

## **Disruptive Innovation – Pharmaceutical Industry / ROHNER Alexander**

This article will be an attempt to place a case that key elements for an disruptive innovation trend is occurring within the pharmaceutical industry due the latest advances of genetic analysis, editing and retrieval.

Disruptive innovation is an theory that might by times be tricky to understand all it's aspects. Often used for companies as "Uber" or "Telsa" it is intriguing that the term has been extended to be used by many people incorrectly.

I am willing to argue the case that the latest genetic technology occurring these past few years have set into place key elements that have lead for the motions of disruption to occur. It is therefore important that I do not fall into some of pitfalls that may apply when discussing "Disruptive innovation".

Stated by this theory entrants of disruptive innovation enter by the low end of the market as the incumbents neglect opportunities in that sector due to their prioritization of higher yielding products or services. This I state can be observed by that pharmaceutical industry due to the nature of their business.

For those who are aware, this industry is highly competitive due to the environment surrounding their businesses. Regulation is a strong component of an success/failure of an product as each one has to be approved by the governing authorities (ex: FDA) before entering the market. This is only one of the heavy constraints faced by the industry as they equally face patent expiration, high R&D costs and many product failures. So due to the very nature of their business they have to aim for high-yielding products with high profit margins to remain sustainable and this therefore leaves the entrance to the low end of the market for disruption.

I believe that the latest development of independent genetic technology have set into place for the low end of the market to disrupt this industry in a slow process that could require many years to observe its effects due to the complexity of the subjects at hand.

As mystifying it might be genetic-DNA retrieval or simply put "DNA Sequencing" is an technology that people might think is new but has it's foundation back into the 1950's. As many technologies, the inception of DNA sequencing methods occurred at Universities with academic pursuits. As the technology progressed, it was further

incorporated into genomic analysis, protein analysis and has tremendously helped solve inconsistencies in taxonomy through the development of evolutionary biology.

Genetic sequencing has been an tremendous tool for understanding deoxyribonucleic acid (DNA) the backbone found of every cell within every organism past and present. But as any great technology there is an non-negligible amount of time requirement before it becomes relevant to an common core. As attested by people in the field, genetic sequencing is an arduous, very manual, time consuming processes that leads many scientists and analysts frustrated due to many errors that can occur. Notoriously expensive (for long sequences) in an Science that requires utmost precision this indubitably has limited potential applications.

But those limitations are being removed layer by layer by technological improvements most celebrated by “Illumina” an industry leader. Illumina has caught international attention thanks to their sequencing technology which has arguably reached the symbolic mile-stone of the “1000 \$ Genome”. This is indivertibly one element of the disruption as an 1000\$ genome has been seriously argued as the achievement would signify the possibility of widespread genomic analysis to worldwide populations. In other worlds everybody could now benefit from having their DNA sequenced without being too costly<sup>1</sup>. This is an game-changer in genomics. I argue that is no reason to believe that due to cost reduction having your whole DNA sequenced will not be as routinely performed as an blood test. This wealth of information is an cornerstone for future applications, but there is no “real” value if you do not have the tools to exploit this information.

This is where “CRISPR/CAS9” technology comes into play. CRISPR/CAS9 is an extraordinary technology that is truly revolutionary. Never in the history of genetic editing has there been such an move forward into it’s technology that we can declare it as an revolution. CRISPR/CAS9 is such an forward leap into genetics that I believe it will be hard to avoid seeing it’s effects on society within the future. I argue this case as CRISPR/CAS9 possess many of the characteristics of an technology that can be easily widespread. First of all it is cheap to use as accessible basic supplies can be found for around 100\$ and the adoption period required for mastery is short.

---

<sup>1</sup> For information, the human genome project cost approximately 3 Billion \$

CRISPR/CAS9 is not an manmade technology but is roughly speaking an mechanism taken form bacteria which allows precise editing of genetic information. The bacteria uses this system to “splice-out” unwanted foreign DNA that can introduced by foreign agents such as viruses. The beauty about this system is it’s precision as this quality is often lacked by other methods used. CRISPR/CAS9 is interesting because this accuracy opens the gate for precise genome editing<sup>2</sup> necessary for any meaningful impact. One can easily imagine deleting genes that may lead to cancer, tumors or allergies. The applications can therefore be exhaustive if one is willing to commit time and resources towards the cause. This I argue will lead to an acceleration of disruption when combined with genetic sequencing as discussed above and genetic analysis.

Genetic analysis is from my observation the 3<sup>rd</sup> and final cornerstone for innovative disruption to occur. When information is retrieved from sequencing there is unfortunately no user manual brought beside it. Genetic information is vast ( ~1GB) containing a lot of “junk” information and is difficult to understand it’s meaning. One of the great disappointments of the Human Genome Project was the realization of the difficulty to link genetic information to protein synthesis and disorders. A challenge that remains strongly present today. People uneducated within the field may falsely associate one “faulty” gene as the cause of malfunction which leads to disease or cancer. While there are some instances which this is the case a vast majority of disorders are “polygenetic” (involving many genes), involve post-transcriptional errors and implicate highly complex dynamics difficult to understand and control.

Nevertheless thanks due to an increasing number of human genomes available for analysis<sup>3</sup> an increase in understanding and interpretation of abnormalities will be available to the medical community. This I believe will only be accelerated by the parallel development of “Big Data” occurring within the informatics industry.

Aside from strict academic use, companies such as “23 and Me” have already initiated the 1<sup>st</sup> steps of personal genomics as we provide our DNA to them and in return we are offered an analysis and interpretation of the information.

---

<sup>2</sup> Although it is an bacterial system an virus is used later on as an vector to insert DNA in your body

<sup>3</sup> <http://www.technologyreview.com/news/531091/emtech-illumina-says-228000-human-genomes-will-be-sequenced-this-year/>

It is therefore not difficult to grasp the understanding that the combination of wide spread genetic information, accelerated interpretation of that information and powerful tools to handle it will lead to disrupt an industry focused on solving reactive problems than preventive solutions. And first steps have already been observed! As an example hepatitis C virus within cultivated eukaryotic cells<sup>4</sup> were inhibited by using CRISPR/Cas9. Hepatitis C being an disease costing approximately 100'000 \$ for each U.S patient.

Start-ups as “Editas Medicine” are emerging seeking the potential of gene-editing in solving types of cancer and disorders.

Nevertheless with such promising outcomes there is undoubtedly risks and uncertainty associated with it especially if we add the complexity and time necessary to witness its full potential.

The strongest concern I believe will affect widespread preventive gene-editing will be Ethics. There is undoubtedly many questions that society will have to face to it before gaining acceptance. For example who will hold our genetic information ? How much manipulation will we accept as tolerable? Will we allow the engineering “super-humans” ? and this will certainly clash with some personal and religious beliefs, therefore slowing down the progress associated with the technology.

Another concern is the complexity associated with the risks involved in manipulating genetic information. One reason why so few gene-therapies manage to overcome the governing authorities is because it is highly risky. When one starts “playing around” with such sensitive information we are more likely than not of an risk of mutation which will lead to cancer. Simply spoken one wrong mistake = cancer. So when the outcome may be so costly it might be not worth to subject ourselves to this risk, at least for now.

I can also envision resistance within the medical field for widespread gene-editing to be successful. The medical field bread and butter is to be reactive and not preventive. People go to the medical community when the have a problem and need it fixed, this being cancer, fever or any abnormality one can experience. Their whole business model revolves around administrating an relief to an existing pain.

---

<sup>4</sup> Category of cells than human possess

Preventive medicine such as widespread gene-editing circumvents this business model by preventing an pain to occur in the first place.

Some incumbents such as “Bayer” have publicly taken notice of the changing environment within the field most noticeably CRISPR/Cas9 but without changing their business model. For instance in this case they plan to use this technology as to create increasingly efficient drugs which would fit their high-margin product pursuit.

“Roche” in the other hand subjected an hostile takeover of “Illumina” back in 2012 of an 6.2B buyout offer at 44.5\$ per share (today 170\$) which eventually failed but clearly showed their interest. Therefore I do not believe that the incumbents do not see the writing on the wall but I can only suspect that for now it is to further enhance their business model without willing to change it.

It is hard to blame them for not having an interest of changing their core business. As I have stated earlier the motions have only recently been set in place and start-ups entering field are not generating any revenue to come even close to those earned by the pharmaceutical industry.

But disruptive innovation can be long process that takes decades to fully take effect and I am convinced that preventive medicine here illustrated by wide-spread genetic editing will take an increasing importance with each passing year. Today health monitoring devices such as “Withings” takes track of steps, pulse and activities. If we can associated such accessories with our further understanding of ourselves there only can be an increase of the possibilities made available.

Today’s market of curing disease and cancer treatment are dominated by high profit drugs for problems that wide-spread genetic editing will solve increasingly cheaper and easier than ever before. The incumbents have not focused on this end of the market not because of ignorance but because it goes against their business model. Preventive medicine does not possess the same returns as the pharmaceutical industry therefore it can be considered unattractive today. But by circumventing the core of the incumbent’s revenue by the preventing the diseases, cancers and abnormalities that make such organization financially successful, preventive medicine will I believe increasingly disrupt the pharmaceutical industry within the decades to come.

I do not believe drugs or treatments will ever be eliminated but with the these new technologies and genetic information and tools always more efficient, cheaper and available. There is in my view an unequivocally trend threatening the pharmaceutical industry at large today.

### **Additional Reading**

<http://www.nature.com/news/is-the-1-000-genome-for-real-1.14530>

<http://news.berkeley.edu/2015/07/23/simple-technology-makes-crispr-gene-editing-cheaper/>

<http://motherboard.vice.com/read/what-is-crisprcas9-and-why-is-it-suddenly-everywhere>

<http://www.technologyreview.com/news/531091/emtech-illumina-says-228000-human-genomes-will-be-sequenced-this-year/>