Zoonoses of Rural and Agricultural Occupations:

Principles and common examples

NE/CS-CASH. Ag Med Core Course
July 13, 2022

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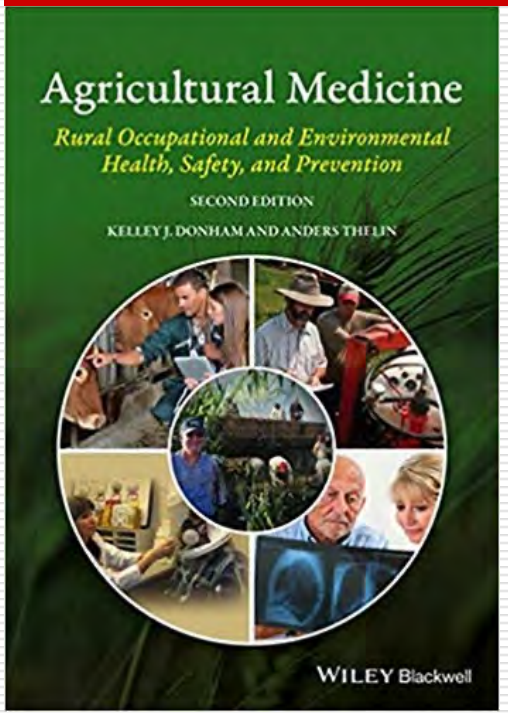
Bibliography



Donham and Thelin, 2016
Wiley-Blackwell

Zoonoses - Infections Affecting Humans and Animals
Sing, A, Springer, 2015

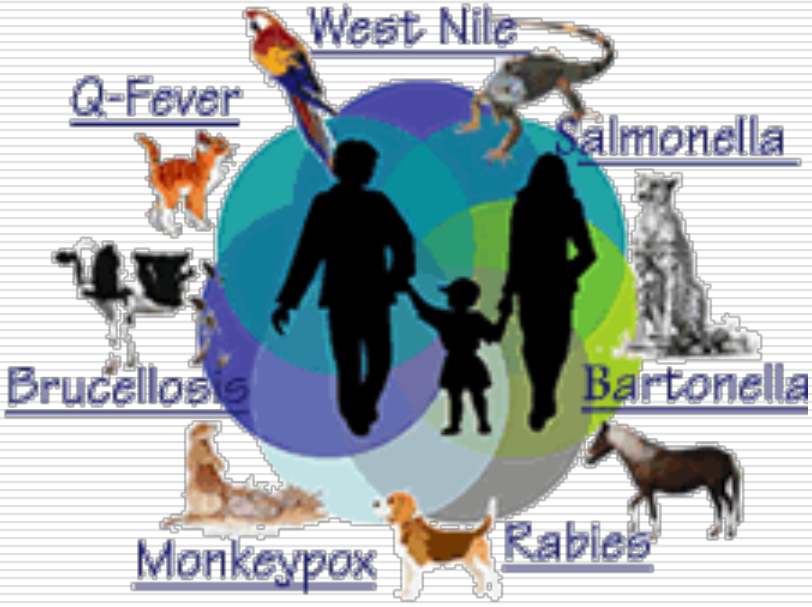
Zoonoses: Recognition, Control, and Prevention
Hugh-Jones, M., Hubbert, W., Hagstad, H.
Wiley & Sons, 2008

Zoonosis emergence linked to agricultural intensification and environmental change
Bryony A. Jones, Delia Grace, Richard Kock, Proc Natl Acad Sci U S A. 2013 May 21; 110(21): 8399–8404.

Human–livestock contacts and their relationship to transmission of zoonotic pathogens, a systematic review of literature
Gijsklous, Heederik, Coutinho
One Health 2; pp 65-76
December 2016, Pages 65-76
open access

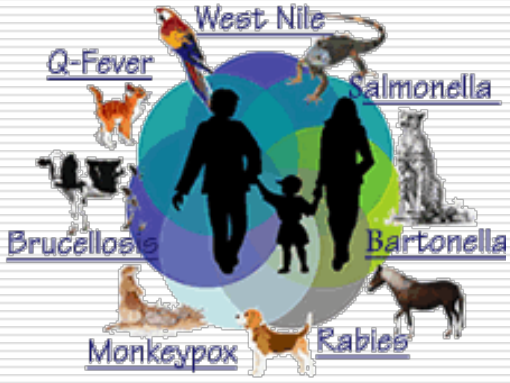
Topics Covered

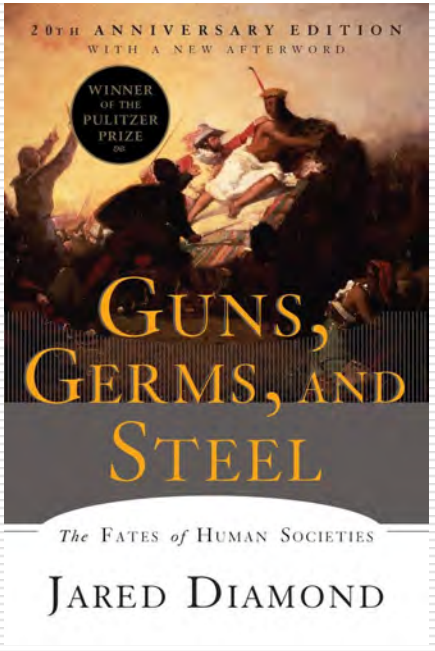
- Overview and general epidemiology
- Endemic and Epidemic Zoonoses
- Epidemic Zoonoses
  - Influenza A
  - Corona Virus
- Endemic Zoonoses
  - Leptospirosis
  - Erysipeloid
  - *Strep suis*
  - MRSA (Methicillin resistant *Staphylococcus aureus)*
  - Tetanus



General Features of Agricultural Zoonoses

1. Zoonoses are diseases <u>common</u> to animals and man
2. Historically they have changed history.





2. There are over 250 zoonoses in the world

3. 60% Human pathogens, and 75% of emerging diseases = zoonotic. http://fazd.tamu.edu/

(Donham and Thelin, 2006, pp 357 - 380)

E.G.: Influenza, CORONA, HIV, ebola, Mad Cow, zika, nipa

General Features of Agricultural Zoonoses

4. The risk of contracting a zoonotic disease depends on activities that bring humans into close association with animals/environment

5. Twenty-four of these are hazards for agricultural workers in the U.S.

General Features of Agricultural Zoonoses

6. Agricultural zoonoses can be classified by their “relative risk” with type of livestock, e.g. swine, dairy, beef, poultry, or the general outdoor environment

Zoonoses can be classified by their "relative risk" with type of livestock, e.g. swine, dairy, beef, poultry, or the general outdoor environment

BEEF CATTLE:

Anthrax

BSE

Rabies

Leptospirosis

DAIRY CATTLE:

Milker's nodule

Q Fever

Staph infection

Vesicular Stomatitis

Zoophilic Ringworm

POULTRY:

Histoplasmosis

Newcastle disease

Influenza Ornithosis

SHEEP:

Contagious ecthyma

Brucellosis

Hydatid disease

Tularemia

SWINE:

Leptospirosis

Erysipeloid

Swine influenza

NIPAH Virus

S. suis

Hepatitis E

MRSA

RURAL ENVIRONMENT:

Blastomycosis

Arthropod-borne

Viral encephalitis

Rocky Mountain Spotted

Tetanus

Toxoplasmosis

Epidemiologic “generalities” of Zoonoses

7. Seven general characteristics of these diseases:

   a. They have non-specific symptoms, often resembling severe influenza

   b. They are difficult to diagnose

   c. They cause illness, but are rarely fatal

   d. Animals are often sub-clinical chronic carriers

   e. Humans are the dead end hosts

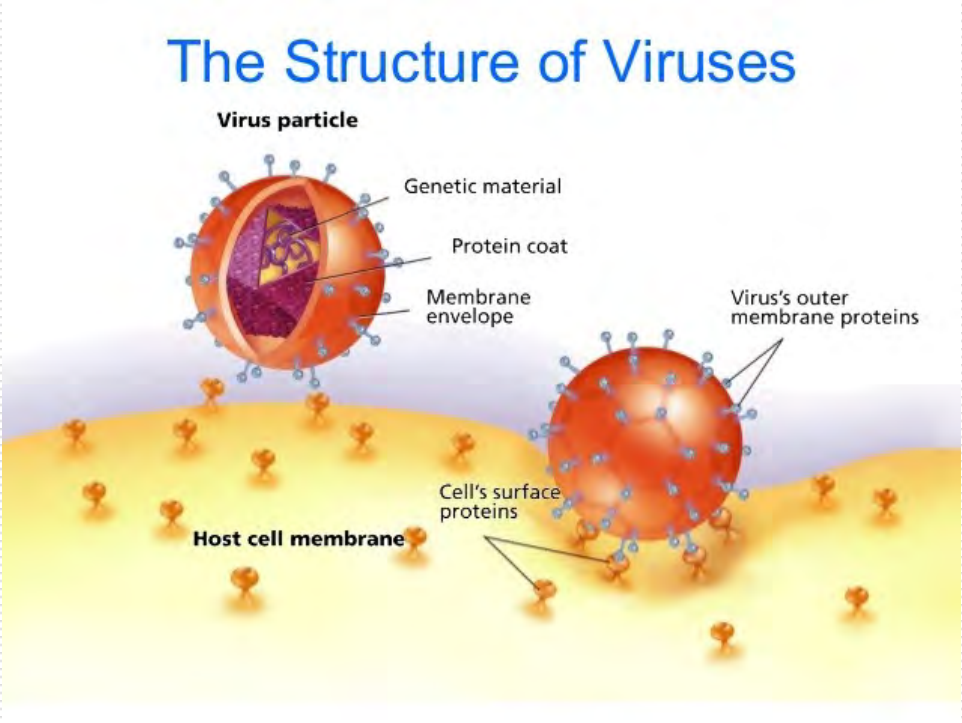
   f. They cause economic losses when livestock are affected

   g. Human cases are usually sporadic, (epidemics uncommon)

Vulnerable Populations:

- Children
  - Lower immunity
- Those lacking “herd immunity”
- Women
  - Abortion risks
    - Brucella,
    - Q Fever,
    - Listeria

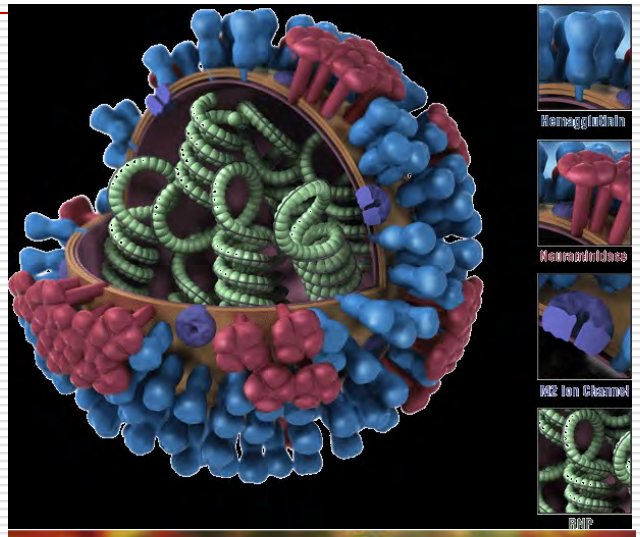
Pathogenesis of Infectious Agents

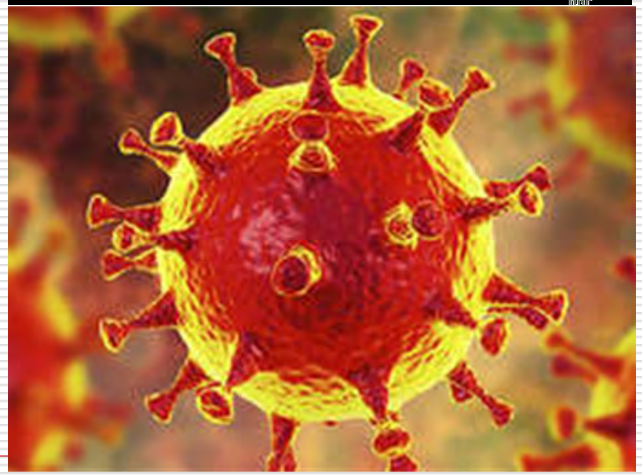


- "Germs" are parasites
- A battle between host defenses and the mechanisms of the agent.
- Example of viruses entering cells.

Endemic and Epidemic Zoonoses

- Epidemic viruses
  - Influenza viruses
  - Corona Viruses





Zoonotic Influenza

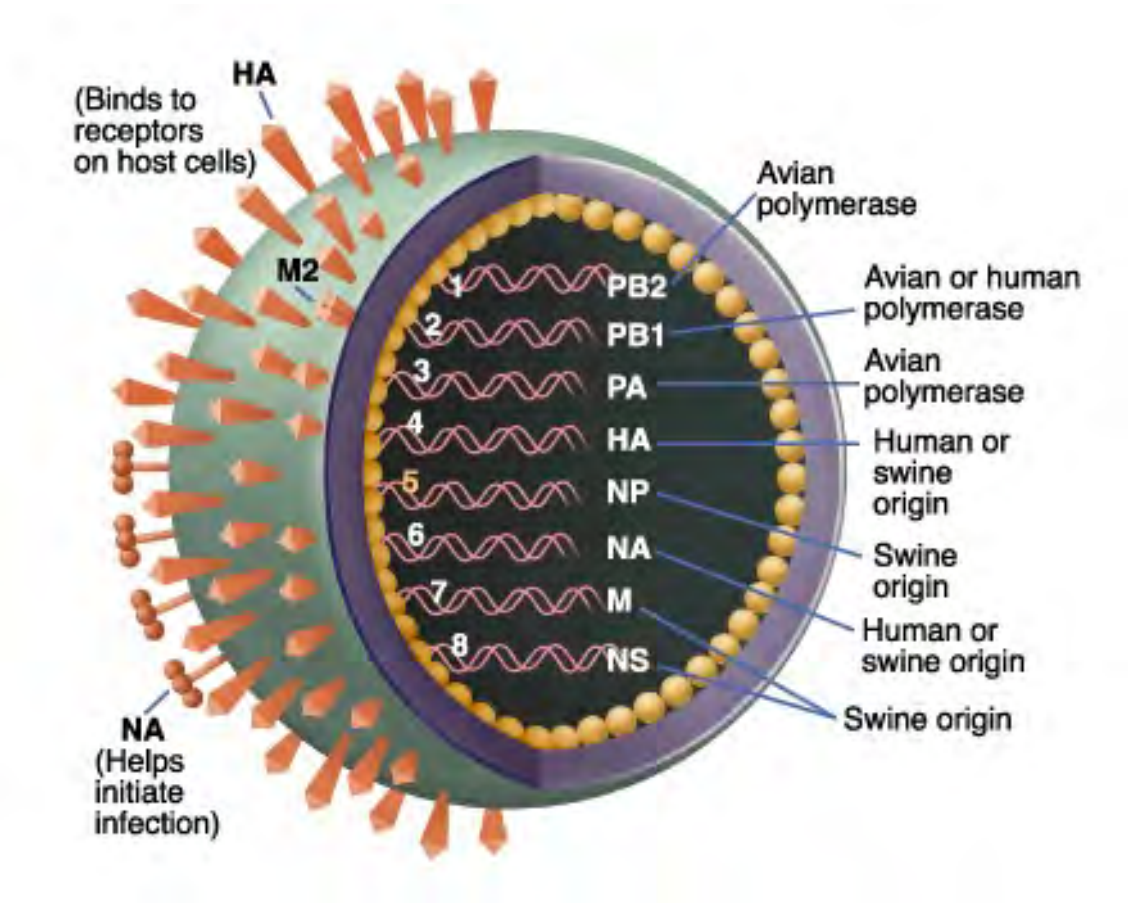
Swine, Avian, Human
Horses and Dogs

(Donham and Thelin, 2006 p 371, Capua, 2013 Vet Microbiol. 2013 26;165(1-2):7-12 *)*

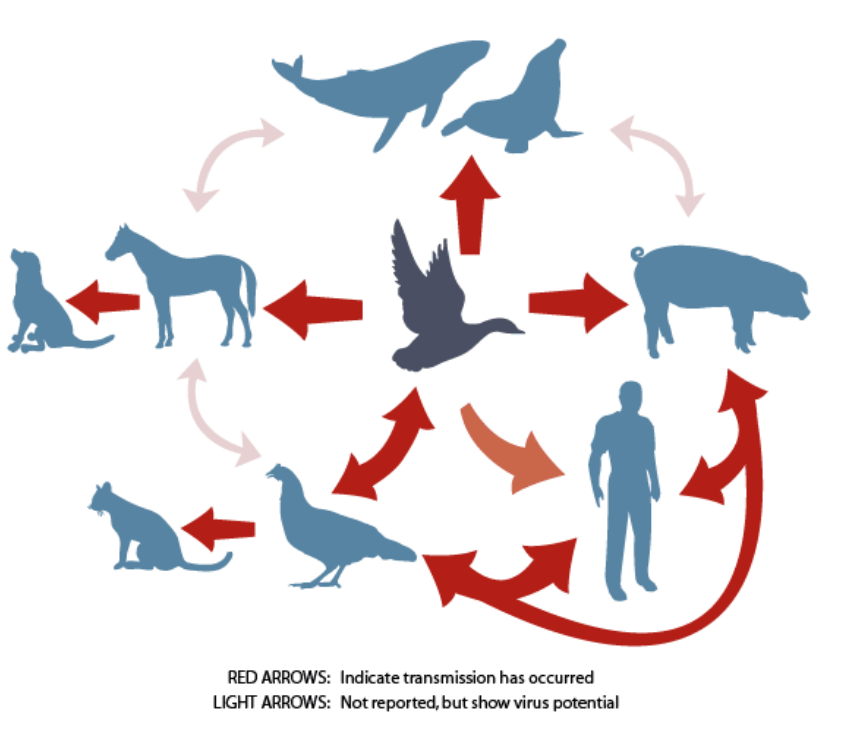
Influenza Virus

- Family Orthomyxoviridae
  - "myxo" means mucus
- Three main types
  - Type A
    - Zoonotic strains
    - Multiple species
  - Type B
    - Humans
  - Type C
    - Humans and swine

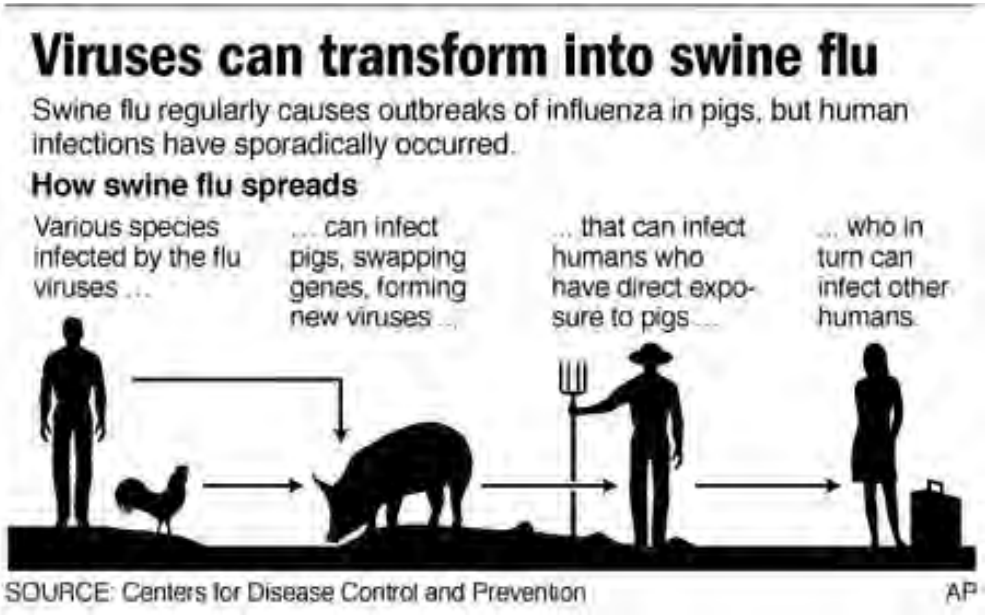
Genetics of Influenza A



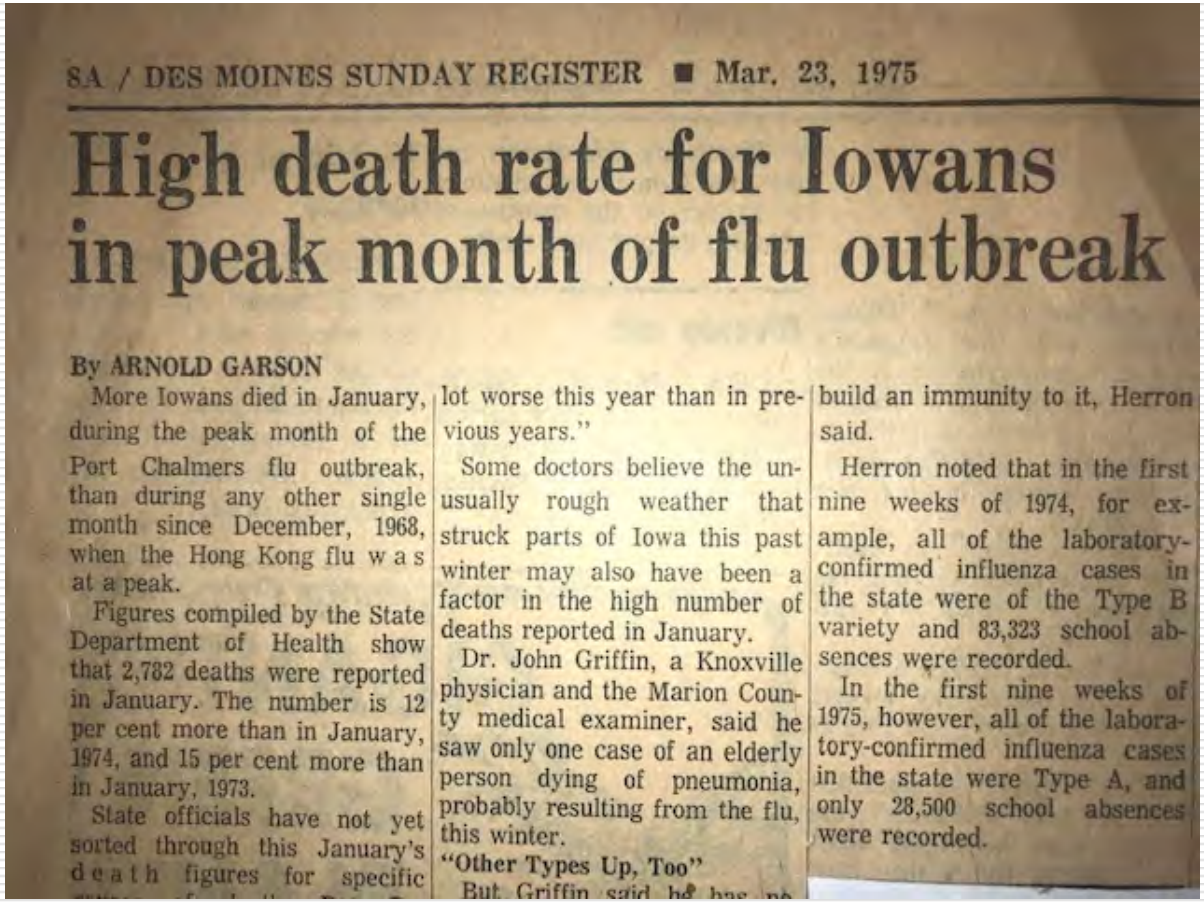
Interspecies Transmission



RED ARROWS: Indicate transmission has occurred
LIGHT ARROWS: Not reported, but show virus potential



Annual influenza and periodic pandemics



8A / DES MOINES SUNDAY REGISTER ■ Mar. 23, 1975

High death rate for Iowans in peak month of flu outbreak

By ARNOLD GARSON

More Iowans died in January, during the peak month of the Port Chalmers flu outbreak, than during any other single month since December, 1968, when the Hong Kong flu was at a peak.

Figures compiled by the State Department of Health show that 2,782 deaths were reported in January. The number is 12 per cent more than in January, 1974, and 15 per cent more than in January, 1973.

State officials have not yet sorted through this January's death figures for specific

lot worse this year than in previous years."

Some doctors believe the unusually rough weather that struck parts of Iowa this past winter may also have been a factor in the high number of deaths reported in January.

Dr. John Griffin, a Knoxville physician and the Marion County medical examiner, said he saw only one case of an elderly person dying of pneumonia, probably resulting from the flu, this winter.

"Other Types Up, Too"

But Griffin said he has no

build an immunity to it, Herron said.

Herron noted that in the first nine weeks of 1974, for example, all of the laboratory-confirmed influenza cases in the state were of the Type B variety and 83,323 school absences were recorded.

In the first nine weeks of 1975, however, all of the laboratory-confirmed influenza cases in the state were Type A, and only 28,500 school absences were recorded.

Zoonotic Influenza History and Biology

The “Spanish Flu H1N1” 1918-1919

50 – 100 million estimated deaths

I had a little bird
Its name was Enza
I opened a window
And in-flu-enza

1976 H1N1 Swine Flu Re-emerges

A/New Jersey/76? =

A/Swine [HSW_1N_1] =

Virus of 1918-1919

2009 Swine Flu Again? (Novel H1N1)

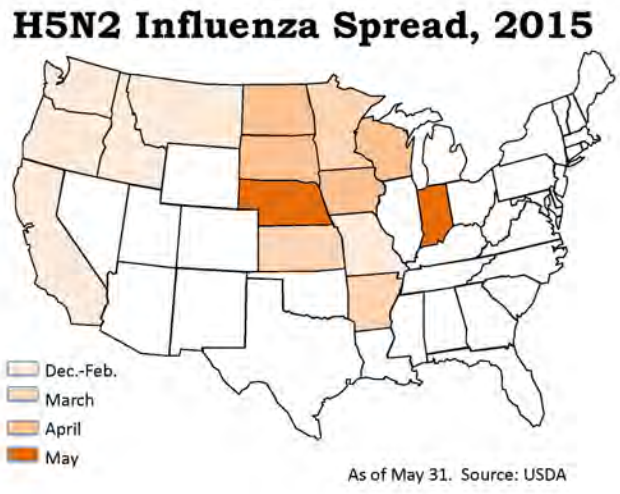
Now, Novel H1N1 of 2009 aka “Swine Flu”

Avian Influenza in North America 2015 & 2022

(http://www.cdc.gov/flu/avian/outbreaks/current.htm)
(https://www.cdc.gov/flu/avianflu/north-american-lineage.htm)

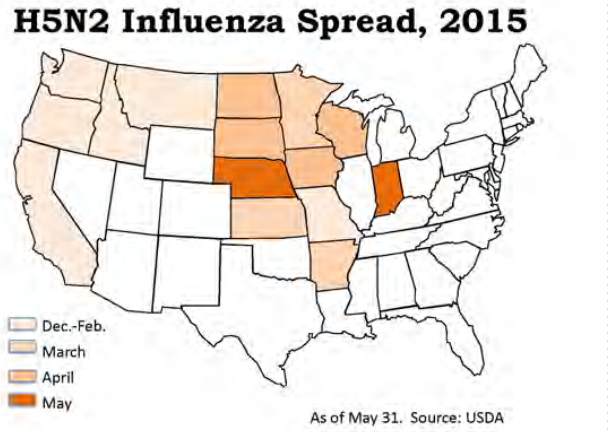
- Most low path – no problem
- High Path (most H5 N1 something)
- Low transmission to humans
- One diagnosed Human illnesses in U.S>
- Asian & Arica human cases 447 fatalities
- http://www.who.int/influenza/human_animal_interface/EN_GIP_20150501CumulativeNumberH5N1cases.pdf?ua=1

North American Lineage avian viruses Low risk transmission to humans (H5N2 in 2015)



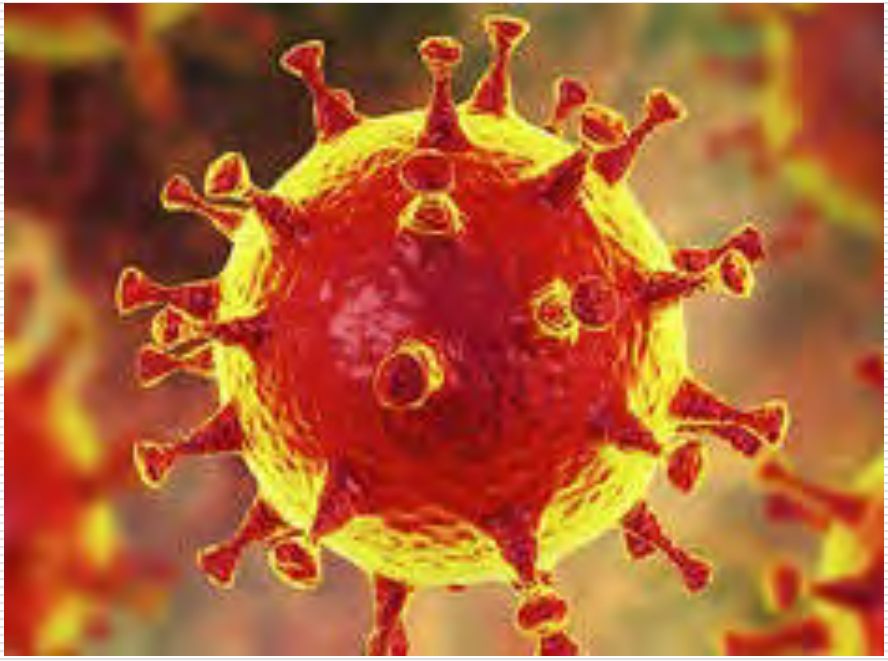
Bird Flu –Where did it come from where is it going?

- High Path Strain
- H5N1 mainly
- Outbreaks in 2015, and 2022
- Origan wild migrating waterfowl.
- Human not very susceptible (1 case in U.S.- no sx.)
- Asia & Africa since 2003. 864 cases 456 fatal)
- **Avian Influenza A (H5N1) - United States of America , WHO 5/6/22**



Corona Viruses

- RNA virus
- Surface binding proteins allow entry to cells
- RNA recombination results in Variation in pathologic and infectious capability
- Many different strains that can infect animals and humans



History of Corona viruses infecting humans

- Many common Corona viruses
- 3 NOVEL corona viruses have resulted in epidemics

SARS

- (severe Acute Respiratory syndrome)
- 2003 -2004
- Origin – China
- Bats -- Civet Cat –People
- Pandemic – but brief
- 8000 total human cases

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3747533/

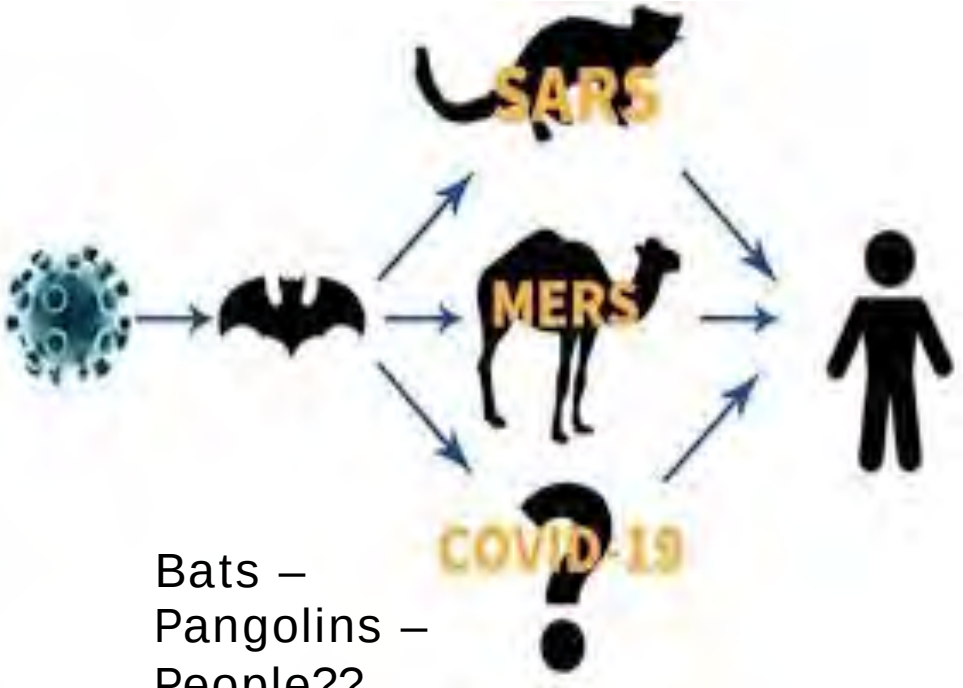
MERS

- Middle East Respiratory Syndrome
- 2012 (still around)
- Origin – Saudi Peninsula (localized there)

COVID 19 PANDEMIC

- July 2021. 1.9 million cases > 4million deaths. World wide. U.S. >34 million cases, >600 deaths.
- 188 countries

https://coronavirus.jhu.edu/map.html



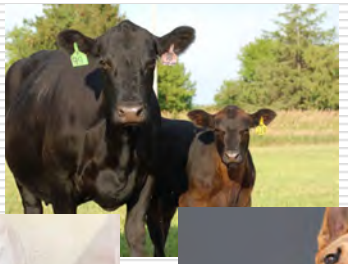
Bats – Pangolins – People??

(SARS-CoV-2)COVID 19)

- February 2020 - ???
- China
- “Wet” markets
- Bats
- Pangolins?
- Laboratory Escape?
- Continued research

Animal species susceptible to COVID 19

Domestic livestock/poultry	Pets	Other
Cows	Dogs	Bats
Pigs	Cats	Pangolins
Chickens	Ferrets	Mink
Ducks		Mice
		Lions
		Tigers
		Camels
		Primates



CDC: https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/sa_one_health/sars-cov-2-animals-us
USDA: https://www.cdc.gov/coronavirus/2019-ncov/daily-life-coping/animals.html

Low Risk of transmission of COVID 19 between animals and humans

From the CDC

- Re Pets
  - *"At this time, there is no evidence that (domestic) animals play a significant role in spreading the virus that causes COVID-19".*
  - *"People sick with COVID-19 should isolate themselves from other people and animals, including pets, during their illness until we know more about how this virus affects animals".*
- *Re Livestock*
  - *No known risk of humans infected from pigs or cows.*
  - *Risk to farmers is emotional and economic because of euthanizing pigs as slaughter plants closed because of COVID 19*

Monkey Pox ??

- Not new
  - 2003 – import of African pet prairied dogs
    - 2022 – Human to human (sexual trans?)
- Trans by Direct contact, not aerosol like COVID
- Not a big threat
- Not an Agricultural risk

Endemic Zoonoses

Swine Zoonoses

Case Study

- Malais
- 103º F
- Chills
- Muscular aches

- Headache
- Stiff neck
- Photophobia

Leptospirosis

- *Leptospira interrogans*
- Worldwide distribution

Treatment/Control and Prevention

- Antibiotics
  - Tetracycline
  - Penicillin
  - Streptomycin
  - Erythromycin
- Vaccination
- Caution in handling tissues
- Avoid direct contact with water/urine of potentially infected animals.

Erysipelothrix rhusiopathiae

"Erysipelas" In pigs

Pigs mainly but there are Other Sources of Erysipeloid

- Various Livestock species
- Soil
- Contaminated objects (fomites)

Infection in People: Typically on Hand or Foot

- Swelling
- Deep burning, throbbing pain
- Skin tense
- No suppuration
- Violet-colored zone of erythema surrounding lesion
- Joints of phalanges, tender limited movement
- Axillary lymph nodes, swollen and tender
- Lesions on other body parts

Case #1 - Swine producer stopped by police - driving erratically

- No evidence of alcohol or drugs
- Taken to hospital
  - Severe septicemia
  - High fever, DIC
  - Meningitis
  - Lived, but with permanent CNS damage, extensive skin loss.
  - *Streptococcus suis* was isolated

Case #2 – New York Farmer – Hospitalized for Meningitis – *S. suis* isolate, recently purchases piglets

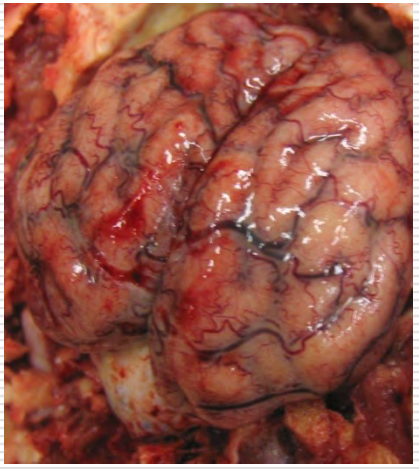
Streptococcus suis

- A common disease of swine
- Can cause infections in humans
- Septicemia, meningitis
- 40% of hospitalized cases = fatal
- Permanent brain damage – especially 8th cranial nerve function (hearing and balance)
- (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2634616/)
- Emerg Infect Dis. 2014 Jul; 20(7): 1105–1114.

Streptococcus suis

- Nursery pigs most commonly affected – Meningitis

- Weak, unable to stand or walk
- Seizures
- Possible arthritis
- High mortality
- Sows are carriers - up to 80% of herd



Primary Epidemiological Aspects of *Streptococcus suis*

In the human population

- Mechanisms of transmission: contact with infected pigs or their environment; consuming contaminated pork.
- Population at risk: pork producers
- Recent China outbreak, 38 fatalities/215 cases
- 2008 sero-survey – 10% of swine exposed persons
- Misdiagnosed/under diagnosed/variance in virulence (Smith et. al. 2008)

- Feng et.al. Virulence. 2014,5(4): 477–497.
- Emerg Infect Dis. 2014 Jul; 20(7): 1105–1114.

Control / Eradication:

- Good hygiene practices
  - Environment – Power wash with biocide
  - Personal
    - Wash hands
    - Treat Lacerations

- Keep *S. suis* out
  - Biosecurity
  - Test/treat/cull
  - No Commercial Vaccine

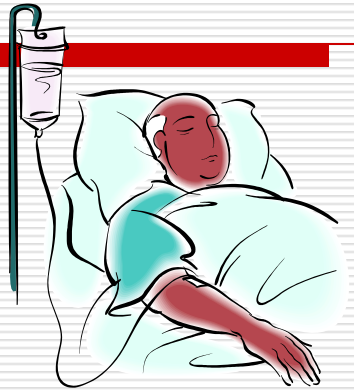
Joel - 1997

MRSA

Methicillin-Resistant *Staphylococcus aureus*

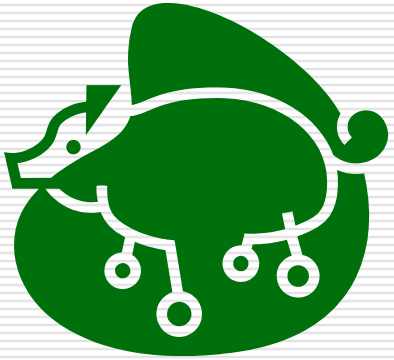
(smith and Pearson 2010)

Three Main Reservoirs of MRSA



Hospital (1980's)

Community
(1990's)

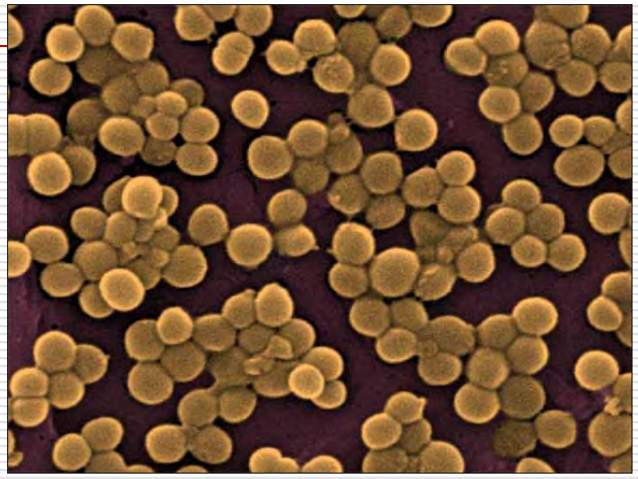


Veal Calves - Netherlands (2004)
Swine – Iowa (2009)

Methicillin Resistant *Staph aureus* MRSA

- The “super bug”
- Since 1981 in the U.S.
- Initially hospital acquired. Now community acquired as well.
- Resistant to Methicillin and often several other beta lactams (penicillin group)
- Tetracycline resistance also common in swine LA MRSA strains
- 1% of the general population are carriers
- 15% - 40% of farm population LA MRSA carriers

The Organism



- *Staph aureus*
  - Gram positive coccus
- Virulence factors
  - Adhere to surfaces
  - Damage/avoid immune system
- Toxins
  - Exotoxins – toxic shock, scalded skin
  - Cytotoxin (PVL) – tissue necrosis
  - Enterotoxins – preformed, gastroenteritis

Epidemiology - MRSA

- Beta-lactam antibiotics damage bacterial cell wall & Penicillin binding sites (PBP)
  - MRSA Inactivates PBPs (penicillin. binding proteins)
- mecA gene codes for PBPa
  - Confers resistance to beta-lactam abx
  - Presence = Methicillin-resistance

J Clin Microbiol. 2004 Dec; 42(12): 5881–5884

MRSA Disease in Humans

Clinical Signs – Humans

- Hospital-acquired
  - Wide variety of infections
  - Surgical site infections to invasive disease
- Community-acquired
  - Superficial skin, soft tissue disease
  - Pneumonia
  - Septicemia
  - Joint infections

MRSA – Treatment

- Drainage and dressing
- Alternative to Beta Lactams antibiotics:
  - Trimethoprim/sulfamethoxazole (Bactrim)
  - Clindamycin
  - Gentamycin
  - Rifampin
- Decolonization – mupirocin (Bactroban)

MRSA Disease in Animals

MRSA in Animal Populations (this is a zoonotic infectious agent)

- Livestock: Pigs, Cattle, Horses
- ST 398 = Livestock Strain
- 60% of pigs infected mainly as carriers
- Mastitis in dairy cattle
- 15% - 40% of veterinarians colonized
- Pets: Dogs, cats
- Clinical disease rare

Smith, Livestock-Associated *Staphylococcus aureus*: The United States Experience

Transmission

- Opportunistic in human
- Animals ⟷ People ⟷ Family
- Direct contact colonized people/animals
- Vertical spread from mother to fetus
- Fomites
  - Towels, used bandages
- Aerosol
- Oral (contaminated food)
- Clinical LA MRSA in U.S. unknown risk

U. IA. Research on MRSA

Tara Smith PhD, Mike Male DVM, Dwight Ferguson, Abby Harper, Kerry Leedom DVM, MPH, Kelley Donham DVM

- Ecology?
- Pigs and people common/temporary carriers.
- Found in settled dust, air inside and outside swine buildings and shower facilities)
- Isolated from meat samples from grocery stores.
- Is it an important occupational or public health concern??

Biosecurity issues?

- ✓ Where does it live in swine buildings?
- ✓ Its in animal feed
- ✓ Spread down wind
- ✓ How do we prevent its spread?
- ✓ Can we use bio-filters?

Diagnosis

- Culture infection site
  - *Staph aureus* is coagulase positive
- Determine if *Staph aureus* is MRSA
  1. Antibiotic susceptibility testing
     - Oxacillin or cefoxitin
  2. Genetic testing
     - PCR to detect mecA gene
     - Livestock strains = St 398
     - Latex agglutination for PBP2a

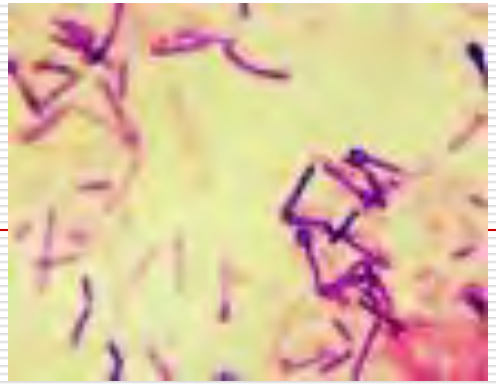
Prevention and Control

- Hygiene, hygiene, hygiene!!
- Cover skin abrasions Avoid sharing personal items
- Shower after exercising; clean equipment
- Screen health care & Swine workers
- Screen New Pts. in hospitals & nursing homes

Summary of MRSA

- It is apparent that farm animals are a reservoir for MRSA
- There are new strains developing in the animal population
- Unknown occupational and public health risk.

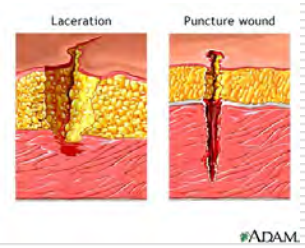
Tetanus



- Clostridium tetani
- Anaerobe – spore former – produces tetanospasm
  - Blocks releasing factors of neurotransmitters at spinal cord level
- Lives in soil – feces from herbivore animals

Tetanus Risk Factors

- Anaerobic wounds contaminated with soil/herbivore feces
  - Deep puncture wounds
  - Tissue necrosis
  - Foreign body
  - Very young and elderly (insufficient immunity)



- Infants of mothers not immunized or not breast feed
- Bowel surgery
- Contaminated needles

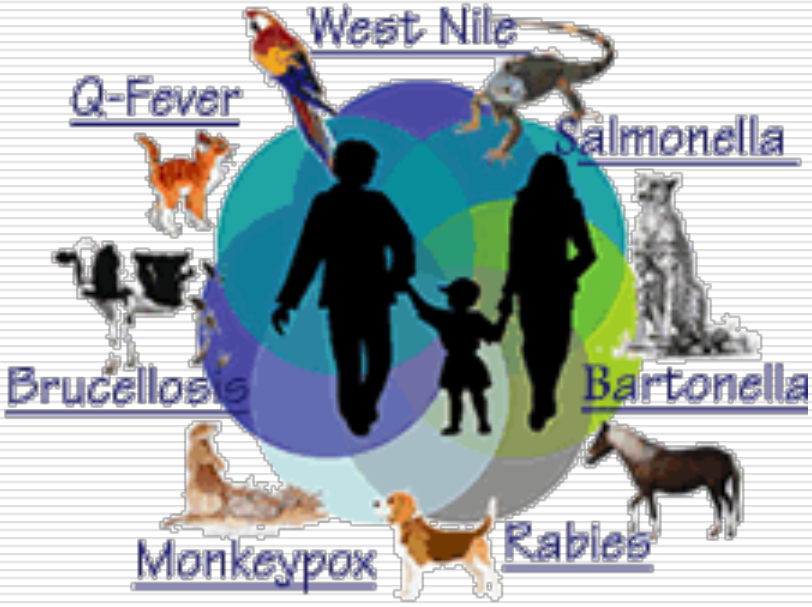
Tetanus the Disease

Tetanus Primary Prevention

- Tetanus Toxoid immunization
  - DPT Children (5 doses)
    - Spaced from 2 mo. – Beginning school age
  - Adults
    - 10 years
    - Or after severe exposure if > 5 years
    - Some recommend DTP in adults for booster

A Quick Review

- Overview and general epidemiology
- Epidemic and Endemic conditions
- Leptospirosis
- Erysipeloid
- *Strep suis*
- MRSA (Methicillin resistant *Staphylococcus aureus)*
- *Zoonotic Influenza*
- Tetanus



Post Quiz

Animals are the primary host for all Zoonoses communicable to man.

- ☐ True
- ☐ False
- ☐ Don’t know

Generally, a zoonotic infection in a person is readily transmitted from person to person.

- ☐ True
- ☐ False
- ☐ Don't know

Which of the following is NOT True?

- Zoonoses in humans usually occur in broad epidemics
- There are over 250 zoonoses in the world
- Zoonoses make up 60% of human pathogens and 75% of emerging diseases

Leptospirosis is disseminated by contact with urine of an infected pig, cow, raccoon, squirrel, or mouse.

- ☐ True
- ☐ False
- ☐ Don’t know

Methicillin resistant *Staphylococcus aureus (MRSA)* is a commonly recognized occupational disease of pork producers.

- ☐ True
- ☐ False
- ☐ Don't know

Which of the following is the greater risk for tetanus?

- Laceration on the hand while castrating pigs
- Dairy farmer sticks his foot with a pitchfork while cleaning the barn
- Stepping on a rusty nail
- Don’t know

Human beings cannot acquire animal ring worm infection

- ☐ True
- ☐ False
- ☐ Don’t know