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MARTIN DEPKEN // INSIDE PEOPLE'S FRIDGE // ORGANELLE ELECTION RESULTS
HISTORY OF NANOBIOLOGY // WNT REVIEW // DIY INCUBATOR // ORIGAMI

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EDITORIAL

NIELS WERIJ

Dear reader,

As this is a triannual zine, I can start every edition describing the seasonal changes, as you may not have been outside the past few months and completely missed them. I know I have. After describing the negative weather conditions, I brighten the mood by introducing the next edition of mRNA. This two step trick is light-hearted as well as contemporary in its subject matter, drawing in the reader. So here goes: just when you think that spring is on its way, the temperature drops drastically again. As the cold secludes you from the outside world, you start to give up hope. But fear not! The next edition of mRNA is here! Etc., etc.

The authors of wikiHow article *3 Ways to Write a Notable Editorial* argue that the subject of an editorial "should be current, interesting, and have a purpose", which can be achieved in four ways: by "[e]xplaining or interpreting", "[c]ritici[s]ing", "[p]ersuading", or "[p]raising". This editorial hopefully touches upon all categories. The praise, of course, is for my committee members, who once again put their heart and soul into the latest edition. With the addition of Erik, Eva, and Mario our collective mRNA heart has grown even more in size.

Let me not keep you from reading their work, as my editorial is dwarfed by the other pages. I hope you will enjoy this edition and that I have persuaded you of the usefulness of wikiHow; it has been a great help in writing this possibly-maybe-might-make-you-smile-a-bit meta humour text.

Happy reading!

Niels Werij, Editor-in-Chief mRNA 3

FROM THE BOARD

MYRTHE SMIT

Dear members,

As I am writing this piece of art the temperatures are dropping to the extreme: all canals in Delft and Rotterdam are frozen and snowflakes turn the world white. We are sharpening our ice skates and preparing ourselves for the Siberian bear that is blowing around our new office.

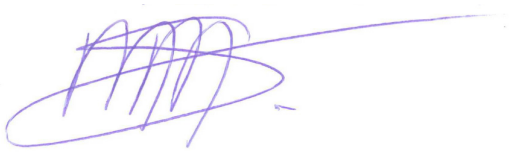
This cold reminds us of our surfing trip to Fuerteventura, where we experienced the coldest winter since 1966. Take this with a grain of salt: I would love to go back to the Canarian sun, blue sky, and refreshing sea! After a few days of mainly paddling and recovering from wonderful evenings, many wnthoes managed to actually surf and look professional on their surfboards. Mountain biking, snorkeling, *HiperDino, Waikiki;* Wnt 2018 was an amazing trip!

Back in the Netherlands we had plenty of time to enjoy our friends during the ATP Christmas dinner in Africa and potluck. At the lunch lectures organized by *AMOLF and Gupta Strategists* our brains were warmed up and the excursion to *Phenom-World* gave us better insight into electron microscopy.

The ice has probably melted and new life is already springing up from the ground when you are reading this, which gives me the opportunity to look forward to an exciting spring; it is the perfect moment for new challenges, new habits and new relationships! But always remember: if you need to know the force created by a spring, Robert Hooke is your man.

I have spoken.

Myrthe Smit
President of S.V.N.B. Hooke



MODELS OF PURPOSE

MARTIN DEPKEN

I counted myself as a statistical physicist until the end of my first postdoc. Non-equilibrium statistical physics was my game, and I still remember how studying physics as an undergraduate gave me the invigorating sense that the world is understandable.


Source: TU Delft

I loved the rigor and logical beauty of the methods I used, but towards the end of that postdoc I had a growing sense that something important was missing. Today, I am a proud member of the Bionanoscience department, where my co-conspirator Timon and I are fortunate enough to run theory groups among a great band of experimenters. As I was already a theoretician, my transition to theoretical biophysics was in some sense trivial—I was using the same tools, just applying them to living rather than non-living matter.

However, my turn toward biology meant a fundamental change in the questions I can ask. To explain this, let me paraphrase the philosopher Daniel Dennett, who points out that there are two senses in which we can ask a why question: we could seek a mechanistic answer to the question "*How come?*" (why does the sun rise?), or we could seek a purpose in the answer to "*What for?*" (why do I have to get out of bed?)

Traditional physics is concerned with non-living matter, and can only ask "*Why?*" in the first sense. A stone cannot usefully be said to be hard for a purpose, it is simply hard due to the strength of the interactions between its constituent atoms.

In contrast, Dennett points to the fact that there is a meaningful way in which evolution through natural selection can be said to endow a physical system with purpose. Your bones are hard, not only because of their atomic composition, but also for the purpose of allowing you to stand tall in a gravitational field. Though I could not put my finger on it at the time of my transition to biophysics, the possibility of purpose behind the phenomena I study has changed how I think about them, and made understanding them all the more exciting.

"It is the construction of the model -not its exact solution- that constitutes the real art."

Biological processes are often complex, and the data is often noisy. The modelling approach of my group can be summarised as a deliberate omission of finer details to produce descriptions concise enough to be intelligible on an intuitive level. In this process, it is the construction of the model—not its exact solution—that constitutes

the real art. You clearly have to include enough information to describe the phenomenon you are interested in, but if you want to generate insight, it is important to keep things simple and respect the limits of the human capacity to grasp complexity (see Figure 1).

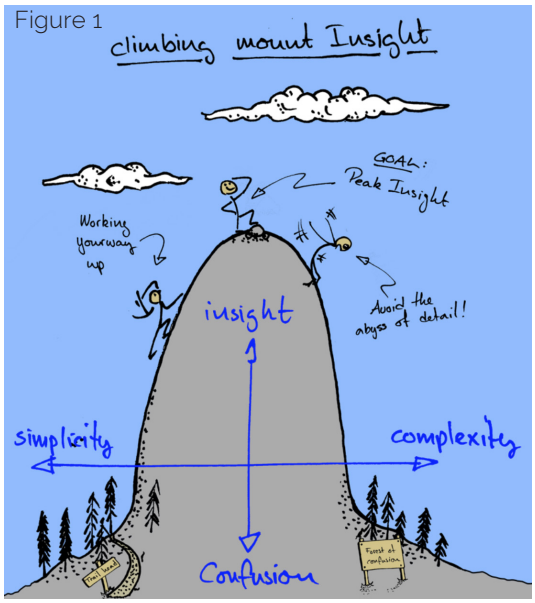
Seeking a model, we usually proceed through intuition driven trial-and-error, starting with a model that is likely much too simple, and adding (or subtracting) components as we realize they are (or are not) needed to describe the experimental data.

To illustrate this process, let me touch upon some recent work on CRISPR-Cas by Misha, Behrouz, and Dylan (M. Klein et al. *Cell Reports* 2018), a team in my group consisting of a PhD student, postdoc, and NB student.

The CRISPR-Cas system is an adaptive immune-system found in many archaea and bacteria and has of late generated a stir because it can be appropriated for gene-editing purposes. By programming a Cas9 nuclease with a short synthetic guide RNA sequence, it can be directed to sites along DNA that have sequence complementary to the loaded guide. When the matching sequence is found, the DNA is cut, offering a versatile pair of scissors that can be applied to cut any position in a genome. Genomes are large though, and even a small chance to hit the wrong site can add up to a sizeable change over all potential off-target sites that can be cleaved in a genome.

By providing a physical understanding of how the CRISPR-Cas system functions and what sequences it will target erroneously, we hope to help to widen the efforts to re-engineer these systems for higher precision, as well as to

Figure 1



understand the various design choices carved out by natural selection. To this end, my team set up a model describing the physics of the targeting process.

After binding, Cas9 is known to sequentially hybridise the guide RNA with the target strand, allowing for cleavage only once the hybridisation process is completed (Figure 2A). To model this, we consider the process of forming an RNA-DNA hybrid as a version of the birth-death process, a process that gets its name from applications to the field of population dynamics (see Figure 2B).

Here we were faced with a choice of how much detail to include. We know the general solution of our model from the literature, but it is complicated and offers little direct insight. There is certainly sequence dependence in that some guides are more promiscuously cutting off-targets than others, but there are also experimental features that seem insensitive to sequence. One of these is that mismatches early on in the hybrid seemed much more likely to prevent cleavage than

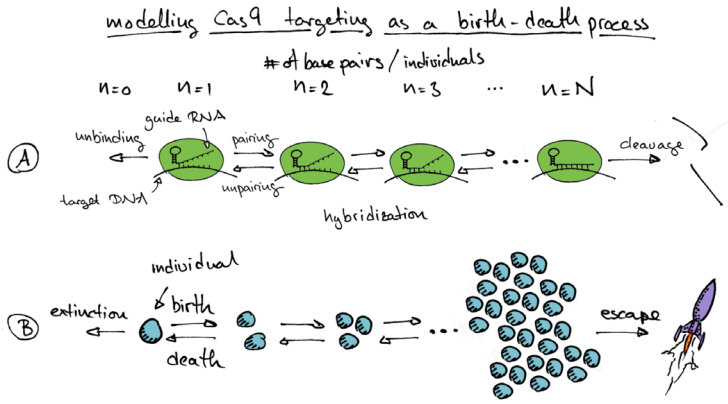
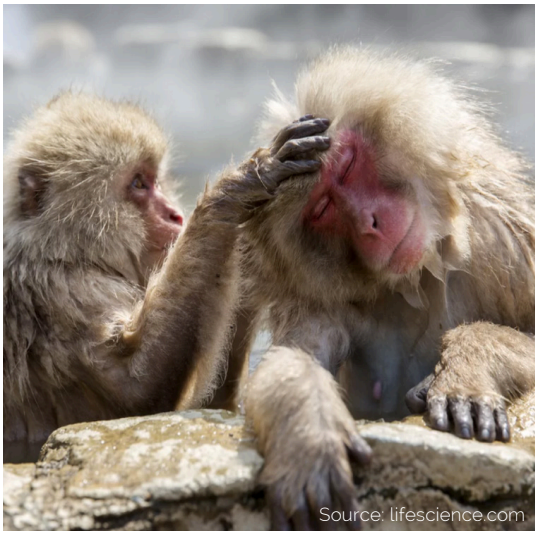


Figure 2

mismatches toward the end. Initially aiming to describe these sequence independent features, we settled for a description containing only correctly matched or mismatched base pairs.

Not keeping track of the bases beyond this level gives us a better shot at a simple yet powerful explanation of the sequence independent features. Doing this, my team could explain why the cleavage probability depends on where mismatches are situated with respect to each other and the underlying sequence. Since then, my team has had further help from Kristian (NB student) and Koen (AP student) in trying to develop this model towards a quantitative tool able to predict cutting probability based on sequence.


Source: lifescience.com

In the end, we are all social animals, primed to look for purpose and intent behind unexplained events And, maybe my preference for studying evolved systems simply springs from a natural instinct to seek intent behind events. Though I changed fields, and now call myself biophysicist, I am still a statistical physicist judging from the methods I use; but one that is pulled toward biology by the treasure trove of purposeful systems available for study in the living world.

Martin Depken
Associate Professor
Bionanoscience Department
Kavli Institute of Nanoscience
TU Delft

INTERVIEW WITH DIRK KRUIT

INSIDE PEOPLE'S FRIDGE

You might have known somebody for many years, but you will never truly know them until you have seen what is in their fridge. Today, we have a look inside the fridge of Dirk Kruit, board member of Hooke. Is the board life too busy to do proper groceries or does he still manage to eat a healthy amount of vegetables each day?

What is the difference between your parents' fridge and your own?
At my parents' house my mom puts everything in the fridge and at my place I do my own groceries, so I have to store it myself. In my parents' fridge, there is more stuff than in my fridge, which is half empty most of the time. My fridge also has more beer.

Are there things that you miss from your parents' fridge?
Ten different kinds of mustard. I like a wide variety of mustard and so do my parents. But I do not really buy it because it is quite expensive and I am not able to finish all the jars by myself.

Most products come from *Albert Heijn*. Are you fond of that supermarket?
There is one really close to where I live, in Rotterdam, near Coolhaven. I live together with five housemates, but we do not share a fridge as most of us have our own. There is, however, a big fridge in the kitchen that I do not use except for the freezer compartment. One roommate does not have a fridge so they basically claim most of the common fridge. Every now and then we eat together. Most often with three or four people, sometimes with everyone.

Are there any products that you must have in your fridge at all times?
Most of the time, I have yoghurt, beer and butter. Oh, and garlic sauce. I use the butter to cook and to spread on my bread. I eat the yoghurt for breakfast.

I see three types of garlic sauce, is there any particular reason?
Sometimes other people's things end up in my fridge because I have the biggest dinner table of my house. Most of the time when we eat together, we have dinner it in my room. Afterwards people sometimes leave garlic sauce, mayonnaise, or ketchup, so I just put it in my fridge.

I noticed that there are not a lot of fresh vegetables or fruits. Is that because you have no time to cook or you do not like cooking?
Mostly, I do groceries on the same day that I cook so I do not have to store anything in my fridge.

Does your fridge always look like this or does it change day by day?
Sometimes it is fuller, sometimes emptier. Right now, I am also out of ketchup, which is something that you would normally find in here.

Your fridge seems really organised. Does this happen spontaneously or by choice?
I do not make the choice to keep my fridge organised. After I came back from vacation it was completely empty. I only went shopping twice since and after the second time I was asked to take a picture so I thought I would put everything in there a bit ordered.

"Most of the time, I have yoghurt, beer and butter.
Oh and garlic sauce.
I use the butter to cook and to spread on my bread.
I eat the yoghurt for breakfast."

There is some meat in your fridge, but not a lot. Have you ever considered becoming a vegetarian?
I only have bacon strips in there now; I do not eat a lot of meat. Normally, I eat vegetarian for three days per week. I do this because meat hurts the environment. However, I could not become fully vegetarian, it would be too hard.

Would you eat anything past the expiration date?
Yes, I would, unless it is moldy or if it smells weird. Anything except meat I think.

I see hummus, sundried tomatoes and olives, which are all Mediterranean foods. Is there a specific reason for this? Do you long for the summer?
A bit, but if that would be the reason, it would be subconscious. It actually could be a subconscious choice.

I also saw an India pale ale beer. Are you fan of this type of beer specifically?
Not really, somebody got it for me but I did not drink it yet. I got this one from the iGEM team after their borrel in *Bar het Lab*. Generally, I think craft beers are alright but not very special.

I noticed that there were three regular beers in your fridge, which is probably less than most student fridges. How come?
I need to buy new beer. I usually prefer *Heineken* or *Grolsch*, because I like the green bottles. Also, *Grolsch* has the "beugels".

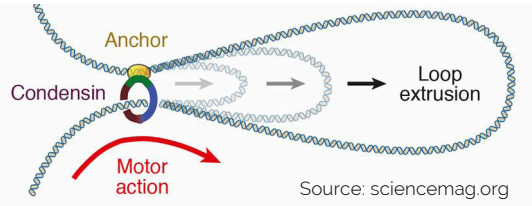
DNA FOLDING, DEPRESSION AND PARENTAL GENOTYPES

NANONEWS

Real-time imaging of DNA loop extrusion by condensin.

As the name suggests, condensin of the protein class SMC (structural maintenance of chromosomes) is an important protein for the spatial organisation of chromosomes. It forms loops in DNA but how was still ambiguous until this article was published. Two different models were most prevalent for explaining the mechanism of the protein; one suggests that condensin connects to two different points that are defined by the amount of supercoiling. The other idea suggests that condensin adheres to one spot on the DNA strand and extrudes a loop asymmetricaly, meaning that one point remains static. Unsurprisingly the name of this hypothesis is also "loop extrusion model".

This February the Cees Dekker Lab, here at BN, together with *EMBL* in Heidelberg published a report in *Science* in which they confirmed the loop extrusion model. They accomplished this by attaching a linear strand of DNA to a surface in a way that there is still plenty of wiggle room for the strand. To this they added ATP, condensin, a stain, and some other necessary components so that

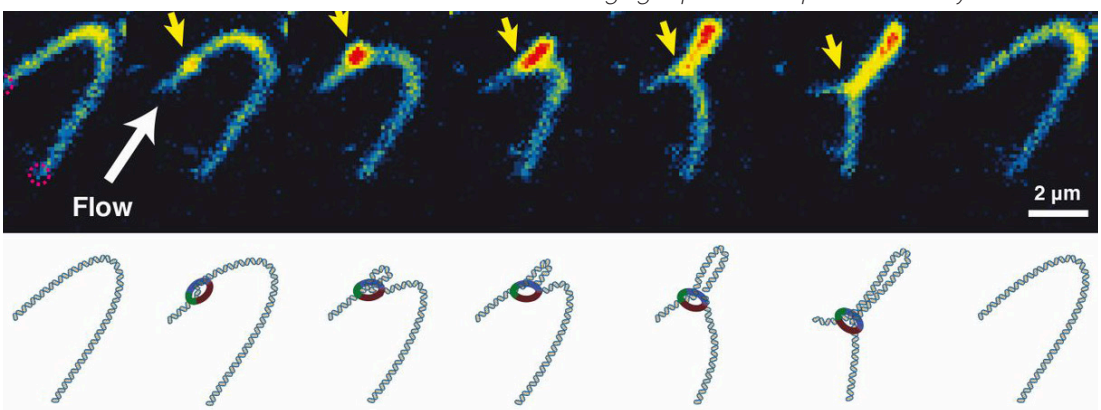


Source: sciencemag.org

the process could be imaged in real-time. With this method they managed to visually confirm the model with several short movies (which you can find online on the *Science* website).

In the article the quantitative nature of the process is also discussed: the speed, how much ATP is required, the maximum loop size and other factors that influence the mechanism. One interesting finding is that the average rate of extrusion is about 0.6 kbp/s which is rather fast. Of course, the rate is influenced by many factors that are too elaborate for this short article. The article is a pleasure to read and is definitely recommended to people who want to know in greater detail how the loop extrusion model works.

Ganji, M., Shaltiel, I. A., Bisht, S., Kim, E., Kalichava, A., Haering, C. H., & Dekker, C. (2018). *Real-time imaging of DNA loop extrusion by condensin.*

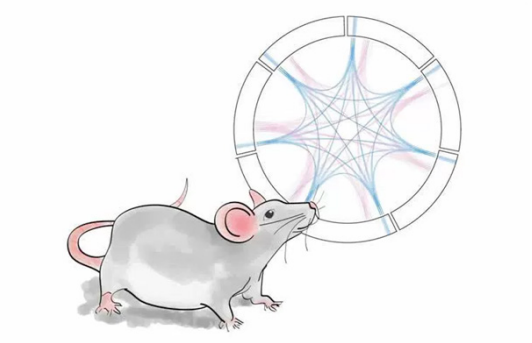


Source: sciencemag.org

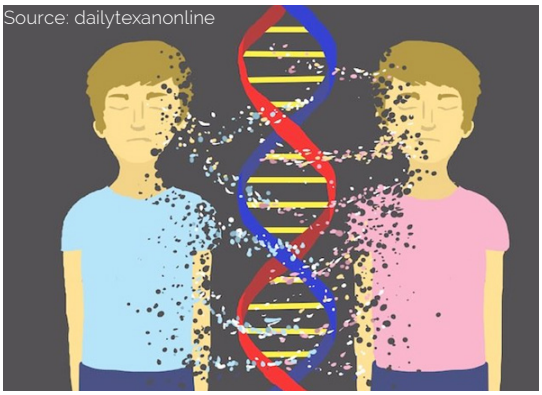
Networks of Brain Activity Predict Vulnerability to Depression

This March an article was published in *Cell* regarding the brain activity of mice when exposed to feelings of depression and anxiety. This has been done by a group from *Duke University* with a relatively new technique that is able to monitor multiple parts of the brain simultaneously. First, a mouse was put in a cage with a rather aggressive partner for ten days. After this period of time the mouse developed symptoms related to depression and anxiety. Then, a full brain scan was made to observe how the different parts of the brain became more or less active and how they worked together.

One interesting result is that mice which can handle stress better and get over it more quickly develop a different brain pattern than mice that are more sensitive, even before the symptoms fully develop. If this can be transposed to human brain patterns we might be able to give better personal treatment to different types of people who cope with these symptoms.



Duke University (2018, March 2). *Networks of Brain Activity Predict Vulnerability to Depression.* NeuroscienceNews. Retrieved March 2, 2018 from http://neurosciencenews.com/depression-brain-activity-8561/



The Nature of Nurture: Effects of parental Genotypes

This January a research group published an article in *Science* regarding the effect of nontransmitted alleles in humans, also known as genetic nurture; the result is quite surprising. The experiments were conducted by looking at different single-nucleotide polymorphisms (SNPs) of tens of thousands of people related to multiple traits e.g. educational attainment, age at first child and body mass index. The expected expression of the transmitted allele was compared to that of the nontransmitted allele and the actual phenotype via polygenic scores.

The conclusion was that nontransmitted alleles have on average 0.342 times the effect of transmitted alleles, looking at the specific examined SNP traits. This result is an interesting development in the everlasting nature versus nurture debate and helps us to get a step closer to an answer.

Kong, Augustine, et al. *The Nature of Nurture: Effects of Parental Genotypes*. Science, American Association for the Advancement of Science, 26 Jan. 2018, science.sciencemag.org/content/359/6374/424.

THE LIFE AND WORK OF EARLY NANOBIOLOGISTS

HISTORY OF NANOBIOLOGY

Nanobiology is a relatively new area of research, but if we look back in time, we will find that some scientists had already begun to study the complexity of living systems in the quantitative way that we seek today.

We all know famous chemists, physicists, and biologists. My question now is: how many nanobiologists can you currently name? My hope is that at the end of this article you will know a bit more about the great lives and discoveries of these early pioneers.

Richard Feynman

Theoretical Physicist

Richard Feynman was born in 1918 in New York City, and is considered one of the greatest physicists of all time. He was a talented teacher and communicator with a great personality and sense of humor.

Feynman redefined quantum electrodynamics (the theory of the interaction between light and matter), changing our way of understanding waves and particles. He was co-awarded the Nobel prize in 1965.

He also developed the concept of nanotechnology. In a lecture at Caltech called *There is plenty room at the bottom* he presented a world of possibilities that could arise from controlling atoms at the smallest of scales. In particular, he was interested in the denser computer circuitry and seeing much smaller things with scanning microscopes. Other provocative ideas were the construction of nanoscale machines and the concept of "swallowing the doctor".

Fun facts:

• When the young Richard Feynman got bored in the New Mexico desert, working on the *Manhattan Project*, he found a hobby: cracking safes. Eventually he became so good, he could open nearly every cabinet, lock or safe.

• He had a passion for playing drums, as well as for the bongos.

• He had a great reputation as a prankster and his autobiography is entitled *Surely You're Joking, Mr. Feynman.*

Source: Wikipedia

K. Eric Drexler
Engineer

Kim Eric Drexler was born in 1955 in California and is best known as "The godfather of nanotechnology" for popularising its potential use and benefits for humans.

Drexler began his early career at MIT, where he wanted to become an astronomer. He took a radical turn to become an engineer at the molecular level. He wanted to find if there was a means by which one could replicate cellular operations through tiny machines.

In 1991 he published his doctoral thesis at *MIT*, and the following year it was turned into a book: *Nanosystems: Molecular Machinery Manufacturing and Computation*. He is best known for his book: *Engines of Creation.*


Source: fhi.ox

Drexler's work on nanotechnology was criticised as naive by Nobel Prize winner Richard Smalley in an article from 2001. The debate was intense, however, backed up by recent discoveries, Drexler is confident that in 30 years there will be a revolution in nanoengineering.

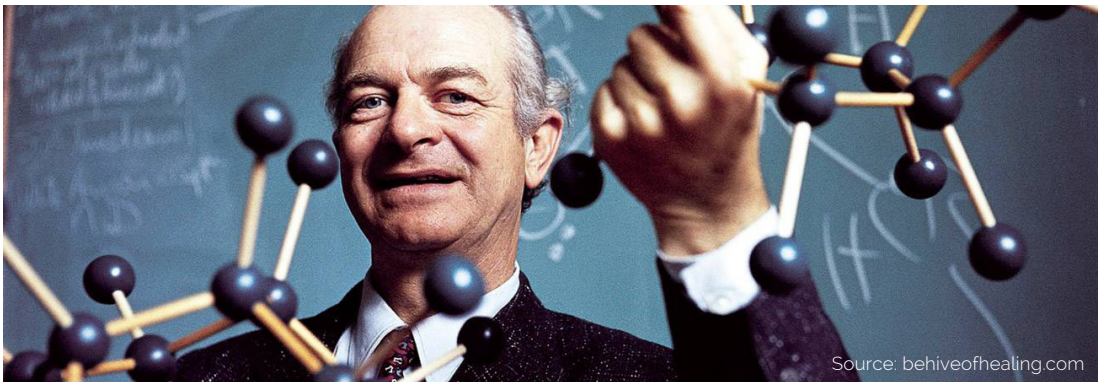
Fun facts:
• He got involved with *NASA* and was active in space politics, opposing the *Moon Treaty.*
• He is an outspoken advocate for cryonics.
• He is present in a lot of sci-fi literature, seen as an idol.

Barbara McClintock
Cytogenetist

Barbara McClintock was born in 1902 in Connecticut. Alongside her scientific career she had three revolutionary achievements that earned her the title of nanobiologist.

First she mapped out the cytology of the maize plant, creating an elaborate and precise genetic map of its chromosomes.
Second she discovered transposable elements, genes that change position among the chromosomes. She won a Nobel Prize in the category of Physiology or Medicine for this discovery in 1983.


Source: Wikipedia


Source: behiveofhealing.com

Third the discovery of what she called "the dynamic genome", a prelude of epigenetics and evolutionary developmental biology. During the last phase of her career she was devoted to integrating genetics, development, and evolution into a sweeping vision of organic change on different time scales.

Sadly, her early works eclipsed all her later findings: She will always be remembered as the discoverer of transposition, not of genetic control.

Fun facts:
• McClintock hated the restrictions and tedium of academic life. She shocked the faculty by climbing in the window of her locked laboratory after hours.
• She loved jazz and played in a band as tenor banjo.

Linus Carl Pauling
Biochemist, Quantum Chemist

Linus Carl Pauling was born in 1901 in Oregon. He discovered so many things in multidisciplinary subjects that the title of nanobiologist suits him well.

Pauling had a hard childhood, growing up in a poor family, even having to drop out of high school to work. Eventually, he saved enough money to study in college, where he graduated summa cum laude.

An intense career followed: he contributed to the theory of the chemical bond with quantum mechanics, worked out the secondary structure of proteins and determined the first molecular disorders. In other words; all the basics we learn in our first year..

During the 40s he attempted to end nuclear bomb testing and speak out for world peace in every speech he made. In recognition of these efforts, he was awarded the 1963 Nobel Peace Prize.

Fun facts:
• He was crazy about the properties of vitamin C, theorising that taking megadoses of vitamins could help treat everything from the common cold to cancer and AIDS.
• James Watson and Francis Crick were afraid that he would discover the DNA structure first.
• He is the only person to receive two unshared Nobel Prizes (Chemistry and Peace).

WNT 2018: TO SURF OR NOT TO SURF

WNT REVIEW

On a Wntry and very early Sunday morning, the adventurous Wnt Hoes gathered at Schiphol airport in front of our beloved *Burger King*. We rolled into the airplane dreaming of catching big waves on the beautiful island Fuerteventura!

After we had left the ice cold Netherlands behind, we were gently welcomed by a warm sun shining on the rocky island. In Corralejo, we were dropped off at two different surf hostels which had been waiting to be terrorised by our lovely group. If we needed a tray of beer or some *Ice*, we visited our beloved *HiperDino*. Walking around town you could see a rare collection of non-typical tourist souvenir shops and an even rarer collection of people under the age of eighty.

Nevertheless the generation gap could not withstand some of Hooke's adrenaline seekers from taking a chance at the British ladies. This all happened at the wonderful beer bucket bar *Spectrum*, where we enjoyed dancing with the oldies. Although this place was **LIT**, the herd had to move on. *Flicks Bar* gave the amazing opportunity to use hidden vocal talents to seduce Amaiia, for example. At bar *Kiwi*, we discovered people (of our age!) going wild on our favorite playlist. After some long island iced teas, the herd of nanos stumbled to its final station, *Waikiki*!

Waking up hungover and smelling liquid leftovers gave enough motivation to jump into the vans that took us to *La Gran Playa*. On the beach we first practised paddling and jumping on the board, which was quite easy.

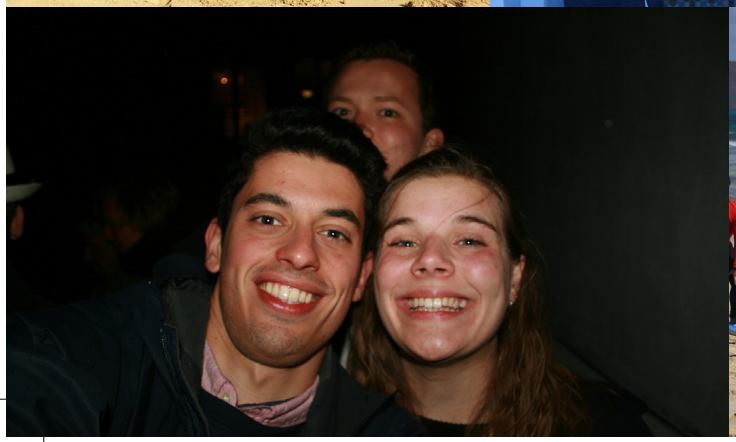


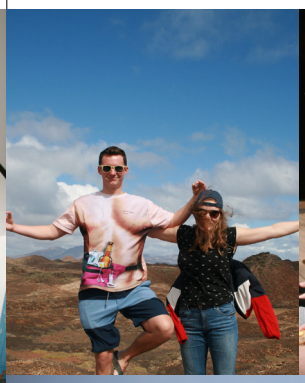

















In the sea, however, waves of up to 3.5 metres high could swallow you whole while strong wnts could knock you off your board. Even though the sea was rough, there were always courageous people daring to challenge the ocean.

Not only the waves were challenged, but volcanoes as well. After climbing to the top, we raced down the wild rocky roads of the volcanoes experiencing the rough wilderness of Fuerteventura. The land contained the most beautiful views, steep hills, and curvy roads. Some roads were a bit too curvy for the high speeds we reached, resulting in open knees.

The wounds were almost healed when another adventure began; the cocktail night.

Five containers filled with cocktails were prepared for a cosy night on the roof of *Sol y Mar* with the Wnt hoes, surf instructors and photographers. Inside the hostel, Katunk was played vividly and cocktails were drunk like water. The *Sol y Mar* party continued in *Down Under* to the sound of live reggae music. Some had to be carried home and others made a few interesting decisions... It was a memorable evening.

On the last day in Fuerteventura we decided to go for a hike on Isla de Lobos, the small island that we could see from Corralejo. On the island, we first hopped on the boat and went snorkeling, surrounded by fish. Afterwards we began the journey to the top of the mountain where we enjoyed a magnificent view.

After this amazing holiday, Wnt 2 wants to thank some people: Claire for giving our deposit back, Greg for teaching us how to surf and for partying along, Ali for the cleaning and the zero tolerance, Cohecie, *Hostel Hanna* (you will always be in our hearts), and most importantly: we want to thank our dear Wnt Hoes!

Lots of love,
Wnt 2

GATTACA

MRNA REVIEWS

Once again, mRNA has cosily gathered to watch a film and review it. This time, one closely related to our study: *Gattaca*. One cannot help but immediately notice the initials of the four nucleobases in the title. It is a good start.

The film is set in a not too distant future where children are conceived using genetic engineering to ensure they possess the best hereditary traits from their parents, providing them with the best opportunities to succeed.

The story is one of a child born from natural means who struggles to overcome genetic discrimination; even against a defectless, artificially conceived brother. In order to make a living the boy works in the most unpleasant positions, unable to climb the ladder due to his less favorable gene pool. "My real résumé was in my cells," he explains.

Source: Gattaca (1997)

He finally ends up as a cleaner in a company called *Gatacca*, an academy for astronauts. Via an elaborate scheme full of fraud and deception, he is able to dodge the system which seeks to discard the imperfections in society's genes and fulfill his dream of travelling into space.

We had a really nice time watching this film and were pleasantly surprised by its scientific accuracy, as well as by its many delightful references, like the spiralled DNA-like staircases, which made us grin in complicity.

Many topics for debate were raised after the movie. The first and most evident one is the dangers of biological determinism, this is, the belief that a person's behavior can be solely explained by its genes.

Scientific knowledge, when treated as an objective truth, can serve as an argument in favour of discrimination, as it has done whenever dealing with concepts like race, gender and sexuality. We ought to keep in mind that determinism in nature has not yet been proven, and that scientific theories are not entirely infallible.

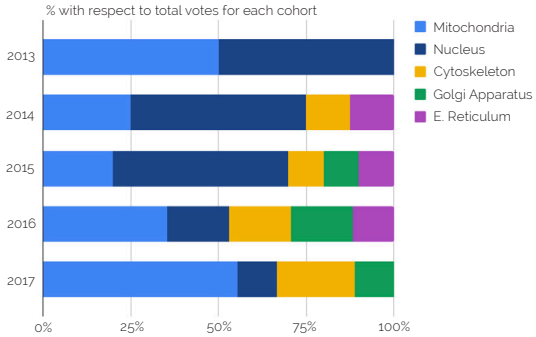
Another subject we covered was the issue with genetically modified babies. This one is trickier, because beforehand, there is not a clear reason why we should not improve human beings. My personal view was that perfection puts an unbearable pressure on people because it leaves them without a reason to fail, which in the end, is what really makes us human.

Mankind has engaged in such a technological race that, in a sprint, we may risk forgetting where we come from. To my relief, films like *Gattaca* keep reminding me that, even in today's rushed and shallow lives, there is still a little space left for a calm and collected analysis of progress.

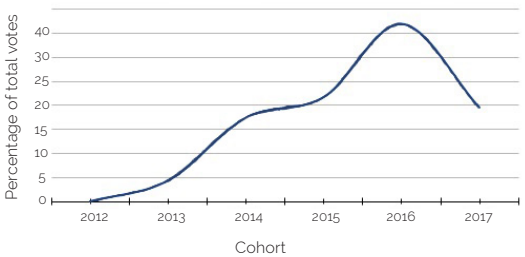
THE ORGANELLE ELECTION RESULTS

THE ELECTION 2017-2018

After a seemingly endless campaign, a neck and neck race resulted in a decisive victory for the mitochondria leaving their political opponents in the dust, once and for all establishing that the mitochondria are indeed the powerhouse of the cell. With a thoroughly extensive analysis of the census statistics I will try to address the effects of residence and age on the election in full detail.



One of the most striking elements of this election is that voter turnout does not increase with age.

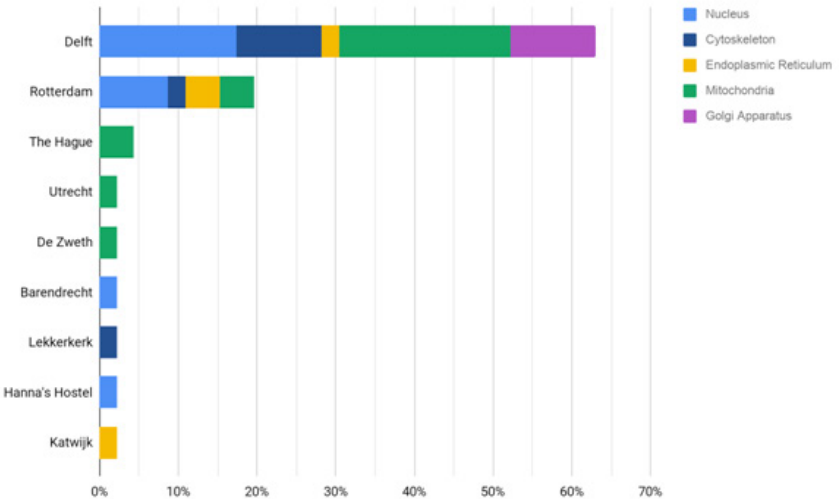


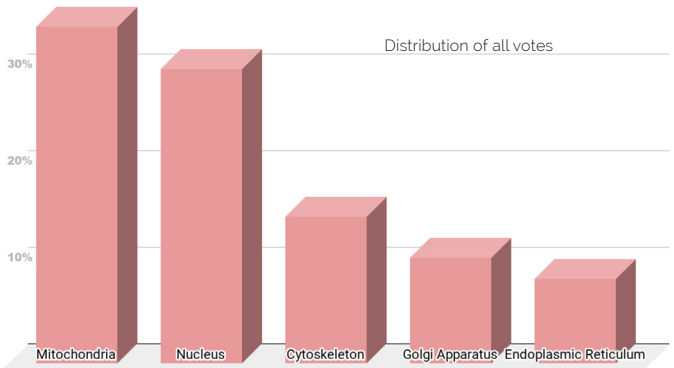
Usually, the elderly vote twice as often as people in their twenties; their numbers completely dwarf those of teens, who apparently do not care about representation whatsoever. Furthermore, there is generally a positive correlation between turnout and education. Where then are the votes of Nanobiology's first cohorts? Could it be that the political representation is completely out of touch?

Another striking characteristic of the vote pattern is how the percentage of votes for the winning candidate changes per cohort. 2017 was most supportive of the mitochondria; 56% were in favour of the political powerhouse. The backing falls to 20% for 2015, but regains momentum for both 2014 and 2013; 25% and 50% of votes respectively.

While the mitochondria votes were in decline, the nucleus elbowed itself into popularity. For the younger generations (2016, 2017) support did not exceed 20%, but the older cohorts chose the cell core en masse; 50% of 2013, 2014 and 2015 favoured it with their vote.

As a vote represents its voter, I argue that the mitochondria exemplifiy the work ethic that is prevalent in student life. The young, energetic freshmen have to struggle to pass their first year. After they have given their all, the exhaustion in combination with the alleviation of BSA stress results in a drop of mitochondria popularity, which is gradually restored when the pressure to get a piece of paper, which somehow represents years of toil and trouble, returns. By extension, the popularity of the nucleus corresponds to the appreciation of the critically acclaimed 70s psychedelic jazz-rock outfit *Nucleus*, which is apparently acquired taste among nanobiologists.





So far, I have not yet referred to the influence of residence on the outcome. Before I do, I should mention some objections that were raised because of residence and other personal information requested on the ballot. Some declared it privacy infringement, others objected to the implicitly supported archaic property qualifications required for suffrage; requesting residence information seems to bar the right to vote from those without permanent accommodation. On behalf of the entire census committee I must apologise, as this was not our intention.

Furthermore, the requested information was not a *condicio sine qua non* to be allowed to cast your vote; a simple "prefer not answer" would have sufficed as well.

Let us continue with exploring the possibility of a correlation between accomodation location and voting behaviour. Most notable is that the places that represent less than 5% of total votes, each support one candidate unanimously, but there seems to be no relation to the outcome.

To summarize, votes for mitochondria seem to correlate to academic stamina, while there is a positive correlation between niche jazz-rock appreciation and age. Lastly, our data does not support the hypothesis that residence influenced the outcome of the election.

INTERVIEW WITH BRAM VERHAGEN

ALUMNUS COLUMNUS

Last year, the first nanobiologists graduated. Bram Verhagen is one of the pioneers who has achieved this wonderful distinction. We interviewed him about his career so far.

When you started the bachelor Nanobiology, what did you have in mind to do after graduation?

It was more like a gamble what to do in the future. It was around my third year that I found out what I would like to do. The bachelor's end project, for example, made it much clearer to me what I wanted to do. By that time, you might notice that working in a lab is not as expected and that it is not something you would like. But for me, it really was the right place.

Source: Facebook

Where do you work right now?

I work at the *Hubrecht Institute* in the group of Marvin Tanenbaum. Here, we are doing research on translation dynamics. I am making screens on translation initiation frequencies, ribosomal and RNA binding proteins for which we use the recently developed imaging technique *SunTag*.

Could you relate this project to one of the courses of Nanobiology?

The project best resembles *Biomolecular Dynamics*. The part I am doing, though, looks more like *Bioinformatics*. Since the project has just started, we do not really know what to expect. We are using a large range of about 15.000 sequences, so something interesting might surprisingly arise. Therefore, in the future, it might be more on molecular pathways, but this is just speculation.

"You might notice that working in a lab is not as expected. But for me, it really was the right place."

Do you have any tips for current students?

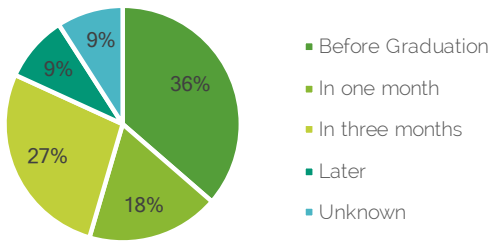
You really have to do what you like. In a project for example, you want to have a nice group and colleagues. The work climate is actually quite important. An interesting topic will be guaranteed, since in life sciences there are plenty.

DATA ANALYSIS OF THE FIRST GRADUATES

ALUMNI ANALYSIS

Do you remember when you were searching for the best bachelor's degree? All the programs showed you diagrams about your possible future. The only bachelor's degree that disappointed you in this respect, was Nanobiology. However, now that the first students have graduated we are finally able to show you why Nanobiology was and is the best choice for your career.

When did the alumni obtain the opportunity for their current job?



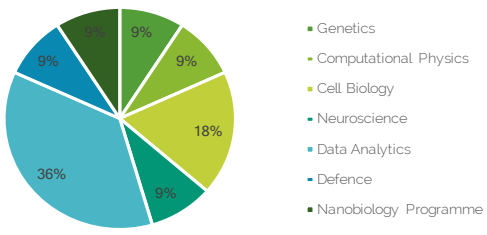
Did you know…

• that 100% of the alumni graduated without any study delay? The study Nanobiology is the only programme with these remarkable statistics!

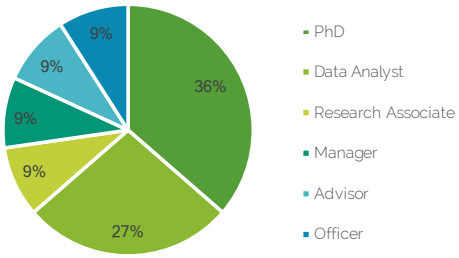
• that just two alumni are women? This is a good reflection of universities in their early days, when only men could join. Luckily, after the first year the first-wave of feminism arose within Nanobiology.

• that just 27% of the alumni continued working at the *TU Delft* or *Erasmus MC*?

In which field of science do the alumni work?



What is their role in the team?



The suitable companies to work for after graduation range from *Ernst & Young* (data analysis) to the research of *Hubrecht Institute* or a university. One of our alumni even works for the *Ministry of Defence*.

Furthermore, the fields where the alumni ended up are evenly divided over the possible fields, as was already indicated before in this analysis. Therefore, it is proven that Nanobiology students have a lot of options to choose from for their career.

Moreover, we are content to announce that the majority of the alumni were certain of a job in one month after graduation!

We conclude that the expectations that the board had are verified to be true. We can guarantee that the Nanobiology students will be certain of a job in all possible fields.

Disclaimer:
Please notice that the analysis has been done with a set of data of just 11 subjects. Therefore, the error could be tremendously large and this group might not be representative for the collection of all remaining students. Keep this in mind while reading the article. This is your responsibility. We cannot guarantee the correctness or completeness of given information. mRNA will not accept any liability for possible misleading conclusions.

ORIGAMI STRUCTURES WITH NANOPATTERNS

RESEARCH

Nowadays, metamaterials are created with 3D printed lattice structures. These lattice structures should be covered with features that give the metamaterials the wanted characteristics. However, since the lattice patterns are 3D printed, it is very complex to adjust the inner surface with micro or nano patterns. Inspired by the Japanese art of origami, A. Zadpoor of the TU Delft Imaging Physics Department chose to print the lattice patterns 2D and fold it afterwards. Hereby, the nanopatterns could be added all over the surface, thus the metamaterial could be given the desired characteristics.

Using a wonderfuly contemporary technique various metamaterials can be made. These 3D printed lattice structures are used in a lot of fields. The characteristics are mainly determined by the shape in which the metamaterials are created.

Metamaterials are used, for example, as medical implants. These metamaterials can gain extra functions by the addition of micro- and nanopatterns on the inner surface. The inner surface, however, is really hard to reach. This is a problem.

Professor A. Zadpoor of the *TU Delft Imaging Physics* department has found a way to solve this issue. The problem, he thought, was created by the fact that the nanopatterns were added when the structure had already been formed. Instead of shaping the material and adding the nanopatterns, he wanted to adjust the surface first and create the shape afterwards. The flat surface should just automatically be able to fold itself. His inspiration for this was the Japanese art of origami.

The structures which can be created easily are composed of several slices which are combined by orthogonal slices. Due to this a raster of cubes is formed (see figure 1, category 1). This raster exists of several so-called floors. If these floors are connected to each other in series in the flat structure, they can be formed to this cube.

When splitting a floor in two and arranging them in series in an alternating manner, the surface will fold to structures of category 2 in figure 1. In the two-dimensional profile, it can easily be seen that the two halfs will end up facing each other in the final structure consisting of octahedrons. A lot of variants are possible for this category.

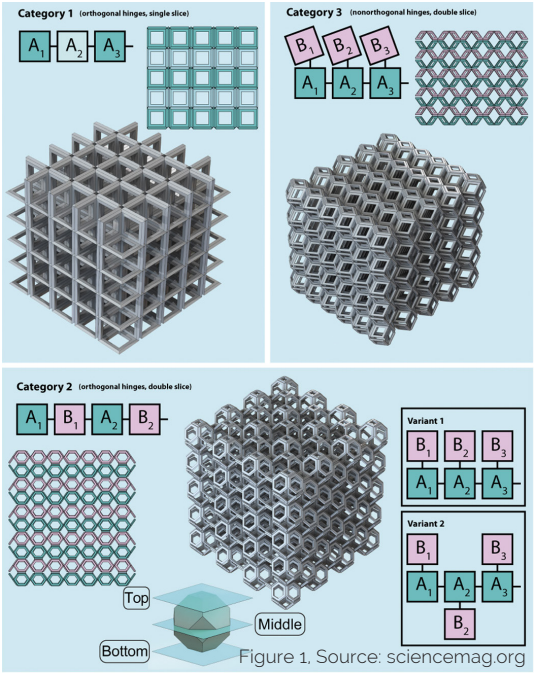
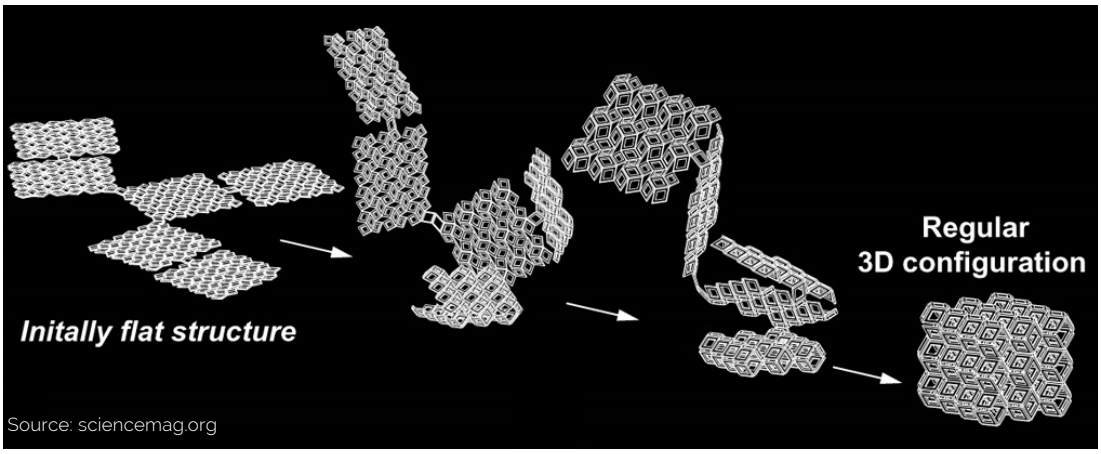


Figure 1, Source: sciencemag.org

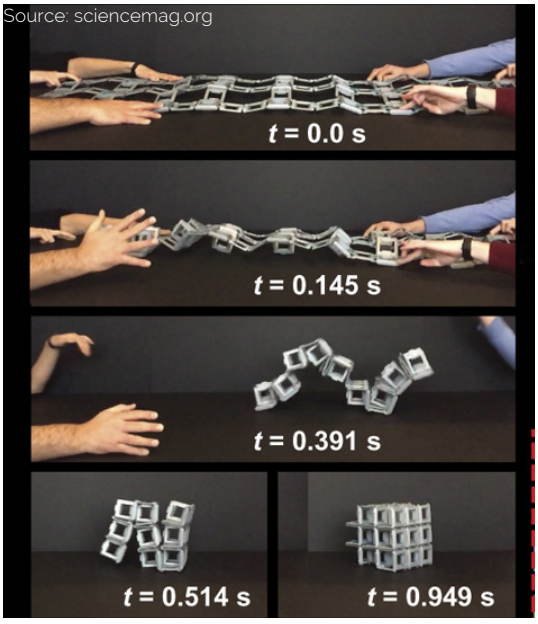


One of these variants created such a different structure that it is seen as a separate category. This structure exists of dodecahedrons. Here the cells of the 3D structure are also made out of two parts. These parts will, contrary to category 2, not be placed orthogonal to each other. Thus the angle is crucial for the way the flat surface will be folded.

The most remarkable part is that the structures do not have to be folded as in origami; they will fold themselves. The folding lines can be seen as hinges, where the angle between the two parts of the surface can be varied. Connecting both sides with the hinge in the middle with normal elastic bands makes the surface fold automatically. Increasing the number of elastic bands used also increases the formation speed of the structure. After the folding, the structure can be locked, and will be stable; it can be used in biomechanical engineering.

This technique can be used to create many different metamaterials. One of the applications is the formation of biomaterials, which can be put in humans to stimulate the regeneration of lost tissue. Certain nanopatterns can be applied to the surface, which gives neighbouring stem cells the sign to start differentiating. Furthermore, through the pores of the biomaterials transport can occur. Both oxygen and essential nutrients can be delivered to the cells. These are just two of the possible applications, but with a little bit of creativity you might accidentally find a magnificent new purpose of this technique.

Janbaz, Shahram, et al. "*Origami lattices with free-form surface ornaments*." Science advances 3.11 (2017)



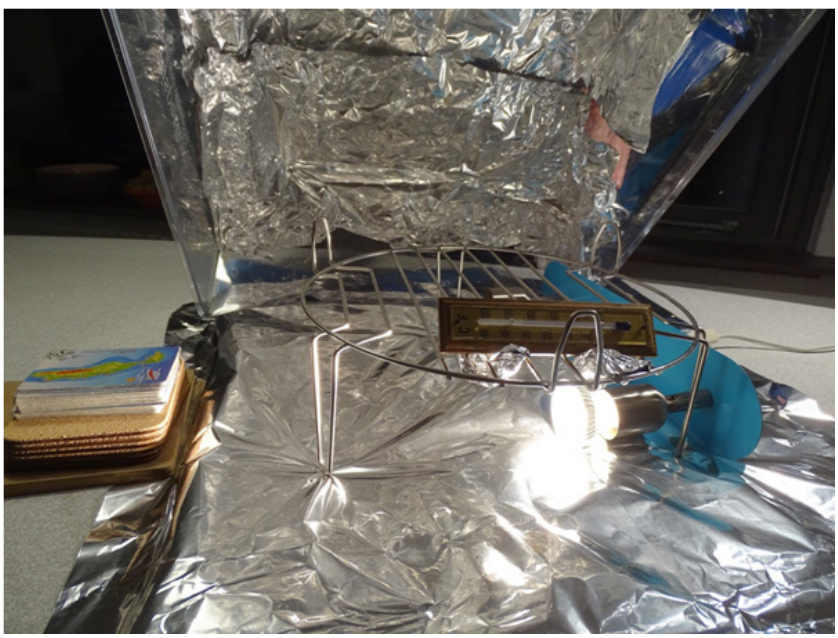
DIY INCUBATOR

IN THE FIELD

As any true nanobiologist, you have probably thought about growing bacterial colonies in your living room. Remember the pretty Petri dishes from *Labcourse 1*? Imagine if you could look at this every day! Here, we present a simple DIY incubator; perfect for the nanobiologist who wants to take their work home. Bacteria are all around us, Petri dishes are easily available online, and agar-agar is sold at most big supermarkets. This leaves you with one missing component: the incubator. Unfortunately, incubators are not cheap; the cheapest one we could find was a mere six thousand dollars. Therefore, we, the editors of mRNA, will explain how to make your own incubator, using solely products that most people already have at home. So next time you are bored on a Sunday evening, you can grow your very own bacterial colonies.

For the best result, use:

- Crisper box (from a Siemens KG36NHI32 2016)
- Non-LED lamp (Fuxing GU10+C 220-240V 50W)
- Aluminium foil (Aromata)
- Microwave rack (from Moulinex MO32ECSL)
- A form of elevation to let in cool air (6 coasters, cheese platter and 52 playing cards)
- Thermometer
- Towels
- Sticky tape



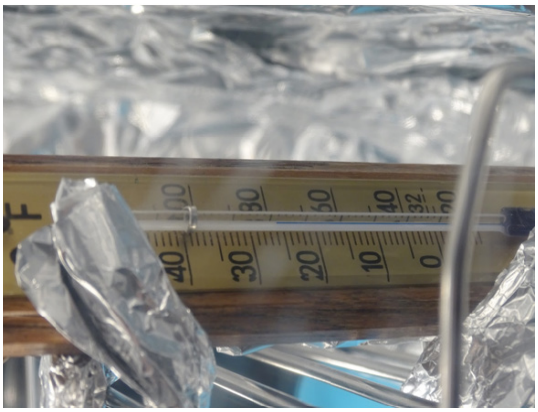
Instructions

1. Start by taking the crisper box out of the fridge and clean it. Cover all insides with the aluminium foil, with the shiny side facing towards the inside of the box. Make sure that you leave one side uncovered to be able to check the thermometer. Use sticky tape if the aluminium foil does not stay in place.

2. Spread the towel over the table and place the lamp and the rack on top. Turn on the lamp and place the thermometer on the rack. This is where you will place your Petri dish, so it is most important that you know the temperature at this location.

3. Place the crisper on top of the rack and the lamp. Check the temperature regularly, such as every two minutes.

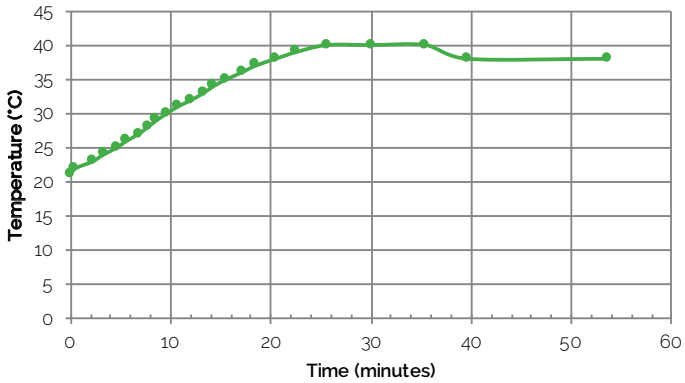
4. You usually want the temperature inside of the incubator to be around 37 °C. However, this depends on what you are trying to grow. If the inside of the incubator becomes too warm, you can lift the crisper box using materials such as but not limited to coasters or playing cards. In our case, we lifted the crisper box 4.9 ± 0.1 cm, using 6 coasters, a cheese platter and 52 playing cards.



That is everything you have got to do to build your own incubator!

N.B. you probably should not leave the lamp on for an extended period of time, as you could burn down your house. Remember to handle the content of the incubator responsibly!

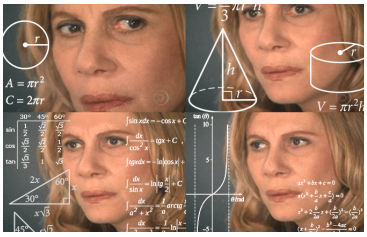
Temperature control of the incubator



SYSTEMS & SIGNALS AND THE WORLD WIDE WEB

MRQNA

Dear mRNA,
Was [*Systems and Signals*] invented or discovered?
Kind regards,
Sonny



Dear Sonny,
To address this question, you need to look at the bigger picture: was mathematics in general invented or discovered?
This problem has baffled mathematicians and philosophers alike for centuries, one interesting take on it comes from Stephen Wolfram, the founder and CEO of *Wolfram Research*. He discusses whether mathematics would look the same if one would arbitrarily describe a system without knowing any of the current mathematics. This is not necessarily so, one could easily take a set of new axioms and rules and still be able to prove modern theorems but in an unusual way. So eventually if you look at the fundamental roots of mathematics you have to say that it was invented and as a result *Systems and Signals* was also invented.

Sincerely,
mRNA

Dear [mRNA people],
I had a question for the new [mRNA]! I was wondering, can you use [*Web Whatsapp*] on your mobile phone[?] Maybe only on [*iOS*] or [*Android*?]
[Groetjes] Marlo

Dear Marlo,
The *World Wide Web* was invented by the English scientist Tim Berners-Lee in 1989. While employed at *CERN* in Switzerland, he wrote the first web browser computer program in 1990. From this, one can argue that the proper habitat of *Web Whatsapp* ought to be on a computer, and not on a phone. This argument comes not from the definition of the word "Web", but rather from the intended usage of the *World Wide Web*, which is on a computer. However, mRNA is willing to ignore this issue in order to answer your question. In search for an answer to what might turn out to be one of the most fundamental questions of life, mRNA set up an experiment. Before we could start, we had to think long and hard about another issue that would keep us up for days as we would find out later. During these endless days and sleepless nights, there was one quote we could not stop thinking about. It was the renowned and well-respected scientist and mathematician Dr. Ian Malcolm who said: "Your scientists were so preoccupied with whether they could that they [did not] stop to think if they should" (*Jurassic Park*, 1993). With these inspiring words in mind, we decided to cancel the experiment and continued InDesigning.

Hope to hear from you soon, my darling,
mRNA

TABLETOP RENAISSANCE

RANDI

>> rng ('shuffle');
>> randi(nr_leden)
ans = 222 %Tjeerd Peters

About two months ago, there was a book that topped that week's *Wall Street Journal* non-fiction bestseller list: *Xanathar's Guide to Everything*. An unassuming title for most, a bit of a strange name for the non-fiction section, but this book is part of a larger trend. It is an expansion to the 5th edition of the pen and paper role playing game *Dungeons and Dragons*, where players sit around a table to describe the actions their characters (an elf wizard, human fighter, dwarven rogue, etc.) take, and one person, the Dungeon Master, who decides what their character can do and how the world reacts. The 5th edition of this game has sold more copies than any previous edition and its core rulebook ranked #40 of total books sold on *Amazon* in 2017. The game's influence is hard to miss if you know what you are looking for.

The setting of *The Elder Scrolls*, most familiar to the public via the game *Skyrim*, started its life as a pen and paper role playing game. *Dungeons and Dragons* (also known as *D&D*) itself features in the series *Stranger Things*, and celebrities like Stephen Colbert and Vin Diesel have shown to be players of the game. The game's own most obvious inspiration is found in the works of Tolkien, but *D&D* came from an amalgamation of many different contemporary fantasy authors, wargaming, board games and improvisational theatre.

Dungeons and Dragons started as the fantasy spinoff of the medieval miniature wargame *Chainmail*, and was first published in 1974 by Dave Arneson and Gary Gygax. In contrast to its predecessor, its rules focused more on individuals, character classes and level progression from one session to the other. Over the years it has been through many different stages; it was subject to a satanic panic in the 1980s and some editions were more successful than others. With the rise of video games and the decline of in-person contact, one might imagine that a game which requires you to sit down around a table for a couple hours might not gain much traction, but its latest edition is the most successful yet.

So what causes it to be so popular now? Well, there could be multiple factors at play. One might be the latest edition's simplicity and comprehensiveness for which it is praised. It might be that the basic rules for an introduction to the game are available for free online, legally. There is also the increased prevalence of *D&D* livestreams and podcasts, the most famous of which, *Critical Role*, a livestream with professional voice actors playing their home game on air, has over 6 million views on its first episode. Or maybe it is just a desire to return to building a story together in a world with no limitations to what you can do. Whatever the cause, it seems to result in a more successful edition of *Dungeons and Dragons* than ever before.

Tjeerd Peters

READY SET GO!

PUZZLES

It is time for puzzles! Each puzzle contains three sets of three words. Each set of three words is related to one new word. These six words together form the solution of the puzzle. Good luck!

fruit	genome	EI
twice	model	hospital
Matlab	LR	morse

imaging	double	G1/S
Freddi	squeegee	hairflip
mate	123	zebra

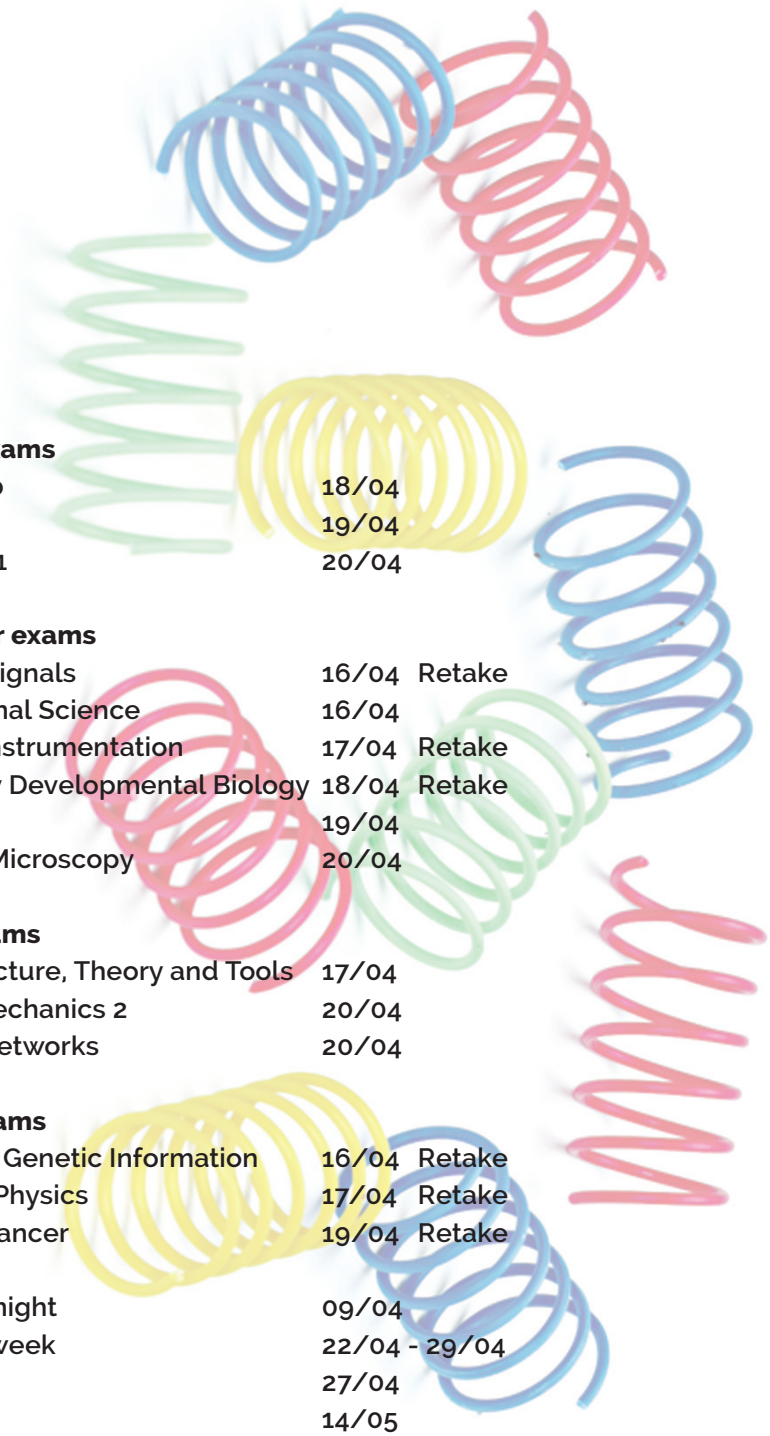
Solution to the previous puzzle:

1. Kasper
2. Okazaki
3. BSA
4. curvasdenivel
5. current
6. ice
7. centraldogma
8. force
9. cytoskeleton
10. Heisenberg
11. mitochondrion
12. skin
13. animal
14. billion
15. experiment
16. niveaukromme
17. Mendel
18. Fourier

Send your solution to mrna-hooke@tudelft.nl and have a chance to win an awesome prize!
The winner of the puzzle of the previous edition is Lex Huismans. Congratulations, Lex!

UNCOMING ACTIVITIES

HOOKE AGENDA



First year exams

Journal Club	18/04	
Biophysics	19/04	
Lab Course 1	20/04	

Second year exams

Systems & Signals	16/04	Retake
Computational Science	16/04	
Electronic Instrumentation	17/04	Retake
Evolutionary Developmental Biology	18/04	Retake
Evolution	19/04	
Optics and Microscopy	20/04	

Elective exams

Protein Structure, Theory and Tools	17/04	
Quantum Mechanics 2	20/04	
Biological Networks	20/04	

Master's exams

Engineering Genetic Information	16/04	Retake
Soft Matter Physics	17/04	Retake
Biology of Cancer	19/04	Retake

Committee night	09/04
B3-is-back week	22/04 - 29/04
King's Day	27/04
LABDance	14/05