

# **Biotechnology and its impact on medicine and computer sciences**

## **Contributed by: -**

**Rohan Arya 20086377**

**Dennis Kolomiyets 20250762**

**Konan Heney 20242603**

**Jai 20045247**

**Timothy Hannon 20276028**

When we talk about biotechnology, we refer to that specific branch of medication that uses living cells and cell materials to research, so produce pharmaceutical and diagnosing agents. [1] It is with the help of these artificially synthesized products and agents that we can help treat and stop diseases. Ranging from the production of vaccines all the way to the mapping of Human DNA, biotechnology has enabled us humans to make massive advancements in the world of scientific research and development while simultaneously helping people. [1]

The very example of the recent and ongoing events of Covid-19 Coronavirus, and many others as well, have had used the vast applications of Biotechnology like genetic testing, drug treatments, artificial tissue growth, and many more. [2] From the very serious and concerning health diseases like Cancer which also provides a vast platform for research, to the industrial sectors that deal with fuel economy and energy generation, biotechnology has offered many promising avenues and has the potential to not only help us but for us to facilitate evolution. [2]

With this exponential growth of the Biotechnology sector, the evolved Sciences may even give us the power to heal people with one touch. Although, at first, that sounds very good to

be true, but as we dig deeper in the realms of Biological Sciences and the ever-expanding world of technology, we may just come across the perfect solution to achieve those results. Call it a dream come true! For example, Tissue Nanotransfection Technology (TNT) is a sophisticated process that works by injecting certain medicinal synthesized chemicals into the skin cells, which then turns those skin cells into opposite varieties of cells required for curing diseases. [1] In certain lab experiments, only one dose of TNT was able to completely repair the injured and severed legs of mice over a short span of just a few weeks by turning those skin cells into vascular cells. [3] Reportedly, these types of Biotechnology can work on other cells as well, besides the skin cells. The potential of such Biotechnology is huge. From helping injured soldiers in the military to people who suffered through the most brutal accidents. Medical biotechnology has enabled the possibility of such advancement and also the continued research and development of this technology will only result in its improvement that will lead to Hospitals and Medical Centres adopting it.[3]

Biotechnology is also synonymous with genetic engineering in some particular cases as certain genes of the living organisms can be changed through its process by recombining the DNA of these organisms. [1] The process of recombinant DNA technology is combining DNA molecules from different species altogether, and consequently inserting that DNA into other living organisms. This results in the host organism producing new genetic combinations for medicine, agriculture, and industry. [4] There are multiple samples of recombinant DNA technology being utilized, from biopharmaceuticals and diagnostics to energy applications like biofuel, and agricultural biotechnology that helped us produce modified fruits and vegetables. [4] Genetically modified products perform much better than regular medicines and produce. This is because recombinant DNA is often more, resistant, efficient and sophisticated. Like Recombinant agriculture has more pest-resistant as well as weather-resistant qualities. Recombinant medicines such as insulin have given better results in reacting in the animal and human body. Due to the extensive benefits of synthesized desoxyribonucleic acid (DNA), for a variety of range of products, there is a positive notion about the future and growth of biosciences in various industries, both quantitative and qualitative.

These days, the trend of Genetic and ancestry kits has grasped on to people's emotions and curiosity, which has helped people understand their genetics and heritage. While there is massive improvement and advancement in this field of biotechnology, this fast-growing and powerful ever-expanding sector has also led to some serious concerns and issues being risen. This field of medicine has always been a topic of volatility and controversies, with several clinical and scientific issues being taken into question.

One of the biggest risks and concerns in the field of Biotechnology happens to be that of Clinical Trials. As the technology is new and still under development, people are often reluctant and scared to use the products offered by this sector. There have been certain incidents where people have gotten hurt or have been in situations where they could've been the victims of fatal accidents as well. [5] It is due to this volatile nature of Biotechnology and the risks that come along with it that it is a must that, extensive research and experimental trials should be performed before selling the products in the open market. People who take part in the entire process should be highly attentive throughout, and this applies to both the persons performing the trial and the one who happens to be the subject. The problems arise in the case of the inevitable paradox where the sick get desperate and fall victim to the irresistible need to get cured. [5] This also creates pressures on the doctors and the researchers carrying out the trials, which often results catastrophically. Due to this, the doctors and researchers have a major ethical responsibility to give precise advice to the patients and guide them throughout and eventually respect their terminal decision.

While medical biotechnology has vast potential to form drugs additional economical and straightforward, what is the cost? This technology is usually massively pricey compared to ancient treatments. [1] The concern is that this particular technology would become inaccessible to a section of society – and a class distinction due to said inaccessibility would become unavoidable. Privacy then also becomes a major concern in this entire process. Reading someone else's DNA can be a major privacy breach. As medical biotechnology continues to advance the flexibleness to browse genes, insurance firms, doctors, and governments can have to be compelled to come up with new programs and privacy techniques to match all the new wants which will arise.

One of the most important factors that a nation's leader has to consider is the safety of her/his people. As biotech advances in the medical field, the increasing need to keep people safe from bioterrorism becomes apparent. The flipside of this problem is that essential funding that is provided to find the cure of known diseases and conditions is thwarted into something else altogether, giving rise to the important question of distribution of resources. [1] But even so, it's not like bioterrorism isn't a point of concern. You can't not spend money on it either since it exists as a legitimate fear in people's minds.

Unfortunately, it doesn't really stop there. Wherever there is biotechnology, questions of ethics and morals always follow suit. It has been observed that in the medical work field, nurses have the most important impact on biotechnology. [1] This is due to the simple reason that they bring in the human element to the field that exists for taking better care of people. Their direct contact with other people – their patients, makes them more knowledgeable of the direct effects of treatments on people.

An overview of the advantages of biotech in other fields, which have also been discussed in detail further on, leads us to some of the following examples. In the agriculture industry, microbes have been used for the preservation of several food products. Modern biotech helps in overcoming severe diseases, improving environmental conditions developing cleaner energy resources and industrial processes. In the medical industry – identification and reduction of life-threatening conditions and serious side effects. Environmental advantages: simplifies chemical manufacturing, reduces pollution by providing greener, cleaner alternatives to producing energy.

### **Biotechnology and the economy**

Biotechnology is a large sector of the specific sciences that have and will naturally affect the economy. Like all other studies, biotech will contribute its findings to benefit itself and the market. Like the steam engine, invented at the closure of the 17th century, who's economists or lords at the time wouldn't know its future significance or with the harnessing of nature's fury in the form of electricity in the centuries to come, biotechnology ends up being one of those "new" forms of technology where no one can predict where it will take us even in the

next five to ten years. [6] Our agrarian ancestors who lived off the land, would not believe the progress made in the area of agriculture. Where they would farm for themselves and there might have been a possibility that they could've grown enough to sell at the market to earn themselves some spare change. Now, in the first world, we have so much food that most of it can be seen going to waste. This of course has come about because of our gradual understanding of farming, but also from say as an example of new vaccines that have come about for healthier livestock. Which in turn means even more meat, as even just over 60 years ago, meat was considered a treat and was not consumed regularly by the working class. This has led to the price of "farmed, mass-produced" foods going down in price, meaning more people can buy more food and a possibility of more demand for said product.

An article from the "Federal Reserve Bank of Dallas" from 2002 says that biotechnology has affected the economy in two ways. They relate those two effects to a stone hitting the water. The immediate splash zone effects, such as a breakthrough leading to widespread use and more importantly profit, and also the ripple left from that immediate splash such as new biotech companies popping up around the area to produce and maybe discover more. These extra companies in turn create more jobs and aid its local economy and their own pockets. [6] The sound of jingling coins is enough to inspire interest in advancing this science and create a sustained focus on discovery and with that a sustainable growth in the expenditure in said discovery. Expenditure in medicine and healthcare has been steadily rising and especially in recent times, where money is constantly being donated to fund research to one day end our global pandemic. It may even be what restarts our collapsed economy and give it a spark of life.

Life Science as a proper industry has only been around for maybe half a century at this point, where we use life to "improve human quality" for the betterment of all, we use each other and better this industry. From crowdsourcing to private investment "catalyze interest in this sector". To paraphrase the quote, "Like how trade between nations takes place to gain from each other, just like how public entities are key in industrial growth". It might be too early to tell of the scientific impact that biotechnology will have on all of us. Biotechnologies' effects on the economy have been recognized 20 years ago and are still growing to this day.

## **Biotechnology in the area of computer and I.T.**

Biotechnology like any modern form of scientific study relies on computers to store information, whether regarding tests or experiments you cannot deny that modern biotechnology benefits from progression in computer science about as much as mechanical engineering can. [7] Though in terms of development computer scientists end up at the data collecting and analyzing stages. But this is not true for all. As an example: in a scientific paper titled “Computer Modeling in Biotechnology, a Partner in Development” created by a group of eleven people in the University of Illinois at Urbana-Champaign, they explain in great detail how, as the title suggests, Computer Modelling specifically can help in the production of biotechnical research and eventually, medical products. In particular, the area titled “Building atomic-scale models of inorganic nanodevices”, can easily be seen as having massive potential in the area of medicine and healthcare. They say that to create inorganic models needed for all-atom simulations of nano bio-devices, they use a method of building atomic structures that can be used with existing molecular devices. [7] The nanostructures are built using a set of common operations that include replication and duplication of an inorganic unit cell, shaping the needed nanodevice, and targeting the connectivity of the inorganic atoms. Now how does this tie in with computers? Well in the same study they then mention how they’ve been able to model all of this in a VMD (Visual Molecular Dynamics) as a plugin where they can build and simulate nanodevice structures. This “Inorganic Structure Builder” plugin can generate molecular structures for common inorganic materials such as Si (Silicon), SiO<sub>2</sub> (silicon dioxide), Si<sub>3</sub>N<sub>4</sub> (silicon nitrate), Au (gold), and graphite.[7]

They delve deeper into the intricate details of these processes such as the particular modeling of the crystalline structure of SiO<sub>2</sub> (silicon dioxide) and how the pH of the environment affects its formation and how the same applies to regular silicon. [7]

Another interesting take in this study was the use of nanodiscs for the study of membrane proteins. Membrane proteins for those who don’t know are a way for cells to interact with their exterior environment. They are directly responsible for the traversing of lipids and molecules across the cell’s membrane and are very important for human health. [7] They then go on about the complications of studying these proteins as they don’t tend to behave so well when outside of their intended habitat i.e. the body. This is where it gets interesting, and they bring computation into the mix. They use GC modeling normally. GC standing for “coarse-

grained” which allows them to use a longer timescale for measuring. They would then use tools such as VMD (Visual Molecular Dynamics) and NAMD (Nanoscale Molecular Dynamics) simulation software to enter data from the GC residue to create nanodisc models to simulate organic proteins. [7]

We do not pretend to understand all of this but what’s important to take away from these papers is how inter-connected computer science and medical biotechnology can be.

### **Biotechnology & Its Effects on Cancer and Other Diseases**

We often see diseases such as cancer or Ebola treated by a means of chemotherapy or immunization. However, this is not always the case. In the last number of years, we have been able to advance our understanding of a certain treatment, that is more effective than any of the traditional treatments.

One such field that we have started to use biotechnology in is cancer research. Biotechnology has helped researchers to understand cancer in various ways such as gene profiling, genome analysis, cell culture, culturing transgenic cell lines, and especially identification of new biomarkers for detection of risk and progression of cancer in patients. [8]

According to the Irish Cancer Society, each year in Ireland, 9,000 people lose their battle to cancer. That’s about 1 person every hour. Around the globe, that number is 9.6 million every year. Faced with an incredible need for innovation and change in oncology, biotech researchers around the world are painstakingly investigating new potential treatment modalities, from immunotherapies and small molecules that target specific mutations in tumour DNA, to genetically modified viruses that deliver cancer-fighting agents into cancer cells, and the development of flexible treatment platforms that can evolve to meet the needs of individual patients. [8]

Another example of where biotechnology intervened and made an impact was during the ebola outbreak in late 2013. [9] As we all know, the ebola epidemic began in December 2013 and lasted until around June 2016. The first outbreak began in West Africa and claimed more than 11,000 lives, with fears of it spreading around the globe and causing mass losses of lives, similar to the Covid-19 pandemic, except less widespread. [9] Ebola was eventually defeated with the aid of a vaccine. For years, scientists who studied Ebola, which belongs to a family of viruses called filoviruses, had given it their all into developing a working vaccine

for this disease that was now so rampant in a diminished area. [9] A small company called 'BioProtection Systems Corp', a spinoff of NewLink Genetics, which was a biotech company working on cancer vaccines offered to produce the vaccine for ebola. The deal fell through and instead was picked up by Merck. Merck agreed to pay NewLink \$50 million for the license. The deal was finally announced on Nov. 24, 2014. [9]

With the aid of biotechnology in the analysis of viruses and gene profiling, tests were conducted on small animals and were eventually successful enough to trial with humans. After a lot of vaccination trials and tests, the ebola outbreak ground to a halt in June of 2016 and has never reached the detrimental impact it had since that outbreak more than 7 years ago. [9]

### **Biotechnology in Ireland**

Ireland's interest in Biotechnology has risen over the last number of years. Some of the top universities to study biotechnology at include; the University of Limerick (UL), University College Dublin (UCD), National University of Ireland Galway (NUI Galway), University College Cork (UCC), and the Dundalk Institute of Technology (DIT). [10]

Roughly 20 years ago, Ireland had about 50 biopharma companies dotted throughout the country. In recent times, however, this number has risen to more than 300 companies. Ireland is home to 10 of the top 10 pharmaceutical companies in the world. Some well-known examples of these include; Pfizer, AstraZeneca, Abbott, GlaxoSmithKline (GSK), and Amgen. [11] What's even more impressive is that Ireland is also an HQ for Johnson & Johnson. They are very well known as the largest biotech company in the world and employ more than 125,000 in 60 countries all around the planet. [11] The Johnson & Johnson family of companies has been operating in Ireland for 80 years, with almost 3,000 employees across a network of locations including Johnson & Johnson Vision Care in Limerick, DePuy Synthes in Co Cork, and multiple Janssen operations in Cork and Dublin. [11]

Ireland's Life Sciences sector has grown rapidly from modest beginnings in the 1960s to reach global significance. Collaborative clusters in Pharmaceutical, Biotechnology, Medical Devices, and Diagnostics have been a key element behind this remarkable growth in a sector that accounts for 32% of GDP. The sector continues to develop and evolve. More recently Ireland has expanded its global hub beyond commercialisation to include innovation,



digitalisation, and next-generation technologies. Companies, research, and government link to create the Irish advanced manufacturing landscape.

Ireland has one of the youngest and most highly educated populations in Europe. This provides a rich and strong pool of talent for the sector, which continues to benefit from high levels of investment in third-level education and the growth of collaborative clusters. Manufacturing in biopharmaceuticals is a benchmark of Ireland's success in the health sector. This is constantly driving growth and Ireland has seen continued capital investment averaging at €1 billion per annum over the last 10 years.

In order to study Biotechnology in any of the Universities mentioned earlier, you need an average of 450 points in the Leaving Certificate exams to gain entry. [12] The role of biological processes in brewing, fermenting, and food production. Biotechnology dates back to the earliest days of agriculture where farmers selected the best crops to grow and cross-breed. Even yogurt is produced by biotechnology. It's also how waste and wastewater are processed. Biotech graduates have studied engineering, cell biology, and bioinformatics (which uses computer science, maths, statistics, and biology to analyze and interpret biological data).

Typically, the 4-year program gives graduates access to the latest industry innovations and advancements, teaching them skills needed to gain employment in the biotechnology, biopharmaceutical, diagnostics, and medical device industries in Ireland and abroad. [12] Innovative teaching methods are used in the program, including the use of social networking, game-based learning, industrial workshops, and visits to target industries and employers. We also recognize the importance of transferable skills such as data presentation, information-sourcing, and scientific-technical writing which allows students to broaden their employment possibilities. [13] The first year focuses on developing student's core scientific skills and building a foundation of knowledge in Biology, Chemistry, Physics, and Mathematics. Students are also introduced to the basics of Medical Biotechnology and its uses. [12] In the second year, students' knowledge and technical skills in the biological field are developed as the program progresses and they are introduced to areas such as Molecular Biology, Microbiology, and Medical Devices. [12] In their third year, students study cell culture and the medical device industry. There is also a work placement in either an industrial or a research setting at the end of year three. In the final year, the focus moves to the

biopharmaceutical industry and its role today. Students also complete a research project on a specific area of interest. [12]

### **Advantages of Biotechnology**

The term biotechnology is pretty self-explanatory – whatever technology that has been able to facilitate biology and its growth in all fields has been referred to as biotechnology. On a deeper level, the understanding of this term is that “harnessing cellular and bio-molecular processes” as a means to improve human life and provide a sustainable environment to all living things on Earth. [14]

The most noteworthy contribution of biotech has been to the medical industry – being the supplement to breakthrough discoveries of treating rare conditions and diseases. By extension, it has also been able to facilitate and teach humans to live a better life and lead a healthier lifestyle so as to reduce the negative ecological impact that mankind has had on the environment throughout the past years. [14] We’ve been able to organise means to generate energy in a cleaner and more efficient manner, making mass production and manufacturing a more sustainable process.

The idea behind biotech lies in harnessing what nature already provides us with. Through the progress made in various industries, using biotechnology as its crutch, we’ve been able to treat countless diseases and save lives, provide means of self-care that didn’t exist before, identify conditions that were overlooked in the past and provide actual treatment for it and so on. [14]

And it doesn’t stop there. One of the most essential industries – agriculture has also benefitted greatly from the incorporation of biotech in its functions. Simple processes of biology that have always been known to mankind, like fermentation, could now be harnessed and be used as microscopic manufacturing plants. Biotech has streamlined numerous processes and reduced energy consumption by a significant amount. A good example would be one of cleaning clothes, regulating temperature saves time, money and energy! Biotech has made it possible for us to become independent of our use of petrochemicals and reduce greenhouse emissions by over 50%. [14]

Biotechnology has an undeniable impact on all sectors and industries. In the medical field, many previously untreatable diseases now have healthcare products and vaccines available to target them. The agriculture industry exploits biotech to an impactful extent, with over 10 million farmers around the globe using biotechnology to provide better crops, avoid pest infestation and even use eco-friendly methods! This then also highlights the need to produce energy in an efficient and eco-friendly manner.

Over the course of this essay, we have seen the direct effect of biotechnology on sciences all across and by extent its impact on the human life. While the moral aspect of biotech is a debate that has no foreseeable end, the leaps and bounds made by humankind cannot be denied. As we wade through these times, biotech has proved itself to be a faithful tool that we can certainly rely on!

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