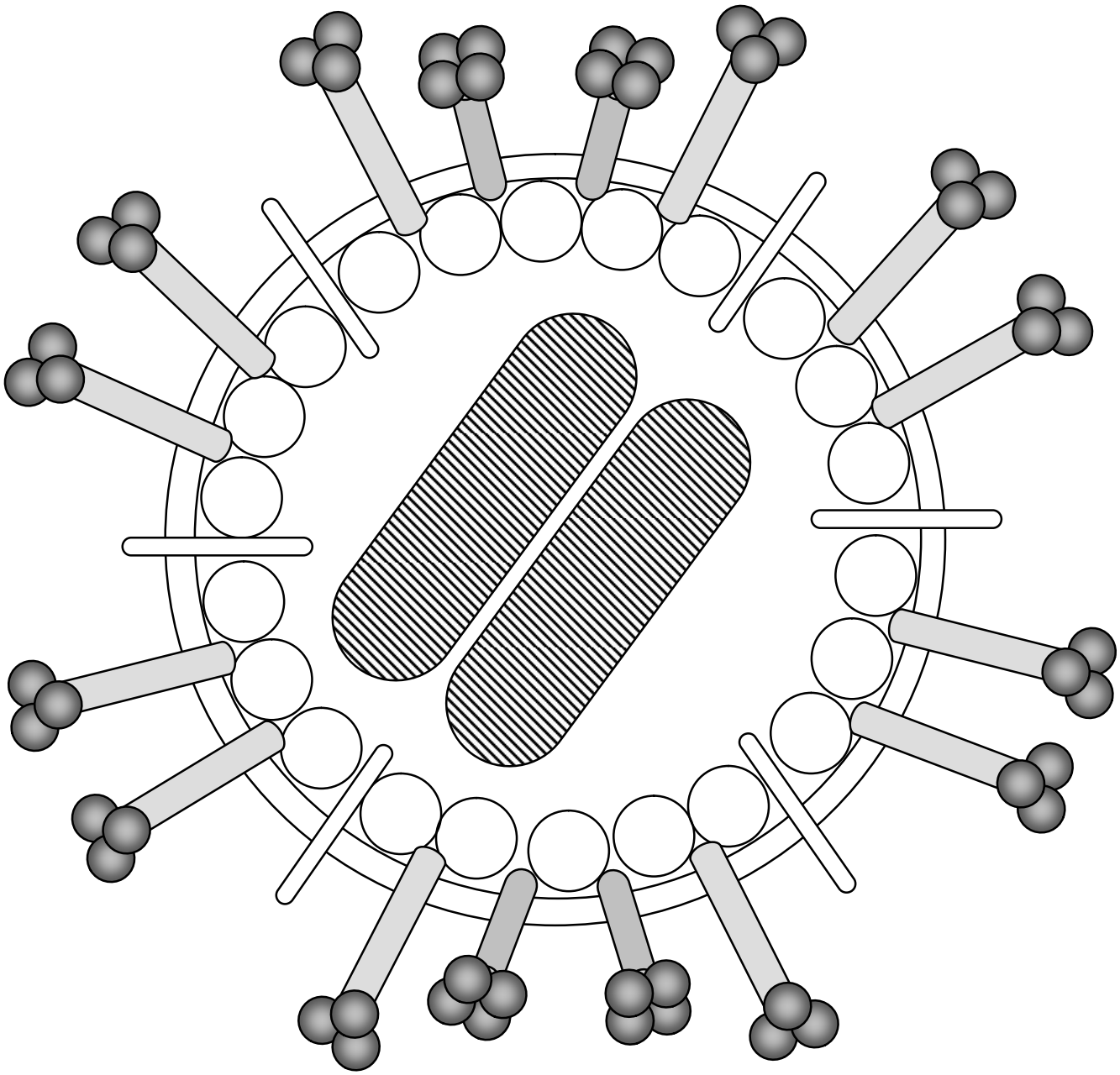
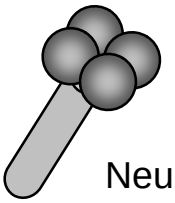
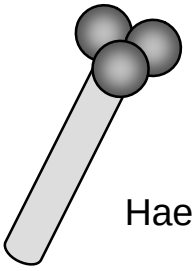


The Influenza Virus

50 nm



Neuraminidase (N) spike



Haemagluttinin (H) spike

The influenza virus consists of genetic material tightly packed inside a protein shell (capsid) which is enclosed in a phospholipid bilayer membrane. This membrane envelope has two types of glycoprotein spike, the haemagluttinin or H spikes, and the neuraminidase or N spike.

Q.1 Influenza virus invades cells lining the mucosal membranes in the nose and throat. The H spikes act like grappling hooks and bind the virus to specific receptors on its target cells and triggers the target cell to take the virus inside by endocytosis.

a) What is endocytosis? [3]

b) The N and H spikes are antigenic, meaning that they can trigger an immune response and the production of antibodies. Suggest how an antibody binding to the H spike may protect the host from infection. [2]

c) There are 16 different types of H antigen and each virus strain has one of these types, e.g. the H5N1 'avian' flu strain has the type 5 H spike and the type 1 N spike. In 2009 the 'swine' flu outbreak happened when genes for the H and N spikes from three different flu virus types (human, pig and avian) were recombined when all three viruses infected the same cell to give a H1N1 type of virus. This antigenic change is known as ***antigenic shift***. Explain how antigenic shift can give rise to new pandemics. [2]

d) Is the mechanism of antigenic shift described in part c) an example of vertical or horizontal gene transfer? Explain your answer. [1]

e) The H spikes have a deep active site pocket which recognises and binds to the monosaccharide sialic acid which is part of polysaccharides attached to the outside of the target cell membrane. Vaccines against influenza contain attenuated strains with mutations in the H and N spikes. Explain how a vaccine against the H5N9 influenza virus which consists of mutations in the H5 gene may work. [4]

f) The H spikes can also mutate over time, so that there are different subtypes of each of the 16 types. For example, a H5N9 strain may mutate over time, slowly changing its H spikes in a process called ***antigenic drift***. Suggest how this helps the virus survive in its host population over long periods of time. Is this an example of vertical or horizontal gene transmission? [3]

Q.2 The neuraminidase or N spikes are sialidase enzymes – they hydrolyse sialic acid from mucoproteins. Mucoproteins are glycoproteins that give mucus its stickiness. The N spikes make the mucus more watery which helps the virus get moved around inside its host, from cell to cell, and also helps it to escape from its host in order to infect a new host. The antiviral drug oseltamivir (sold under the trade name Tamiflu) competitively inhibits neuraminidase, causing influenza viruses to get entangled in mucus rendering them unable to escape from their host cell and infect other cells. What is competitive inhibition? [3]

Q.3 Using the scale bar shown in the figure, find the diameter of the virus in the diagram.