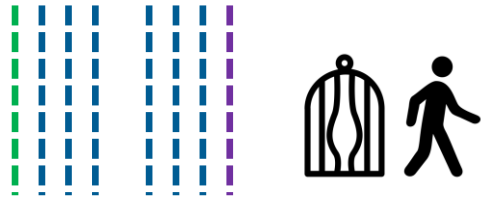
Hemagglutinin



Lipid envelope



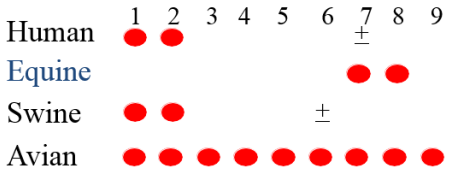
Picture: Wikipedia



Segmented RNA

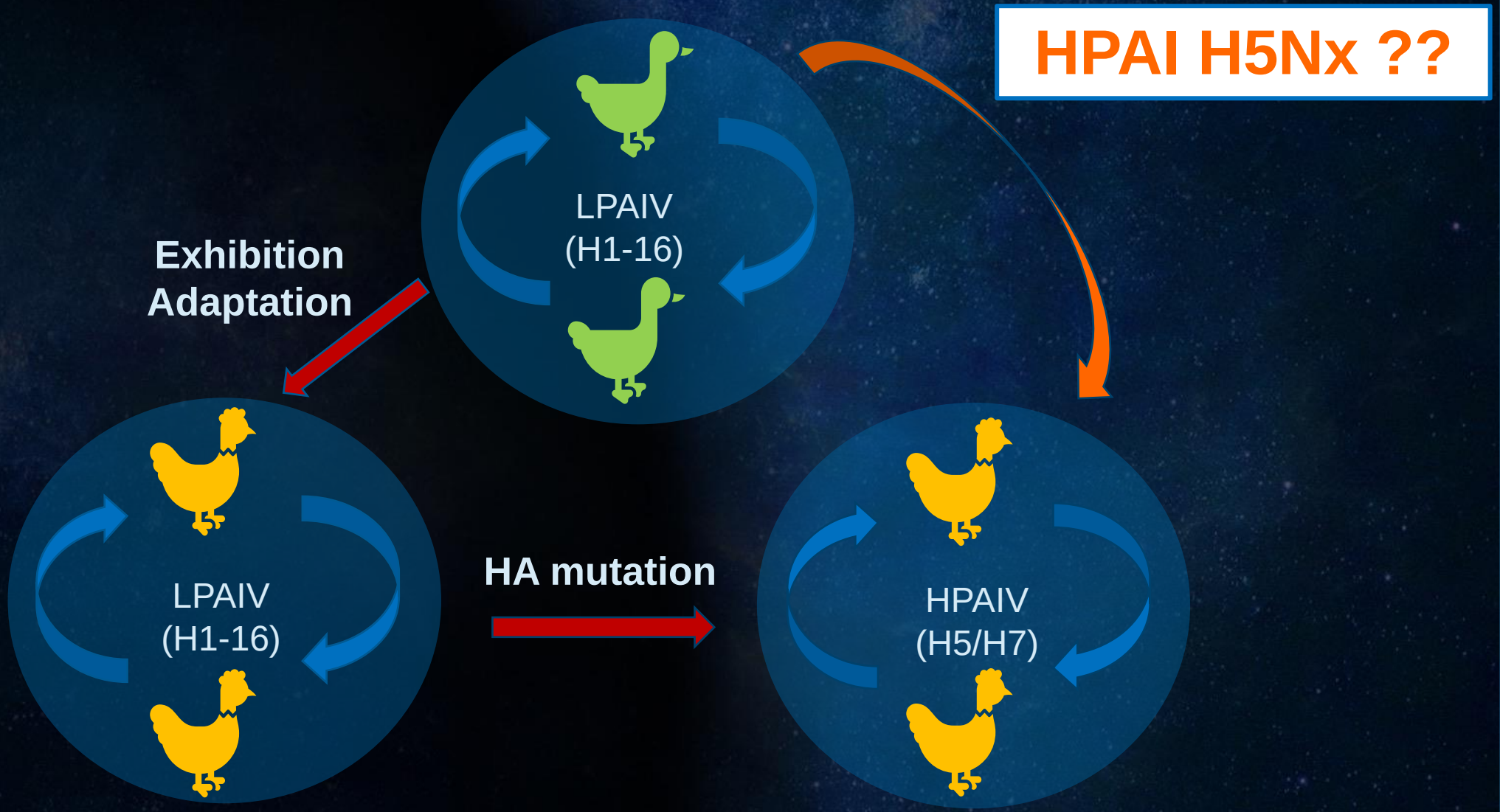
M1 protein

Neuraminidase



Epidemiology

INFECTION CYCLE



Epidemiology

FIRST H5N1 DETECTION IN EUROPE

Laying hens	$10^{6,5}$ ELD50 H7N7 (O/SP)	26% mortality 10 dpi
	$0^{6,5}$ ELD50 H5N1 (O/SP)	100% mortality 2 dpi
Barbarie duck	$10^{6,5}$ ELD50 H5N1 (O/SP) 6 weeks	100% mortality 18 dpi
	$10^{6,5}$ ELD50 H5N1 (O/SP) 18 weeks	Nervous signs 10dpi 0% mortality 18 dpi

Van Borm 2005

Epidemiology

INITIAL INTRODUCTION INTO AI-FREE COUNTRY

Migratory waterfowl and other wild birds

Poultry

Companion or pet birds

Domestic pigs

Pictures: Wikipedia

Epidemiology

TRANSMISSION FROM MIGRATORY BIRDS

Direct Contact

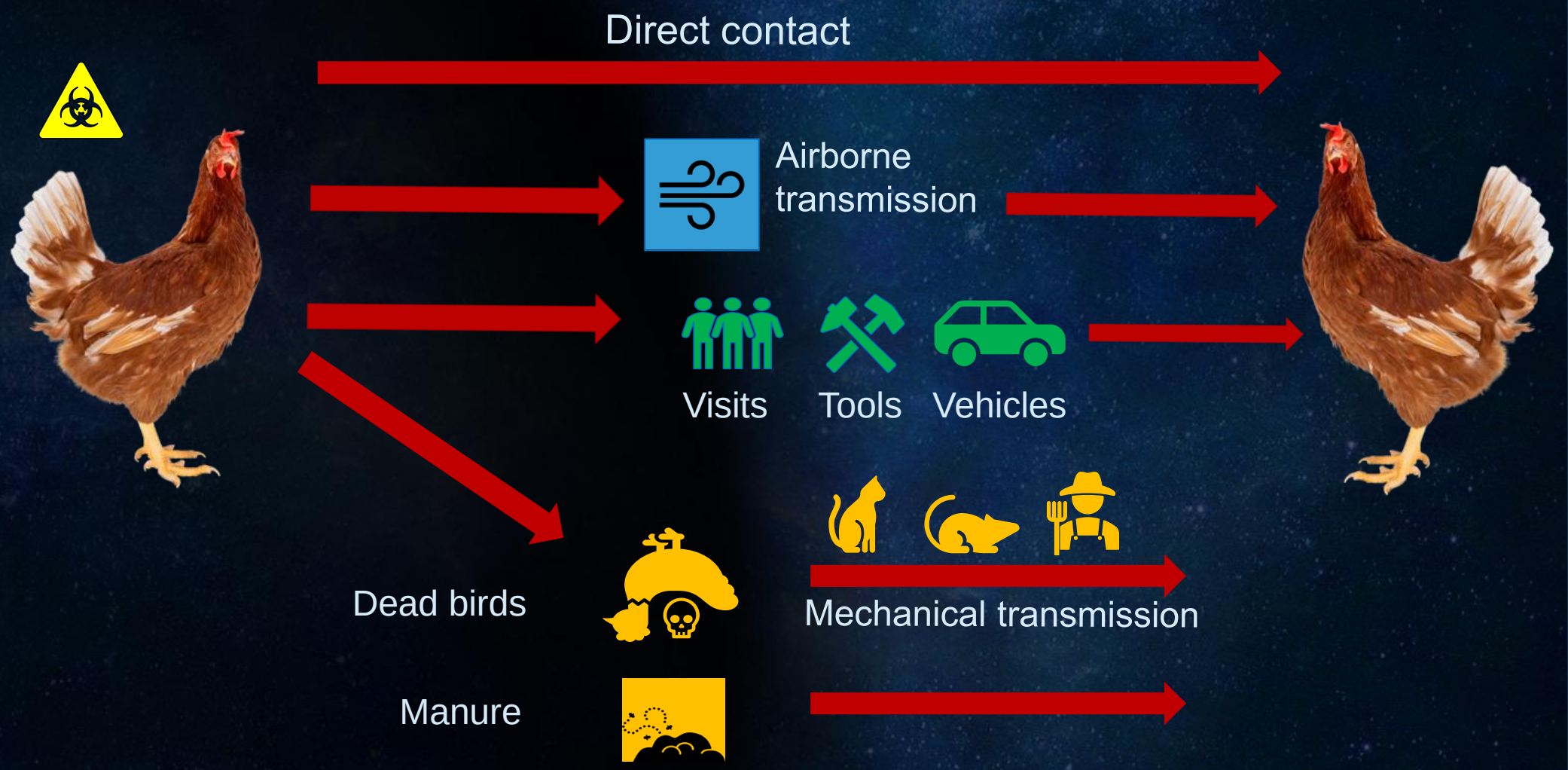
Water

Mechanical transmission

Fecal droppings

Epidemiology

TRANSMISSION FROM INFECTED POULTRY



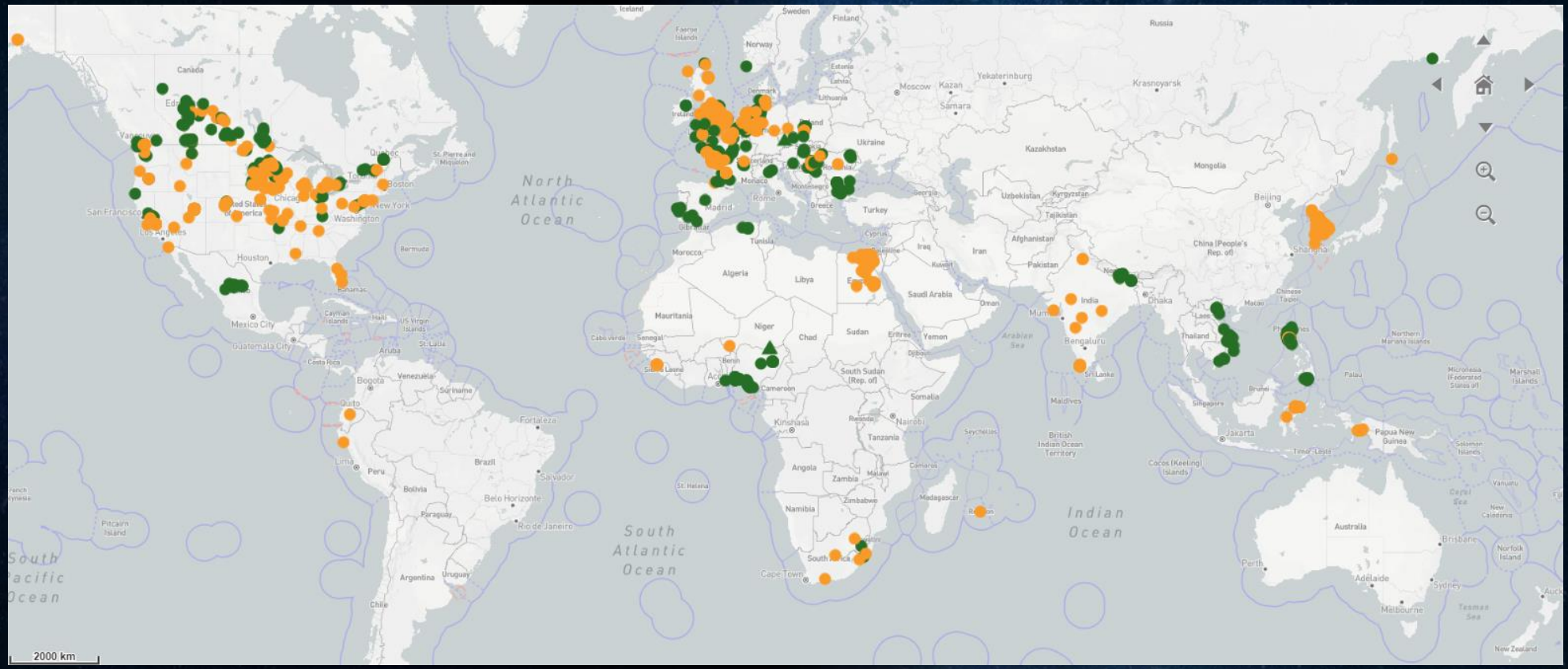
Epidemiology

HPAI POSITIVE COUNTRIES

WOAH

Epidemiology

HPAI CASES IN POULTRY BY 2022



WOAH

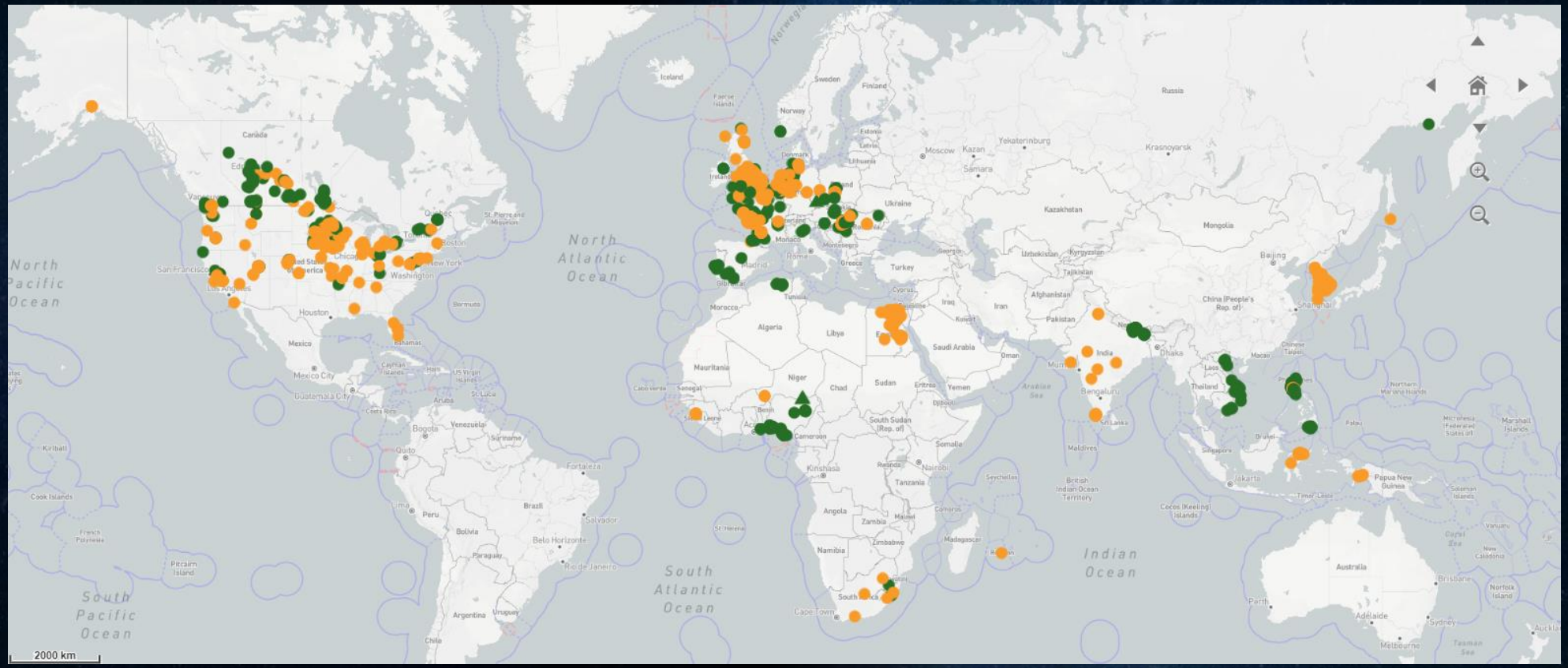
Epidemiology

HPAI H7 OUTBREAKS IN POULTRY IN 2022

WOAH

Epidemiology

HPAI H5 OUTBREAKS IN POULTRY IN 2022



WOAH

Epidemiology

2.3.4.4b H5N1 HPAIV

viruses MDPI

Article

Epidemiological Features of the Highly Pathogenic Avian Influenza Virus H5N1 in a Densely Populated Area of Lombardy (Italy) during the Epidemic Season 2021–2022

Silvia Bellini [1,*], Alessandra Scaburri [1], Erika Molica Colella [1], Monica Pierangela Cerioli [1], Veronica Cappa [1], Stefania Calò [1], Marco Tironi [1], Mario Chiari [2], Claudia Nassuato [2], Ana Moreno [1], Marco Farioli [2] and Giuseppe Merialdi [1]

viruses MDPI

Communication

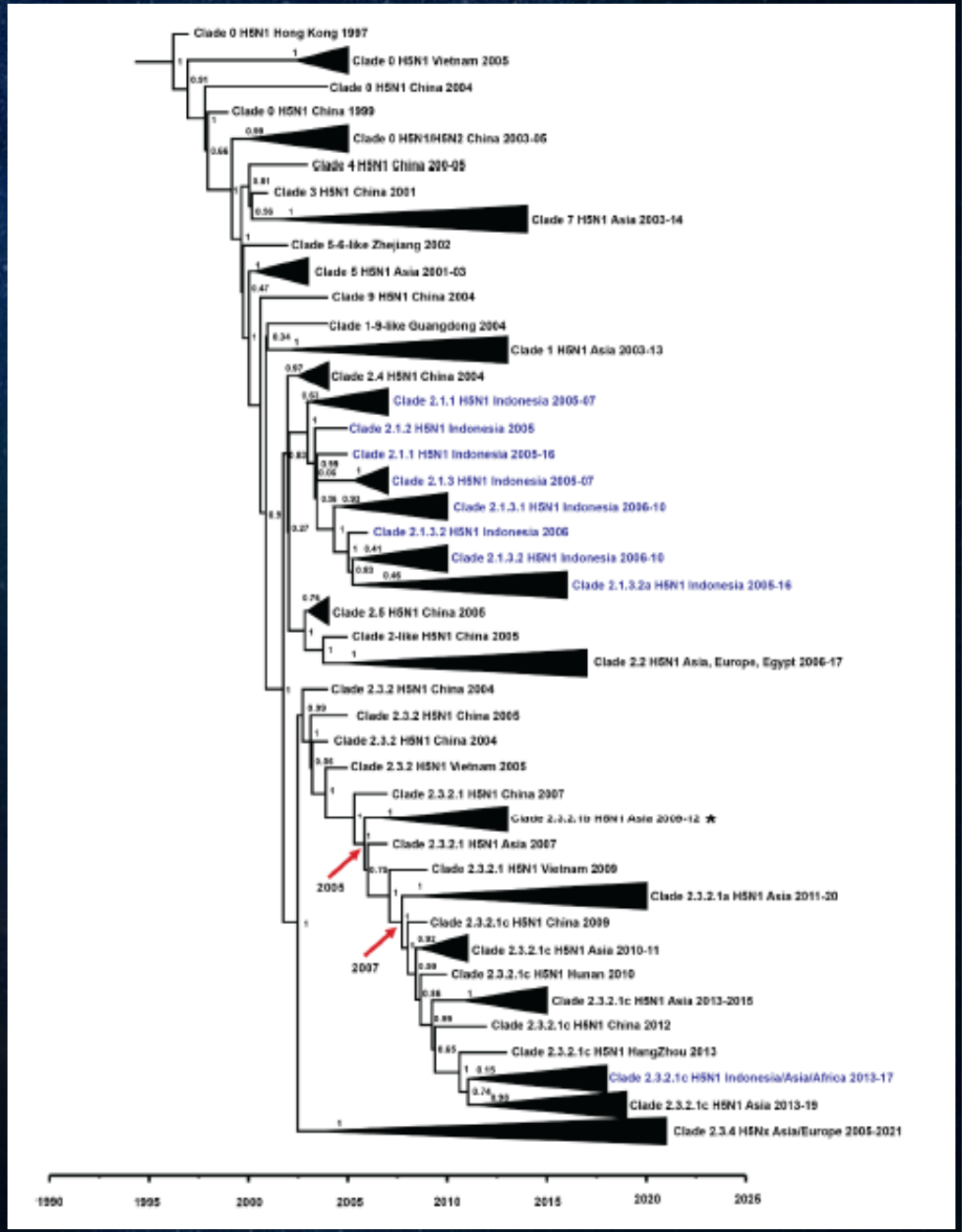
Detection of New H5N1 High Pathogenicity Avian Influenza Viruses in Winter 2021–2022 in the Far East, Which Are Genetically Close to Those in Europe

Norikazu Isoda [1,2], Manabu Onuma [3], Takahiro Hiono [1,2], Ivan Sobolev [4], Hew Yik Lim [1], Kei Nabeshima [3], Hisako Honjyo [3], Misako Yokoyama [3], Alexander Shestopalov [4,*] and Yoshihiro Sakoda [1,2,*]

DISPATCHES

Highly Pathogenic Avian Influenza A(H5N1) Clade 2.3.4.4b Virus in Poultry, Benin, 2021

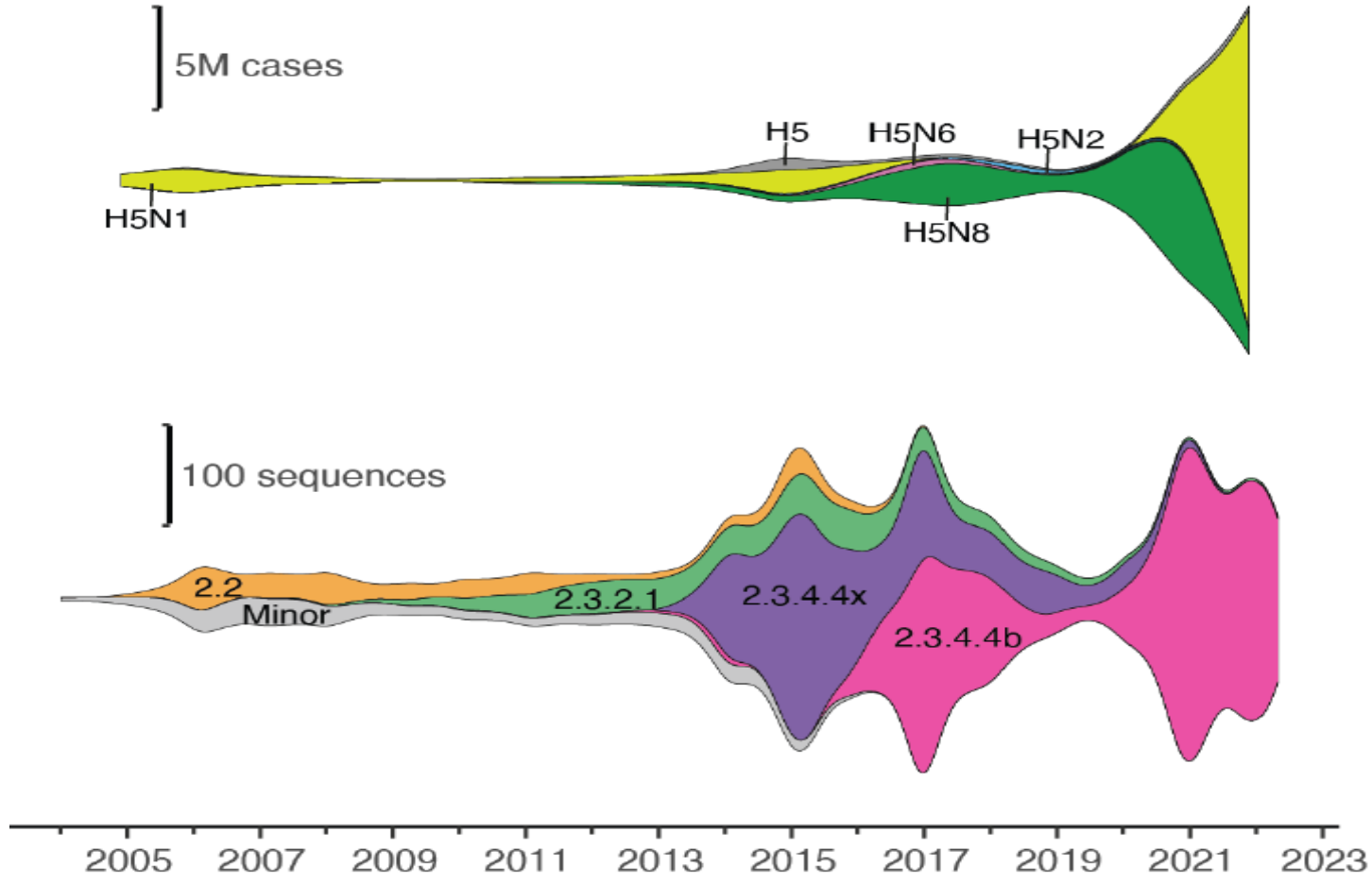
Idrissa Nonmon Sanogo, Fidelia Djegui, Yao Akpo, Corneille Gnanvi, Gabriel Dupré, Adam Rubrum, Trushar Jeevan, Pamela McKenzie, Richard J. Webby, Mariette F. Ducatez



Karo-karo 2022

Epidemiology

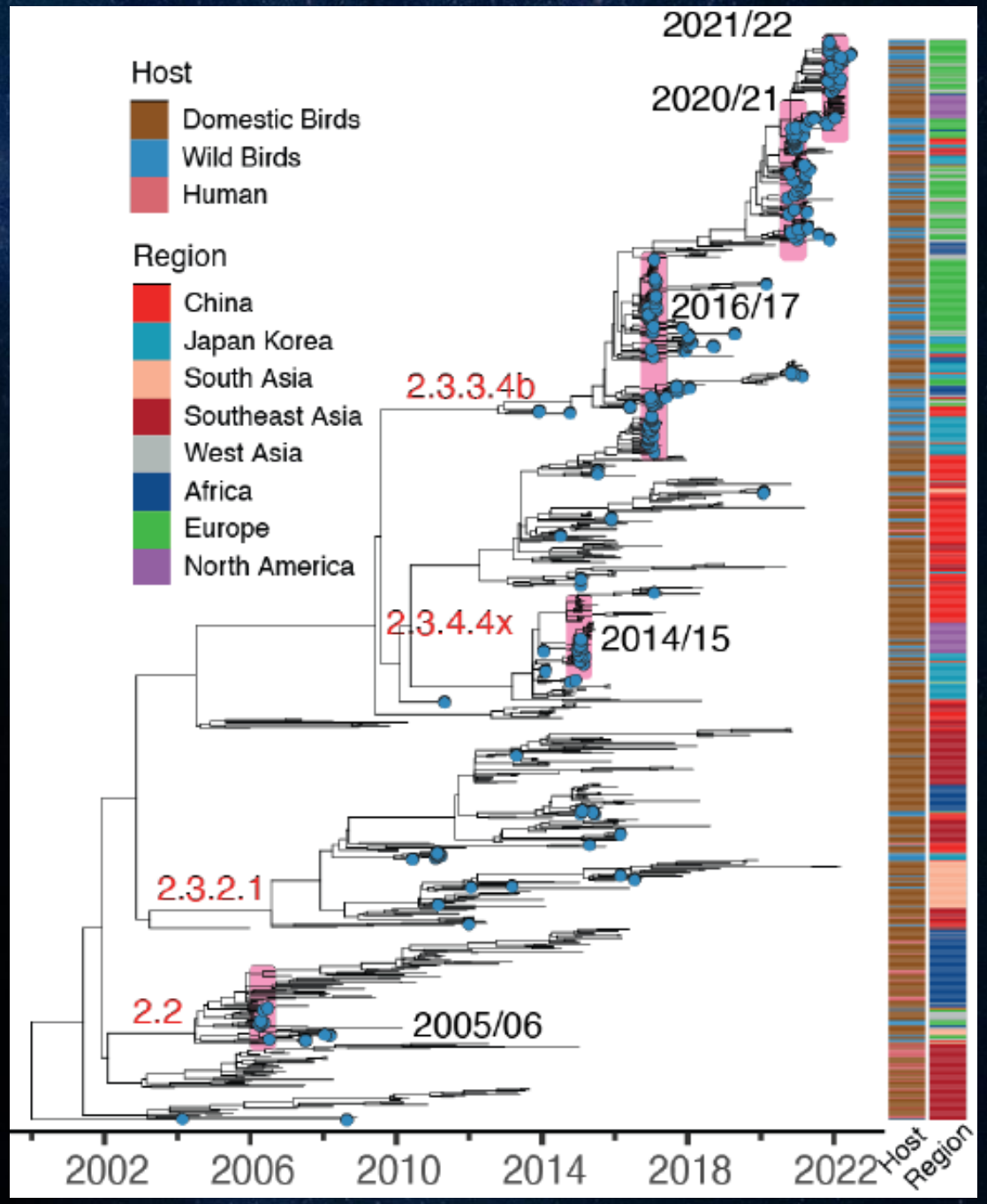
2.3.4.4b H5N1 HPAIV



Ruopeng 2022

Epidemiology

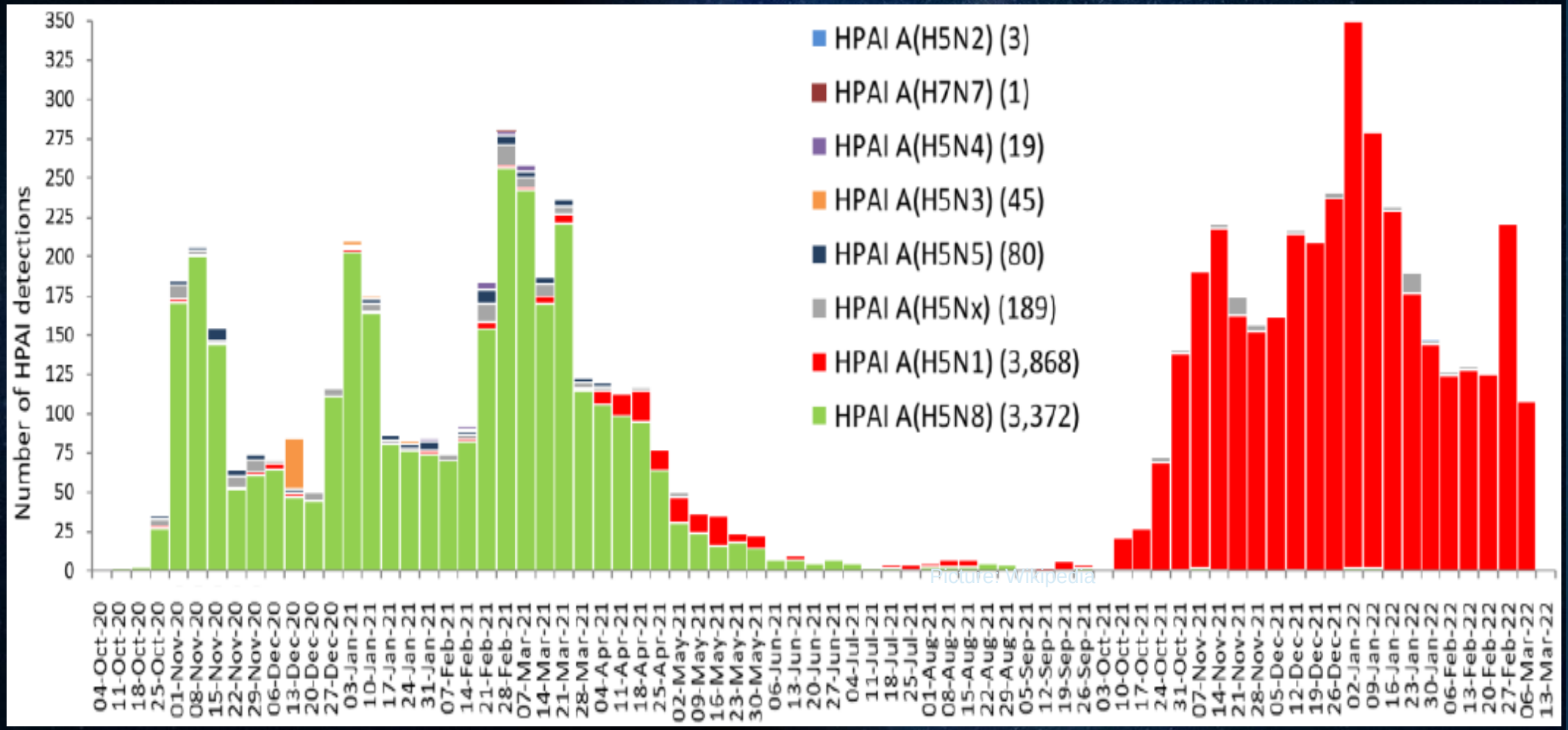
CLADE H5Nx EVOLUTION



Ruopeng 2022

Epidemiology

EVOLUTION OF ISOLATED SUBTYPES IN EUROPE



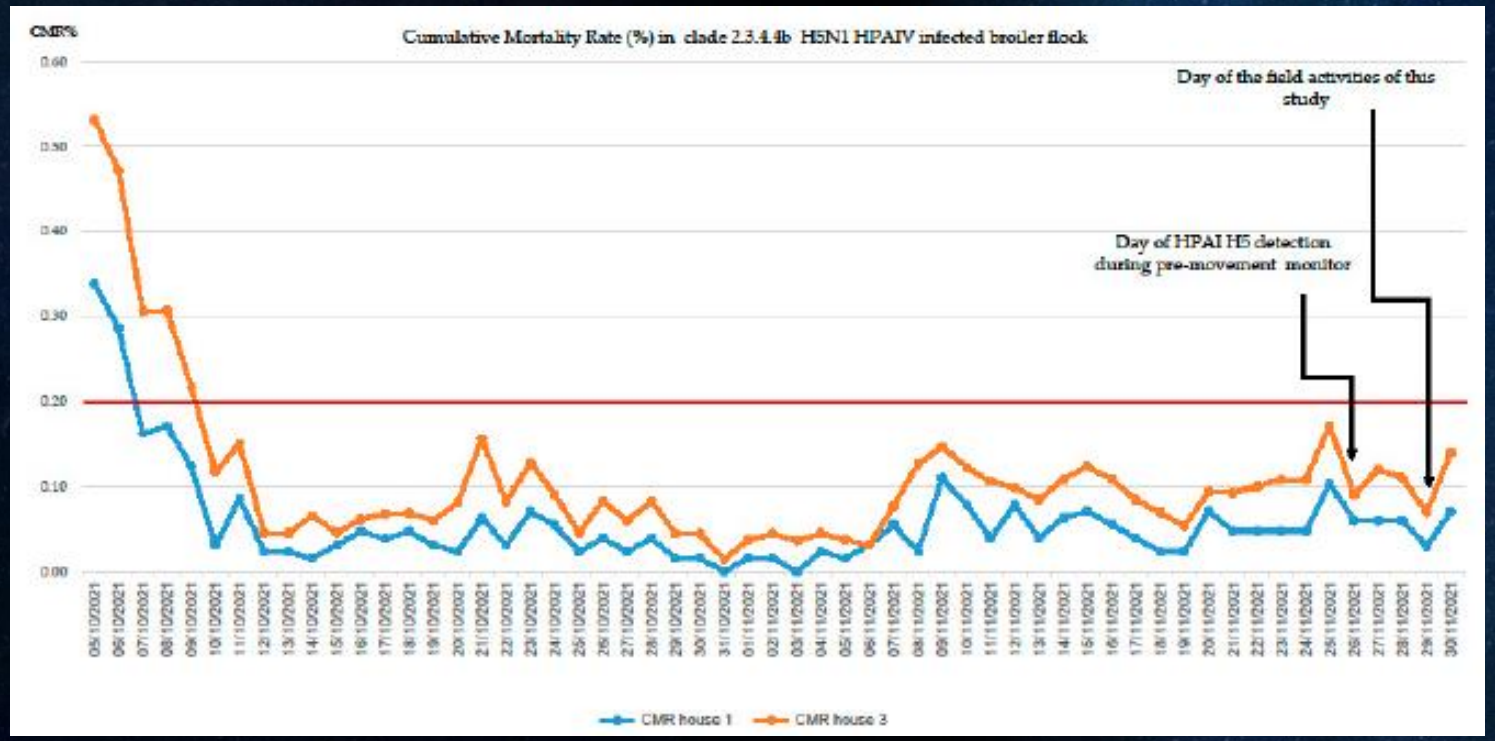
EFSA 2022

Epidemiology

2.3.4.4b H5N1 HPAIV: SILENT INFECTIONS

House 1 Pool PCR 3/6

House 2 Pool PCR 0/6



House 1

ELISA 0/35
Cloacal PCR 7/60
Tracheal PCR 10/60
Organs PCR 5/5

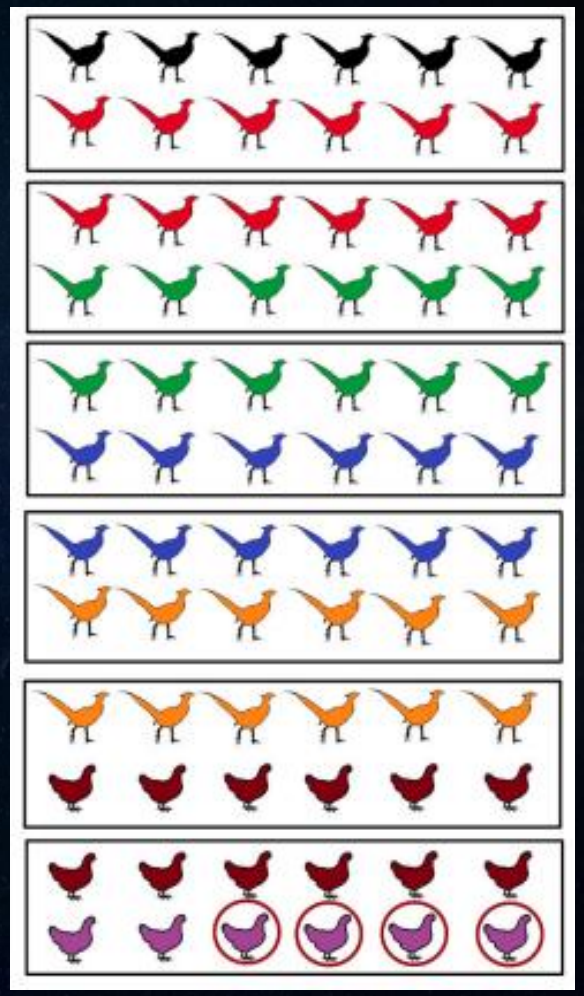
House 2

ELISA 0/35
Cloacal PCR 0/60
Tracheal PCR 0/60
Organs PCR 1/5

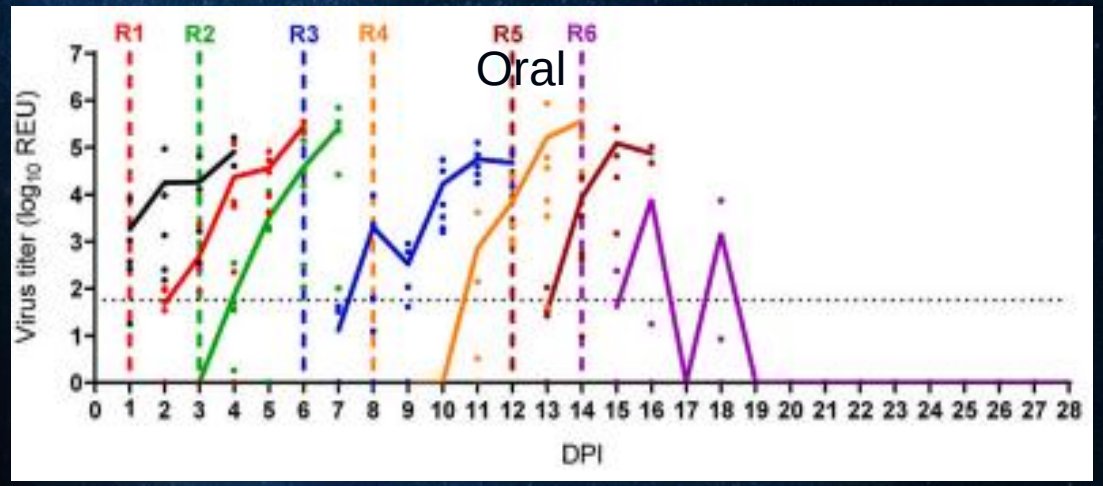
Gobbo 2022

Epidemiology

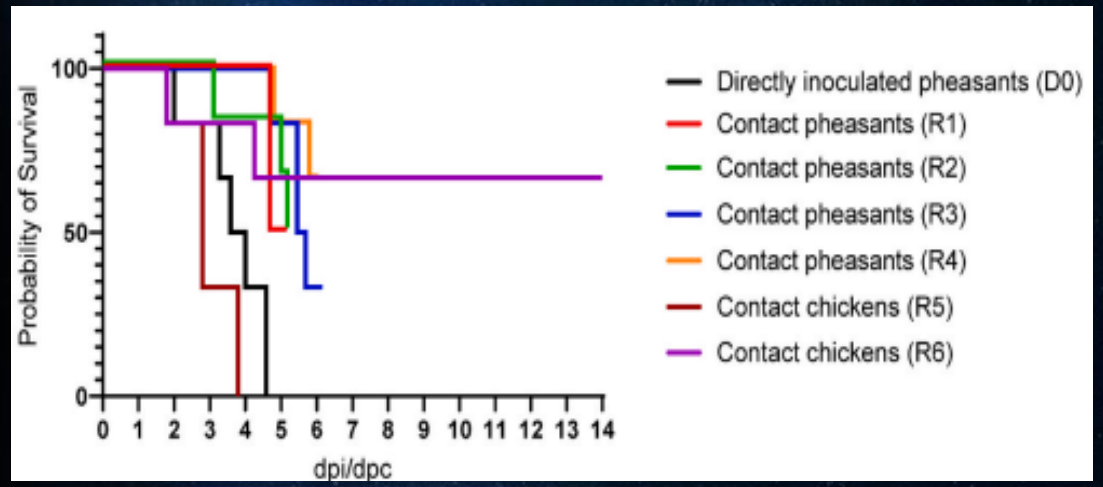
2.3.4.4b H5N1 HPAIV: INFECTIONS IN PHEASANTS AND CHICKENS



Viral excretion



Mortality



Liang 2022

Epidemiology

NEWLY INFECTED SPECIES?

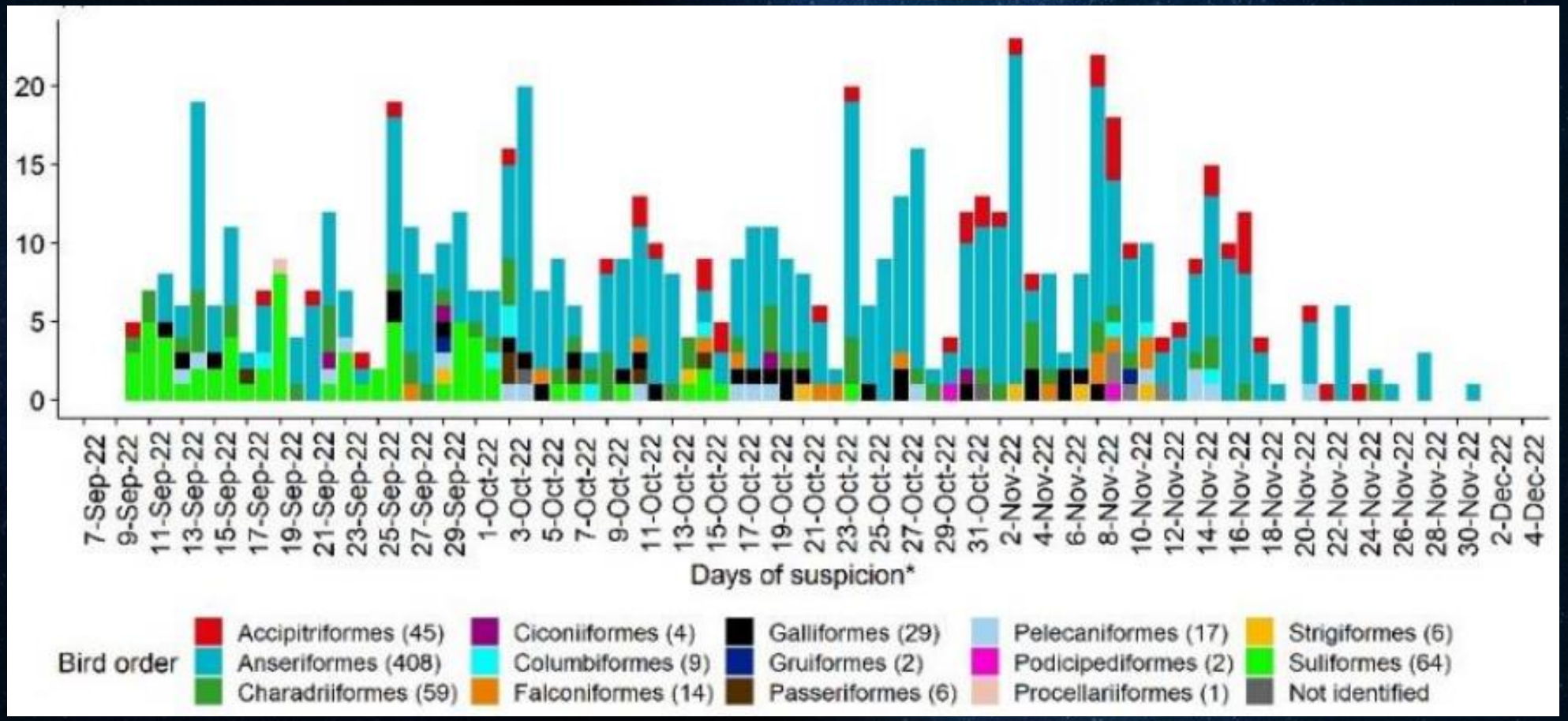
Vet Microbiol. 2022 Jul;270:109461. doi: 10.1016/j.vetmic.2022.109461. Epub 2022 May 13.

Genuine lethal infection of a wood pigeon (Columba palumbus) with high pathogenicity avian influenza H5N1, clade 2.3.4.4b, in Germany, 2022

Martin Peters [1], Jacqueline King [2], Peter Wohlsein [3], Christian Grund [2], Timm Harder [4]

Epidemiology

HPAI-ISOLATED BIRD FAMILIES IN EUROPE 2022

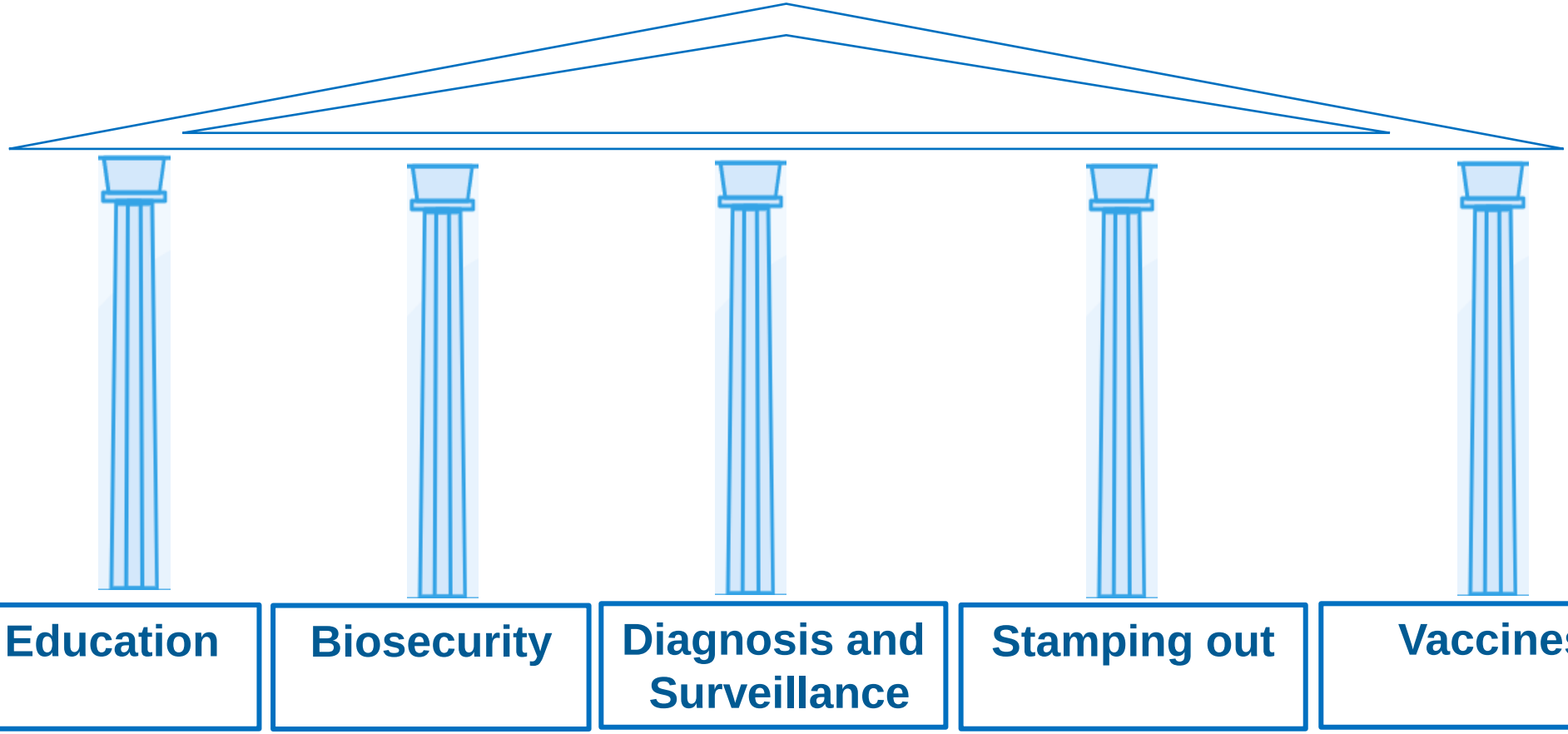


EFSA 2022

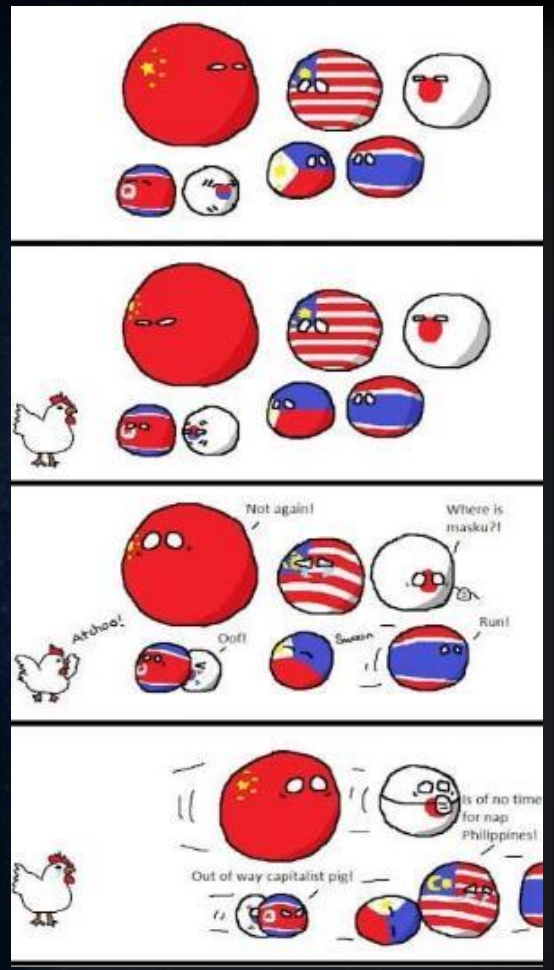
AND ... WHAT DO WE DO NOW?

RESISTANCE IS FUTILE, MY YOUNG DUCKLING

Avian influenza control programmes



Education

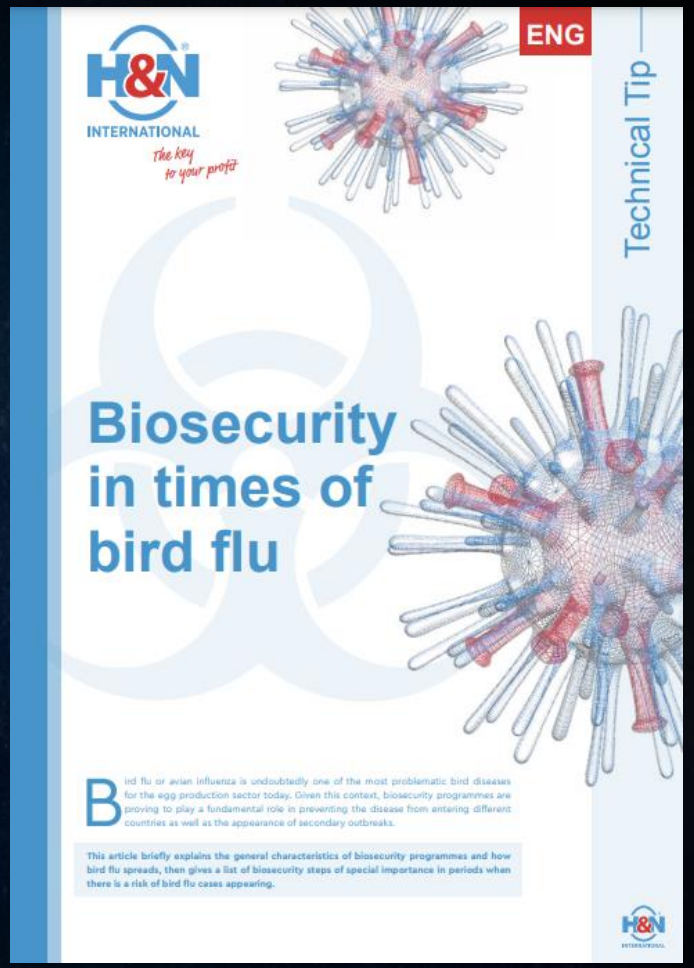


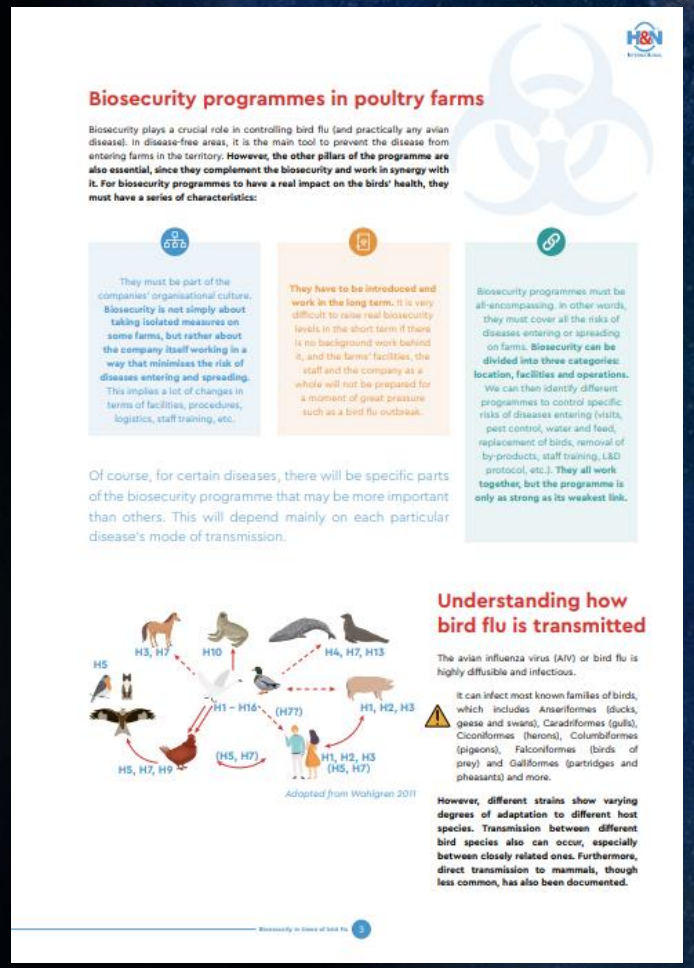
Polandball -Gesundheit

Or

Hongkong Government

Education


ENG
H&N INTERNATIONAL
The key to your profit
Technical Tip
Biosecurity in times of bird flu
Bird flu or avian influenza is undoubtedly one of the most problematic bird diseases for the egg production sector today. Given this context, biosecurity programmes are proving to play a fundamental role in preventing the disease from entering different countries as well as the appearance of secondary outbreaks.
This article briefly explains the general characteristics of biosecurity programmes and how bird flu spreads, then gives a list of biosecurity steps of special importance in periods when there is a risk of bird flu cases appearing.


Biosecurity programmes in poultry farms
Biosecurity plays a crucial role in controlling bird flu (and practically any avian disease). In disease-free areas, it is the main tool to prevent the disease from entering farms in the territory. However, the other pillars of the programme are also essential, since they complement the biosecurity and work in synergy with it. For biosecurity programmes to have a real impact on the birds' health, they must have a series of characteristics:
They must be part of the companies' organisational culture. Biosecurity is not simply about taking isolated measures on some farms, but rather about the company itself working in a way that minimises the risk of diseases entering and spreading. This implies a lot of changes in terms of facilities, procedures, logistics, staff training, etc.
They have to be introduced and work in the long term. It is very difficult to raise real biosecurity levels in the short term if there is no background work behind it, and the farms' facilities, the staff and the company as a whole will not be prepared for a moment of great pressure such as a bird flu outbreak.
Biosecurity programmes must be all-encompassing. In other words, they must cover all the risks of diseases entering or spreading on farms. Biosecurity can be divided into three categories: location, facilities and operations. We can then identify different programmes to control specific risks of diseases entering (visits, pest control, water and feed, replacement of birds, removal of by-products, staff training, L&D protocol, etc.). They all work together, but the programme is only as strong as its weakest link.
Of course, for certain diseases, there will be specific parts of the biosecurity programme that may be more important than others. This will depend mainly on each particular disease's mode of transmission.
H3, H7
H10
H4, H7, H13
H5
H1 – H16
(H7?)
H1, H2, H3
H5, H7, H9
(H5, H7)
H1, H2, H3 (H5, H7)
Adapted from Wahlgren 2011
Understanding how bird flu is transmitted
The avian influenza virus (AIV) or bird flu is highly diffusible and infectious.
It can infect most known families of birds, which includes Anseriformes (ducks, geese and swans), Caradriformes (gulls), Ciconiformes (herons), Columbiformes (pigeons), Falconiformes (birds of prey) and Gallifomes (partridges and pheasants) and more.
However, different strains show varying degrees of adaptation to different host species. Transmission between different bird species also can occur, especially between closely related ones. Furthermore, direct transmission to mammals, though less common, has also been documented.
Biosecurity in times of bird flu 3


Adapting biosecurity in periods of high bird flu risk:
Biosecurity programmes must be set up to prevent the risk of the disease entering before periods of high bird flu risk begin. In any case, during such periods there are some especially critical measures that must be reinforced:
Risks of AIV being introduced due to migratory birds
Avoid contact with wild birds; any direct contact with such birds and poultry must be avoided. To do so, buildings must be made "wild bird proof". This means:
The farm's walls and roofs must be completely closed and not allow any type of wild bird to enter.
Windows and air inlets must be protected with bird mesh or an equivalent system. Such protection must be fitted well and not leave gaps allowing wild birds to enter.
The access door must remain closed when not in use, and in any case it must not give direct access to the birds' area. Doors that are not for daily use must be bolted.
In the case of birds in systems with access to outdoor zones, authorisation must be requested from the official veterinary services to be exempted from the obligation to use such zones where contact with wild birds is impossible to control.
WILD BIRD PROOF
Avoid attracting wild birds to the farm: farms must be "unfriendly" territories for wild birds. To do so:
Prevent areas of stagnant water from appearing. The land in the surrounding areas must be levelled to prevent stagnant water building up. The possibility of using drains and guttering to drain off water from the buildings' perimeter should be considered.
Prevent birds from nesting in farm buildings or nearby structures. It is not advisable to have trees or brushy areas of vegetation in the surrounding area.
Ensure the silos are sealed tight so that birds cannot access the feed. Likewise, spillages of feed that may attract birds must not be allowed.
Prevent chicken manure from building up in the areas surrounding the buildings, since it always contains undigested cereal grains, which attracts various types of birds.
In a free range bird system, avoid having drinkers or feeders in uncovered zones in outdoor corrals.
Remove unnecessary ledges or horizontal surfaces that may be used by wild birds to perch on. Systems such as laser cannons or other devices can also be used to scare away birds.
Farms should not be built in the immediate vicinity of marshes, lakes or other areas where wild birds often make their migratory stops.
Biosecurity in times of bird flu 5

Biosecurity

BIOSECURITY LEVELS

Country level

County level

Farm level

Location

Equipment

Operation

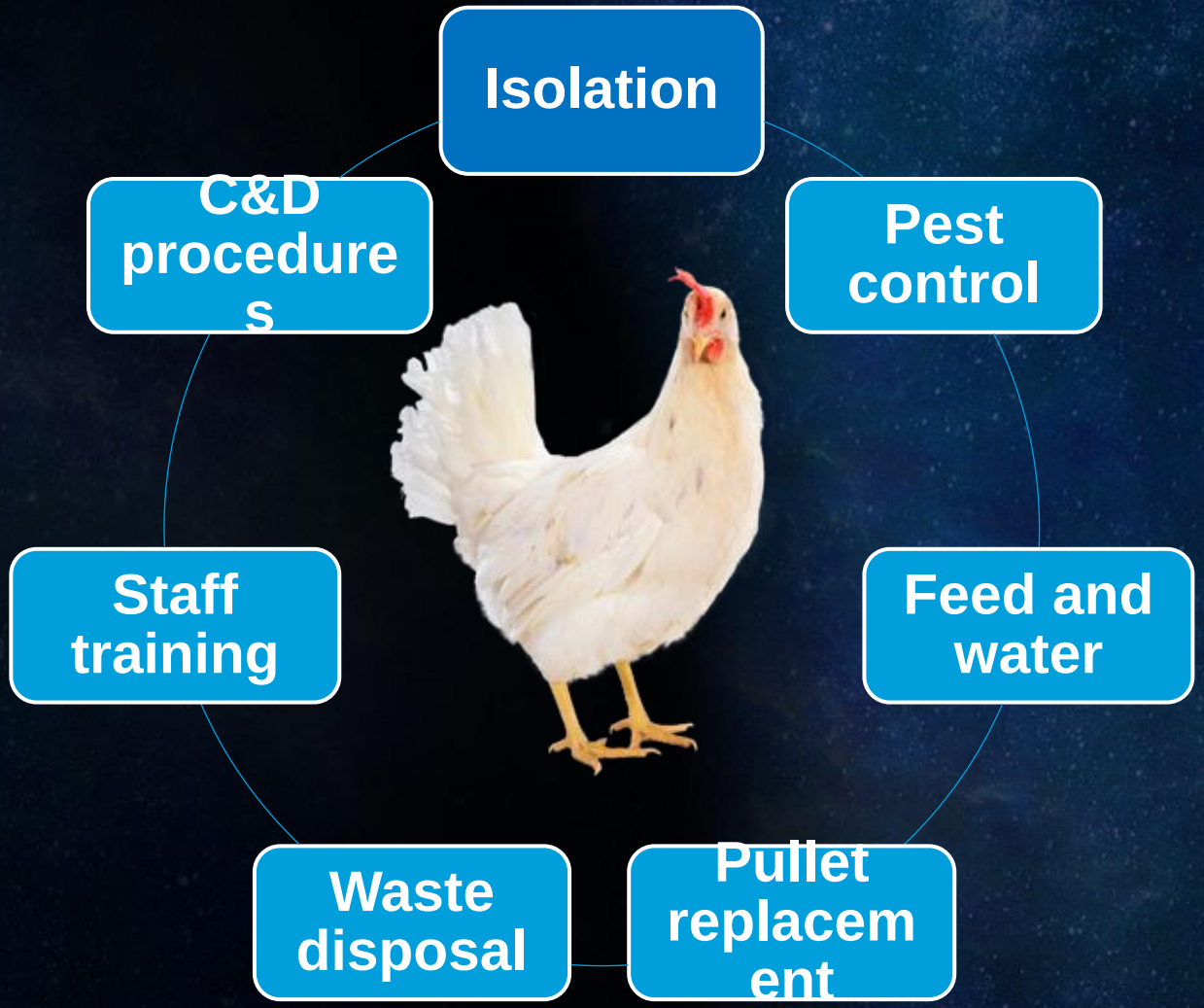
Biosecurity

FARM LOCATION REALLY MATTERS

Picture: Google maps

Biosecurity

BIOSECURITY PROGRAMS



Biosecurity

VISITOR POLICY (The easiest and best to apply)

Biosecurity

A DECISION TREE FOR ACCEPTING VISITORS

Biosecurity

THE VEHICLES ARE NOT FOR DRIVING ON THE FARM

External parking

No entrance to all avoidable vehicles

Complete disinfection for all entering vehicles

Biosecurity

ENTRANCE TO A FARM (IDEALLY)

Logbook

Fecha	Nombre	Empresa	Matrícula vehículo	Motivo de la visita	Última visita en granja	Autorización

Locker

Shower

Farm Cloths

Hygiene block

Biosecurity

TOOLS AND PERSONAL BELONGINGS STAY OUT

Leave your personal belongings outside…

Disinfect any items before bringing them into the farm.

Stuff coming from other farms MUST be rejected

Biosecurity

NOT TO DO FOR POULTRY WORKERS

No visit to other farms.

No keeping backyard poultry at home.

No bird related hobbies.

Biosecurity

RODENTS: WE CANNOT COEXIST!

Erysipelas
(Meerburg 2012)

Salmonellosis
(Meerburg 2012)

Fowl Cholera
(Meerburg 2012)

...

+

Mechanical transmission

Biosecurity

GETTING RID OF RODENTS

Passive control

Active control

Biosecurity

WILD BIRDS: THE FLYING RODENTS (EVEN WORSE)

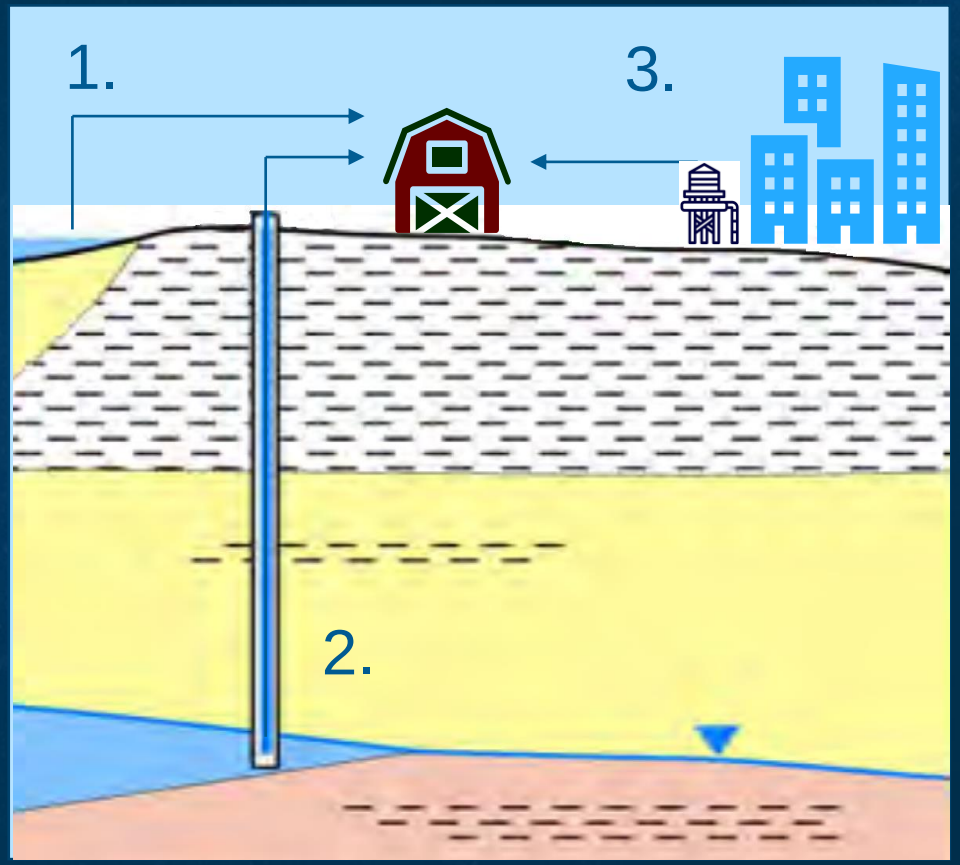
Poultry houses MUST be bird-proof

Do not attract birds by feed spillage or others

Do not allow birds to nest in your premises

Biosecurity

WATER SOURCE REALLY MATERS



1. **Surface waters**
2. **Well**
3. **Public water network**

- Microbiological quality
- Chemical Quality
- Pre-treatment

Biosecurity

DEAD BIRDS ARE NOT A SUB PRODUCT
THEY ARE A BIOLOGICAL RISK

Remove all dead birds from the house daily

Store them in a correct container

Destroy them totally as soon as possible

Biosecurity

MANURE IS A SUB PRODUCT
BUT IT IS STILL A BIOLOGICAL RISK

Remove it from the house as soon as possible

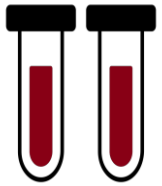
Treat the manure before spreading it on the fields.

Do not spread poultry manure around other poultry houses

Diagnosis and surveillance

SAMPLING FLOCKS





Blood

@ Flock surveillance

Serology
- ELISA
- HI (H1 - H16)
- NI (N1 - N9)

LPAI infections monitoring programs

Vaccination monitoring

Tracheal swabs
Cecal tonsils
Cloacal swabs

@ diagnosis
@ surveillance

Virology
- SPF chicken embryos
- Tissue cultures

Molecular biology
- RT- PCR
- Sequencing

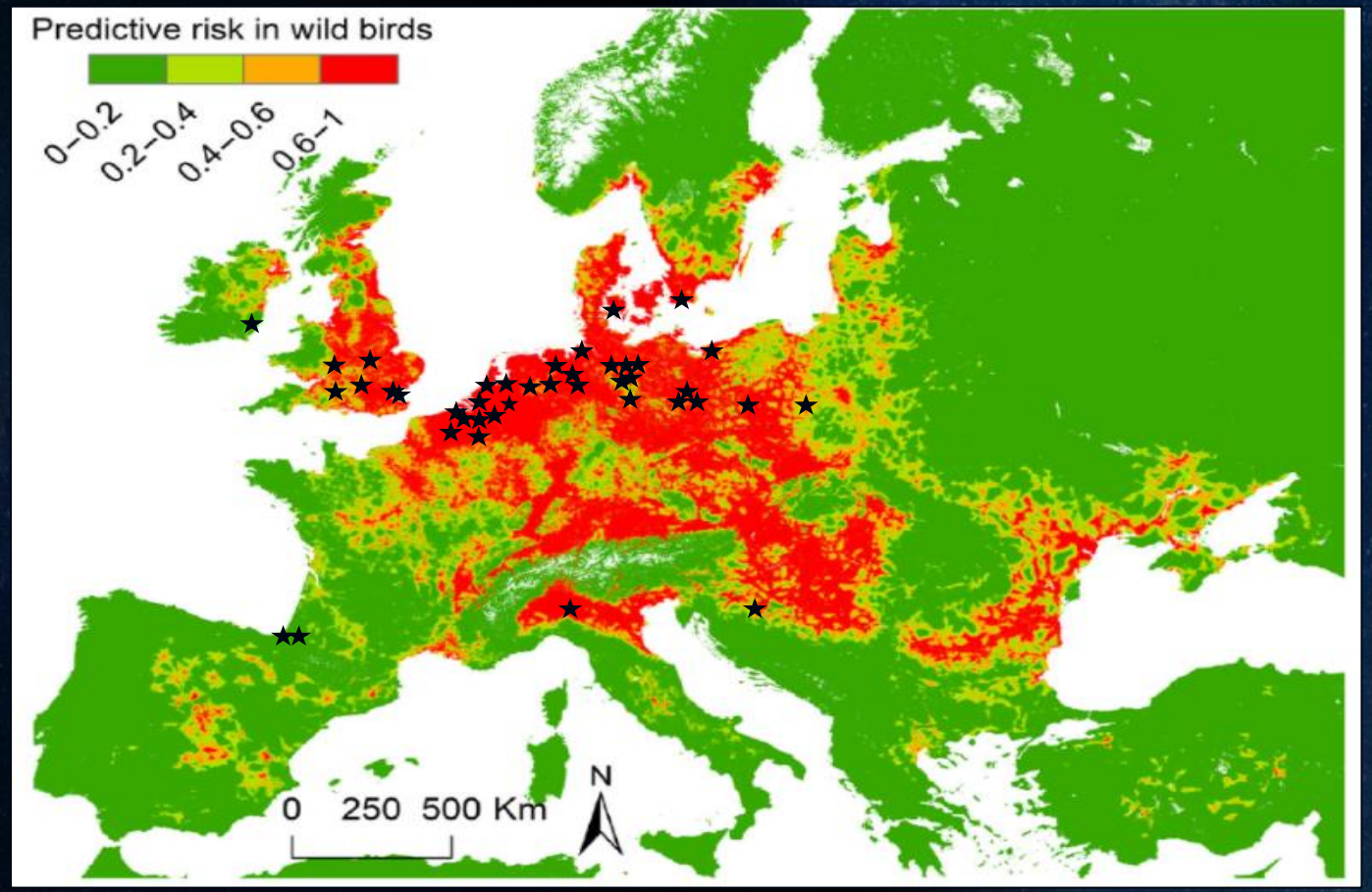
Case confirmation

Clade determination

Epidemiology studies

Diagnosis and surveillance

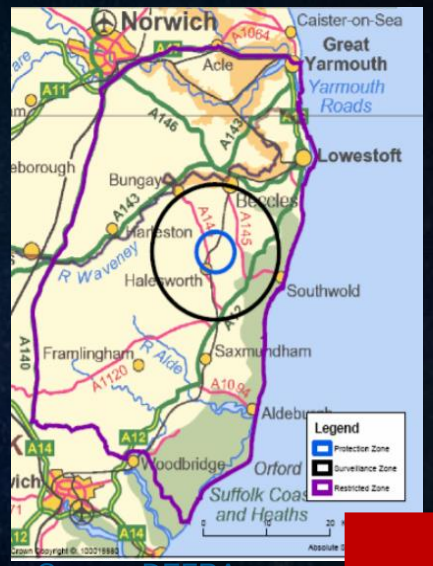
PREDICTIVE RISK MAPS



Stamping out

WORKING FOR BIOCONTAINMENT

RESTRICTIONS



Source: DEFRA

SACRIFICES

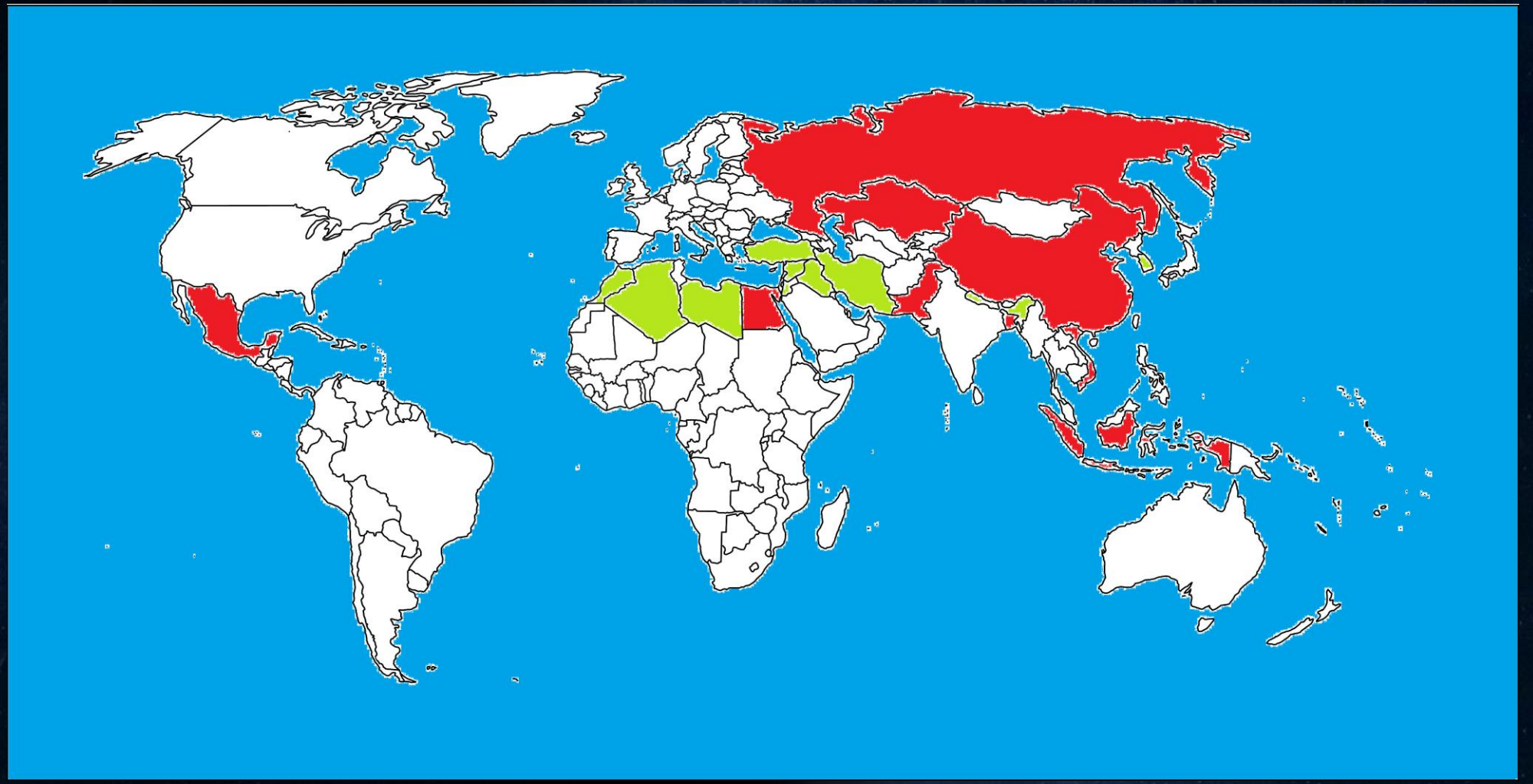
DESTRUCTION

C&D PROCEDURE

Completely prevent the spread of an exotic virus.

Time is of crucial importance. Logistics is the key point.

Vaccination programmes



Vaccination programme against HPAI

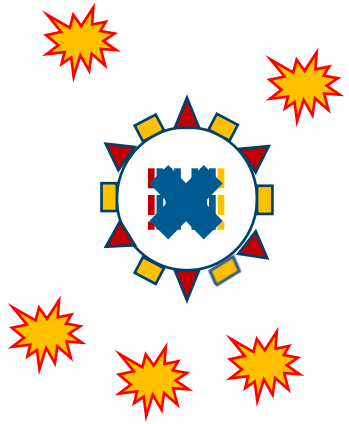
Vaccination programme against LPAI H9N2

Vaccination programmes

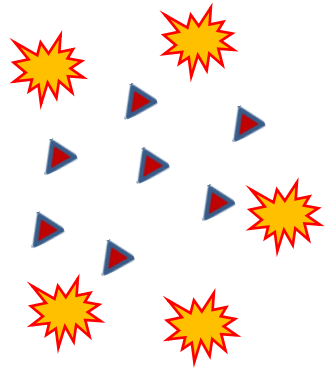
TYPES OF AVIAN INFLUENZA VACCINES

Inactivated vaccines

Oil emulsified inactivated Whole AIV

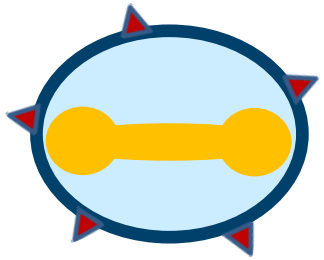


Oil emulsified HA protein

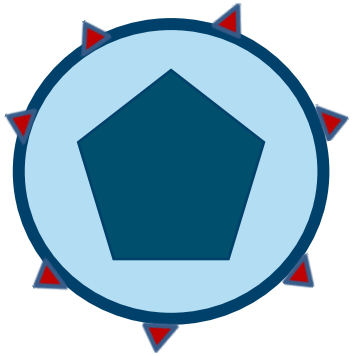


Recombinants vaccines

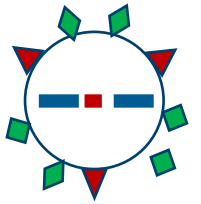
Recombinant fowl pox virus



Recombinant HVT virus



Recombinant ND Virus



Vaccination programmes

WHAT TO EXPECT FROM AI VACCINATION ?

CAN

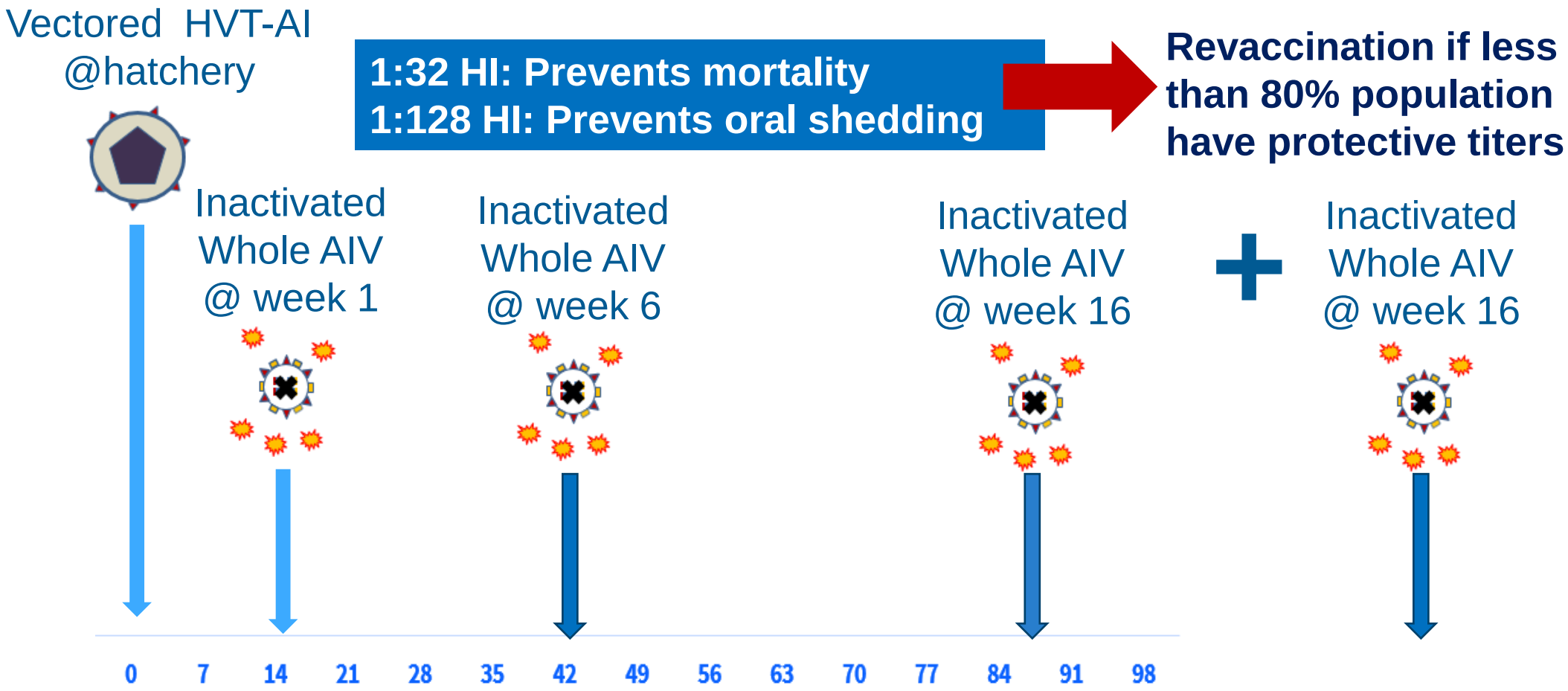
- Reduce replication of AIV in respiratory & GI tract
- Prevent illness and death in poultry
- Reduce transmission to birds and humans

CAN'T

- Infection is still occurring to infection
- Interferes with monitoring programmes
- Poor protection against AIV from other serotypes/clades

Vaccination programmes

Vaccination programmes



Vaccination programmes

MEXICO: H7N3 VACCINATION PROGRAMME

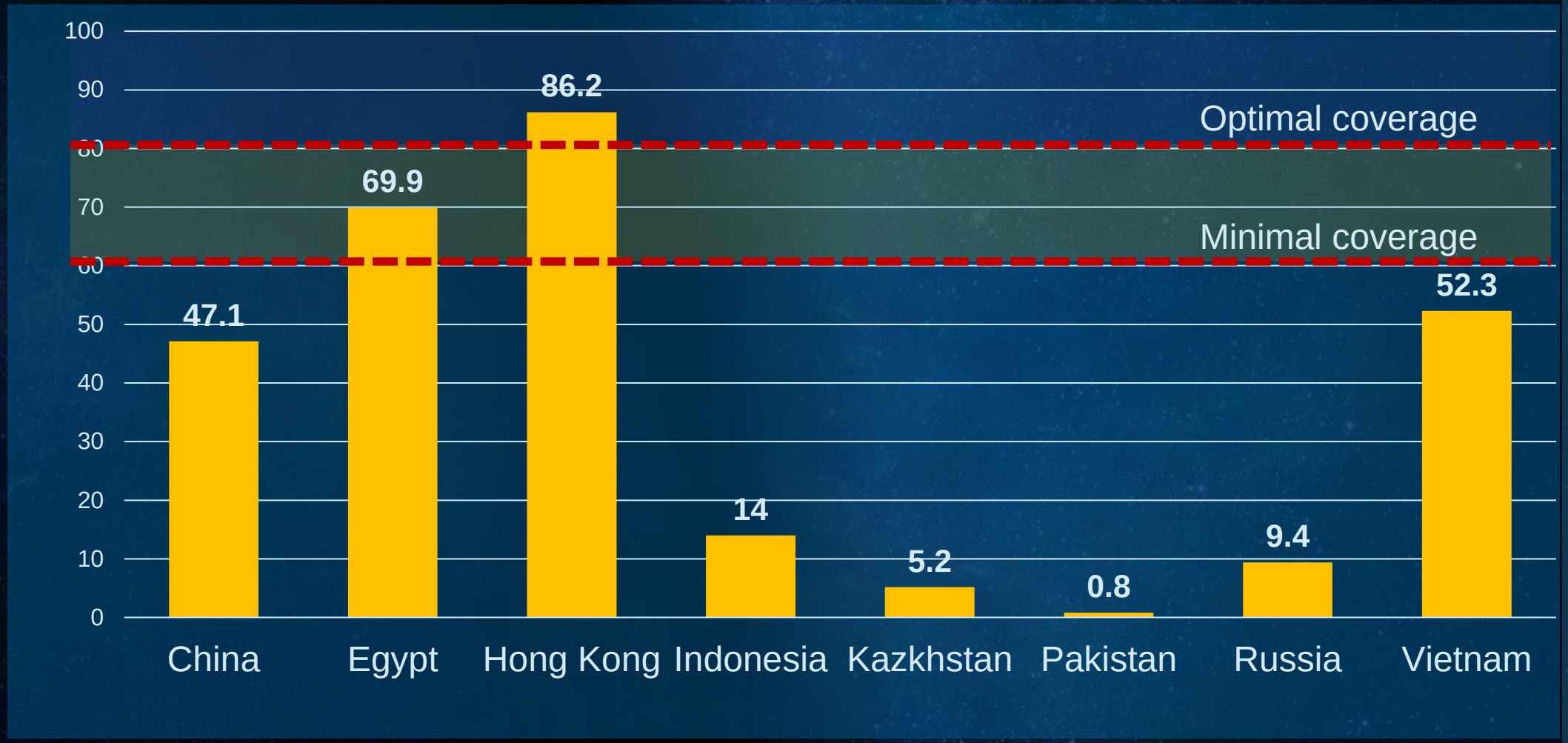
2014

2016

2018

Vaccination programmes

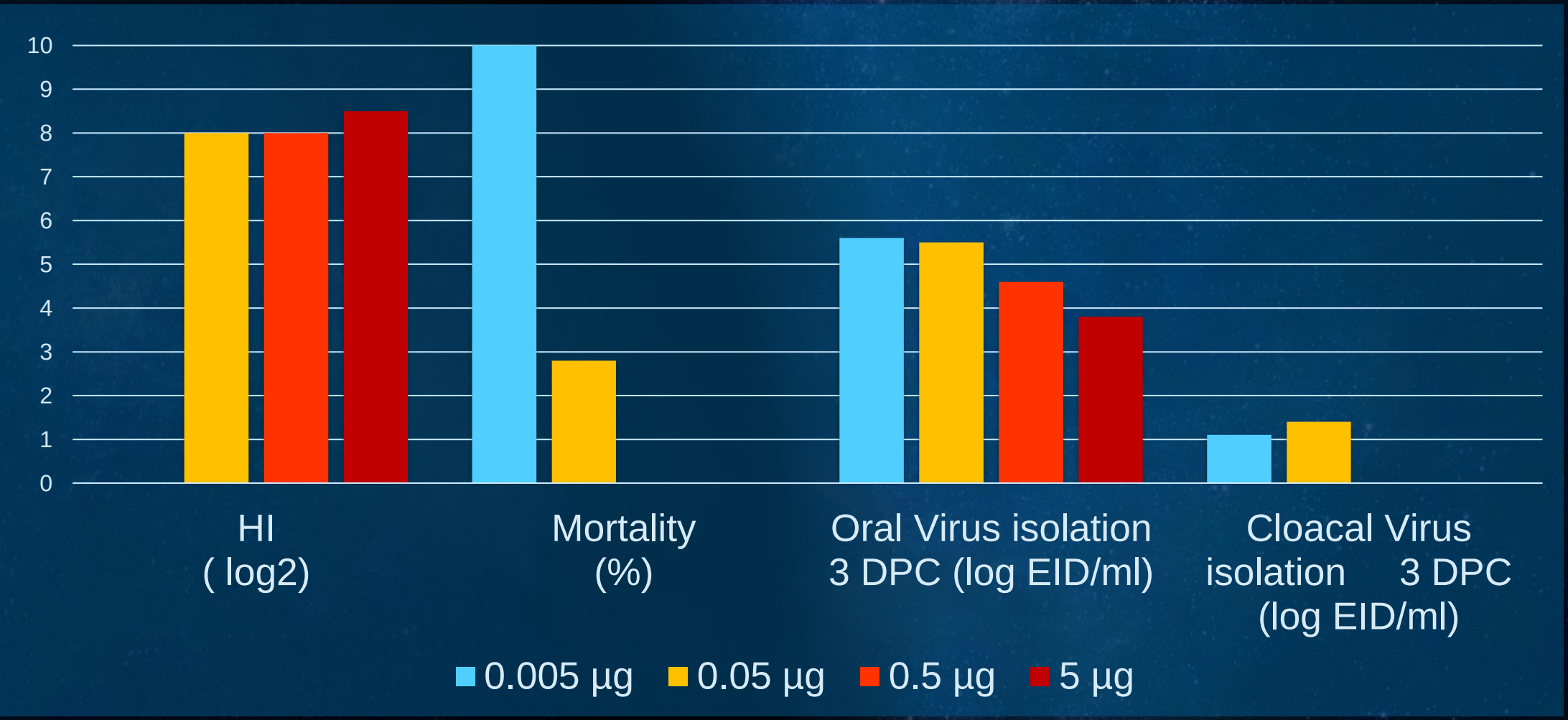
AVERAGE AI VACCINE COVERAGE RATE FOR YEARS 2001-2010 OF USAGE



Swayne 2012

Vaccination programmes

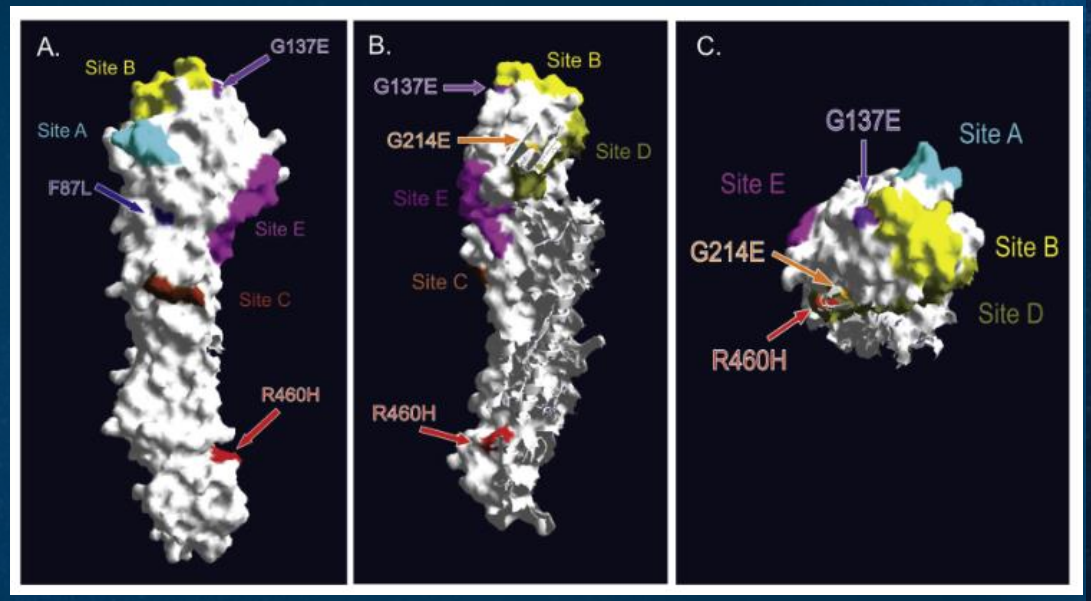
VACCINE POTENCY & PROTECTION



Swayne 1999

Vaccination programmes

VACCINE POTENCY & ANTIGENIC SCAPE



AIV can scape from vaccines protection by mutation at critical antigenic site

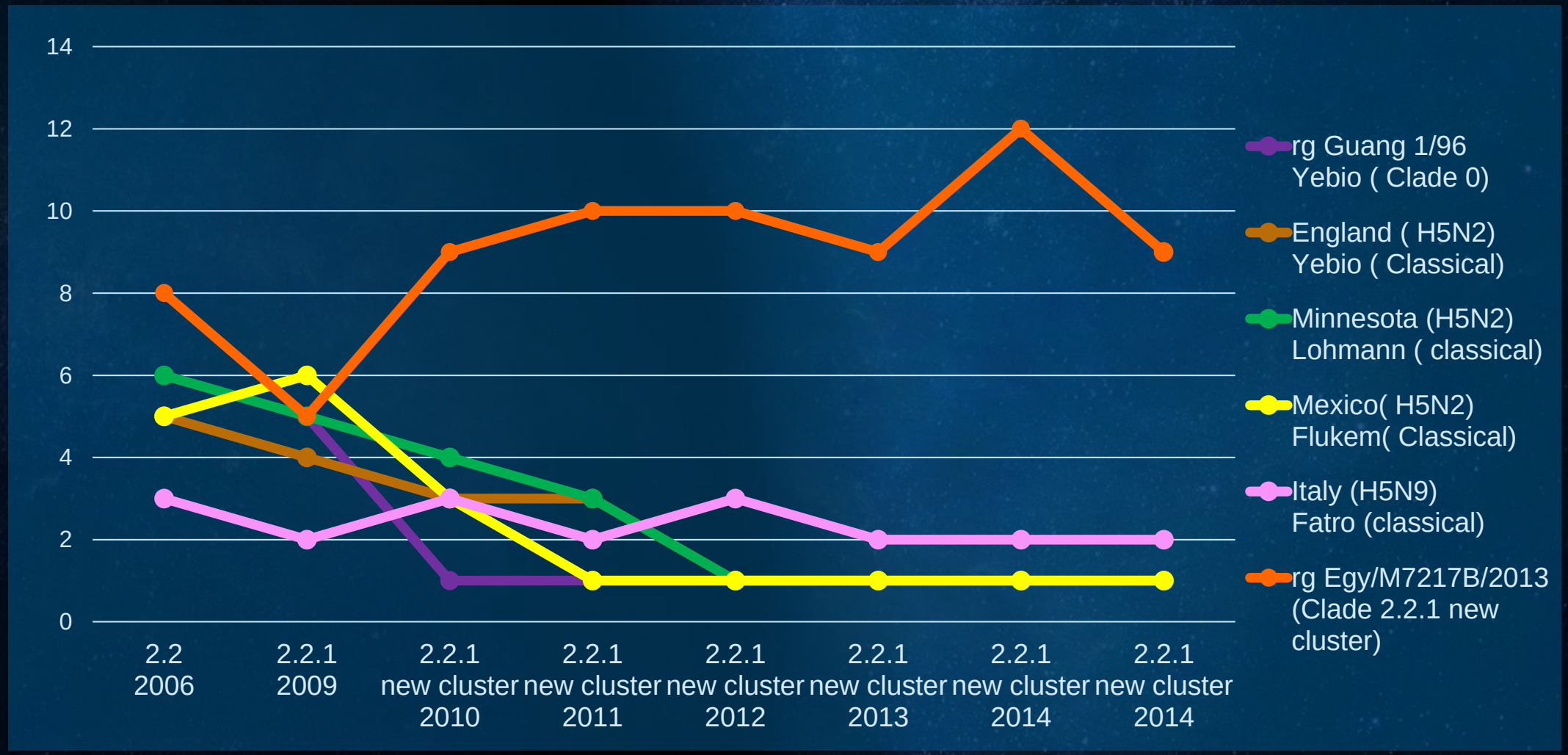
1. Update in vaccine seed strain can be needed time by time.

2. High titers from Antigenically relevant vaccines slow down antigen escape dynamics.

Sitaras 2020

Biosecurity

ANTIGENIC SCAPE: VACCINE RESPONSE EVOLUTION IN EGYPT



Kayali 2016

Vaccination programmes

VACCINE TRIAL - 2.3.4.4B H5N1 HPAIV

Vaccine	H5	Inoculated birds	Contact birds	R (Interval method)
No	-	100% Mort	100% Mort	3.64 (1.89-6.99)
HVT- H5	2.2 (2006)	0% Mort	0% Mort	0 (0-NA)
HVT- H5	2.3.2	0% Mort	0% Mort	0 (0-NA)
DNA	2.3.4.4a	70% Mort	70% Mort	2.15 (1.03-4.50)
Inac (1 dose)	H5N2 (LP)	50% Mort	50% Mort	0.92 (0.37-2.27)

Wageningen
2023

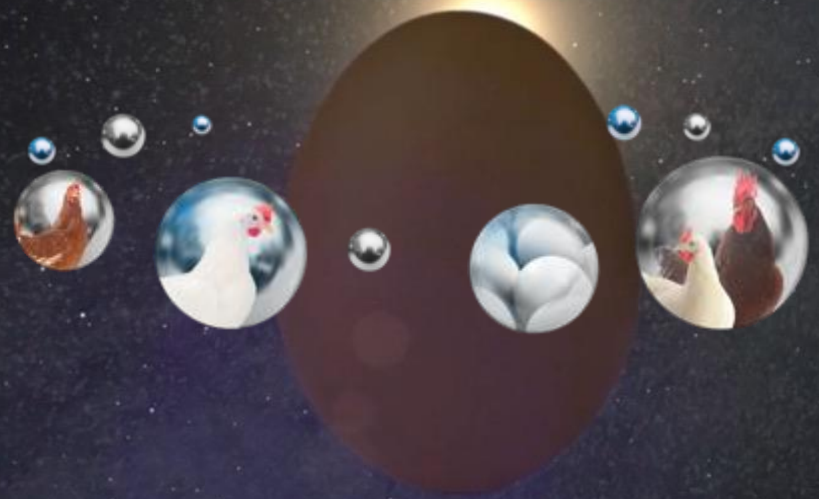
Take home message

1. AIV is a virus with a **great capacity for mutation** and evolution. This must be **taken into account in its control.**

2. The **AI control** programmes are based on several points. **Biosecurity** and **Surveillance** are **fundamental**. **Vaccination** may be advisable **in some cases.**

3. A **properly implemented vaccination** programme is a **great help** in controlling AI in **endemic areas** but cannot solve the disease on its own.

Thank you for your attention



H&N International – Making your success the center of our universe

Follow us on LinkedIn
H&N International GmbH

Find out more about
KAI farming assistant

Patogenia

PRINCIPALES SUPERFICIES PROTEÍNAS

Disolventes orgánicos

Desoxicolato sódico
Dodecil sulfato sódico)

Desinfectantes
(Sensible a la materia organica)

Aldehídos
Beta- propiolactona
Etilenimina binaria

Desinfectantes
(MUY sensible a la materia organica)

Fenólicos
Amonio cuaternario
Agentes oxidantes
Ácidos diluidos
Hidroxilamina

Disolventes orgánicos

Desoxicolato sódico
Dodecil sulfato sódico)