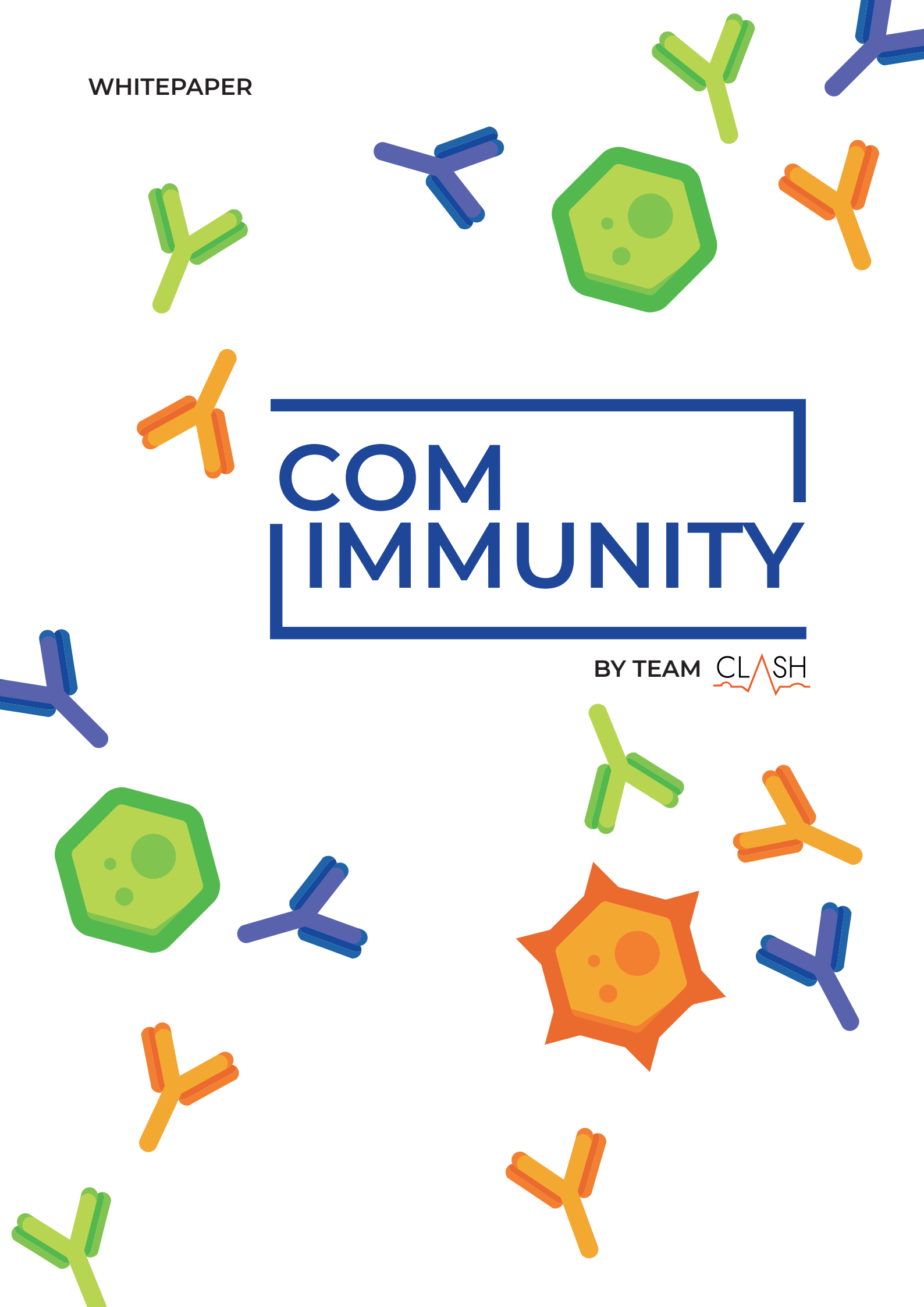
WHITEPAPER



COM IMMUNITY

BY TEAM CLASH

ABSTRACT

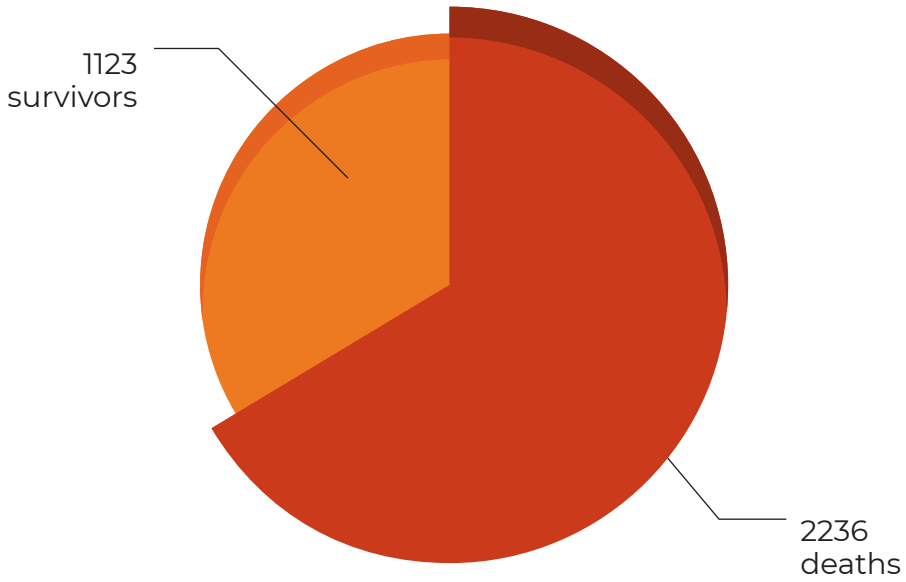
Dengue-Virus, the bacterial Shigellosis, Meningitis or Typhus as well as epidemias like Ebola, Avian influenza (known informally as bird flu) or the Sars-Virus have increased from the 1980s into the 2010s with a rising tendency. [1][2][3]
With ComImmunity we could not just offer a solution to prevent people around the world from these unnecessary deadly hazards those diseases come with but a eradication
of epidemias as well if the product is distributed widely enough.

The idea of ComImmunity is a shared immune memory so that people whose immune systems can handle a disease without help can share the information of their way to defeat the infection to everybody who is in need of a solution.

The treatment would be very close to the naturally healing methods so that the physical, economical and ecological side effects would be minimal and the waste of medicines would decrease what would help the healthcare to become more sustainable.

The design concept presented here aims to the third UN Development Goal „Good Health and Wellbeing“, which ensures healthy lives and promotes well-being for all at all ages until 2030 [4]. This initiative, combined with CERN technology, provides a context of the CBI Challenge Based Innovation program [5].

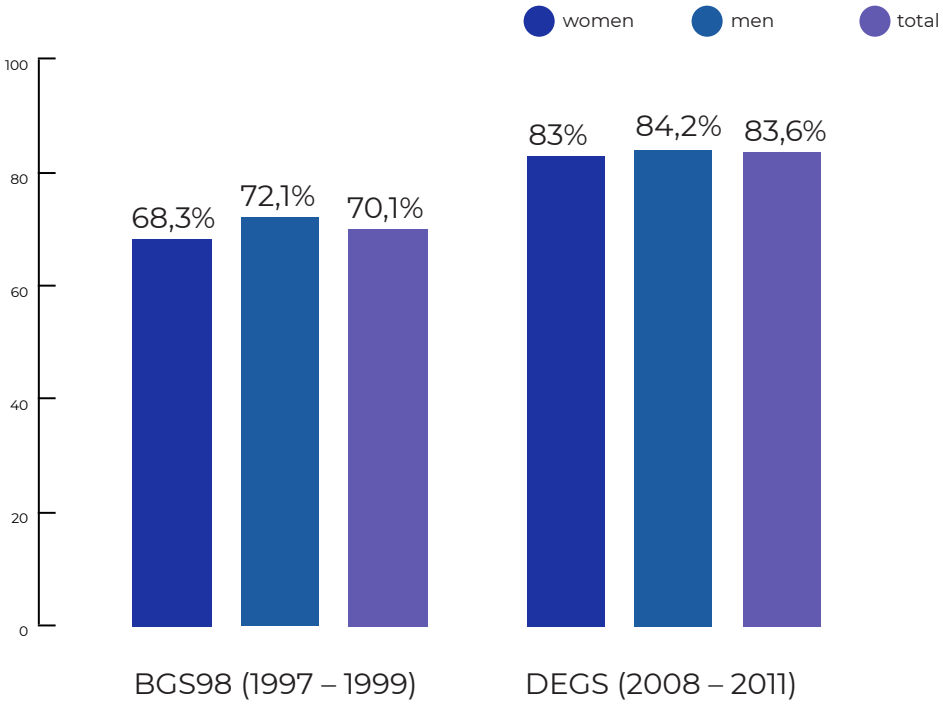
Health and wellbeing is a broad topic. SDG Nr. 3 combines this issue with sustainability. In our research, we found out that Germany alone has several unseen problems concerning this subject such as antibiotic resistance, multiresistent germs and food contaminated with bacteria, causing several deaths nationwide. [6][7][8] Looking at the global context the situation isn't better. Several epidemics or viral and bacterial illnesses, like Ebola, Zika or HIV to just to name a few, are causing millions of suffering and thousands of deaths. As an example, let's take a closer look at the current and ongoing outbreak of Ebola in DR of Congo. Starting from summer 2018 to this day, the 14th January of 2020, they have been 3406 cases of ebola in total. 2236 of those ended fatally. [9] The WHO is predicting an even darker future for humanity: the outbreak of still unknown epidemic caused by "disease-x" – a disease, that is still unknown and will cause huge harm on an international level. [10]



Ebola outbreak in DR Congo, 2018 — 2020

Let's go back to our example. Nearly half of the diseases are fatal. The other half, however, manages to fight the disease – without vaccination. We asked ourselves how these people were able to overcome Ebola? What was the reason their bodies were able to fight the disease when others couldn't? Their answer is clear: it's because of the immune system of these individuals.

In Germany between 2008 and 2011, 83.6% of Germans over 18 years of age were vaccinated, and among children under 18 years 90%. The vaccination process can not only be stressful for the person concerned, but also involve high costs especially for vaccinations against tropical diseases for stays abroad. In general not everything is covered by health insurance and drug costs tend to be high. Another problem concerning medical drugs is the waste they generate.According to ISOE (2008), several thousand tons of waste of human medicines are generated annually. This waste not only has an impact on human beings, but also on their relocation (flora and fauna).

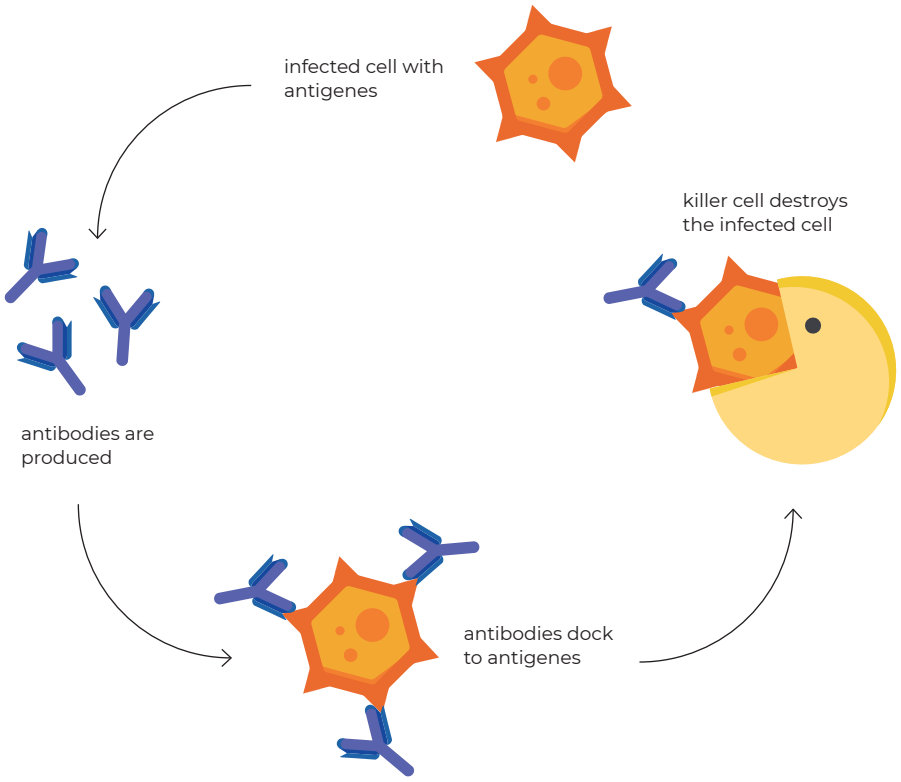


Proportion of persons in Germany who have been vaccinated in the last 10 years by gender in 1999 and 2011 (RKI)

So for our challenge we focused on health in its most biological way: fighting these diseases from your own body, from your immune system. A society and widely spoken the whole human race needs to be secured from diseases, before epidemics can outbreak and before scientists will find a way to stop these epidemics.

ComImmunity can be compared to a global immune memory. It is supposed to improve the specific immune defence to give people with a weak immune system the chance to fight diseases efficiently. The system includes an implant and a database.

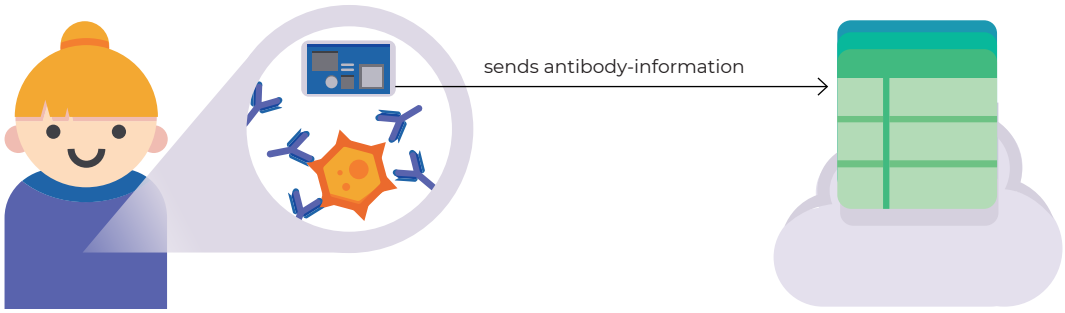
Antibodies, also known as immunoglobulins, are protein molecules formed by the immune system to fight pathogens and other foreign substances. As soon as the body comes into contact with surface structures (so-called antigens) of a foreign substance such as parasites, bacteria, fungi or viruses attempt to enter the body, the antibodies are produced and released. They then bind to the foreign body to be combated at one end. At the other end, they dock to the body‘s own cells, which thus render the foreign body harmless and protect the organism from infection. Foreign substances that lead to the formation of antibodies are usually bacteria, viruses, fungi or parasites and substances produced by them. [11][12]



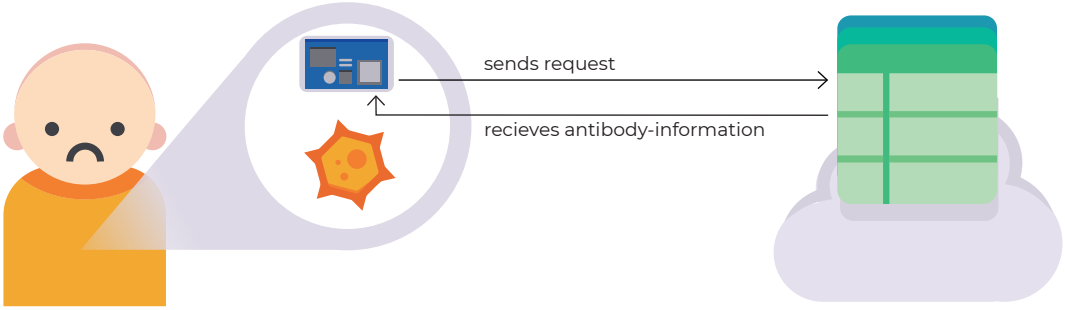
And this is exactly where ComImmunity should start.

In detail, the implant has various sensors that make it possible to detect antigens in the body and assign them to a disease. In addition, it uses additional sensors that enable it to detect whether the body forms suitable antibodies that bind to the antigens. The implant is ultimately part of our immune system. Once the implant has completed the detection, there are two possible paths.

When it detects that the body is producing antibodies, the implant analyzes the composition of the antibodies and sends this information to a database.



However, if the implant discovers that the body is not forming the appropriate antibodies, it sends a request to the database. This request includes the type of antigen and the disease. The database is then searched for the disease. If the disease is stored in the database, the antibody composition to combat the disease is sent back to the implant. The information about the composition is then sent to the human immune memory, which, based on the information, forms the appropriate antibodies to fight the disease.



IMPLANT

All in all the implant has 5 (several) tasks:

1. detection of antigens.
2. detection of antibodies.
3. analysing antibodies.
4. sending information and
5. receiving information.

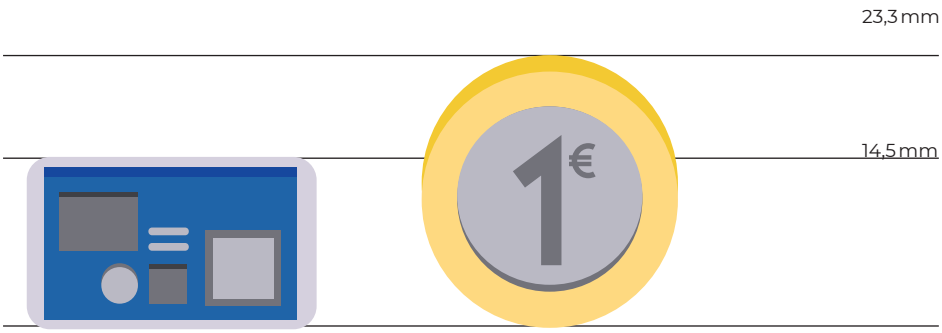
(stimulating the body to create the right antibodies)
(loop to check if the antigens are defeated)

The implant will need a large number of channels, which results in a high space requirement and low flexibility. This must be taken into account during development. As energy supply we use the so-called Energy Harvesting. This is a system that extracts energy from its immediate surroundings. The energy is produced where it is consumed and only needs to be stored for a short time. Energy sources for the miniature power plants are ambient temperature, movements or vibrations, which are converted into electrical energy by micro generators. The heart is proving to be a promising source of energy: it regularly contracts 24 hours a day, seven days a week. [13][14]

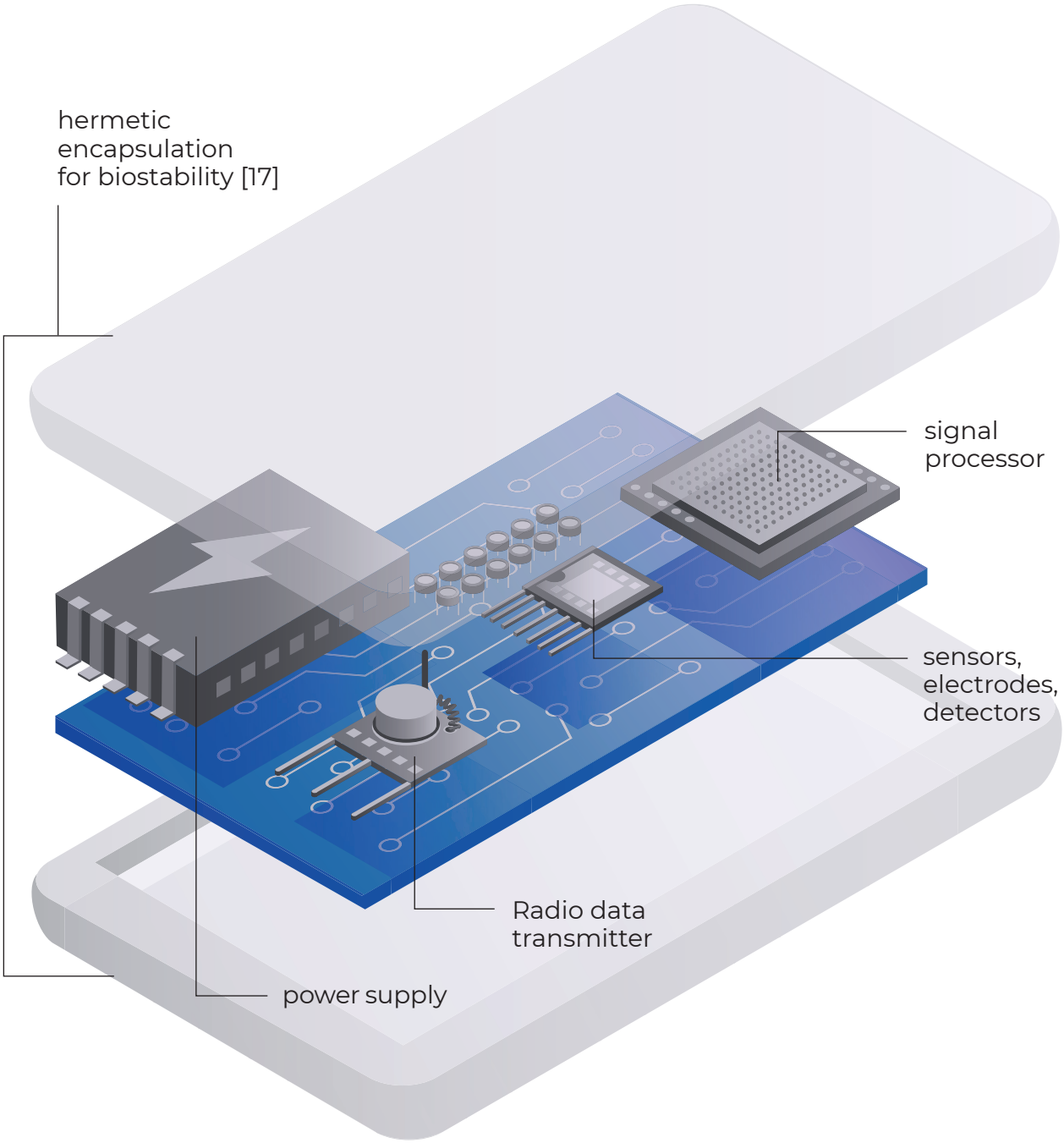
For the data transmission we have decided to use a data transmission by radio. This enables higher transmission distances and frequencies. The MICS band (Medical Implant Communication Service) would be a suitable frequency band. It offers a bit rate up to 800 kBit/s. [15][16]

The following needs apply when encapsulating the implant:

1. biostability,
2. biocompatibility,
3. hermetic sealing,
4. guarantee of function.



Implant size compared to 1-Euro-coin



A biocompatible cellulose shell with a three-dimensional microstructure might be suitable for the capsules. Connective tissue forms on this surface and the function of the implant is not affected because the implant is not encapsulated by the body. [18][19][20]

DATABASE

The database is a kind of network database. A network database consists of data records which consist of different fields. A field has a name and a value. Each record describes a person, an object, or an event. In this way, disease information and suitable antibody composition can be well filed. [21][22][23] To get an initial basis for the database, we use existing antibody databases like the Bionity.COM database. It offers over 48,000 different antibodies. [24]

The whole system will run unnoticed, the person will not feel the implant and will not be affected in any way. The system will become part of our immune system and we will not actively perceive it.

USERS AND TOUCHPOINTS

IMPLANT WEARERS

This is because every person who has the implant will benefit if his natural immune system is not able to fight the disease. Through the implant the immune system is helped and the disease can be successfully fought. Antibiotics become obsolete. As a result, there will also be no more resistance.

HUMANITY

With the implant you are not only helping your own body. You are also doing something for the general public, because if your body produces the right antibodies, the information is made available to other people through the database.

DOCTORS

The first effects are likely to be visible to doctors and hospital staff through relief. However, the more people wear the implant, the less infectiologists and bacteriologists, for example, will be needed.

PHARMACEUTICAL INDUSTRY

Through ComImmunity it is likely that the pharmaceutical industry will not benefit or make a profit. Quite the opposite in fact. Vaccines and drugs that we use today to fight bacterial or viral diseases will be obsolete.

HEALTH INSURANCE COMPANIES

Health insurance companies will also save money. Money for vaccinations and medications as well as treatment fees due to illness will be eliminated. In addition, the costs for the use of ComImmunity could be covered by them to increase the reach of our product.

RESEARCH

Research would benefit fundamentally from ComImmunity. It could gain insight into various disease patterns and natural immune reactions through the database.

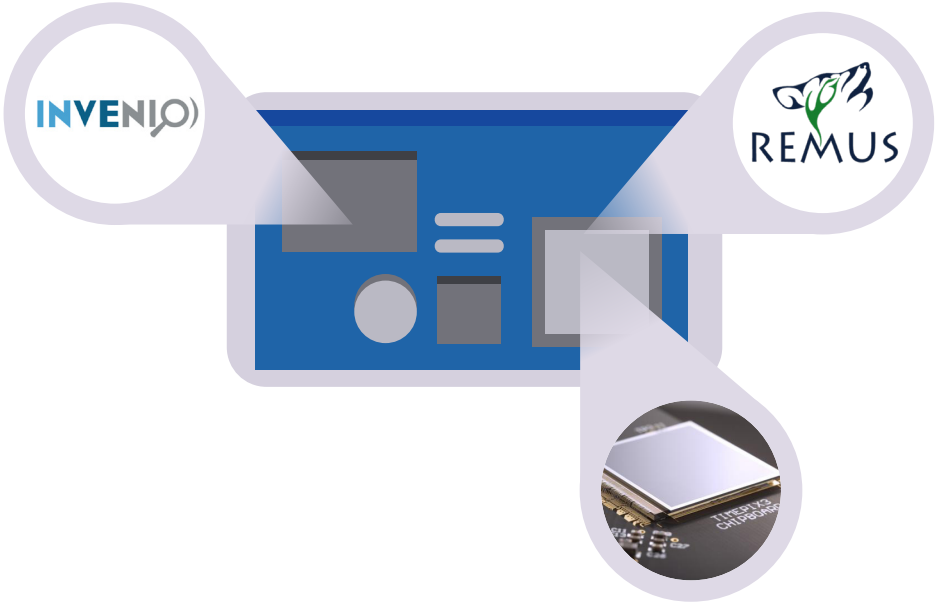
ENVIRONMENT

The environment would also benefit, as drug waste would be drastically reduced. Pharmaceutical residues can be found almost everywhere in the environment: in rivers, soils and groundwater, and occasionally in very low concentrations in drinking water. Some of these substances are harmful to the environment. Livestock management Farmers would save costs for medicines, because what helps us humans also helps the animal world. The implant could therefore also be used to help and cure animals.

The amount of data resulting from measuring the particles generated in the LHC at Cern is immense. The engineers at CERN know how to handle a large amount of data. Therefore we decided to use the database included in INVENIO [25] to manage the obtained data that are generated in the implants and also to serve the right information in case of a undefeated illness. Invenio is a digital library and repository system for research and data management that can run autonomously. It uses the MARC 21 standard that is a digital format to catalogue items in libraries. Furthermore it complies with the Open Archives Initiative metadata harvesting protocol (OAI-PMH) which supports the main idea of ComImmunity, the collectively fighting against diseases. The informations collected in the database are shared to scientists and interested people and can be proceeded with the help of big data methods to learn more about immunology and the spreading of diseases.

For the analyses of the collected data and metadata we want to use the REMUS technology [26], that is used at CERN to acquire, monitor and control the radiation in their environment. We hope that we can use REMUS to monitor the data, collected by the implants and analyze geological differences between epidemics and the spreading of a disease to prevent further infections.

As a detector we could imagine to use another CERN technology, a customized micro version of the TpxCam [27] that contains the Timepix3[28] sensor and a laser beam to analyze the molecules of the sample. That is necessary to detect the antigen, for example a virus or bacteria, as well as the endogenous reaction, the antibody. The detection needs to analyze the antibody and the antigen down to its protein structures. The structure of the antibody is then used to create a blueprint of the antibody. This can then be shared with other ComImmunity members if the implant detects the same antigens.



We are firmly convinced that ComImmunity will have a very large positive impact on every single person and the environment. With ComImmunity, medicines as we know them today will become absolutely obsolete. We are helping the human body fight diseases in a natural way. We just provide a little jump-start. ComImmunity users no longer have to go to the doctor all the time if they need a vaccination, prescription for medication or suffer from a disease. As a result, they get more enjoyment of life and more time for things they enjoy doing. There is also no longer a risk of antibiotic resistance due to the consumption of antibiotics to fight disease. Furthermore, ComImmunity possibly also promotes the interaction between people. Because by wearing the implant you are also doing something good, you help each other. Someone else can benefit from the strength of your immune system. The environment is also helped by the lack of medication. Because waste medication puts an extreme strain on our ecosystem. For example, a feminization of male fish that had come into contact with hormonally active drugs was observed below sewage treatment plant drains. Drug residues from our drinking water are also reduced. Researchers will benefit from ComImmunity, as the database will allow them to access countless disease patterns and the antibodies used to combat them and develop further innovations based on this information. Agriculture will also benefit from this. What helps us humans cannot be bad for animals either. So why not also offer ComImmunity for animals. This will reduce the amount of medication, farmers will save money and we humans will no longer have to worry about meat with antibiotic leftovers. When farmers stop giving medicines to their animals, less medicine in the form of excreta enters our ecosystem. Our water will be purer and our vegetables and fruits will be less polluted.

ComImmunity could not only be used for the classical function of the antibody reaction in the body. Research has shown that antibodies are also used in cancer therapy. For example, therapeutic antibodies are supposed to release certain „brakes“ in the immune system so that the body‘s own defence destroys the tumour. Other antibodies specifically attract immune cells to the tumour, which are then supposed to fight it. Therapeutic antibodies can also block important growth signals of the tumour cells. [29][30][31] What if this immune reaction could also be induced via ComImmunity? Another research suggests that antibodies can also be used in the treatment of strokes to reduce the side effects of lysis treatment and promote recovery. Antibodies have been known for a long time to prevent blood vessels from being blocked by blood platelets in the brain. [32][33][34][35][36]

However, ComImmunity will have the greatest impact on health. There will be significantly fewer deaths. Epidemics can be prevented. In simple terms: people will survive diseases that are still considered a death sentence today.

SUGGESTIONS FOR FURTHER RESEARCH

In our current status we have an idea for the implementation of the individual components, but we do not know if everything can really be implemented in this way. We need to think further about the data transfer from the implant into the human immune system and find a suitable solution. The type of detectors used to detect antigens and antibodies will also have to be looked at more closely in the progress of the project.

Regardless of the described factors of our concept, we are aware of the fact that we also have to think about side effects. These include ethical factors as well as invasive intervention in the human body. With ComImmunity we want to intervene and improve the nature of the human body. This intention can also easily be misunderstood. What about natural selection? Why change something that‘s worked for thousands of years? These could be questions that may arise in the process of the project and we have to deal with them.

Data security must be guaranteed because under no circumstances should this technology fall into the wrong hands. Also ComImmunity should not lead to a two-tier society, because some people can afford the system and others cannot. These are all factors that must be taken into account. With all these things and the economic benefits in mind, it should be possible to successfully and safely implement ComImmunity.

CONCLUSION

ComImmunity makes it possible to support the human immune system to defeat invasions from the outside like viral or bacterial infections. To provide a sustainable solution to drug waste and deadly diseases for people with weakened immune systems. The CERN technologies Invenio, REMUS, TpxCam and Timepix3 are used for implementation. Roughly speaking, the technologies are used to detect in the body, monitor the whole process and store the data. The whole system can also be knitted even further and can be an alternative and substitute for any kind of medicine. For this project, however, it is necessary to understand the human immune system in detail in order to be able to intervene skilfully. Investigating and research is the first important step to build that knowledge.

We are in a position to create a future without epidemics, without deadly disease courses and without drug waste. Humanity can open a new chapter - our future.

TEAM INFORMATION

CLARA DIEING

Clara is a Biomedical Engineering Master student at the University of Applied Science in Mannheim. During her studies, she focused on high-frequency hardware-based medical research and medical imaging. She is looking forward to the challenge to „clash“ the CERN technologies with the SDGs.

MANUEL WALTER

Manuel did his bachelor degree in Mechatronics. Now he studies Informational Technology. He loves to be creative and to prototype; corresponding to his mechatronic studies he always tries to „clash“ the different disciplines, mechanic, electronic and Information Technology.

MARIYA BOLOTNIKOVA

Mariya is in her sixth semester studying communication design at the Mannheim University of Applied Sciences. In her studies, she concentrates on UX/UI and brand design. She “clashes” innovation with a clean design. When she’s not designing, she can be found drinking coffee and watching bad movies.

Together we are Team Clash. Our student backgrounds are all different – combining Design, Mechatronic and Biomedical Engineering to achieve our goal to create something sustainable with a positive impact. Challenge accepted!

APPENDIX

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