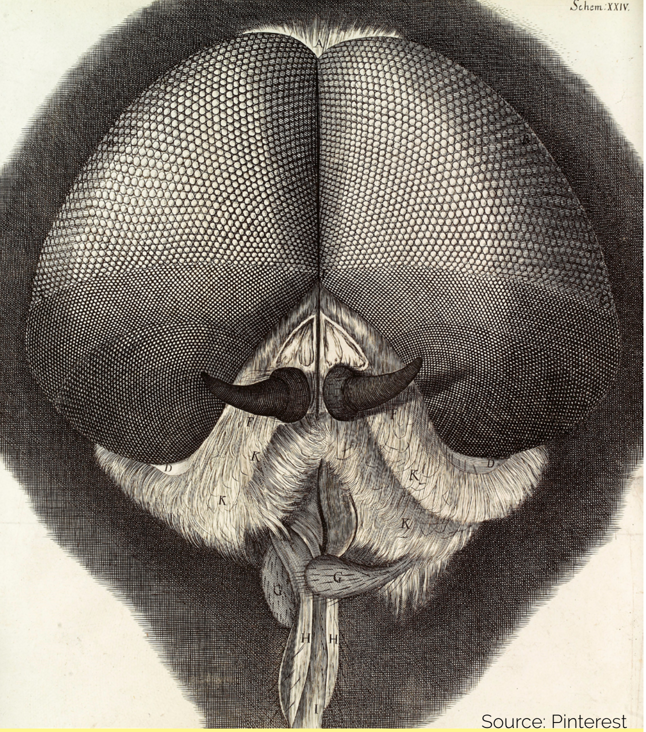
mRNA

YEAR 4 // ISSUE 2 // MARCH 2019

CHIRLMIN JOO // ARTISTS' MISCONCEPTIONS // PUZZLE // SCIENCE ON THE TABLE
3D BACTERIAL PRINTING // NANO ARCHITECTURE // SUSTAINABLE FASHION



Source: Pinterest

This drawing of a grey drone fly, also known as *Eristalis tenax*, was published by Robert Hooke in his 1665 book *Micrographia: or some physiological descriptions of minute bodies made by magnifying glasses with observations and inquiries thereupon.*

CONTENT

EDITORS

Editor-in-Chief: Mario Román Cabezas
Minuting Editor: Simon van Staalduine
Commissioner of Acquisition: Eva van Oosten
Captain InDesign: Erik Berding
Captain InDesign: Roos Kraaijveld
Captain InDesign: Ruben Sangers
QQ: Sara Okhuijsen

S.V.N.B. Hooke
mrna-hooke@tudelft.nl
Van der Maasweg 9
room C0.010
2629HZ Delft
015 2781639

If you do not want to receive the mRNA anymore, send an e-mail to mrna-hooke@tudelft.nl.

COLOPHON

The mRNA is the official magazine of the study association for Nanobiology, S.V.N.B. Hooke. Printed versions will be sent to and distributed among the members. The committee strives to enforce copy-right laws of the texts and images used. If you believe to have the rights to used pieces, we ask you to contact us. We reserve the right to shorten, alter or reject submitted documents and thank all people involved for their contributions.
March 2019. Year 4. Issue 2. Print run: 450.
A PDF version will be published on Hooke's website: hooke.tudelft.nl/mrna.

This edition was made possible by

TU Delft | Universiteitsfonds

MARIO ROMÁN CABEZAS

EDITORIAL

Dear reader,

As I am writing this piece, it is still pretty cold in Delft. However, you can feel that the days are starting to get longer, bringing hope to us warm-blooded creatures. This can only mean one thing: spring is almost here!

Oh spring, what a great season! As the campus starts to blossom, students' hearts fill with joy, which brings to my mind one of my favourite poems: *'Dark swallows will return'* by the Spanish poet Bécquer. It is about how every year, a flock of swallows comes to visit a pair of lovers, reminding them that spring has arrived. This is the happy part of the poem: the swallows always come back, reminding us that life, as a cycle of hope, always repeats itself. However, these swallows are special: they are not the same ones as last year. Those, unfortunately, will never return.

The dark swallows will return
to your balcony to hang their nests
and, once again, with a wing to its glass
playing, they'll call;
but those that held back their flight
when contemplating your beauty and my bliss,
those that learned our names...
those... will not return!

Is this a happy or a sad poem? I think both. It is clearly an invitation to leave the past as it is, as a memory, to enjoy the upcoming spring. It is time to live in the present.

As the swallows that once came, a batch of mRNA leaves this spring. A little sad, but mostly proud of our job, we say goodbye to this great journey with our little wings. And as for the new generations, will they ever find their nests? We wish them all the best.

Enjoy your reading,

Mario Román,
Editor-in-chief of mRNA 3.5

AMÁRIA VLEDDER

FROM THE BOARD

Dear members,

Before you lies the second edition of the mRNA of this academic year, implying that we are well on our way in yet another study year. For some, the first year students, this means they will have found their niche in the student world. Others, more matured, may start to realise they are becoming the new cohort of experienced students. Whether you are the former or the latter, remember to balance everything in life. The phrase 'studying is combining' might sound like just another saying that students use because it rhymes, but it is the key to a great student time and a successful career. By earning study points whilst resting enough and having fun with extracurricular activities, you show exceptional skills and are worthy of hiring.

Right before the TU break, the cold winter took us by surprise. After a long period of soft weather the first snow fell, just in time to get us prepared and excited for our winter destinations. In La Foux d'Allos and Scandinavia we maneuvered over the slopes and impressed companies with our warm glow and memorable knowledge. Exploring Wnter wonderlands and historical cities together with our peers made us forget about the burden of the tough exam week that preceded. The successful closure of these vacations is a milestone for our association. Being able to carry out not one, but two vacations, shows that we are growing, not only in size but also in excellence.

The next semester has lots of new activities for us in store, here you can get your desired dosage of extracurricular activities. Fun ones like our first members weekend Exon, which will be legendary. Educational ones like a debate and excursions by Cohecie.

I have spoken,

Amária Vledder
President of S.V.N.B. Hooke

UNILEVER PRIZE AND CRISPR-CAS9 BABIES

NANONEWS

Unilever Prize

Every year Unilever's Research and Development team organises an event to let us appreciate a few exceptional students for their remarkable work. All universities may put forward their most talented student. This year the honour has been received by Marloes Arts, a Nanobiology student, for her Master's End Project at the Erik Meijering group. She has made a tool to analyse the mobility of BRCA2 using deep learning. BRCA2 is a protein which is involved in the process to repair double-stranded breaks in the DNA. It is very interesting to see how this protein moves within the cell as it is trying to reach the breaks. Having fluorescence images as input, her method finds the trajectories of the BRCA2 protein, determines their speeds and the type of motion they carry out. In the end, this tool can be used in cancer research. The mutations that are responsible for an increased risk of breast cancer change the mobility of BRCA2 as well. Therefore, treatments can already be started when detecting nonstandard behaviour of these proteins at an earlier stage.

Source: https://www.unilever.nl/about/innovatie/unilever-research-prijs/

CRISPR-Cas9 Babies

You cannot have missed it, but the Chinese researcher Hè Jiànkuí has created the first human genetically edited babies using CRISPR-Cas9 last November. He did this experiment such that the unborn babies of a couple, of whom the man was HIV-positive, could be born immunised to HIV. Hè has done this by modifying the CCR5 gene, which is a gene involved in the immune system. Mutated CCR5 receptors stop the HIV virus from infecting the cell. By changing this gene and thus the receptor to the mutated variant, the twins were born immune.

After Hè announced his breakthrough in an interview, many researchers were shocked. The technique was still very young, which means that possible side effects for these girls and their offspring are not yet known. On top of that, both the university Hè was in and China did not know anything about this project. Also, it has not been published and he has not shown any data, nor proof. China has commanded him to stop the project and further charges may follow.

Source: genengnews

The experiment has not succeeded completely. The daughters showed a phenomenon called 'mosaicism' meaning that only a few cells were edited. Another mother is already pregnant for this same project, but the chance it will be carried out is fortunately very low.

Source: https://nos.nl/artikel/2261073-chinese-wetenschapper-onder-vuur-na-claim-dna-manipulatie-gestoord.html

Eva van Oosten

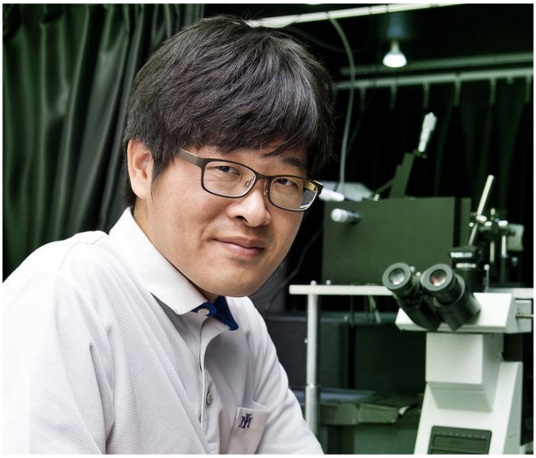
AN ALTERNATIVE TO CRISPR-CAS9

RESEARCH

If you are in touch with current scientific topics, you will probably have heard about CRISPR-Cas9. This genome editing tool has recently resulted in a revolution in science with a myriad of applications. Dr Chirlmin Joo has received a generous grant from *European Research Council* to develop an alternative. Here are the reasons why.

CRISPR-Cas is a prokaryotic immune system that confers resistance to foreign genetic elements, in a form of acquired immunity. Since the publication about CRISPR immunity appeared in the *Science* magazine in 2007, ideas for genome engineering applications sprouted immediately, relying on its high fidelity and the simplicity of construction. The genome editing revolution was subsequently made after CRISPR-Cas9 was reported in the same magazine in 2012.

Chirlmin Joo is fascinated by these kinds of applications. After many years of fundamental research, he was pleasantly surprised to hear of the great impact that it could have on applications, and made him aware of his own potential.



Limitations of CRISPR-Cas9

Due to its extended use in scientific research, it is presumed that CRISPR-Cas9 can be directly applicable in medical settings, like the genome-edited designer babies from China. However, according to Joo, this baby would carry more problems than babies with HIV. This is because CRISPR-Cas9 itself has fundamental limitations.

One of these is its property to bind off-target sequences, which is advantageous in bacteria: they use CRISPR-Cas9 as defence mechanism, so they can 'memorise' foreign genomes to stay protected from viruses. However, viruses evolve quickly by mutating their genomes, and bacteria compensate for this by recognising off-target sequences. This is a disadvantage for the genome editing mechanism, as it decreases its fidelity. Scientists are working on this, but they have not reached full fidelity yet.

This is where Dr Joo's research comes in. His motivation goes beyond improving CRISPR-Cas: he is looking for something entirely new.

"It is a high-risk, high-gain project."

We may ask ourselves: is there a specific benefit to look for a solution elsewhere? According to Joo, the answer is yes. An inspiring example is the history behind the discovery of fluorescent proteins. After GFP was discovered, people tried to push its spectrum from green to red for optical benefits, but could not achieve more than yellow. They found the solution somewhere completely different: RFP (Red Fluorescent Protein) from a coral. Nowadays RFP is used in almost every biology laboratory.

Joo's interest lies in the DNA elimination system in ciliates, a group of protozoans. An amazing feature of this system is that it does genome editing by itself, as opposed to CRISPR immunity.

How it works

Ciliates have two nuclei. One is a somatic nucleus called the macronucleus, and the other, a germline one, the micronucleus. The macronucleus is transcriptionally active, however, under stress conditions it is discarded and a new copy is made using the information in the micronucleus.

Genome editing is required after the re-synthesis of the macronucleus: RNA transcripts from both nuclei pair by homology and certain transcripts are selected in order to reconstruct a newly functional macronucleus through massive DNA elimination processes. A still not fully understood genome-editing complex is involved during this process: it is speculated that it consists of a protein named Twi1, a nuclease, and other cofactors and enzymes.

His research has two fundamental goals: To understand how Twi1 finds its target, and to discover the DNA nuclease involved, together with the additional factors in the process.

Experimental approach

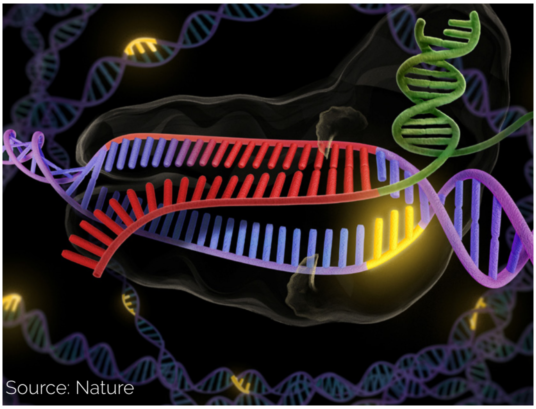
Chirlmin Joo's group is very interested in single-molecule targeting techniques. In particular they are aiming to enhance the throughput of single-molecule fluorescence using a high-throughput sequencing platform. The new method will enable them to extend single molecule targeting studies to multiple molecules at the same time. This could prove very useful when determining the effectiveness of his genome-editing alternative.

Potential Gains

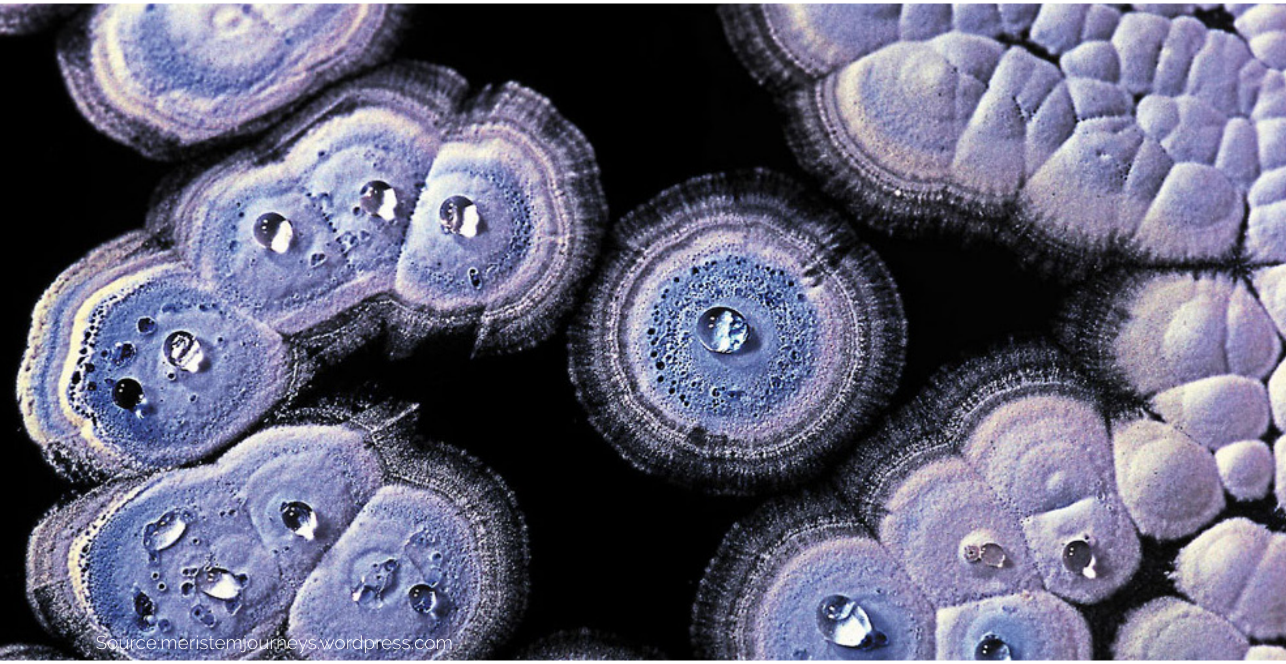
Although it is still very early to speculate, Joo expects a reduction in off-target effects. Another benefit would be the improved accessibility to the structured genome. CRISPR-Cas9 comes from bacteria, whose genome lacks any chromatin. Protozoans are eukaryotes, therefore, their genome has a chromatin structure and various proteins are involved in the process of accessing the genome during genome reconstruction. Associated proteins such as helicases could prove beneficial for more efficient genome-editing.

Furthermore, with this system they are aiming for a reduction of immune responses. It is debated whether CRISPR-Cas9 could potentially induce an immune response when it enters human cells. However, *Tetrahymena*, a fresh-water living organism, rarely interacts with humans, so the effect on our immune system is expected to be smaller.

In his own words: "It is a high-risk, high-gain project." It highlights the importance of fundamental research towards applications and serves as great inspiration: if you are stuck with a problem, start anew by looking somewhere unexpected. Great things are still waiting to be discovered!



Mario Román Cabezas


Source:meristemjourneys.wordpress.com

SUSTAINABLE FASHION
APPLICATIONS OF NANOBIOLOGY

Many people are aware of the food industry: eating less to no meat or dairy is already a huge step. But what about the fashion industry? This industry alone is responsible for 1.7 million tonnes of carbon dioxide emissions, approximately 5% of the total emissions globally. Even more shocking, is that the textile industry is responsible for 20% of water pollution. Engineers, fashion designers, and biologists are looking at new ways to reduce carbon emissions and water use, so let us take a look!

Growing your own clothes

Ready for a challenge? Grow your own clothes! Suzanne Lee looked at ways to do this, simply by spinning cellulose from a mix of microorganisms. First, brew 30 litres of green tea, stir in some kilos of sugar and leave it to grow in your bathtub at a constant temperature with some acetic acid. In a couple of days, a thick mat should be produced, which can be taken out and dried to let the absorbed water evaporate. There you go! You now have a material that can be cut and moulded any way you want. The next step that Lee is working on is to make it water resistant, as with this recipe you would absorb water when it rains...

Dye

Most of the water pollution is due to dyeing clothes. Around 200 tonnes of water are used to dye one ton of fabric. The remaining quantity of water is often disposed in rivers, which makes it unsurprising that China stated that they believe that 90% of their groundwater is polluted by the textile industry. So what can we do about this as Nanobiologists?

Designer Natsai Audrey Chieza works with *Streptomyces coelicolour*, which is a bacterium that produces different colour dyes depending on the acidity of its environment. She dyes a fabric by growing the bacteria onto silk with just 200 ml of water, without using any hazardous chemicals. By growing them in different ways, you can make different patterns. The only problem that still needs to be solved is the scaling of the producing of dyed textiles by the use of bacteria.

Leather

Breeding of animals for food or fashion is one of the leading polluting industries, not to mention the ethical side of leather and meat. Two techniques, using mushroom or skin cells, introduce a strong, attractive and sustainable solutions for the fashion industry. Even better, everything is biodegradable.

Researchers at companies such as *Bolt Threads* and *MycoWorks* develop leather by using mycelium, which is the root structure of mushrooms. Growing mycelium in a controlled 3D network produces a leather looking material.

Another company, *ModernMeadow*, is looking to produce leather without harming animals. Using biofabrication techniques, they take skin cells from cows through a biopsy and grow them on Petri dishes. With help from collagen, sheets can be formed which can then be transformed to leather through a tanning process. The advantage of this is that you can grow it in exactly the shape and thickness you want by layering the sheets in certain ways, minimising waste.

All of these examples of sustainable ways to incorporate synthetic biology and bioengineering into the textile industry are looking good. There is still a long way to go to launch production on a larger scale, but once it gets on the road, it will definitely make a difference.

Source: wired.com

COMPUTING BEYOND THE CLASSICAL BOUNDARIES

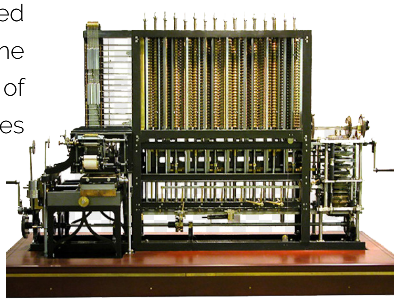
RESEARCH

For the last decades, the amount of data stored on chips has increased tremendously, according to Moore's law. This means that the number of transistors on a chip doubles every two years. Right now a chip already contains 20 billion transistors! The consequences are not only visible in the scientific world, but also in your personal life. In the previous years, you have probably switched from a large SIM to a micro SIM first, and shortly after that even to the nano SIM. This decrease in size is quite minor compared to the gigantic change in computer sizes.

1837 - Charles Babbage designed the first computer ever called the 'Analytical Engine', it would have had storage of just 16 kB to store a thousand numbers.
This computer would have been able to add, subtract, multiply and divide. An addition would have taken the computer three seconds to calculate and a multiplication would take even more than two minutes. Unfortunately, this computer was never built by Babbage himself.

1941 - Inspired by Babbage, more engineers attempted to design a computer system. The person who got the honour of developing the first working computer is Konrad Zuse for the Z3. This computer contained, besides mechanical components, fully electrical parts and performed calculations much faster than the Analytical Engine. The instructions for these processes were programmed in binary code, just like modern computers.

The Z3 was quite a large computer, fortunately, computers have decreased in size and increased in storage for the past decades. One thing has not changed: almost all computers use binary code. As you might know from Electronic Instrumentation, this binary code is determined by the confirmation of transistors. A transistor contains a base which can control current by either letting electrons pass or by blocking them. Blocking and flowing currents are represented by zeros and ones respectively. The mechanism underlying the blocking of electrons is the p-type base having holes where electrons should be. These holes act as a barrier for electrons to pass.



Analytical Engine

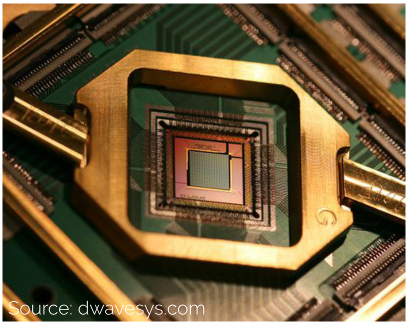
This is exactly the point where small

transistors start to fail. When the surface spanned by these holes is really small, high energy electrons can 'jump' over them, which is called tunneling. Due to this, transistors will always return binary ones, such that no useful information can be produced anymore.

1981 - As the malfunctioning of modern computers is caused by quantum physics, the solution to this problem might also lie in this field of science. This was exactly the idea of Richard Feynman when he urged the world to start creating quantum computers. After this moment the progress in quantum computing began to pick up pace.

1984 - Three years later, Bennet and Brassard published the first quantum cryptography protocol which describes how to transmit a secret message with qubits. Qubits are the quantum alternatives of bits that do not need to be in either state 0 or 1, instead they can be a superposition of the two such that more information can be stored. They only collapse to one state when being measured, which is used to detect the presence of a third party trying to intercept your message.

2009 - Lots of research on multiple characteristics of quantum computing preceded the first processor, made by *Yale University*. This chip could only perform a few simple tasks, but it was a great step towards making full computers.



D-wave

2011 & 2015 - Finally, the first fully operational quantum computer was created by *D-wave*, a Canadian company specialized in quantum computing. It was also one of their computers becoming the first to be generally available and actually be installed in a lab at *NASA*.

2017 - *TU Delft* started to play an important role in the progress of quantum computing by collaborating with *Microsoft*. Together they want to make quantum computing easier such that also non-quantum researchers will use it to solve important problems faster.

ARTISTS' MISCONCEPTIONS

MRNA REVIEWS

When they say a picture is worth a thousand words, this also goes for explaining scientific concepts. For nanobiological purposes, we can either rely on experimental data to make these images for us, or we can simplify them to get a specific point across. The fun starts when these simplifications go so far that the images end up laughable. Here are a few highlights.

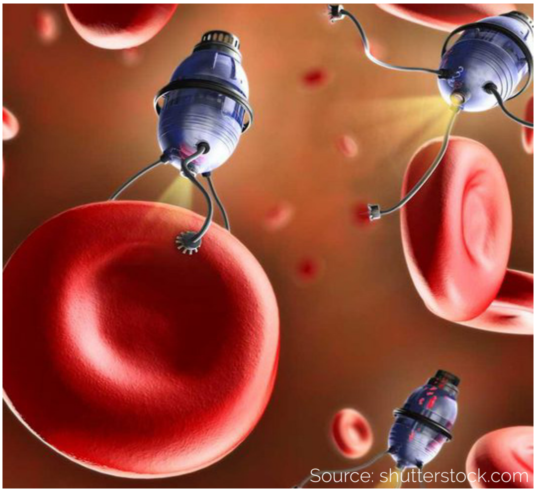
DNA is one of the most popular molecules to be butchered by artists. Major and minor grooves are forgotten; covalent bonds along the backbone are ignored, whereas hydrogen bonds between bases are accentuated, and measurements are all off. The image on the right is a particularly bad example, insinuating that chromosomes are just a container for DNA.

Source: shutterstock.com

Source: shutterstock.com

On the topic of bad stock photos, you will not believe how many pictures of DNA being held by tweezers were made in response to CRISPR-Cas9's discovery. The metaphor may be an apt one for the layman, but the precision and accuracy implied in the image just does not translate to the real thing.

On a different scale, we have nanobots. Yes, these robots that look like they are suctioning themselves onto these red blood cells, are generally classified as nanobots. While the idea is cute, and we are getting closer to tiny bots in our body, the design of these things is ludicrous. It has 'space theme' all over it. From the burner on the back, to the ring that is attached to nothing, to the very poorly done lights at the bottom of these ships. I almost pity the artist that made this; so excited about space, and you get told to make something on microscale. Must be disappointing.



Source: shutterstock.com

All pictures in this article were used in some way by various news organisations

APPLIED SCIENCES CONNECT

The career event specialised for you!

Save the date: 14th May

Connect with companies searching for talented Applied Sciences students at presentations, stands, workshops or during the networking drinks.

www.asconnect.nl

www.facebook.com/asconnect



















COFFEE





SCIENCE ON THE TABLE
APPLICATIONS OF NANOBIOLOGY

Science and food have always been intertwined. Different chemical reactions take place in the pots and pans whilst we cook and in our mouths when we eat. Nowadays, both concepts meet again in the exciting new realm of molecular gastronomy. This field delves into the science behind normal techniques of food preparation and explores its historic and cultural backgrounds in the most artsy and creative way.

"Without chemistry there would be no chocolate, no coffee, and no 'meaty' flavors."

Not your regular kind of ice cream

Are you done with the 'boring' ice desserts at a restaurant and want to try something new? Fortunately, several scientific chefs have come up with cool techniques to make your scoupe of ice cream a lot less 'normal' and this has resulted in some of the most surprising desserts you will ever see. Take Heston Blumenthal for example, who was the first to make ice cream using liquid nitrogen. Not only does this make your dessert look extra awesome, but due to rapid freezing you will get ice without ice crystal formation, resulting in a much more creamy substance!

Source: shutterstock.com

Hot 'n Cold

We all know how special the English are with their tea. Heston Blumenthal is the creator of *Hot and Cold* tea, a dessert that guarantees to blow your senses away. The secret: a particular gelling agent to create a sort of 'liquid jelly', which allows the two different 'teas' to remain unmixed, at least until they enter your mouth.

And then there is also the invention of Ferrán Adriá. Who says ice cream has to be cold? he must have thought when he made his first dessert using 'hot ice cream'. He found out that, with just the addition of several teaspoons methylcellulose powder, you can make a substance of your ice cream that melts at low temperatures and gets solid when it gets warm!

Source: zelvehotel-restaurant.com

Source: theflavorbender.com

Molecular margaritas

Just imagine, you are desperately needing a cocktail but after going through your entire household, you find out that you are all out of glasses! No need for panic, because molecular chefs have been able to make margaritas without the need of a glass, using a physics-bending technique called 'reverse spherification'.

This technique, discovered in the molecular restaurant called *el Bulli*, relies on a reaction between calcium lactate and sodium alginate that instantly cools, forming a kind of 'shell' around the liquid. After its discovery, this technique has been cleverly used to make all kinds of surprising cocktails, and because of its simplicity, this technique can also easily be applied at home. So, if you are feeling fancy and want to surprise your roommates, look it up!

A world of foams

The concept of culinary foam was invented by Ferrán Adriá, who is considered to be one of the fathers of molecular gastronomy. A foam consists of an aqueous phase and a gaseous phase, separated by a thin layer of surfactant. The idea is to "add flavor without significant substance", allowing cooks to integrate new flavors without changing the physical composition of a dish.

One of Adriá's most provocative creations was the espuma de humo ('smoke foam'), a small glass filled with smoked water foam and served with oil, salt and croutons. This creation was sort of a joke, as the idea was for the guests to 'eat smoke' as a dish.

In his own words: *"There's a reason we don't eat smoke… It's very interesting, but I'm not sure it's very good. Nobody likes it."*

Source: rock-cafe.info

Interested in experimenting with food yourself?
Check the link: www.molecularrecipes.com

MATERIAL PRODUCTION BY 3D BACTERIAL PRINTING

APPLICATIONS OF NANOBIOLOGY

In 2015, the *TU Delft iGEM Team* started a project on bacterial 3D printing, hoping to find a reliable and automated way of material production with the help of bacteria. Now four years later, the research on this subject is still advancing and this way of material production promises to be a field that will have a great role in our future society. To get more information on the ins and outs of the present day research on this, we talk about it with Benjamin Lehner, who made huge advances in this field during his project in 2016.

What did your project look like?

After doing my masters in biology, I joined this project on Bacterial 3D Printing at the lab of Anne S. Meyer. She was closely related with the *iGEM* project in 2015 and had continued the research on this subject. Our goal was to take a regular 3D printer, and then modify it to make it usable for 3D printing bacteria instead of plastic.

And did you succeed?

We were successful and were able to make a 3D printer that was capable of producing several bacterial 3D structures. Before us, there were already some groups that had been researching bacterial 3D printing but fortunately, our group was the first with success. We have published it and our paper was the most read article in 2017 in the journal of *ACS Synthetic Biology.* We were also working with the group of Lynn Rothschild at the *NASA Ames Research Centre* on the development of a printer with a higher resolution to print bacteria and sponge cells. So, our research group can be seen as a pioneer in this field, but the scientific community and Anne Meyer's lab in the *University of Rochester* made major steps forward to improve the process since our paper in 2017.

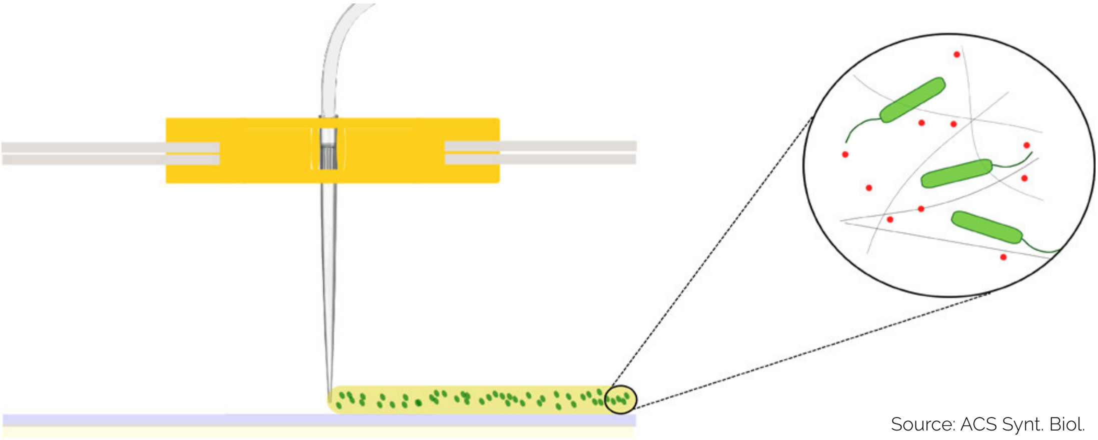
What kind of challenges did you have to overcome to achieve this result?

To create the bacterial 3D printer, a part of our work went into the components of the 3D printer itself. To make the printer suitable for handling a bacterial solution instead of plastic, we needed to remove the extruder, which normally melts the plastic and pumps it, and replace it with a syringe pump that could pump a bacterial solution. Most of the research had to be done on the properties of the bio-ink to maximise the bacterial health and the spatial resolution, because this relies on a lot of variables such as printing temperature and printhead speed.

What are the main applications of your project?
There are two main ideas behind the 3D printing of bacteria. The first one is to be able to precisely print a 3D structure containing bacteria that can produce metabolites. In this way, by creating a certain bacterial structure, you can exactly determine the structure of the end product that is made by these bacteria. We tested this with bacteria that were able to produce a dye, so we could exactly see the end product that was made by the bacteria.

The second goal of bacterial 3D printing is the production of high-resolution biofilms. This is a huge field in research, because there is not really a perfect technique to produce biofilms in a controllable way. The idea is to precisely print bacteria within a 3D scaffold, such that they are embedded throughout the entire scaffold. These bacteria will then form an extracellular matrix, such that all cells are linked to each other. Now the scaffold is not needed anymore and can be washed away, and you are left with a high-resolution bacterial biofilm.

How do you see the future of this way of making bacterial structures?
I think most of the future perspectives are concerned with the field of biofilm production, which is where pharmaceutics are already showing a lot of interest in. For example also *NASA* has a water filtration system which they are developing for use in space via bacterial 3D printing methodology.



Source: ACS Synt. Biol.

Schematic view of the printing process

MINORS IN THE NETHERLANDS

EDUCATION

In the previous edition, mRNA has highlighted a few minors in Canada, Switzerland, Sweden, and Japan. However, if you love cheese, rain, and chocolate on your bread you should definitely stay in this wonderful and flat country. Below are two examples about minors to inspire you.

Tim Zonjee

Which minor did you attend and what is it about?
I attended the minor Brain & Cognition at **Leiden University**. The minor is interdisciplinary between the field of psychology an neuroscience. The courses consist of topics like neurochemistry, brain diseases, language, communication, perception, attention, and decision making. At a pretty superficial level you look at the biological and psychological theories behind these topics.

What were the main differences in the set-up between Nanobiology and your minor?
The minor consists of six courses which you take 'in series'. Every three weeks there is an exam about the one and only course you followed that time. In one way it is nice to focus on one course, but in another way it is annoying to have so many exams.

Which minor would you choose if you could do one again?
I would have probably made the same choice.

Ranmadusha Hengst

Which minor did you attend and what is it about?
The minor I chose was Computer Science at **TU Delft**. This minor mainly teaches students how to program in different languages (mostly Python) using different algorithms. The minor has three tracks: software engineering, game development and data science.

What were the main differences in the set-up between Nanobiology and your minor?
I guess it would be the organisation of the minor. The courses are taught in quarters rather than in octals, so there were only two main exam periods. Also, there was a lot of freedom to choose your courses. There were three main tracks within the minor, each specialised for a different purpose, but you could mix and match your courses to your liking.

Which minor would you choose if you could do one again?
I would probably choose this minor again, because I learned a lot.

KILOGRAM REDEFINITIONS AND CIRCUITRY RENDITIONS

NANONEWS

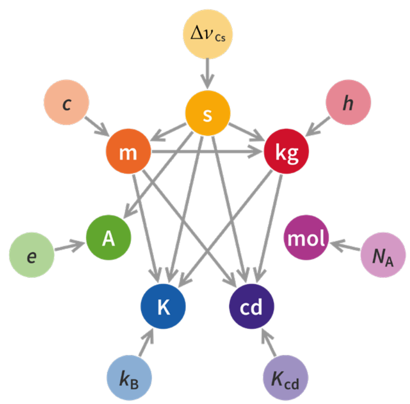
Redefining the kilo

On November 16th 2018, the General Conference on Weights and Measurements redefined the base SI units. Realising that the universal prototype for the kilo was going to change its mass unavoidably, the decision was made to redefine the kilo using the Planck constant. As a result of this, a lot of fundamental universal constants have been made exact.

While the redefinition of the kilo was the biggest change in the SI unit system, this implied changes in other units. A big effect of the redefinition was that all fundamental physical constants were set in stone with exact values. The SI units would then be based on these constants, instead of the other way around, as has been happening with the kilo. In the image below, a dependency graph can be found of SI units and fundamental constants.

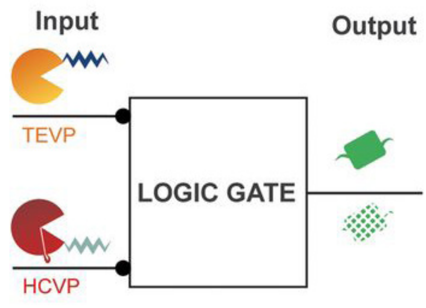
Protease circuitry

Researchers at the *Howard Hughes Medical Institute* have started tinkering around with protein circuitry. Using the system they developed called *CHOMP (Circuits of Hacked Orthogonal Modular Proteases)*, they used viral proteases as a basis for creating Boolean logic such that the inputs and outputs are defined as protein amounts. One of the upsides to this is that it can be theoretically done in any cell, because there is no interaction with the nucleus, let alone DNA. This also means that reaction time is fast, and unpredictable interferences are minimised. This technology is still in its infancy though, and useful functionalities like multistability and oscillatory behaviour still have to be implemented. However, the Boolean on display here, done with just three proteases, shows promise.



Source: Emilio Pisanty

https://www.nist.gov/news-events/news/2018/11/historic-vote-ties-kilogram-and-other-units-natural-constants



Source: NCBI

Gao, X., Chong, L., Kim, M., & Elowitz, M. (2018, September 21). Programmable protein circuits in living cells. Science. https://doi.org/10.1126/science.aat5062

APPLICATIONS OF NANOBIOLOGY

So growing your own clothes sounds a little crazy, but growing your own house seems rather impossible. However, it is not surprising that architects have taken inspiration from biology for many years. One of the main examples is Binet, who started using nature's structures and creatures, such as *Clathrocanium reginae,* to inspire his architectural design.

It is one thing to take inspiration from nature, but it is another thing to build using nature. Neri Oxman and her team at *MIT* made a dome using silk worms. They first made a simple skeleton and then tied yarn to make a more detailed structure. When the silk worms were mature, they were put onto the skeleton and spun their silk. Eventually, an igloo made of silk worms was formed.

Mitchell Joachim of the '*Fab Tree Hab*' uses a technique called pleaching to grow his own house. Pleaching has been around for thousands of years and it is simply an act of interweaving branches or trees or hedges in a particular way. These branches then form stronger structures, which can grow together by inosculation. By repeating this over and over, and controlling its geometry computationally, it allows for the formation of a natural graft which can be the basic structure of a house. For the smaller details, smaller branches can be used.

Source: inhabitat.com

Could this be a solution for the housing of a growing urban population, while also reducing emissions? Of course, having a naturally grafted house may have its disadvantages, such as insects and whatnot, but replacing some of the urban housing or infrastructure like bridges may just offer the sustainable, inexpensive solution that some people are looking for.

Source: kayserworks.com

MRNA ON TOUR
IN THE FIELD

Last Christmas, Roos and Aisha, current and previous mRNA members, took a trip to the other side of the world. In the Netherlands we already have amazing natural history museums, but the one that tops all natural history museums has got to be the one in New York: *The American Museum of Natural History*. Here are some of the cool facts we thought you might not know!

Koala have fingerprints that are almost indistinguishable from humans. Not very handy when working at a crime scene!

Some sheep are bred to have fat tails that are so big that they have to be dragged in special carts.

If you put a goldfish in the dark, it becomes pale... Don't try this at home!

If you have 30 or more papillae, which are the small bumps on your tongue, per quarter-inch, you are a super-taster!

Five species of beans have been bred into approximately 40,000 varieties.

Wild chickens, like Red Junglefowl, produce 15 eggs a year. The eggs we find in the supermarket are from domesticated chickens that produce 200 to 300 eggs.

A group of owls is called a parliament.

Almost every apple you eat is cloned in a process called grafting where a branch is connected to that of a tree that produces sweeter apples to make your apple even sweeter.

Roos Kraaijveld & Aisha So

SMALL SCALE FARMING

OPINION ARTICLE

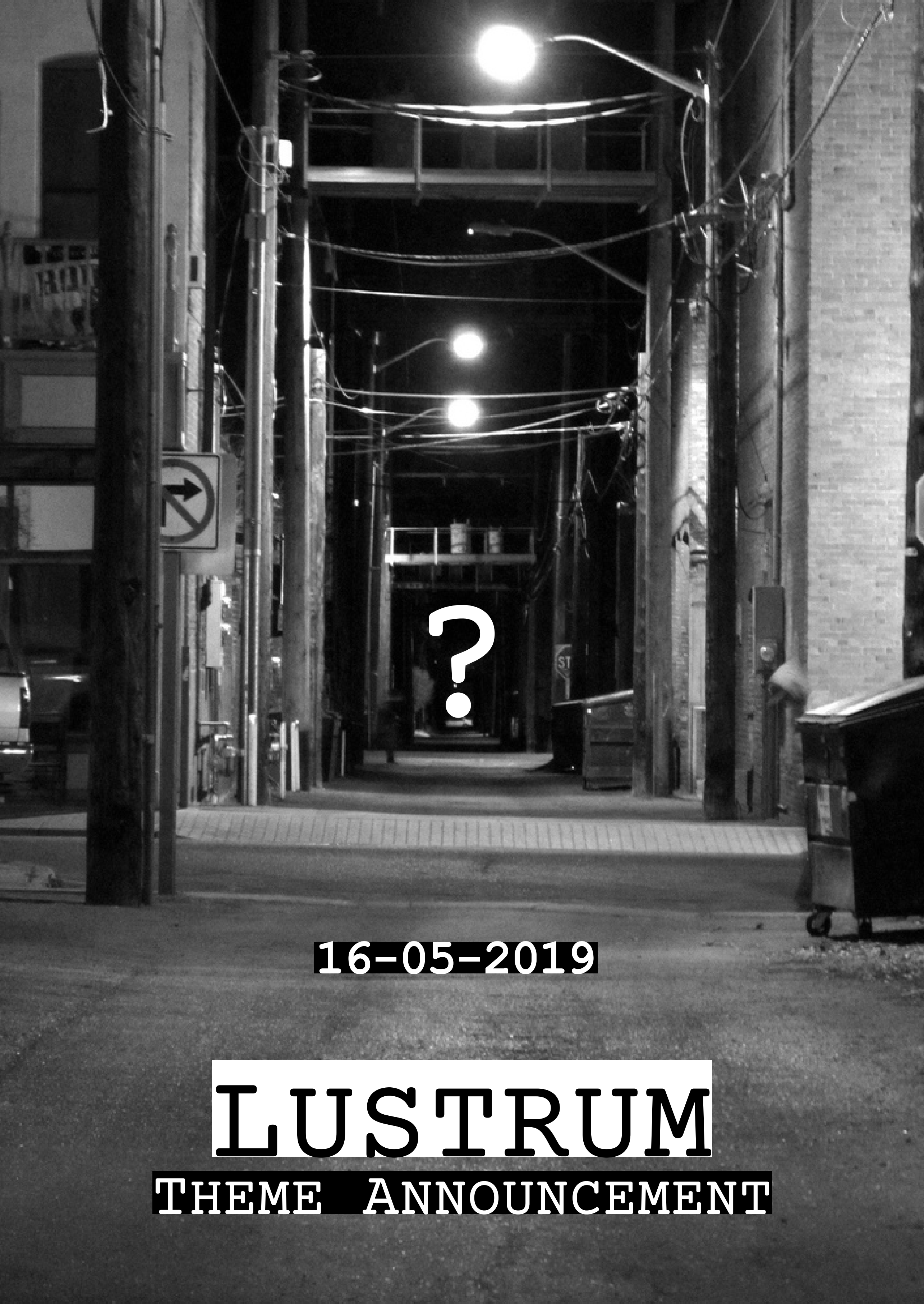
Okay, the title might be a little bit misleading. Small is not meant to be nanoscale-small. But comparing a 60 m² farm to the roughly average 18 hectare farm, one can still speak of small scale farming.

One of the cities where small scale farming is on the uprise is Johannesburg, South Africa. An estimated 100 urban farms are providing Jozi inhabitants with locally produced vegetables, fruits, and herbs. These urban farms are located on wasted spaces in the city, such as rooftops. There are numerous advantages that come with small scale urban farming. The most important improvement compared to 'traditional' rural farming is that the transportation costs are significantly reduced.

Our local correspondent Erik has visited a number of urban farms during his three months stay in Johannesburg for the minor International Entrepreneurship and Development.

"It was inspiring to see the entrepreneurial mindset of these farmers. They often started from nothing and they have been able to quickly become fully independent companies. Reduced transportation cost gives more people access to food. We met with Themba, an urban farmer who sells and donates his produce partially to the residents of the apartment building on which his farm is located. By doing this, he is able to feed 700 people who would normally struggle to buy their food."

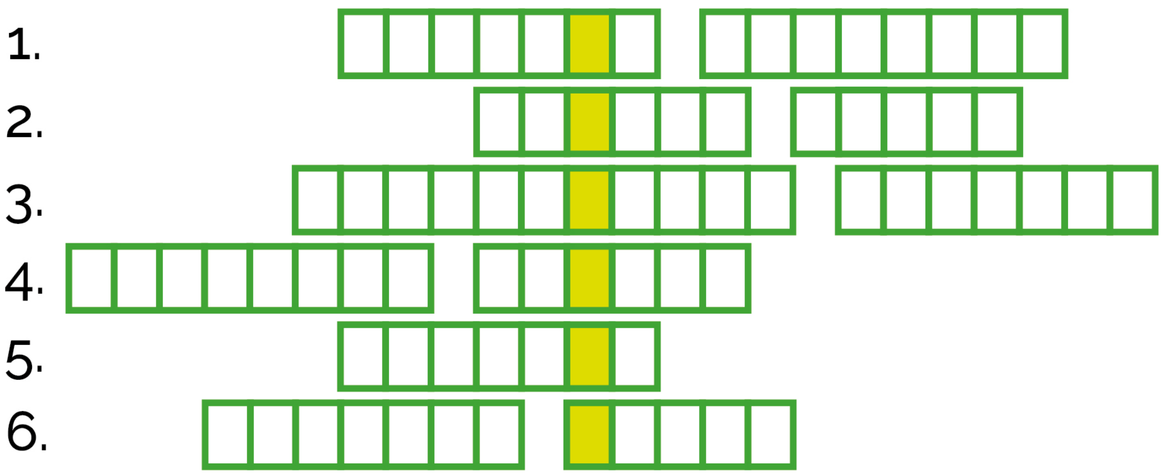
So despite this small scale farming not being on the nanoscale, there are definitely benefits compared to traditional farming. This just leaves the question of how terrific actual nanoscale farming would be.


?
16-05-2019
Lustrum
Theme Announcement

SPRING EDITION: PUNZZLE
PUZZLES

Warning: the puzzle in this edition contains jokes and puns! For every line, we provide a set-up, and you have to guess the punchline.

1. Nanobiological tool that traps forces throughs Trump's favourite social medium.
2. What do you call a gathering of citrus fruits?
3. This mathematical concept calculates the square circumference using the sum of two squares from an italian dish.
4. The amount of time it takes to ripen a particular tropical fruit.
5. This cryptocurrency lets you split your wallet antero-posteriorly!
6. An alternate theory to the pathways of DNA, mRNA and proteins, for people who don't want to walk their pets.



The answer will show that we are mostly working at an ______ level.

Answers:

1. Optical Twitters
2. Citrus Press
3. Pizzagorean Theorem
4. Avocado's Number
5. Bitcoid
6. Central Catma

mRNA Simon van Staalduine & Sara Okhuijsen & Roos Kraaijveld

UPCOMING ACTIVITIES
HOOKE AGENDA

March

3	Death of Robert Hooke (1635-1703)
11-15	Exam Week
17	Cohecie Debate
17	LABdance
18-22	B4 is Back Week
28	Graduation
30	Hox's Parents Day

April

2	MDE/LYSE Destination Announcement
4	General Assembly 4
12-18	Exam Week
25	Heartbeat
29	After-Wnt

May

1	Interfacultary Beerpong Tournament (IFBT)
3-5	Member Weekend Exon
10-11	Lower Years Study Excursion (LYSE)
14	ASconnect
16	LUSTRUM Theme Announcement
27-29	Exam Week

June

7-9	Multiple Day Excursion (MDE)