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Five Technology Trends

EUROPEAN CENTER FOR DIGITAL COMPETITIVENESS
BY ESCP BUSINESS SCHOOL

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Contents

Introduction

The breakthroughs that made 2023 so exciting for entrepreneurs and investors are poised to transform our lives in the coming years.

The whitepaper offers a glimpse into five technology trends we believe will redefine the future. This research was compiled for you in collaboration with Professor Philip Meissner and the European Center for Digital Competitiveness at ESCP Business School in Berlin.

Immersive learning, accelerated by the COVID pandemic, integrates virtual reality technology to improve educational results while simultaneously addressing environmental concerns.

Sustainability is a thread running through these trends. Green hydrogen offers a viable alternative to fossil fuels and clean meat, produced via cellular farming, has a significantly lower environmental footprint compared to traditional farming methods.

Synthetic biology using tools like CRISPR gene editing has life-changing applications and has the potential to transform health care at the individual and population level.

Finally, satellite internet is poised to provide global connectivity without geographic limitations.
These innovations point to a more sustainable, interconnected and forward-thinking future.

Synthetic Biology

Reprogramming cells to reengineer and enhance living organisms

Application

Every day with our clients, we have the privilege to witness first-hand the profound impact that emerging technological trends can have on the world of entrepreneurship, as Joseph Najjar, Head of Specialist Solutions Group EMEA, states. In today's dynamic business world, staying attuned to these transformative forces is paramount for companies, their leadership, and those who allocate capital.

Synthetic biology is a field of science aimed at reengineering and enhancing living organisms. It is seen as having tremendous potential to disrupt and reshape the world over the next 20 years.[1] Synthetic biology's central enabler is CRISPR technology[2] – a cheap, easy and precise gene-editing tool.[3] This technology acts like a pair of genetic scissors that can be used to cut, add or replace DNA at specific locations.[4]

The rapid development of the COVID-19 vaccine, fueled by technological advances in chemistry, computation, and artificial intelligence,[5,6] is an example of the opportunities synthetic biology offers.[7]

Its applications are poised to transform the fields of medicine, agriculture, and energy.[8]

45 %

of global diseases could be addressed using synthetic biology.

Synthetic biology has the potential to eradicate life-threatening diseases, cure blindness,[9] and significantly extend human life expectancy.[10] In addition to enabling genetically personalized medicine[11], synthetic biology could aid in developing genetically superior offspring,[12] and producing individual human organs to solve the organ-donation crisis.[13]

In agriculture, synthetic biology could help eliminate pests, increase nutrients in produce and support the development of biofuels from algae.[14] It may also make a significant contribution to the biodiversity crisis by conserving endangered species or even bringing back extinct species.[15]

Market growth and drivers

The global synthetic biology market was valued at approximately USD 9.5 billion in 2021.[16] But given its immense application possibilities, the economic impact could reach USD 4 trillion per year over the next 10 to 20 years.[17] By 2030, McKinsey expects the biggest market share in CRISPR technology to be held by North America with Asia-Pacific in second place.[18]

The development timeline differs across sectors. In agriculture, genome-edited products are already commercially available.[19] In the healthcare sector, however, genome-edited products may not be available for several years.[20] Thus, more than half of immediate impact is expected to be in agriculture and other fields outside of healthcare.[21]

Synthetic biology's strong positive outlook is influenced by increased R&D funding, the high number of patent registrations for CRISPR-related technologies and recent significant capital investments.[22] The ongoing fight against chronic and infectious diseases as well as the global climate crisis has prompted governments to support more technology testing. In addition, several human tests are in the pipeline,[23] which could influence the development of the healthcare market.[24]

Opportunities

One out of every six deaths worldwide is caused by cancer.[25] In November 2022, the media reported that CRISPR had been used to alter immune cells so they would attack a person's tumor.[26] Reports like these suggest synthetic biology's huge potential for tackling the world's deadliest diseases.

CRISPR can specifically target the individual genes responsible for specific conditions, making treatment of unique illnesses possible and relatively inexpensive. Using CRISPR, patients with specific genetic markers could receive tailored treatments.[27]

The technology could significantly change medicine by shifting the focus from treatment to prevention. Diseases resulting from inherited genes could be predicted using algorithms to evaluate the tiniest variations in DNA; it could be possible to eradicate them even before a child is born.[28]

On the population health front, genetically engineered mosquitoes that cannot spread malaria appear to be a promising long-term effective step in the fight against this deadly virus.[29]

In the agriculture sector, gene editing can be used to boost the immunity and strength of livestock. After 50% of its pig herd succumbed to African swine fever in 2018, China started to develop virus- and weather-resistant pigs.[30,31]

Similarly, by changing the wheat genome so that it needs less water and fewer fertilizers,[32]synthetic biology can be used to improve sustainability in the agriculture sector and prevent food shortages.

Challenges

Biology self-replicates at scale.[33] Thus, any change made using synthetic biology will affect the natural ecosystem. Those changes might be permanent[34] and may lead to unexpected outcomes.[35]

This was the case in Brazil, where 450,000 genetically modified male mosquitoes were released in nature but were not expected to reach maturity. However, they are still reproducing five years later.[36]

In addition, global regulatory and ethical frameworks are not standardized and may hinder the development of synthetic biology applications. Some countries have more restrictive regulations than others[37] and this could lead to a global imbalance, with some regions lagging while others advance.

Low barriers to entry raise ethical concerns, as well as the risk that cheap and accessible CRISPR tools can be misused.[38]

Synthetic biology could also lead to deeper global divisions and inequality. Currently, 92% of the gene-editing market is divided between three key players: North America, Europe, and the Asia Pacific region.[39] Estimates suggest that unequal access to opportunities in this field would translate to a 70% reduction in diseases in high-income countries, but only a 30% reduction in disease globally.[40]

Finally, if the focus of synthetic biology shifts from the prevention of illnesses to the modification and enhancement of human beings, we could see a global genetic divide, increasing ethical concerns.[41]

Green Hydrogen

Producing hydrogen using renewable energy sources that can be used to decarbonize industrial production

Application

Green hydrogen is a topic that frequently features in our discussions, Hanns-Christian Ehret, Head Business Development EMEA, explains. Entrepreneurs in this sector are poised to redefine the energy landscape, helping disrupt conventional fossil fuels and spearheading innovation in energy storage and transportation. Many of the investors we interact with are keen to support ventures that drive this transformation.

Green hydrogen is produced by electrolysis, using renewable energy sources to split water into oxygen and hydrogen.[42] Currently, only 1% of overall hydrogen production is green. Traditional hydrogen production, which uses natural gas and fossil fuels, dominates, creating about 830 million tons of CO_2 emissions annually.[43] That's the equivalent of the CO_2 production of the United Kingdom and Italy combined.[44] Green hydrogen has the potential to become the new standard for a sustainable global energy supply.

With current technologies, it's impossible to electrify or replace fossil-based fuels in sectors such as the chemical, iron, steel, aviation, and shipping industries,[45] which together account for 31.9% of global emissions.[46] Green hydrogen, with its versatile use cases, could be the key to decarbonizing these industries.

> In Germany alone, green hydrogen has the potential to create **800,000** new jobs – equal to the number of jobs in the automobile sector.

Market growth and drivers

Global hydrogen demand was estimated at 87 million metric tons in 2020, of which just 1% was green hydrogen. However, that figure could reach 85% by 2050.[47] By 2030, green hydrogen is expected to reach competitiveness with other energy sources[48] and account for more than 15% of the global energy mix.[49,50]

Since the COVID-19 pandemic, governments have injected significant green recovery funds into the global economy.[51] From 2020 to 2021, the number of green hydrogen projects tripled, primarily in Europe and Australia.[52] More than 40 countries have established national green hydrogen strategies; as of December 2022, 680 green hydrogen projects are in the global pipeline totalling more than USD 240 billion in investments.[53]

At the same time, carbon pricing initiatives penalize the use of carbon-intensive energy. Currently, the average carbon tax is USD 2 per metric ton. However, according to the UN Global Compact, carbon taxes of at least USD 100 per metric ton are needed.[54]

Countries such as Sweden and Switzerland are meeting these minimum carbon tax requirements and more countries are moving in this direction. These taxes incentivize investment in green hydrogen production projects.

Opportunities

Green hydrogen offers the most promising opportunity to decarbonize current production while providing a low-cost renewable energy source for the future. Over 130 countries have committed to achieving net zero emissions by 2050, covering 89% of global greenhouse gas emissions.[55]

Initiatives such as electrification, energy efficiency, and the use of other renewable technologies support this goal. However, electrification is difficult and costly in heavy industries, advancing the case for green hydrogen. By replacing fossil-based fuels with green hydrogen in the heavy and commercial industries, green hydrogen can reduce global CO_2 emissions by 25%.[56]

Green hydrogen production technologies present other opportunities for innovation, too. Heliogen, for example, has developed solar reflectors that concentrate sunlight, creating the high temperatures needed for green hydrogen production.

Green hydrogen is more versatile as an energy source, pointing to much broader use cases. Notably, green hydrogen is suitable as a carrier for renewable energy due to its higher density, which can extend the transportation distance and the length of storage.[57] Green hydrogen can also be used in the production of green ammonia and methanol – the most important components in chemical agents and feedstock.[58]

Because it's suitable for extremely high temperatures, green hydrogen is expected to have a significant impact on the production of plastics and steel, and as a replacement for coal in iron production. In the future, green hydrogen is expected to become a low-cost, low-carbon alternative to gas, presenting a potential solution to the global heating crisis.

Some sectors, such as shipping and aviation, have limited options for low-carbon fuel. Green ammonia could represent a unique and important eco-friendly alternative, positioning green hydrogen to gain a 32% share of the aviation fuel market by 2050.[59]

Globally, the rise in green hydrogen demand could lead to the development of new energy hubs similar to those currently seen for oil and gas. Given the current renewable energy infrastructure, countries such as Australia, the US, Canada and China are expected to become key global energy players.[60] However, other countries are also recognizing the potential of green hydrogen exports and investing heavily in the development of new plants. Saudi Arabia, for example, has invested USD 5 billion in a new green hydrogen plant to be completed by 2026.[61]

Challenges

Production costs presented the biggest obstacle to scaling green hydrogen over the past ten years. Today, green hydrogen production is 4-8 times more expensive than the production of the liquid natural gas used in shipping.[62]

However, prices for green hydrogen are expected to be competitive with fossil-based hydrogen by 2030, based on the dramatic decrease in renewable energy costs over the past five years,[63] as well as falling production costs due to experience-curve effects. By 2050, green hydrogen may be the cheapest energy source across most global locations.[64]

Cross-national cooperation could accelerate the price decrease. For example, Green Hydrogen Catapult, a global coalition of leading green hydrogen organizations, has announced a goal for the price of green hydrogen to be equivalent to the price of conventional hydrogen by 2025.[65]

Production sites and infrastructure present the core challenges to scaling green hydrogen. At the moment, only 4,500 kilometres of the pipeline needed to transport large quantities of green hydrogen are available. By contrast, Germany alone has 40,000 kilometres of natural gas pipelines.

Green hydrogen can only reach its predicted growth if the supply chain is improved, and potential bottlenecks are removed. By 2025, 40 large distribution pipeline clusters for green hydrogen are needed globally.[66] Japan and other countries are developing capabilities to repurpose gas pipeline infrastructure for green hydrogen to reduce the need for additional infrastructure investments.[67] To address the need for additional infrastructure between renewable energy and green hydrogen plants, countries like Spain are establishing solar and hydrogen plants in a single location.[68]

Regulations that do not support – or even restrict – the development of green hydrogen present a major barrier to the large-scale rollout of green hydrogen projects around the world. Some studies suggest that, globally, only 20% of the policies necessary to enable green hydrogen production have been introduced.[69]

In addition, estimates suggest that scaling green hydrogen to meet global environmental goals would require annual investments of USD 400 billion in the coming years.[70]

Developing experiential teaching methodologies using augmented, virtual, mixed or extended reality technologies to simulate real-life scenarios

Application

In our dialogue with clients, immersive education often surfaces as a transformative force in knowledge dissemination. Joseph Najjar points out that visionary entrepreneurs pioneering virtual and augmented reality-based learning platforms are reimagining education, and the astute investors we cover are well aware of the potential to democratize access to quality learning experiences.

Immersive education is an experiential teaching and training method that uses technology to simulate real-life scenarios to train people in an engaging and safe environment.[71] The main technologies in immersive education include augmented reality (AR), virtual reality (VR),[72] mixed reality (MR) and extended reality (XR), which combines all the previously mentioned technologies.[73]

Experts have long observed limitations in traditional learning methods, such as a lack of efficiency and adaptability, low engagement, and static learning speed. Immersion has the potential to overcome these limitations. The central benefits lie in the increased engagement and accelerated speed of learning, which translate to higher effectiveness overall.[74]

Studies show that individuals who participate in immersive learning are four times more engaged with the content than conventional classroom learners,[75] due in part to the substantial reduction of the time needed for learning and training. Immersive education takes just 5% of the time needed for traditional learning.[76]

Immersive education helps educators push the boundaries of conventional teaching. It eliminates time restrictions, allowing students to experience events that occurred in the past. It also enables learners to explore locations that would otherwise be difficult to reach. For example, US-based Immersive Technologies has partnered with Arizona State University to use VR technology in introductory biology classes, creating an immersive virtual setting called the "alien zoo".

Immersive education can help minimize the risks associated with dangerous conditions, such as catastrophe scenarios and ethical problems.[77] Even better, there are significant cost reductions[78] with immersive education, as well as improved analytics to track students' progress.[79]

Immersive technologies are already being used in fields such as arts and entertainment, gaming, and medical training. Given their versatility, immersive teaching methods work in a wide variety of educational environments, from elementary schools and higher education at colleges and universities to vocational training and extracurricular daily learning such as driving instruction.[80,81]

> Immersive education leads to **75%** learning retention, compared to **10%** from reading and **5%** from in-person lectures.

Market growth and drivers

The COVID-19 pandemic helped drive awareness and acceptance of digital-learning options, accelerating the demand for remote or hybrid solutions. The immersive education market was estimated at USD 8.7 billion in 2022, representing a 36% increase year over year. This expansion is expected to gain strength over the medium term, resulting in an estimated market size of around USD 33 billion by 2026, at a CAGR of approximately 40%.[82]

The digital transformation has also impacted the skill requirements for the workforce of the future.[83] Researchers believe that 35% of the top skills needed in the labor market will change in the short term.[84] The need for innovative education solutions for employee upskilling and reskilling is an additional driver of growth.[85]

Hardware improvements, cloud-based content delivery, improved data storage and network infrastructure enhancements all contribute to the demand for immersive technologies.[86] These changes not only enabled substantial improvement in immersive technology products, but they also led to a reduction in prices, making them accessible to a wider audience.

The hardware segment of the immersive technologies market is relatively consolidated. In the first half of 2022, nearly 99% of the market was held by three solutions: Meta's Oculus line, ByteDance's Pico, and the HTC Vive.[87]

The software landscape, on the other hand, is still highly dispersed.[88] A large number of small players caters to different application areas and requirements, such as comprehensive learning ecosystems, dedicated immersive teaching content, and development tools and platforms.

Opportunities

Education has undergone a remarkable "techceleration" since 2020, driven largely by the COVID-19 pandemic and supportive governmental measures.[89] Consequently, the infrastructure changes needed for advanced immersive solutions have largely been undertaken, paving the way for accelerated adoption.

In addition, several trends and developments could fuel the sector's further growth in the medium term. Sustainability is one overarching trend impacting the adoption of immersive learning. Due to its digital and interactive nature, immersive learning mitigates traditional education's ecological footprint in several ways – eliminating the need for printed learning materials and reducing the need to travel to classrooms, to name just two. The increased political focus on climate change means that all sectors will be required to contribute to carbon-reduction targets. Educational methods that offer emission-reduction potential are likely to be in demand.

Personalization, specifically personalized learning, is another trend shaping the education landscape.[90] In recent years, demand has risen for more tailored educational approaches that break away from traditional one-size-fits-all teaching methods. Immersive teaching content can accommodate a much larger range of topics, and it is endlessly adjustable based on the learner's interests, capabilities, and progress. Today's immersive solutions are designed to enable a comprehensive hybrid approach that supports learners, teachers, and coaches.

Challenges

Several technical components in the immersive interface still do not allow for a fully engaging and effective learning experience. These include graphics deficiencies, latency issues due to insufficient GPU power or internet connection speeds, and lagging sensor, camera, and lens technologies. While there has been substantial progress in some of these areas, market observers suggest the technology might not be mature enough to convincingly emulate real-life scenarios and deliver on its intended objectives.

Another tech-related challenge is the slow pace of digitization in the education sector.[91] However, the accelerated digitization during the pandemic suggests this may be a thing of the past.

Finally, cost may present a high barrier to entry, at least compared to more conventional education methods such as textbooks and standard online courses. However, given the current immaturity of the immersive education industry, economies of scale should significantly drive down costs in the short term, improving accessibility to the required hardware.

Satellite Internet

Providing wireless internet through communication satellites

Application

From an entrepreneurship perspective, this trend presents very significant opportunities that many are eager to seize. Entrepreneurs are creating disruptive companies that are redefining entire industries. Hanns-Christian Ehret emphasizes that incumbent company leaders must remain agile to adapt to these transformative shifts or risk obsolescence.

Today, the Internet runs primarily through submarine and subterranean cables that transfer data through wires. This terrestrial infrastructure isn't capable of providing reliable internet to many rural areas. In Africa, for example, more than half of the population has no internet access. Satellite internet provides a solution to connect them.

Satellite internet service relies on communication between satellites in space and on the ground, complementing or potentially even completely replacing the terrestrial infrastructure.[92]

Satellites can establish internet in different orbits, such as the geostationary orbit (GEO), with an altitude of approximately 35,800 kilometers; the medium Earth orbit (MEO), with an altitude of 10,000 to 20,000 kilometers; and the low Earth orbit (LEO) at a height of 160 to 1,600 kilometers. Depending on the altitude, the latency and the area that can be covered with internet access varies.[93] Satellite internet is typically provided through constellations of satellites.[94]

Energy and utilities, oil and gas, agriculture and the military are all examples of industries in which terrestrial infrastructure is often suboptimal. Companies operating in these industries could benefit from uninterrupted communications through satellite internet.[95] Satellite internet could also play an essential role in humanitarian and natural disasters.[96] Consider for example the use of the Starlink satellite internet in Ukraine after the Russian invasion disrupted the terrestrial internet.

40 %

of all people worldwide do not have internet access.

Market growth and drivers

Revenue in the global space economy reached USD 386 billion in 2021. Fully 72% of it was generated by the commercial satellite industry, which consists of communications, broadband internet, direct-to-home television, radio, and image/mapping services.[97]

In 2021, the value of the satellite internet market was USD 71.6 billion. It is expected to grow at a CAGR of 9.5% until 2030, at which point its value will exceed USD 145 billion.[98]

Demand for satellite internet is driven in part by the rapidly increasing speed and data volume. Access requires only installation of a satellite dish, which is far less complex and costly compared to expanding the terrestrial infrastructure. In markets such as Latin America, the Middle East, Africa, and Asia, it is almost impossible for providers to guarantee sufficient internet coverage.[99] The emerging demand for satellite solutions in these countries is a major market driver.

Military and government institutions are another important driver of demand. These institutions are currently using commercial satellite technology for military communication networks and to eliminate gaps in high-speed internet service.[100] The European Union's Iris,2 a satellite network for Europe, aims to make Europe independent of private companies or third countries.[101]

The implementation of 5G is another factor accelerating growth in the satellite internet market. Compared to earlier generations, 5G dramatically increases data speeds, reduces latency and improves network capacity, enabling new applications and services such as self-driving cars, AR and VR, and the Internet of Things (IoT).[102] To reach their full potential, these applications require constant internet connectivity of the type satellite internet can provide.

The logistics sector is already using satellite internet for intelligent transport systems. These systems use the IoT to constantly monitor logistics processes, such as the routes and progress of trucks, even in rural areas.[103]

Opportunities

Connecting satellite internet with terrestrial infrastructure opens up major market opportunities. With the help of satellite internet, it will be possible to create a stable 5G mobile network on land, air, and water. A seamless, worldwide internet connection could enable applications such as autonomous driving and telemedicine.[104]It could be used to connect sensors in mines or other remote workplaces to the IoT, for example.[105]

Satellite internet not only supports technological development, it's also a reliable and cost-effective solution for countries with poor internet access. Satellite internet is often more reliable than terrestrial broadband and can be used to provide access to services such as e-commerce, telemedicine, and remote education. As the technology becomes more affordable, it presents a viable option for countries with limited or no access to terrestrial broadband infrastructure.[106]

Related product innovation is also exploding. For example, in 2020, a Japanese company developed a tiny 3 mm transceiver capable of communicating with satellites 22,000 meters above the Earth's atmosphere.[107] Innovation is expected to steadily increase the speed of satellite internet from 20 Tbps today to 60 Tbps by 2030.[108]

Challenges

Cost is one of the biggest challenges for the satellite internet market. The cost of internet access through traditional terrestrial infrastructure is USD 1-3 per megabit per second per month. By comparison, the price of one month of satellite internet is USD 200-400. The main reason for the high price is the cost of launching satellites. However, the development of reusable rockets like those used by SpaceX has already significantly lowered these costs. With further innovations, satellite launch costs could drop by 90%, which should lower the price per month for consumers.[109]

Another problem with satellite internet is latency – the time it takes for data to travel from its origin to its destination. The greater the distance between a satellite and Earth, the more time it takes the data to travel. This is why LEO satellites are in high demand. However, the closer a satellite is to Earth, the less internet coverage area it can provide. To keep latency low, more LEO satellites would be needed to cover the same area, which in turn generates higher installation costs.[110]

Moreover, launching an increasing number of satellites into space, especially in low orbit, inevitably increases the density of objects in orbit. This raises the probability of collisions and increases the creation of space debris. For example, in September 2019, the European Space Agency had to move a satellite because of the potential for a collision with a Starlink satellite.[111]

In addition, astronomers around the world are worried that the increasing number of LEO satellites will disrupt their ability to observe the night sky. These satellites create streaks of light that can block up to 40% of observations made from ground-level observatories at dawn or twilight. Starlink is working with scientists to address this problem by changing the way the satellites fly.[112]

Clean Meat

Producing meat from the stem cells of animals

Application

Clean meat is another recurring topic in many of our client discussions, given the broad focus on the evolution of food systems by governments, environmentalists, entrepreneurs, and the general public, Joseph Najjar explains. We featured several clean meat companies at our client events, like the Private Innovation Circle. This is a tangible and topical theme, with products starting to become available for consumption.

Rapid population growth is driving demand for meat. The OECD expects a 14% increase in global meat protein consumption over the next 10 years.[113] However, supply shortages make it difficult to meet this demand. Diseases such as bird flu and swine fever, as well as the transmission of viruses during the refrigeration chain are further challenging the global meat supply.[114]

The ecological footprint of traditional meat production also poses challenges, with 80% of agricultural land worldwide used for livestock, which only produce 20% of the calories consumed. Concerns about environmental damage and animal ethics are also on the rise.[115]

Clean meat, which is also called in-vitro meat or cultivated meat, offers an innovative solution to these challenges. Clean meat is produced using tissue engineering and cellular farming techniques. Unlike soy and other meat alternatives, clean meat is actual meat and contains key nutrients humans need, such as vitamin B12, omega-3 fatty acids, protein, and iron.[116]

In the clean meat production process, manufacturers extract muscle tissue to develop stem cells which are then used to grow muscle fibers. These fibers can be used to create ground meat products or stretched on scaffolds to simulate structured meat products like steak or chicken breast.

Clean meat has the potential to transform the food and feed industry. Clean meat has many of the same benefits of its traditional counterpart but without the ethical and environmental challenges.[117] A life-cycle analysis shows that clean meat could cut greenhouse gas emissions by 78-96% compared to conventional meat.[118] Also, replacing traditional meat with clean meat could reduce land use by 99%, with a corresponding reduction in water use of 82-96%.[119]

> Clean meat requires **99%** less land and **96%** less water than traditional animal agriculture.

Market growth and drivers

The market for clean meat is still in its infancy. In 2016, only about 10 companies were involved in clean meat production.[120] However, as the concept has advanced, the market has grown significantly. The value of the global cultured meat market is expected to reach USD 25 billion before 2030.[121]

Currently, there are clean meat products for poultry, beef, pork, duck, and seafood. Of these, pork is the most developed and has the highest nutritional value.[122] North America has been the largest market so far, with a share of revenue of more than 35% in 2021. Asia-Pacific is expected to reach the highest CAGR of 12.1% by 2028 due to the increasing demand for poultry in emerging markets such as China and India.[123]

New clean meat start-ups are continually entering the field. The market is diversifying and a B2B branch is emerging to make manufacturing more efficient and products more scalable. Singapore is the current market pioneer, becoming the first country to approve lab-grown meat at the end of 2020.[124] While clean meat is not yet approved in Europe, 40% of all companies involved in the clean meat market come from that continent, closely followed by North America with 35%.[125]

Opportunities

The reduced public health risk is a significant benefit of clean meat. Increasing antibiotic resistance among humans is a major concern today and farm animals are fed large amounts of antibiotics to prevent disease. When humans eat meat from these animals, they ingest unnecessarily high amounts of antibiotics. Clean meat does not contain any antibiotics, potentially lowering the risk of antibiotic resistance in humans.[126] Moreover, the likelihood of developing animal-transmitted illnesses is reduced.

Clean meat holds new potential for farmers because the bioreactors needed to produce it can be built in different sizes and set up anywhere. A decentralized production system distributed among various farms enables the creation of local clean meat variations and meets the demand for micro-individual niche products.[127]

The downward cost trend for clean meat leads to positive market expectations. A burger made from cultivated meat cost more than USD 330,000 in 2013,[128] but today, the production price for a chicken breast is less than USD 2.[129] Clean meat is poised to scale, given the sharp reduction in production costs. Researchers estimate that clean meat will be cost-competitive with most traditional types of meat by 2030.[130]

Challenges

Clean meat still faces some challenges. The most significant hurdle is obtaining regulatory approval worldwide. In 2020, Singapore became the first country to allow lab-grown meat.[131] In Europe, foods from cell and tissue cultures fall under the Novel Food Regulation and are therefore currently not permitted.[132]

Another obstacle is consumers' unwillingness to buy and eat this type of meat. According to one study, consumers are concerned about the perceived unnaturalness of clean meat: Only 31.5% were willing to replace conventional meat with lab-grown meat.[133]

Plant-based meat is clean meat’s biggest competitor. Plant-based meat is perceived as more natural and has no perceived associated health concerns. The challenge is to convince consumers that clean meat is just as natural as plant-based meat with the added advantage of offering the same nutrients found in traditionally grown meat.[134]

According to the Good Food Institute, alternative meat producers will need to invest USD 27 billion and build 800 manufacturing facilities over the next ten years to reach an estimated 6% share in the global meat and seafood market.[135] Along with these high investment needs, scientific challenges make scaling difficult. Current methods of production must be adapted for large-scale production, especially regarding the size of the bioreactors, the speed of growth and the storage of the cell lines. Developing the frames and scaffolds needed to produce different cuts of meat are also necessary for large-scale production.[136]

Conclusion

This brief glimpse into the worlds of the five technology trends we have identified – synthetic biology, green hydrogen, immersive education, satellite internet, and clean meat – provides a solid basis for further discussion.

Disruption is a major theme in the tech trends of the future. Most of the new technologies will require very significant amounts of capital to reach scale and commercialization. Investors play a pivotal role in identifying and nurturing ventures that embody these trends, capitalizing on the potential for substantial returns and positive societal impact.

As we continue to engage in conversations with our clients, it becomes clear that embracing these trends and their transformative potential is no longer an option but a necessity. These tech trends hold enormous potential for solving challenges and opening new opportunities to redefine entire industries.

Endnotes

The European Center for Digital Competitiveness was founded at ESCP Business School in Berlin with the goal of bringing digital competitiveness to the political and public debate, where it currently only plays a minor role.

Given the digital revolution that our economy and society currently face, digital competitiveness must take center stage in debates to secure our prosperity for the future.

Similarly, in this increasingly dynamic environment we want to support the initiative to position Europe as a global leader for the responsible application of technology for the benefit of society.

Synthetic Biology

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