

# VIRUS EVOLUTION AND PANDEMICS

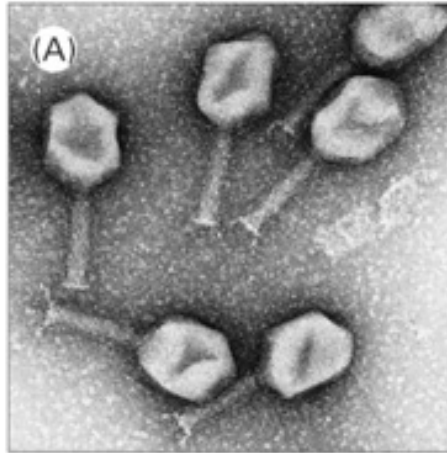
*Influenza, HIV, and Beyond*

J. A. Sands, November 19, 2007

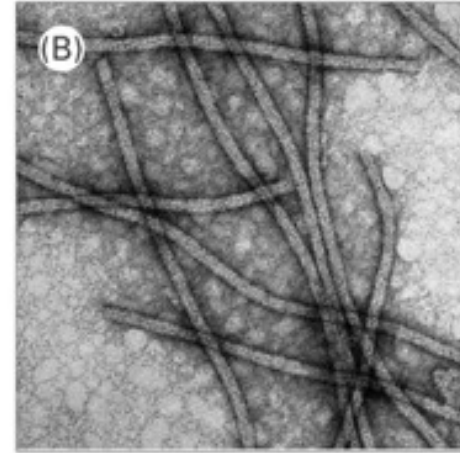
Lehigh University

## Electron Micrographs of Viruses

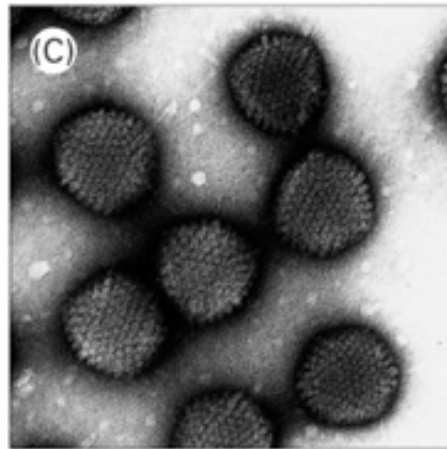
A. Bacteriophage T4



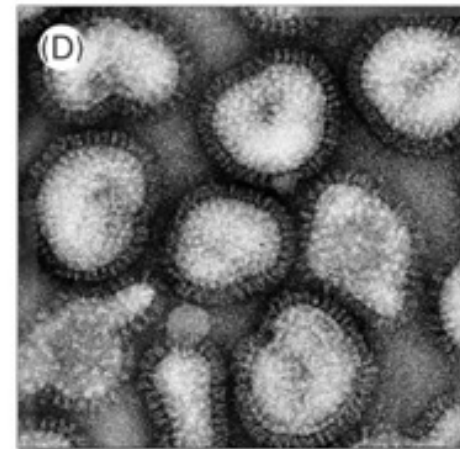
B. Potato virus X



C. Adenovirus



D. Influenza virus



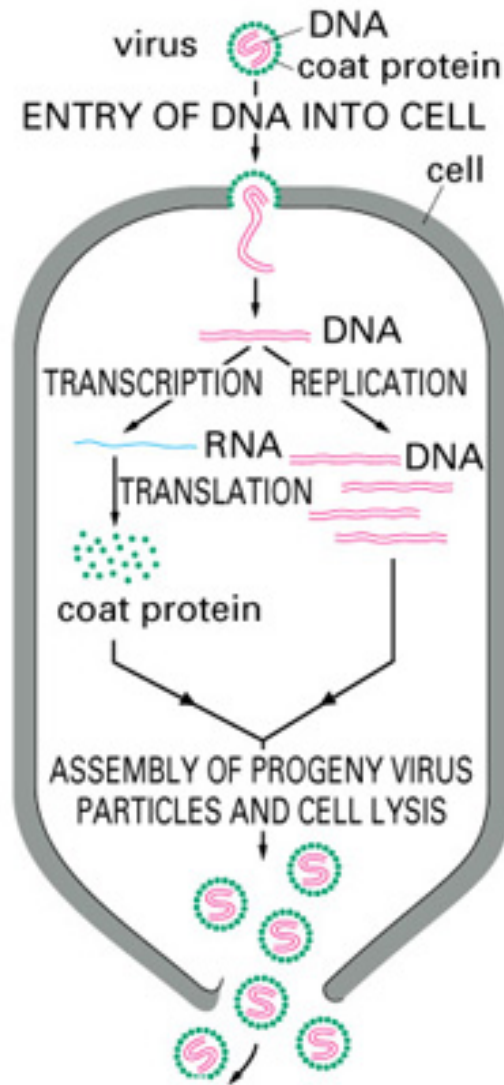
100 nm

Figure 6-38 Essential Cell Biology, 2/e. (© 2004 Garland Science)

**What are the human pandemic potentials of these viruses?**

# How do viruses reproduce?

Shown here is the simplest possible virus replication cycle.



Now, let's do some math on the board.

Figure 6-37 Essential Cell Biology, 2/e. (© 2004 Garland Science)

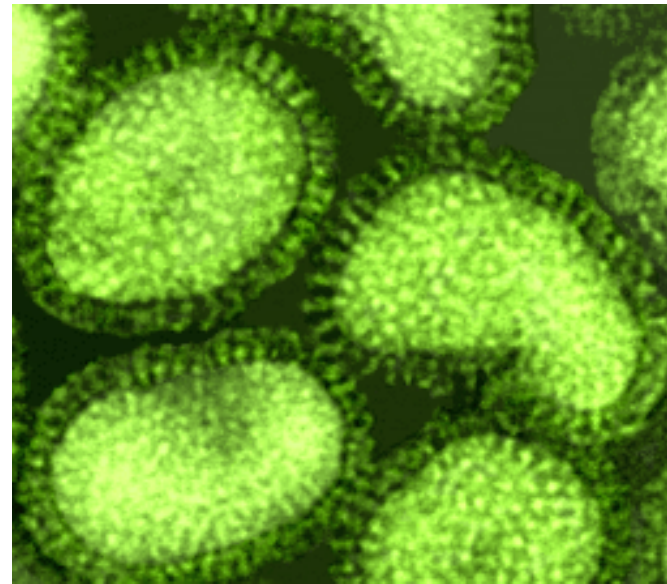
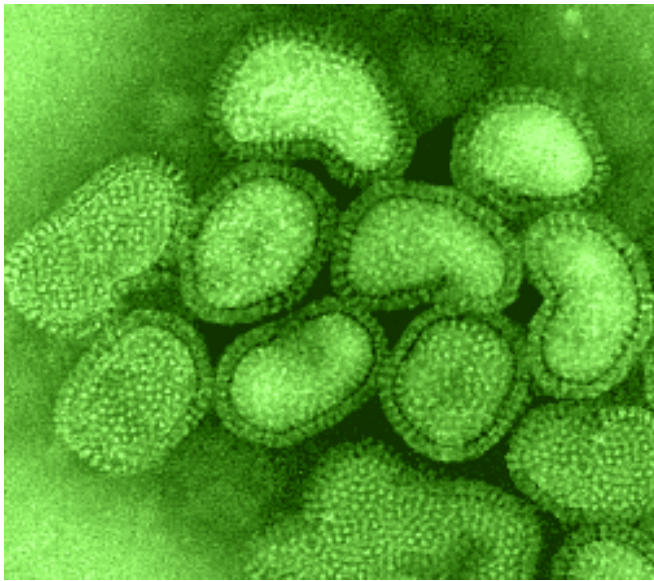
# Influenza and HIV:

What are some pandemic-related parameters?

- Virus particle structure
- Mechanism of transmission
- Species specificity
- Human immune response
- Evolutionary change
- Previous pandemics
- Vaccines and/or antiviral drugs

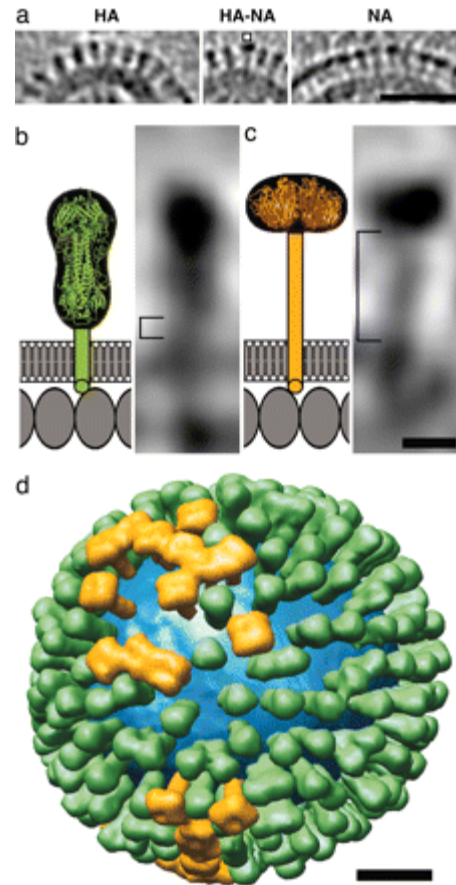
# Electron Micrograph of Influenza Virus

© Linda M Stannard, 1995

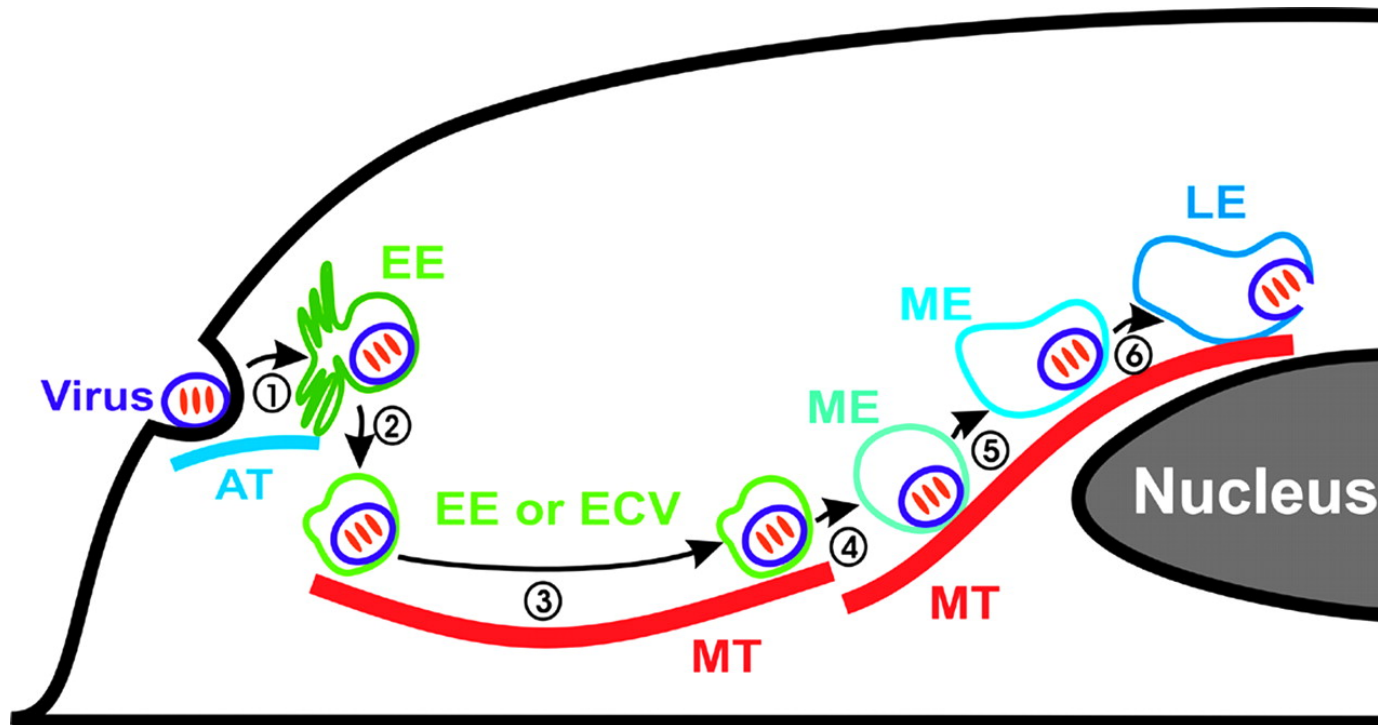


# Cryo-Electron Tomography of Influenza Virus

Harris *et al.*  
*Proc. Nat. Acad. Sci.*  
2006



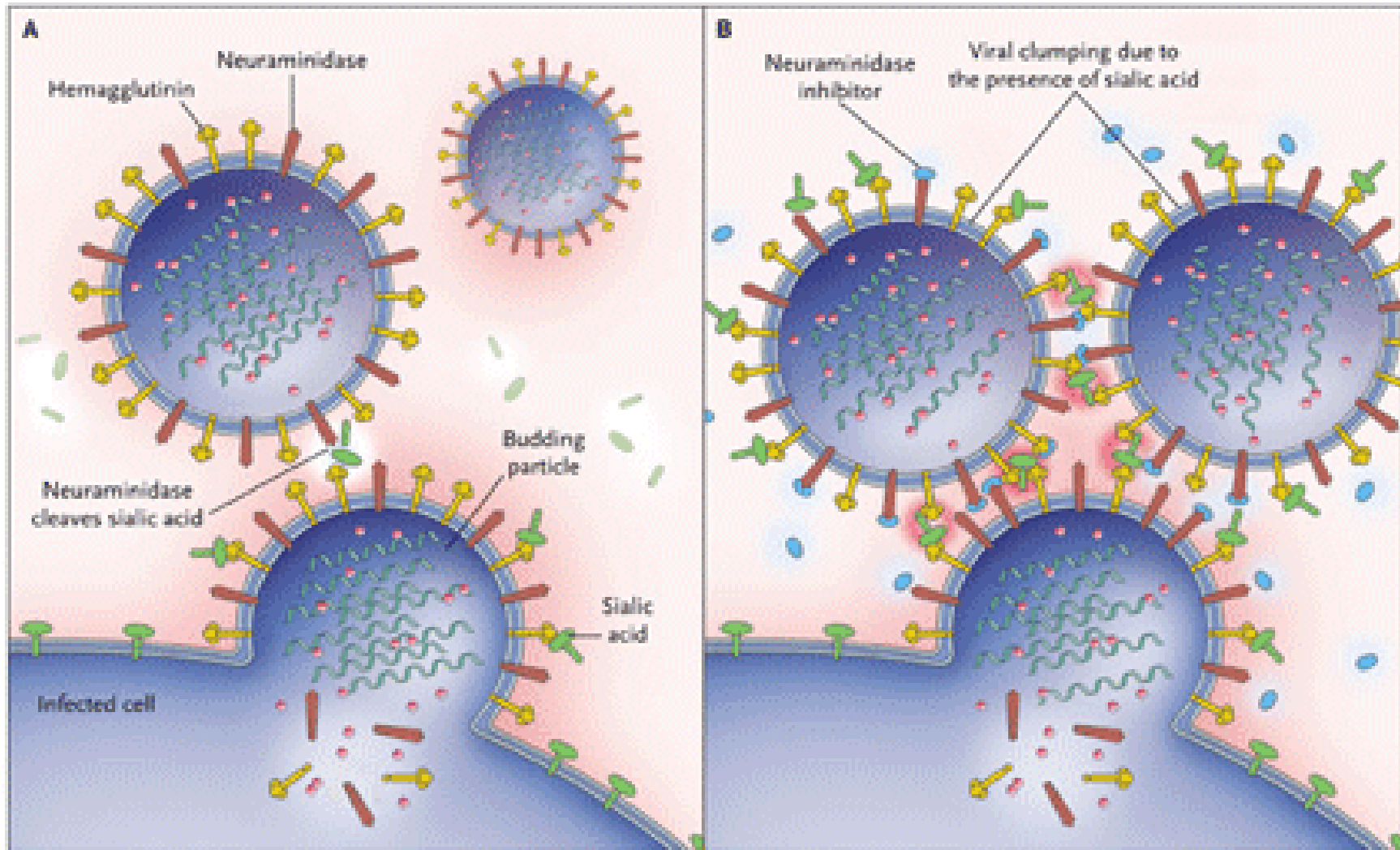
## Influenza Entry into Cell



Lakadamyali, Melike et al. (2003) Proc. Natl. Acad. Sci. USA 100, 9280-9285

# Influenza Exit from Cell: Effect of Neuraminidase Inhibition

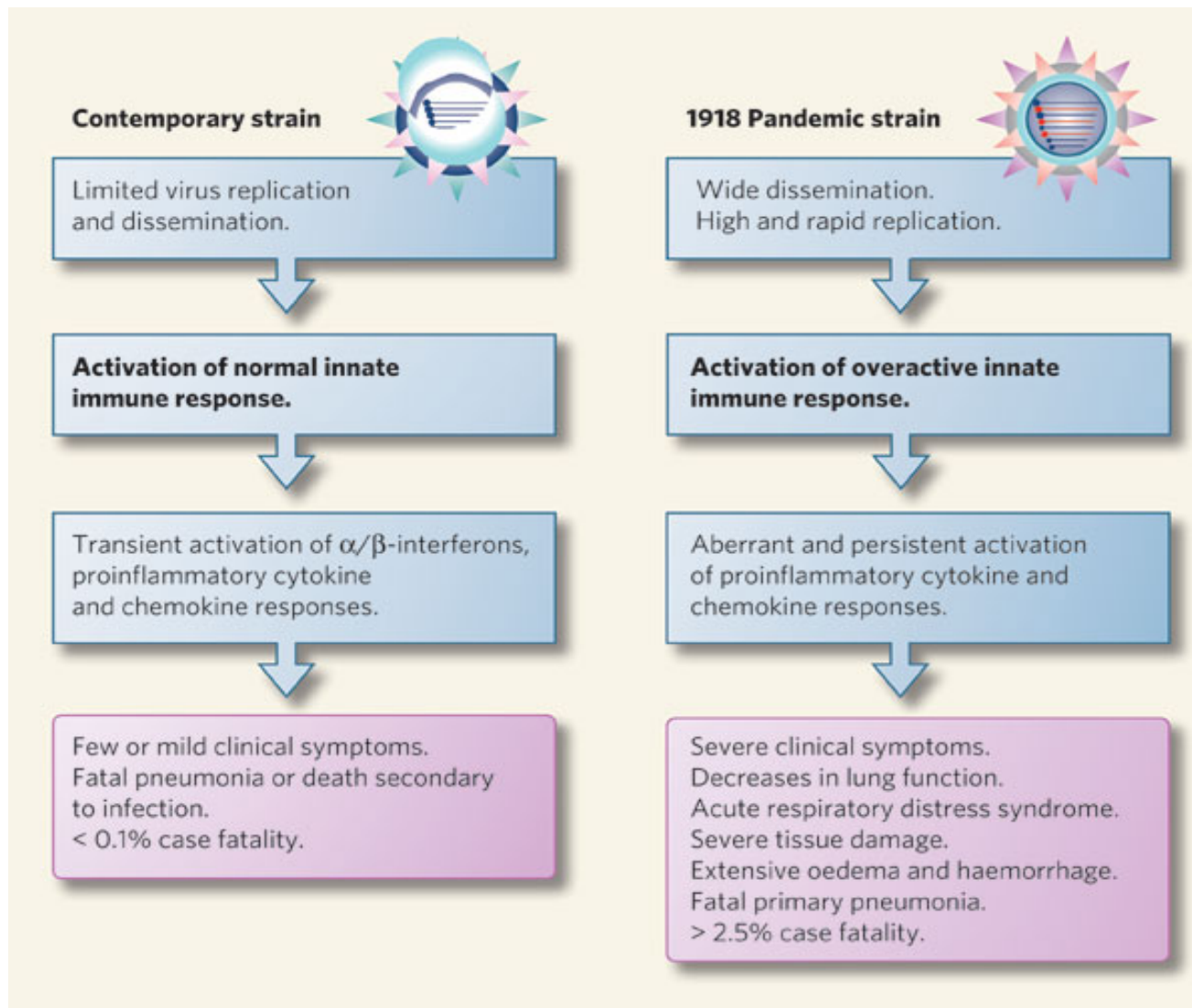
*New England Journal of Medicine, 2005*





# 2007 & 1918 Human Influenza

Loo and Gale, *Nature*, 2007



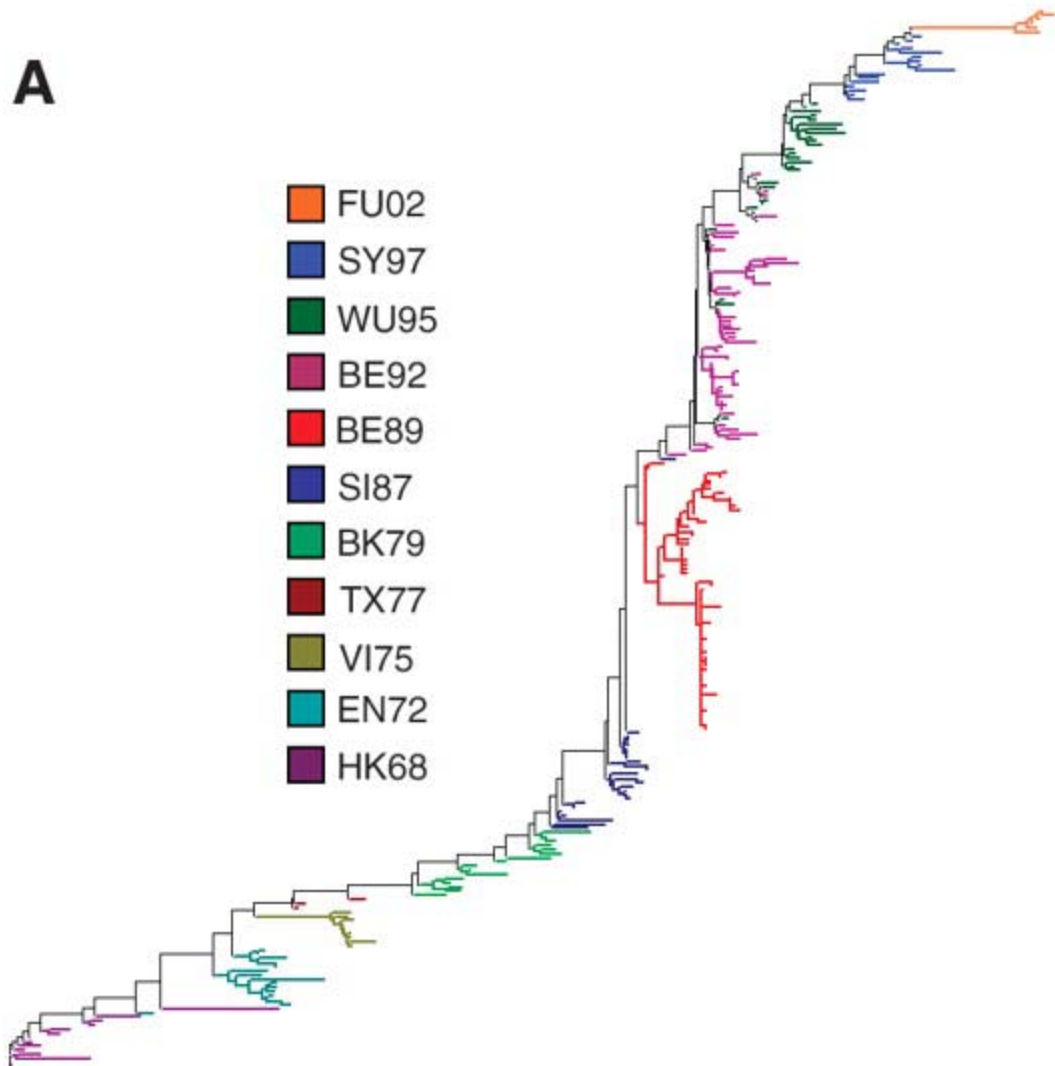
# **Expression of the 1918 Influenza A Virus PB1-F2 Enhances the Pathogenesis of Viral and Secondary Bacterial Pneumonia**

McAuley *et al.*, *Cell Host and Microbe*, Vol 2, pgs 240-249.  
October 2007

*“These findings help explain both the unparalleled virulence  
of the 1918 strain and the high incidence of fatal  
pneumonia during the pandemic.”*

Evolutionary change  
("Antigenic Drift") of  
Human Influenza  
H3N2 :  
1968 - 2002

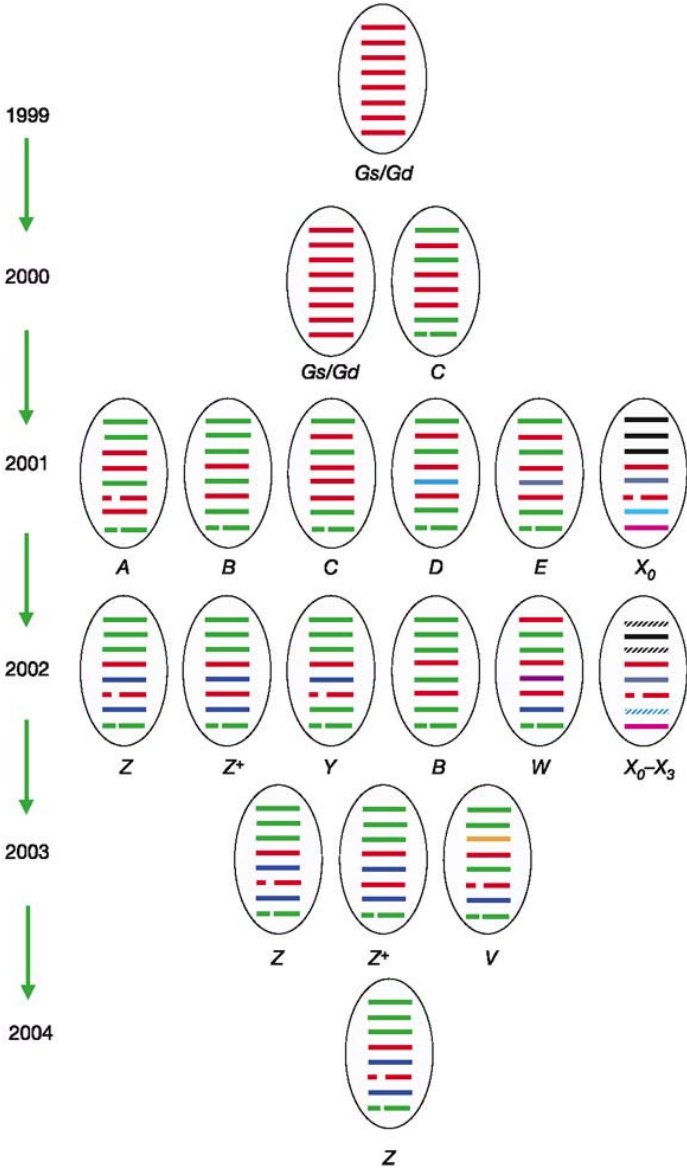
Reference: Fig. 1 A  
Koelle *et al.*  
*Science*  
22 December 2006.



# Avian Influenza Reassortments (Antigenic Shifts) in Eastern Asia: 1999 – 2004

Li et al., *Nature*, 2004

Figure 3



# Immunization by Avian H5 Influenza Hemagglutinin Mutants with Altered Receptor Binding Specificity

Yang *et al.*, *Science*, 10 August 2007, pgs 825-828.

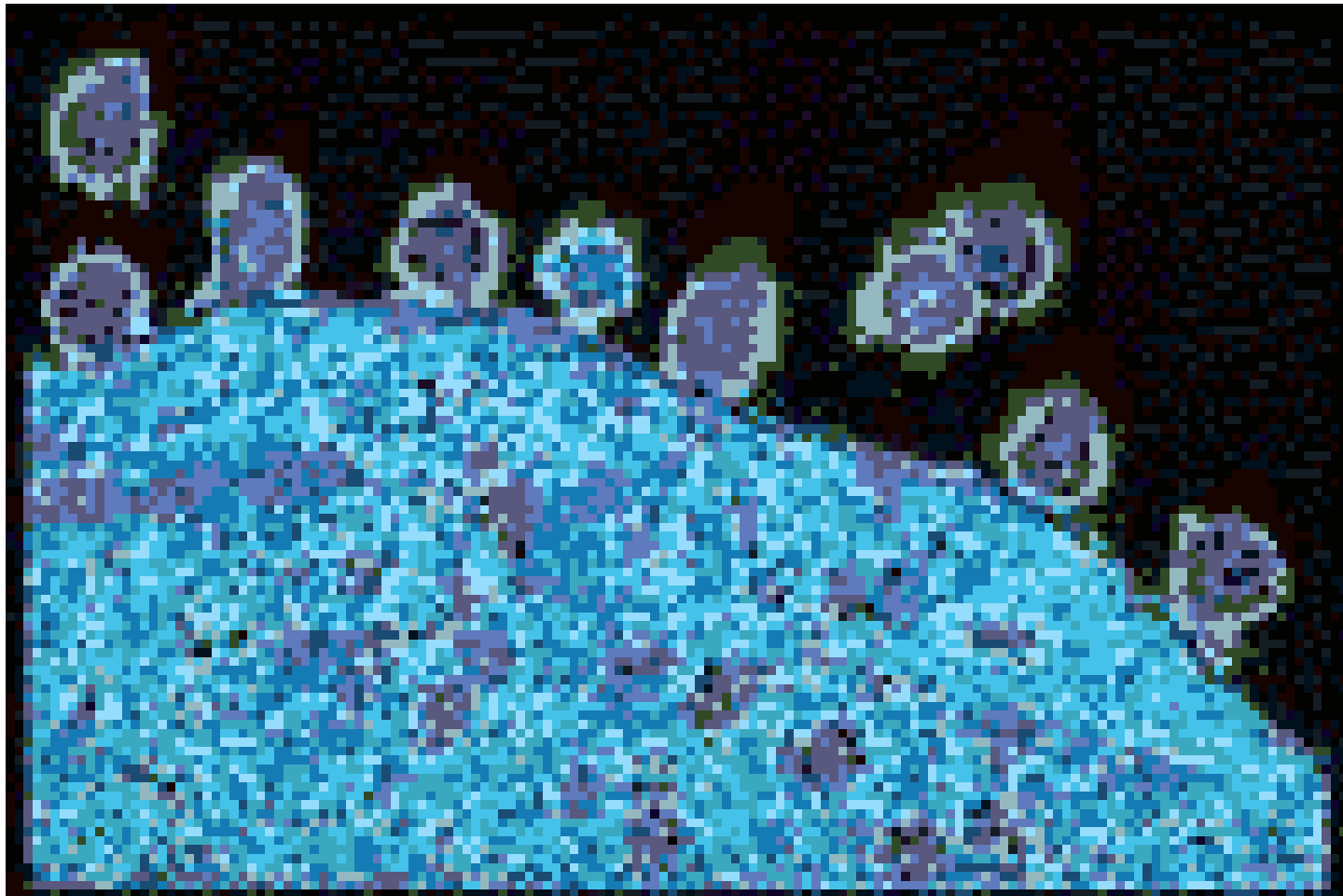
*“ Structure-based modification of HA specificity can guide the development of preemptive vaccines and therapeutic monoclonal antibodies that can be evaluated before the emergence of human-adapted H5N1 strains.”*

# Pandemic Flu Website

- <http://www.pandemicflu.gov/>

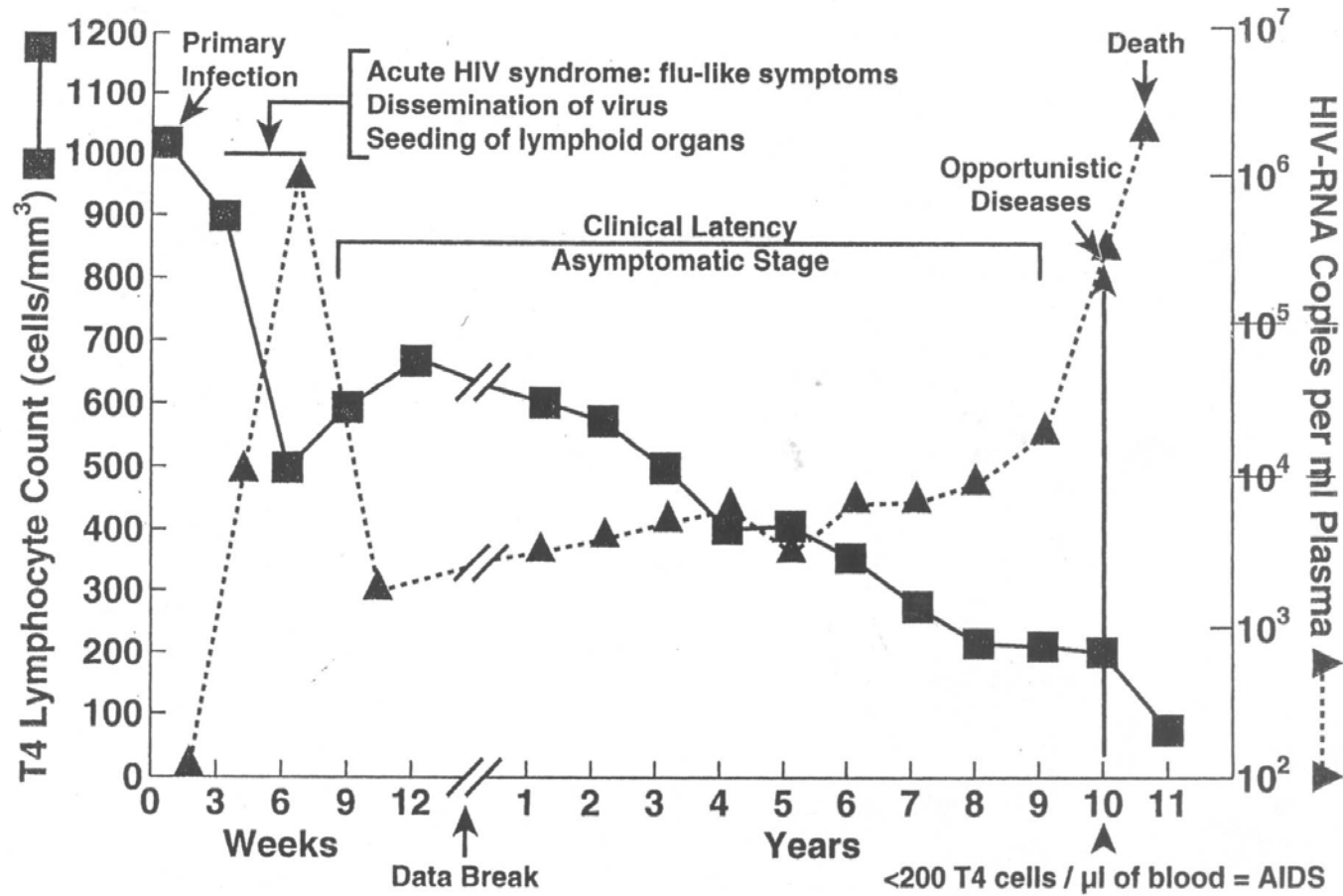
# HIV Pandemic

Over 20,000,000 dead.  
Over 40,000,000 now infected.



From Dr. Anthony Fauci, Director, NIAID

### The typical clinical course of HIV disease.

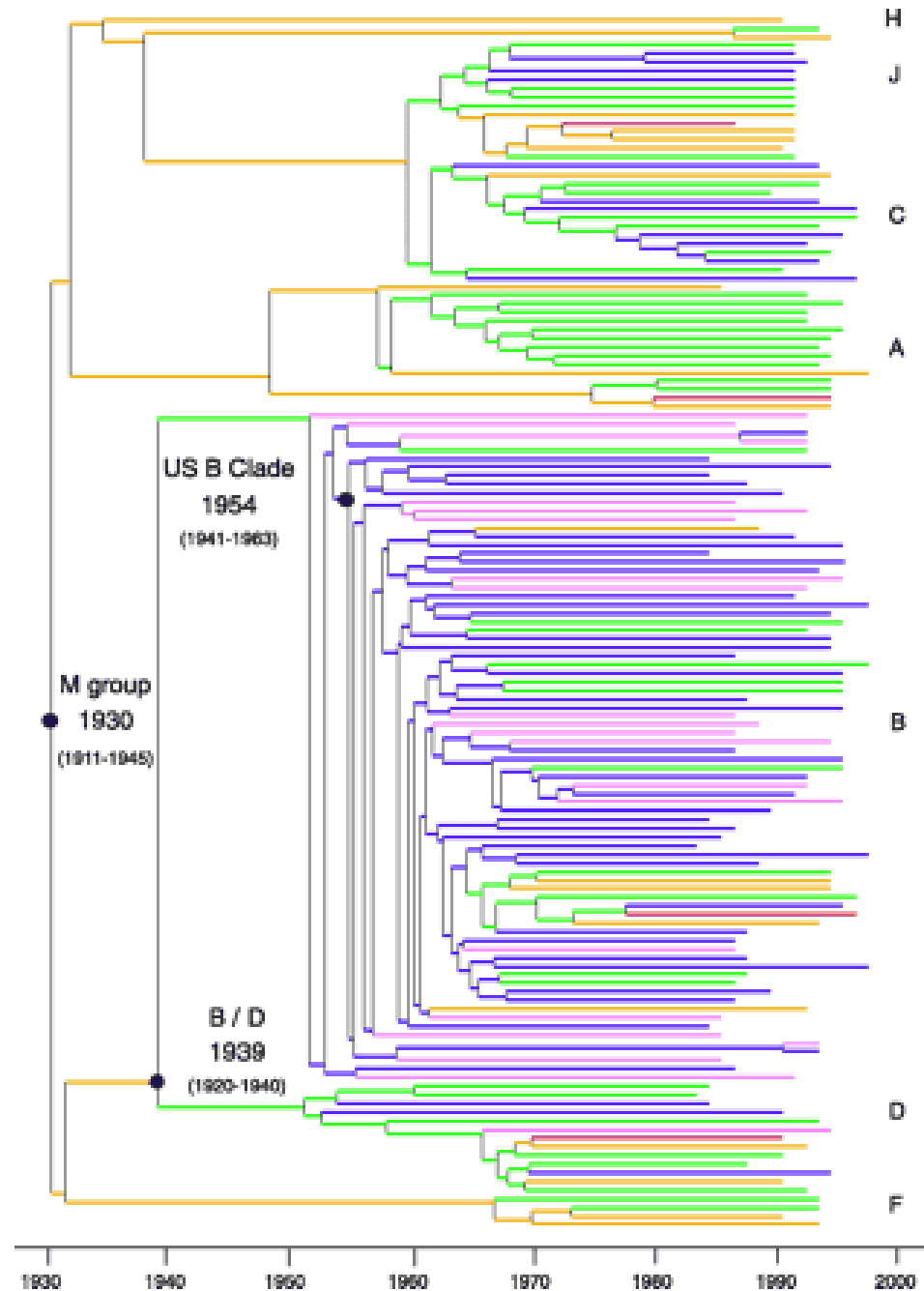




# HIV-1 Group M Evolution since ~ 1930

Korber *et al.*  
*Science*  
2000

[http://www.sciencemag.org/  
cgi/content/abstract/288/54  
72/1789](http://www.sciencemag.org/cgi/content/abstract/288/5472/1789)



# **“Rapid Reversion of Sequence Polymorphisms Dominates Early Human Immunodeficiency Virus Type 1 Evolution”**

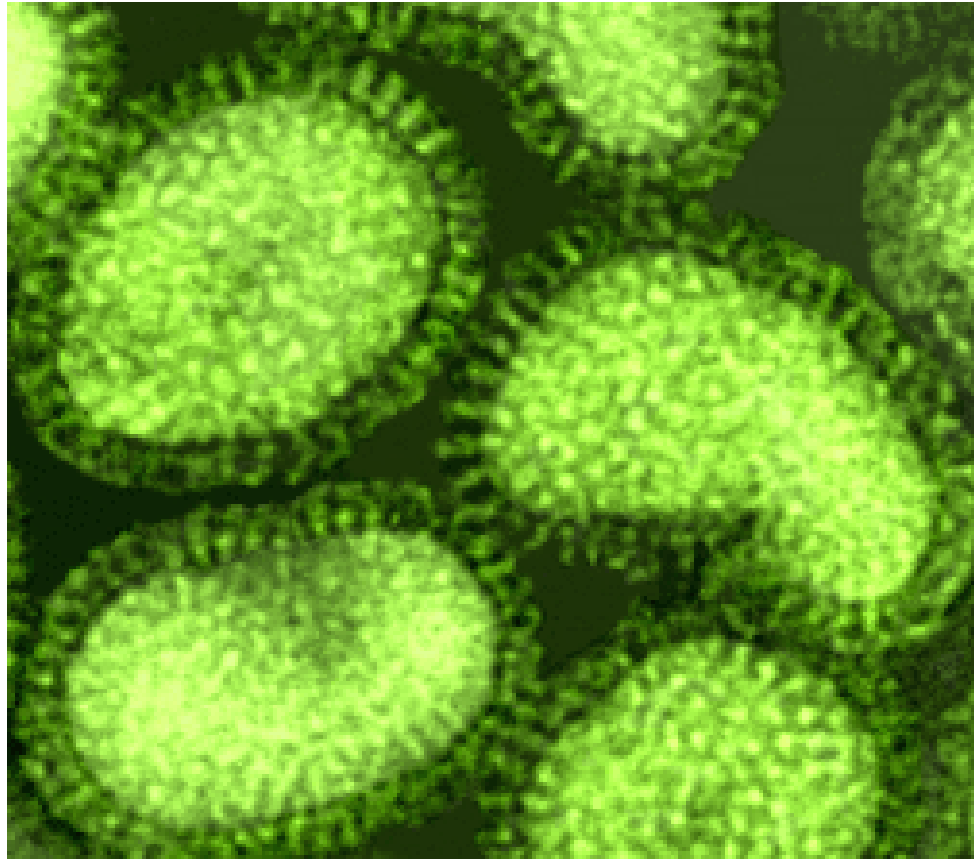
*Li et al., Journal of Virology, 2007*

<http://jvi.asm.org/cgi/content/abstract/81/1/193>

# HIV/AIDS Information from National Institute of Allergy and Infectious Diseases (NIAID)

- <http://www3.niaid.nih.gov/research/topics/HIV/>

# Summary



*And beyond?*