Virology
Different types of flu viruses

- Flu viruses are divided into three main groups: Influenza A, B and C
- A viruses – source of ‘ordinary’ flu epidemics and all pandemics
- A viruses also infect birds and other animals such as pigs and horses
- B and C viruses infect humans only
<table>
<thead>
<tr>
<th>Influenza Types</th>
<th>Hosts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A</td>
<td>Humans, birds, pigs and horses</td>
</tr>
<tr>
<td>Type B</td>
<td>Humans only</td>
</tr>
<tr>
<td>Type C</td>
<td>Humans only</td>
</tr>
</tbody>
</table>
How flu viruses change

“Some of the commonest infections have a particular ability to change, influenza viruses being the chameleons of the microbial world.”

Getting Ahead of the Curve – a strategy for combating infectious diseases
– A report by the Chief Medical Officer, January 2002
Classification of influenza viruses

Two proteins on the surface of the virus:

Haemagglutinin (H)
- glycoprotein enables virus to attach to host cell
- 15 exist in nature
- H1, H2 and H3 most commonly associated with human infection

Neuraminidase (N)
- glycoprotein enzyme essential for virus replication
- enables new virion to be released from host cell
- N1 and N2 most commonly associated with human infection
Change

- Particular characteristic that enables influenza A viruses to cause annual epidemics, even pandemics
- Type A viruses undergo frequent changes in their surface antigens or proteins
  - Minor changes - *antigenic drift*
  - Major changes - *antigenic shift*
Antigenic drift

- Occurs among influenza A viruses resulting in emergence of new variants of prevailing strains every year
- New variants result in seasonal flu each winter
- Some years are worse than others – partly related to degree of ‘drift’
Antigenic shift

- Major changes occur in the surface antigens of influenza A viruses
- Occurs by mutation or by ‘reassortment’ between viruses
- Changes are more significant than those associated with antigenic drift
- Changes lead to emergence of potentially pandemic strains by creating a virus that is markedly different from recently circulating strains
Antigenic shift

Occurs in two ways:

- Sudden ‘adaptive’ change during replication of a normal virus OR
- From an exchange of genes between human strain of an influenza A virus and an animal strain
Antigenic shift

- Genetic exchange or ‘re-assortment’ produces a new virus capable of causing a pandemic in humans
- Can occur when an animal becomes infected with human and animal flu virus at the same time
- Animal within which this genetic exchange takes place know as ‘mixing vessel’
Antigenic shift

- Population will have little or no immunity to new virus:
  - all or most people will not previously have had infection due to it
  - will not have been vaccinated against it

- Lack of immunity allows virus to spread more rapidly and more widely than ‘ordinary’ flu viruses
Antigenic drift and shift

**Drift - 2003**
- From Influenza A (H3N2), Panama strain
- To Influenza A (H3N2), Fujian strain

**Shift - 1957**
- From Influenza A (H1N1) variants
- To Influenza A (H2N2) ‘Asian’ flu
How antigenic shift can occur

Karl G Nicholson, John M Wood, Maria Zambon
Lancet 2003; 362: 1733-45
Origin of Pandemic Influenza

Karl G Nicholson, John M Wood, Maria Zambon
Lancet 2003; 362: 1733-45

Migratory water birds
H 1-15
N 1-9

Domestic pig

Domestic birds

Karl G Nicholson, John M Wood, Maria Zambon
Lancet 2003; 362: 1733-45
Pandemic strain reassortment in pig

Migratory water birds
Pandemic strain
Reassortment in humans

Migratory water birds