**Corona Virus Background**

In December 2019 a new Corona virus was identified in the Chinese city of Wuhan. Sufferers of this new virus were presenting with symptoms such as shortness of breath, a dry cough, fever and pneumonia. An autopsy of a recent victim showed high levels of alveolar damage including dead cells and proteins lining the alveoli and squamous epithelial cells peeling away. Blood tests of those infected with this new virus are showing many molecules associated with inflammation, overstimulation of cytotoxic T cells but also overall low levels of lymphocytes.

Epidemiologists are studying the spread of 2019-nCoV, as it has been named, and have determined it is likely to have originated from the seafood market in Wuhan. Through aerosol transmission, contact transmission and direct transmission Covid-19 disease has spread rapidly and cases have now been confirmed in over 30 countries

2019-nCoV is part of the Corona virus family and as such has the structure of a single strand of RNA surrounded by a protein envelope. (Figure 1)

Molecular biologists have sequenced the RNA strand and found it to contain 30,000 bases and it shows a strong genetic similarity to Chinese Horseshoe bat corona virus.

Structural biologists have used advanced imaging techniques to determine the intricate, three-dimensional structures of biological molecules found in the protein envelope.

**Figure 1**

The spike protein has been of special interest as it is thought to be the molecule used by the virus to gain entry to host cells. Analysis of the tertiary structure of the spike proteins has found it to be able to bind to ACE2 receptor proteins.

ACE2 receptors are transmembrane peptidase molecules found in the plasma membranes of human cells. It is expressed in many different tissues including lung, cardiac, kidney and gastrointestinal tissues.

When 2019-nCoV infects a cell, it hijacks the existing molecular machinery to create long chains of proteins required by the virus to generate even more copies of itself. These long viral proteins, however, only become functional when cut into smaller pieces by proteases. Thus, coronavirus proteases like that of 2019-nCoV play an integral role in propagating the virus.



**Figure 2**

As seen in Figure 2, the protease’s distinctive heart shape is the result of two identical protein subunits (coloured orange and red) coming together to form a functional protease. Similar to a lock and its key, the protease’s activity is triggered by the binding of molecules to specific points on the protease called active sites (shown in blue). The binding of a substrate effectively switches the protease on, allowing it to cut the long viral protein strands into smaller chains.

Now scientists know the structure of these two important proteins (spike and protease) they can apply this knowledge in trying to create treatments and vaccines to this virus. Finding a protease inhibitor which will work effectively against this enzyme would be a first step in preventing the virus from replicating in the host cells. If a drug could be developed which would stop the spike protein binding to the ACE2 receptors this could stop the virus spreading to other cells.

Other Biologists are trying to create a vaccine against the spike proteins. The vaccine would need to contain a molecule which would induce the host to create antibodies against the spike proteins in a primary immune response. If the host were to then come into contact with 2019-nCoV they would mount a secondary immune response and hopefully show no symptoms of the virus.

**Corona virus questions for AP Bio 12** Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Why does a host increase their core temperature when infected with a pathogen?
2. Why would the dead cells & proteins lining the alveoli cause the host issues?
3. Which molecules are associated with inflammation? Which cells release these chemicals? What effect do they have on the body?
4. What role do cytotoxic T cells play in the immune system?
5. What is epidemiology?
6. What are aerosol, direct & contact transmission?
7. Covid-19 is part of the corona virus family. What is the sequence of taxonomic groups used in classification (including family)?
8. Name 3 differences between RNA & DNA
9. The RNA of Covid-19 has 30,000 bases – what is the maximum number of amino acids that could be coded for by this nucleic acid? Explain your answer.
10. How are genes sequenced?
11. Why are genes sequenced?
12. What is the level of protein structure being described as ‘intricate three dimensional structure’?
13. What can you deduce about the structure of the spike protein from the fact it binds to the ACE2 receptor?
14. What can you deduce about ACE2 receptors from the description ‘**transmembrane peptidase**’?
15. ACE2 receptors are expressed in many types of tissue –what does express mean? How does it occur?
16. Covid-19 ‘hijacks existing molecular machinery’ – what is this referring to?
17. The Protease enzyme has 2 identical subunits – which level of protein structure is being described here?
18. Scientists are trying to find suitable inhibitors of protease – what are the two methods of inhibition and how do they differ?
19. Which cells produce antibodies? From memory sketch and label an antibody.
20. How do primary and secondary immune responses differ? Why?