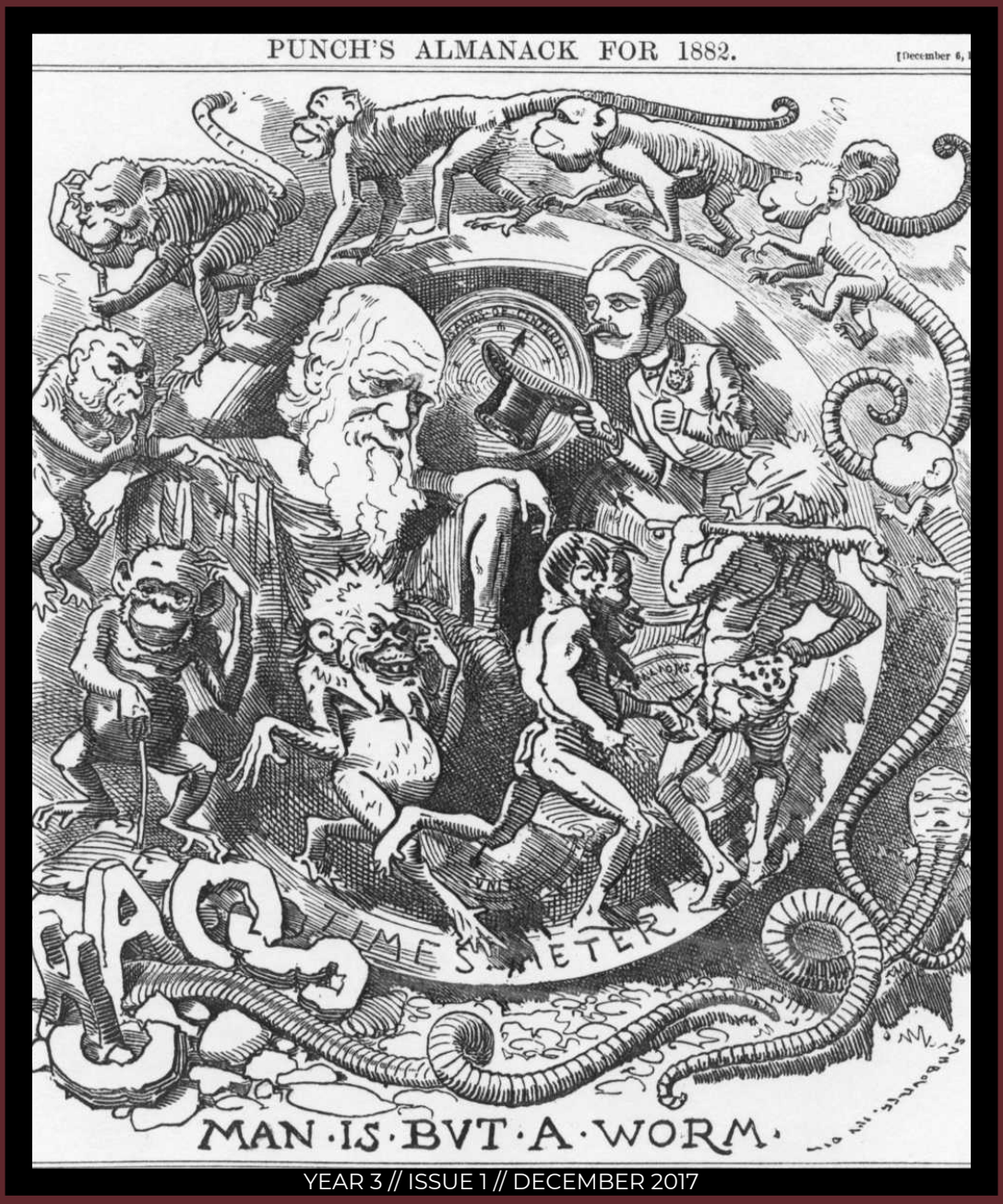
mRNA



YEAR 3 // ISSUE 1 // DECEMBER 2017

THEORIES OF EVOLUTION // PANSPERMIA // MINORS // BERTUS BEAUMONT // MRQNA // INSIDE PEOPLE'S FRIDGE // BERND RIEGER // ORGANELLE ELECTION

Image: Wikipedia

EDITORS

Editor-in-chief: Niels Werij
Editor: Sonny Floyd de Jong
Captian InDesign: Tessa Vergroesen
Captian InDesign: Nico Kerkhoven
Commissioner of Acquisition: Aisha So
QQ: Danilo Remmers

CONTENT

DEAR READER,

It is time to snuggle up by the fireplace with your favourite periodical: there is a new edition of Hooke's very own magazine hot off the press. Updated with four SNPs (Aisha, Danilo, Nico and me), the mRNA is in the words of A Tribe Called Quest: stirn, ferm and young with a laid-back tongue. As this is the first edition of the renewed committee, we have learned a lot in the making of it, but we still have a long way to go. Either way, we aim to maintain the standard of our predecessors, while adding something new of our own. This ewdition could not have been made without Sonny and Tessa, who will leave the committee after this has been published. To them I say: we got it from here. Thank you for your service.

Niels Werij
Editor-in-chief of mRNA 2.5

COLOPHON

The mRNA is the official magazine of the Study Association for Nanobiology, S.V.N.B. Hooke. Printed versions will be send 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.

S.V.N.B. Hooke
mrna-hooke@tudelft.nl
Van der Maasweg 9
room D0.120
2629HZ Delft
015 2781639

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FROM THE BOARD

Dear members,

It is already freezing outside and sunlight is a rare phenomenon these days, yet it feels like yesterday that we were appointed as the fourth board of S.V.N.B. Hooke. With one hundred freshmen we sang our hearts out during the OWee to show the entire Auditorium that Nanobiology is the most awesome study programme of Delft (and Rotterdam of course). On 4 September, we realised that being board members had led to the most chaotic and busiest period of our life. Our days were filled with meetings, lunches with mentor groups, "constitutieborrels", and trying to find out what we were actually doing all day.

After a few weeks, the first exam period arrived and the hectic days came to an end. Now, the first master's graduates have officially received their degree in Nanobiology, our new committees started organising activities, and many people enjoyed the members' dinner. Our days as a board have become more structured. The ideas we had at the beginning of this year are starting to take shape and it makes us happy and proud to see so many nanobiologists enjoying activities and developing themselves. S.V.N.B. Hooke is also still growing: on 20 November, our association turned three years old, which was celebrated in a wonderful dies week.

While the days are short and filled with stress for Physics 1a and S&S, never forget to take a second and smile. Personally, I am excited about the upcoming holidays and our surfing

trip to Fuerteventura, which promises to be a lot of fun. For now, enjoy this beautiful mRNA and happy holidays!

I have spoken,

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

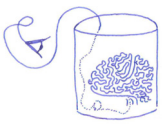
MRQNA
QUESTIONS SUBMITTED BY W. DUVERGER AND T.ZONJEE

"How can mirrors be real if our eyes aren't real?" – Jaden Smith (submitted by Wouter Duverger)

Dear Wouter,

In this question, Jaden Smith was probably referring to Descartes' *Meditationes de prima philosophia* (1641), in which this French philosopher uses an ontological proof of God to rule out sceptical scenarios on the basis of "strong inclination". Appealing to theistic benevolence, the existence of a Cartesian evil demon, an intelligence of utmost power that employed all his energies to deceive us, is thereby rejected.

A more recent, non-theological answer can be found in philosophy of language, specifically in *The Meaning of 'Meaning'* by H. Putnam (1975). According to semantic externalism, the word "mirror" does not refer to an actual mirror, but to our perception of a mirror. If you, now, happen to be a brain in a vat, dismissing the existence of your eyes, the meaning of the word "mirror" still exists. That is how mirrors can be real if your eyes aren't real.



Kind regards,
mRNA

Hi mRNA,

As we know the core of an atom exists of neutrons and protons (and even smaller particles, but let's not look at that scale). I wondered: is there a certain conformation of these neutrons and protons that is most common? Is the core built in a totally logical way which then is the lowest energy state (symmetric core)? Or is there some randomness in the structure? And if there is some randomness, can we speak of higher and lower energy conformations for different atoms of the same species?

Good luck!! Tim Zonjee

Hi Tim,

You asked us three questions which all revolve around the confirmation of the atomic nucleus. I will address your first one: "is there a certain confirmation of [these] neutrons and protons that is most common?"

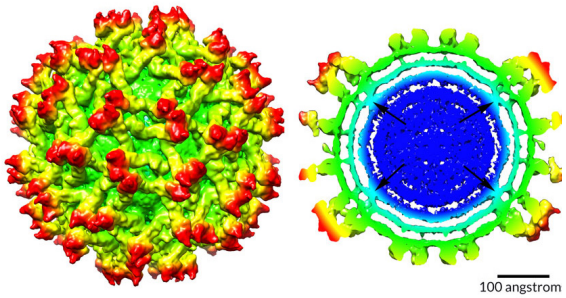
Your question is a rather tricky one, mainly because you use the word "certain". In the quantum realm, absolute certainty is rejected by the statistical interpretation. The position of particles can be expressed with the wave function of their state.

That said, there is an expectation value of the positional conformation. However, the interactions within the atomic nucleus complicate the problem: the wave function of a particle in a multiparticle system is dependent on the position of all particles in the system. Unfortunately, I can't solve this an-alytically for you. However, I can only recommend to follow the elective course *Quantum Mechanics for Nanobiology*, so that you might be able to.

Until soon, my love,
mRNA

EVOLUTION IN THE CITY
LIFE IN URBAN ENVIRONMENTS

The world is becoming increasingly urbanised which changes the native habitat of all species. This will inevitably have an effect on the genes and the phenotype of the animal. A recent article in Science discusses what the exact effect is on the evolutionary development. Some of the conclusions are that the mutation rate increases while the gene flow through mating decreases. This causes a rise in differentiation between populations. Another question for further study is how species adapt to environmental challenges and at what pace?



CRYO-ELECTRON MICROSCOPY
NOBEL PRIZE IN CHEMISTRY

This year's Nobel prize for chemistry has been awarded to Dubochet, Frank and Henderson for their work on cryo-electron microscopy. This technique can be used to capture images of biomolecules at atomic resolution, using a combination of a weaker electron beam, a multi-angle approach and a glucose solution to prevent molecules from drying out. Usually, freezing samples would cause damage from ice crystals, but in rapidly cooled samples, water molecules cannot form a regular structure. This effort enabled scientists to study the Zika virus and proteins in Alzheimer's disease at revolutionary sharpness.

SAFELY RELEASING MODIFIED GENES INTO THE WILD

One major improvement over the past years in medical science is the CRISPR-Cas9 technology. This makes it very easy to genetically modify any living species. A practical use for this could be making mosquitoes resistant to the malaria virus and thereby saving millions of lives. But what is the effect of it on ecosystems? Lately, a group of applied mathematicians and physicists made a model of this phenomenon with nonlinear reaction-diffusion equations to model where to insert the genes to maintain ecological stability. This model predicts that the inserted genes should be very close to each other and that a slight defect should be incorporated in the code to keep the ecosystem safe from accidental release from the lab. This research gives us more insight on how to deal with these novel problems that become more and more relevant in this evolving world.

Johnson, M. 2017, "Evolution of life in urban environments". Science, ed. 358, is. 6363.

Nu.nl, "Nobelprijs voor de Scheikunde naar ontwikkelaars cryo-microscopie", nu.nl, 4 Oct. 2017, 27 Nov. 2017.

Rosen, M. "Map of Zika virus reveals how it shifts as it matures", ScienceNews, Vol. 191 No. 4, March 4, 2017, p. 32.

Tanaka, H. 2017, "Spatial gene drives and pushed genetic waves", PNAS, vol. 114 no. 32

THEORIES OF EVOLUTION
A DIFFERENT VIEW ON EVOLUTION AND SCIENCE

How does reality evolve for us? - By the connection of observation, understanding and known concepts. Everybody lives in a somewhat different reality, because everyone shapes their own understanding from different perspectives. Thus, the way that we form concepts is very important for our identity, because this decides in what reality we live. To get a better grasp of our concept formation, it is useful to study the practice of science.

In science, we describe, organise and explain. We explain in three ways: reductionistically, theoretically and synthetically. Synthetic reasoning is collecting observations, comparing these and summarising the patterns that occur. This is a step toward objective thinking. However, judgements and concepts always arise with observation. Thus, here the art is to not superimpose theories on your observations, but to let the observations speak for themselves.

A paradigm is a coherent system of models and theories that form a frame of mind with which the reality can be observed. The prevailing paradigm can change with time. The question is whether one true reality exists or not; whether there is an upward trend in our thinking. Darwinian evolution supplies such an explaining mechanism for the arising of various species.

Evolutionary theories are attempts to explain the phenomenon of how characteristics of species gradually form, change or get lost over time. There are various theories of evolution that heavily contradict each other.
One of these is creationism, of which the best known form is the Genesis creation narrative found in the Bible. Apart from this narrative, there are a lot of other creation stories. In Native American myths, animals often get their own various characteristics from experiences. The chipmunk, for example, is said to have gotten his stripes from a bear's claws while running away.

In Greek mythology Prometheus gave fire

Animals in the Greek mythology were created by the Gods for amusement. In order to make the new creatures more interesting, Zeus ordered Prometheus and Epimetheus to divide some gifts among them. Epimetheus distributed beauty, agility, strength and speed. However, he did not give anything to the humans. Prometheus liked humans and realised that they were left defenceless. Therefore, he gave all his gifts to mankind and stole reason from Athena and fire from Hephaestus to give away as well. Prometheus became the protector of

Humans learned to process metal with the fire they received. Therefore, Prometheus is still associatiated with technology and the official macotte of the TU Delft.

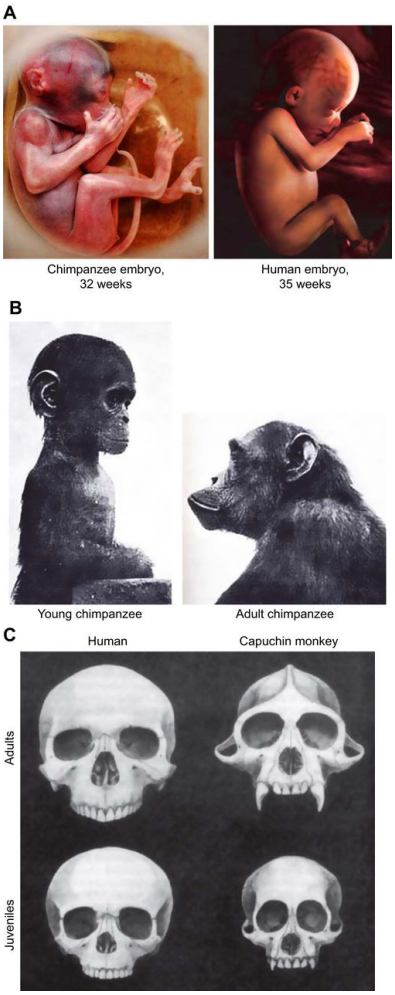
the human race, but he got heavily punished by Zeus for making humans resemble the Gods.

We interviewed Mr Ger van de Ven about evolution theories. Mr Van de Ven is a biology teacher at the Rudolf Steiner College in Rotterdam, which is a Waldorf School (Vrije School). Waldorf Schools tend to view the world from various perspectives, not necessarily the most common or conventional scientific ones.

Van de Ven: "I found the acquaintance with the evolution theory during biology to be fascinating. This was a theory with which you could really explain everything. It is a clear thinking model with simple concepts, mutation and selection, that you can use effortlessly. However, the weaknesses of this approach slowly became clear to me. Firstly, it is based on huge assumptions; that a timespan of millions of years made coincidental successes possible. And, secondly, this theory is not verifiable; try to come up with an experiment that really creates new species.
Furthermore, I increasingly experienced the enormous reduction of nature to an empty and meaningless whole, which was entirely accidental and mechanical as a consequence of this vision. Nevertheless, I always like to introduce my students to this scientific achievement. I like to show them the simplicity and clarity of the explanatory model and the thrill of the seductive feeling to be able to explain everything. But also, to let them experience the free feeling that the theory of evolution offers with the non-teleology of existence presented by it and finally to deliberate on its ultimate consequences.

"With time, I have become very enthusiastic about the far too little known ideas of Jos Verhulst. This independent Belgian researcher has thrown himself on a phenomenological comparison of the ontogenetic development of the great apes and humans. This means Verhulst compared the development of human and great ape fetuses. He described two types of properties in humans.

"Verhulst called the first class of characteristics fetalization phenomena. Man retain these qualities, juvenile characteristics of the great apes, while the apes lose them. Examples are the restrained snout formation, the occipital gap which stays right under the skull, and the fetal foot shape that is retained, of which the big toe does not become opposable in humans.

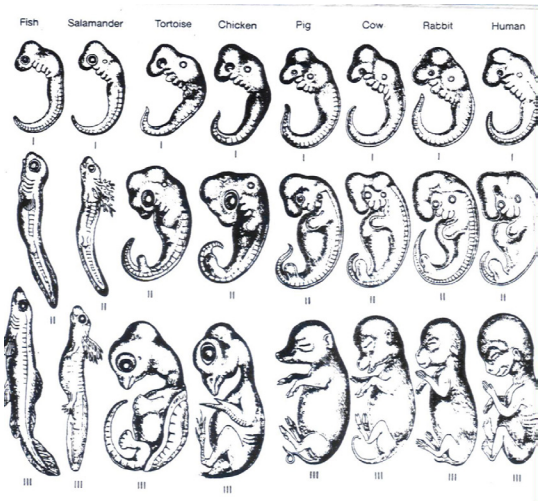


Comparison of great apes and humans during developement. Image retrieved from: Vladimir P. Skulachev et al. Published 1 April 2017

"On the contrary, Verhulst also found features that people will receive. These characteristics are latecomers in the development, which he calls 'hypermorphosis characteristics'. Examples are:

- The cerebrum, formed last of the nervous system and developing the longest in humans.
- A strongly developed thumb, which again is the latecomer of the fingers.
- Relatively long legs, which develop after the head

"Thus, the human body appears as a composition of reticence and growth. The interesting thing about these findings is that the building plan of the human being is already announced with its evolutionary predecessors, but that, by specialising, they deviate from it. This is, of course, difficult to reconcile with the current theory of evolution, in which there is no room for any purpose. This creates a relativisation of the theory of evolution, which makes it possible to view the case with a fresh perspective."



Heackle's comparison of early embryonic stages across vertebrate groups, 1998.

What is your favourite organelle?

"My favourite organelle is the 'king' of the cell, the nucleus. Sovereignty is the bearer of wisdom, the connection with the forefathers and his subjects' organelles can go to him for word and deed. Do not think that it is an authoritarian leader, it is a servant who puts his powers at the disposal of the greater good."

MRNA REVIEWS

ICE AGE: A MAMMOTH CHRISTMAS

When the air is getting frosty and the deciduous trees are losing their leaves, it is the time of the year to stay inside and watch a christmas special.

We, the mRNA, decided on watching the Ice Age christmas movie: A Mammoth Christmas. This prehistoric Odysseus about a young mammoth, Peaches, takes us back to when we wholeheartedly believed in Saint Nick as children. Peaches and her friends, Sid and two possums, who incidentally are her brothers too, search for a spark of light in an otherwise tenebrous existence.

During Peaches' pursuit of Santa Claus, she encounters multiple troublesome ordeals, while modern Christmas traditions come into being. For example, Sid adorns a pine tree to ensure Santa will be able to find them in the vast icy plain.

While there are many things done right in this movie, we could not help but spot some flaws in the plot. At some point Sid, Peaches and the possums find Prancer, a flying reindeer. Prancer tells them that one does not simply walk to the North Pole, but that he, since he is a flying reindeer, can bring them there with the power of flight. However, later in the story there is a reasonably sized natural disaster "ruining Christmas" and Peaches' parents and sabertooth tiger uncle just happen to be very close by, while they did not have a flying deus ex machina at their service.

This, however, could not ruin the joy we felt while watching this delightful Christmas adventure.

5/5 would recommend

Tessa Vergroesen

LIFE ON EARTH
OFFSPRING FROM OUTER SPACE

Panspermia, the theory that life on earth came from pollination by asteroids, comets, and spacecrafts even, may be one of the most underrated theories of the origin of life. Nowadays, it is almost taboo to even think that life on earth came from anything but earth itself. This is due to the general disbelief of the crazy conspiracies that humans are somehow the progeny of extraterrestrial lifeforms. However, panspermists might be more in the right than you think.

Charles Darwin is claimed to be the instigator of panspermia with his *Origin of Species*. With creation under pressure, the origin of life on earth became a subject of philosophy again. It was in the nineteenth century that the first scientific proposals were written about the possibility of organic matter coming from beyond earth. However, it was in Ancient Greece, close to the year 450 BC, that philosopher and astronomer Anaxagoras first theorised that all things have existed from the beginning, but in infinitely small fragments, or seeds, of themselves, scattered around the universe. Panspermia, in a broad sense, has thus been around for some time.

In 2006, NASA scientists found organic globules, 250 nm in diameter, in meteorites that were formed at a temperature of -260 degrees Celsius, which is near absolute zero. This means that these globules were probably formed in space around the time our Solar System was born, and not on a planet like earth. From this, they hypothesised that meteorites might have been seeding earth with organic matter since the very beginning of its existence.

With more and more findings like this, panspermia is starting to sound like a reasonable theory. It might not have been aliens that send these meteorites to distant planets loaded with microbes, but outer space just might be a key player in the origin of life on earth.

Tessa Vergroesen

TELL ABOUT YOUR MINOR!
EXPERIENCES FROM PEERS

The minor is an interesting part of your bachelor's. Wether you use it as a perfect career extension, a brave attempt to enrich your personality or as a bridging programme to another master's, some experiences from previous students may be useful to read.

TEUN HUIJBEN
minor **Nanobiology**
place **Delft/Rotterdam**
age **22 years old**
colour **green**
organelle **cytoskeleton**

What minor did you attend?
The Nanobiology minor. It consisted of a triad of small projects carried out in couples or groups of three. In each period, students indicate their preference for laboratories in Delft or Rotterdam, choosing from a list of projects that is different each period. I happened to be arranged in Delft for all of the projects, namely in the Youk, Dogterom, and Depken labs.

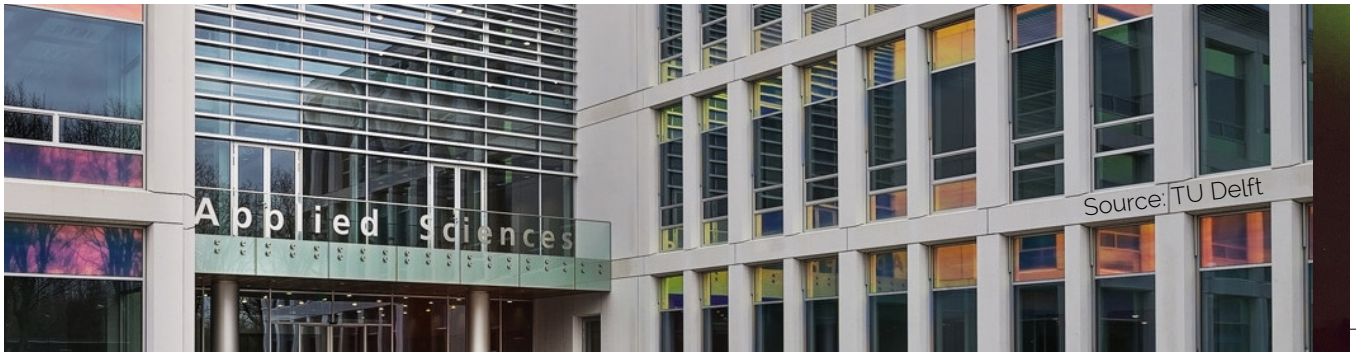
How was your first day?
In my case, that was in Youk's lab. After a short introduction in his office, we started straight away with laboratory work. I remember that Hyun Youk personally accompanied us, which was quite special and he was very friendly.

Was the minor as you expected?
Yes. It only turned out to be a bit more work than I expected. That is probably because it is quite comparable to the BEP phase, in which you work full-time and make long days. We obtained a good grasp of the departments. We lunched with the research groups and joined lab meetings. It suits very well as a preparation for the BEP, although I had rather used this minor for orientation.

What was the biggest difference with the usual curriculum of Nanobiology?
There are no courses. That is quite a big difference. And I discovered the benefits of *Labcourse*, which I remember as a strange course when I attended it before. Many techniques that were practised during this course are used in the minor, so a familiarity with those techniques proved very useful.

How was your last day?
Each of the three periods was concluded with a presentation, like a little symposium. It was nice to meet the other groups. In total, seven students followed this minor.

If you had the chance to attend another minor, what would you choose?
Another minor? I would probably choose a bridging minor to Applied Physics. Not to bridge to that master, but for the sake of the nice subjects. I tend to like the physics part of Nanobiology slightly more than the other parts, although I am content with the physics-related subjects that I am able to choose now in the Nanobiology master's programme.



Source: TU Delft

Do you have any advice for people that have to choose a minor now?

People should consider that this minor is a perfect preparation for a BEP. The disadvantage is maybe that it feels like you are doing a BEP for the entire third year. However, it is a perfect way to see the department from within and orient on which research directions you like. In general, I would encourage people to do in their minor something they really like!

KATJA SLANGEWAL
free minor **abroad**
place **Lund, Sweden**
age **21 years old**
colour **turquoise**
organelle **cytoskeleton**

What minor did you attend?

I did a free minor at Lund University in Sweden. There, I followed master's courses: Biophysics, Image Analysis, Swedish, and Molecular Genetics (specialised in eukaryotes). I found molecular genetics the most fun. We studied the material extensively, because it was awarded 15 ECTS. Also, the course consisted of a lot of lab work.

The best thing about my minor actually was all the people I met and the friends I made. We have done a lot of nice things. There was plenty of time for this as well, because nobody went home during the weekend.

Lund is a fantastic city! It is fairly small and half of the inhabitants are students. Therefore, the city is really geared towards students. The student associations ('nations') were organised very differently in Lund. It was much more mixed and all parties were open. You can also have brunch at the nations during the weekend.

How was your first day?

Lund is known for its long introduction period, which includes international students as well. It was a lot of fun and I immediately got to know a lot of people. The introduction period started simultaneously with the Swedish classes and continued when all my courses started. Swedish was, of course, very different from Nanobiology, because it is a language. I followed the course together with people from many different countries. For me, it was relatively easy because Swedish resembles Dutch much more than, for example, Spanish.

In Biophysics, we were with a very small group, which was more like Nanobiology. This is contrary to Image Analysis, where we were with hundreds of people in a lecture hall. Those two courses were from the technical part of the university. They had few contact hours and two days off which was very nice. The second block, I followed molecular genetics at the science section of the university. We were in the lab a lot and we had longer days with more contact hours. I found it remarkable that all teachers spoke english very well and were very involved.

How was your last day?

The semester ended a little earlier than in the Netherlands. Therefore, I could go to Lapland with friends. That was the best trip I made that semester. When the courses were over, we were all looking forward to it. Afterwards, the other international students had already left. It was very weird that everything was suddenly over and you had to say goodbye.

Overall, everything turned out better than I expected! I left the Netherlands not knowing whether I had made the right decision, whether I was going to feel lonely or not. However, soon I met very nice people that I still see regularly

If you had the chance to attend another minor, what would you choose?
I would go abroad again. To another place, of course, because Lund will never be the same again. Maybe I would like to go to Canada once, or Switzerland.

Do you have any advice for people that have to choose a minor now?
If you want to go abroad, you really have to persevere. The process that precedes is very slow with all kinds of different forms that may or may not get approved and eventually you might have to choose other subjects etc. Anyway, you just have to choose what you like!

ROSANNE WALLIN
minor **Mind and Brain**
place **Leiden**
age **20 years old**
colour **rgb(144,0,0)**
organelle **Golgi apparatus**

What was the minor about?
It focuses on cognitive processes: how does your brain work? For example, I learned about theories that explain the relation between emotional and physical response. Are you happy because your heart rate increases? Or does the heart rate increase from happiness?
By the way, it is a minor that lasts for an entire year. That happens more often in Leiden.

How was your first day?
That was when I went to the mandatory tutorial sessions. I used to skip the lectures because I was a member of the board. I remember that, at first glance, I thought that all the people were first year psychology students, although they turned out to be minor students as well. It just seemed to be of the type *Introduction to studying Nanobiology*.

Was the minor as you expected?
Having looked into the course guide of Leiden, I knew I was going to have psychology courses only. On the contrary, there are some minors with the word brain in their name, which focus more on biology. Perhaps my minor turned out to be a bit easier than I expected. The way of learning was very different: I had to study everything by heart and I was tested by multiple choice questions.

What was the biggest difference with the usual curriculum of Nanobiology?
I had fewer contact hours. There were one tutorial session and two lectures per week. That was all, although they were usually scheduled on very strange moments of the day.

What was the nicest thing about your minor?
I liked that it was something completely different from Nanobiology. Not only the subjects, but the people as well. To bring up a funny explanation, the women in Delft might be exposed to more maleness in Delft. I don't want to express any preference toward one or the other, though. Maybe, it has something to do with the nature of the universities as well?

If you had the chance to attend another minor, what would you choose?
I would take a totally different direction again, probably on economics, management or marketing. A broadening minor is fun for people who like more than Nanobiology. It was a chance to discover what I liked and disliked.

Do you have any advice for people that have to choose a minor now?
I enjoyed learning things that are beyond Nanobiology. If you have other interests, I would encourage you to discover those. It is a chance to try out other fields.

INTERVIEW WITH AN ALUMNUS
ILIAS ZARGUIT, MSC

Master's degrees have been awarded for the first time since Nanobiology's conception. We interviewed Ilias Zarguit, MSC, one of the lucky few, to tell us about his beginning career after graduating from the program.

What is your current job?
I was offered a temporary position for a year at the Erasmus MC and the TU Delft to improve the content of the bachelor's and master's programme of Nanobiology. I had a lot of complaints myself, as I went through the programme, and now I can really make a change.

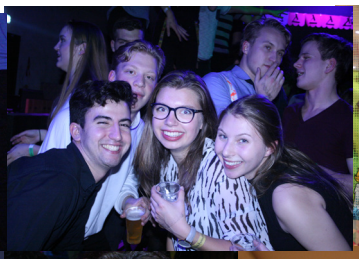
How are you trying to improve the programme?
First, with more integration between the courses of Delft and Rotterdam: more integration between physics and biology. My main focus is *Labcourse*. This is what I was officially hired for, but it is hard to work only on this task for an entire year, hence I am also improving other aspects of the programme as well. For example, I am trying to make more electives available in the bachelor as well as in the master's.

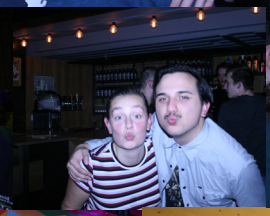
How did you get this job?
The job offer had been available for quite a while. Claire Wyman thought it would be a good idea to send the application to the first cohort of master's alumni. I responded and was accepted for the position. This gave me the opportunity to reflect on my future for an additional year after getting my master's degree, while still remaining in the academic world, seeing things from a totally different perspective.

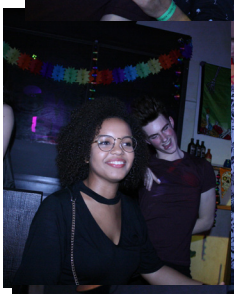
What future were you planning to pursue during your study?
During my studies, I had wanted to pursue a PhD, but while I was working on my bachelor end project, in an internship or other involvement in academics, I started wondering whether this was really what I liked to do. You must be aware of the fact that it's a commitment for four years, during which you have to work very, very hard. Of course you would study a subject that interests you very much, but you lose a lot in your social life. It is still a dilemma for me. I want to have experience outside of academics before I make my decision: if I do not enjoy working for a company, I think I will apply for a PhD, but I do not think this will be the case.

Do you have any tips for current students?
Start looking for what you want to do after getting your degree. I got lucky with this job: I had the time to think over the alternatives, but start looking ahead, especially if you are in the final phase of your master's. Better yet, start looking even sooner: during your bachelor's degree. Do not study for just the degree. Study with a clear goal in sight.
Another thing that I regret a little bit: I did my internship in academics, at the TU Delft. It was relatively easy to find a position there, and at the time I did not want to go to a company, but now, even though I enjoyed my internship very much, I do not have experience in business.

What is your favourite organelle?
I am a Nanobiologist; every organelle is my favourite organelle.





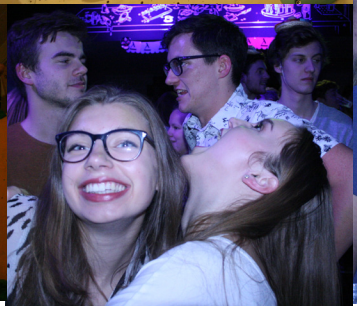












A REPORT ON AN INTERVIEW WITH BERTUS BEAUMONT
PROGRESSION ON THE THEORY OF DARWINIAN EVOLUTION

A short introduction of Dr Beaumont

Bertus Beaumont has a background in microbiology with focus on molecular microbiology. He did his PhD at the Vrije Universiteit Amsterdam and later did postdoctoral research on experimental evolutionary biology in New-Zealand at The University of Auckland. Eventually, he came back to the Netherlands to Leiden University where he began doing his own research after which he started here at TU Delft as a principal investigator and assistant professor.

We asked Dr Beaumont about the present day standing of Darwinism

After correcting us that Darwinism is not the correct term for Darwinian evolution he explained that evolution can be seen as a process which has two steps. The first part is population change, causing some to go extinct: this is survival of the fittest. If that happens in about systems: `if` a system can replicate and `if` upon replication its structure changes and `if` this happens in the heritable way and `if` these changes have an effect on the rate of replication, you will get evolution. It is that simple. This is the part where heritable phenotypic variation affecting fitness is being generated. The second part is natural selection. Those replicating systems come in different varieties. Some species grow faster than others and therefore their frequencies in a parallel over millions of years, *that* is evolution. This is one way of talking about evolution, but it is even better if you leave out the natural selection as a separate thing. It is just a phenomenon. Sometimes, people talk about natural selection as if it is a force but it is not. Natural selection just happens when you have multiple variants that have slight differences and therefore grow at different rates. Then, a consequence is just that the fittest ones will survive. So that is why you do not actually need natural selection to explain evolution or why it is not an external factor.

"I can tell you what the process of Darwinian evolution is like, but Darwinism sounds more like a movement of people."

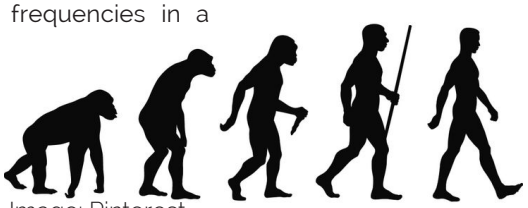


Image: Pinterest

Is this theory about Darwinian evolution complete or have there been any advancements?

Dr Beaumont pointed out that one thing is really important. The system also needs a special property referred to as evolvability. This means that the system has to be built in such a way that accidental internal changes cause the system to perform better. Dr Beaumont illustrates evolvability with an example:

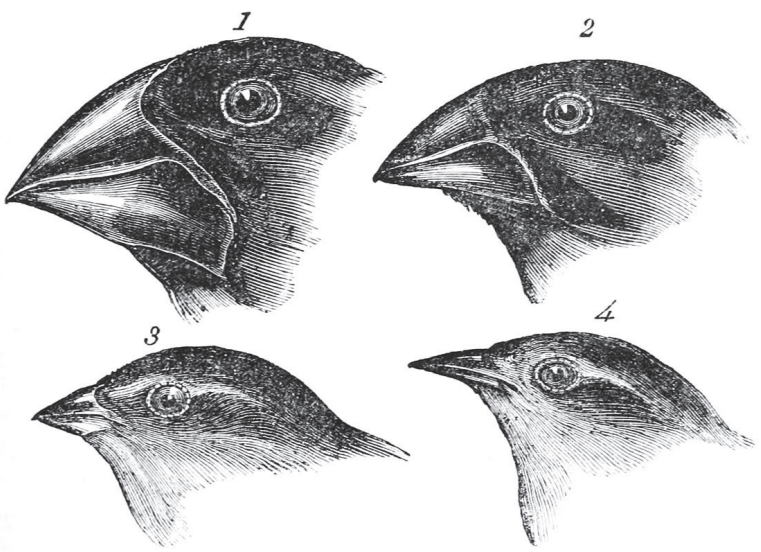
"I could put a magical dongle into my laptop and it would now just "poof" produce little laptops that in three weeks grow to the size of an adult laptop. You will just have to accept that this can work. And when it does that, imagine it has some description of itself. It could be a binary code or a blueprint that it uses to make this copy and passes this on, but then with some small modifications. These changes, which are the equivalents of mutations would in the case of a man-made laptop almost certainly always be lethal and yeild a non-functional device. The reason for this is that man-made systems depend on components with very specific properties that are assembled in a very specific manner. As a consequence, the probability of random change causing an improvement such as a faster CPU or cooler looks is exceedingly small."

What is your favorite cell organelle?

"I'm a microbiologist and bacteria are not supposed to have cell organelles. So I would rather choose the type six secretion system, which is a large protein complex that some bacteria use to puncture other cells. But I think the Golgi apparatus is a cool one, I mean, it is still highly mysterious and it has looks that are just too difficult to comprehend."

Do you have a message or anything you want to say to the readers?

"Be a good scientist. By good I mean honest."



1. Geospiza magnirostris.
2. Geospiza fortis.
3. Geospiza parvula.
4. Certhidea olivacea.

Image: Wikipedia

INSIDE PEOPLE'S FRIDGE
THIS EDITION: SERGE DONKERS

Whether it concerns a mouldy nightmare or an alphabetically ordered walk-in cabinet, everyone has a refrigerator at home. The content tells us about our food habits. It might convey things about our personality. Today, we will discuss the fridge profile of Serge Donkers, the programme coordinator of Nanobiology.

What is the biggest change in your refrigerator since your student time?
In my student-life, the refrigerator was a total chaos, of course, because we shared it with seven fellows. Since then, I tried to seek for more variation in my cuisine than what I typically ate at my parents'. I remember asking my parents what we were having all day, even though I could predict that the answer would most certainly be "potatoes-vegetables-'n-meat". Now, I am more familiar with the Indian cuisine, or Moroccan food, certainly when prepared in a proper tagine, because that gives a special touch to the meal... (but don't mistake me as an expert on tagines). And I can still enjoy good-old stew very much.

"If I host dinner with friends, I like to serve home-made plum wine, together with a bit of cheese or fig bread."

That is an internationally oriented taste. Can I say that you use that in your job as well?
Of course. Research is often a very international business. Especially when I moved to TU Delft in 2007; there was much variation in the nationality of researchers. I don't have to tell you that Nanobiology has gone international as well. It is so inspiring to meet people from all over the globe, certainly if you achieve things together.

What product must always be in your fridge?
Milk! Funny, because it did not fit into the picture. Just to drink, not for the muesli or coffee. Perhaps it has something to do with my youth in Noord-Brabant? My father always drank milk.

What about butter? There seem to be loads of butter there.
Actually not. It only seems a lot, because of the way it is packed. When I am at the supermarket, I always think that I need some extra butter, although I usually cook in oil. It is only for the pancakes, that I sometimes make for my children. That is not tasty when baked in oil, obviously.

Do you bake those pancakes yourself?
Yes, and it is still a suspense if the first pancake succeeds. My children love it. I encourage them to cook themselves as well. In particular, I seek to teach them that there is more than "potatoes-vegetables-'n-meat". Rendang, for example, which is Indonesian stewed beef. You can see that I use home-made sambal, which I got from the mother of a friend of mine.

In the bottom of the fridge, there is a leftover, right? Do you care about the environment?
Yes, I do! Nice that you mention that. It probably was a leftover from spaghetti with a red, vegetarian sauce. I do not like to throw away food. Today, for example, I ate lasagne that was prepared by my son. It was delicious, with cooked eggs and fresh vegetables.

Do you save things past the perishable date?
Yes, I have no objection to food that past the expiration date. For example, yoghurt is still edible, milk, if it is not soured, or cheese as well. As long as it has not gone mouldy, I just use my taste to determine if I can use it.

But why do you have several cheese packets?
My children still have to get used to the pronounced flavours of old cheese, so for them I bought a younger cheese. On a side note, I normally prefer cheese cut from a wheel, but since my children go to secondary school, it is easier in the morning to have pre-sliced cheese. It is a pity, nevertheless, that the slices of pre-sliced old cheese are so difficult to separate.

You have a lot of order in your refrigerator. Do you make an effort to keep it that way?
Well, I do not have a predetermined place for every item, because that is not possible when living with children. But I care to have a certain amount of order in my fridge. Perhaps, that applies to my work as well. As coordinator, it is always pleasant to have a good overview. Currently, we work with flexible workspaces, so there is no fixed place for anyone. Officially, my laptop is my desk. I have to admit, however, that my spice cabinet is way more chaotic than my refrigerator.

Looking at the pickles, beers and wine, I would like to ask: Do you consider yourself a bon vivant?
I received the speciality beers as a birthday present, but I am fond of fancy meals, especially when shared with others. I enjoy cooking for others. You can see that there is still a bottle of wine left from our birthday dinner, which was not home-made, by the way.

So, you sometimes serve your own wine? How did that start?
Ten years ago, I moved to my current house. In that year, all the harvest from a plum tree in the garden fell on the ground, unused, which was a pity of course. But the next year, I decided to use those plums for my own wine. As a biologist, I did research on baker's yeast for a while, so I already understood the biological process. In the attic, there is a small barrel made of glass (10 L) that bubbles for several weeks. The start of the fermentation is crucial. After that, I just leave it in the attic until it is done, apart from transferring it once every while.

What does your wine taste like?
It is quite a full-bodied, sweet wine. Of course, to get better control over the taste, I could include an entire business of alcohol measurements, or determine the sulphate and sulphite content, but I prefer to let the process do its own work and taste at the end. If I host a dinner with friends, I like to serve it as a dessert wine, together with a bit of cheese or fig bread.

ARTIS-MICROPIA
SPONSORED EXCURSION TO THE MICROBES

Microbiology mostly enters the public eye in a negative light: the outbreak of diseases, resistance to antibiotics and fear of GMOs. *ARTIS-Micropia* is an answer to this pessimistic trend. A small museum with even smaller content aims to introduce its audience to the little known field of science. The result is deceitfully simple; the exhibition is engaging for young and old; layman and nanobiologists.

As the elevator took us to the exhibition, we were made aware of life at the smallest scale. Our guide, who worked in the museum lab, showed us a phylogenetic tree. She said that *Micropia* contains 300 species, while, in comparison, *ARTIS* has 547 species. In the first display, multiple erlenmeyers were connected, within was a murky primal soup. The guide told that they contain cyanobacteria, which were among the first organisms to produce oxygen, effectively making human life possible. With a microscope, guests can observe the bacteria themselves. Multiple species are observable *in vivo*, but microscopes are not the only means of visualisation used in the museum. Movies, 3D animations, interactive TVs, and ants are also part of the deal. These macroorganisms have their own ecosystem within the museum. Leafcutter ants, as the species is called, are in symbiosis with a fungus. They function as farmers to the fungus, on which the ants greatly depend as a result. Once again exemplifying the importance of life on the smallest scale; this time as part of the food chain.

Micropia is a small laboratorium for its visitors, complete with living microbes. The information is presented in a comprehensible way. Because most exhibits exemplify the relation between microorganisms and mankind, you get a clear sense of the importance of the invisible, but omnipresent world. *ARTIS-Micropia* is certainly a fun and engaging attempt at bridging the gap between public and science.

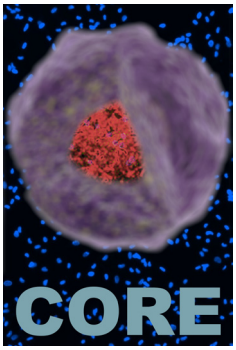
Image: ARTIS-Micropia, Meike

ORGANELLE ELECTION 2017-2018
COMPARTMENTS FOR PRESIDENT

Hereby, we, the mRNA, launch the official organelle election 2017-2018! All members of our editorial office have written a plea for their favourite organelle. In every speech you will find the candidate's argument for their party. There is a digital ballot box on the Hooke website with which you can vote. You can also find a link in the Hooke facebook group.
If you are a cell-respecting citizen; VOTE!

NUCLEUS

"We are all connected at the core"



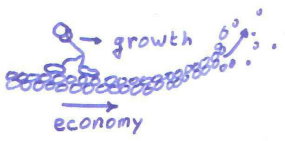
The belief that we are connected as one cell is what drives me. If there is a neuron on the dorsal side of the cortex that cannot send action potentials, that matters to me, even if it is not my soma. If there is a red blood cell somewhere that lacks the ability to bind oxygen and has to choose between being broken down or being excreted, that makes my life poorer, even though red blood cells have no nuclei. It is that fundamental belief - I am my myocyte's keeper, I am my stem cell's keeper - that makes this body work. It is what allows us to pursue our individual dreams, yet still come together as a single organ. *"E pluribus unum."* Out of many, one.

Even as we speak, there are those who are preparing to divide us, the carcinogenic substances and radiation that damage our DNA and try to deflect us from our purpose. Well, I say to them tonight, there's not a germ cell and a somatic cell; there is the encapsulation of our DNA. There is not a digestive system's body *and* respiratory system's body *and* circulatory system's body *and* skeletal system's body; there is just the body as a united whole.

All across the body, from head to toe, from back to belly, we must all come together and realise that eventually, we are all products of the same DNA and we all have the same dreams. Together we can make them come to life: Vote Nucleus!

CYTOSKELETON

"Build a solid foundation for the next cell."



The government needs a reorganisation. These days, after the crisis, vesicles are scattered all over the cell. There are lysosomes, synaptic vesicles, even peroxisomes ravaging the nucleus. More and more mitochondria, who have a different ethnic background, are invading our cell. Strict policing and a strong government are necessary. We have to export the bad proteins and protect the cell against them. The Cytoskeleton will be a template for the reconstruction of the cell, not only internal, but at the borders as well. We are going to build an impenetrable, physical, tall, powerful, beautiful cell wall! It will be huge, and we will make the mitochondria pay for it.

Mr Tubulin for president

MITOCHONDRIA

Mitochondria Independencia

Since the beginning of eukaryotic cells, the mitochondria have been exploited by the other cell organelles. After millennia of harsh abuse, wrongdoing and robbery of our ATP, The time for a revolution has come. We have no choice but to become independent.

You might be hesitant to vote for such an abrupt change, but this is simply the only way to continue. There are some rumours that the mitochondrion isn't able to live on its own, but I can assure that this is fake news. The mitochondrion is perfectly capable of becoming entirely self-sufficient: we have our own DNA and membranes, replicate independently and, most importantly, make our own ATP. This will give us an enormous advantage while renegotiating all trade deals which will be, given our strong currency, no problem at all.

Of course, we shall win this election effortlessly because there are many mitochondria in a cell and only one copy of each of the other cell organelles. Yet, every vote counts, so please think about what you can mean to this cell and make the right choice. Vote for the "Mitochondria Independencia".

ENDOPLASMIC RETICULUM

Organelles and organils, we face adversity as never seen before. Our ATP reserve has dropped to critical levels and the invasion of unwanted water molecules has put us in a state of osmotic shock.

We are left to suffer in common cytoplasm, while they, safe in behind the membrane of the nucleus, employ autophagy to harvest what limited resources we have left. The boundary between us and them could not be more apparent. My friends, now is not the time of separation: a cell divided against itself cannot stand. I believe this cell cannot endure, permanently, half in G phase and half in S.

I do not expect the nucleus to be dissolved – I do not expect the cell to fall – but I do expect it will cease to be divided. It will become all one thing or all the other. Either the opponents of S phase will arrest the further spread of it, and place it where the public mind shall rest in the belief that it is in the course of ultimate extinction; or its advocates will push it forward, till it shall become lawful in all cells, old as well as new – mother as well as daughter cell. I propose to you, my friends, and through you, that government be made solvent: it must be decentralized, accessible to the public sphere. We need our government to be in the cytoplasm. We need ER.

GOLGI APPARATUS

The Golgi apparatus is commonly known as the most important organelle of the cell. Here is why.

The Golgi apparatus is the gatekeeper and postoffice of the cell. It selects and it overthinks. Selecting and overthinking is crucial, and without it the cell would get lost in input, without any hope to recover.

This vital organelle provides posttranslational modification, selects which proteins to keep and prepares others for secretion. As a result, not only the cell will benefit from its work, but also the environment will thrive under the influence of the Golgi apparatus.

It forms pathways for protein transport using its flexible and ever changing membrane layers; pathways to the future in which the proteins get modified by enzyme stacks attached to the membrane.
The future is important to the apparatus and therefore it uses lysosomes to recycle and break down old cell parts to reuse their building blocks. Hereby, ATP is saved and this partly relieves the pressure on other organelles.

Now ask yourself: What is content without consideration? What is possession without selection? The cell may not have input without the nucleus; would not convert information without the endoplasmatic reticulum; but without the Golgi apparatus the cell would lose its character. A cell is a network, a regulatory network that needs selection, decisions and enhancement. Without the Golgi apparatus the future would not look as bright.

Select your path to the future! Vote for the Golgi apparatus!

THE RESEARCH OF A BIONANOSCIENCE LAB

SUPER-RESOLUTION MICROSCOPY FOR LIFE SCIENCES AT THE MOLECULAR LEVEL

For a hundred years, a key rule in microscopic imaging was that the resolution in a microscope is determined by the diffraction limit. This states that the smallest detail separable is given by the wavelength of the light divided by twice the numerical aperture, where the latter is a measure for how much light is captured by the objective lens from the sample. For typical values of visible light, which has a wavelength ~500 nm, and high quality immersion objectives, this results in diffraction limits of ~200 nm.

Of course, 200 nm is too large to visualize the cellular machinery of life. Since Van Leeuwenhoek, the microscope has been used to discover "small animals" first but soon already subcellular components. With the advent of single molecule localisation microscopy (SMLM) around 2006 with the landmark papers of Betzig et al. in *Science* and Bates et al. in Nature Methods, resolutions in the order of tens of nanometers have been increasingly reported in the literature. As a consequence, in 2014 this particularly successful imaging modality was awarded the Nobel Prize in Chemistry. The key idea is that you localise single blinking fluorescent molecules over a long time series of images instead of all at the same time. Therefore, the final image must be "reconstructed" from millions of estimated positions.

Since my time as a Postdoctoral researcher at the Max-Planck Institute for Biophysical Chemistry in Göttingen, Germany, I have been involved in imaging below the diffraction limit and already in 2005 we investigated

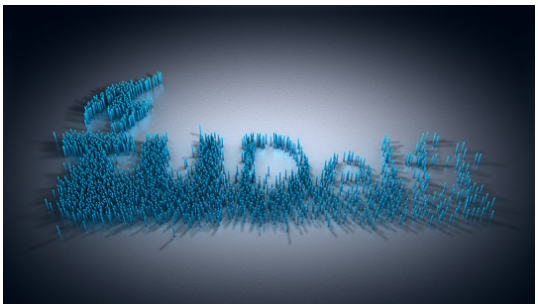


Figure 1: Infographics of TU Delft logo for single molecule localization microscopy. Localization uncertainty and density of localizations together determine the interpretable resolution in images beyond the diffraction limit. On the top left, localization uncertainty is small and the density high, going down the uncertainty increases and to the left the density decreases.

super-resolution by the blinking of quantum dots and reported resolving distances of ~20 nm (wavelength over 30). This line of research developed strongly over the years and is now very prominent in my lab. Today's images are no longer just direct recordings of photons (or electrons), but results of computerised processing, reconstruction and analysis and that is exactly where my research enters. In my lab, we develop techniques that offer the highest spatial (and temporal) resolution in microscopic imaging. With this aim, we place ourselves in between purely curiosity and purely applied driven research. I already teach the course *Systems and Signals* in the second year of the curriculum for many years as this course lays the foundation for understanding and quantitatively describing image formation in microscopy, but also for example for describing the kinetics of bacterial chemotaxis. In the master's programme of Nanobiology, I teach the light microscopy part of *High Resolution Imaging*.

Our current research relates to understanding what you can reliably interpret in an image below the diffraction limit. That question lies at the heart of reliable biological interpretation of the images. Figure 1 shows an infographics for SMLM using the TU Delft logo. It exemplifies that both the localisation uncertainty (from estimation the positions of the single molecules) and the density of localisations determine the interpretable resolution in images beyond the diffraction limit.

We realised that the limitation of the density of localisation could be mitigated if you image not only one copy (of e.g. a macromolecular complex), but many copies in combination. This directly increases the signal-to-noise ratio of the reconstructed image after proper combination. We directly applied this in a biological context where we imaged many Nuclear Pore Complexes (NPCs) with SMLM in collaboration with a leading experimental group in Germany. In Figure 2 (top), we show many 2D images of NPCs from a frog. In the inset you see a single NPC and the quality of the image. After combining 450 NPCs into one, we obtain the right inset image, which has a spectacular image quality. In addition, you can estimate the diameter of the NPCs with sub-nanometer precision due to the very high data quality. In Figure 2 (bottom), you see the result for the combination of ~500 human NPCs imaged now in 3D with SMLM in collaboration with a lab in the USA. Again, the very high image quality lets us perform quantitative measurements with unprecedented precision.

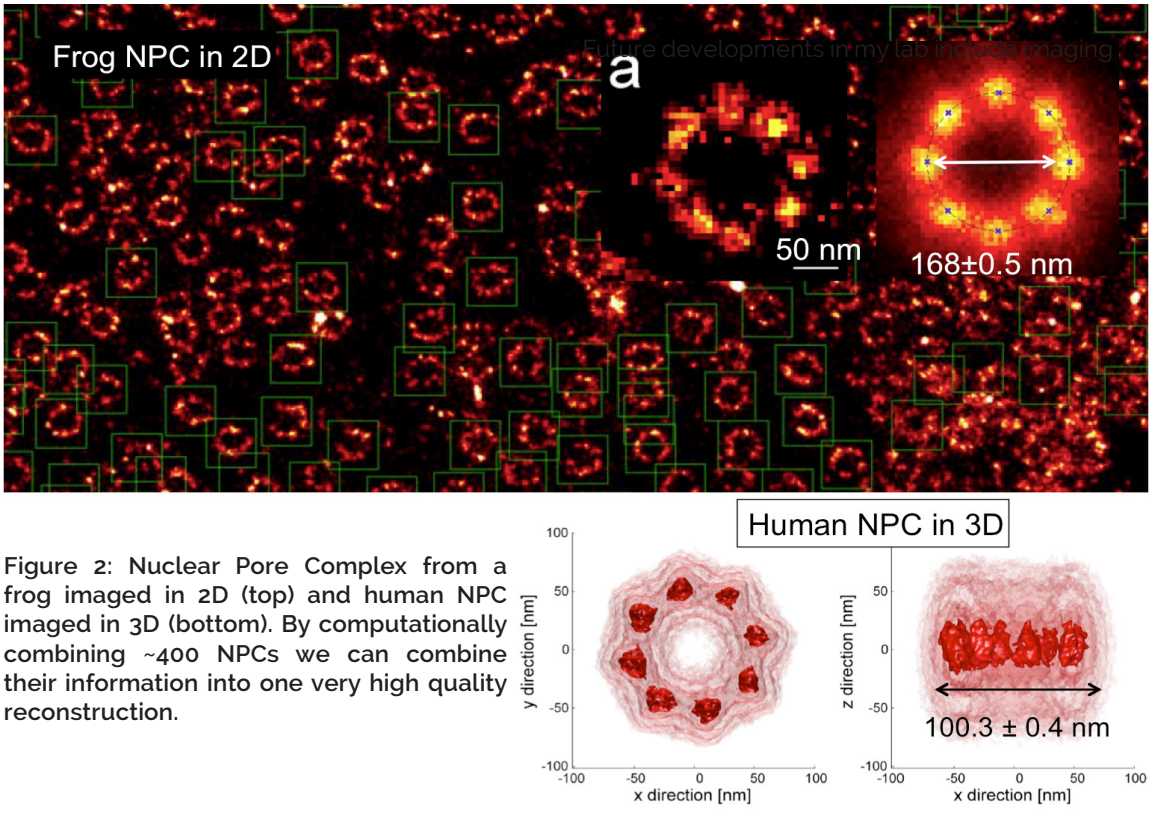


Figure 2: Nuclear Pore Complex from a frog imaged in 2D (top) and human NPC imaged in 3D (bottom). By computationally combining ~400 NPCs we can combine their information into one very high quality reconstruction.

Future developments in my lab include imaging fluorescently labeled biological structures at cryogenic temperatures. That will allow us to localise single molecules with precisions below one nanometer and make even better images. In addition, we are investigating methods for smarter and more robust combination of identical structures to reconstruct one "super-super" resolution structure.

We have worked together with professional cartoon animators from Mooves in Amsterdam to make a 5 minute animation of 350 years about light microscopy in Delft, the story of the rise of single molecule localisation microscopy and a glimpse of what we are currently doing in Delft to further advance the resolving of smaller and smaller distances in the light microscope. Scan the QR-code in Figure 3 to see the video (figure 3).

Prof Dr Bernd Rieger
Department of Imaging Physics
TU Delft

Figure 3: QR-code to the video about the history of microscopy in Delft

https://youtu.be/vh3_qOy2uls

All figures were provided by the author

As we know, the best stories arise from spontaneous conversations. Therefore, mRNA likes to yield the floor to members of S.V.N.B. Hooke, who all indubitably have magnificent stories to share. We used a Mersenne Twister and linked the outcome to the membership database. We asked this person to write a column about a topic of personal preference.

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>> rng('shuffle');
>> randi(nr_leden)
ans = 250
```

NANOBIOLOGICAL PLANT CUTTING

A few months ago, I brightened up my sober student room with a touch of green. From light-green stems to needleless cacti, there are plants of all kinds. All my plants have one thing in common: they are very small. Slowly but surely, they are growing to be the same size as the plants I have cut them from, because that is the way I got them: I cut the plants of my grandmother. It could be that you only know plant cutting from the biology books you had to read when you were still growing to become the incredible student you are now. That is why I will gladly explain the principles of cutting with a nanobiologically sound example.

Let's say you want to clone a certain gene, such as the Sonic Hedgehog gene (SHH), in a strain of *Escherichia coli*. You could do this by transforming the plasmid containing SHH: after designing a cloning plan and performing PCR with the correct primers, you transplant the transformed plasmid into your E. coli. At this point you might think "So far, so good, but what does this have to do with cutting?" Well, after you have transformed the plasmid correctly, you place the *E. coli* on an agar plate, and after 24 hours the plate will be chock-full of colonies. These can be moved to different plates with a sterile pipette. (NB: do not touch anything else with the pipette!) On this new plate, your emigrated *E. coli* will happily continue growing with a new batch of nutrients.

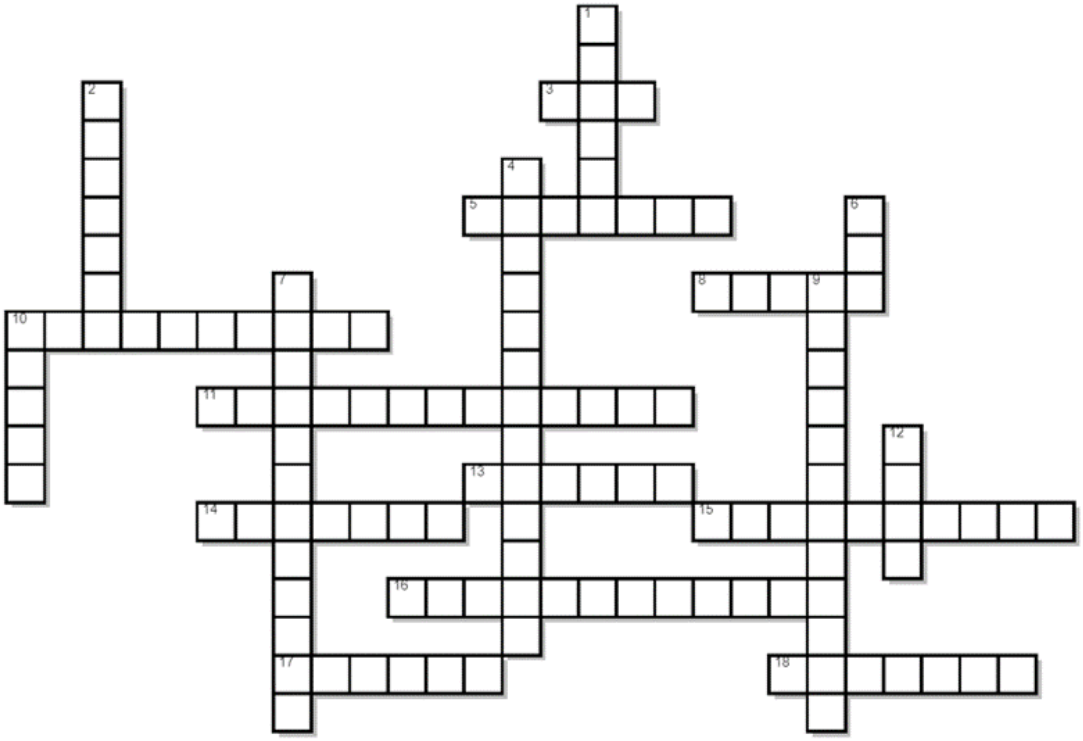
Cutting works in the same way: when you cut a small part from a fully grown plant, it will grow its own roots and the little sample will become as big as the mother plant.

Unfortunately, I have not yet succeeded in cloning genes in my plants, but who knows: I might be able to grow a homemade genetically modified strain, well fit for nanobiology. P.S. If you are interested in plant cutting yourself, look for me in spring: my plants will most probably have their own cuttings ready!

Mirte Golerdingen, BSc

PUZZLES-'N-RIDDLES

WIN TWO SOCKS!



HORIZONTAL

3 Buffer that frightens propaedeutic students.
5 Flow of electrons
8 Derivative of momentum over time.
10 Whenever he had the energy, he did not have the time.
11 Powerhouse of the cell.
13 Kingdom without cell wall.
14 The earth is about four ____ years old.
15 Method of testing different hypotheses.
16 Dutch translation of 'level curve'.
17 Father of genetics.
18 World of rainbows.

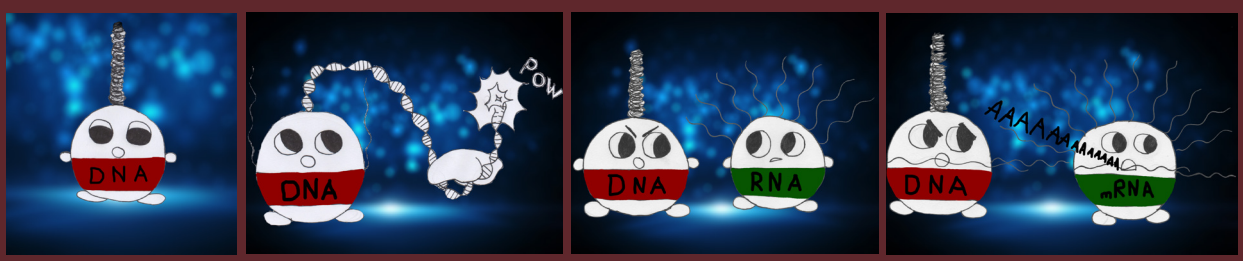
VERTICAL

1 First name of S.V.N.B. Hooke's first member.
2 The lagging part.
4 Spanish translation of 'level curve' (no spaces).
6 Very cold drink.
7 Fundamental principle of cell bio (no spaces).
9 Winner of the organelle election.
10 Unit of electrical inductance.
12 Largest organ of human body.

Send your solution to mrna-hooke@tudelft.nl and you can win an awesome pair of socks.

UPCOMING ACTIVITIES
HOOKE AGENDA

Christmas Holiday	25/12 - 05/01
1st year exams	
Analysis 2	31/01
Physics 1A	01/02
Biomolecular Dynamics-1	02/02
2nd year exams	
Systems and Siwwgnals	31/01
Electronic Instrumentation	01/02
Evolutionary Developmental Biology	02/02
Master's exams	
Engineering Genetic Information	29/01
Mathematics for Nanobiology	30/01
Biology of Cancer	01/02
Soft Matter Physics	02/02
Lunch lecture AMOLF	09/01
Wnt vacation	04/02 - 11/02


DNA
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