

# Unit 7: Contemporary Issues in Science



## Past paper articles samples Part 1

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## Beware the mix of food and fear – the truth about ultra-processed foods is still emerging (Jan 2025)

This article is more than 1 year old

[Amelia Tait](#)



Research on UPFs should be a wake-up call – but if people miss out on nutrients in a quest to avoid them, is it really helping?

If you consumed a lot of news last year, you'd be forgiven for thinking that strawberry yoghurt wants to murder you. Since last spring, a new obsession has spread across Britain: have you heard? Don't you know? UPF is our new food enemy. What is UPF? It is [ultra-processed food](#). What is ultra-processed food? It can include cereal and sausages and fruit-flavoured yoghurts and instant soup. How exactly can I determine if something is ultra-murderous? Anecdotally, my friends don't seem to know the definition of UPF – but they do know they should be afraid of it.

Another person who, by his own admission, hasn't quite mastered the definition is [Chris van Tulleken](#), the infectious diseases doctor who wrote the bestselling book *Ultra-Processed People: Why Do We All Eat Stuff That Isn't Food ... and Why Can't We Stop?* At the beginning of his book, he forgoes "a long formal scientific definition" of UPF, instead arguing it can be boiled down to this: "If it's wrapped in plastic and has at least one ingredient that you wouldn't usually find in a standard home kitchen, it's UPF."

Later, Van Tulleken and his brother debate whether a Marks & Spencer sausage roll is UPF – his brother thinks it is, because he doesn't have pasteurised egg and calcium carbonate at home. Yet he says calcium carbonate doesn't count because "it's added by law to most white wheat flour". Instead, he questions the snack's "purpose" – another way he defines UPF is as something marketed "aggressively" for "no other reason than financial gain". This seemingly leaves Van Tulleken just as confused as the rest of us – "to be fair" to his brother, he writes, "I find myself having these same debates internally all the time."

Herein lies the problem with the current focus on UPF. It is fundamentally muddled. It's not that studies about UPF haven't already had troubling results – one [randomised controlled trial](#) found that people on UPF diets ate more calories and gained more weight than those on unprocessed diets. It's that while scientists use somewhat more rigorous definitions of UPF for their trials, these definitions are not universally standardised or agreed upon and are often ambiguous, making things confusing for consumers.

The shiny, slippery new category of UPF, and the news of its associated evils, implies that a protein-packed yoghurt is just as likely to cause heart disease as a frozen pizza, just because both come wrapped in plastic and contain [xanthan gum](#).

Where does that leave us? Are we supposed to be afraid of everything in a packet and hate ourselves for eating it? This isn't what Van Tulleken wants. He notes that there is likely "a spectrum" of UPF and possible harms, and concludes "Whatever happens, don't beat yourself up." But with worries about UPF amplified across the media, I think this is a tough ask as long as its very definition remains vague.

What happens when someone thinks their favourite strawberry yoghurt will cause them to have a stroke? Do they suddenly magically find the time to make their own, healthier version from scratch? Do they miraculously start being able to afford the more natural, organic yoghurt they've always hated the taste of?

It's not that I think it's wrong to question our current food culture, or that we won't one day identify a mechanism involved in food processing or an additive in UPF that is inherently harmful. It's just that I think it's too early and things are too uncertain for us to descend into panic. In July, the government's scientific advisory committee on nutrition (SACN) [said](#) "there are uncertainties around the quality of evidence" that links UPF with adverse health outcomes such as heart disease, cancer and depression. The committee warned that many UPF studies did not take confounding variables – such as a person's smoking history or calorific intake – into account. "The evidence to date needs to be treated with caution," it said.

Then, in November, a WHO-backed study [found](#) that some UPF is actually good for our health, with the fibre in bread and cereal associated with a reduced risk of developing cancer, heart disease and diabetes.

The fact that new information like this is emerging all the time means I think we should wait to know more before we scare consumers into emptying their shopping baskets. My view is coloured by my history of having had an eating disorder – I had anorexia as a teen and am now recovered, so I am very aware of the dangers of mixing food and fear. The UPF hype reminds me of the "clean eating" trend that dominated social media in the 2010s. Some advocates cut out entire food groups in an attempt to be "healthy", and former clean eating influencers have [said](#) that the fad led them to spiral into eating disorders.

Duane Mellor, a registered dietitian and nutrition researcher at Aston Medical School, says he has seen "increasing" reports that some individuals "are starting to avoid UPFs and not managing to meet their nutrient needs, putting their health further at risk". The nutritionist believes that we should promote healthy foods rather than stigmatise the foods that many people rely on (a 2021 Australian study [found](#) that poorer people ate more UPF). "Rather than arguing about the fine details of which foods or ingredients need to be avoided," Mellor says, we should emphasise healthy foods, "as largely there is agreement about the foods we *should* eat more of, which are vegetables, fruits, nuts, seeds and legumes."

Researchers and writers raising the alarm about UPF often call for greater regulation of the food industry and a world in which consumers are more informed. It is an admirable aim, but I wonder whether the UPF classification is even the best avenue for change. We already know so much about how foods high in fat, salt or sugar affect our health – shouldn't we go further with regulations here? I

can't understand why consumers should feel guilty for ignoring a warning label when supermarkets simply shouldn't be allowed to sell a sandwich containing 50% of your daily salt intake.

We live in a world where consumers are blamed for companies' poor choices. Sometimes, I feel I can't go a day without people telling me about something I should or shouldn't eat – and I've lived long enough to see some of these claims reversed (a glass of red wine is **actually** bad for you, cheese is **actually** good for you, the egg thing is **complicated**). I wish everyone had enough time and money to make the happiest and healthiest choice about food for themselves, but that isn't the case. While we fight food inequality and push for further regulation, there is a fine line between educating people and terrifying them. That line might be arbitrary – but, then again, so are many definitions of UPF.

- Amelia Tait is a freelance journalist

[https://www.theguardian.com/commentisfree/2024/jan/02/truth-about-ultra-processed-foods-upfs?utm\\_campaign=Bundle&utm\\_medium=referral&utm\\_source=Bundle](https://www.theguardian.com/commentisfree/2024/jan/02/truth-about-ultra-processed-foods-upfs?utm_campaign=Bundle&utm_medium=referral&utm_source=Bundle)

### Social implications

Public concern about UPFs may lead to confusion and anxiety about what foods are safe to eat. Media coverage often oversimplifies scientific findings, creating fear that all packaged foods are harmful. This can encourage unhealthy eating behaviours, such as avoiding whole food groups or developing restrictive diets.

There is also a **social inequality** issue: people with lower incomes often rely on processed foods because they are affordable, accessible, and have a longer shelf life. If UPFs are stigmatised, these groups could be unfairly judged or pressured to buy foods they cannot afford, widening the gap in diet-related health outcomes between richer and poorer populations.

However, increased awareness of UPFs might encourage consumers to think more critically about their diet and could promote healthier eating habits if clear, balanced guidance is provided.

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### Environmental implications

The UPF debate also connects to environmental concerns. Many ultra-processed foods are **heavily packaged in plastic**, which contributes to waste and pollution. Reducing UPF consumption could therefore reduce packaging waste and the carbon footprint associated with manufacturing and transporting processed foods.

On the other hand, a sudden shift away from UPFs could increase **food waste** if people lack time or facilities to prepare fresh food from scratch, or if fresh produce spoils quickly. Any policy encouraging reduced UPF intake should therefore consider sustainable food systems that balance health with environmental impact.

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### Financial implications

There are several financial implications for both individuals and the economy.

For consumers, unprocessed or organic foods are often more expensive, meaning that following advice to avoid UPFs could increase food costs. This can add financial pressure on low-income families, potentially worsening food insecurity.

For the food industry, increased regulation or changes in consumer behaviour could require companies to **reformulate products** or invest in alternative packaging and ingredients, which may raise costs.

However, in the long term, if reducing UPF consumption improves public health, this could lower **NHS spending** on diet-related diseases such as obesity, diabetes, and heart disease, offering financial benefits at a national level.

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### **Ethical implications**

The article highlights the ethical responsibility of scientists, the media, and policymakers to communicate evidence accurately. Because research into UPFs is still developing, it would be unethical to create public panic or guilt without clear proof of harm. Overstating the dangers could lead to **eating disorders** or malnutrition if people cut out foods unnecessarily.

There is also an ethical issue around **corporate responsibility**. Food companies often market UPFs aggressively for profit, even when they are high in fat, sugar, or salt. Ethically, manufacturers should be more transparent about ingredients and nutritional value, and governments should regulate harmful products to protect consumers.

Finally, there is a moral debate about **individual choice versus protection** — whether people should be free to choose what they eat, or whether regulation is justified to protect public health.

## The death of diesel: has the one-time wonder become the new asbestos? (January 2020)

### Article 1

#### The death of diesel: has the one-time wonder fuel become the new asbestos?

*This is an edited version of an article that appeared in 'The Guardian' newspaper in April 2017.  
The article was written by Adam Forrest.*



Photograph: Jinny Goodman/Alamy

Exhaust from a car. Air pollution kills 3.3 million people prematurely every year.

#### **Diesel was the dream fuel, promoted by governments and the car industry as a cheaper way to save the planet. Then the cracks started to appear.**

Air pollution now kills 3.3 million people prematurely every year – more than HIV, malaria and influenza combined – with emissions from diesel engines among the worst culprits; a joint investigation by the Guardian and Greenpeace showed hundreds of thousands of schoolchildren across England and Wales are being exposed to illegal air toxicity levels from diesel vehicles. And yet, such was the more or less widely accepted thinking as recently as 2010 that cars running on diesel fuel could be driven with a pure, unclouded conscience.

Diesel was touted at inception as a wonder fuel. It was a way of driving cost-efficiently while doing your bit to save the planet. Government, industry and science united to sell us the dream: cars running on diesel would help us cut our CO<sub>2</sub> emissions as we eased smoothly into a new eco-friendly age.

It was particularly owing to advances in engine technology that the diesel passenger car market was able to blossom in the 1990s, particularly in Europe. Drivers liked the fuel efficiency of diesel engines, which made running costs cheaper than petrol over the long term. Governments, meanwhile, alarmed by rising carbon emissions, began advising citizens to switch to diesels, which were thought to emit less CO<sub>2</sub> than their petrol counterparts. Diesel's biggest moment in the UK was probably in 2001, when Gordon Brown, then Chancellor of the Labour government, cut fuel duty on diesel vehicles as a deliberate effort to encourage people to switch.

The cracks took a long time to appear, but when they did they splintered rapidly. In 2012 came the first major evidence of some truly dreadful health impacts. Nitrogen oxides (NO<sub>x</sub>) and dioxides (NO<sub>2</sub>) and particulate matter (PM) pumped out by diesel exhausts were fingered as silent killers. The studies multiplied. The European Environment Agency found that nitrogen dioxide (NO<sub>2</sub>) from diesel fumes had caused around 71 000 premature deaths across the continent in a single year. It said the UK experienced 11 940 annual premature deaths from NO<sub>2</sub>, the second highest in Europe behind Italy. The World Health Organisation (WHO) declared diesel exhaust a carcinogen, a cause of lung cancer in the same category as asbestos and mustard gas.

Then in 2015 came Dieselgate. In September of that year Volkswagen rocked the industry by admitting that it had cheated on its emission tests. Following that disclosure, David King, the UK government's former Chief Scientific Adviser on climate change, admitted ministers had made a huge mistake by promoting diesel. They had trusted the car industry when it said the fuel was clean. "It turns out we were wrong," he said.

Cities worldwide have scrambled. The mayors of Paris, Madrid, Athens and Mexico City have agreed to completely outlaw diesel vehicles from the centre of their cities by 2025. The political leaders that make up the C40 group of global megacities are all taking steps to crack down on diesel vehicles and reduce smog. But other cities, including British ones, are tinkering around the edges; London is proposing low-emission zones and toll charges but has stopped short of a ban.

Banning diesel is trickier than it seems. The scale of the problem remains enormous. Diesel never made huge inroads into the US, where gasoline remained cheap, and where American automakers focused their innovation efforts on hybrid and electric vehicles. But in Europe, diesel passenger cars remain a major part of the auto industry: astonishingly, they still account for nearly 50% of all new cars sold across the continent.

Meanwhile, a study of the latest diesel cars by the International Council for Clean Transportation (ICCT) says real-world emissions of nitrogen oxides (NO<sub>x</sub>) are, on average, seven times higher than safety limits allow. A separate ICCT study showed that the latest diesel cars produce 10 times the NO<sub>x</sub> of heavy trucks or buses, which are more strictly regulated than cars.

The car manufacturers, too, have a hugely powerful lobby still at their disposal. According to Greg Archer, who once managed the UK government's air pollution research, automakers used their influence to ensure a "regulatory holiday" after the financial crash of 2008. They claimed that the Euro 5 and Euro 6 emissions standards, aimed at limiting pollutants from exhausts, led to significant reduction in pollutants. But a recent study of real-world performance shows those claims were bogus: Emissions Analytics found that 97% of the diesel cars made since 2011 exceed NO<sub>x</sub> safety limits.

Governments were complicit too. Germany agreed in 2013 to halt a proposed EU cap on bankers' bonuses – dreaded by the City of London – in return for British support to protect the German car industry and thwart a stricter emissions regime.

Nor is it easy to persuade drivers to switch. Many motorists are understandably angry that they were encouraged to invest in diesel engines but are now expected to face clean air zones, pollution charges and other restrictions. Many feel that they are, in effect, being punished for what they were told was the smart, responsible choice.

The UK government is keenly aware of the hypocrisy. The government must publish updated clean air plans but the Prime Minister, Theresa May, is "very conscious of the fact that past governments have encouraged people to buy diesel cars, and we need to take that into account".

While national governments wring their hands, it is cities that are taking the lead. In Germany, Berlin has already banned the oldest, highest-polluting diesel cars from its centre, while Munich is developing a clean air ban that will bring in some form of diesel ban in 2018. The Spanish capital, Madrid, has now introduced a system to halve the number of cars on the roads during smog outbreaks, based on odd or even number plates on alternate days; various other cities have experimented with similar trials.

In January, Oslo city council introduced a ban on diesel cars for the first time, halting their use completely for one day during a high pollution alert. The city also plans to raise the road toll for diesel cars entering the city centre from 33 Krone (£3) to 58 Krone (£5.50) in rush hour.

Green party councillor Lan Marie Nguyen Berg stated, "Since 2012 we've been talking about how bad diesel is for people's health, and people are adjusting to the science. In the past year we've seen quite a big change in attitudes. People are well aware of the health implications now. They don't think children and elderly people should have to stay in their homes to avoid pollution."

Paris has been typically one of the more aggressive cities. Under Mayor Anne Hidalgo, it introduced a system of coloured stickers to classify car types and emission levels. Any diesel-run car made before 2000 will not be allowed on the roads inside the French capital. Diesel cars built between 2000 and 2010 could soon be subject to tighter restrictions, as the mayor tries to phase out diesel entirely by 2025.

Some French drivers are unhappy. A national campaign group, 40 Million Motorists, says the new system is unfair to poorer diesel drivers who cannot afford to buy a new cleaner car.

Romain Lacombe, founder of Plume Labs, a Paris-based organisation that monitors air quality around the world, is not persuaded by their argument. He backs the new system because "it means the oldest cars will be the first off the road, which makes a lot of sense".

"The stock of diesel vehicles will take time to be phased out, but I only see momentum building to move away from diesel," says Lacombe. "There is a rising understanding of how damaging to health diesel emissions are. People are beginning to realise they are the first victim of their own vehicle. It's a personal health issue, a life or death issue."

Sadiq Khan, the Mayor of London, has stopped short of an outright ban on diesel, but he has ordered the replacement of the capital's current diesel bus fleet with clean alternatives. The mayor's office will also enforce a £10 toxicity charge on the highest-polluting cars entering the city centre. The measures are part of a wider plan to create an ultra-low-emission zone (ULEZ) in central London.

Khan has expressly urged drivers to "ditch dirty diesel", and has backed it up by urging the UK government to come up with a "national diesel scrappage fund" to fairly compensate diesel drivers, suggesting a sum of up to £3,500 offered for each car or van taken off the road.

The black cabs are a test of whether diesel is on its way out. Many of the cabs use diesel, and drivers had initially complained about clean-air restrictions. But the Licensed Taxi Drivers' Association (LTDA) now backs Khan's idea of a scrappage fund. And last month the government and City Hall both announced a plug-in taxi grant scheme giving cabbies £7,500 to buy new electric models built in Coventry. Steve McNamara, General Secretary of the LTDA, predicts diesel cabs will be "a thing of the past" within six years.

### **'The most unpopular measure'**

Although nearly three-quarters of all the world's diesel cars are driven on European roads, bold moves are being made elsewhere, too. Hong Kong has introduced subsidies to help phase out older diesel vehicles. Later this year Seoul will ban all diesels made before 2006 from a city-centre low emission zone.

But it is in Mexico City, where mountains surrounding the metropolis help trap a semi-permanent blanket of smog over the city, that Mayor Miguel Ángel Mancera has decided to ban diesel completely by 2025.

"I know it is a good thing for the city," Mancera said on a recent visit to London to meet Khan's team. "It's something that is absolutely essential to protect the environment. We're changing: our taxis have to be electric or hybrid, and our buses are being changed from diesel to new technologies."

The mayor has also pledged to invest more in the public transport system and cycling lanes, and persuaded delivery companies to use their diesel trucks at night to reduce daytime emissions.

Worldwide, polls suggest citizens of some big cities are beginning to put clean air before convenience. A YouGov poll last year showed 52% of Londoners would support a ban on diesel cars in London's city centre; a similar poll in France on a ban on diesel in the centre by 2020 was backed by 54% of Parisians.

This is probably how the death of diesel will come about – not through regulation but through consumer disgust. Many auto experts expect the global sales dip that followed Dieselgate to continue as consumers turn up their noses and manufacturers correspondingly invest less in new models. “The regulations will deter people, at least people in big cities, from buying diesel cars at their next purchase if they think they are going to be restricted,” says Professor David Bailey of Aston University.

Are car buyers entitled to have any confidence at all in buying diesel, or do we need to get rid of it altogether? Unfortunately it is difficult to determine precisely how the latest breed of diesel cars compare with petrol ones, pollution-wise. Since the Volkswagen scandal, no one has a great deal of faith in emission testing done in the laboratory.

A tougher on-the-road testing regime, the “real driving emissions” (RDE) tests, is set to take place across the EU. “There is going to be a tightening up on testing and it will make diesel cars more expensive to make,” says Bailey. “It will mean a lot of diesel cars disappearing because it won't be worth it for the manufacturers.”

“I think a substantial reorientation will take place away from diesel, part of a larger shift away from the combustion engine toward electric cars in the 2020s.”

According to Steve Gooding, Director of the RAC Foundation, a UK motoring research group, “the mere talk of action might already be altering buying behaviour”. He points to a recent dip in diesel car sales in the UK. But Gooding also argues that schemes to remove the highest-polluting diesel cars from the roads are impractical, mainly because working out exactly how “dirty” a car is remains difficult. “The issue is not just the age of a car, but where it's driven, how far it's driven and under what conditions,” he says. “Unfortunately, the data needed to target the most polluting vehicles accurately are not easily available.”

Yet the prize for hastening the decline of diesel could be huge – not least because, with so many big climate battles ahead of us, it would demonstrate that we and our political leaders can fix crises when science identifies them.

“I'm optimistic we can see the end of diesel vehicles,” says Berg. “The end of diesel would be a pretty big change in a relatively short period of time.”

## responses

The article “Beware the mix of food and fear – the truth about ultra-processed foods is still emerging” by Amelia Tait, published in *The Guardian* on January 2, 2024, delves into the complexities surrounding ultra-processed foods (UPFs). It highlights the scientific uncertainties and the societal reactions to UPFs, raising several ethical, social, and economic issues. ([The Guardian](#))

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## Scientific Issues Discussed

### 1. Ambiguity in Defining UPFs

The article underscores the lack of a clear, universally accepted definition of UPFs. For instance, Chris van Tulleken describes UPFs as foods "wrapped in plastic and have at least one ingredient that you wouldn't usually find in a standard home kitchen." However, this definition is subjective and can lead to confusion. Even van Tulleken admits to internal debates about whether certain foods, like a Marks & Spencer sausage roll, qualify as UPFs. This ambiguity complicates both scientific research and public understanding. ([The Guardian](#), [The Guardian](#))

### 2. Inconclusive Health Impacts

While some studies suggest potential health risks associated with UPFs, the article points out that the evidence is not definitive. The UK government's scientific advisory committee has cautioned that evidence linking UPFs to adverse health outcomes is not conclusive. This uncertainty makes it challenging to formulate clear dietary guidelines. ([The Guardian](#))

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## Ethical Issues

### 1. Fear-Based Messaging and Public Health

The article raises concerns about the ethical implications of promoting fear around UPFs without solid scientific backing. Such messaging can lead to anxiety and potentially harmful behaviors, like disordered eating. The author, who has a history of anorexia, emphasizes the dangers of mixing food and fear, suggesting that alarmist narratives can do more harm than good. ([The Guardian](#), [The Guardian](#))

### 2. Responsibility of Influencers and Media

There's an ethical question regarding the role of media and influencers in disseminating information about UPFs. Spreading unverified or sensationalized claims can mislead the public and contribute to unnecessary panic. The article implies a need for responsible communication that balances awareness with accuracy.

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## Social Issues

### 1. Impact on Eating Disorders

The fear surrounding UPFs can exacerbate eating disorders, such as orthorexia nervosa, characterized by an obsessive focus on healthy eating. The article suggests that the current discourse on UPFs might trigger or worsen such conditions, especially among vulnerable populations. ([The Guardian](#))

## 2. Socioeconomic Disparities

The consumption of UPFs is often higher among lower-income groups due to affordability and accessibility. Stigmatizing these foods without providing viable alternatives can disproportionately affect these communities, highlighting a social equity issue. ([The Guardian](#))

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### Economic Issues

#### 1. Affordability and Accessibility

UPFs are generally more affordable and have a longer shelf life, making them a staple for many, especially in low-income households. Demonizing these foods without addressing the economic factors that drive their consumption overlooks the broader systemic issues.

#### 2. Industry and Market Dynamics

The food industry heavily markets UPFs due to their profitability. Calls to reduce UPF consumption can have significant economic implications, affecting jobs and market dynamics. Balancing public health concerns with economic realities presents a complex challenge.

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### Conclusion

The article emphasizes the need for a nuanced approach to UPFs, considering the scientific uncertainties and the ethical, social, and economic dimensions. Rather than promoting fear, it advocates for informed discussions and policies that address the root causes of UPF consumption, such as socioeconomic disparities and lack of access to healthier options.

## Five ways to end plastic waste (Jan 2021)

### Article 2

#### Five ways to end plastic waste

#### **From packaging made out of organic waste to nano-engineering, the winners of the \$2 million New Plastics Economy Innovation Prize provide real answers to the plastic problem**

*This is an edited version of an article published by 'Circulate News' on the Medium website in January 2018. The article was written by Joe Iles.*

There's no love lost for plastic packaging. Whether it's complicated recycling instructions on the products we buy, startling images of the impacts on wildlife, or simply the economic value lost through waste, plastics have been climbing the international agenda for years. So how do 8 million tonnes of plastic still end up in the ocean each year?

#### **Searching for the right solutions**

The urgency of the issue has led to brands, governments, NGOs and celebrities promoting a host of solutions. Reusable packaging is part of the answer, and shopping bags, water bottles and coffee cups have become popular purchases for those trying to do their bit. This works to replace certain types of packaging, but think about all the other different pieces of plastic we come into contact with every single day. Plastic film can keep food fresher for longer, and wrappers ensure medical equipment is safe for patients. In many cases, it wouldn't be hygienic, convenient or feasible to go fully reusable.

There are also a number of initiatives that aim to tackle the impacts of the problem, from scooping plastics out of the ocean to collecting litter from beaches. Again, these are valuable efforts and must continue. However, the three best known major international ocean clean-ups combined deal with less than 0.5% of those 8 million tonnes of plastics that enter the ocean annually. We need to treat the cause, as well as the symptoms. This means looking upstream to design a plastics system that works, in which this material never ends up as waste in the first place.

The challenge here is that when it's used, plastic packaging becomes dispersed. These items are distributed throughout the world in endless configurations and uses, with billions of different customers. They're often tiny, lightweight, difficult to collect and individually aren't worth that much. So to truly rethink the way we make and use plastics, we need to come up with new approaches and systemic solutions.

#### **Designing a better system**

That's the thinking behind the New Plastics Economy Innovation Prize, launched in 2017 by the Ellen MacArthur Foundation, together with the Prince of Wales' International Sustainability Unit, and funded by Wendy Schmidt. The competition invited designers and materials scientists to reinvent the types of plastic packaging that are almost never collected and recycled, and end up in landfill, incinerators or in the environment.

The winners are awarded a share of the \$2 million prize, as well as a 12-month accelerator programme, in collaboration with Think Beyond Plastic.

The Innovation Prize is comprised of two parts. At the Our Ocean conference in October, the organisers announced the first batch of winning submissions. For this Circular Design Challenge, teams were tasked with coming up with superior alternatives to items like shampoo sachets, wrappers, straws and coffee cup lids. These 'small-format packaging items' account for 10% of all plastic packaging, and are currently not recycled and often end up in the environment.

### **Inventing circular materials**

The second group of winners is being announced at this year's Annual Meeting of the World Economic Forum in Davos. The Circular Materials Challenge seeks ways to make all plastic packaging recyclable. This means inventing better solutions than conventional packaging, and the features that we take for granted. For example, many plastic films aren't just made of one type of polymer, but a range of different materials all mixed up. Each material has a function – water resistance, airtightness, appearance – but they also make common packaging items unrecyclable.

The Circular Materials Challenge invites innovators to find alternative materials that could be recycled or composted. The five winning entries show what's possible when the principles of a circular economy are used to guide the research and development process. The intention is that these innovations not only inspire further progress, but are adopted, scaled and integrated into a working plastics industry.

### **Packaging inspired by nature**

The University of Pittsburgh team applies nano-engineering to create a recyclable material that can replace complex multi-layered packaging that is unrecyclable. This mimics the way nature uses just a few molecular building blocks to create a huge variety of materials.

### **Recyclable packaging, with help from magnets**

Aronax Technologies Spain proposes a magnetic additive that can be applied to a material, creating better air and moisture insulation – making it suitable to protect sensitive products such as coffee and medical products, while still being possible to recycle.

### **Packaging from food waste**

Working together, Full Cycle Bioplastics, Elk Packaging, and Associated Labels and Packaging make a compostable high-performance material from renewable materials, agricultural by-products and food waste to pack a broad range of products from granola bars and crisps to laundry detergent.

### **'Plastic' made from wood**

The VTT Technical Research Centre of Finland has created a compostable multi-layer material from agricultural and forestry by-products, which could be used for stand-up food pouches for products like muesli, nuts, dried fruit and rice.

### **Compostable coatings**

The Fraunhofer Institute for Silicate Research ISC has developed a coating with silicate and biopolymers that can be used in many different food packaging applications, protecting biopolymer packaging and food against premature degradation and is fully compostable.

### **The circular economy transition**

"These winning innovations show what's possible when the principles of a circular economy are embraced", said Ellen MacArthur, responding to the announcement of the winning entries. She continued: "Clean-ups continue to play an important role in dealing with the consequences of the waste plastic crisis, but we know we must do more. We urgently need solutions that address the root causes of the problem".

In 2016, the Ellen MacArthur Foundation released the first New Plastics Economy report, which provided the alarming and widely shared statistic that if we don't change how we make and use plastic, by 2050 the oceans could contain more plastics than fish, by weight. Viewers of the BBC series Blue Planet 2 saw this concern brought to life last year, resulting in another spike in public attention.

The New Plastics Economy reports have called for a redesign of the plastics system in line with the principles of a circular economy, a shift that will require a change in mindset.

Because try as we might, as a society we haven't made much progress on the 'plastics problem'. The recycling symbol has been around for over 40 years, but just 14% of plastic packaging is actually collected, and of that only 2% is properly recycled. The rest is lost during the recycling process, or goes to lower value goods. Despite best intentions, that yoghurt pot you recycled probably won't be reborn as another yoghurt pot.

So the new goal, according to the Ellen MacArthur Foundation, is "a New Plastics Economy, in which plastics will never become waste or enter the ocean in the first place."

### **Creating system level change**

While the winning innovations represent the type of solutions needed to build a plastics system that works, these teams cannot drive the transition alone.

That's why the Innovation Prize is part of the New Plastics Economy Initiative, an ambitious collaboration led by the Ellen MacArthur Foundation, with participation from a broad group of leading companies, cities, philanthropists, policymakers, academics, students, NGOs, and citizens.

Following an announcement in Davos, there are now 11 leading brands, retailers, and packaging companies working towards using 100% reusable, recyclable or compostable packaging by 2025 or earlier.

Together, these bold commitments, along with the right policy incentives and demonstrators of radical innovation, provide us with the best chance of creating a plastics system that works.

Emblematic of the 'take, make, dispose' world we live in; if we can make plastic packaging fit within a circular economy, there's reason to believe that other industries can follow suit.

<https://medium.com/circulatenews/five-ways-to-end-plastic-waste-69ee2dec0f81>

### Social implications

- The ubiquity of plastic waste affects communities in many ways: litter, pollution of beaches and rivers, and microplastics in food chains. The article notes that about 8 million tonnes of plastic still enter the ocean each year. ([Medium](#))
- There's a societal burden on waste-management infrastructure, especially in lower-income countries where collection and recycling may be weak. This can lead to health and sanitation problems for vulnerable populations.
- Consumer behaviour is implicated: people are being asked to use reusable packaging, avoid single-use plastics, and think about system design rather than only individual actions. The shift in mindset has social education implications. ([Medium](#))
- There is a risk of social inequality: if alternatives to current plastics are more expensive or require infrastructure (refill stations, compostable packaging, etc), then less well-off consumers may be disadvantaged in making the “better” choices.

### Environmental implications

- The article emphasises the environmental cost of plastic packaging ending up in landfill, incineration or the natural environment. That means harm to wildlife (marine and terrestrial), ecosystems and biodiversity. ([Chatham House](#))
- There is also a **circular economy** implication: plastics need to be redesigned so they fit into systems where waste is minimised and materials are reused. The article refers to the call for a “plastics system that works” so that materials never become waste. ([Medium](#))
- Persistent environmental damage: plastics degrade slowly, create microplastics, and flush through ecosystems, with long-term unknown effects on human health and environmental health. The article points out the complexity of this problem and the need for upstream change.
- The environmental implication also extends to resource use: conventional plastics derive from fossil fuels; increasing plastic production therefore contributes to climate change, resource depletion and pollution.

### Financial implications

- For governments and local authorities: increased costs of waste collection, management, recycling systems, clean-up of plastics in the environment. If current systems are inadequate, financial burdens will grow.
- For industry: the article outlines how major initiatives (such as the Ellen MacArthur Foundation/New Plastics Economy innovation prize) are driving costs into redesigning packaging, developing new materials, investing in recycling and circular systems. ([Medium](#))
- For consumers: if alternatives to single-use plastics are more expensive (for example, refillable systems, compostable packaging) this can raise household costs or shift burden.
- Long-term cost savings may occur if plastic pollution and its consequences (health impacts, environmental clean-up, wildlife loss) are reduced; hence upfront investment may pay off.
- There is also lost economic value: the article mentions that productive value is lost when plastic packaging is thrown away or dispersed instead of being part of a circular system.

### Ethical implications

- Ethical responsibility of businesses and governments: The article implicitly raises the question of who bears responsibility for plastic waste — is it individuals, manufacturers, governments? If packaging is designed with little regard for end-of-life disposal, there is an ethical concern.
  - Ethical treatment of the global south: Plastic waste is often exported or ends up in developing countries with weak infrastructure, burdening communities with the consequences. There is an ethical dimension of equity and global justice.
  - The ethics of prevention vs cure: The article suggests that focusing on clean-up alone is insufficient (the “ocean clean-ups” deal with less than 0.5% of plastics entering the ocean) and that it is more ethical to design plastics out in the first place. ([Medium](#))
  - Consumer ethics: informed choice, transparency of packaging and materials, and corporate marketing ethics (to what extent companies can claim “green” credentials when packaging still ends up as waste).
  - Ethical implications of innovation: Developing new materials may have unintended consequences (toxicity, disposal issues) so ethical due diligence is required in research, production and deployment.
- 

## Conclusion

The scientific issue of plastic waste — specifically packaging that is hard to collect or recycle and ends up dispersed in the environment — carries very wide-ranging implications. Socially we face issues of equity, behaviour change and health; environmentally we face ecosystem damage, climate change and resource depletion; financially we face rising costs, lost value and investment needs; ethically we face responsibility, justice, transparency and innovation risk. The article makes it clear that while individual actions matter, system-level change in design, material choice and circular economy thinking is essential. ([Medium](#))

## Nanotechnology can launch a new age of space exploration (Jan 2019)

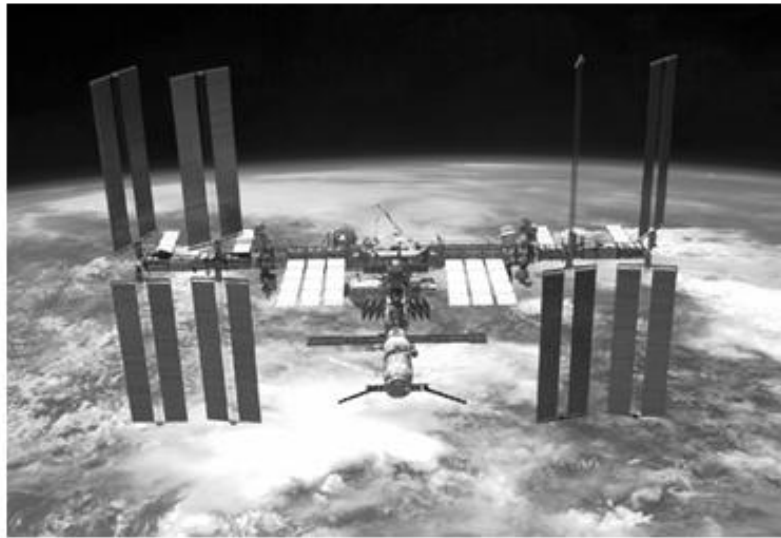
### Part A Set Task Information

#### Article 1

#### 'Nanotechnology can launch a new age of space exploration'

*This is an edited version of an article that appeared in 'The Guardian' newspaper in April 2012. The article was written by Stuart Clark.*

NASA and the European Space Agency have some ambitious plans. But if manned missions to Mars, super-thin spacesuits and shoebox-sized shuttles become a reality, then nanotechnology will undoubtedly have played a key role.



Existing multi-tonne spacecraft may one day be swapped for shoebox-sized craft weighing just 2kg-5kg as developments in nanotechnology progress.  
Photograph: NASA/Getty Images North America.

Launching equipment into space is an expensive business: it costs \$10,000 (£6,300) to lift every 0.45kg (1lb) of stuff into orbit. Making things smaller and lighter is, therefore, a natural route to reducing the cost of launching a spacecraft. It is no surprise then that the principles of nanotechnology – and the potential to reduce the mass and size of spacecraft and payloads – are focusing the minds of space engineers.

“When nanotechnology is really developed, even countries that don't presently think about space will be able to afford space exploration,” says Meyya Meyyappan, Chief Scientist for Exploration Technology at NASA's Centre for Nanotechnology, California.

He envisages swapping the multi-tonne spacecraft of today for shoebox-sized craft weighing just 2kg-5kg, yet matching all the capabilities of today's behemoths.

Taking its first step towards nano-sized instruments, NASA has developed a sensor, which utilises nanotechnology, for the International Space Station (ISS) that is the size of a postage stamp and can detect toxins in the air. It was taken into space briefly in 2009 for tests and, according to Meyyappan, is now ready for deployment. It is likely to be incorporated into NASA's space shuttle replacement vehicle and could be used on a future Mars rover to sample the alien atmosphere.

The sensor could also be modified to sample liquids. At present, astronauts' blood and urine samples have to be returned to ground control in Houston and checked in large-scale laboratories there for diseases, infections and general health. Nano-based sensors on board the ISS could provide instantaneous analyses and diagnoses. If manned Mars missions were ever to become a reality, such capabilities would be vital.

The European Space Agency (ESA) has also been studying the potential of nanotechnology. "There seems to be no limit to the potential application of nanotechnologies for space applications. Almost all technical domains covered by space research and development could benefit from these emerging technologies," says Laurent Marchand, Head of Components Technology at ESA's European Space Research and Technology Centre, Noordwijk, the Netherlands.

Nanoengineering could produce surfaces that regulate spacecraft temperatures more efficiently than the materials used today. It could also generate more efficient solar cells, rendering large panels redundant. This summer, ESA will be hosting its eighth biannual meeting to assess the technological readiness of various micro and nanotechnologies. Topics of discussion will include the possible uses of nanotech, how to test its reliability in space, and the current strategy for the development of such systems for space.

While making smaller components is an obvious way to drive down the mass and power consumption of an otherwise conventional spacecraft, nanotechnology offers much more potential than that.

"Nanotech can completely change the way we do space exploration," says Constantinos Mavroidis, distinguished Professor of Engineering, Northeastern University, Boston, Massachusetts. In 2006, he assembled a team to investigate concepts that could be possible within 50 years. "We wanted to think of what was simply not possible without nanotech," he says.

They hit upon two ideas. The first was a lightweight spacesuit that was more flexible than current garments. It would consist of three layers and be suitable for spending long periods of time exploring the Moon or Mars. Being thinner, however, the potential for damage would be higher, so Mavroidis investigated how to make it repair itself using self-assembling nanounits held inside the suit's layers. The nanounits would be based upon proteins and free to move along the suit layers. In the event of a breach, they would spill out, attaching to one another and building bridges across the damage. They could even carry emergency drugs to immediately treat any wound the astronaut may have suffered.

The team's second idea was a "spider's web" of hairline tubes that could be deployed across large tracts of a planet's surface. Inside the tubes would be an army of nanosensors that could measure the surface temperature and composition. Each web would span a dozen kilometres and be capable of sensing a planetary environment in great detail.

In space itself, nanotechnology-based missions hold great promise. Instead of general purpose spacecraft, hundreds or even thousands of identical microchip-sized spacecraft could be deployed to perform highly specific tasks. Using funding from the European Research Commission, Colin McInnes, Professor of Engineering, University of Strathclyde, Scotland, is currently studying such missions.

At present, ESA uses four nearly identical spacecraft called Cluster to measure the Earth's magnetic field and gauge its response to solar storms. Large numbers of smaller, nanotechnology-based spacecraft, known as "nanosats", could do a more detailed job by "carpeting" a much wider volume of space to provide continual monitoring of magnetic behaviour with high sensitivity.

Such nanosats would be so small that any gravitational attraction to the Earth would easily be overwhelmed by other forces, such as the pressure of sunlight and the minuscule drag of the Earth's highest atmosphere. This means that a nanosat would find it much easier to escape Earth's gravitational pull altogether, opening up new possibilities for propulsion.

Part of McInnes's study is to find the natural pathways in space that such nanosats could settle into. Once identified they could be exploited for future missions, allowing the tiny spacecraft to drift like dandelion fluff through the solar system.

"Nanotech is a new way of thinking about space missions. Once the idea is out there, people will think of all sorts of applications," says McInnes.

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### Social Implications

- Reduced cost and size could democratise space access: nations or organisations previously excluded might enter the field of space exploration. [The Guardian](#)
- Shifts in workforce skills: more demand for nano-engineering, smart systems, miniaturisation, creating new educational/training requirements.
- Public engagement and excitement: novel missions may raise interest in STEM, but also risk generating unrealistic expectations of when such technologies become practical.
- Equity: if only wealthy nations/corporations adopt nanosat technologies, there might be a new divide in space capability.

### Environmental Implications

- Lighter payloads mean lower launch mass → potentially lower fuel consumption, fewer emissions from launches.
- However, proliferation of small nanosats could lead to increased space-debris if not managed, which poses environmental risk for orbital ecosystems (collision hazard, long-term debris).
- Production of nanotech materials may involve novel materials (rare elements, chemical processes); environmental costs of mining, manufacturing and disposal must be considered.
- Smaller spacecraft could enable more frequent missions, including to moons/asteroids, which in turn raises concerns about planetary protection, contamination and disturbance of pristine environments.

### Financial Implications

- Launch cost savings: the article cites ~\$10,000 (£6,300) to lift each 0.45 kg into orbit; thus miniaturisation offers big savings. [The Guardian](#)
- Industry investment: companies and agencies may need large upfront R&D investment into nanotech for space, with uncertain timeline and return.
- Market creation: new business models (small-sat swarms, nano-probes) may open commercial opportunities (communications, Earth monitoring) but also risk if investment outpaces practical deployment.
- Cost to public sector: if governments fund this new tech, budgets may shift away from other priorities; risk of technology not yet mature leading to wasted spend.

### Ethical Implications

- Responsibility in design: Should nano-spacecraft be developed rapidly without fully understanding long-term effects (e.g., space-debris, environmental contamination)?
- Dual-use concern: Nanotechnology in space may have military/defence applications; ethical oversight of such uses is required.

- Access & justice: If only certain nations/corporations access this technology, issues of space equity and exploitation (of celestial bodies) arise.
- Sustainability: Ethically, the drive to explore must balance against impact on environments (both Earth's and other planetary bodies) and ensure responsible stewardship of space.

### **Conclusion**

The transformative potential of nanotechnology in space exploration is clear, yet its implications are multifaceted. Socially, environmentally, financially and ethically there are both opportunities and risks. As the article emphasises, thinking small (in spacecraft) may enable big leaps — but only if decision-makers integrate caution, fairness and long-term thinking alongside innovation.

## Dolling out too many antibiotics “will make even scratches deadly”: WHO warns that crisis could be worse than AIDS (June 2018)

### Part A Set Task Information

#### Article 1

#### Extract from ‘Dolling out too many antibiotics ‘will make even scratches deadly’: WHO warns that crisis could be worse than AIDS’

*This is an edited version of an article that appeared in the ‘Daily Mail’ newspaper in April 2014.*

- Spread of deadly superbugs that evade antibiotics is happening globally
- It’s now a major threat to public health, the World Health Organisation (WHO) says
- It could mean minor injuries and common infections become fatal

Deaths from cuts and grazes, diarrhoea and flu will soon be common as antibiotics lose their power to fight minor infections, experts have warned.

The World Health Organisation says the problem has been caused by antibiotics being so widely prescribed that bacteria have begun to evolve and develop resistance.

It claims the crisis is worse than the AIDS epidemic – which has caused 25 million deaths worldwide – and threatens to turn the clock back on modern medicine.

The WHO warns that the public should ‘anticipate many more deaths’ as it may become routine for children to develop lethal infections from minor grazes, while hospital operations become deadly as patients are at risk of developing infections that were previously treatable.

Doctors are increasingly finding that antibiotics no longer work against urinary and skin infections, tuberculosis and gonorrhoea.

The WHO is urging the public to take simple precautions, such as washing hands to prevent bacteria from spreading in the first place.

Doctors are also being told to prescribe antibiotics sparingly and ensure patients finish the full course, as if they stop mid-way the bacteria may become resistant. In England last year some 41.7 million prescriptions were written out, up from 37.2 million in 2006.

Dr Keiji Fukuda, the WHO’s assistant director for health security, said: ‘Without urgent, co-ordinated action, the world is headed for a post-antibiotic era, in which common infections and minor injuries which have been treatable for decades can once again kill.

#### SUPERBUGS: THE GUIDE TO BUGS RENDERING ANTIBIOTICS OBSOLETE

**MRSA** – patients infected with MRSA (methicillin-resistant *Staphylococcus aureus*) are 64 per cent more likely to die than those with a non-resistant form of *S. aureus*.

People infected by resistant superbugs are also likely to stay longer in hospital and may need intensive care, pushing up costs.

**C. difficile** – this bacteria produces spores that are resistant to high temperatures and is very difficult to eliminate. It is spread through contaminated food and objects and can cause blood poisoning and tears in the large intestine.

**E. coli** – this now accounts for one in three cases of bacterial infections in the blood in the UK and a new strain is resistant to most antibiotics. It is highly contagious and could cause more than 3,000 deaths a year.

**Acinetobacter Baumannii** – a common bacteria which is resistant to most antibiotics and which can easily infect patients in a hospital. It can cause meningitis and is fatal in about 80 per cent of patients.

**CRKP** – this is a bacterium that is associated with extremely difficult to treat blood infections and meningitis. It is resistant to nearly all antibiotics and is fatal in 50 per cent of cases.

Multi-drug resistant tuberculosis is estimated to kill 150,000 people globally each year.

**NDM-1** – a bacteria detected in India of which some strains are resistant to all antibiotics.

'Effective antibiotics have been one of the pillars allowing us to live longer, live healthier, and benefit from modern medicine.

'Unless we take significant actions to improve efforts to prevent infections, and also change how we produce, prescribe and use antibiotics, the world will lose more and more of these global public health goods and the implications will be devastating.

'We should anticipate to see many more deaths.

'We are going to see people who have untreatable infections.'

Only last month, Britain's Chief Medical Officer Dame Sally Davies criticised GPs for needlessly 'dishing out' antibiotics to patients.

In the largest study of its kind, the WHO looked at data from 114 countries on seven major types of bacteria. Experts are particularly concerned about bacteria responsible for pneumonia, urinary tract infections, skin infections, diarrhoea and gonorrhoea.

They are also worried that antiviral medicines are becoming increasingly less effective against flu.

Dr Danilo Lo Fo Wong, a senior adviser at the WHO, said: 'A child falling off their bike and developing a fatal infection would be a freak occurrence in the UK, but that is where we are heading.'

#### **THE COUPLE WHO LOST BABY TO INFECTION AFTER SUPERBUG OUTBREAK**

The human cost of the rising number of superbugs is becoming all too familiar.

Distraught young couple Jenna and Andrew Hannon lost their second son to an infection at a hospital neo-natal unit in Bristol.

Little Oliver was born early at 24 weeks and although he had seemed well enough to go home with his parents, he soon fell dangerously ill.

He was taken to Southmead Hospital but the infection had taken hold and the youngster passed away.

Tragically the couple had lost another prematurely born son, Travis, to infection in 2010, just five-and-a-half hours after his birth at 26 weeks.

An inquest into Oliver's death later found he had been killed by the pseudomonas bacteria.

He was one of three babies in the hospital to be hit by the killer bacteria, which was later linked to baby deaths around the country.

An investigation took place at the hospital into Oliver's death, but it could not find what caused his infection.

The inquest was told that Oliver was being given two types of antibiotics before he died as a precaution, but neither specifically fought pseudomonas.

As a result of the investigation, the hospital also now uses antibiotics which more specifically target the bacteria.

British experts likened the problem to the AIDS epidemic of the 1980s. Professor Laura Piddock, who specialises in microbiology at the University of Birmingham, said: 'The world needs to respond as it did to the AIDS crisis.

'We still need a better understanding of all aspects of resistance as well as new discovery, research and development of new antibiotics.'

The first antibiotic, penicillin, was developed by Sir Alexander Fleming in 1929. But their use has soared since the 1960s, and in 1998 the Government issued guidelines to doctors urging them to curb prescriptions. Nonetheless, surveys suggest they are still prescribed for 80 per cent of coughs, colds and sore throats.

**Link to video: WHO warns antibiotic-resistant bacteria is spreading.**

[www.dailymail.co.uk/embed/video/1093014.html](http://www.dailymail.co.uk/embed/video/1093014.html)

Jennifer Cohn of the international medical charity Médecins Sans Frontières agreed with the WHO's assessment and confirmed the problem had spread to many corners of the world.

'We see horrendous rates of antibiotic resistance wherever we look in our field operations, including children admitted to nutritional centres in Niger, and people in our surgical and trauma units in Syria,' she said.

Earlier this month, Government body NICE said that one in 16 patients are developing infections on NHS wards because of poor hygiene among staff.

NICE said 800 patients a day, the equivalent of 300,000 a year, are infected by a member of staff or by dirty equipment. It is estimated the infections cause 5,000 deaths annually and contribute to another 15,000.

#### WHAT CAUSES ANTIBIOTIC RESISTANCE?

Antibiotics are substances that kill or interfere with the growth of microorganisms, especially bacteria. But not all microorganisms are susceptible to all antibiotics, according to Public Health England.

Microorganisms which are not killed or inhibited by an antibiotic are called 'antibiotic resistant'.

They continue to grow and multiply in the presence of that antibiotics.

There are several ways in which bacteria can be resistant. Some destroy the antibiotic, for example by producing enzymes against it; some prevent the antibiotic getting into their cells; others get the antibiotic out of their cells before it can harm them.

#### HOW DOES RESISTANCE DEVELOP?

Some bacteria are naturally resistant; new resistances also arise spontaneously by chance mutations and these resistant strains then multiply.

Some resistances can be passed from one bacterium to another, spreading resistance between species. Loops of DNA (called plasmids) carry the resistance genes from one bacterium to another.

When an antibiotic is given, it kills the sensitive bacteria, but any resistant ones can survive and multiply.

The more antibiotics are used (in animals and agriculture as well as in man) the greater will be the "selective pressure", favouring resistant strains – i.e. survival of the fittest.

Antibiotics don't 'cause' resistance; rather, they create an environment which favours the growth of resistant variants which already exist in nature or arise by chance.

The article highlights the growing global crisis of **antibiotic-resistance (AMR)** — that is, bacteria evolving to evade existing antibiotic drugs, making once-treatable infections much harder (and sometimes impossible) to cure. This scientific issue has wide-ranging implications across social, environmental, financial and ethical domains.

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### Social implications

- As bacteria become resistant to antibiotics, common infections could become life-threatening again, putting populations at risk — especially vulnerable groups (elderly, immunocompromised, those in poorer countries).
  - The burden on healthcare systems and communities increases: longer hospital stays, more intensive treatments, higher morbidity and mortality.
  - Inequalities are deepened: low- and middle-income countries often have weaker health infrastructure, less access to new antibiotics or diagnostics, so the social impact is greater there.
  - Public behaviour and awareness must change: misuse and over-use of antibiotics (in humans and animals) contribute to resistance. Social norms around antibiotic prescription, self-medication, and awareness of microbial risks are impacted.
  - There is also a potential threat to progress in medical practice: many procedures (e.g., surgery, chemotherapy) rely on effective antibiotics. If these become ineffective, it may limit access to these treatments socially.
- 

### Environmental implications

- The use and disposal of antibiotics in humans, animals and agriculture leads to environmental exposure of microbes to antibiotic residues, increasing selective pressure for resistance in the environment. [World Bank+2Birmingham Polytechnic School+2](#)
  - Resistant bacteria and resistance genes can spread through water, soil and wildlife, creating ecological reservoirs of resistance.
  - The scale of antibiotic usage in livestock and aquaculture (for prophylaxis or growth) contributes to environmental antibiotic load and resistance emergence.
  - The environmental impact also includes the lifecycle of antibiotics packaging, manufacturing and waste, which imposes ecological costs.
  - If infections become untreatable, environmental health (e.g., in ecosystems and human-animal interfaces) may worsen due to increased disease burden in animals and humans, affecting biodiversity and ecosystem services.
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### Financial implications

- The economic cost of antibiotic resistance is considerable: treating resistant infections is far more expensive (longer hospital stays, more intensive care, more toxic/novel drugs) than treating non-resistant infections. [World Bank+1](#)
- For health systems, this means increased expenditure and budget strain — fewer resources for other services.

- On a national/global level, AMR threatens economic productivity: more people ill, more mortality, more healthcare costs, reduced workforce capacity, and potentially reduced investment returns in health and social care. [World Bank](#)
  - The pharmaceutical and biotech industry faces high costs and risk: developing new antibiotics is expensive, scientifically difficult and financially uncertain (low return on investment).
  - For individuals and families, increased costs (through healthcare, loss of income due to longer illness) may impose financial burdens, worsening inequality.
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### Ethical implications

- There is a responsibility (ethical duty) for prudent antibiotic use: doctors, veterinarians, farmers and patients all share responsibility to preserve antibiotic effectiveness for future generations. Misuse is an ethical problem.
  - Global justice concerns: wealthy countries may have access to newer antibiotics or better stewardship programs, while poorer countries may suffer greater burdens — raising issues of fairness and equity.
  - Intergenerational ethics: if current misuse leads to future generations losing effective treatments, that is an ethical breach of duty to future humans.
  - Animal welfare issues: heavy antibiotic use in livestock raises ethical questions about farming practices, animal husbandry and the impact on resistance.
  - Environmental ethics: disposal of antibiotics and the spread of resistance genes into environment raises moral responsibility to ecosystems and non-human life.
  - Research and development ethics: the antibiotic pipeline is weak, yet companies may be reluctant to invest. The ethics of allocating public funds, supporting low-profit essential medicine development, and incentivising innovation are all implicated.
  - Informed consent and public communication: individuals need clear, accurate information about antibiotic resistance; oversimplification or alarmism could be unethical if it misleads or causes unintended behaviour.
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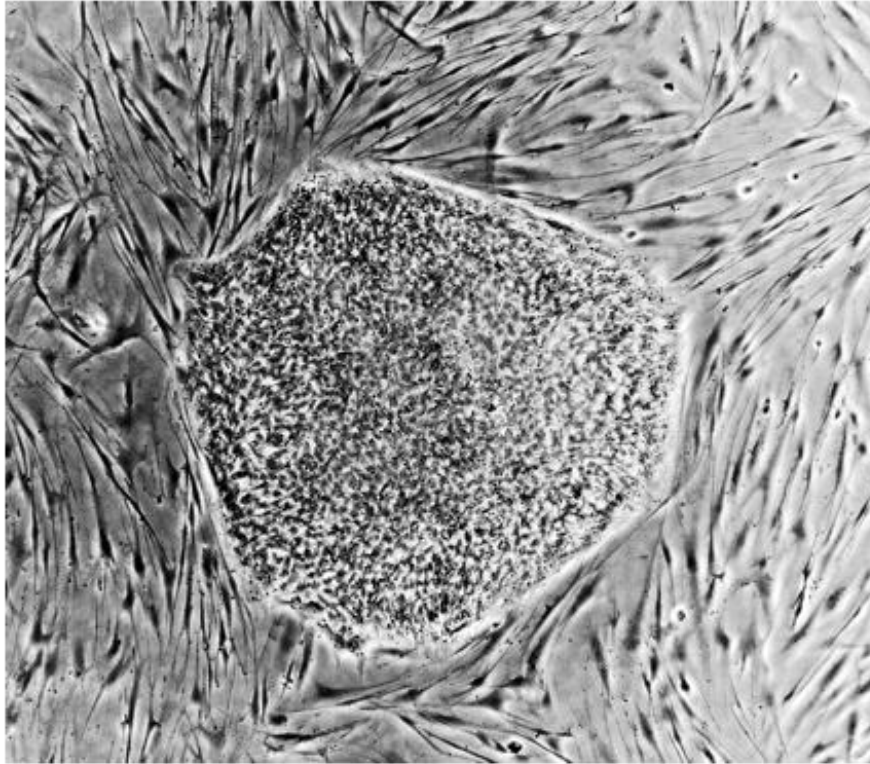
### Conclusion

The scientific issue of antibiotic resistance is one of the most critical challenges in modern medicine. It extends far beyond microbiology and affects society, the environment, economies and ethics. Addressing it requires integrated action: stewardship, innovation, global collaboration, behavioural change and equitable access. The article emphasises that without concerted effort, we risk returning to a “post-antibiotic era” in which minor infections are deadly.

## Why stem cells could be the medical innovation of the century

### Why stem cells could be the medical innovation of the century

*This is an edited version of an article published by the World Economic Forum in January 2020. The article was written by Mike Moradi.*



*A colony of embryonic stem cells*

(Source: © Science Source/SCIENCE PHOTO LIBRARY)

- At the moment, the demand for stem cell therapies is growing extremely quickly and will rapidly expand when a breakthrough treatment for non-communicable disease or a lifestyle factor occurs.
- Funding is flowing into the sector from investors and large companies.
- With greater resources and an increasingly experienced talent pool, scientists and doctors may be able to develop stem cell science to cure the world's most challenging diseases.

Right now, your body's stem cells are working hard replacing your skin every two weeks, creating new red and white blood cells and completing thousands of other tasks essential to life. They are your own individual way of keeping young.

Scientists generally agree that a stem cell should be able to do both of the following:

- Self-renew: divide into another stem cell, which means making an identical copy of itself; and
- Differentiate: change into a variety of other cell types.

One theory of ageing suggests that between the ages of 30 and 50, our stem cells reach a turning point and start to decline in number and function. This results in the typical features associated with ageing.

## A brief history of stem cells

There does not seem to be a single discoverer of stem cells. Accounts date back to the 1800s and even further, but the first successful medical procedure was a bone marrow transfusion<sup>(i)</sup> in 1939.

<sup>(i)</sup><https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4222417/>

Advances in immunology led to donor matching, initially via siblings and close relatives. Unrelated donor matching grew rapidly in the 1970s, alongside donor registries.

In the 1980s, scientists identified embryonic stem cells in mice, leading to the 1997 cloning of Dolly the sheep. This created immense interest for human and medical applications and a negative response in the US as government research and development (R&D) funding was essentially stopped in 2001.

In 2012, a Nobel Prize<sup>(ii)</sup> was awarded for the earlier discovery of induced pluripotent stem cells (iPS). Essentially, scientists are able to make mature cells act like stem cells again.

<sup>(ii)</sup><https://www.nobelprize.org/prizes/medicine/2012/press-release/>

In the 10 years between 2010 and 2019, the first lot of stem cell start-up companies emerged, alongside R&D programmes at many large pharmaceutical companies, leading to innovation and the first human clinical trials for iPS and other related therapies.

## Regenerative medicine in 2019

Regenerative medicine is an area of medicine that develops ways to regrow, replace or repair damaged or diseased cells, tissues or organs.

There is substantial investment in regenerative medicine across the world. According to data published in 2019, there were 959 regenerative medicine companies worldwide sponsoring 1,052 active clinical trials; 525 of these companies are in North America, 233 in Europe and Israel, and 166 in Asia. In total, \$7.4 billion has been invested in regenerative medicine companies in 2019, \$5.6 billion of which has been dedicated to gene and gene-modified cell therapy, \$3.3 billion in cell therapy, and \$114 million in tissue engineering.

Curative therapies are starting to be sold and the results are astonishing: 60% of Acute Lymphoblastic Leukaemia patients taking Novartis' Kymriah showed a complete response (no traces of cancer) and were declared in full remission. Meanwhile, 75% of patients with  $\beta$ -Thalassaemia treated with bluebird bio's Zynteglo achieved independence from transfusions. 93% of spinal muscular atrophy (wasting away) patients treated with Novartis' Zolgensma were alive without permanent ventilation 24 months after treatment. We should expect more medical breakthroughs in the coming years.

## What is next?

**New science, new start-ups:** several companies in the sector have gone from being private companies to being publicly funded. This leads to the recycling of talent and capital into new companies. Because the science and commercial systems have also advanced, the new companies are pursuing bigger challenges and driving innovation with even greater resources.

**Patients are eager:** the demand for stem cell therapies is growing each year, though it will rapidly expand when a breakthrough occurs toward the treatment of a non-communicable disease (such as cancer, diabetes, heart disease) or a lifestyle factor (for example, growing hair in the correct places, expanding cognitive abilities or increasing healthy lifespan).

**New R&D models:** funding is flowing into the sector from large companies, funds from investors, and institutions such as the California Institute for Regenerative Medicine (CIRM) and New York State Stem Cell Science programme (NYSTEM). Some of the leading university R&D organisations include the Center for the Commercialization of Regenerative Medicine<sup>(iii)</sup> in Toronto, the Stanford Institute for Stem Cell Biology and Regenerative Medicine<sup>(iv)</sup>, the Oxford Stem Cell Institute, and most notably, the Harvard Stem Cell Institute (HSCI)<sup>(v)</sup>.

<sup>(iii)</sup><https://www.ccrm.ca/>

<sup>(iv)</sup><https://med.stanford.edu/stemcell.html>

<sup>(v)</sup><https://hsci.harvard.edu/startups>

## Where can I get some stem cells?

Though patients' needs are immediate, those seeking treatments should think very carefully about the risks. There are many untrustworthy clinics offering expensive stem cell treatments and some patients have experienced horrifying complications. Dr. Paul Knoepfler of UC-Davis has written a practical and scientifically accurate guide<sup>(vi)</sup>, a strongly recommended read if you or a family member are considering treatment or a clinical trial.

<sup>(vi)</sup><https://ipsell.com/patients-guide-to-stem-cell-treatments/>

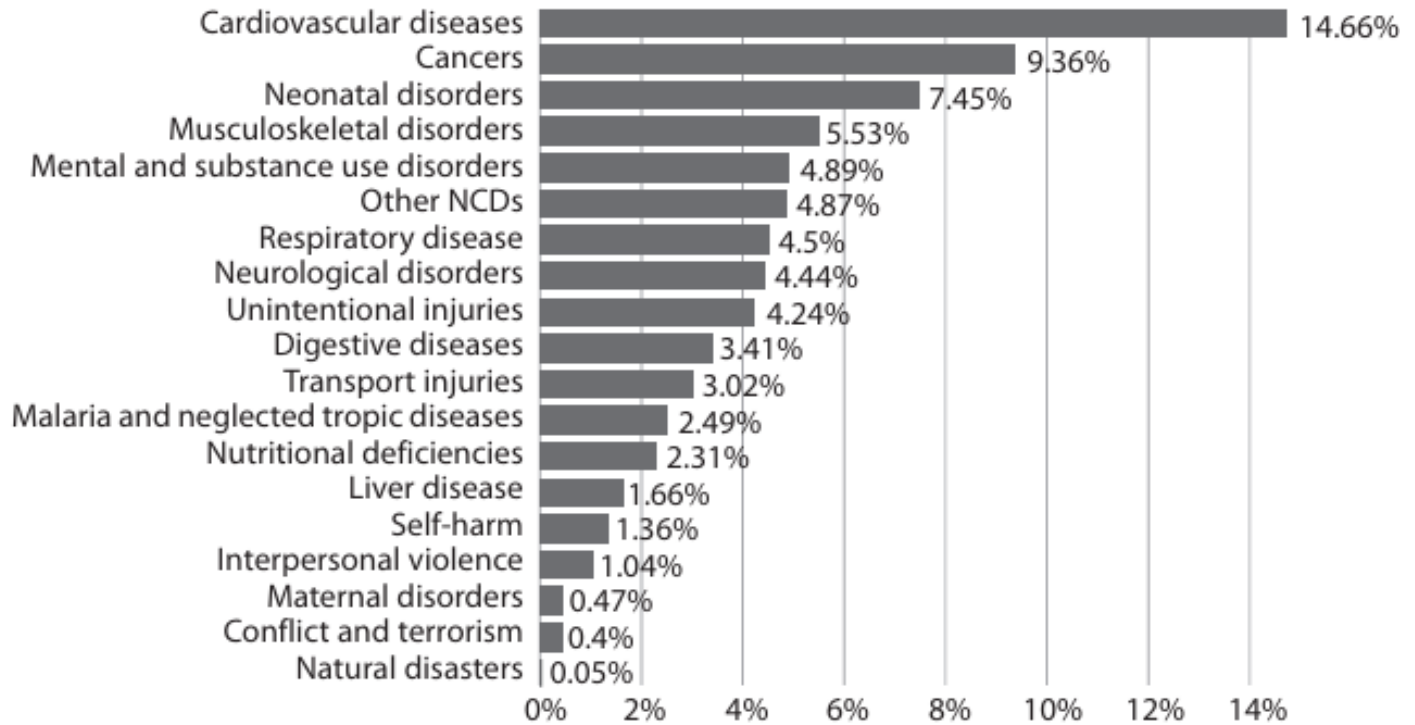
## Why stem cells? Why now?

The leading causes of death in 1900 were mostly infectious/communicable diseases<sup>(vii)</sup>. While the prevalence (number of cases in a population at a specific time) of most infections has decreased, the largest increases include heart disease (+40%) and cancer (+300%). It is true that this is partly due to doubling life expectancy and a lack of death from other causes. However, given time and resources, scientists and doctors may cure these challenging diseases.

<sup>(vii)</sup><https://www.nejm.org/doi/full/10.1056/NEJMp1113569>

**Share of total disease burden by cause, World, 2017**

Total disease burden, measured in Disability-Adjusted Life Years (DALYs) by sub-category of disease or injury. DALYs measure the total burden of disease – both from years of life lost due to premature death and years lived with a disability. One DALY equals one lost year of healthy life.



(Source: IHME, Global Burden of Diseases  
OurWorldInData.org/burden-of-disease · CC BY)

**Figure 1**

Today, six of the seven leading causes of death are non-communicable diseases (NCDs e.g. heart disease, stroke, lung diseases, cancer, Alzheimer’s disease and diabetes). Based on the early promise mentioned above, regenerative medicine may be our best hope to solve the great non-communicable diseases of our time, and perhaps the single most transformative medical innovation in a century<sup>(viii)</sup>.

<sup>(viii)</sup><https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death>

### **Question 1: Discuss the implications of the scientific issue identified in the article**

The article 'How will stem cells impact the future of medicine?' from the World Economic Forum explores the scientific issue of using stem cells to treat a wide range of diseases. Stem cells are unique because they can develop into many different types of cells in the body and have the potential to repair or replace damaged tissues. This exciting field of biotechnology has the potential to revolutionise medicine but also raises important social, environmental, financial, and ethical implications.

#### **Social Implications**

Stem cell research offers hope for patients suffering from diseases such as Parkinson's, diabetes, heart disease, and spinal cord injuries. It could significantly improve quality of life and extend life expectancy. However, access to these treatments may be uneven, leading to social inequality. Only those in wealthier countries or with private healthcare might benefit in the early stages of development. The use of stem cells also challenges cultural and religious beliefs, as some people oppose using embryonic stem cells due to moral concerns. Public understanding and acceptance will be key to the responsible use of this technology.

#### **Environmental Implications**

Stem cell therapy generally has a limited direct impact on the environment compared with industrial technologies, but laboratory research and clinical trials require specialised equipment, materials, and energy, which contribute to the carbon footprint of biomedical research. On a positive note, successful stem cell treatments could reduce the environmental impact of healthcare by lessening the need for long-term drug use, surgery, and hospitalisation. As the technology matures, sustainable lab practices and waste reduction in biotech research will become increasingly important.

#### **Financial Implications**

Developing and testing stem cell therapies is extremely costly. Clinical trials, specialist equipment, and regulatory approval processes require significant investment. This makes treatments expensive and potentially limits access to those who can afford them. However, in the long term, regenerative medicine could reduce healthcare costs by curing chronic diseases rather than just managing symptoms. The field also creates new economic opportunities through biotechnology companies, research funding, and international collaboration, contributing to job creation and innovation-driven growth.

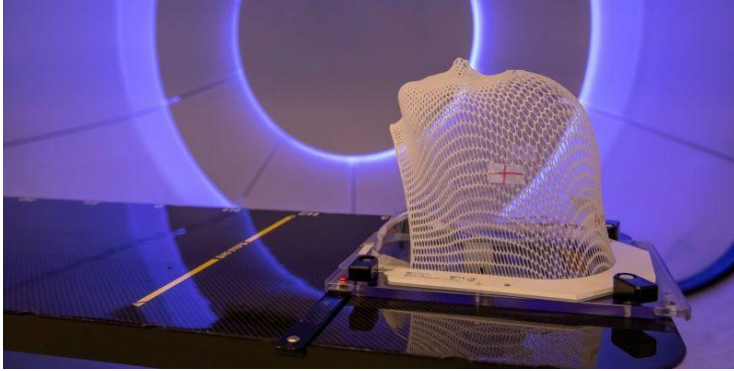
#### **Ethical Implications**

Stem cell research raises complex ethical issues. The use of embryonic stem cells involves the destruction of human embryos, which many people consider morally wrong. This has led to debates about the value of potential human life versus the potential medical benefits. Ethical frameworks must ensure that stem cell research is conducted with respect for human rights, informed consent, and transparency. Additionally, the rise of unregulated private clinics offering unproven stem cell treatments poses ethical and safety risks. Scientists and regulators have a duty to protect patients from exploitation and ensure research integrity.

#### **Conclusion**

Stem cell research has the potential to transform medicine by offering cures for previously untreatable diseases and improving millions of lives. However, it also presents major social, environmental, financial, and ethical challenges. Responsible governance, public education, and equitable access are essential to ensure that this technology benefits all of society without compromising ethical standards or sustainability.

## Groundbreaking proton beam therapy cancer trial opens



**A cancer treatment that is currently available to only a limited number of UK patients is to be tested in a clinical trial to see if it causes fewer long-term side effects than standard radiotherapy.**

The brain cancer trial, which is now recruiting patients in Leeds, Manchester, Oxford, London, Cambridge and Kent\*, will determine whether proton beam therapy can reduce the long-term side effects of radiotherapy and improve quality of life of patients compared with photon radiotherapy, the current standard treatment used globally.

The technology uses a beam of a highly charged proton particles to destroy cancer cells. It does this by releasing a powerful burst of energy at the tumour site and delivers less radiation to the surrounding normal tissues.

The clinical trial, called APPROACH, funded by the National Institute for Health and Care Research (NIHR) and led by the University of Leeds, is open to patients with a type of brain cancer called oligodendroglioma that is diagnosed in about 350 UK patients per year. APPROACH stands for Analysis of Proton vs Photon Radiotherapy in Oligodendroglioma and Assessment of Cognitive Health.

The trial is academically co-led by Dr Louise Murray, Yorkshire Cancer Research Associate Professor and Honorary Consultant Clinical Oncologist, and Professor Susan Short, Professor of Neuro-Oncology, both from the University of Leeds's School of Medicine.

**“This trial is vital to determine how we can use radiotherapy treatments appropriately, to give patients the best possible future.”**

*Dr Louise Murray, School of Medicine*

It will be delivered through the University of Leeds Cancer Research UK Clinical Trials Unit, led by Professor Sarah Brown. Specialist teams at [University College London Hospitals NHS Foundation Trust \(UCLH\)](#) and [The Christie NHS Foundation Trust](#) in Manchester – the two UK proton beam therapy treatment centres – will lead on the development and delivery of proton beam therapy for this new clinical indication and support patients and families through treatment.

Dr Murray said: “We really need to know if this new technique can help reduce damage to the healthy brain tissue that surrounds a tumour, so that fewer patients have their lives affected by cognitive problems, such as difficulties with memory and processing information; problems like these can have a huge impact on daily life.

## Protons vs photons

In the UK, standard radiotherapy is considered to be the most appropriate and effective treatment for the majority of cancers that are responsive to radiation treatment. It uses x-ray photons to destroy cancer cells, a technique which has been used successfully for more than 100 years, with continuous improvement resulting in greater accuracy and precision. Proton beam therapy is a relatively new technology in the UK. The NHS has invested in two major high energy proton beam radiotherapy centres and patients who receive proton beam therapy in the APPROACH trial will receive it at The Christie NHS Foundation Trust in Manchester, or University College London Hospitals NHS Foundation Trust (UCLH).

Proton beam therapy is only available to a small number of patients in the UK and up until 2018 could only be accessed abroad. Now it is available in the NHS at The Christie NHS Foundation Trust in Manchester and UCLH.

Current clinical indications for proton beam therapy have focused on where there are benefits over standard treatment, particularly where tumours are close to vital or delicate parts of the body, and some children's cancers. More clinical research is required to understand how proton beam therapy compares with other treatment modalities to ensure the best treatment is selected for patients and is why this trial will play an important role in addressing some of these questions.

In both proton beam therapy and photon radiotherapy some damage may be caused to healthy tissue by the radiation beam inside the patient. In the case of photon radiotherapy, this also includes healthy tissue behind the tumour, since the x-rays continue to pass through the body beyond the tumour, albeit with less energy. Proton beam therapy may reduce the side effects from radiotherapy treatment because the beam of protons delivers a large burst of energy at the tumour site, with significantly less radiotherapy deposited beyond the tumour.

Dr Murray said: "We need high quality clinical trials to determine whether proton beam therapy is a better treatment for certain cancers. Clinical trials such as APPROACH are therefore of critical importance. Although we have some data to suggest that proton beam therapy might reduce long-term side effects, it is essential that we directly compare the two treatment approaches, and this will determine how future patients are best treated."

Dr Naomi Fersht, consultant clinical oncologist at UCLH and one of the APPROACH trial investigators, said: "We are keen to begin this important trial and hope to be able to show that the use of proton beam therapy can minimise some of the side effects of radiotherapy for adult brain cancer patients. APPROACH is an example of the type of research we are now able to invite UK patients to participate in, working in collaboration with our partners nationally."

### Recruiting in 2024

Professor Nick Lemoine CBE, from the National Institute for Health & Care Research, which is funding the trial, said: "The launch of proton beam therapy in the UK is a major milestone in cancer care, but we need evidence for how best it can be used and that can only come from high quality clinical trials such as APPROACH."

The trial will ultimately be open to patients from up to 18 recruiting cancer centres across the UK. Those taking part will be randomly assigned to receive either standard photon radiotherapy or proton beam therapy, so the side effects can be compared. Patients interested in joining the trial should contact their treating clinician to discuss suitability.

The APPROACH trial team has worked closely with brain tumour patients and their relatives, as well as staff working at The Christie, UCLH and the Leeds Cancer Research UK Clinical Trials Unit, in designing the trial. The [National Cancer Research Institute Clinical Trials Radiotherapy Research Working Group \(CTRad\)](#) provided expert support and guidance throughout the trial design process to ensure the trial would be efficient and of high quality. CTRad, now closed, brought the UK radiotherapy research community together to create world-leading large scale randomised trials that directly compare standard photon and proton beam radiotherapy.

David Sebag-Montefiore, Professor of Clinical Oncology and Health Research at Leeds' School of Medicine and former CTRad Chair, said: "The APPROACH trial will answer critically important questions for brain cancer patients regarding the use of proton beam therapy. We hope that this treatment will improve quality of life for patients and reduce the long-term side effects they can often face."

Dr Helen Bulbeck is co-founder of UK brain tumour charity brainstrust, and former patient representative for proton beam therapy in CTRad. She said: "This trial is so important and will help to dispel the myths that have developed about proton beam therapy.

"People need to be able to make informed decisions about their treatment choices. To do this we need the evidence that this trial will produce. This will put people in the driving seat, enabling them to be co-pilots in their care and the decisions they make."

The trial will follow up with patients to assess their side effects, quality of life and survival rates for five years after treatment. The researchers hope that the trial results will lead to improved care and outcomes for patients with brain cancer and will help inform treatment of other cancers in the years to come.

## References

<https://www.leeds.ac.uk/news-health/news/article/5517/groundbreaking-proton-beam-therapy-cancer-trial-opens>

## Question 1: Discuss the implications of the scientific issue identified in the article

The article 'Groundbreaking proton beam therapy cancer trial opens' from the University of Leeds describes a major development in cancer treatment using proton beam therapy (PBT). This advanced form of radiotherapy uses high-energy protons instead of X-rays to target tumours more precisely, reducing damage to surrounding healthy tissue. The scientific issue explored in the article concerns the development, accessibility, and ethical use of this new medical technology. The introduction of proton beam therapy has significant social, environmental, financial, and ethical implications.

### Social Implications

Proton beam therapy represents a major social advancement in healthcare by improving cancer treatment outcomes and quality of life. By targeting tumours more accurately, it can reduce side effects and long-term complications, which is especially beneficial for children and young adults. However, access to this treatment is currently limited due to the small number of proton centres in the UK and worldwide. This raises concerns about healthcare inequality—patients who live near specialised centres or who can afford travel may receive better treatment. Public awareness and

understanding of the technology are also crucial to ensure realistic expectations and informed consent.

### **Environmental Implications**

Building and operating proton beam therapy facilities require large amounts of energy and advanced infrastructure. The machines used in treatment, such as particle accelerators, consume significant electricity and require specialised materials. However, as the technology advances, newer systems are becoming smaller and more energy-efficient. Environmentally, the reduction in post-treatment complications and shorter hospital stays can decrease medical waste and resource use over time. Sustainable development of these facilities, using renewable energy and environmentally responsible construction, could reduce the carbon footprint of healthcare technology.

### **Financial Implications**

Proton beam therapy is considerably more expensive than traditional radiotherapy. The construction of a single facility can cost hundreds of millions of pounds, and the technology itself is complex and costly to maintain. This presents a major challenge for healthcare funding. However, in the long term, more precise treatment could reduce the costs associated with managing side effects and secondary cancers, potentially saving the NHS money. Investment in UK-based facilities, like the Leeds trial, also reduces the need to send patients abroad for treatment, which previously added significant travel and accommodation costs.

### **Ethical Implications**

The ethical implications of proton beam therapy include fairness, accessibility, and patient consent. There is an ethical responsibility to ensure equal access to cutting-edge treatments regardless of a patient's income or location. Decisions about who receives proton therapy must be based on clinical need, not social or financial factors. Ethically, patients should also receive clear, evidence-based information about the benefits and risks of proton therapy compared to other treatments. Furthermore, as new technologies emerge, researchers must ensure that trials are conducted safely and transparently, with patient welfare as the top priority.

### **Conclusion**

The introduction of proton beam therapy marks an exciting advancement in cancer treatment. It promises better health outcomes and reduced side effects, but it also presents challenges relating to cost, equity, and sustainability. The social, environmental, financial, and ethical implications of this technology highlight the need for careful planning, responsible investment, and fair access so that all patients can benefit from scientific progress.