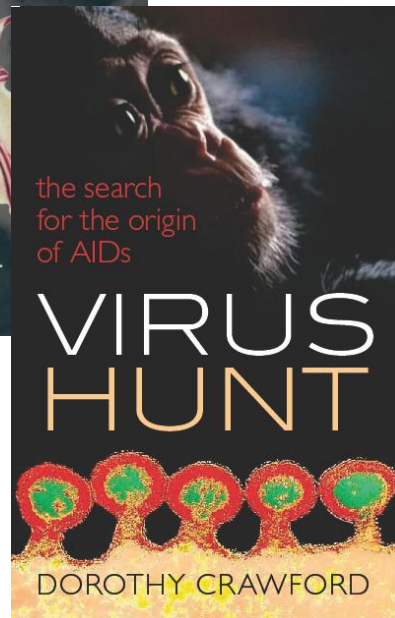
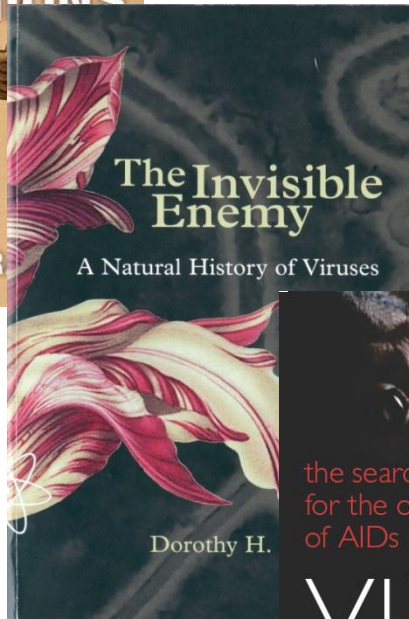


# The Invisible Enemy – Microbes and Us:



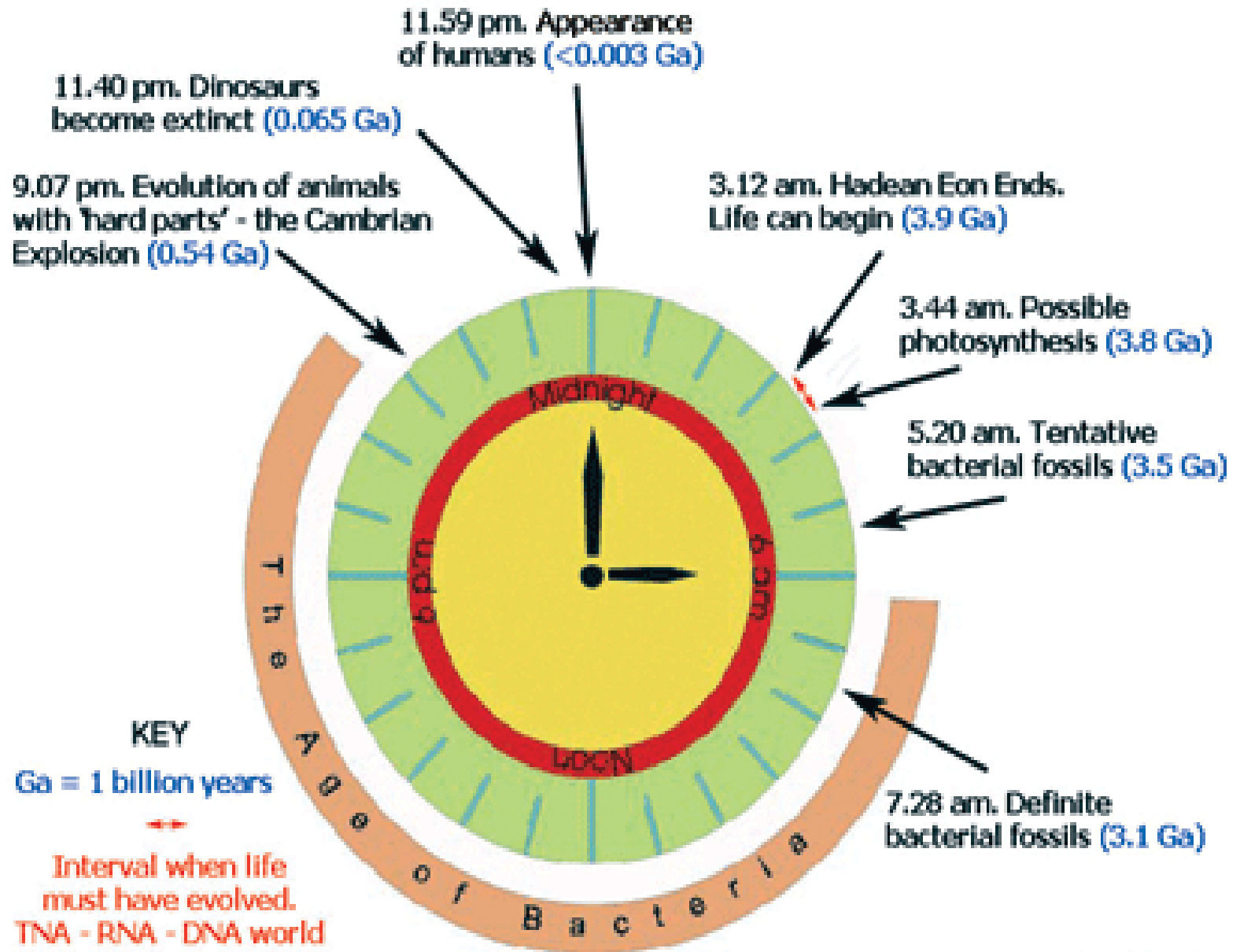
Dorothy H Crawford  
Emeritus Professor of  
Medical Microbiology  
University of Edinburgh



# Talk Outline

- Microbes
- Infectious diseases through the ages
- How microbes have affected our history
- The present day

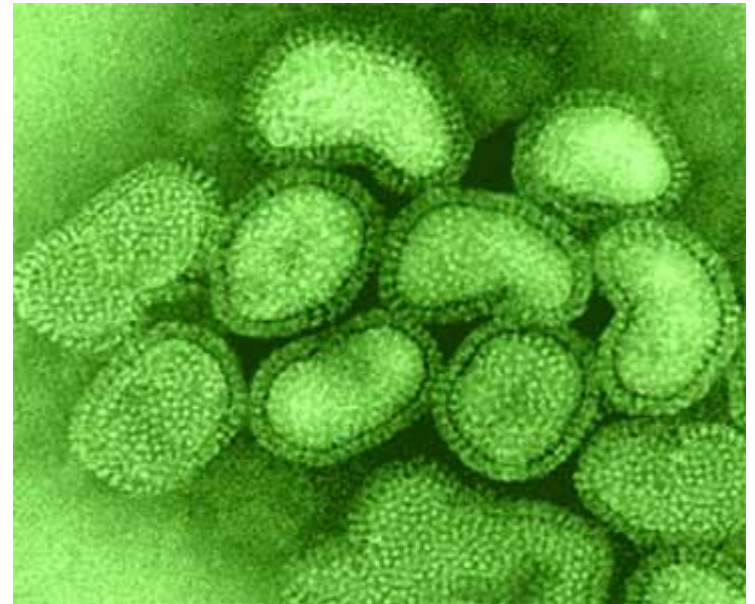
# The Origins of Life on Earth



# Acute Infectious Microbes

- Infect a susceptible host
- Must reproduce rapidly and jump to another host before immunity develops
- Require a continuous chain of susceptible hosts
- Surviving hosts become immune to further infection
- Cause epidemics and pandemics - mainly in children

Flu virus



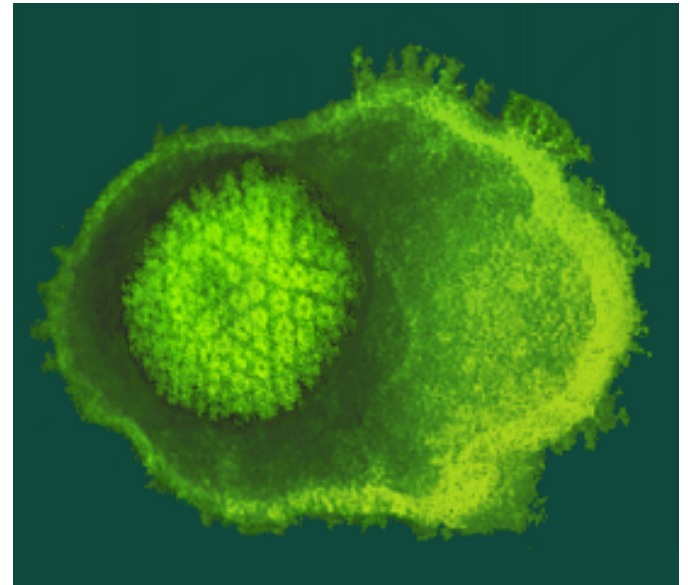
# How Microbes Spread



# Persistent Microbes

- Infect and colonise a host for life
- Hide in the body to evade immune response
- Infected hosts act as a reservoir of the microbe
- Reactivation over a lifetime passes microbe to next generation

Herpes virus



# The Ages of Man

- Hunter Gatherers
- The Farming Era
- Town and City Dwellers
- Travellers, Traders and Colonisers
- The Modern Era

# The Hunter Gatherer Era

- ~200,000 -10,000 years ago
- Small, isolated, mobile bands of 30-50 people
- No permanent dwellings
- Life expectancy 25-30 years





# Hunter Gatherers' Microbial Problems

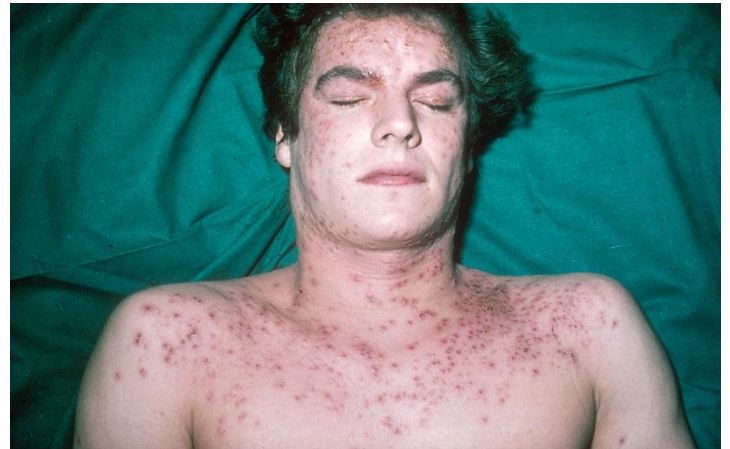
**Acute infections:** 

**Persistent infections:** 

- Herpes viruses – varicella zoster,
- Tuberculosis
- Vector-borne microbes - trypanosomiasis (sleeping sickness)

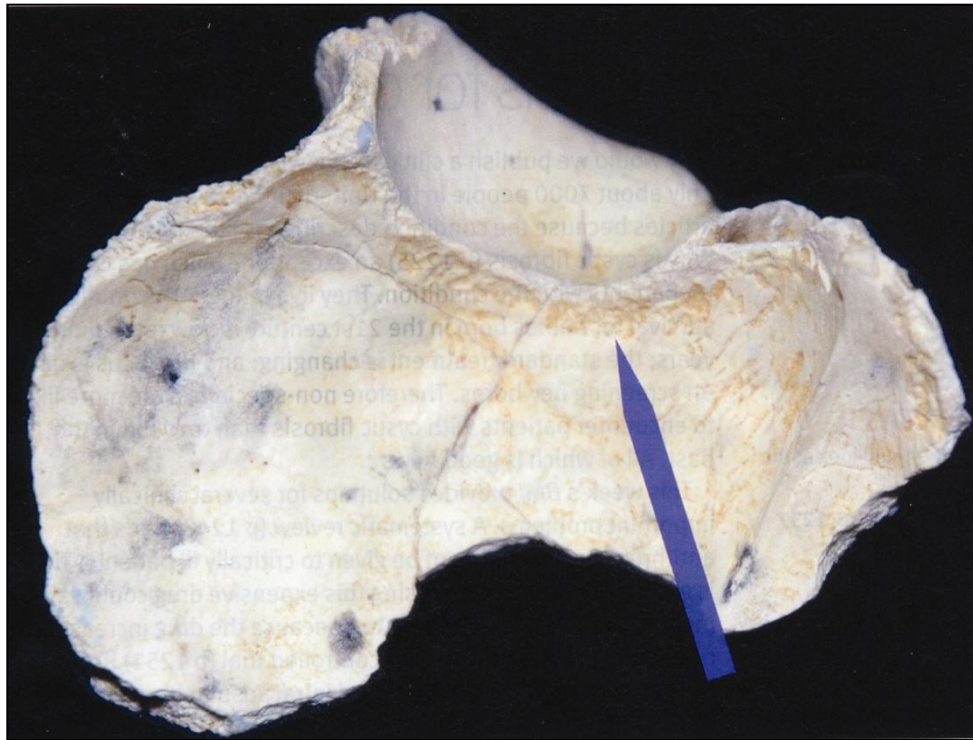
# Varicella Zoster Virus (The Chicken Pox Virus)

- Generally infects children causing chickenpox
- Infects nerve fibres in skin and travels to nerve cells in spinal column
- Life long latent infection in nerve cells
- May reactivate in single nerve cells to cause shingles



# Tuberculosis

Skull bone from young male *Homo erectus* found in western Turkey ~500,000 years old.

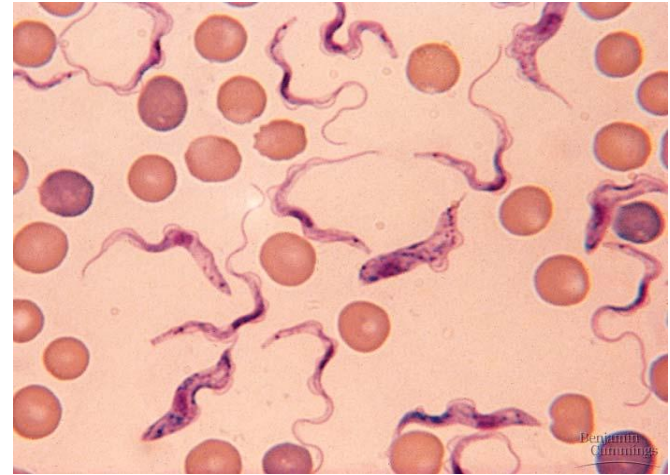


BMJ 335, 15 Dec, 2007

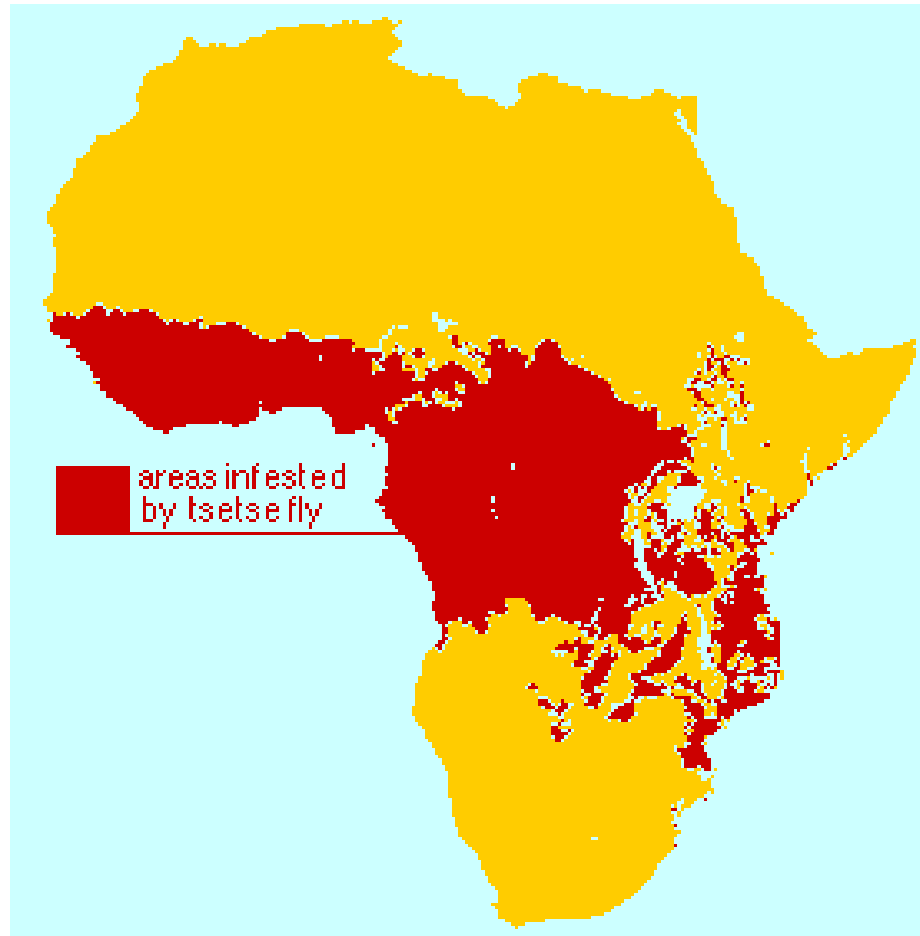
Blue arrow points to lesions behind right orbit suggestive of TB meningitis

# Trypanosomiasis - Sleeping Sickness

- Caused by the trypanosome
- Natural infection of African wild game
- Spread by the tsetse fly
- 100% fatal in humans



# Sleeping Sickness: Geographical Distribution

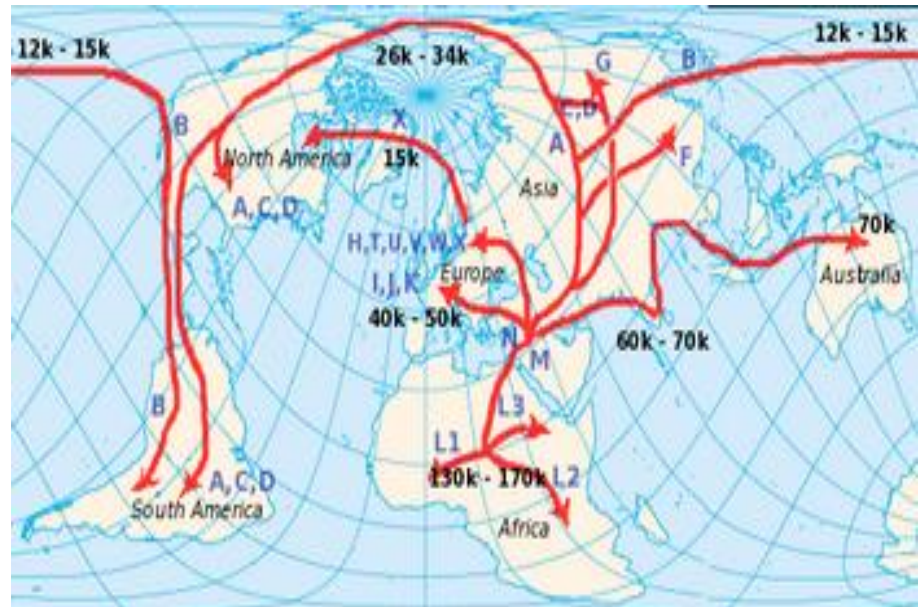


# Out of Africa

- Modern man evolved in Africa ~ 200,000 years ago
- Exodus from Africa ~50,000 years ago

Most experts believe that:

- Hunter gatherer bands could not have survived in the trypanosome belt of Africa
- Man's exodus from Africa thought to be caused in part by the trypanosome



# The Farming Era

- Began ~8,500BC in the Fertile Crescent with domestication of wheat, goats, sheep
- Other centres include:
  - China (~7,500BC)
  - Papua New Guinea (~7,000BC)
  - Africa (~5,000BC)
  - The Americas (~3,500-2,500BC)



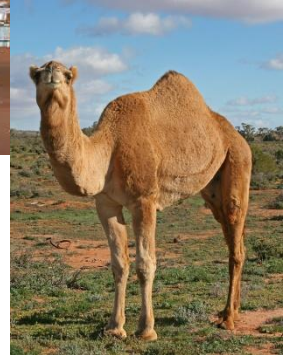
# The Consequences of the Farming Revolution

- Permanent village settlements
- Closer contact between people
- Stored food and water
- Accumulation of sewage and waste materials
- Shared dwellings with domestic animals





# How Microbes Spread

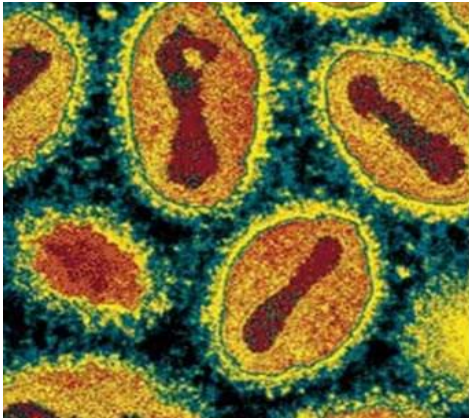


# The Emerging Infections of the Farming Era (Crowd Diseases)

- Most jumped to man from domestic animals (zoonoses)
- Then evolved to spread between humans
- Thrived in filthy, crowded farming villages
- Caused recurring epidemics

- Smallpox
- Measles
- Whooping cough
- Diphtheria
- Typhoid
- Mumps
- Scarlet fever
- Rubella
- 'Flu
- Common cold

# Smallpox Virus Origins



Topnews.ae

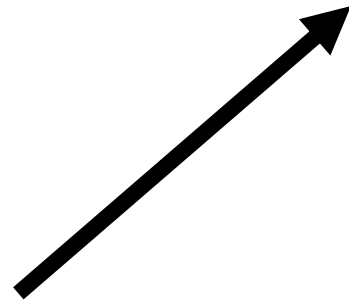


freewebs.com

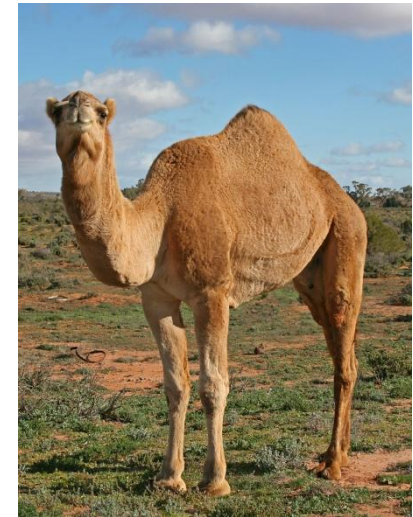
Gerbil



Jakeandkims.blogspot.com



~5,000 BC



Camel

Cdmi.cesr.fr

# Smallpox: King Ramses V

- Ramses V died suddenly in 1157BC while in his early thirties
- Lesions on his face resemble smallpox
- Virus-like particles found in these lesions



# Measles Virus: Evolution

- Measles genome is most closely related to rinderpest and to a lesser extent canine distemper viruses
- Molecular studies show that rinderpest and measles viruses diverged ~2,000 years ago



# Towns and Cities

- Measles requires a population of ~500,000 to circulate continuously
- First cities of this size arose in Mesopotamia ~5,000 years ago
- Microbes spread by traders, travellers, armies, causing large epidemics in naïve populations



# Smallpox

- The world's number one killer virus
- Killed ~300 million in 20<sup>th</sup> century
- Fatal in ~30% of cases and blinded and scared many survivors
- 1798 Vaccination
- 1980 Virus eradicated



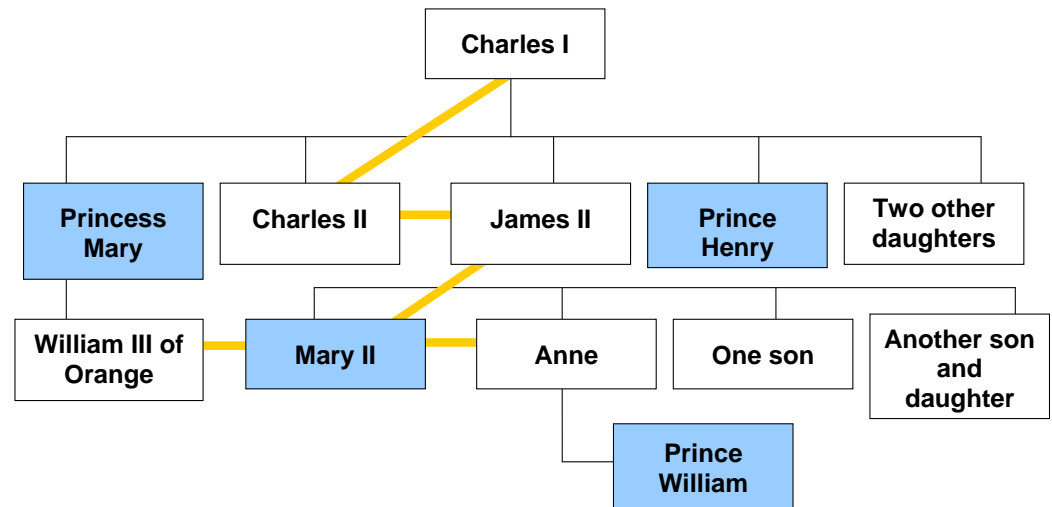
# Did Smallpox Change the Course of History?

In the 17<sup>th</sup> century Smallpox wiped out the UK House of Stuart and within 80 years killed:

- Luis 1 of Spain
- Louis XV of France
- Ulrika Eleanora of Sweden
- Tsar Peter II of Russia

## HOUSE OF STUART FAMILY TREE

■ = died of smallpox





# Globalisation of Microbes

- Humans crossed the Bering Strait land bridge from Siberia to Alaska in ~14,000 years ago
- Bridge submerged ~10,000 years ago
- Contact between 'Old' and 'New' Worlds re-established in 1492



# Colonisation of the Americas

## Before Europeans arrived in 1492:

- No crowd diseases in the Americas
- Incas and Aztecs had large populations and crowded towns
- Probably because few domestic animals (llamas, turkeys, guinea pigs, dogs)



# The Acute Infectious Diseases in the Americas

## Native Americans had:

- A large population
- Crowded, dirty cities
- No immunity
- No genetic resistance

## Human adapted microbes:

- Smallpox
- Measles
- Whooping cough
- Diphtheria
- Typhoid
- Mumps
- Scarlet fever
- Rubella
- 'Flu
- Common cold

# East to West Spread of Microbes

- European explorers, travellers, and traders carried acute infectious diseases
- 90% of Native Americans died and the population dropped to 3 million in 50 years
- African slaves brought malaria and yellow fever
- By 1700 Eurasian microbe dispersal in Americas was complete



# West to East Spread of Microbes

## Syphilis:

- Appeared in Europe in 1494
- Spread throughout Europe, Asia and North Africa in 6 years
- Caused an acute, fatal disease



Bartholomew Steber's *Syphilis*. 1497

# The Spread of Syphilis

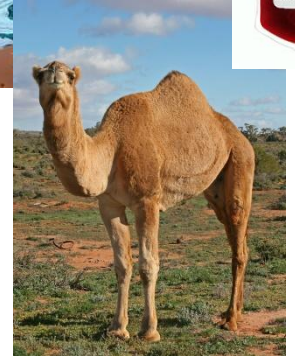
The Italians called it '*the French disease*', the French '*the disease of Naples*', the Poles '*the German disease*' and the Russians '*the Polish disease*'.

In the Middle East it was named '*the European pustule*', in India '*the Franks*', in China '*the ulcer of Canton*', and in Japan '*Tang sore*'.

# The Evolution of Acute Infectious Disease Epidemics

- **Exposure to animal microbes** - farming
- **Crowding** – towns and cities
- **Travel** – traders, armies, explorers
- **Poverty** – poor living conditions

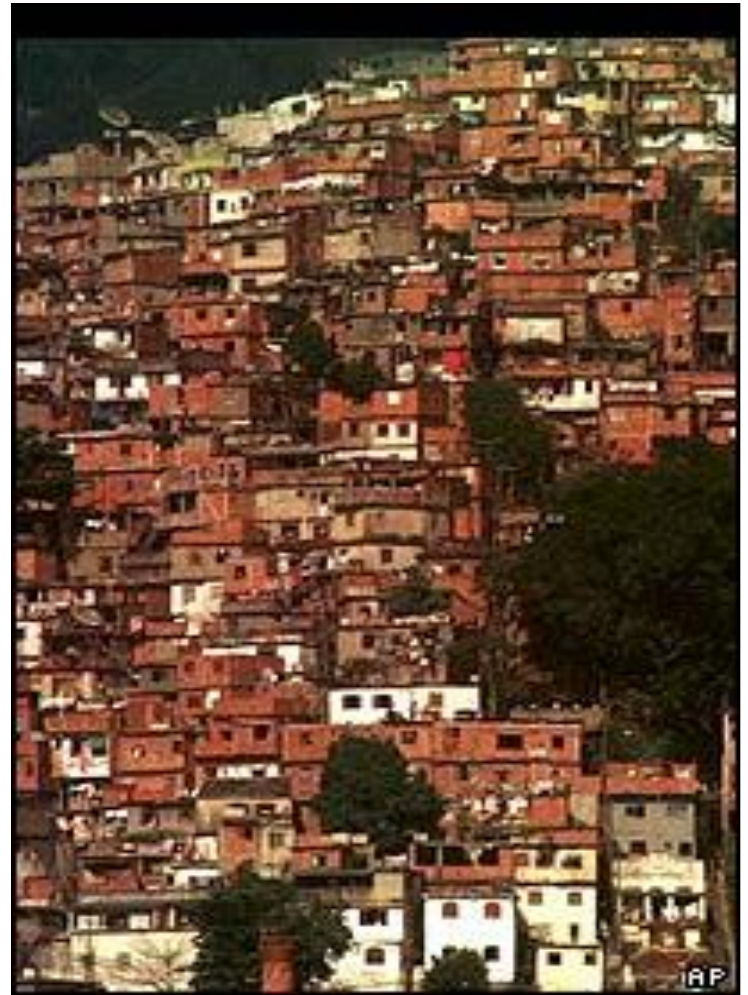
# How Microbes Spread





# Modern Times - Crowding

- Over 6 billion people in the world today
- Over 9 billion by the end of 21<sup>st</sup> century planet
- Over half of us live in cities – Tokyo 34M, Mexico City >20M



# Modern Times - Poverty

- Microbes kill 17M people annually
- 95% of these deaths are in resource poor countries
- 1.5 billion people have no access to clean water



# Modern Times – Travel

## Travel time from UK to Australia:

- 18<sup>th</sup> century ~1 year by sailing galley
- 19<sup>th</sup> century 100 days by clipper
- Beginning of 20<sup>th</sup> century 50 days by steamer
- Mid 20<sup>th</sup> century ~20 hours by jet



# Modern Times - Travel

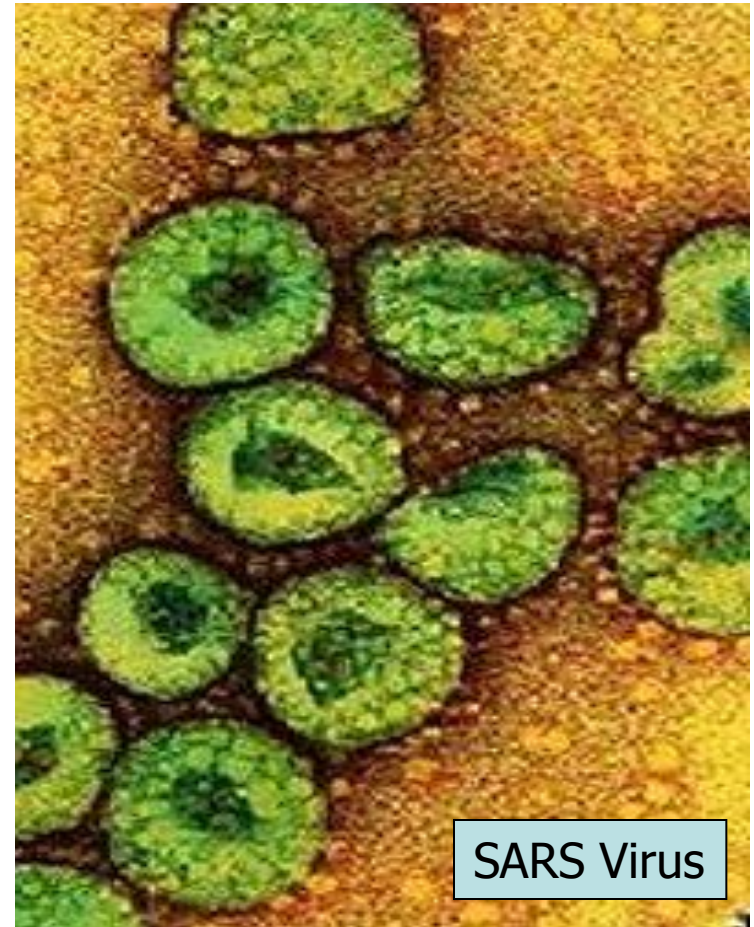
- >1 billion people board international flights annually to/from ~ 200 countries
- Rapid movements of huge numbers of refugees, pilgrims, armies, migrants



# Emerging Microbes

Despite modern knowledge, antimicrobials, health services etc:

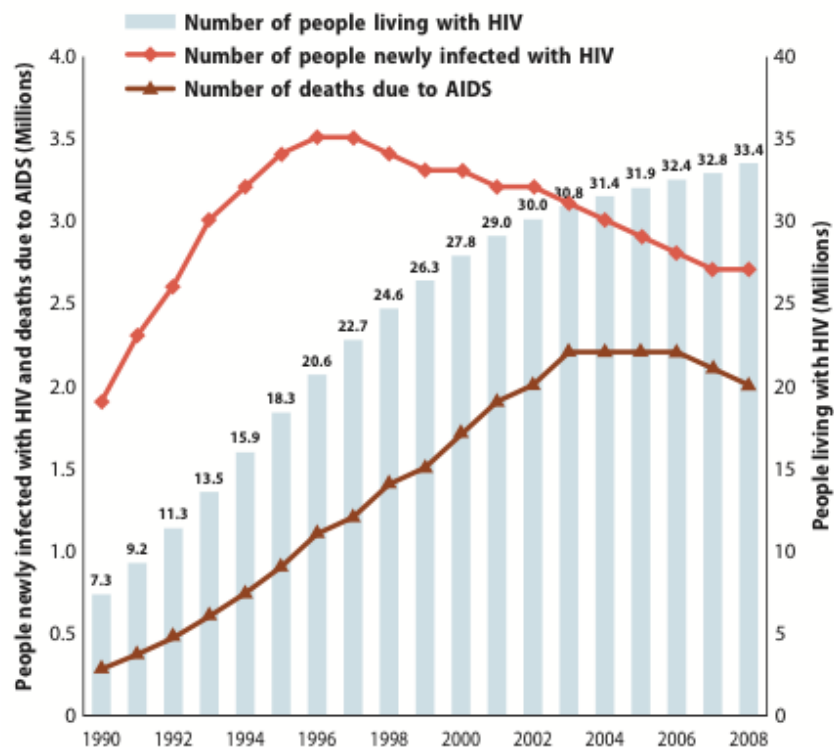
- Increasing numbers
- Average of 1 per year
- Most jump from animals
- Rapidly spread by travellers
- Often highly lethal



# HIV Pandemic

- 60-80 million infected worldwide
- 25 million deaths
- 2.5 million new infections annually
- One in 3 people in S African cities are HIV+

Number of people living with HIV, number of people newly infected with HIV and number of AIDS deaths worldwide, 1990-2008 (Millions)

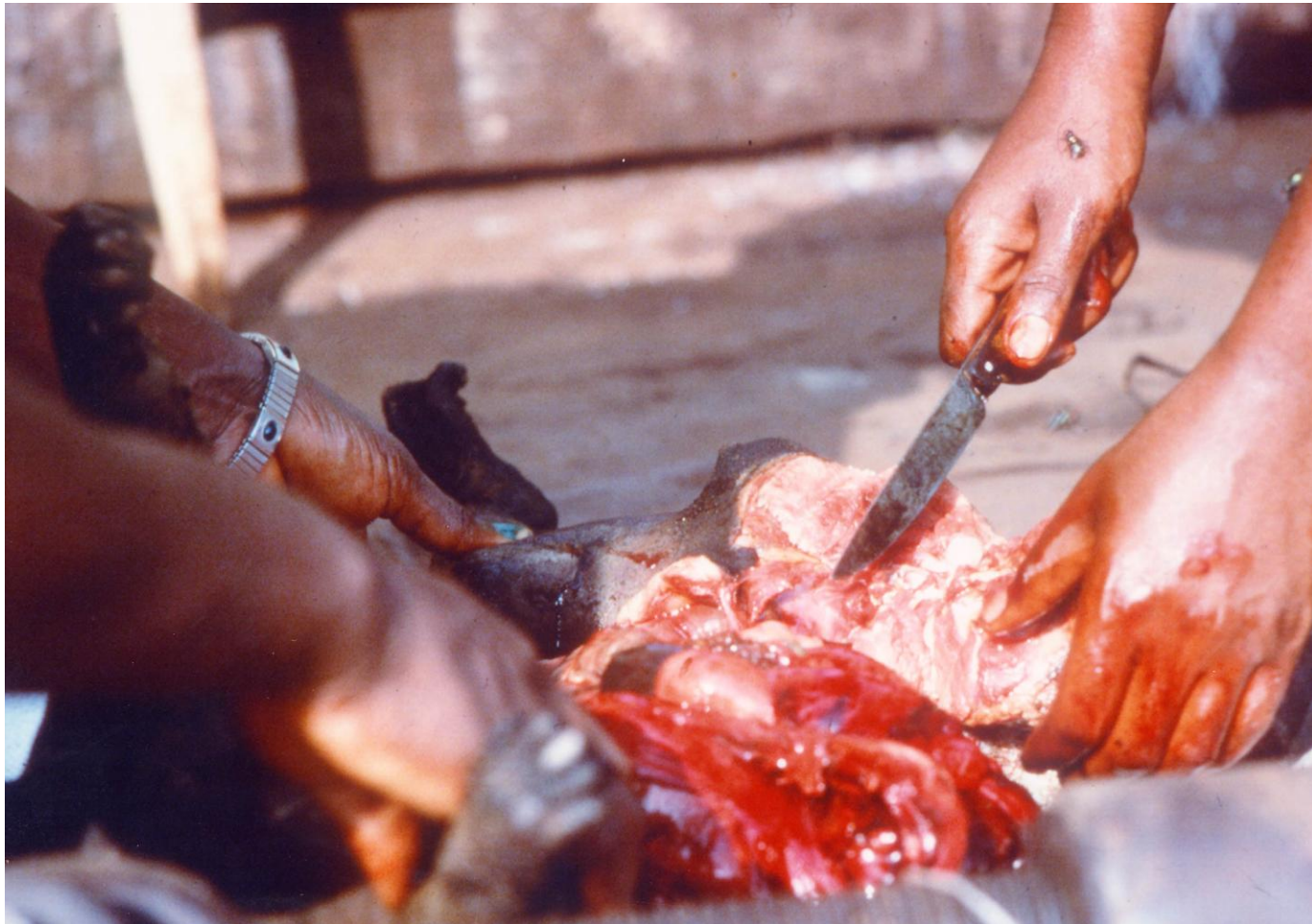


# Chimpanzee

Subspecies *Pan Troglodytes troglodytes*



# Hunting and Preparing Bush Meat





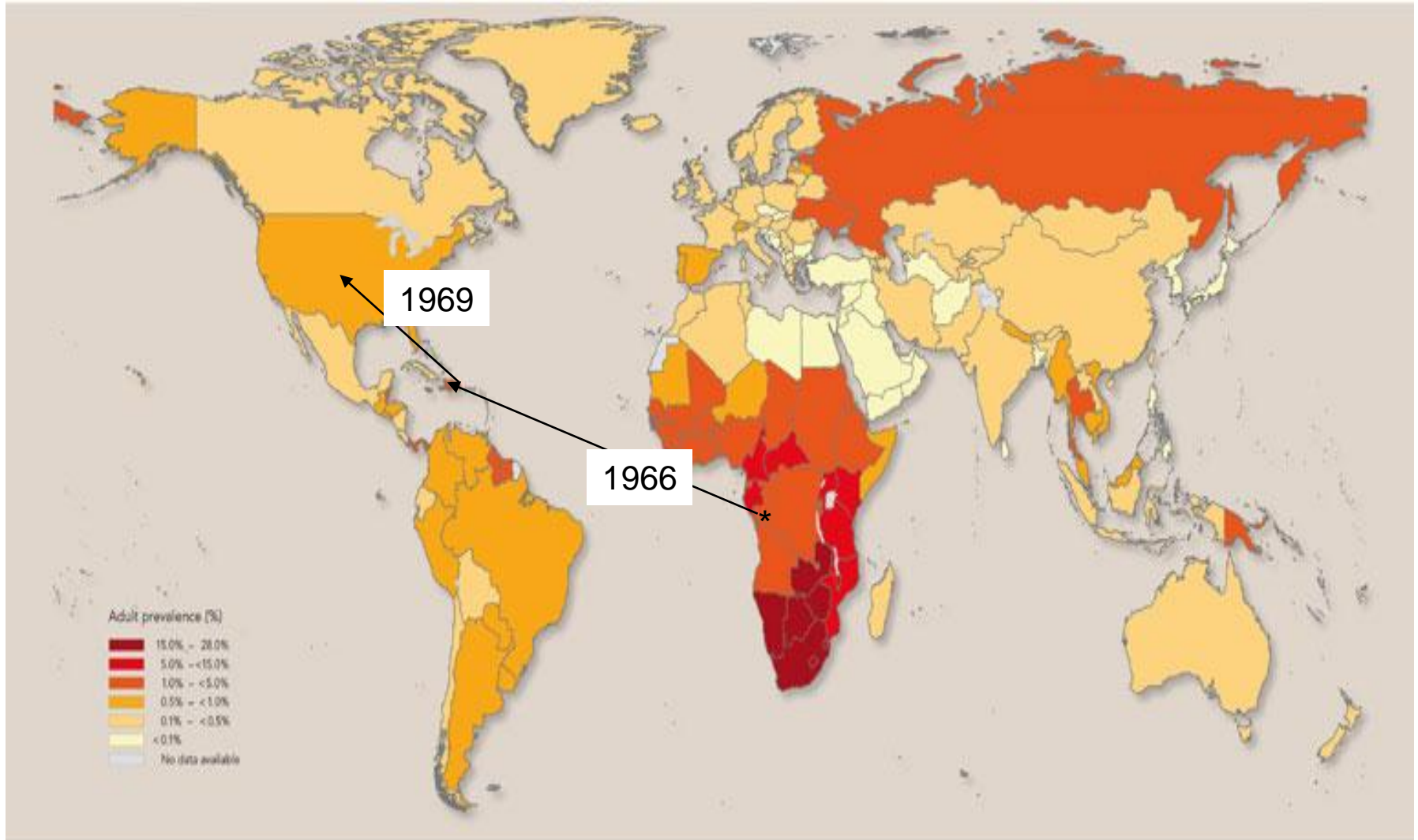
# HIV: Early Spread

Transfer to Humans  
~1921

Spread from  
Cameroon to  
Kinshasa by 1959



# HIV: Global Spread



# Nipah Virus

[..\animation\animations\NippahVirus.avi](#)



[..\animation\monkeypox260711.mov](#)



# Are we Better Off than our Ancestors?

## **YES:**

- More scientific knowledge
- More resources – anti-microbials, money, technology, manpower
- Rapid response
- Controlled SARS (so far)

## **NO:**

- Resources not distributed equally
- Poverty still rife
- Lack of global cooperation
- Antibiotic resistance
- Global warming
- H5N1 or H7N9 flu pandemic?

# The Stupidest Virus is Cleverer than the Cleverest Virologist

*George Klein*

**Thank you for listening!**

