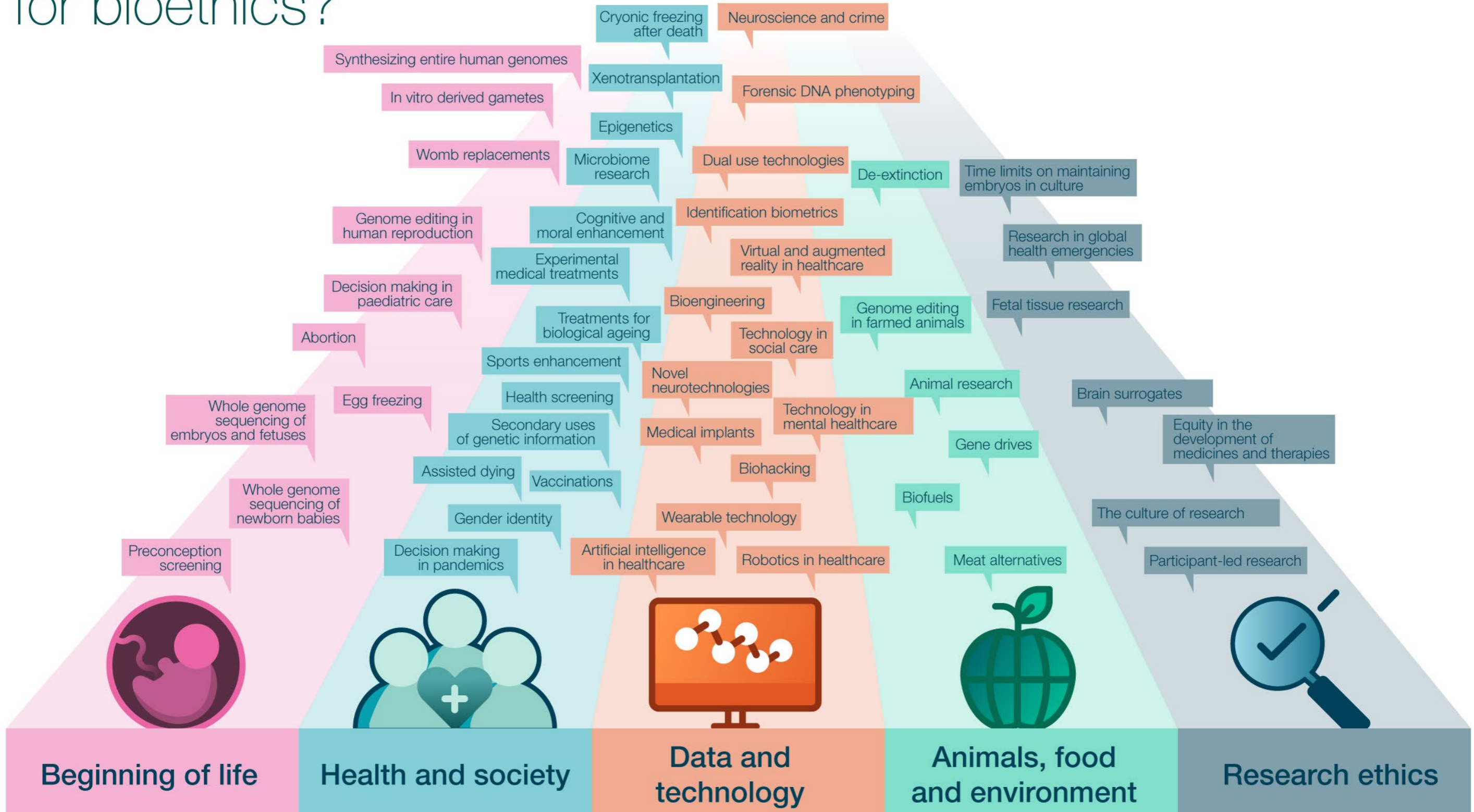


What's on the horizon for bioethics?



What's on the horizon for bioethics?



Beginning of life

Preconception screening

Couples with a family history can have genetic testing before they conceive to find out if they are carriers for conditions like cystic fibrosis. Testing is likely to become cheaper and more accessible, allowing any couple to test for a wide range of genetic conditions and features relatively cheaply. Should there be limits on what people can test for?

Whole genome sequencing of embryos and fetuses

Pregnant women and couples can have prenatal screening for some genetic conditions in the first trimester of pregnancy. Embryos can undergo pre-implantation genetic diagnosis during IVF. The number and type of conditions that embryos and fetuses can be screened for is likely to increase, with whole genome sequencing a possibility in future. This could provide important information to parents and promote reproductive choice, but there are concerns about the impact of expanded prenatal testing on termination rates, and on the lives of people with disabilities.

Whole genome sequencing of newborn babies

The Government has announced an ambition to offer whole genome sequencing to parents of all newborn babies to identify babies' risks of developing disease and to create a genetic data resource for research and future healthcare purposes. This is likely to be available in the near future to parents through commercial genetic testing companies. Will this have real benefits for the health of children, or simply create confusion and worry for parents, and is it ethical to obtain and store this information without the child's consent? [Read our briefing note on this topic.](#)

Egg freezing

As freezing techniques improve, egg freezing is emerging as a viable way of preserving women's fertility. The number of women choosing to freeze their eggs is growing, and some companies offer egg freezing as an employee benefit. There are calls to extend the storage time limit for electively frozen eggs, which is currently 10 years. Should we be worried about women feeling coerced to freeze their eggs, and what could be the knock-on social effects of this trend for women? Is this another example of a technological solution to a social problem? [Read our briefing note on this topic.](#)

In vitro derived gametes

Mouse sperm and eggs cells have been created in the lab from other cells in the mouse's body, resulting in fertile offspring. This could become possible for humans in future, offering a new kind of fertility treatment for people who cannot conceive, and overcoming the shortage of eggs for research. It could also increase the risk of children being produced without one parent's consent or knowledge, and raises questions about what ethical significance ought to be placed on genetic parenthood.

Womb replacements

Researchers have been able to keep premature lambs alive in artificial wombs for several weeks. This technology might help improve outcomes for premature human babies in future. Looking further ahead, when more or all of pregnancy might one day take place outside the human body, would the use of artificial wombs lead to social changes relating to the nature of motherhood and parenthood?

Synthesizing entire human genomes

Researchers have synthesized entire bacteria in the lab, and the possibility of creating human cells from scratch is now being explored. The cells could be engineered to resist viruses, radiation, freezing, ageing and cancer, and would be a valuable resource for research. Such a development would raise significant ethical and philosophical questions about the nature of life, parenthood, and scientific hubris.

Abortion

Debate about UK abortion law is likely to continue well into the future. This is a polarised issue that has implications for areas of medicine such as prenatal screening. Some are campaigning to decriminalise abortion across the UK, but others are seeking to reduce the upper time limit for abortions in response to changes in the thresholds of fetal viability.

Decision making in paediatric care

There have been several recent high-profile court cases where healthcare teams and parents disagreed about the care of a critically ill child. Wider changes in society, such as increases in social media use and medical tourism, and advances in medicine, might be contributing to the way in which disagreements develop. Are there ways in which disagreements such as these can be avoided, or resolved more quickly?

Genome editing in human reproduction

It could become possible to use genome editing to alter the DNA of embryos, sperm or eggs to help a couple have a child without a particular heritable disorder. This is currently illegal in the UK. Before it can be permitted, it is widely agreed that consideration is needed of the clinical safety of the techniques, and their potential to impact on the welfare of the future person, and on discrimination and division in society. The announcement by a Chinese researcher that gene-edited twin girls have already been born has been condemned by scientists and ethicists around the world. [Read our report on this topic.](#)

Health and society



Cognitive and moral enhancement

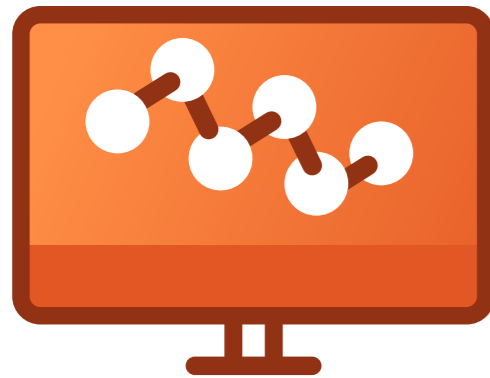
New drugs and techniques, such as transcranial magnetic stimulation, that might enhance cognitive function are being explored in a range of contexts, including education, military, employment and sport. Would this give some people an unfair advantage, and is this cheating or 'playing God'? Could and should we intervene in the biological bases of human motivation, using drugs, genetic selection or neurotechnologies, to enhance our sense of morality? Some philosophers suggest that moral enhancement is necessary for tackling the major challenges facing society such as climate change.

Sports enhancement	Sporting performance can be improved through biomechanics, genetics, materials science, nutrition, pharmaceuticals, physiology, psychology, and surgery. Technology is advancing all the time. Where should the lines be drawn and where do responsibilities lie for the potential harmful effects and other consequences?
Treatments for biological ageing	Much effort is going into finding treatments that could delay biological ageing, thereby reducing the risk of age-related diseases and conditions. Clinical trials of drugs that target ageing are already underway. If effective interventions became available, these could have implications for health and lifespan, the economy, models of care, personal identity, and how people work and live later in life. Read about our current inquiry on the future of ageing.
Assisted dying	In the UK, assisting or encouraging another person to commit suicide is a criminal offence. There have been several attempts to liberalise the law to align with some European countries and states in the USA, but this has been met with resistance particularly from the medical profession. However, in 2019, the Royal College of Physicians adopted a neutral stance on assisted dying, having previously opposed it. MPs rejected an Assisted Dying Bill in 2015, but the issue is likely to return to Parliament in future.
Cryonic freezing after death	Cryogenic freezing of humans in an attempt to avoid permanent death is commercially available, but the likelihood of ever being revived is low. However, there is little regulatory oversight and, if revival was achieved, it would raise complex questions about the nature of consciousness and identity, and our understanding of the nature of death.
Experimental medical treatments	Patients, or parents and carers of patients, with limited options might wish to try experimental treatments despite uncertainties about safety and efficacy. Now that patients can easily find out about experimental treatments online, and crowdfund to pay for them if necessary, a key challenge will be respecting the interests and autonomy of patients while ensuring they are protected from harm. Read our briefing note on this topic.
Microbiome research	Research is exploring how the human microbiome - i.e. the microorganisms living in the body - can be manipulated for therapeutic benefit. Treatments already in use include faecal transplants and dietary supplements. Microbiome analysis can reveal information about a person's behaviour, and microbiome composition has been known to affect behaviour. Microbiome research and intervention raises questions about privacy and the nature of individual responsibility for health.
Epigenetics	Researchers are understanding more and more about epigenetics - changes in gene expression caused by environmental effects, such as diet, stress, smoking, and childhood trauma. These effects might begin in the womb. Epigenetics research could have applications in many areas of policy, such as public health, healthcare and early years intervention. As the science develops, ethical issues relating to intergenerational equity, medicalisation of social problems, and privacy will need attention.

Gender identity	Increasing recognition of people with non-traditional gender identities has spurred significant public debate about gender and biology, appropriate medical intervention, and social acceptance. What does this mean for gender restricted roles and activities, such as sporting competitions, and how should interventions that pause puberty or alter sexual characteristics be made available to children and adolescents? Read our background paper on this topic.
Xenotransplantation	Tools such as genome editing could, in future, lead to the production of organs that are safe for transplantation from animals to humans. This could help address shortages in organs for transplant and reduce or eliminate the need for human organ donation. However, using animals to create organs might not be acceptable to people for animal rights or ‘yuk factor’ reasons. Greater availability of organs might lower the threshold for transplantation, affecting incentives to live healthily.
Vaccination	In 2019, the World Health Organization declared that ‘vaccine hesitancy’ is one of the world’s top ten global health threats. The reasons for vaccine hesitancy involve the interplay of social, cultural and personal factors. Decisions about how to respond to it require consideration of how much weight should be given to individual rights versus the collective interest - can mandatory vaccine programmes be justified? Wider ethical questions around vaccination relate to research and development; equity of access (nationally and globally); and, where vaccines are in short supply, how access should be prioritised.
Secondary uses of genetic information	Healthcare institutions and companies that provide genetic testing services are collecting large amounts of personal genetic information that could be used for secondary purposes. Individuals might upload their genetic data to find out about parentage and donor conception. Genetic databases are commonly accessed by researchers, both in the public and private sectors, and genealogy databases have been accessed by the police in the US. Future uses are difficult to predict. There are questions about what kind of consent is required in these situations, how data should be controlled and used, and whether individuals should have a share in any profits made from its use.
Health screening	Whole populations are offered health screening at various life stages to identify those at risk of developing diseases such as cystic fibrosis and cancer. Early diagnosis can enable earlier intervention, and reduce morbidity and mortality. At an individual level, ethical issues centre around questions of informed consent and choice and the potential for harm through over-diagnosis, over-treatment, anxiety, stigma and false negatives. On a population level, the focus is on issues of resource allocation, fairness and equity of access. The potential for genomic sequencing to be utilised in more screening programmes in future raises particular questions about what results and information should be returned or withheld, how much uncertainty people are willing to accept, and whether the purpose of screening should expand beyond improving the health of the screened individual to benefiting the person’s family, the NHS and wider society.

Decision making in pandemics

The response to COVID-19 has highlighted the number of profound ethical challenges which can arise during a pandemic - not only for treatment decisions about individuals, but for population-level policy decisions. Approaches to containing the spread of the virus have involved significant infringements of individual liberty, and required governments to reach decisions based on trade-offs between a number of competing values and interests. Matters of equity and fairness have also arisen in relation to decisions about allocation of scarce resources and the development and distribution of treatments and vaccines. With similar pandemics likely to become a recurring feature of modern life, these questions will persist.



Data and technology

Artificial intelligence in healthcare

A wide range of applications of AI are being explored with considerable public and private investment and interest. AI is being used or trialled for detection and diagnosis of disease, management of chronic conditions, delivery of health services, and drug discovery. Ethical issues to consider include difficulties in validating the outputs of AI systems, and the inherent biases in the data used to train AI systems. [Read our briefing note on this topic.](#)

Robotics in healthcare

Robotic technologies have the potential to carry out administrative, caring, diagnostic, mobility, and surgical tasks within the healthcare setting. Robotic-assisted surgical systems have been approved by the FDA in the US, and the Japanese government is hoping robots will help meet the care needs of its ageing population.

Wearable technology

Wearable devices are starting to be used for monitoring and managing health conditions, with the aim of improving health and patient engagement. The use of these technologies in non-competent people and where power relationships between doctors and patients are imbalanced require careful consideration. Wearables manufacturers are collecting large amounts of data which could provide useful information about population health. However, this data is of a sensitive nature, and devices can be vulnerable to hacking.

Biohacking

Biohackers apply the hacker ethic to change or enhance the human body using, for example, devices and implants, gene editing, drugs and pathogens. The emphasis is on self-experimentation, creation, and modification of existing technology. Should biohackers be prevented from harming themselves, and do they pose a threat to national security?

Medical implants

Medical implants are used to replace body parts such as hips or knees, deliver medication such as pain relief, and monitor and regulate body functions such as heart rate. A new EU regulation to improve the safety of medical devices will be implemented in 2020, but concerns remain about transparency of the approval process and conflicts of interest in the system. Challenges for policy-makers include ensuring effective post-market surveillance of implants, promoting innovation that addresses patient need, and preparing for data and cybersecurity risks associated with connected implants.

Technology in social care

A wide range of technologies could play a role in social care contexts. Internet of things systems, assistive technologies, wearables and robotics could provide practical, social and emotional support to people at home, as well as monitoring and responding to user needs remotely. Automation and increasing reliance on technologies give rise to questions about the reliability and safety of these technologies, and about transparency and accountability if something were to go wrong. Concerns have been raised about the potential for a loss of human contact and whether technologies would help to address or exacerbate loneliness and social isolation.

Technology in mental healthcare

Apps and other technologies could lend themselves well to supporting people with mental health issues. They can offer immediate help, and some patients may prefer to discuss problems through a screen rather than face-to-face. Trust in the confidentiality of these conversations will be vital. Technologies such as virtual reality and computer games are being developed as potential treatments for people with psychosis, ADHD and anxiety. A controversial area of research is using machine learning to analyse speech or written communications to detect signs of mental health deterioration. There are concerns about stealth monitoring and the pathologising of normal behaviours.

Novel neurotechnologies

Technologies that intervene in the brain offer the potential to help many neurological conditions, like Parkinson's, stroke, and chronic pain. Although there are many possible benefits, the potential unintended consequences require careful consideration. The unique status of the brain as the organ of the mind raises ethical and social concerns around personal identity and autonomy, moral responsibility, and free will, which are not seen in the context of other biomedical technologies. The potential for non-therapeutic applications give rise to further questions about the ethics of cognitive enhancement and dual use, while the emergence of the field of "neurorights" calls for greater consideration of rights to cognitive liberty and mental privacy and integrity. [Read our in-depth report on novel neurotechnologies.](#)

Virtual and augmented reality in healthcare

VR and AR that emulate or modify perceptions of reality have a number of potential applications in healthcare, eg surgery assistance, pain management, psychotherapy, rehabilitation and training of healthcare professionals. Might this lead to an invasion of privacy if not used in controlled environments, and is there the danger that virtual environments could be too realistic, causing confusion between real and virtual worlds?

Identification biometrics

Future identification biometrics might include gait, voice, breath and heart rate recognition, with possible applications in criminal justice, security, healthcare, and commercial fields. Mirroring questions raised by the use of DNA, fingerprints and facial images, will these new biometrics be reliable, and how can they be used in a way that's proportionate to the aim of, e.g. solving crime?

Forensic DNA phenotyping

Predicting what someone will look like - their phenotype - from a sample of their DNA is still a fairly inaccurate science, limiting its use in criminal investigations. It is starting to be used in Europe to estimate biogeographical ancestry, eye colour and age. DNA photofitting is a more speculative area. However, as our understanding of genomics advances, DNA phenotyping is likely to become more precise, but its use is likely to raise concerns about racial bias and invasion of privacy.

Neuroscience and crime

Brain scans and the resulting neuroscientific data have a range of potential uses in the criminal justice system, for example assessing competency to stand trial, criminal culpability, witness credibility and the risk someone will commit a crime or reoffend, and for lie detection purposes. Even if the technology was proven to be reliable, it would raise a host of ethical issues relating to coercion to undergo scanning, the framing of criminal responsibility, and the possibility of new interventions for criminals being developed.

Dual use technologies

Many technologies can be used for both peaceful and hostile ends. This has always been part of violence between individuals and groups, especially in the context of warfare. Do some new technologies, such as synthetic biology and neurobiology, prompt particular concerns about dual use?

Bioengineering

Bioengineering refers to the application of engineering principles and techniques to biological processes and systems, including medicine, agriculture, and food. The concept is not new, but many potential future applications present new ethical challenges: for example, “bioelectronic medicine” (the use of implanted devices to read and modulate electrical activity in the body, for the purposes of diagnosis or treatment - or possibly enhancement); the use of 3D printing to create complete replicas of organs and cells; and the use of nano-materials for diagnostic or therapeutic purposes. Questions around human enhancement, identity, regulation and access, and the potential for dual use should be considered alongside research and development in this area.

Animals, food and environment**Meat alternatives**

There is growing interest and investment in plant-based and cultured meat alternatives that attempt to closely imitate meat produced from animals. The environmental profile of meat alternatives looks promising in some scenarios, but there is little independent evidence on the effects of large-scale production. Long-term studies are needed to assess the health implications of eating meat alternatives. The proportion of people willing to try plant-based and cultivated meat alternatives is increasing. The potential for meat alternatives to contribute to sustainable food systems should be considered within broader contexts and alongside a range of other potential solutions for achieving food sustainability. [Read our briefing note on this topic.](#)



De-extinction

Scientists are attempting to 'revive' extinct animals and plants in the lab. For example, genome editing techniques are being used to try to create a hybrid of a woolly mammoth and Asian elephant. If de-extinction become possible, how would species be selected, and would it really have a positive effect on today's ecosystems?

Biofuels

Some practices surrounding the use of biofuels might be harming the environment, for example the burning of wood pellets and deforestation for the supply of pellets and vegetable oil-based fuels. Also, energy policies relating to biofuels in wealthy countries could be having deleterious effects in poorer countries, and there is concern that climate change policies might be over-reliant on biofuel-using technologies.

Gene drives

Gene drives are systems that bias the inheritance of a particular DNA sequence. Animals populations can be altered or suppressed by allowing a mutation or foreign gene to spread quickly through a population. This has potential applications in the control of disease vectors such as mosquitos, rodent pests, and invasive species. If released into the wild, organisms carrying gene drives may be hard to contain. If the technique has low efficiency, it could leave time for species to evolve resistance. There are calls for a global moratorium on gene drives, but so far these have been resisted.

Genome editing in farmed animals

Genome editing could enable modifications to be made in farmed animals that have previously not been feasible. Researchers are exploring producing cattle without horns to prevent harm to other cattle and handlers, and making pigs and chickens resistant to certain diseases. Research to make animals more productive and tolerant to heat are also being explored. What would be the implications of these developments for animal welfare, product safety, and human health, and would meat and dairy products from genome edited animals ever be widely accepted by farmers and consumers? Which farmers would have access to these technologies? Will it be possible to scale this up to commercially viable levels? It is also important to ask where genome editing techniques sit within wider conversations about sustainable farming. Read about our current inquiry on this topic.

Animal research

The number of animals used in research continues to increase, largely due to the use of GM mice, and research trends are making research on larger animals more frequent and complex. Is it time to review the way in which research involving animals is being incentivised, carried out, regulated, replaced and shared?



Research ethics

Time limits on maintaining embryos in culture

UK law, set in 1990, states that human embryos cannot be kept or used for research for longer than 14 days. Recent research showed that it might now be possible to sustain embryos for longer, raising questions about whether the time limit should be extended. New entities, such as SHEEFS (synthetic human entities with embryo-like features), add to questions about the continuing relevance of the law.

Participant-led research

Research activities led by patients or volunteers, rather than professional researchers, are increasing in popularity. Research that is controlled by participants challenges the whole basis for traditional research ethics, which focuses on protecting participants from exploitation by researchers. Do traditional research ethics approaches need to adapt and change?

Equity in the development of medicines and therapies

There are concerns that the current system of medical research and development, particularly commercial R&D, does not benefit patients equitably and is unduly influenced by factors other than patient need, such as profit. Areas that might be influenced negatively include the prioritisation and funding of research, data availability, and drug licensing. Publication bias in relation to the suppression of negative findings could affect patient safety, and there might be unfair distribution of risks and benefits, particularly in the area of precision medicine.

Brain surrogates

Brain surrogates are being developed to facilitate research on human brain function. They include organoids grown from stem cells, preserved human brain slices, and human-animal chimeras. These new techniques might reduce the need for animal research, but raise questions about the nature of suffering, consciousness, humanness and death.

Fetal tissue research

Fetal tissue, resulting usually from elective terminations of pregnancy, is used in developmental genetics and medical research. The use of fetal tissue in research interacts with debates about the acceptability of abortion. There are questions about the status of a pre-viable fetus, and the ethics of not using tissue that could contribute to valuable research. In Sept 2018, the US Government announced it was discontinuing research using human fetal tissue. Ways of reducing the need to obtain fetal tissue, such as growing fetal cells in vitro, are in the early stages of development.

Research in global health emergencies

Research in global health emergencies, such as infectious disease outbreaks, natural disasters and conflict, unavoidably takes place in non-ideal circumstances characterised by disruption, uncertainty and great health need. This presents significant challenges for ethical decision-making and raises questions around balances of power between participating countries, the involvement of relevant stakeholders, seeking informed consent from research participants, the welfare of front-line workers, and the collection, storage and sharing of biological samples and data. Read our in-depth report on this topic. [Read our in-depth report on this topic.](#)

The culture of research

Aspects of the culture of research, such as high levels of competition and perceptions about how researchers are assessed for jobs and funding, has been found to encourage poor research practices and hinder the production of high quality science. Wellcome, a major funder of research, has stated publicly that the emphasis on excellence in the research system is stifling diverse thinking and positive behaviours. Wellcome and other key UK bodies are rethinking research culture, particularly within academic institutions. Less is known about how the culture of research in commercial environments affects research practices and outcomes, yet the business sector is responsible for the majority of R&D expenditure. [Read our report on this topic.](#)