The Invisible Enemy – Microbes and Us:

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Talk Outline

• Microbes
• Infectious diseases through the ages
• How microbes have affected our history
• The present day
The Origins of Life on Earth

- 11.40 pm. Dinosaurs become extinct (0.065 Ga)
- 9.07 pm. Evolution of animals with 'hard parts' - the Cambrian Explosion (0.54 Ga)
- 11.59 pm. Appearance of humans (<0.003 Ga)
- 3.12 am. Hadean Eon Ends. Life can begin (3.9 Ga)
- 3.44 am. Possible photosynthesis (3.8 Ga)
- 5.20 am. Tentative bacterial fossils (3.5 Ga)
- 7.28 am. Definite bacterial fossils (3.1 Ga)

KEY
Ga = 1 billion years
Interval when life must have evolved.
TNA - RNA - DNA world
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
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.

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

*BMJ 335, 15 Dec, 2007*
Trypanosomiasis - Sleeping Sickness

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

Kindly provided by Dr A Walker
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

creationwiki.org
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)

A contemporary map of Iraq and the surrounding region showing Mesopotamia (literally, “between rivers”).
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

~5,000 BC

Gerbil

Camel
Smallpox: King Ramses V

- Ramses V died suddenly in 1157 BC 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 20th 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\textsuperscript{th} 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
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
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 21st 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
Travel time from UK to Australia:

- 18th century ~1 year by sailing galley
- 19th century 100 days by clipper
- Beginning of 20th century 50 days by steamer
- Mid 20th 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+
Chimpanzee
Subspecies *Pan Troglodytes troglodytes*
Hunting and Preparing Bush Meat
HIV: Early Spread

Transfer to Humans ~1921

Spread from Cameroon to Kinshasa by 1959
Nipah Virus

..\animation\animations\NippahVirus.avi
# Are we Better Off than our Ancestors?

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<th>YES:</th>
<th>NO:</th>
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<tr>
<td>• More scientific knowledge</td>
<td>• Resources not distributed equally</td>
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<td>• More resources – anti-microbials, money, technology, manpower</td>
<td>• Poverty still rife</td>
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<td>• Rapid response</td>
<td>• Lack of global cooperation</td>
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<td>• Controlled SARS (so far)</td>
<td>• Antibiotic resistance</td>
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<td>• Global warming</td>
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<td>• H5N1 or H7N9 flu pandemic?</td>
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The Stupidest Virus is Cleverer than the Cleverest Virologist

George Klein

Thank you for listening!