acting in bad faith. It certainly sent the worst possible message to any future UK industrial investor or life sciences partner. Valneva was ultimately approved by the MHRA, which justified our confidence in the company – but only after the Government had controversially, and in my view improperly, cancelled the contract.

Recommendations for improvements in the future

I have often been asked about the lessons of the VTF, and what we can all do better next time. My immediate response is that we need better vaccines. The ones we are using now are excellent for stopping serious disease and hospitalisation. But we need next-gen vaccines that will be a lot better at protecting against infection and transmission, and last for longer. We need vaccines that will protect against all coronavirus variants (and ideally against flu and other respiratory viruses such as RSV too) and that are stable at room temperature. Even better, we need vaccines that are needle-free and can be self-administered – whether a pill, patch or spray with a single dose. Calling all innovators around the world to help!

My longer answer is that we need a fundamental reset that goes far beyond addressing individual symptoms. It will be very expensive not to address these issues now. While my experience working in government was on vaccines, what I saw was symptomatic of broader concerns across sciences more generally, so we need to act now to avoid being left behind globally.

Here, then, are five broad recommendations for the future:

1. REWARD OUTCOME NOT PROCESS

My first recommendation is to refocus Whitehall and government on outcomes not procedures. There are lots of easy wins here.

Professional development and promotions should focus not on rapid rotation between roles and departments as is the case now, but on contributing skills of demonstrable value. As part of professional

development, I would reward specialist science skills as much as generalist skills, and explicitly reward tempo and focus on outcomes. I would also punish for failing to act.

I would change the current system to reflect the proven practices of organisational management in the private sector. This means promoting the outperformers rapidly and culling the deadwood. I would seek robust references on past performance of prospective candidates. I find it bizarre that the civil service presently recruits people from outside based on references but bars the use of references internally. How on earth can you tell if someone is any good unless you talk to the people they have previously worked with and for?

I would mandate that mid-level civil servants should not be able to climb the Whitehall ladder without at least two years of productive industrial or commercial secondments and public sector operational delivery experience. Unless they see how companies work from within, I don't see how officials can discharge their roles effectively.

I would also make changes to improve the effectiveness of government itself. I would train ministers in commissioning, business and financial skills and make such training mandatory for reward elevation to senior roles. Ministers should be chosen on the basis of skills and relevant experience rather than simply on perceived loyalty.

I would introduce serious relationship management with key sectors. I would assign Ministers to manage relationships with CEOs of the leading bioscience companies operating in the UK. Sir John Bell and Sir John Symonds have developed a robust life sciences strategy with government and this can help provide the roadmap. The role of ministers should be to build closer relationships with bioscience leaders and instil new confidence that the Government is serious about working with them and supporting their work for the long term.

Ours is a small industry, and fiascos like Valneva do not leave a good taste. Only by building trust with these critical organisations will we encourage them to invest in the UK, providing jobs,

economic growth, and crucially resilience against future healthcare threats.

2. EMBED SCIENTIFIC THINKING AND SCIENCE IN POLICYMAKING, JUST LIKE ECONOMICS

When we wrote Business Cases at the VTF recommending the purchase of vaccines, the Whitehall template required multiple different areas of analysis including strategy, economics, commercial, finance, management and legal. But not, astonishingly, science.

In the VTF, our due diligence provided that scientific and technical underpinning, but I would require the science case to be made for all government decisions. The science case should be added to the Whitehall template. Scientific evidence should be central to policy and decision-making and should be just as important as economics. Creating a science case would also have the effect of stimulating wider and more in-depth understanding of science across Whitehall.

I would give the science advisers within each government department more authority and status to influence policy and decision-making based on scientific principles. I would appoint advisers based on their industry experience and problem-solving track record. I would incentivise departments to collaborate on relevant areas of science.

Finally, I would encourage the government to embrace the scientific method. This means enquiry, experimentation, observation and the accumulation of evidence and knowledge. Whitehall should be charged to challenge orthodoxy, but be flexible to pivot and change in response to new information, data and evidence. Using the scientific method can help deal with uncertainty and manage risk.

3. COMPLETELY OVERHAUL THE RECRUITMENT, PROFESSIONAL DEVELOPMENT AND INCENTIVES OF CIVIL SERVANTS

Science-related competencies, problem-solving and quantitative analysis should be essential skills for officials in today's data-based and innovation-driven economy.

I would set a target of recruiting fifty per cent STEM graduates at entry, prioritising those with research, analytical and statistical expertise. New STEM graduates should also have some training in economics so that they have a breadth of relevant skills. It is much easier to train scientists in economics than the other way round! Massachusetts Institute of Technology – MIT in Cambridge, Massachusetts – does this really well; they produce lots of brilliant PhDs trained in finance, accounting and economics.

I would take measures to slow down the turnover within the civil service, so as to build up specific, valuable expertise.

I would fire half the people dealing with public affairs communications across government, as I cannot see what the supposed 120 comms people in BEIS actually achieve. I would redeploy this talent to more productive ends. This would send a clear signal that the focus on government is on the delivery of outcomes rather than on spinning.

In the private sector, incentives are widely used to implement change. So, one suggestion would be to delay awards of honours to civil servants and politicians when they retire, so that a better judgement could be reached of their actual achievements and effectiveness while in post.

4. APPOINT A SENIOR AND PERMANENT PANDEMIC SECURITY CAPABILITY

The reason why the VTF was required in 2020 was that there was no one to advise on this work in government. Healthcare threats are just as serious as national security and defence and should be treated with at least the same importance. We invest in our conventional and special forces, we recognise the importance of developing our intelligence services, and we plan and train for a vast array of difference scenarios, yet we are neglecting the most likely and potentially most severe collective threat to the nation – the next pandemic.

I would appoint a permanent pandemic security expert from the private sector, perhaps as or alongside an experienced senior

minister, with authority for building and maintaining a co-ordinated UK pandemic preparedness capability.

As it does with defence and security, this will involve close collaborations across Whitehall as well as with companies and governments globally. We will need to continue to invest in next generation vaccine and antiviral therapeutic formats, partnering with researchers and AI experts to predict future pandemic threats as well as to design new vaccines and therapeutics. The government will need to provide a budget for this work. I recommend that this individual reports to the Prime Minister, just like I did.

5. AGREE A STRONG INTERNATIONAL APPROACH FOR THE FUTURE MANAGEMENT OF PANDEMICS

The Western countries were too slow to join together, and too self-interested. Of course, it is essential for democratically elected governments to protect and support their citizens, but the Covid-19 pandemic has been made worse – including for those citizens – by the West's instinct to hoard vaccines. While the UK fared well, as matters have turned out so far, global surveillance to identify pandemic threats and emerging variants could be considerably more thorough and more joined up.

It is essential that the UK, and maybe the G20 and other motivated countries, invest in building vaccine manufacturing facilities around the world, especially in Africa. These facilities should ideally be located in low-population countries, to mitigate the risks of their being swamped by domestic vaccine needs, and so the imposition of export bans. We need to build the skills, infrastructure and capabilities to make safe, approved vaccines, and to do so quickly in a pandemic. Such skills and facilities are relevant for all advanced medicine manufacturing, so an investment here will help build global health security as well as long-term economic growth in these countries.

I don't pretend to have all the solutions, and there are plenty of experts in global health, but we must agree a robust long-term basis