

Emergence of new pathogens 'Viruses'

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Outline

- Emerging pathogens -trends
- Emerging & re-emerging diseases
- Factors contributing to emergence
- Examples/ Case studies
- Public health response
- Control and prevention

Emerging pathogens-trends

- Changes in environment - ecological changes provide new opportunities for pathogens to emerge and gain access to human populations
- Ease of world travel(trade and tourism) and increased global interdependence – transmission of infectious agents, disease reservoirs/vectors

Emerging pathogens-trends

- A pathogen may emerge as an important public health problem because of changes in itself or its transmission pathways.

The viruses with the greatest potential for emergence in the near future include: hantavirus, dengue, influenza, and HIV etc

- Since last quarter of 20th century - New & Reemerging infectious diseases
- Unusually large number - Rotavirus, HIV/AIDS, Hantavirus, Hepatitis E, Hepatitis C,

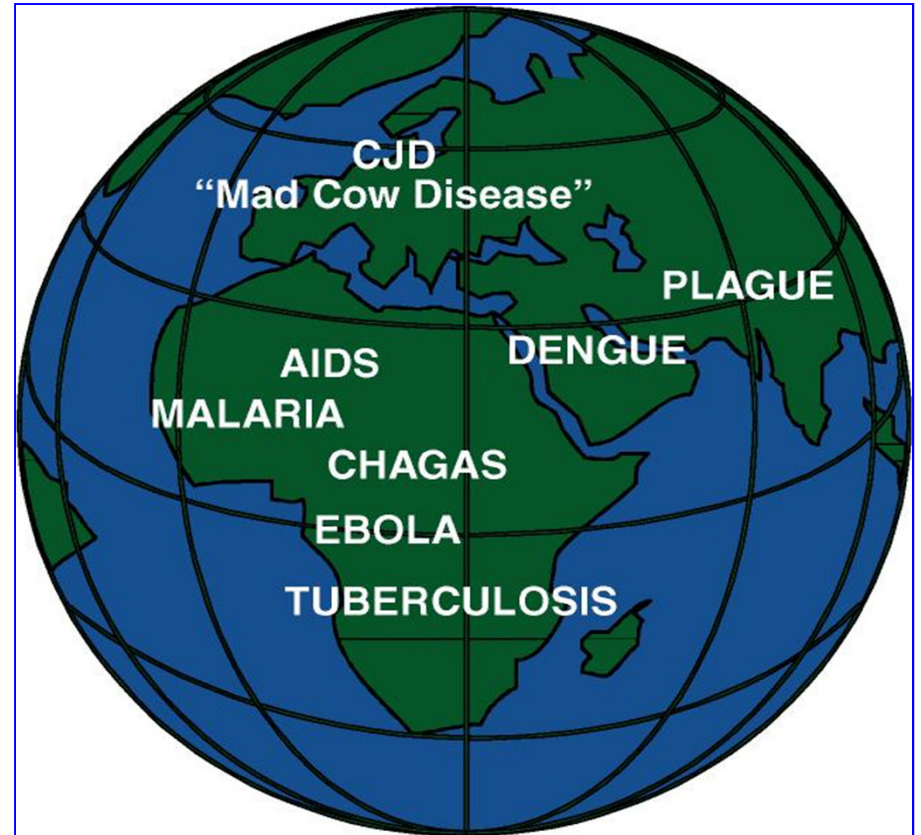
- **MERS (Middle East Respiratory Syndrome)** similar to SARS caused by *coronavirus* which appeared in Saudi Arabia in late 2012, caused 52 deaths (van Boheeman *et al.*, 2012).
- India (**Bangalore**) - a Haj returnee was diagnosed with MERS this week (*Deccan Herald- Nov,11.2013*).

WHO - November,4, 2013 – 149 affected,64 deaths (53 in Middle East)

- ‘**Severe fever with thrombocytopenia syndrome**’ (**SFTS**) in China in 2010.- *bunyavirus*, (Dexin Li, 2013). **Ticks** are suspected to be the vector that transmits the virus to human.
- China, May,2013- new H6N1 avian influenza virus (Nov, 15, 2013, *Deccan Herald*)

Emerging infections

- “New, emerging infections whose incidence in humans has increased within the past two decades or whose incidence threatens to increase in the near future.”



Emerging Viral Infections in the World and US since 1973

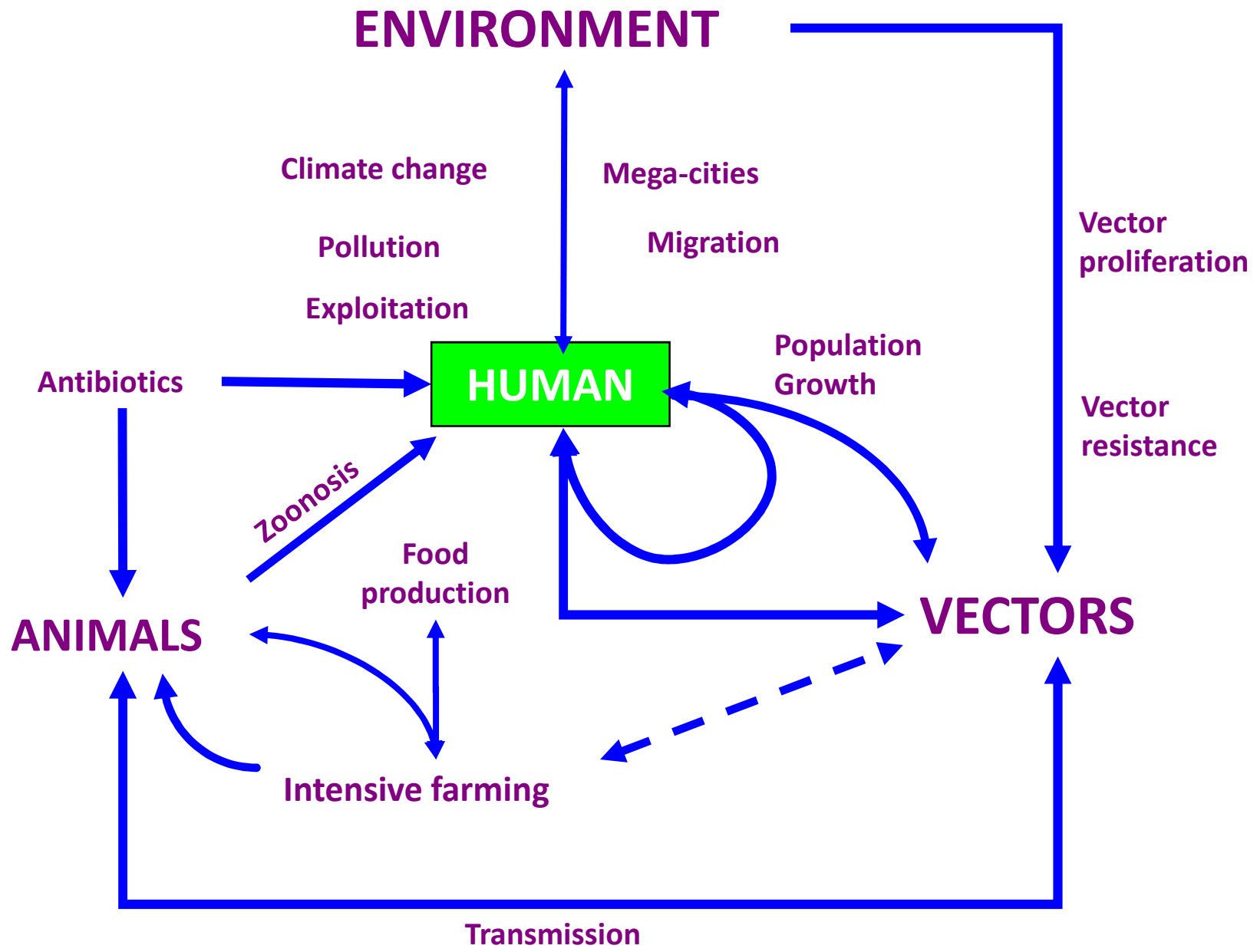
1973	Rotavirus	Enteritis/Diarrhea
1977	Ebola virus	VHF
1977	Hanta virus	VHF / renal failure
1983	HIV	AIDS
1988	Hepatitis E	Hepatitis
1989	Hepatitis C	Hepatitis
1990	Guanarito virus	VHF(Venezuela)

Emerging Viral Infections in the World and US

1993	Sin Nombre virus	Hanta Pulm. Synd.
1994	Sabia virus	VHF (Brazil)
1994	Hendra virus	Respiratory dz
1995	Hepatitis G	Hepatitis
1995	H Herpesvirus-8	Kaposi sarcoma
1997	Avian influenza (H5N1)	Influenza
1999	Nipah virus	Encephalitis
1999	West Nile virus	Encephalitis
2003	Monkey pox	Pox
2003	SARS-CoV	SARS

Major Factors Contributing to Emergence of new pathogens

Microbial agent	Human Host	Human Environment
Genetic adaptation & change	Human susceptibility to infection	Climate and weather
Dev. of resistance to drugs	Human demographic and behaviors	Changing ecosystems
	International trade and travel	Economic development and land use
	Intent to harm (bioterrorism)	Technology and industry
	Occupational exposures	Poverty and social inequality
	Inappropriate use of antibiotics	Lack of public Health measures
		Animal populations
		War and famine
		Lack of political will



Emerging viral Infections:

Climate & environmental change

- **Deforestation** forces animals into closer human contact- increased possibility for agents to breach species barrier between animals & humans
- **El Nino**- Triggers natural disasters & related outbreaks of infectious diseases, altered vector range, vectorborne diseases, Hantavirus pulmonary syndrome ([HPS](#)),
- **Global warming** - spread of Dengue, Malaria, Leishmaniasis, Filariasis

Emerging viral Infections:

Economic Development, Land Use, Changing Ecosystems

- Changing ecology influencing **waterborne, vector borne** disease transmission
Dams, Changes in water ecosystem - RVF
Deforestation/ reforestation : Kyasanur Forest dis, Lyme disease)
- More exposure to wild animals and vectors (*RVF, Lassa fever*)
- Agricultural activities - Hanta, Argentine hemorrhagic fever, Nipah, West Nile
- Contamination of watershed areas by animals

Waterborne viral infections

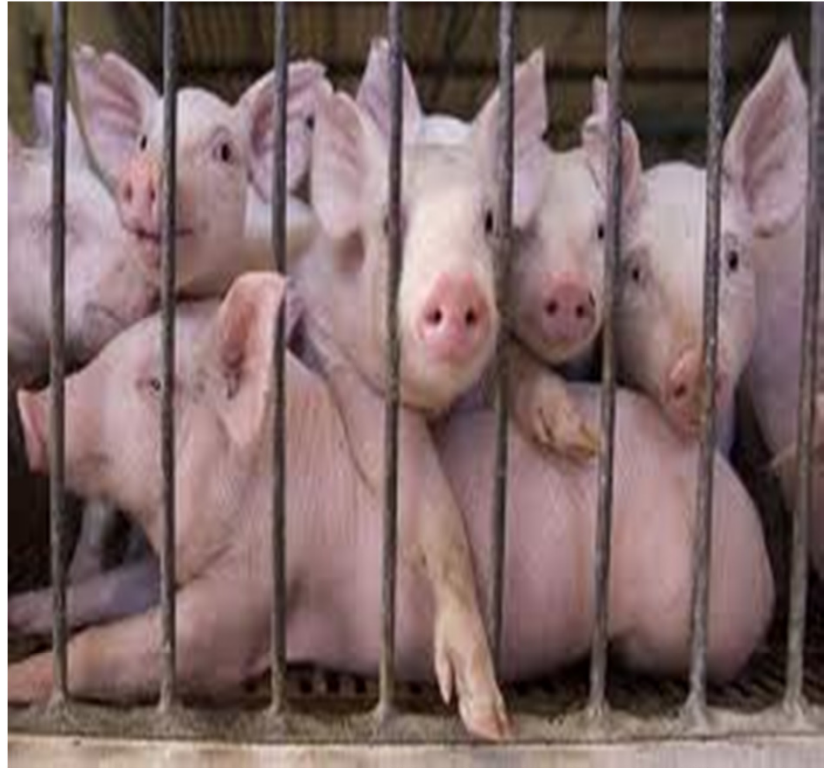
Feces Contaminated drinking water and improperly treated water

Disease	Virus	symptoms
Hepatitis A disease	Hepatitis A virus	Fever, jaundice, vomition, diarrhea, severe abd.pain
Poliomyelitis/Polio	Poliovirus	90-95% no symptoms, physical abonormalities in later stages
Hepatitis E	Hepatitis E virus	Fever, jaundice, vomition, diarrhea severe abd.pain
SARS	Corona virus	Fever, myalgia, cough, sore throat
Adenovirus infection	Adenovirus	Pharyngitis, pneuomonia
Calicivirus	Viral gastroenteritis	Severe diarrhea
Rotaviral diarrhea	Rotavirus	Severe diarrhea in children
Rift valley fever	A bunyavirus	Fever, severe myalgia, diarrhea
West Nile fever	WNV- a Flavi virus	encephalitis

Emerging viral Infections:

Technology and Industry

- Food-handling practices - [SARS](#), H5N1 influenza,
- More organ transplants and blood transfusions (Hepatitis C, HIV, Kaposi Sarcoma)
- New drugs for humans (prolonging immunosuppression)
- **Animal husbandry practices** - (H1N1, H5N1, Nipah etc. 60 to 80 % new human infections likely originated in animals, rodents and bats, (hantavirus pulmonary syndrome, Lassa fever, and Nipah virus encephalitis)



Emerging viral Infections:

Human Demographics, Behavior, Vulnerability

- Uncontrolled urbanization -more people, more crowding , unsafe water, poor sanitation
- Changing sexual mores (HIV, STDs)
- Injections (HIV, Hepatitis C)
- Changing eating habits: out more, more produce (food borne infections)
- More populations with weakened immune system: elderly, HIV/AIDS, cancer patients and survivors, persons taking antibiotics and other drugs

Emerging Viral Infections

International Travel and Commerce

- Movement of persons infected with an exotic disease (SARS, VHF,...)
- Exotic pet trade (Monkey pox)

Microbial Adaptation and Change

- Increased virulence
- Jumping species from animals to humans (avian influenza, HIV?, SARS?)

Emerging viral Infections

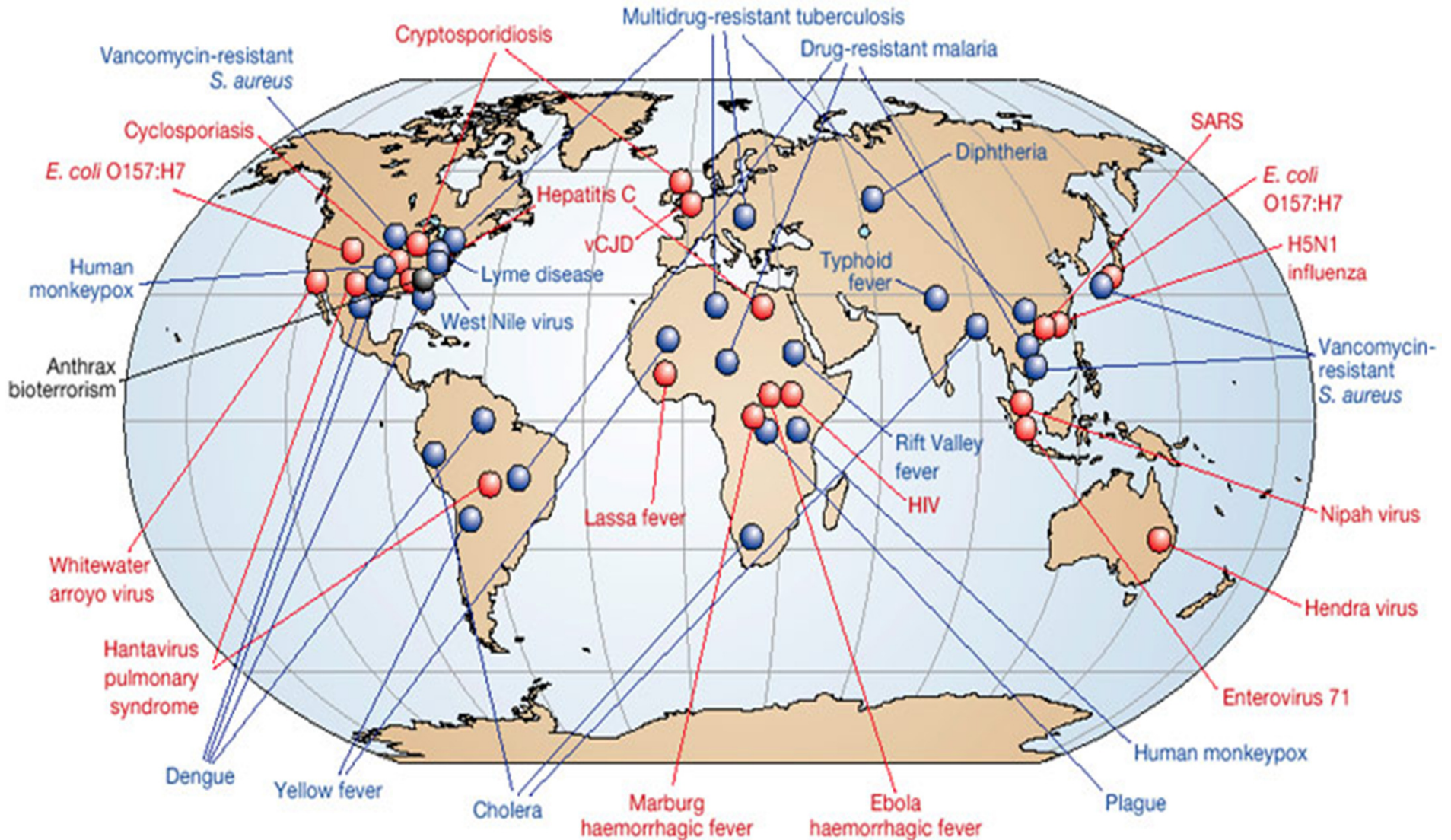
Poverty, Social Inequality, Breakdown of Public Health Measures

- Lack of basic hygienic infrastructure (safe water, safe foods, etc... Marburg angola 2004)
- Discontinued mosquito control efforts (dengue, WNV, RVF)
- Lack of monitoring and reporting (SARS)

Examples of Emergence of new viral pathogens / Case studies

- 1. Hantavirus Pulmonary Syndrome-1993
- 2. Hendra virus- Australia 1994
- 3. Nipah virus-Malaysia -1999
- 4. SARS-China 2003
- 5. Marburg - Angola 2004
- 6. MERS in Middle east -2012

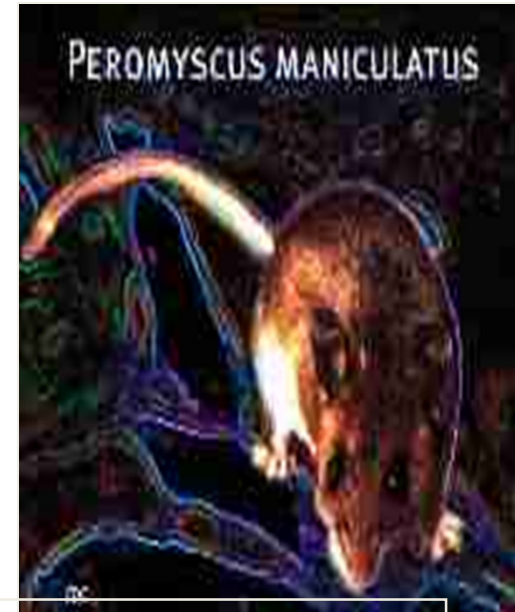
Examples of recent emerging diseases



Source: NATURE; Vol 430; July 2004;
www.nature.com/nature

Hantavirus outbreak in 1993

- May, 1993 - unexplained acute resp. failure in New Mexico - healthy adults of 20-24 yr age
60% fatality,
associated with a field mice - 'Hantavirus'
- **Hantavirus pulmonary syndrome** - Sin Nombre virus, **deer mouse**-reservoir
- 1992- El Niño - heavy rainfall - increased pinyon nuts, more mice - increased exposure



Hantavirus Pulmonary Syndrome

deer mouse

Hendra virus-1994

- severe respiratory disease with high mortality in thoroughbred horses in Brisbane, Australia
- Two persons at the stable developed a severe influenza-like disease and one died. A new virus- **Hendra virus** of Paramyxoviridae, was isolated from both affected horses and a human,
- sporadic but continuing cases of this devastating disease in both horses and humans, including veterinarians who performed necropsies on affected horses.
- **Fruit bats**-reservoir host

Nipah virus outbreak in 1998

- Sept, 1998- encephalitis in Malaysia mainly in pig farmers (also resp. illness & encephalitis in pigs) - 40 % fatalities
 - New virus 'Nipah' was isolated, related to Hendra
 - possible transmission from pigs
 - Singapore-import ban on pigs from Malaysia
 - Malaysia - >1million pigs culled,
 - **Fruit bats** (*Pteropus giganteus*) –reservoirs
- (Hendra and Nipah belong to Henipavirus of Paramyxoviridae)

Reasons for Nipah emergence

- Fruit bats habitat reduced by deforestation,
- 1997-98 drought led to fires further decreasing avail. of fruits
- Bats urine and eaten fruits dropped onto pigs

2001- 2012 Bangladesh- Nipah

161 deaths /209 cases 77 % fatality

Feb,2013 - 10 deaths/12 cases

Person to person transmission (no pig involvement),

Suspected date palm juice

India-2001-2007- 50 deaths/71 cases in West Bengal-70 % fatality (WHO,2013)

Fruit bats (*Pteropus giganteus*) seropositive to Nipah

SARS: First Emerging Infectious Disease Of The

21st Century - First case in Nov,2002 -atypical pneumonia in

Guangdong, China, spread to Vietnam, Canada, Singapore, - **corona virus**

No infectious disease has spread so fast and far as SARS did in 2003

SARS Cases
19 February to 5 July 2003

Total: 8,439 cases, 812 deaths,
30 countries in 7-8 months



Source: www.who.int.csr/sars

Marburg and Ebola hemorrhagic fevers

- In 1967, 31 cases of hemorrhagic fever, with **seven** deaths among laboratory workers in **Germany** and **Yugoslavia** who were processing kidneys from African green monkeys imported from Uganda - **'Marburg virus'**
- 1976, two epidemics of hemorrhagic fever with high mortality occurred, in Zaire (Democratic Republic of Congo) and southern Sudan - **'Ebola virus'**
- June, 1997 - 1054 cases with 754 deaths by WHO
- 2004-05 - Marburg VHF in Angola children, 95 deaths out of 102 cases,

- **Ebola and Marburg viruses** cause a **most devastating clinical disease** in humans and non-human primates, including chimpanzees, gorillas, and macaques, with extremely rapid and florid tissue damage, and with a very high mortality rate
- **Fruit bats** reservoir hosts of ebola- and marburg viruses (Filoviridae)



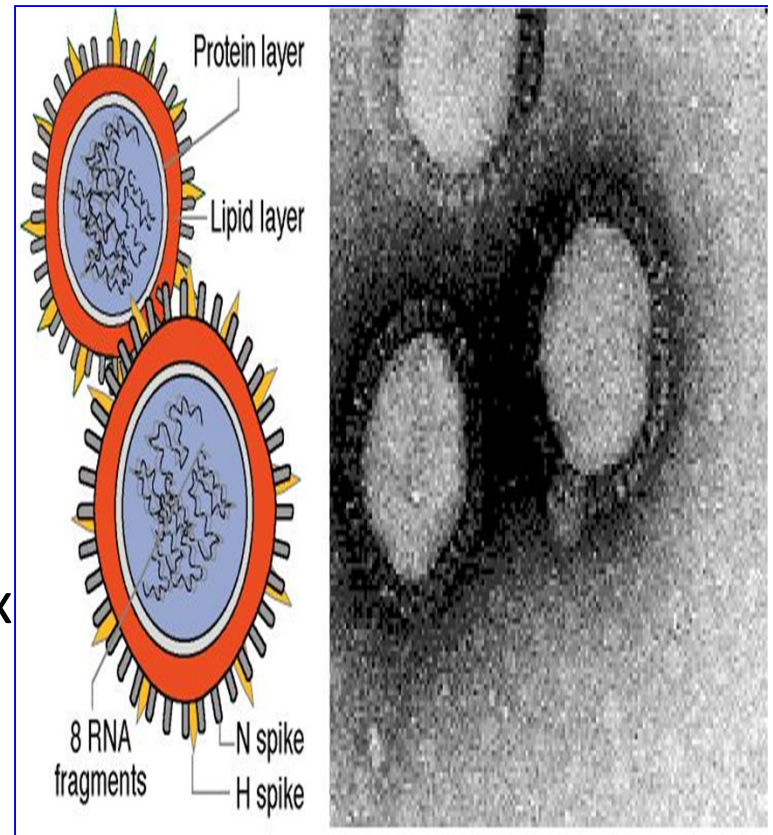
Ebola virus



Marburg virus

Avian and Swine flu

- 1997-**H5N1** Avian influenza - movements of birds, both migratory fowl and domestic poultry,
- 2009-**H1N1**-Swine flu emerged from pigs - virus was emerged after complex exchanges of human, swine and avian influenza virus genes
- Early 2013- **new H7N9 avian** influenza- China-132 cases , 28% fatalities(Li Q *et al.*, 2013)
- China, May, 2013- new **H6N1** avian influenza virus (Nov, 15, 2013, *Deccan Herald*) in a Taiwan woman- flu like illness



New Influenza A (H1N1), Number of laboratory confirmed cases and deaths as reported to WHO

Status as of 27 May 2009
06:00 GMT



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: Public Health Information and Geographic Information Systems (GIS)
World Health Organization



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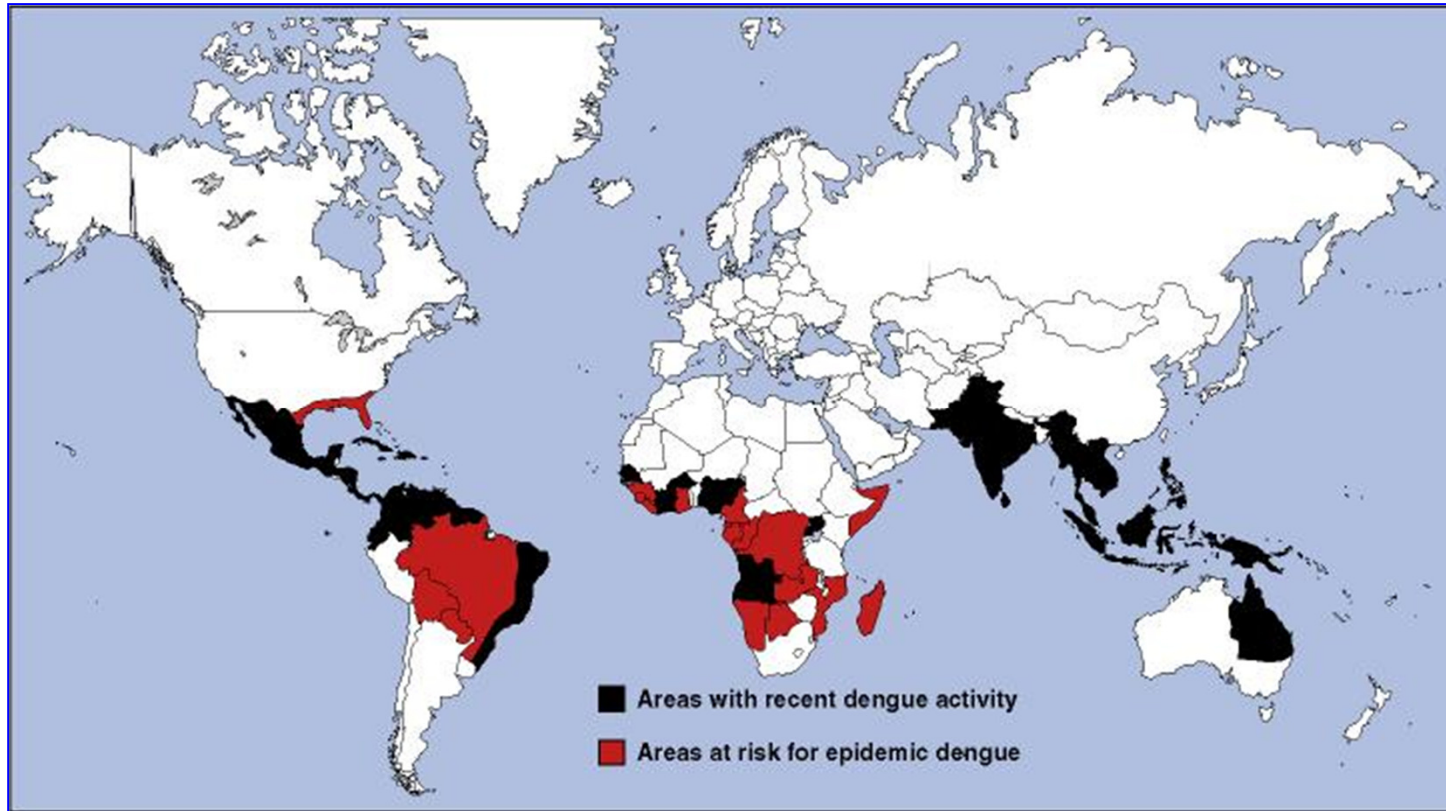
Map produced: 27 May 2009 06:30 GMT

Reemerging viral pathogens

- First appeared long ago, survived and persisted, continue to appear in new locations
- **Dengue fever** –millions of cases annually
- **West Nile virus**-1990-middle east- Europe-Americas, leading cause of Encephalitis
- 2007-2010-**WNV in India** –children in Northeastern states(Khan *et al* 2011), 2013-Kerala
- **Rift valley fever**-1997-98 in Kenya and Somalia - >400 deaths, 2006-07 - 75 deaths
- **Yellow fever**- Africa and South America
- **CCHF**- more cases, ticks vectors

Adapted from EID Dispatch.⁹³

Dengue fever



Monkey pox in 2003 in US

- Transmitted from imported African rodents (rope squirrel, giant pouched rat)– to prairie dogs (co-housed) - to humans
- 82 infections in children and adults
- US-Ban on import of African rodents
- > 500 human cases in **Congo** 1996-97
- Signs and symptoms similar to Smallpox
- Virus is maintained in rodents and non human primates

PRACTICAL APPROACHES IN LIMITING THE EMERGENCE OF INFECTIOUS DISEASE

- (1) promptly investigate and monitor emerging pathogens, the diseases they cause, and factors of emergence;
- (2) integrate laboratory science and epidemiology to optimize public health practice;
- (3) enhance communication of public health information about emerging diseases and ensure prompt implementation prevention strategies; and
- (4) strengthen local, state, and national public health infrastructures to support surveillance and implement prevention and control programs.

- Microbial genetics

Methods for disease detection, control & prevention

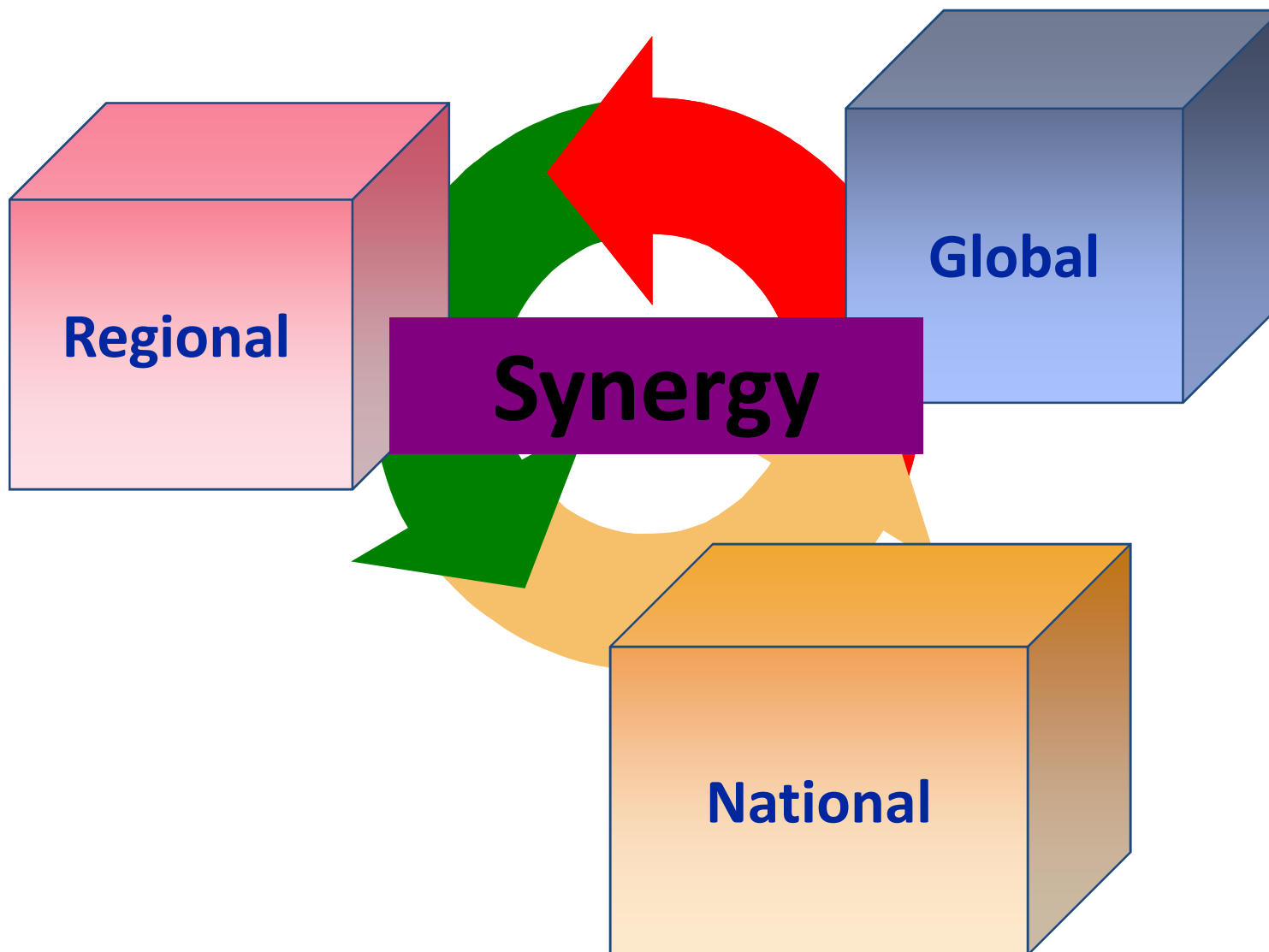
- Improved diagnostic techniques & new vaccines

- Geographic Imaging Systems

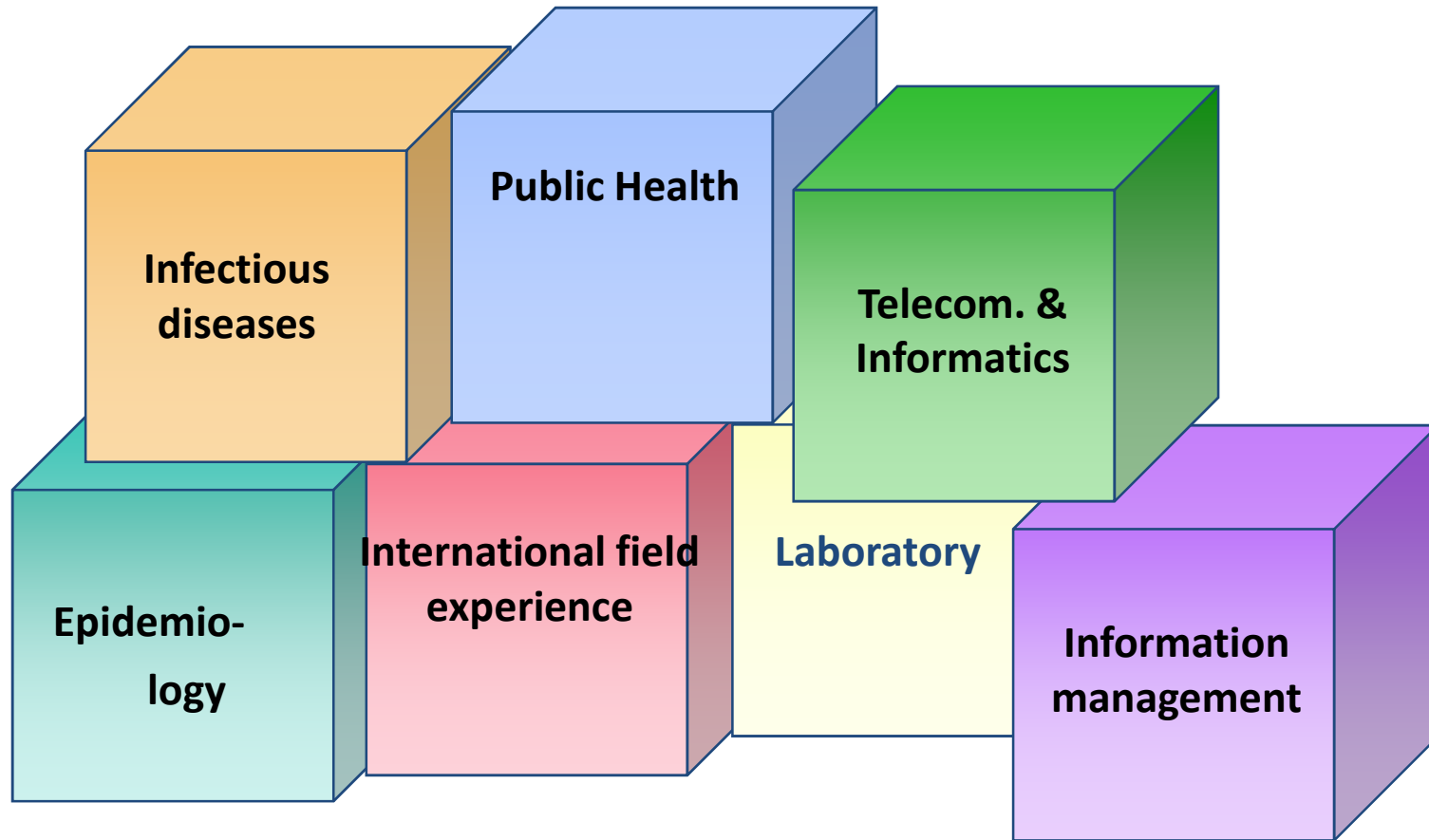
Monitor environmental changes that influence disease emergence & transmission

- Coordinated, well-prepared, well-equipped public health systems
- Improved methods for detection & surveillance
- Effective preventive & therapeutic measures
- Political commitment & adequate resources to address underlying socio-economic factors
- International collaboration & communication

Key tasks - carried out by whom?



What skills are needed?



Multiple expertise needed !

THANK YOU