The UK in the race for a COVID-19 Vaccine within UK manufacturing

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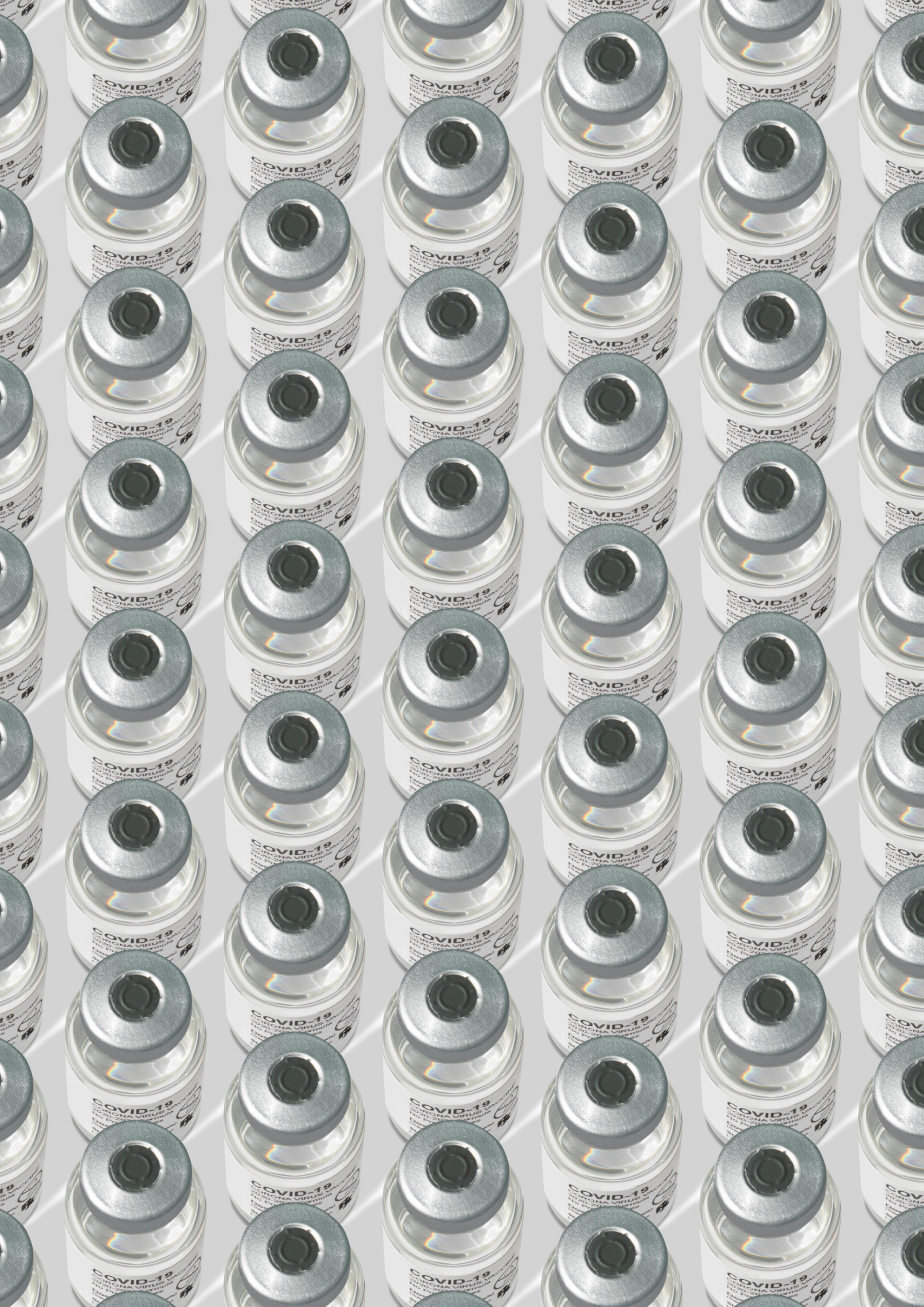

COVID-19
CORONA VIRUS VACCINE

Tony Devlin, National Officer
Unite Chemicals, Pharmaceuticals, Process and Textiles

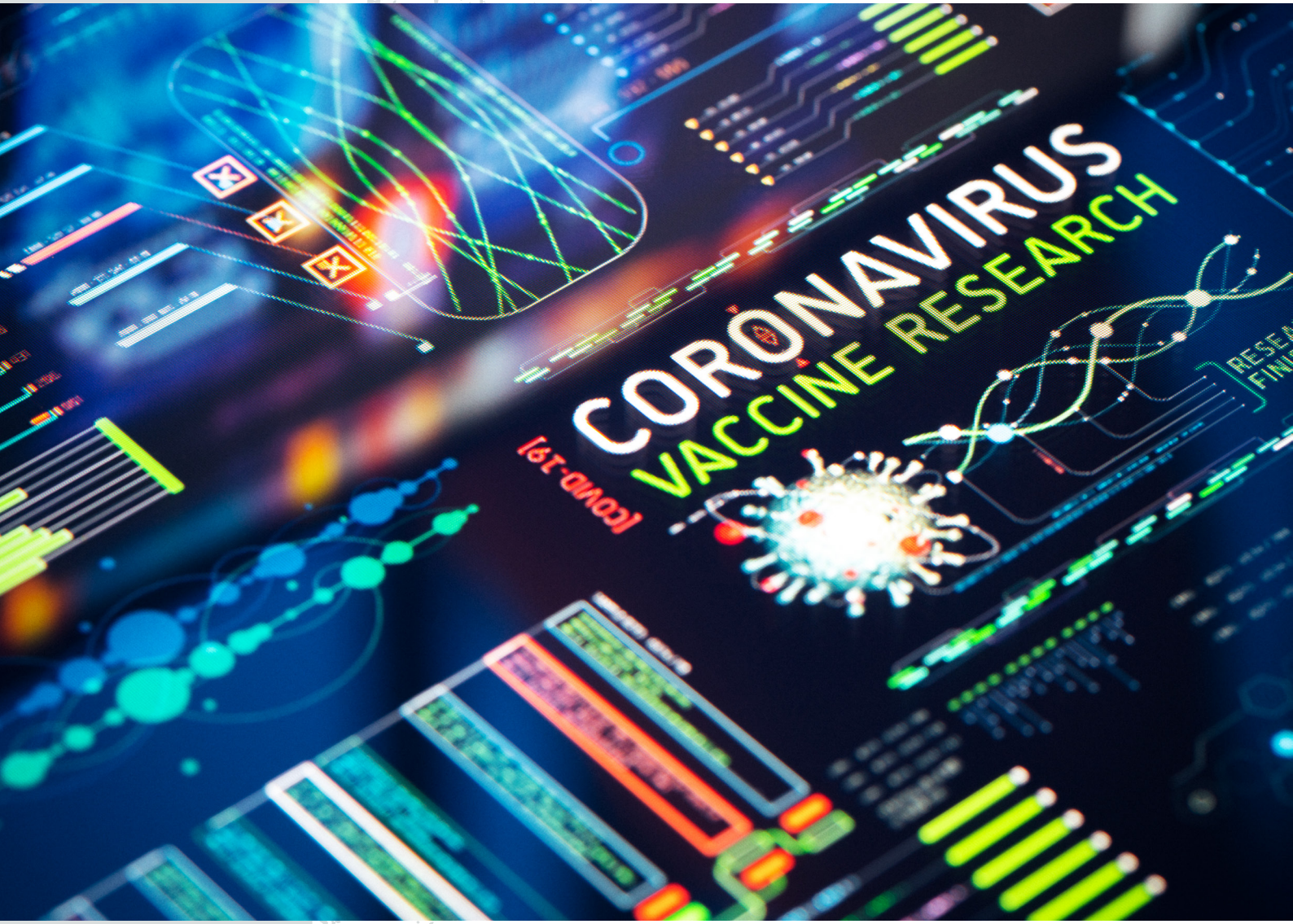
It is a basic right of any UK citizen to expect the UK government to provide a position of medicine security and to provide a manufacturing environment in the UK that sees our pharmaceutical sector capable of providing its citizens with medicines and it workers with good skilled jobs from discovery to administration within the UK.

As you will see from this document the UK is not in an acceptable or secure manufacturing position to do this, and has instead had to seek a global solution to securing a vaccine and medicines for UK citizens, this is a position that Unite believes cannot continue and is not only detrimental to UK citizens but also to workers and the UK pharmaceutical and associated manufacturing sectors throughout the UK supply chain.

To address this Unite believes that the UK government must urgently embark on a journey to ensure medicine security in the UK by creating an industrial and economic environment that delivers a strong secure UK pharmaceutical manufacturing sector creating skilled well paid jobs that not only supports our citizens and society but UK workers and the UK economy.

To achieve this, Unite's key priorities are:

- The UK government must adopt and implement a base principle of having the ability as a country to provide UK citizens with medicines from discovery to administration.
- That the UK government is investing at the required capacity to support the delivery of a vaccine and all future medicines.
- That UK investment directly supports our pharmaceutical manufacturing base in the UK.
- That UK companies are supported throughout the pharmaceutical supply chains to derive good quality jobs and societal benefits from the development of a vaccine and all medicines manufactured in the UK.
- The discovery, manufacture and roll out of any vaccine or medicines provides quality sustainable skilled jobs in the UK pharmaceutical sector and supply chains.


CORONAVIRUS
VACCINE RESEARCH
(COVID-19)

Introduction

The Coronavirus global pandemic has affected every part of our lives. Lives have been lost and we have had to live with the impact and threat of being infected with COVID-19. Our working lives, and jobs have been severely affected. We've changed our social norms and adapted our workplaces to allow a safe return to work.

At the outset of this public health crisis it was clear that there existed the potential for an unprecedented number of deaths and that our NHS was under acute pressure. This has been exacerbated by the a UK government whose response was a lack of adequate planning, failing to provide our health service and care workers with the appropriate levels of and mixed messaging on lock down rules has resulted in thousands of deaths which could have been prevented.

While we learn to live with the threat of COVID-19, and make adjustments in all areas of their daily lives, it is abundantly clear that the development of a vaccine is of utmost importance to allow restoration of normal life and to support the ability of international economies ability to return to pre-pandemic levels.

Unite's CPPT sector (Chemicals, Pharmaceutical, Process and Textiles) sector has identified the current situation in the race to develop a vaccine and to examine the involvement of government, universities and global pharmaceutical companies in achieving that ultimate goal.

In this document we identify those engaged in the global race to develop a vaccine and chart the progress of government, university research laboratories and multinational pharmaceutical companies. Without a vaccine against SARS-CoV-2- the coronavirus that causes COVID-19 there remain a risk that new outbreaks of the disease will emerge.

Critically the document evaluates the situation in the UK and the capability of the UK pharmaceutical sector to discover, manufacture, and administer a vaccine for UK citizens.

Executive summary

Currently 76% of the vaccines for worldwide use are produced in and exported from Europe. With its numerous centres of excellence in vaccinology and related disciplines, Europe should have the capacity and capability of continuing to lead the discovery of next generation vaccines capable of addressing unmet medical needs and emergency situations.

Vaccines remains nevertheless a very marginal segment of the pharma industry. In European countries, only a small percentage of national healthcare budgets are allocated to prevention, with an even smaller proportion devoted to vaccination. Over the 2005 – 2016 period, prevention accounted for 0.90% - 4.66% of healthcare spending, whereas, vaccines accounted for less than 0.5% (range 0.15% - 0.50% in all countries except Germany, allocating 0.62% in 2016).

Some of the biggest players in the vaccine industry are registered in the UK. GlaxoSmithKline along with AstraZeneca, are two of the main vaccine manufacturers. These companies compete (and sometimes collaborate) mainly with US companies such as Merck &Co, Pfizer and European companies such as Sanofi.

In the UK, the overall Core Biopharma sector contains 703 businesses employing 63,300 people with a turnover of £33.4 bn in 2018. The sector breakdown shows that businesses main economic activity involves:

- Small molecule therapeutics form the largest segment, accounting for 67% (585) of sites,
- 77% of employees (48,900) and
- 83% (£27.8bn) of turnover.

Antibodies, therapeutic proteins and vaccines are the next largest segments, together making up 19% (12,000) and 15% (£4.9bn) of employment and turnover respectively. To date Germany remains at the top of the list followed by France, Italy and the Netherlands. Employment in the UK has remained almost static in this sector since 2017.

The UK should play a significant role in the global race for the COVID-19. Nevertheless, despite a strong R&D capability and a significant biopharma sector, the UK government's strategy is rather timid compared to peers. Stronger support from the UK government, notably directed to the building of additional manufacturing capability, would help the global fight against the virus, secure access for UK citizens to a vaccine and support an industry which has been fragilized by years of a strategy based on offshoring to India and China in an attempt to lower costs and boost the return for the shareholders. The shortage of Bacillus Calmette–Guerin vaccine (BCG) protecting against tuberculosis at the end of the last decade was an illustration of the limit of a market-only driven industry. 60-80% of the world's active pharmaceutical ingredients are produced in India and China and some were barred from export during the outbreak.

Vaccine R&D can be a long and risky journey. Finding a new vaccine begins with understanding the structure of the virus or bacterium and how it causes the infection which you are trying to prevent. Vaccines contain a harmless form of the bacteria or virus that causes the disease.

The process to develop a vaccine requires:

- 10 years of research for each successful vaccine
- 12-18 months for first regulatory approval
- 6% probability of market entry from preclinical
- £448 million cost of building a biological manufacturing site
- 70% of production dedicated to quality control
- £374 million - £1.5 billion cost of development
- 24 months to manufacture

Given current events, the race for the vaccine for COVID-19 implies that investment in manufacturing capabilities developed before the vaccine is declared safe and efficient. There is an immense financial risk which will require public funding to secure investments.

Comparison of pledges by countries shows to date, the UK has pledged the least amount to the cause among the most important developed countries. The UK government has allocated funds in the amount of £131 million to boost investment in vaccine infrastructure and increase capacity to manufacture a vaccine for COVID-19 in the UK.

An agreement was signed between Oxford Biomedica and VMIC on June 8, 2020 to scale up the manufacturing of viral vector based vaccines. The vaccine targeted is a collaboration between AstraZeneca and University of Oxford. The VMIC facility will be capable of the production of 70 million vaccines doses over a 4-6 month period. This facility is scheduled to open in Oxfordshire mid 2021.

The UK's strategy to developing the vaccine is atypical in Europe. France, Germany, Italy and Netherlands have formed an alliance ('Inclusive Vaccine Alliance'). The aim of the "Inclusive Vaccine Alliance" is to allow for vaccine production on European soil wherever possible.

Germany and France have explicitly advised national pharmaceutical companies of their national priorities, and have been financially incentivised to commit to them. Sanofi a French pharmaceutical has three vaccine factories in France and three in the US. However, none of its European facilities can make vaccines using novel recombinant DNA technology, which is now being tested for coronavirus vaccines. As such Sanofi has committed €600m to developing a facility in France with €200m public support creating 200 jobs and saving the site of Neuville sur Saone from closure.
The new development is said to be the most advanced plant with capabilities of producing 4 vaccines simultaneously. Sanofi has also pledged to invest €120m in a R&D facility.

Germany extended the regulation of foreign takeovers of healthcare companies. Under the new regulations, a health company must notify the German government if a buyer outside the EU seeks a stake of more than 10% -- compared with a previous threshold of 25%. This law is evident. The US attempt to control CureVac failed by taking control of 23% of the company at a cost of €300m.

Despite a significant share of vaccines under development in the UK, the UK has failed to prioritise production of the vaccine nationally and relies on imports of vaccines. Hesitation is evident as the UK

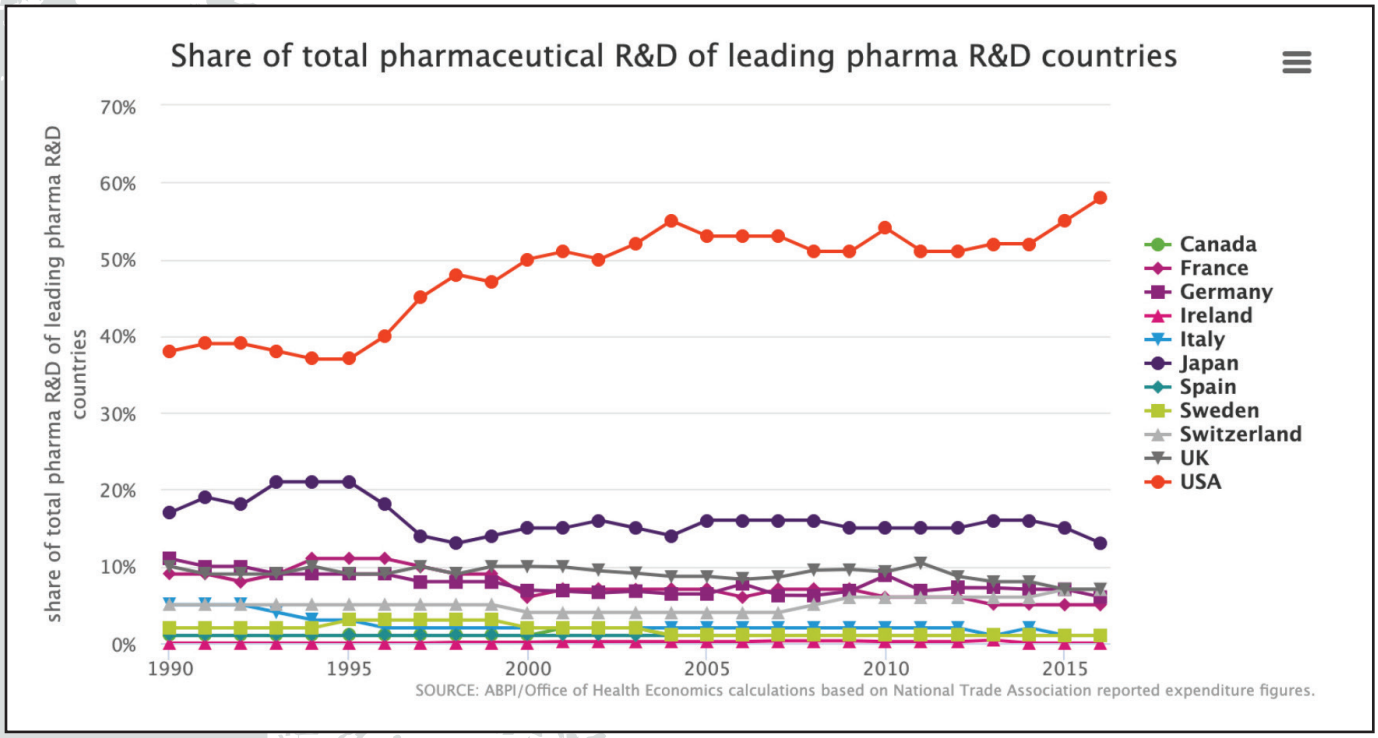
1 The Vaccines Manufacturing and Innovation Centre (VMIC), is a not-for-profit organisation providing the UK's first strategic vaccine development and advanced manufacturing capability.

continues to unilaterally buy up supplies rather than join the EU common procurement platform. The race to secure access to the vaccines is dominated by the US. With the Biomedical Advanced Research and Development Authority (BARDA) the US has already invested billions. The Operation Warp Speed (OWS) aims to deliver 300 million doses of a safe, effective vaccine for COVID-19 by January 2021. The UK will face the determination of the US in securing the vaccine paying a significant price for the supply. Press reports that the UK government is liaising with GSK and Sanofi on a £500 million deal to buy 60 million doses if proved successful.

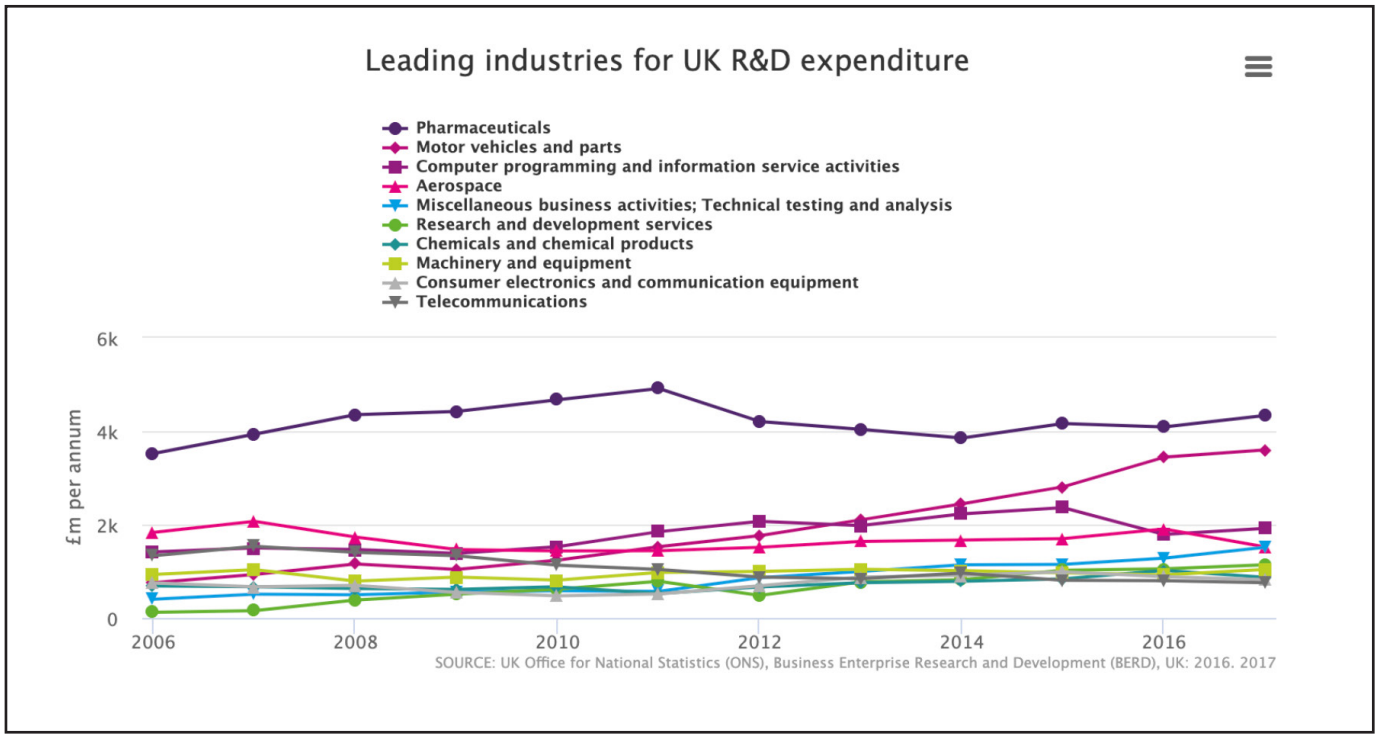
Employing a strategy of modifying the current manufacturing facilities and the development of new capabilities would be more efficient in the long term, especially in the scenario of the development of a new type of pandemic in the future. This will be an economic investment in the UK pharma given the escalation of the entry ticket to secure supply over the last weeks as the pandemic continues to spread.

Research & Development in the pharmaceutical sector: the UK is one of the global key players

The global pharmaceutical industry invested over £1.082 trillion in R&D in the decade from 2007 to 2016 and forecasts prior to the pandemic predicted an annual investment of £144 billion by 2022. The race for the COVID-19 vaccine will boost the investments in R&D. The US retains the highest share of R&D expenditure in the world, in Europe, the UK has the highest share.



In the UK, following substantial growth from 2014 to 2015 (8%), expenditure has remained steady, showing a slight decline in 2016 followed by growth in 2017 to £4.3 billion. The sector reached a peak in its share of overall UK business expenditure on R&D in 2010, with a share of 29% of the total business expenditure on R&D across sectors. Overall, pharmaceutical R&D represented 18% of all business expenditure on R&D in the UK in 2017.



The UK is a relatively R&D intensive country for pharmaceuticals, with an intensity (that is, UK R&D expenditure as a share of UK sales) of 33% in 2016. The only sector with a higher R&D intensity is consumer electronics and communications equipment, which has grown substantially since 2010 and which has also seen a recent decline.

UK Biopharma overview

Antibodies, therapeutic proteins and vaccines represents 19% of employment (12,000) in UK Biopharma (and 15% (£4.9bn) of turnover respectively.

Geographical analysis of employment shows Core Biopharma businesses in all areas of the UK with the greatest concentration in the South East, East of England, London, and the North West of England which together account for 80% (50,650) of Core Biopharma employment.

Analysing the size of the businesses shows 31% (220) of Core Biopharma businesses are non-SMEs.

These large businesses employ 58,000 people (92% of Core Biopharma employment) and account for £32.4bn of turnover (97% of Core Biopharma turnover). They represent 44% of total life sciences industry turnover and 23% of employment.

To date Germany still remains at the top of the list followed by France, Italy and the Netherlands. The employment in the UK has almost not increased in this sector since 2017 with current figures at circa 63,300, which coincides with the educational trends seen in STEM in the UK.

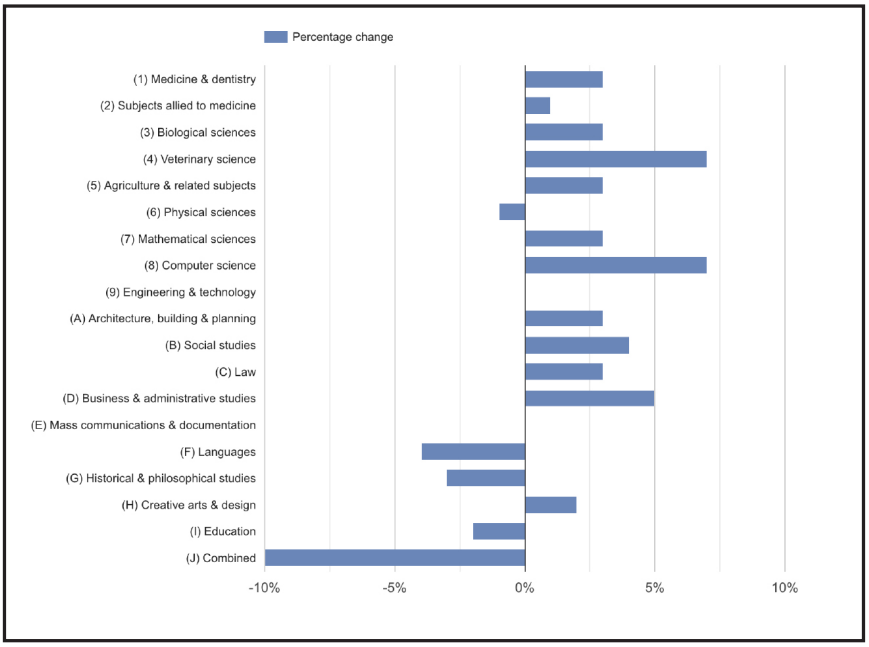
The diagram below of the Higher Education Student Statistics shows the extent at which careers are being pursued in the UK. When compared to the previous year students pursuing courses in STEM has only grown by 3% compared to other scientific courses.

PHARMACEUTICAL PRODUCTION

EFPIA 2017	€ million		€ million
Austria	2,712	Latvia	157
Belgium	10,768	Lithuania	n.a
Bulgaria	121	Malta	n.a
Croatia	585	Netherlands	6,180
Cyprus	180	Norway	1,072
Czech Rep.	n.a	Poland	3,172
Denmark	14,391	Portugal	1,694
Estonia	n.a	Romania	655
Finland	1,766	Russia	5,052
France	21,900	Slovakia	356
Germany	30,555	Slovenia	2,083
Greece	954	Spain	15,199
Hungary	3,044	Sweden	7,686
Iceland	89	Switzerland	44,944
Ireland	19,305	Turkey	4,439
Italy	31,200	U.K.	20,609
TOTAL			**250,868**

Note:
All data based on SITC 54
Iceland, Turkey: 2016 data; Bulgaria: 2015 data; Ireland: 2014 data; Romania: 2013 data; Cyprus, Netherlands: 2010 data
Croatia, Denmark, France, Ireland, Italy, Netherlands, Norway, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland: estimate
Bulgaria, Croatia, Cyprus, France, Germany, Hungary, Ireland, Latvia, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden: veterinary products excluded

Source: EFPIA member associations (official figures)



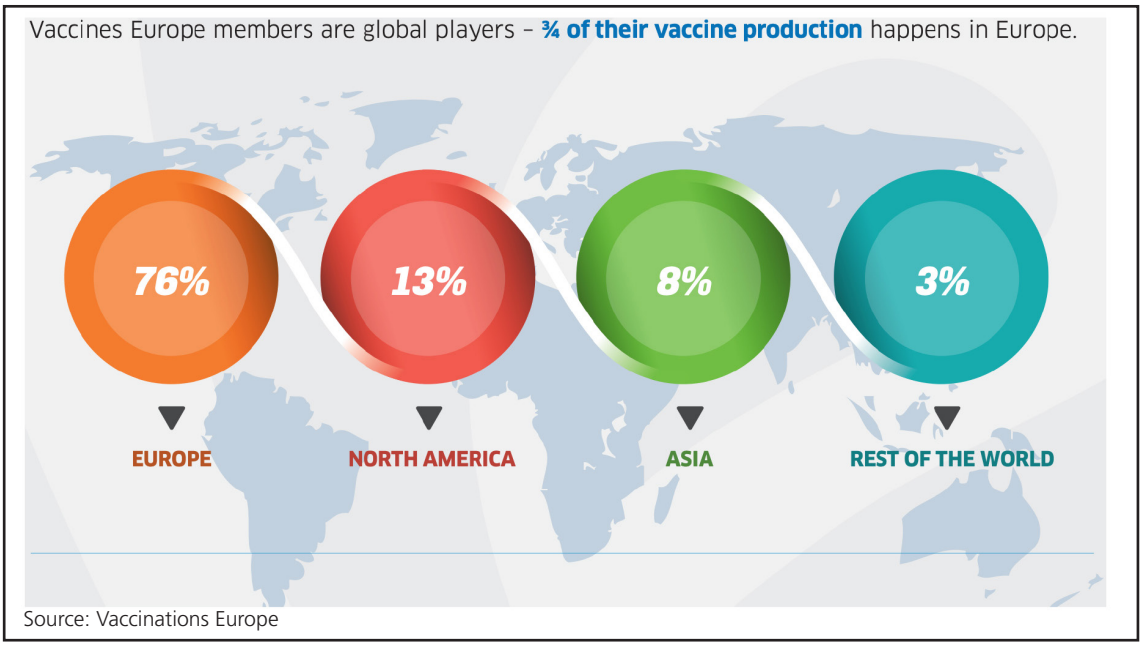
Source Higher Education Student Statistics

Furthermore, According to ONS data, EU migrants make up a significant proportion of life science staff in the UK, often in roles that are highly specialised, and where expertise may be limited. According to the English Health Service's Electronic Staff Record, 55,000 out of the 1.2 million staff in the English NHS are citizens of other EU countries.

EU migrants make a significant contribution to life sciences in the UK, including research and development, manufacturing and distribution. A potential cessation in the rights of these professionals to work in the UK may cause a staffing crisis.

Introduction to the vaccine industry

Europe has a long history of vaccine discovery, development and manufacturing, and benefits from a strong industrial infrastructure.

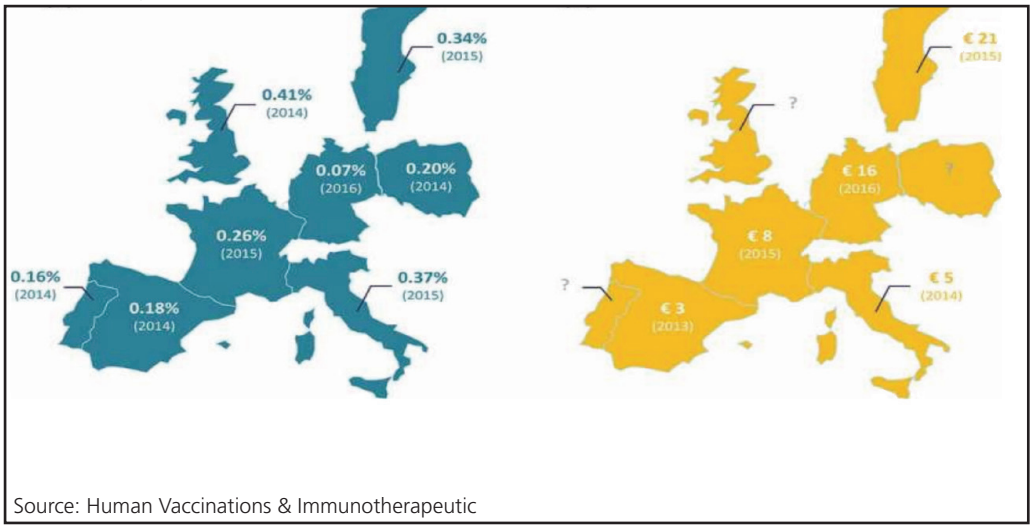


Source: Vaccinations Europe

Currently 76% of the vaccines for worldwide use are produced in and exported from Europe. With its numerous centres of excellence in vaccinology and related disciplines, Europe should have the capacity and capability of continuing to lead the discovery of next generation vaccines capable of addressing unmet medical needs and emergency situations.

However, this is not necessarily the case. In Europe, Only a small percentage of national healthcare budgets are allocated to prevention (which also has an expanding agenda e.g. healthy ageing, obesity etc.), with an even smaller proportion devoted to vaccination. In a study covering seven Western European Countries, prevention accounted for 0.90% to 4.66% of healthcare spending over the 2005– 2016 period, whereas, vaccines accounted for less than 0.5% (range 0.15%-0.50% in all countries except Germany, allocating 0.62% in 2016). Moreover, spending on health prevention per capita has decreased in most countries and for vaccines, the decline has been even more dramatic at up to a 10% p.a.

Proportion of GDP allocated to prevention and public health services (a) and cost of vaccination per capita (b). Estimates are from national sources and the year within brackets represent the latest year for which data are available.



Source: Human Vaccinations & Immunotherapeutic

Prevention accounted for 0.90% to 4.66% of healthcare spending over the 2005–2016 period. Vaccines accounted for less than 0.50% of healthcare spending, with a range of 0.15% – 0.50% in all countries except Germany, where 0.62% of healthcare spending was allocated to vaccines in 2016.

Prevention spending per capita has decreased in most countries; in France by –0.2% per year (between 2008 and 2015), Germany by –1.7% per year (between 2008 and 2016), Spain by –3.7% per year (between 2008 and 2013) and in Portugal by –4.6% per year (between 2008 and 2014). Only Sweden, Poland and Italy have increased their prevention spending per capita by + 5.4% (between 2005 and 2015), + 6.4% (between 2009 and 2014) and + 0.7% (between 2012 and 2014) per year, respectively.

This decreasing trend is even more dramatic for vaccines spending per capita with annual rates of –5.4%, –6.0% and –9.9% in France over 2008–2015, Italy over 2012–2014 and Spain over 2008–2013, respectively. However, it should be noted that only three years of data were available for Italy on vaccines spending and thus caution should be exercised when interpreting spending per capita over such short time period. Sweden is the only country who has increased the part of its healthcare investment per capita allocated to vaccines (+ 5.4% per year between 2005 and 2015). France and Germany increased their healthcare spending and decreased their prevention and vaccines spending over 2008–2015/16.

Although immunisation is widely recognised as one of the most cost-effective public health interventions for disease prevention, updated observations show that prevention and vaccines still entail a relatively low level of investment in European countries and have even continued to decrease. Less than 0.5% of GDP is allocated to prevention and vaccines account for a minimal part of the healthcare spending, falling below 0.5% in many countries. Sweden remains an exception and appears to be the only country that has increased its investment in immunisation over the last decade.

COVID-19 vaccine: the capacity challenge

Vaccines (not only COVID-19 vaccine) are produced in 12 European countries across 27 production sites. Countries included are as follows: -

- Ireland
- UK
- France
- Italy
- Sweden
- Germany
- Belgium
- Netherlands
- Austria
- Hungary
- Switzerland
- Belgium

Within Europe in particular the EU 5, 4 of the countries being France, Germany, Italy and Netherlands have formed an alliance ('Inclusive Vaccine Alliance'). The aim of the "Inclusive Vaccine Alliance" is to allow for vaccine production on European soil wherever possible. Furthermore, The new EU Commission pledge of £269 million represents more than its total contribution to Gavi, the Vaccine Alliance so far.

When the list of countries and biotechnology firms are considered within the EU5, Germany appears to be the only one that has capacity to actually manufacture the drug.

COUNTRY	PLEDGE converted from € rate
Italy	£341,000,000
Netherlands	£172,000,000
France	£1,030,000,000
Germany	£470,000,000
UK	£131,000,000

Whilst all countries have pledged a significant amount to the cause, the UK has pledged the least. The Vaccines Manufacturing and Innovation Centre (VMIC), a not-for-profit organisation providing the UK's first strategic vaccine development and advanced manufacturing capability, has been awarded up to £131 million by the government, boosting investment in the UK's vaccines infrastructure and increasing capacity to manufacture a COVID-19 vaccine. Of the £131m pledged, £93M will be used to develop infrastructure toward manufacturing vaccines in the UK.

On June 8th, 2020, the WMIC has signed an agreement with Oxford Biomedica to enable scaled-up manufacture of viral vector-based vaccines. The targeted vaccine is the AZD1222 of AstraZeneca and the University of Oxford. Due to open in mid-2021 the permanent VMIC facility will have the capability to produce up to 70 million pandemic vaccine doses in 4-6 months. The U.K. government has agreed a deal with GlaxoSmithKline and Sanofi to buy 60 million doses of their investigative shot if it later proves successful.

The strategy of the UK government is an outlier in Europe where the big countries have decided to develop significant manufacturing capabilities. France, Germany, Italy and Netherlands have formed an alliance ('Inclusive Vaccine Alliance'). The aim of the "Inclusive Vaccine Alliance" is to allow for vaccine production on European soil wherever possible.

Governments in Germany and France have explicitly expressed the importance of pharmaceutical companies committing nationally, and have been financially incentivised to do so. Sanofi has committed to develop a facility in France for €600m with €200m public support. This will create only 200 jobs and save the site of Neuville sur Saone from the closure. This will be the most advanced plant in the world, able to produce four vaccines at the same time. Sanofi will also invest €120m in a R&D facility. Germany has blocked the attempt of the US to control CureVac by taking control of 23% of the company at a cost of €300m. Germany has also extended the regulation of foreign takeover of healthcare companies. Under the new rules, a health company must notify Berlin if a buyer outside the EU seeks a stake of more than 10% -- compared with a previous threshold of 25%.

VACCINE R&D CAN BE A LONG AND RISKY JOURNEY

Finding a new vaccine begins with understanding the structure of the virus or bacterium and how it causes the infection which are you are trying to prevent. Vaccines contain a harmless form of the bacteria or virus that causes the disease.

This means the bacteria or virus will be killed, greatly weakened, or broken down into small parts before being used to trigger an immune response in the person receiving the vaccine but without making them ill.

Carefully working out how to do this and selecting appropriate technologies happen in pre-clinical testing. It is then a case of thoroughly testing a vaccine through clinical trials to make sure it's effective and safe to use.

Historically, developing a new vaccine has required:

- 10 years of research for each successful vaccine
- 12-18 months for first regulatory approval
- 6% probability of market entry from preclinical
- £448 million cost of building a biological manufacturing site
- 70% of production dedicated to quality control
- £374 million - £1.5 billion cost of development
- 24 months to manufacture

Given the level of funds the UK government has pledged to finding a vaccine in the UK, the amount is not adequate to facilitate cost of building a significant biological manufacturing site.

Although Europe holds the largest number percentage of vaccine production industry, the majority of companies that are actively pursuing the COVID-19 drug are not based in Europe. European Pharmaceutical companies have been put under pressure to prove their loyalty to their home country. The pandemic has caused some pharmaceutical and medical supplies executives to consider whether the offshoring of production in pursuit of cost savings has gone too far. 60-80% of the world's active pharmaceutical ingredients are produced in India and China, according to industry groups, and some

were barred from export during the outbreak. Sanofi is an example of a company that is facing this issue and is seeking to remedy that issue by spinning out its European pharmaceutical ingredients unit by 2022 in a bid to expand.

Sanofi has three vaccine factories in France and three in the US. But none of its European facilities can make vaccines using novel recombinant DNA technology, which is now being tested for coronavirus vaccines. Sanofi has committed to develop a facility in France for €600m with €200m public support. This will create only 200 jobs but will secure the position of France in the race for the Vaccine.

In April, GSK a UK pharmaceutical company announced a collaboration with Vir Biotechnology to use Vir's monoclonal antibody platform technology to accelerate existing and identify new anti-viral antibodies that could be used as therapeutic or preventative options for COVID-19. Subject to regulatory review, the companies plan to proceed directly into a phase 2 clinical trial within the next three to five months. GSK does not have the facilities in place currently to manufacture the cure on European soil, let alone the UK. GSK is currently restructuring is vaccine capability in Europe, notably in Belgium. GSK has not confirmed yet any manufacturing expansion in the UK.

On 20th July the UK Government announced it had secured early access to 90 million coronavirus vaccine doses from the BioNTech/Pfizer alliance and Valneva with more in the pipeline as part of its strategy to build a portfolio of promising new vaccines to protect the UK from COVID-19.

Following the partnership with Valneva, which has a facility located in Livingston, Scotland, the UK Government intends on contributing to UK clinical studies costs and is negotiating funding to expand Valneva's Scottish facility. This increased manufacturing capacity could potentially supply up to 100 million vaccine doses to the UK and internationally, which will significantly contribute to the local area and economy through the creation of high-skilled jobs.

The Livingston facility is in addition to the new Vaccines Manufacturing and Innovation Centre (VMIC) which is currently under construction in Oxfordshire. Upon completion the facility (completion expected in summer 2021) the facility will have flexible capacity to manufacture vaccine doses at scale.

Furthermore, treatments containing COVID-19-neutralising antibodies have been secured from AstraZeneca to protect those who cannot receive vaccines.

CONCLUSION

In terms of vaccine production the UK is in the same boat as a lot of European countries as that don't have the capacity to manufacture a vaccine for COVID-19 at the required level. Nevertheless, the fund dedicated to this issue by the UK lags behind the biggest EU countries.

The UK, which relies on imports for its vaccines, however in recent weeks has made production on national grounds a priority, with a significant share of vaccines under development in the UK. Whilst hesitating to join the EU common procurement platform, the UK has committed funds to the development of COVID-19 vaccine as well as developing manufacturing capabilities on UK soil. This race to secure access to the vaccines is dominated by the US. With the Biomedical Advanced Research and Development Authority (BARDA) the US has already invested billions in the race for the Vaccine. The Operation Warp Speed (OWS) aims to deliver 300 million doses of a safe, effective vaccine for COVID-19 by January 2021.

The UK Government is adopting a strategy based on the reconversion of the current manufacturing facilities (Valneva, Oxfordshire) and the development of these new capabilities could prove more efficient in the long term, notably if there's different strain of COVID-19 or development of a new type of pandemic in the future. This would also support the UK pharmaceutical manufacturing and offering high-skill jobs to thousands of workers. It could prove to be a more financially efficient solution given the escalation of the entry ticket to secure supply of the vaccine over the last few weeks as the pandemic continues to spread. Indeed, the acceleration of the spread in the United States as shown an increased activity of the US government in bids to secure supply, pushing the price up. In July, as part of the OWS, Novara has been awarded $1.6 billion by the federal government to complete late-stage clinical development, including a pivotal Phase 3 clinical trial; establish large-scale manufacturing; and deliver 100 million doses of NVX CoV2373, Novavax' COVID-19 vaccine candidate, as early as late 2020. An alternative approach based on UK manufacturing should also be feasible given the role of some of the UK big pharma companies in the race for the vaccine.

APPENDIX: RACE FOR THE CORONAVIRUS CURE

According to the World Health Organization, there are currently 70 vaccines in development, 4 of which are in clinical trials and the other 66 under preclinical evaluation. Since the first COVID-19 vaccine candidate entered clinical trials on 16 March 2020, rapid progress has been made to develop and clinically test vaccines and drugs in patients with COVID-19.

The race to combat the coronavirus pandemic has been growing urgently with several key players in the pharmaceutical industry joining forces with biotech companies, universities and government agencies in hope of developing solution to treat and prevent COVID-19.

To date, a range of approaches are being pursued in particular:

- Vaccines to prevent the disease
- Neutralising antibodies from recovered patients to treat active infection.

With an estimated 12-18 month time frame for the vaccine to be successful, an antibody-based approach could offer an important therapeutic option in the nearer term.

A number of collaborations have been signed in recent weeks to expedite the development of COVID-19 vaccine projects, with several big pharma companies involved utilising vaccine platforms that have previously been deployed against other viral diseases. Aside from companies centred on vaccine development, several alliances have emerged focused on the identification of novel antibodies to neutralise the SARS-CoV-2 virus, which may be used therapeutically to treat infected patients, and which could also be given to people with a heightened risk of exposure to the virus.

As of 10th June 2020, the list of vaccines in development is as follows:-

Country	Company	Phase	Modality	Pledge converted from $/€ rate
USA	Amgen and Adaptive Biotechnologies	Preclinical	Antibody treatment	undisclosed
USA	Altimmune University of Alabama at Birmingham	Preclinical	Vaccine	undisclosed
Germany **USA** **China**	BioNTech Pfizer Fosun Pharma	Phase I/II	mRNA vaccine	£449M
USA	CytoDyn	Phase II/III	Treatment	undisclosed
USA	Gilead Sciences	Emergency use authorisation	Treatment	£797M
UK **USA**	GSK Vir Biotechnology Inc	undisclosed	Vaccine, treatment	£199M
USA	Heat Biologics University of Miami	Preclinical	Vaccine	undisclosed
USA	Inovio Pharmaceuticals	Phase I	DNA-based vaccine	£27M
USA	Johnson & Johnson	Preclinical	Vaccine	£797M
USA	Moderna	Phase I	RNA-based vaccine	£385M
USA	Novavax	Phase I	Vaccine	undisclosed
USA	Regeneron Pharmaceuticals	Preclinical	Prevention & treatment	undisclosed
USA **France**	Regeneron Pharmaceuticals and Sanofi	Phase II/III	Treatment	undisclosed
Switzerland	Roche	Phase III	Treatment	undisclosed
France	Sanofi Pastuer	Preclinical	Vaccines	undisclosed
Japan	Takeda Pharmaceutical	Preclinical	Antibody treatment	undisclosed
USA	Vaxart	Preclinical	Vaccine	undisclosed
China	Cansino Biological/ Beijing Institute of Biotechnology	Phase II	undisclosed	undisclosed
UK	University of Oxford & AstraZeneca	Phase II/III	undisclosed	undisclosed
Japan	Fujifilm Toyama Chemical	Experimental Repurposed	undisclosed	undisclosed
China	Ascletis Pharma	Phase III	undisclosed	undisclosed
Austria	Apeiron Biologics	Phase II	undisclosed	undisclosed
Germany	CureVac	Preclinical	Vaccine	£287M
Germany	InflaRx	Phase II/III	undisclosed	undisclosed
USA	Arcturus	Preclinical	LUNAR -COV19	undisclosed
Russia	BIOCAD	Preclinical	RNA-based vaccine	undisclosed
Thailand **USA**	Chula VRC University of Pennsylvania	Preclinical	RNA-based vaccine	undisclosed
China	China CDC Tongji University Stermirna Therapeutics	Preclinical	RNA-based vaccine	undisclosed
Spain	CNB-CSIC (RNA)	Preclinical	RNA-based vaccine	undisclosed
UK	Emergex Vaccines George Mason University	Preclinical	RNA-based vaccine	undisclosed
Belgium	eTheRNA Immunotherapies	Preclinical	mRNA vaccine	undisclosed
Russia	FSRI SRC VB VECTOR, Rospotrebnadzor, Koltsovo (RNA)	Preclinical	RNA-based vaccine	undisclosed
China	Fudan University Shanghai Jiao Tong Universoty RNACure Biopharma (VLP)	Preclinical	RNA-based vaccine	undisclosed
China	Fudan University Shanghai Jiao Tong University RNACure Biopharma (RBD)	Preclinical	RNA-based vaccine	undisclosed
USA	GeneOne Life Science Houston Methodist	Preclinical	RNA-based vaccine	undisclosed
USA	Greenlight Biosciences	Preclinical	RNA-based vaccine	undisclosed
USA	HDT BioCorp	Preclinical	RNA-based vaccine	undisclosed
UK	Imperial College London	Preclinical	RNA-based vaccine	undisclosed
Germany	Max Plank Institute of Colloids and Interfaces (RNA)	Preclinical	RNA-based vaccine	undisclosed
USA	RNAimmune Inc	Preclinical	RNA-based vaccine	undisclosed
USA	Rochester Clinical Research	Preclinical	RNA-based vaccine	undisclosed
Japan	University of Tokyo Daiichi-Sankyo	Preclinical	mRNA vaccine	undisclosed
Belgium	Ziphius Therapeutics Ghent University	Preclinical	ZIP 1642	undisclosed
USA	Aegis Biodefense	Preclinical	Vaccine	undisclosed
Canada	Entos Pharmaceuticals	Preclinical	DNA Vaccine	undisclosed
Korea	Genexine Consortium	Preclinical	GX-19	undisclosed
USA	Immunomic Therapeutics Epivax PharmaJet	Preclinical	DNA Vaccine	undisclosed
Sweden **USA**	Karolinska Institute Cobra Biologics	Preclinical	DNA Vaccine	undisclosed
Japan	Osaka University Anges Takara Bio	Preclinical	DNA Vaccine	undisclosed
UK	Scancell University of Nottingham	Preclinical	DNA Vaccine	undisclosed
Italy	Takis Biotech	Preclinical	DNA Vaccine	undisclosed

Italy **USA**	Evvivax Applied DNA Sciences			
UK	University of Cambridge DIOSynVax	Preclinical	DNA Vaccine	undisclosed
UK	University of Waterloo	Preclinical	DNA Vaccine	undisclosed
USA	UW Madison Pan Genomes Systems	Preclinical	Vaccine	undisclosed
USA	Zydus Cadila	Preclinical	DNA Vaccine	undisclosed
Spain	CNB CSIC	Preclinical	Vector Vaccine	undisclosed
Germany	DZIF German Centre for Infection Research	Preclinical	MVA-S encoded vaccine	undisclosed
USA **China**	GeoVax BravoVax	Preclinical	MVA-VLP Vaccine	undisclosed
USA	Greffex	Preclinical	Grevax	undisclosed
Spain	IDIBAPS Hospital Clinic	Preclinical		undisclosed
USA	Immunity Bio NantKwest	Preclinical	Spike/Nucleocapsid	undisclosed
USA	Massachusetts Eye and Ear Massachusetts General Hospital	Preclinical	AAVCOVID	undisclosed
USA	Massachusetts General Hospital Grousbeck Gene Therapy Centre AveXis	Preclinical	AAVCOVID	undisclosed
Canada	McMaster University	Preclinical	Vector Vaccine	undisclosed
Thailand	National Centre for Genetic Engineering & Biotechnology (BIOTEC) GPO		Vector Vaccine	undisclosed
Italy **Germany** **Belgium**	ReiThera Leukocare Univercells	Preclinical	Vector Vaccine	undisclosed
UK	Stabilitech	Preclinical	COVID 19	undisclosed
USA	Thomas Jefferson University	Preclinical	CORAVAX	undisclosed
China	Tsinghua University	Preclinical	Vector Vaccine	undisclosed
USA	University of Georgia University of Iowa	Preclinical	Vector Vaccine	undisclosed
Canada	University of Manitoba	Preclinical	Vector Vaccine	undisclosed
Finland	Valo Therapeutics Ltd	Preclinical	Pan - Corona	undisclosed
China	Beijing Institute of Biological Products Wuhan Institute of Biological Products Sinopharm	Phase I/II	Inactivated Vaccine	undisclosed
Russia	BIOCAD IEM	Preclinical	Vector Vaccine	undisclosed
USA **India** **USA**	FluGen Bharat Biotech UW-Madison	Preclinical	CoroFlu	undisclosed
Russia	FSRi SRC VB VECTOR Rospotrebnadzor, Koltsovo (vector #1,2,3)	Preclinical	Vector Vaccine	undisclosed
Brazil	Fundacao Oswaldo Cruz)FIOCRUZ) Instituto Buntantan	Preclinical	Vector Vaccine	undisclosed
USA	IAVI Merck	Preclinical	Vector Vaccine	undisclosed
France **Austria** **USA** **Germany**	Institute Pasteur Themis University of Pittsburg Merck	Preclinical	Vector Vaccine	undisclosed
Netherlands	Intravacc Wageningen Bioveterinary Research Utrecht University	Preclinical	Vaccine	undisclosed
Belgium	KU Leuven	Preclinical	Vector Vaccine	undisclosed
UK	Lancaster University	Preclinical	Vector Vaccine	undisclosed
Korea	Sumagen International Vaccine Institute	Preclinical	Vector Vaccine	undisclosed
USA	Tonix Pharma Southern Research	Preclinical	Vector Vaccine	undisclosed
China	University of Hong Kong	Preclinical	Vector Vaccine	undisclosed
USA	University of Western Ontario	Preclinical	Vaccine	undisclosed
India	Zydas Cadila	Preclinical	Vector Vaccine	undisclosed
China	Beijing Minhai Biotechnology Co	Preclinical	Inactivated Vaccine	undisclosed
China	Institute of Medical Biology Chinese Academy of Medical Sciences	Phase I/II	Inactivated Vaccine	undisclosed
Japan	Osaka University BIKEN NIBIOHN	Preclinical	Inactivated Vaccine	undisclosed
Khazakstan	Research Institute for Biological Safety Problem	Preclinical	Inactivated Vaccine	undisclosed

China	Sinovac	Phase I/II	Inactivated Vaccine	undisclosed
China **USA**	Sinovac Dynavax	Preclinical	Inactivated Vaccine	undisclosed
France **USA**	Valneva Dynavax	Preclinical	Inactivated Vaccine	undisclosed
USA **India**	Codagenux Serum Institute of India	Preclinical	Attenuated Vaccine	undisclosed
Germany	DZIF – Geramn Centre for Infection Research (live)	Preclinical	Attenuated Vaccine	undisclosed
India	Indian Immunological Ltd Griffith University	Preclinical	Attenuated Vaccine	undisclosed
Japan	AdaptVac	Preclinical	Vaccine	undisclosed
Denmark	AJ Vaccines	Preclinical	Protein Vaccine	undisclosed
USA **India**	Akers Bioscience Premas Biotech	Preclinical	Protein Vaccine	undisclosed
China	Anhui Zhifei Longcom Biopharmaceutical Institute of Microbiology Chines Academy of Sciences	Preclinical	Vaccine	undisclosed
China	AnyGo Technology	Preclinical	Protein Vaccine	undisclosed
USA	Applied Biotechnology Institute Inc	Preclinical	Protein Vaccine	undisclosed
Slovakia	Axon Neuroscience	Preclinical	Vaccine	undisclosed
USA	Baylor College of Medicine	Preclinical	Protein Vaccine	undisclosed
India	Biological E Ltd	Preclinical	Protein Vaccine	undisclosed
Italy	BIOMVis Srl University of Trento	Preclinical	Vaccine	undisclosed
USA	Boston Children's Hospital	Preclinical	Protein Vaccine	undisclosed
UK	British American Tobacco	Preclinical	Protein Vaccine	undisclosed
UK **UK** **USA**	Clover Biopharmaceuticals Inc GSK Dynavax	Phase I	Vaccine	undisclosed
USA	EpiVax	Preclinical	Protein Vaccine	undisclosed
USA	EpiVax University of Georgia	Preclinical	Protein Vaccine	undisclosed
Sweden	ExpreS2ion Biotechnologies	Preclinical	Protein Vaccine	undisclosed
USA	Flow Pharma Inc	Preclinical	Protein Vaccine	undisclosed
Russia	FSRi SRC VB VECTOR Rospotrebnadzor, Koltsovo (protein #1,2)	Preclinical	Protein Vaccine	undisclosed
USA	G+Flas Life Sciences	Preclinical	Vaccine	undisclosed
USA **USA**	Generex EpiVax	Preclinical	Vaccine	undisclosed
USA **China**	iBio CC-Pharming	Preclinical	Protein Vaccine	undisclosed
Canada	IMV Inc	Preclinical	Vaccine	undisclosed
Switzerland	InnoMedica	Preclinical	Vaccine	undisclosed
China **UK**	Innovax Xiamen University GSK	Preclinical	Vaccine	undisclosed
Netherlands **USA**	Intravacc EpiVax	Preclinical	Vaccine	undisclosed
USA **UK**	Kentucky Bioprocessing British American Tobacco	Preclinical	Vaccine	undisclosed
USA	LakePharma Inc	Preclinical	Vaccine	undisclosed
China	Liaoning Chengda Biotechnology Tsinghua University	Preclinical	Vaccine	undisclosed
Russia	Lomonosoc Moscow State University	Preclinical	Protein Vaccine	undisclosed
Germany	Max Planck Institute of Colloids and Interfaces (subunit)	Preclinical	Protein Vaccine	undisclosed
China	Medigen Vaccine Biologics Corp NAID Dynavax	Preclinical	Protein Vaccine	undisclosed
South Korea	MOGAM Institute for Biomedical Research GC Pharma	Preclinical	Protein Vaccine	undisclosed
USA	Natioanl Institute of Infectious Disease	Preclinical	Protein Vaccine	undisclosed
Switzerland **Israel**	Neovii Tel Aviv University	Preclinical	Vaccine	undisclosed
Malaysia	OncoGen	Preclinical	Protein Vaccine	undisclosed
Japan	Osaka University BIKEN NIBIOHN (subunit)	Preclinical	Protein Vaccine	undisclosed

USA	PDS Biotech	Preclinical	Vaccine	undisclosed
UK	Quadram Institute Biosciences	Preclinical	Vaccine	undisclosed
Russia	Scientific Research Institute of Vaccines and Sera	Preclinical	Vaccine	undisclosed
Japan	Shinogi	Preclinical	Vaccine	undisclosed
China	Sichuan University Zhejiang Teruisi Pharmaceutical Others	Preclinical	Protein Vaccine	undisclosed
Korea	SK Bioscience	Preclinical	Protein Vaccine	undisclosed
Cananda	University of Alberta	Preclinical	Protein Vaccine	undisclosed
USA	University of California, San Diego	Preclinical	Protein Vaccine	undisclosed
USA	University of California, Los Angeles	Preclinical	Protein Vaccine	undisclosed
USA	University of Pittsburgh	Preclinical	Vaccine	undisclosed
Australia **UK** **USA**	University of Quennsland GSK Dynavax	Preclinical	Vaccine	undisclosed
Vietnam	Vabiotech	Preclinical	Vaccine	undisclosed
Canada	Vaxil Bio	Preclinical	Protein Vaccine	undisclosed
Australia **USA**	Vaxine Pty Flinders University Oracle	Preclinical	Protein Vaccine	undisclosed
USA	Versatope Umass (subunit) (OMV)	Preclinical	Protein Vaccine	undisclosed
Canada	VIDO_InterVac University of Sasaktchewan	Preclinical	Vaccine	undisclosed
USA	Walter Reed army Institute of Research USAMRIID	Preclinical	Protein Vaccine	undisclosed
Singapore	Yisheng Biopharma	Preclinical	Protein Vaccine	undisclosed
USA	AbVision	Preclinical	Vaccine	undisclosed
USA	Aivita Biomedial Inc	Phase I	Vaccine	undisclosed
Germany	ARTES Biotechnology	Preclinical	Vaccine	undisclosed
Thailand	BioNet Asia	Preclinical	Vaccine	undisclosed
Korea	Boryung Biopharma	Preclinical	Vaccine	undisclosed
USA **Spain**	Catholic University Millennium Institute Of Immunolgy & Immunotherapy	Preclinical	Vaccine	undisclosed
China	Changchun Zhuoyi Biological	Preclinical	Vaccine	undisclosed
China **China**	Chongqing Zhifei Biological Products Chinese Academy of Sciences	Preclinical	Vaccine	undisclosed
USA	City of Hope	Preclinical	Vaccine	undisclosed
USA	Codial BioSciences	Preclinical	Vaccine	undisclosed
USA	Ragon Institute	Preclinical	Vaccine	undisclosed
Australia	Doherty Institute	Preclinical	Vaccine	undisclosed
India	REC Worldwide	Preclinical	Vaccine	undisclosed
USA	HaloVax Hoth Therapeutics	Preclinical	Vaccine	undisclosed
Nigeria **Nigeria** **USA** **Nigeria**	Helix Biogen Consult Elizade University Massasoit Community College Ladoke Akintola University	Preclinical	Vaccine	undisclosed
China	Hualan Biological Engineering	Preclinical	Vaccine	undisclosed
Thailand	Immunitor Inc	Phase I	Vaccine	undisclosed
UK	Imophoron Ltd Bristol University	Preclinical	Vaccine	undisclosed
Sweden	ISR Immune System Regulation	Preclinical	Vaccine	undisclosed
Thailand	Mahidol University GPO	Preclinical	Vaccine	undisclosed
Canada	Medicago Inc	Preclinical	Vaccine	undisclosed
Israel	MIGAL Galilee Research Institute	Preclinical	Vaccine	undisclosed
China	Minhai Biotechnolgy	Preclinical	Vaccine	undisclosed
Spain	Navarrabiomed	Preclinical	Vaccine	undisclosed
USA	Oragenics	Preclinical	Vaccine	undisclosed
France	OSIVAX	Preclinical	Vaccine	undisclosed
China	Royal Wuxi Biopharmaceutical	Preclinical	Vaccine	undisclosed
Switzerland	Saiba GmbH	Preclinical	Vaccine	undisclosed
China	Shandong Buchang Pharma	Preclinical	Vaccine	undisclosed
China **USA**	Shenzhen Geno Immune Medical Institute Modified APC	Phase I	Vaccine	undisclosed
China **USA**	Shenzhen Geno Immune Medical Institute Modified DC	Phase I	Vaccine	undisclosed
USA	SmartPharm Therapeutics Ince Sorrento Therapeutics	Preclinical	Vaccine	undisclosed

Canada	Symvovi	Phase I	Vaccine	undisclosed
USA	Tulane University	Preclinical	Vaccine	undisclosed
China	Ufovax	Preclinical	Vaccine	undisclosed
Canada	University of Laval	Preclinical	Vaccine	undisclosed
Brazil	University of Sao Paulo	Preclinical	Vaccine	undisclosed
USA **Canada**	VBI Vaccines National Research Council of Canada	Preclinical	Vaccine	undisclosed
USA	Verndari Inc UC Davis	Preclinical	Vaccine	undisclosed
USA **Singapore**	Vivaldi Biosciences Esco Aster	Preclinical	Vaccine	undisclosed
China	Walvax Biotechnology	Preclinical	Vaccine	undisclosed
Canada	Western University	Preclinical	Vaccine	undisclosed
Canada	ZhongeKe Biopharm	Preclinical	Vaccine	undisclosed
China	Zhongyi Anke Biotechnology	Preclinical	Vaccine	undisclosed

1. Sanofi has two ongoing COVID-19 vaccine partnerships: with BARDA to investigate an advanced preclinical SARS vaccine candidate that could be modified to protect against COVID-19 and with Translate Bio to develop an mRNA vaccine, drawing upon a 2018 agreement between the parties to develop vaccines for infectious diseases using mRNA technology.

2. Pfizer has agreed to co-develop BioNTech's COVID-19 mRNA vaccine program, which entered clinical testing at the end of April 2020. As part of the deal, BioNTech will receive £237 million upfront, comprised of £147 million cash payment and a £90 million equity investment. The two companies have been collaborating since 2018 to develop an mRNA- based influenza vaccine.

3. Eli Lilly teamed up with AbCellera in March to co-develop antibody therapies for COVID-19 by leveraging the Canadian biotech's rapid pandemic response platform. The two companies will select from more than 500 unique antibodies isolated from one of the first US patients who recovered from COVID-19.

4. As part of a deal with Amgen, Adaptive Biotechnologies will use its immune medicine platform to rapidly screen B-cell receptors from individuals that have recovered from COVID-19 to identify naturally-occurring antibodies that neutralise SARS-CoV-2.

5. A different approach is being taken by Neurimmune and Ethris which have partnered to develop mRNA- encoded, neutralising anti-SARS-CoV-2 antibodies that will be delivered directly to the lungs of patients with COVID-19.

6. In April, GlaxoSmithKline (GSK) agreed to make a £199 million equity investment in Vir-Biotechnology as part of a broad collaboration between the parties. Subject to regulatory review, the two companies hope these antibody candidates will be expedited into Phase II clinical trials within the next 3 to 5 months. This initiative adds to GSK's existing collaborations in the COVID-19 vaccine field under which it has provided access to its pandemic adjuvant system to several parties developing COVID-19 vaccine candidates, including Xiamen Innovax Biotech, Clover Biopharmaceuticals and the University of Queensland. Vir has itself accumulated a roster of COVID-19 collaborations, such as expanding its existing partnership with Alnylam Pharmaceuticals to include the development and commercialisation of RNAi therapeutics targeting SARS-CoV-2 and signing new deals with Biogen, the NIAID's Vaccine Research Centre, WuXi Biologics, Xencor and Generation Bio.

7. Johnson & Johnson (J&J) and the Biomedical Advanced Research and Development Authority (BARDA) have together committed more than £797 million of investment to co-fund research, development and clinical testing of a vaccine for COVID-19. J&J has selected a lead COVID-19 vaccine candidate from constructs it has been working on since January and expects to initiate human clinical studies by September at the latest and to have the first batches of a COVID-19 vaccine available for emergency use authorisation in early 2021.

8. In mid-March, Moderna initiated the first clinical trial to test a COVID-19 vaccine in humans and announced the dosing of the first participant in a Phase I study of its mRNA-1273 vaccine candidate against SARS- CoV-2. mRNA-1273 was selected in collaboration with investigators from the US NIH's National Institute

9. China-based CanSino Biologics followed days later with its adenovirus-based vaccine, Ad5-nCoV, which is being developed in alliance with the Beijing Institute of Biotechnology. In April, Inovio Pharmaceuticals dosed its first participant in a Phase I study of its DNA vaccine INO-4800.

   In a further collaborative research effort, 15 pharmaceutical companies, including Novartis and GSK, have agreed to share libraries of molecular compounds that already have some degree of safety and activity data with the newly-launched COVID-19 Therapeutics Accelerator for screening for potential against COVID-19. The aim is to move successful hits into in vivo trials in as little as two months.

Of all the companies above, the USA is dominant in the race for the cure in the sense that 54% of the companies pursuing the race are all American companies. On the European front, Germany is dominant with 3 companies actively pursuing the race. Whilst all other countries have a maximum of two companies actively pursuing the cure.

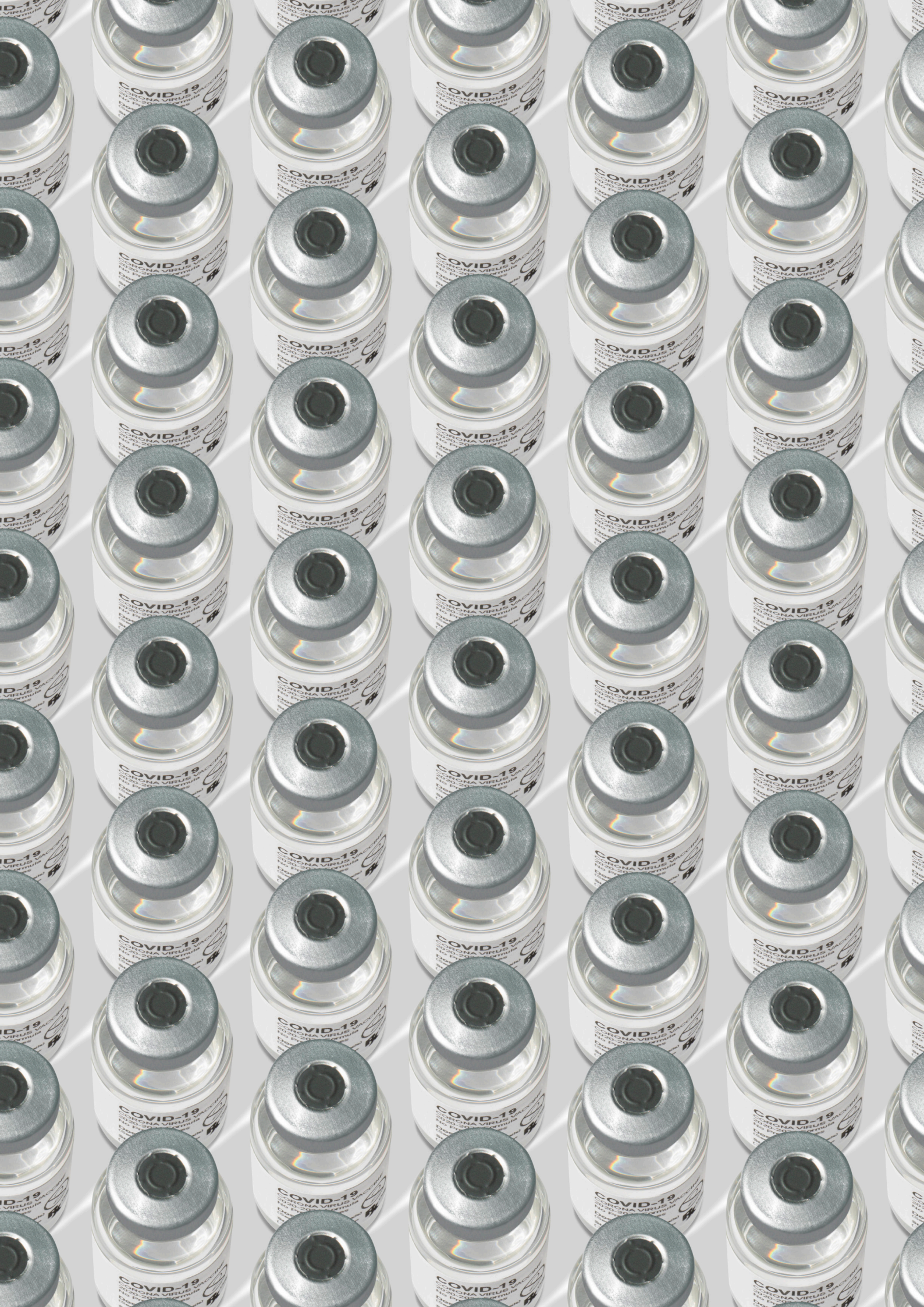
USA pledged £955M pounds to AstraZenaca for 300 million COVID vaccines.

As I stated and the start of this document, it is a basic expectation of UK citizens and workers to expect the UK government to manufacture medicines for them when they need them, and not to be at the vagaries of a global pharmaceutical manufacturing industry and global politics, to achieve this the UK government must create a UK pharmaceutical manufacturing sector that delivers for the UK.

Unites key priorities to achieve this are:

- The UK government must adopt and implement a base principle of having the ability as a country to provide UK citizens with medicines from discovery to administration.
- That the UK government is investing at the required capacity to support the delivery of a vaccine and all future medicines.
- That UK investment directly supports our pharmaceutical manufacturing base in the UK.
- That UK companies are supported throughout the pharmaceutical supply chains to derive good quality jobs and societal benefits from the development of a vaccine and all medicines manufactured in the UK.
- The discovery, manufacture and roll out of any vaccine or medicines provides quality sustainable skilled jobs in the UK pharmaceutical sector and supply chains.

Tony Devlin, National Officer
Unite Chemicals, Pharmaceuticals, Process and Textiles.


COVID-19
CORONA VIRUS VACCINE

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