Royal Society of Chemistry – Written evidence (COV0031)

This document presents a summary of where the chemical sciences are contributing to the science of COVID-19. Contributions are described in relation to the problem they address and for each topic, some examples of research groups and companies who could speak to the science in more detail have been suggested. Our aim with submitting this overview is to ensure that these contributions are considered and appropriately covered in the inquiry. *Note that this overview is not exhaustive.*

Understanding the virus

To be able to effectively target a virus, with drugs or a vaccine, understanding is needed of properties that lend themselves to intervention and disruption of the virus' action. Such properties include the genetic profile of the virus, its structural properties, and the way in which the virus interacts with cells in the human body. Areas of chemistry that contribute to understanding of such viral properties include analytical tools, principles of organic, biophysical and biomolecular chemistry, and molecular dynamics simulations.

Biophysical chemistry to understand viruses - **Dr Ehmke Pohl** at Durham University is contributing to the Horizon 2020 consortium '**Virus-X: Viral Metagenomics for Innovation value**'. He uses biophysical and structural characterisation to contribute to the understanding of viral diversity (and how 'possible' viruses would be expected to interplay with their hosts).

Biochemistry for rapid sequencing of SARS-CoV-2 - **Oxford Nanopore** is working with public health laboratories and researchers around the world to sequence SARS-CoV-2. Sequencing can support characterising the coronavirus and help public health authorities understand the identity of the virus, whether it is changing and how it is being transmitted.

Analytical and computational chemistry to understand COVID-19 - **Professor Max Crispin's group** at the University of Southampton, uses mass spectrometric approaches to understand the structures of the various glycans (sugar groups) on the surface of coronavirus . He is collaborating with **Dr Elisa Fadda** at Maynooth University, who is modelling this 'glycan shield', which helps the virus evade the human immune response (similarly to HIV) and could have major implications for the likelihood of vaccines being effective.

Treatments & vaccines

Development of drugs and vaccines requires a series of consecutive steps and chemistry plays an important role in many of these. Identification of promising candidate molecules for a treatment or vaccine relies on drug design methodologies that predict which candidates will be most effective. Once a candidate is identified, organic chemistry is relied on to develop the best route to produce the candidate (molecule) and after candidates are produced, analytical tools are deployed to test predictions of their effectiveness. Identification of an effective candidate is just the beginning of the process, where other disciplines take over, moving through clinical trials. Finally, materials chemistry tools support development of the drug delivery system to the human body.

Chemistry principles to design molecules that target the virus - The **COVID MoonShot** collaboration is an international group of researchers who are designing potential drugs, targeting specific sites of the SARS-CoV-2 virus, based on current chemical understanding of the virus. **Dr Fraser Scott** at the University of Strathclyde identified a new class of anti-viral chemical compounds, that are promising candidates against COVID-19.

Chemical science for vaccine development - Chemical researchers, such as **Professor Molly Stevens and Dr Rongjun Chen**, are part of Imperial College London's cross-disciplinary **Future Vaccine Manufacturing Research (FVMR) Hub**.

Chemistry to design drug delivery systems - **Professor Steve Rannard's group** at the University of Liverpool, uses polymer and bio-nano chemistry to create materials for enhanced drug delivery. **Professor Cameron Alexander's group** at the University of Strathclyde, part of the **FVMR Hub**, develops polymer-based materials to improve the delivery of drugs and components of vaccines, enhance therapeutic efficacy and reduce side-effects. **Micropore** uses liposomes and lipid nanoparticles for development of drug encapsulation technologies that ensure a drug or vaccine reaches the correct target and performs its function effectively.

Detection & diagnostics

To be able to understand where a virus is present in the environment (air, surfaces) and who is infected with the virus, we need to be able to detect it. Sensor development and analytical chemistry tools are used to detect the virus in the environment and in patients, respectively. Analytical tools can further be used for prognostic diagnosis, or in other words, the study and prediction of how different patients are expected to respond to the disease, which can support the facilitation of public health efforts. Chemical researchers also are working to improve existing diagnostic tests so they are more accurate, faster, easier to use and, ultimately, allow for point-of-care testing.

Analytical chemistry tools to understand the patient's response - Mass spectrometry can contribute to better understanding of patients' responses to COVID-19, which can help identify whether or not someone is likely to develop severe symptoms, and facilitate public health efforts. The **COVID-19 Mass Spectrometry Coalition** is coordinating research activities in this area.

Chemical research to improve existing point of care lateral flow tests - The **i-sense team** is developing a point-of-care diagnostic test that can detect ultra-low concentrations of the SARS-CoV-2 virus. Researchers at **Iceni diagnostics** in Norwich, and **Professor Matthew Gibson's group** at the University of Warwick, are developing a rapid test based on the detection of glycans on human cells that interact with the virus (rather than detecting the virus directly), using a device similar to a home pregnancy test. **ATDBio**, a biotech company based in Oxford and Southampton, is providing academia and industry with modified oligonucleoticdes (short pieces of DNA and RNA) to aid development of improved COVID-19 tests.

Transmission & containment

Alongside research for virus detection and development of effective treatments, efforts are ongoing to better protect ourselves from the virus. Here as well,

chemistry makes its contribution. Materials chemists are developing new PPE materials, new surface coatings and new filtration materials with better antiviral, viral droplet capture or other desirable properties. A better understanding of viral spread, that can inform how to effectively mitigate infection, is achieved through studying airborne droplet and aerosol behaviour in different environments.

Chemistry to develop anti-viral materials and coatings - The **Open Innovation Hub for Antimicrobial Surfaces** at the University of Liverpool, led by Professor Rasmita Raval, is developing new anti-viral surfaces and materials. The company **Smart Seperations** is developing new coatings that can combat viruses on contact and smart filtration technology that can destroy the virus from the air in buildings.

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