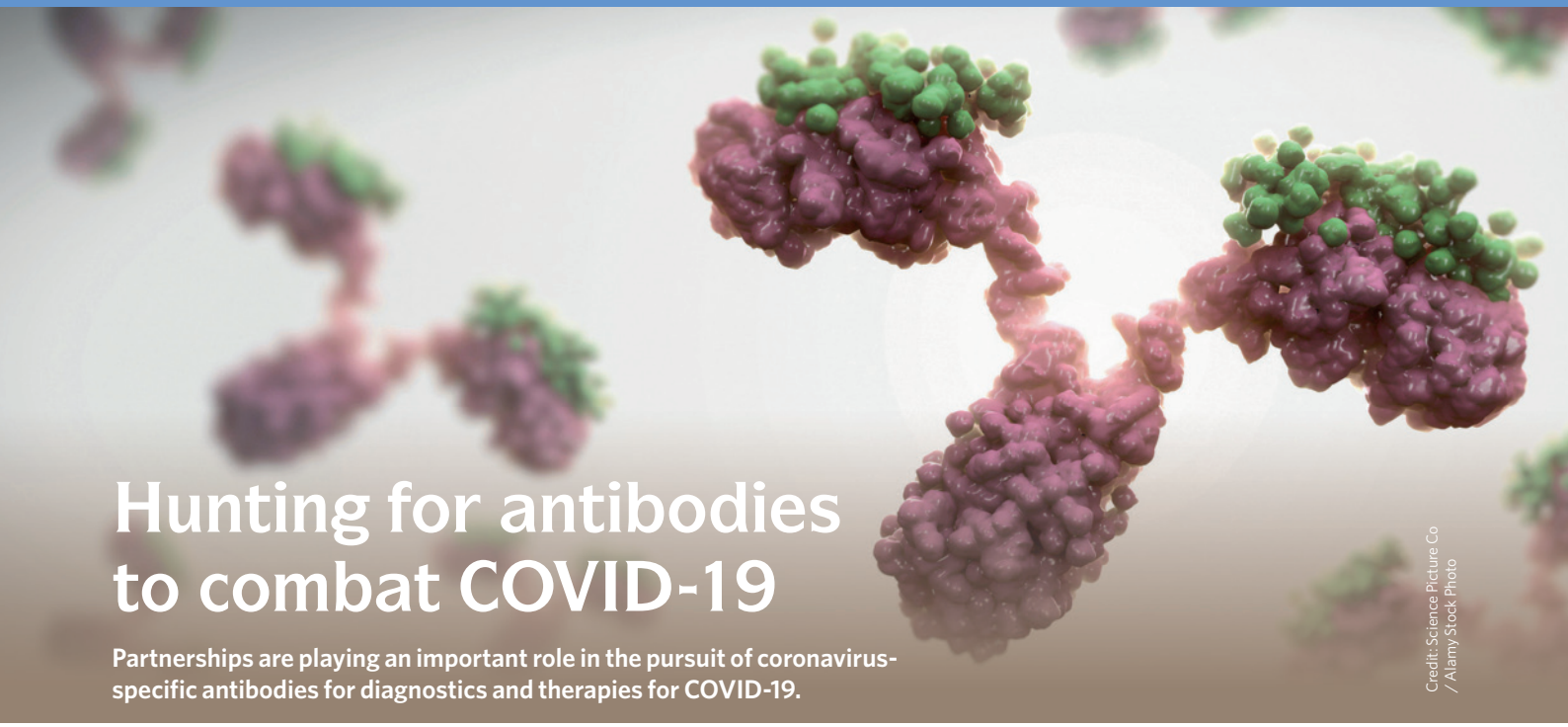

Hunting for antibodies to combat COVID-19

Partnerships are playing an important role in the pursuit of coronavirus-specific antibodies for diagnostics and therapies for COVID-19.

Biopharma Dealmakers

Antibodies produced by the body in response to infectious pathogens such as SARS-CoV-2 are at the center of the fight against COVID-19. The vaccines in development seek to train the immune system to produce neutralizing antibodies that can protect people against infection (Biopharma Dealmakers, B18, June 2020), while antibodies produced in people who have been infected with SARS-CoV-2 can be the basis for diagnostic tests, as well as starting points for the development of antibody products that could be used for prevention or treatment. In this feature, with the help of data from DealForma we look at the application of antibodies in the development of both diagnostics and treatments for the COVID-19 pandemic, with a focus on some of the partnerships established to accelerate development.

Diagnostic testing for COVID-19

The diagnostic tests for COVID-19 in use at present fall largely into two groups: those that detect viral nucleic acid sequences and those that detect antibodies to SARS-CoV-2 produced by the immune system in people who have been infected. Nucleic acid-based tests are the simplest to develop and are highly accurate. Globally, these tests have been heavily used from early on in the pandemic. However, they only pick up active infections, whereas immunoassays that detect antibodies that patients have produced in response to SARS-CoV-2 have the potential to identify people who have been infected (perhaps unknowingly) and recovered. The downside of immunoassays is that they are more challenging to develop, and the readouts may be affected by the complex nature of immune responses to infection.

Spurred by the need for speed and scale, companies and academic institutions developing both types of diagnostics for COVID-19 have been active in partnering. According to data from DealForma, more than 70 deals involving the development of diagnostics for COVID-19 have been made since February (Fig. 1). The majority of the deals were focused on the development of nucleic acid-based tests, but there were also several notable deals related to antibody-based diagnostics (Table 1). As with vaccines in development for COVID-19 (Biopharma Dealmakers, B18, June 2020), the US Biomedical Advanced Research and Development Authority (BARDA) has been a key player in such partnerships.

Antibodies as treatments

In parallel with the pursuit of diagnostic tests, a number of biopharma companies are searching for antibodies as treatments against SARS-CoV-2, harnessing the wealth of expertise and manufacturing capabilities that has been built up through the development of highly successful monoclonal antibody (mAb)-based therapies for cancer and immune disorders.

Antibodies developed to treat infectious diseases have historically been few and far between, owing to factors such as the availability of small-molecule drugs and vaccines. However, given the novelty of SARS-CoV-2—with no vaccine available yet and the only near-term options for small-molecule drugs being the repurposing of compounds, such as remdesivir, that have been developed for other diseases—antibodies have attracted intense interest as potential treatments for COVID-19. Furthermore, antibodies could be used in prevention strategies until a vaccine is successfully developed and be valuable afterwards for various groups for whom vaccines are not applicable, such as immunocompromised patients.

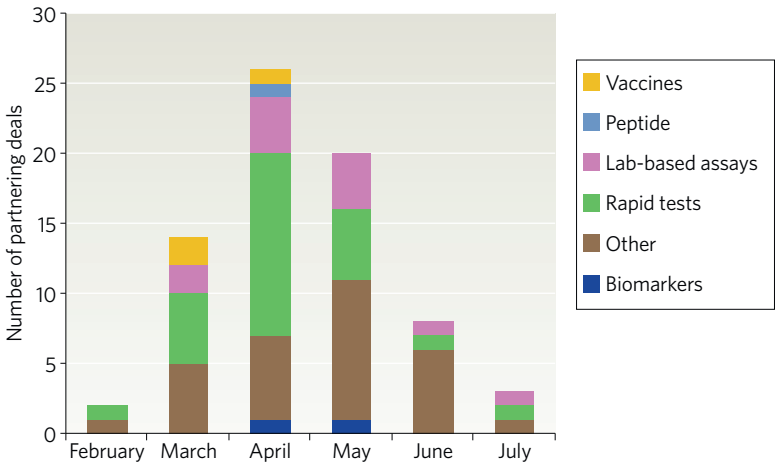

Fig. 1 | Partnering deals by diagnostic type in development to target COVID-19 (February – July 2020). More than a fifth of the deals were focused upon antibody-based diagnostics. Source: DealForma, July 2020.

The antibodies in development originate from analysis of the blood of people who have recovered from SARS-CoV-2 infection, who presumably have raised an effective immune response against the coronavirus. Although convalescent plasma itself could be used as a therapy, it has key limitations linked to manufacturing at scale, batch-to-batch variability and the need for blood type matching. Consequently, efforts to harness antibodies as COVID-19 therapies have largely focused on identifying suitable neutralizing antibodies in convalescent plasma and optimizing them as therapies. The aim for such mAbs is to block viral entry into cells by binding to the spike protein of SARS-CoV-2 (Fig. 2).

Biopharma companies working on mAbs for COVID-19 include Regeneron, Vir, Lilly, AstraZeneca, Amgen and the Adimab spin-out Adagio Therapeutics, and partnerships are prominent in accelerating their efforts. Some of the companies, such as Vir and Regeneron, already have well-established platforms for identifying and optimizing suitable mAbs, and their partnerships have focused on development of their candidates with partners that can offer large-scale manufacturing and commercialization capabilities.

For example, in April, Vir and GlaxoSmithKline (GSK) entered a collaboration to accelerate the development of two neutralizing mAbs identified by the Vir platform, VIR-7831 and VIR-7832, with GSK making a $250 million equity investment in Vir (Table 1). And in July, Regeneron announced a $450 million contract awarded by BARDA to manufacture and supply REGN-COV2, a cocktail of two neutralizing mAbs identified by Regeneron that is in phase 2/3 trials for the treatment of COVID-19 and a phase 3 trial for the prevention of SARS-CoV-2 infection.

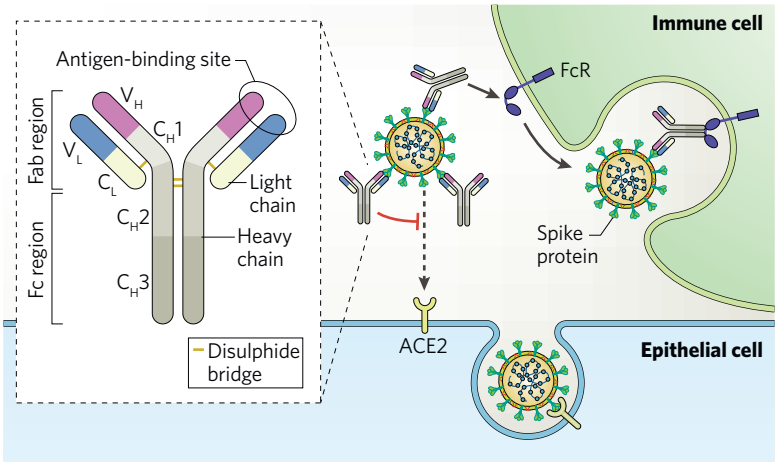

Fig. 2 | Antibodies in the battle against COVID-19. Mode of action of therapeutic monoclonal antibodies for treatment or prevention of COVID-19. Antibodies that bind to the viral spike protein can block the interactions with the cellular receptor angiotensin-converting enzyme 2 (ACE2), inhibiting viral entry. Some regions of the antibody such as the Fc region can be specifically engineered to improve the characteristics of therapeutic mAbs. mAbs, monoclonal antibodies; C_H, constant heavy domain; C_L, constant light domain; Fab, fragment antigen-binding; Fc, fragment crystallizable; FcR, Fc receptor; V_H, variable heavy domain; V_L, variable light domain.

Other large companies have partnered with academic institutions and biotech companies to gain access to promising potential mAb candidates. One of the earliest deals of this type was penned in March when Lilly partnered with the biotech

Table 1 | Selected partnering deals announced for the development of diagnostics involving antibodies for COVID-19 (February–July 2020)

Partner	Partner	Month	Deal summary
Ortho Clinical Diagnostics (Carlyle Group)	Biomedical Advanced Research and Development Authority (BARDA, HHS)	June 2020	BARDA gives $0.67 million as a grant to Ortho Clinical Diagnostics to develop IgG antibody-based tests for the detection of COVID-19
Bio-Rad Laboratories	Biodesix	May 2020	To detect COVID-19 antibodies, Bio-Rad partners with Biodesix to commercialize blood-based immunoassay-based serology test
Kantaro Biosciences (Mount Sinai, Renalytix AI)	Bio-Techne	May 2020	Kantaro Biosciences collaborates with Bio-Techne to develop and manufacture COVID-19 IgG antibody test kit
Duke-NUS Graduate Medical School, Agency for Science, Technology and Research (A*STAR)	Genscript Biotech	May 2020	Duke-NUS partners with Genscript to co-develop and commercialize serological COVID-19 detection system, surrogate virus neutralization test (sVNT) or cPass for the rapid detection of neutralizing antibodies (NAbs) against COVID-19
Thermo Fisher Scientific	Mayo Clinic, WuXi Diagnostics	May 2020	Thermo Fisher signs research deal with WuXi Diagnostics and Mayo Clinic to develop an antibody-based test
Mologic	BioSure UK	May 2020	Mologic collaborates with BioSure to develop an antibody self-test using its COVID-19 lateral flow test combined with BioSure's design to detect COVID-19. The self-test will deliver results in ten minutes
InBios International	BARDA, HHS	April 2020	InBios partners with BARDA in research deal to develop a rapid diagnostic test to detect SARS-CoV-2 antibodies in blood samples
Merck & Co. Inc.	Institute for Systems Biology (ISB)	April 2020	Merck partners with the ISB to identify molecular mechanisms and prognostic biomarkers for SARS-CoV-2
Hememics Biotechnologies	BARDA, HHS	April 2020	To detect SARS-CoV-2 in nasal swab samples and associated antibodies, Hememics Biotechnologies signs research partnership with BARDA to develop bluetooth-connected rapid diagnostics
ProMIS Neurosciences	BC Neuroimmunology	April 2020	ProMIS Neurosciences partners with BC Neuroimmunology Lab and Neurocode Labs to develop high-throughput serological assay to detect SARS-CoV-2
Chembio Diagnostics	Oswaldo Cruz Foundation	March 2020	Bio-Manguinhos buys Chembio's DPP COVID-19 IgM/IgG system for $4 million to detect and differentiate COVID-19 IgM and IgG antibodies in whole blood in Brazil

Source: DealForma, July 2020.

Table 2 | Selected partnering deals announced for the development of treatments involving antibodies for COVID-19 (February–July 2020)

Partner	Partner	Month	Deal summary
Regeneron	US government (Operation Warp Speed)	July 2020	Regeneron signs deal worth $450 million with the US government to supply it with doses of its antibody candidate REGN-COV2, including up to 300,000 treatment doses and up to 1.3 million preventive doses
Regeneron	The National Institute of Allergy and Infectious Diseases (NIAID), part of the NIH	July 2020	Regeneron collaborates with the NIAID, part of the NIH to conduct phase 3 COVID-19 prevention trials
Harbour BioMed (HBM), Utrecht University (UU) and Erasmus Medical Center (EMC)	AbbVie	June 2020	AbbVie announces a collaboration to develop the antibody therapeutic candidate 47D11 discovered by UU, EMC and HBM. AbbVie will contribute to preclinical development work, be ready to handle later stage development work and in line for an option to exclusively license the antibody for global clinical development and commercialization
Vanderbilt University	AstraZeneca	June 2020	AstraZeneca licenses six neutralizing antibodies from Vanderbilt University, two of which will be used in a dual antibody program
Junshi Biosciences	Lilly	May 2020	Lilly partners with Junshi Biosciences to co-develop antibody therapeutics to treat COVID-19
Vanderbilt University Medical Center, Chinese Academy of Sciences, United States Army Medical Research Institute of Infectious Diseases, University of Maryland School of Medicine	AstraZeneca	April 2020	AstraZeneca collaborates with government and academia. The research pact aims to identify monoclonal antibodies that could recognize and neutralize SARS-CoV-2
Adaptive Biotechnologies	Amgen	April 2020	Amgen announces deal with Adaptive Biotechnologies to discover and develop fully human neutralizing antibodies targeting SARS-CoV-2 to potentially prevent or treat COVID-19
Vir Biotechnology	GlaxoSmithKline	April 2020	GlaxoSmithKline partners with Vir Biotechnology to research and develop solutions for the treatment of COVID-19 including new antiviral antibodies VIR-7831 and VIR-7832, which were identified by Vir's antibody platform as having a neutralizing effect on SARS-CoV-2, once bound to its spike protein
AbCellera	Lilly	March 2020	AbCellera and Lilly sign a co-development deal for antibody therapies for the treatment and prevention of COVID-19

Source: public press releases.

AbCellera to co-develop antibody therapeutics based on screening the blood of one of the first US patients to recover from COVID-19. Lilly initiated a phase 3 trial of LY-CoV555, the lead mAb candidate identified from this collaboration, in partnership with the National Institute of Allergy and Infectious Diseases in August. Lilly also partnered with the Chinese biotech Junshi Biosciences on COVID-19 mAbs in May 2020, with Junshi maintaining all rights within China and Lilly having an exclusive license outside of China. Phase 1 trials of their neutralizing mAb JS016 commenced in June. Another large company, Amgen, partnered with the biotech Adaptive Biotechnologies to develop COVID-19-neutralizing mAbs in April 2020.

Academia has also been a source of many therapeutic candidates and chosen to collaborate to further their developments. In June 2020, AstraZeneca licensed two neutralizing mAbs from Vanderbilt University, building on a research collaboration first initiated in April 2020, and AbbVie partnered with Harbour BioMed, Utrecht University and Erasmus Medical Center to develop a neutralizing mAb known as 47D11.

In addition to traditional partnerships, the escalating pandemic has triggered the formation of larger, never-seen-before collaborative efforts to combat the virus, including mAb therapies. These partnerships include Operation Warp Speed (a joint effort announced in May this year, between US agencies including the Centers for Disease Control and Prevention (CDC), the FDA, the NIH and BARDA); the COVID R&D alliance, which brings more than 20 pharmaceutical companies together to accelerate promising therapeutics for COVID-19; and the COVID-19 Clinical Trials Alliance, which connects sites, sponsors and CROs to speed up drug and vaccine development against COVID-19. All of these partnerships underline the magnitude of the problem and the motivation of the industry to work together and share resources to accelerate the development of countermeasures.

DealForma data and methodology

The DealForma database was used to analyze licensing transactions, mergers and acquisitions, asset purchases, and various research partnerships focused on diagnostics for SARS-CoV-2 and COVID-19 announced between 20 February, 2020 and 13 July, 2020. Furthermore, the technologies and modalities of the diagnostics were categorized when disclosed as were the deal terms from early stage research grants to commercialization deals.

Feel free to contact analysts@dealforma.com with any questions.

Acknowledgements

We would like to acknowledge DealForma for the use of its COVID-19 diagnostic deals data.