



# ACID

## Why Do We See Rainbows?

Amsterdams  
Chemisch  
Dispuut

The Colours of Love Chocolate  
Interview with Dr. Jocelyne Vreede  
Majors and Minors of the Master Chemistry

A personal view on the major Science and Communication  
by ACD'er Marit Beerse

Volume 53  
Edition 2



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# Colophon

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# From the Editor

Dear reader,

Now that the winter is over and the sun starts to shine brighter and longer, we encourage you to spend some time outside and produce some vital amines (a.k.a. vitamins). It can of course happen that it starts raining and that you observe a beautiful rainbow. In this edition, we shed some more light on the formation of rainbows so that you can appreciate the beauty of them! We also have a lovely piece about our love for chocolate, diving deeper into the science of producing chocolate. Besides fully writing pieces ourselves, we approached several people for interviews such as dr. Jocelyne Vreede, computational chemist and the new BSc. programme director, Marit, a major science communication student and Tim, the new treasurer of the ACD. In addition, we get an update from the chair and OC about the upcoming period and finally, we finish off with reviews of our favourite books, a delicious recipe and, of course, the "chemistry vs" rubric. Enjoy!

*On behalf of our entire editing team,*

Siebe Lekanne Deprez

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# From the Chair

Dear ACD'ers,

The last couple of months have not been easy for most of us. New covid measures upon new covid measures sending us back home to study, leaving an empty campus behind. But first, we go back to November. This month started with the amazing ACDxLEC symposium and a party the day after. After that, we still had a few more weeks of smooth sailing with Friday drinks, a game night, the first orientation market, the Chemunity kick-off, and even lectures!

Then, the new measurements happened in December, and life started switching back to online, including an online crafts course and an online TATA-steel excursion, which I really enjoyed, even though they were online. Then the December holiday happened and everybody who was able to, went home for Christmas and New Year's Eve. It was around this time everybody around me started getting covid. My roommate, my parents, I still do not understand how I managed to dodge covid in these weeks.

Then the first weeks of January started, when a lot of things were still happening online, including the second track lecture. But the covid situation started getting better nearing the end of January and physical activities were allowed again. Drinks in the Oerknal on Wednesdays were possible again at the end of January, giving the opportunity of talking about the holidays and the last couple of months, which were an experience again, to say the least.

At the start of February on Friday we had our alumni lecture, which gave everyone an insight into the paths of three different chemistry alumni and created a broad scope for which jobs you can do after your study Chemistry. Next was another event to give insight into the future, the Chemu-



nity meet your PhD'ers event, where master students could ask PhD'ers questions about their job and research.

Then a few weeks on our semi-annual General Meeting happened where we were able to welcome a new board member, Tim de Groot, which means the board now consists of five people, Perry, Arthur, Tim, Ben, and me. With this expanded board, we hope to be able to make the next half year extra enjoyable for all ACD-members. On that Friday, the all-years weekend could finally proceed to Maastricht. Through the storm, we drove to the far south to enjoy a terrific evening with a pub crawl which covered an amazing twelve meters of the center of Maastricht. And while writing this piece, we are going on an excursion to Baril coatings in 's Hertogenbosch and are finally returning to our Friday afternoon drinks in the brainwave from 17-22, where I hope to see everyone again and have a chit-chat while enjoying refreshments.

For now, the future weeks look good. With covid regulations being reduced to a minimum and spring and summer coming up, the ACD will be able to organize amazing activities where all our members are able to have a wonderful time with their peers.

From your chairman,  
**Martijn ten Brink**

# Meet the New Treasurer

Dear members,

It is a pleasure to introduce myself as your new treasurer. At the latest ALV, I was voted in as treasurer to help the by the then four-headed board for the rest of this year. I am currently in my second year of the bachelor chemistry. To increase cohesion with the first-year students, I will also be following Physics with them this year. My interests vary wildly, from musical theatre to video games and from dungeons and dragons to punk music, so if you want to talk about these topics (or anything else!) feel free to approach me because I'm always up for a chat.

As treasurer, I will oversee the money of ACD to ensure it is taken care of and will be used for many fun and educational activities for the remainder of the year. Alongside this, I will also be performing various other tasks in front of and

behind the scenes. Besides my board work I will continue my committee work, which means I will be organizing this year's parties and FLUX with the Feestcommissie and the excursion to Munich this May with the BEC. I hope to see everyone at these and at the other fun events that we will bring you this year!

I'm looking forward to a wonderful half-year and am sure that together with the rest of my board, we will finish this year on a high.

Greetings and hugs,

**Tim de Groot**  
Treasurer of the 76th Board of ACD



# Het Wel en Wee van de OC Part 2

Sverre Overdijk

Dear reader,

Since it is February by now, this means we had some new master students join the program. For those of you that don't know what the OC is, I would like to invite you to read the 'Wel en Wee' of the first ACiD. In that edition, I explained what the OC is, who we are, and what we do.

Now let's get on with the update on what we have been up to since the last 'Wel en Wee'. We have seen the UvA-Q platform go down. This was very unfortunate since the UvA-Q course evaluations are our main way of obtaining your opinion on the courses you followed. An alternative method was devised to cover the time till the platform got up again. However, we received signals from many students that they did not receive evaluation forms for some courses. Luckily, the UvA-Q platform should be up and running again by now. So please keep filling them in, since it is the easiest way for us to know what you think about the courses.

We also saw Sape, after having fulfilled this position since 2012, leave as program director. The new program director is, as you all probably know, Jocelyne Vreede. I am sure she will also do an amazing job fulfilling this function. However, this unfortunately also means she has left the OC. Jocelyne will be replaced as OC teaching member by Hong Zhang. Hong Zhang is an associate professor in the Molecular Photonics group, and most of you will probably know him from the Molecular Spectroscopy course.

The committee goes through quite a period of change since we also saw Rene Williams leave the OC. Unfortunately, we yet have to find a permanent replacement. However, for now, Tati Fernán-

dez Ibáñez will fulfill this position. Tati is the head of the Fernández-Ibáñez research group, which operates at the interphase between the organic synthesis and catalysis fields.

We are also still looking closely towards anything that has to do with the new curriculum for the Bachelors. Since the first-year students are well underway, more and more becomes clear concerning the influences of changes in the curriculum. From what we hear, the curriculum is received very positively. The new challenge coming up is of course the second year of this curriculum. The first-year students have had lectures on the tracks they can choose, and the level of tunability of the program for everyone looks very interesting and promising. As always, if any problems with the new curriculum arise, please contact the OC, and in all cases, please fill in the course evaluations.

On a more general note: at the moment of writing, we are very close to dropping all Covid-measures. However, the high number of cases means a lot of students need to self-isolate. This means lectures need to be given in a hybrid form, which often brings new challenges for the lecturers. If any issues arise concerning the hybrid way of lecturing, please let your lecturer know, so you can figure out a solution together, as I'm sure the lecturers want the best experience for both the at-home and on-site students.

OC mail: [ocs-science@uva.nl](mailto:ocs-science@uva.nl)

OC page: [student.uva.nl/sck/content/az/opleidingscommissie/opleidingscommissie](https://student.uva.nl/sck/content/az/opleidingscommissie/opleidingscommissie)

# A career outside of academia? Take a look at the majors and minors of the master Chemistry!

A personal view on the major Science Communication by fellow ACD'er Marit Beerse

*Michelle van Dongen*

What can you do outside of research? I can imagine this being a question a chemistry student has asked themselves at least once during their bachelor- or master programme's curriculum. After all, we are mostly living in the bubble of the academic world with our courses and internships at universities, making it hard to picture a job outside of it. Contrastingly, many of us move on to areas outside of research such as teaching, consulting, writing, or entrepreneurship. For that reason, you can choose for 3 major (major = 1 year, 60 EC) and 2 minor (minor = 0.5 years, 30 EC) programmes within the master Chemistry. Within the major programmes, you can choose from the major Science Communication, Science in Society and Teaching. The minor programmes are Science for Sustainability and TESLA. To get an insight into one of the majors, I spoke to Marit Beerse who is currently enrolled in the major Science Communication.

Marit has been at the UvA/VU for quite some time, and you probably know her from the wonderful BEC holidays she helped organize, the wonderful ACD-parties, the beautiful posters, and even pieces in and lay-out of the ACiD. She did her Bachelor Scheikunde here at the UvA/VU and continued with the master Chemistry, track Molecular Sciences of which a part is the major Science Communication.

## **Goal of the Major Science Communication**

The first question I asked her was about the learning goal of this major. What do students learn from the major and what is its focus? Marit answered that the main goal of this major is to learn how to communicate about science in the best manner. According to her, the major entails a lot of reflection and discussion on how you can communicate well, how you can establish that people feel heard during a debate and how you achieve an understanding of what you are saying. It is a lot like management. She told me that the courses of this major and of the major Science in Society are actually part of a master that has a name that is way too long to type here (google MPA VU and you'll find it). If you follow the major Science in Society, you mostly follow the policy courses and if you follow the major Science Communication you mostly attend the communicative courses.

## **Her interest in the Major Science Communication**

How did Marit end up at this major? "A true adventure" were the words Marit used. She said that after her bachelor Scheikunde, she believed she didn't want to have anything to do with this subject anymore. For that reason, she did the minor Earth and Climate at the VU, so she could start with the master Earth Sciences, focus-

sing on climate change. She wanted to save the world. However, during the minor she concluded that the world could not be saved anymore and changed her plans once more. She contacted the study advisor and together they came up with major Science Communication, because Marit always wanted to combine science and communication. It was the perfect fit.

### **The structure of the Major**

Officially, you start with a year of the Master Chemistry. During this year, you must do four courses of the compulsory part, a literature study of 6EC and a chemistry research project of 30 EC. The second-year you start with the major Science Communication. The first semester starts with standard courses after which you do an internship in the second semester. Two choices can be made for the internship: a research internship where you conduct social sciences-oriented research for a company, and a more company-oriented internship where you delve into the communication world by spending your time at a company four days a week and then do research for one day. An example for the latter is that you can help with exhibitions at NEMO or write articles for New Scientist. You can do an internship at every company that is connected to science communication. For example, Marit will do her internship at Next Nature Network which is a company connected to many aspects of society and science. The idea of the company is that they form the bridge between society and scientists (cause we all know that we don't make a lot of sense sometimes, especially if we start rambling about our beloved chemistry). Their philosophy is that nature and technology are not that different, and that technology does not only have a negative impact on nature.

### **What Marit likes best about the Major**

Naturally, I asked Marit what she thought was the best aspect of the major and she answered



“writing, a lot of writing”. As an example, she mentioned the course ‘Science Journalism’ which entailed writing an article for a magazine, making a podcast, and a video. Currently, she is following the course ‘Science in dialogue’ and learns how one should talk about science and how one can prevent discussions where people talk alongside each other. For this course, she receives a take-home exam every week in which she must write an essay. She told me that you can barely compare the minor to the master Chemistry since you have to collaborate non-stop with other people. In the beginning, she found this a bit hard, because according to her you usually work alone during the Chemistry courses.

### **More difficult aspects of the Major**

After having talked about the best aspects of the major, I got curious if there were any things Marit really needed to power through. She answered that she mainly found it difficult to learn a new way of writing and conducting research. For her first course, she had to write a proposal for research in a new format, and now she has to carry out ethnographic research: what are the habits, customs, and views of certain groups of people? For this, she has to find out how her organization



views and shapes the border between science and society.

### **Surprising aspects of the major**

Next, I asked Marit if she encountered any unexpected things during her major. She answered that she underestimated how much you have to collaborate, how much you have to interview and how many surveys are involved. Chuckling, she added that during the courses they always emphasize how the students should not use too much jargon, but at the same time continue with their own jargon.

### **What if she had not liked it?**

On this question, Marit stated that she wouldn't have had a clue, what she would've done if she didn't like the major; she would probably have changed to another master.

### **Prospects of the major**

Marit's dream is to one day write for a popular scientific journal as KIJK, Quest or New Scientist, but before then she will probably be a freelancer writing pieces for multiple magazines or websites. She added (semi-)jokingly that she could always keep writing pieces for the ACiD. Of one thing she was certain: she will find her way in journalism.

### **Advice for the ones interested**

I wondered if Marit had advice for people also interested in this major to which she answered

that you should be able to handle 'deep philosophical subjects' and the focus on pondering how to best communicate. The latter is something that is difficult to learn if you're from Chemistry according to Marit. You need to be interested in analyzing the news and noticing concepts you've learned in society. She mentioned how she now looks different at press conferences, can critically analyze their statements, and whether they accomplish the point the speakers are trying to make. Lastly, she mentioned that you do not have to mind self-study and need to have self-discipline, since the major does not have many contact hours but does require you to do work regularly. In other words, you really have to go for it, but eh, that should not be too difficult if you are interested in what you are learning.

Are you possibly interested in the major and would like to contact Marit? Then mail to [blad@acdweb.nl](mailto:blad@acdweb.nl).

For information about the Majors and Minors check out these links:

<https://bit.ly/VUmajor>

<https://bit.ly/UvAmajor>

# The Science of Rainbows

*Siebe Lekanne Deprez*

Rainbows are truly magnificent in my opinion. Just the sight of seeing one while being surrounded by dark rain clouds sends shivers down my spine every time. There is something about this natural phenomenon involving light and colours that interests me and I am clearly not the only one, since its influence can be seen everywhere. Rainbows appear in art, movies, literature, and music, but also in mythologies and religion. One well-known example is that one could supposedly find a pot of gold at the end of a rainbow, which was placed there by leprechauns. My favourite influence of rainbows is that it led to one of the most frustrating racing tracks in-game history called 'Rainbow Road' in Mario Kart DS. Nevertheless, this article will be less about the influences and more about the science of rainbows, which we will achieve by answering the following key questions:

1. Which requirements are there for rainbows to form?
2. What influences the angle at which rainbows are observed?
3. Why do we observe a colour spectrum when rainbows form?

## Requirements for rainbows

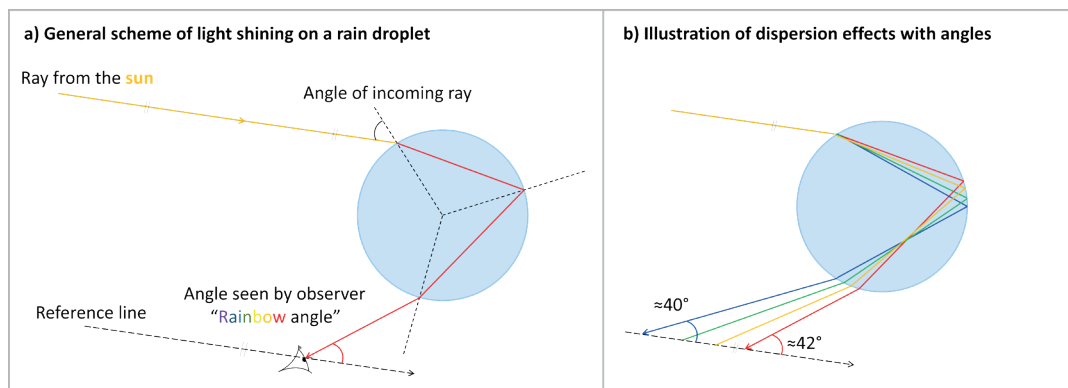
First, let us consider the characteristics of rainbows. Rainbows are not physical objects in the sense that you cannot touch it; they are solely an optical illusion where light is reflected, refracted, and dispersed. Think of shining (sun)light on a prism which bends light and disperses it into a colour spectrum. A similar thing occurs with rainbows, but the difference lies in the medium

in which light is dispersed. Intuitively, one can guess that rain droplets are required because it is obviously in the name. While that is true, rainbows can also form in the presence of small ice crystals. The essence is therefore that the air should contain enough condensed water.

Besides the requirement of water, there is another requirement and that one is, of course, light! It turns out that the light should contain all wavelengths (like the light rays of the sun) and that the light must be coming from your back. **Figure 1** clearly shows that the light is opposite to the "place" where the rainbow is located. Thus, the light that comes from the opposite direction is reflected in the water medium and enters our eyes. One remarkable consequence is that everyone sees a different rainbow, since the phenomenon depends on where you are and in which direction you are looking at.



**Figure 1.** A clear example of a rainbow. The picture is taken from Wikipedia.<sup>1</sup>



**Figure 2.** Schematic drawing of reflection, refraction, and dispersion of light in water droplets. Sunlight is represented by the yellow line and is split into different colours of light. Part a) shows the general scheme and b) highlights the influence of different frequencies of light (i.e., colours) on the observed angle.

### Light reflects, refracts, and disperses in water droplets

Now that we know we need two components – a water medium and a white light source – we can investigate what happens in the medium that causes light to not only disperse, but also to reflect into our eyes. A schematic representation of this process is shown in Figure 2a wherein white light (yellow line) from the sun shines upon a spherical water droplet and is dispersed into red light.<sup>a</sup> The process can be divided into three steps: first, a light ray hits a droplet and the ray is refracted due to changing mediums, meaning its direction changes. Then, the ray is reflected, which inverts its direction, and finally, the ray is refracted again by going from water to air. The figure shows the angle of the incoming ray and the angle as seen by the observer. Note that the observed angle is with respect to the incoming ray and not the ground/horizon. The observed angle depends on the angle of the incoming ray; if the incoming angle

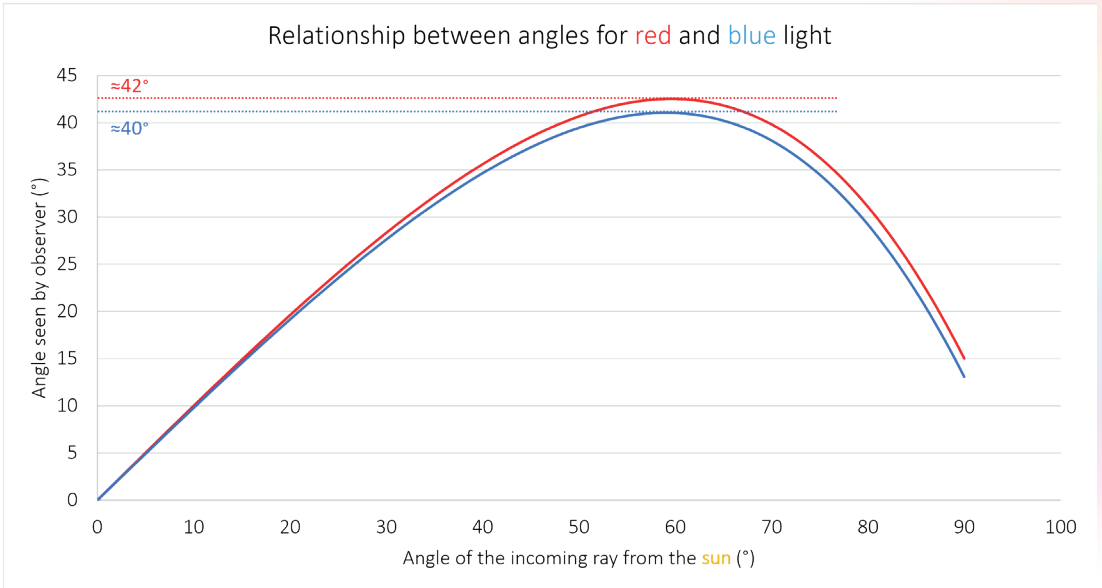
becomes too large, you will not see any colour being reflected and you will see no rainbow. In other words, you can only see a rainbow when the sun is low! However, this leaves us with the questions ‘What is the relation between the angle of the incoming ray and the angle seen by the observer?’, and, ‘How does that explain the different colours we see in a rainbow?’, which we will consider next.

### The importance of the refractive index

The answer to both questions lies in the refractive indices (“brekingsindex”) of air and water. The refractive index basically indicates how much light is bend/refracted when light moves from one medium to another. For air it is around 1 and for water around 1.33. By applying geometric relations between angles and by using the refractive indices of air and water, one could determine the relationship between the incoming angle and the observed angle.<sup>b</sup> However, the refractive index

**a** Red light is used just as for illustration purposes at this point. Later, other colours will be included.

**b** For the curious readers:  $\text{Angle}_{\text{obs}} = -2 \times \text{Angle}_{\text{incoming}} + 4 \times \sin^{-1}\left[\frac{1}{n_{\text{water}}} \times \sin(\text{Angle}_{\text{incoming}})\right]$  with  $n_{\text{water}}$  being the refractive index of water, which depends on the colour!

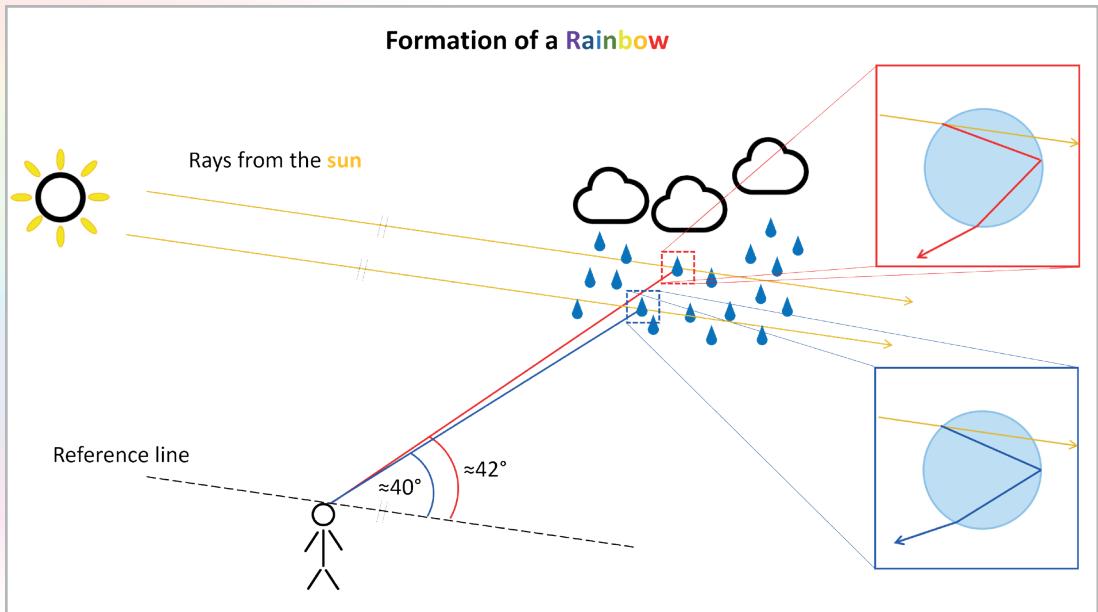


**Figure 3.** Relation between the incoming and observed angles in degrees for red and blue light. Both curves have a maximum at  $40^\circ$  and  $42^\circ$  for red and blue light respectively.

for water deviates slightly for different colours, meaning that the observed angle depends on the colour even though the angle of the incoming ray remains the same. Thus, the path of red light varies from the path of blue light, which leads to a separation of colours and hence, dispersion (Figure 2b). The relationship between the angles is shown in Figure 3, wherein the observed angles for red and blue light are plotted as the incoming angle is varied. In the figure, we can see that the curves show a maximum at  $40^\circ$  and  $42^\circ$  for red and blue light respectively. As a result, an observer will observe a rainbow occurring between  $40^\circ$  and  $42^\circ$  with respect to the incoming light ray. As for why the rainbow shows an arc, you should realize that you can rotate around the  $40^\circ/42^\circ$  arc, leading to a cone of light where the edge of the cone is your rainbow. Actually, the horizon stops

the rainbow from becoming a full circle, but you can see the whole arc if you're high enough above the ground!

To summarize, we have seen that the formation of rainbows requires sufficient condensed water and white light. When these conditions are met, light shines upon the water medium and, due to the refractive index of water and air, white light is reflected and eventually enters the eyes of the observer. The refractive index depends on the frequency/colour of the light, which causes the white light to disperse into a spectrum of colours. Water is special in this regard, because the two sides of the visible spectrum, blue/violet and red, lead to the observed angles  $40^\circ$  and  $42^\circ$ , being in the perfect range for creating a beautiful rainbow! The whole process is summarized in Figure 4



**Figure 4.** Overview of the formation of a rainbow. White light shines upon raindrops that disperse and reflect light. Since the refractive indices of water are slightly different for blue and red light, their paths within the droplets also differ from each other. As a result, the observer sees a colour spectrum between  $40^\circ$  (blue) and  $42^\circ$  (red) with respect to the reference line/sunray.

where I have tried to make it as clear as possible, but I found it difficult to include all colours, so one should imagine a rainbow between the outer edges – blue and red.

Finally, there are some interesting details that I have not mentioned. For example, the curves in Figure 3 show that the observed angle of a rainbow cannot be greater than  $42^\circ$ , regardless of the incoming angle. As a result, the reflection angle is always smaller than  $42^\circ$ . Now, could this be related to the fact that the area enclosed by the rainbow is much brighter than the area outside

the rainbow (Figure 1)? Or what about a second rainbow that can be sometimes observed? We assumed that light refracts only once inside a rain droplet, but we could also consider processes where light refracts twice. Could additional light refraction explain the optical illusion of a second rainbow with inverted colours? There is so much more to discover about rainbows and if you are interested, I sincerely, no, immensely recommend that you watch this video<sup>2</sup> of 20 minutes; it will feel like a wonderful story about the beautiful connection between nature and rainbows.

1. Wikipedia. Rainbow. [https://en.wikipedia.org/wiki/Rainbow#Culture\\_and\\_mythology](https://en.wikipedia.org/wiki/Rainbow#Culture_and_mythology) (accessed 24 Feb, 2022).
2. Physics Explained. The Physics of Rainbows. <https://www.youtube.com/watch?v=M90XEREE66s> (accessed 25 Feb, 2022)

# Nasi Goreng

by Tim Lugtenburg

This time we move to the Indonesian Archipelago for our dish of the edition: nasi goreng. It translates to fried rice, but a variety of ingredients are added. What really sets the taste apart from fried rice dishes in other countries is the use of kecap manis, which means sweetened soy sauce, and is widely used in Indonesia. Nasi goreng is a great one pot meal with rice, vegetables and chicken, so it has all the ingredients for a complete dinner.

## Ingredients:

### Chicken

- 1 tbsp oil
- 150g chicken thigh, thinly sliced
- 1 tbsp kecap manis

### Rice

- 1.5 tbsp oil
- 2 garlic cloves
- 1 tsp chopped red chilli pepper
- 1 onion, diced
- 3 cups cooked white or brown rice, day old, cold
- 2 tbsp kecap manis
- 2 tsp shrimp paste (or fish sauce)

### To serve

- 4 fried eggs
- 1 sliced green onion
- 2 sliced tomatoes

## Preparation:

### The day before

1. Cook the rice according to instructions and place in the freezer overnight. This ensures a crisp texture instead of regular soft rice.



### Eating day

2. Heat oil in a large wok pan at high heat. Stir fry chilli and garlic for 10 seconds.
3. Add the onion and cook for another minute.
4. Then add the chicken until it is mostly cooked on the sides and add 1 tbsp kecap manis. Cook until chicken is mostly cooked through.
5. Add the rice along with 2 tbsp kecap manis and the shrimp paste. Stir constantly for 2 min and see the sauce get incorporated into the rice grains.
6. In a separate pan fry the eggs sunny side up, so that the yolk is still nicely runny.
7. Serve together with the eggs and the green onion.
8. Enjoy!

## Chemical detail:

Although it significantly improves the texture of the rice, not much interesting chemistry is going on when freezing it: it just dries the rice out.

But while looking into the method of freezing rice before eating, some research suggests that this potentially decreases the amount of calories in the rice by converting the starch in it to resistant starch.<sup>2</sup> This term includes different types of starches, but one type has an altered conformation which prevents degradation by enzymes in the stomach or intestines.

Like much nutritional research it has to be taken with a grain of salt (pun intended) as not all papers seem to agree and the original paper discussed by several news outlets was nowhere to be found.<sup>3</sup> Nevertheless, it is still interesting that freezing rice potentially has an effect on its nutritional content at all.

1. <https://www.recipetineats.com/nasi-goreng-indonesian-fried-rice/>  
2. <https://www.acs.org/content/acs/en/pressroom/newsreleases/2015/march/new-low-calorie-rice-could-help-cut-rising-obesity-rates.html>  
3. Raungrusmee, S.; Anal, A.K. Effects of Lintnerization, Autoclaving, and Freeze-Thaw Treatments on Resistant Starch Formation and Functional Properties of Pathumthani 80 Rice Starch. *Foods* **2019**, *8*, 558. <https://doi.org/10.3390/foods8110558>





# The Colours of Love Chocolate

*Rianne van Diest*

You probably noticed that last Valentine's Day, all stores were full of chocolate again. Although you might think this is some commercial business, the relationship between chocolate and love goes a long way back, even to the Aztecs!<sup>1</sup> Cacao beans were then considered to be food of the gods, with a value higher than gold. The emperor Montezuma II consumed lots of cacao drinks because he believed it fuelled his romance. It might sound a bit weird, but is actually not that surprising, as consuming chocolate releases serotonin and dopamine. These same hormones are released when ... you are in love!

Chocolate and cacao come in many colours. In addition to the classic chocolate colours dark, milk, and white, a new colour was introduced in 2018: ruby chocolate. The colour is not achieved by adding colorants, but by chemical processes during the production. Besides, you might have encountered red cacao pastries, such as red velvet cake. Nowadays, the red colour is produced by adding colorants, but originally, red velvet was formed naturally when baking with cacao. Red and pink chocolate, how romantic! But how do

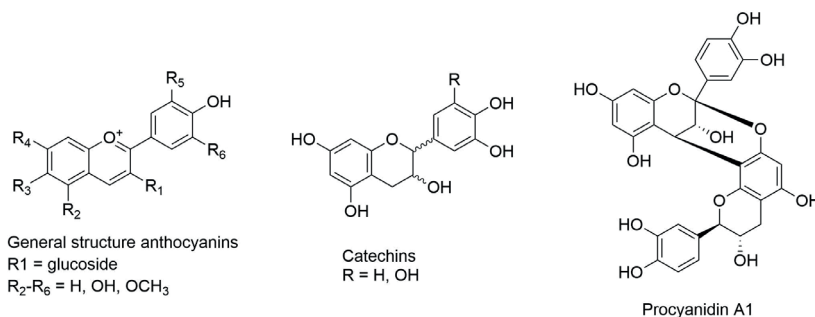
these chocolates get their colour? To understand how this works, we first have to zoom in on the basic chocolate production process.

## **Production process**

After the cacao beans have been isolated, fermentation takes place.<sup>2</sup> This is a very important (biochemical) step, yielding the precursors for aroma development. The next stage is drying, which finishes the fermentation and lowers the moist content. Then, the beans are roasted: here, precursors from the fermentation are converted in chocolate aromas and flavours, mainly via the Maillard reaction (the same reaction that happens during caramelization). Thereafter, the beans are grinded, which creates a chocolate liquor. By applying pressure, the liquor is separated in cacao butter and - after more grinding and tempering - cacao powder. The cacao butter can be mixed with the chocolate liquor and other ingredients to make chocolate bars.

During all these processes, proteins, carbohydrates, lipids, polyphenols, and other compounds undergo various chemical reactions. For the





**Figure 1.** The structures of anthocyanins, catechins and an example of a proanthocyanidin.

colour, the polyphenols are most important, so this story will focus on them. However, the other compound groups definitely have impact as well. Unfermented cacao beans contain 12-18% w/w polyphenols, from which 37% flavan-3-ols (catechins), 4% anthocyanins, and 58% proanthocyanidins (Figure 1). In the general production process, the polyphenol content is mostly reduced during fermentation, but the other steps reduce the percentage as well.

### Red Velvet cake

The characteristic colour of red velvet can arise while baking a cacao cake. However, it does not work with the regular cacao from the store, because usually, (European) cacao has undergone 'Dutch-processing'.<sup>5</sup> This process takes place after grinding, with the natural cacao. Dutch processing not only changes the colour of the cacao, but also increases its solubility and makes the taste more chocolate-like as we know it. Natural cacao is very bitter and also slightly acidic, with a pH of 5-6. By mixing the natural cacao with an alkali solution, the pH can be increased in various degrees. The higher the pH, the darker the colour, as shown in Figure 2.<sup>4</sup> Even black cacao can be made, which is used for Oreo cookies.

Alkalization initiates a whole range of chemical processes with different chemical groups.

For the polyphenols, the most important effect is oxidation.<sup>2</sup> Firstly, oxidation of polyphenols by the enzyme polyphenol oxidase (PPO) is improved (Figure 3).<sup>5</sup> This enzyme works optimal at pH = 8, and converts the polyphenols in brown melanoidins. It is active during fermentation as well, but the high pH from the alkalization improves the activity. Proanthocyanidins are oxidized to anthocyanins and anthocyanins, in turn, to brown products. Secondly, the alkalization itself also induces oxidation and interaction of the polyphenols with many other compounds present in the cacao. Besides, it has been shown that due to alkalization, anthocyanins can react with sugar or products from Maillard reactions via a condensation reaction, as depicted in Figure 3. Together, these processes greatly reduce the polyphenol content of the cacao, which is also shown in Figure 2.<sup>5</sup>

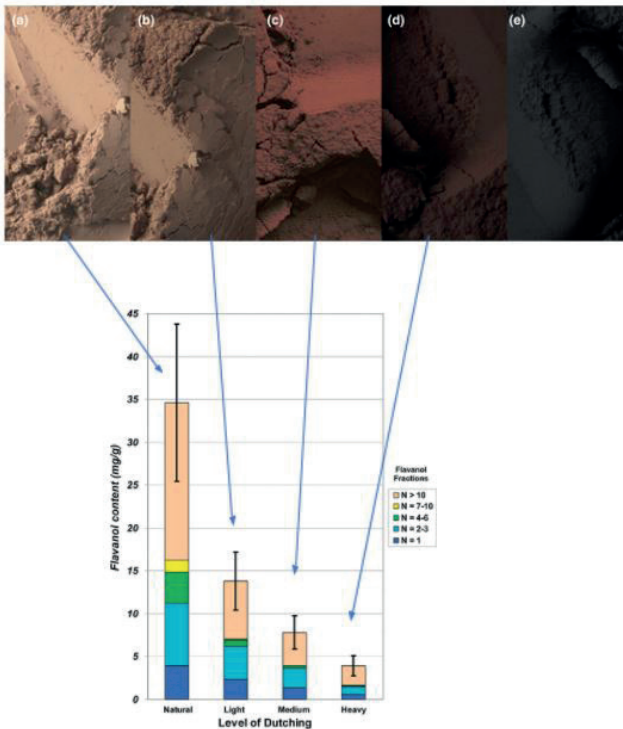
Unfortunately, precisely anthocyanin is responsible for the characteristic red velvet colour. Anthocyanin is a pigment that can have various colours, depending on the pH.<sup>6</sup> It is the same compounds that makes your red cabbage ... purple. At a pH of 1-3, however, anthocyanin is red, as shown in Figure 4. By using natural cacao (pH 4-5) and adding acidic ingredients, such as vinegar and buttermilk, the beautiful red colour will be revealed in the baking process.

## Ruby chocolate

From the colour, you might have guessed that anthocyanin plays a role in ruby chocolate as well. Sadly, the production process of ruby chocolate is still patented, so the exact production process is a mystery. Nonetheless, it is known that unfermented – or shortly fermented – beans are used.<sup>7</sup> As we saw in the section about red velvet, fermentation reduces the polyphenol content through enzymatic oxidation. Therefore, skipping this step will increase the polyphenol compound compared to the normal production process. In addition, it is known that the cacao nibs are treated with an acidic solution as extra step in the production process, resulting in a red or purple colour.

Research by Tuenter has shown that especially procyanidin A-type compounds (Figure 1) are preserved in ruby chocolate and not in dark chocolate.<sup>8</sup> These compounds have a brownish colour, but they can interact with anthocyanins and other polyphenols. The structures resulting from these interactions are poorly understood and also vary for different products. However, it is likely that procyanidin A compounds also produce red-pink tints by interaction.

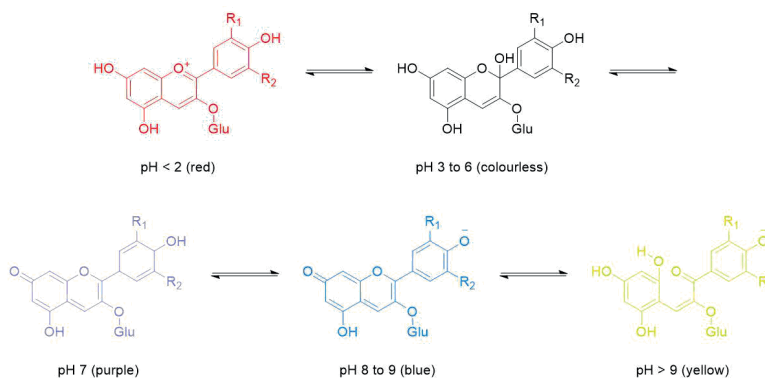
Montoya *et. al.* tried to reproduce the ruby production in their lab.<sup>7</sup> They heated the unfermented beans to 95 °C, and then quickly cooled them to inactivate the PPOs and glycosidases. Next, the beans were soaked in a citric acid solution. This step probably ensures pH-stabilization; the anthocyanins are 'locked' in their red pigment, but it also reduces oxidation reactions by PPOs. Still, the thermal shock is essential as well, because glycosidases remain active at low pH's and hydrolyse the red anthocyanin to cyanidin (Figure 3).



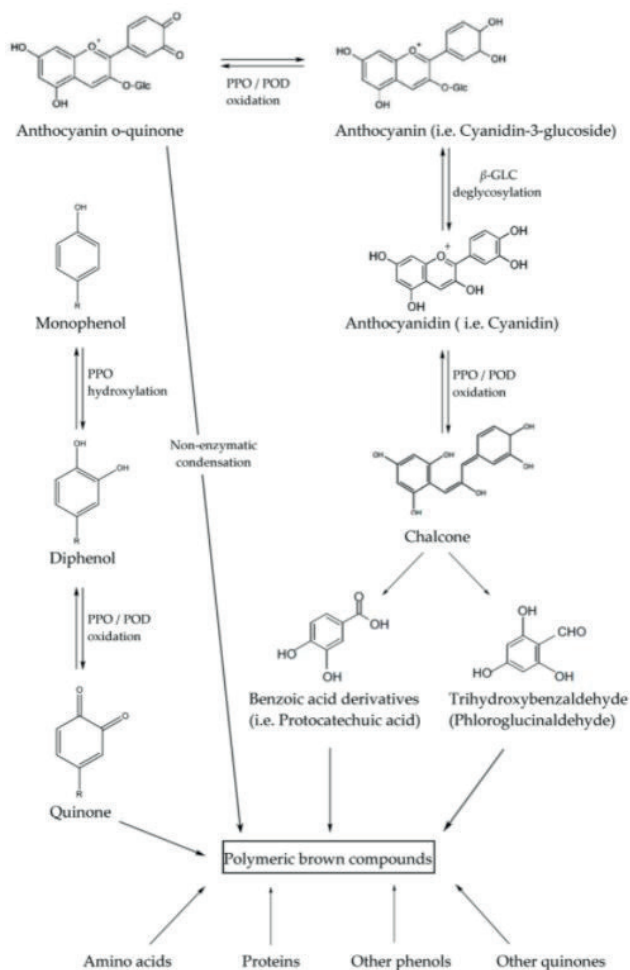
**Figure 2.** Colour of natural cacao (a) to light (b), medium (c), heavy (d), and ultra (e) Dutch processed cacao, and their flavanol content.<sup>3,4</sup> Here, N indicates the oligomer content of the flavanols.

## Anthocyanin as the colour of love

In conclusion, the lovely red and pink colours of cacao can be achieved by conserving anthocyanin and other polyphenols as much as possible in the cacao production process, and by making the cacao acidic enough to reveal the red colour of anthocyanin. That being said, I'd like to share a fun fact to finish this article: polyphenols – and especially anthocyanins – are efficient antioxidants, which is beneficial for your health.<sup>7</sup> So, here is your perfect excuse to eat an entire ruby chocolate bar. And don't forget the health of your loved ones! They definitely need some antioxidants as well ;).



**Figure 4.** Structure and colour of anthocyanin at different pH-values.



**Figure 3.** Degradation of anthocyanin in Dutch processing via enzymatic oxidation and deglycosylation, and non-enzymatic condensation.<sup>5</sup>

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## Bladcommissie Bookreviews

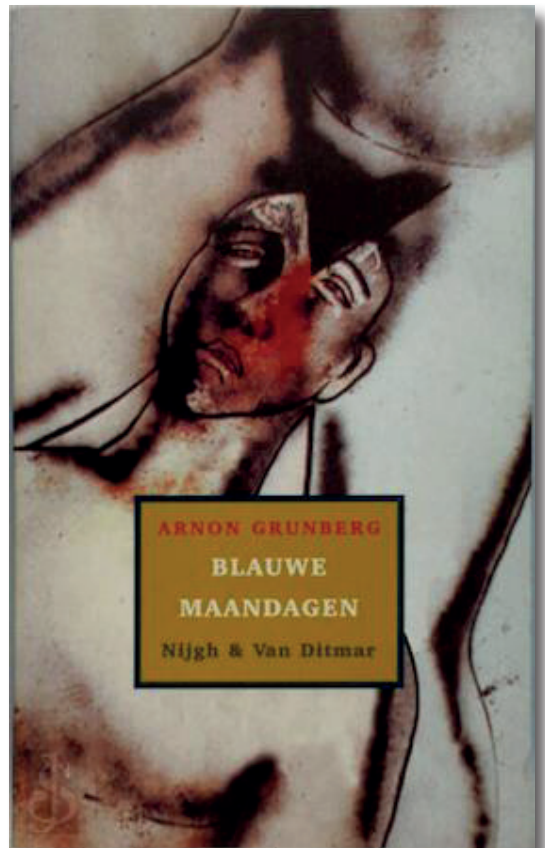
### *Blauwe maandagen* - Arnon Grunberg

*Blauwe maandagen* is the debut novel of celebrated writer Arnon Grunberg, written when he was 23 years old. In this book the protagonist, also Arnon Grunberg, looks back on his life in which he was indifferent to most everything that happened to him or occurred around him. This being a result of living with parents traumatized by the holocaust.

The book is written extremely vividly, taking you from astonishment to astonishment. Starting at the Vossius Gymnasium in Amsterdam, Arnon was only interested in drinking beer until he ran out of money. This gave way to a life of obscure jobs, a path perhaps recognisable to students. Especially the beginning of the book is not recommended to be read on the train, as is most difficult to keep oneself from laughing at passages such as, 'When I like someone, I suddenly remember that you are able to use a spoon to remove the eyeballs from someone's face'.

As the book progresses to the later part of the main character's life, his attitude towards life remains unchanged. His life now a blur of escort girls and meeting the same people in bars, one begins to feel disillusioned.

The book is also part of the Dutch high school reading list, so if you always felt bad reading all of them, this is your chance!



"One of the most important books I've ever read—an indispensable guide to thinking clearly about the world." —Bill Gates

# FACTFULNESS

Ten Reasons  
We're Wrong About  
the World—and Why  
Things Are Better  
Than You Think

New York Times  
Bestseller

Hans Rosling with Ola Rosling and  
Anna Rosling Rönnlund

## Factfulness - Hans Rosling

With the corona crisis' wave of disinformation, one book has become even more relevant than it already was: Factfulness by statistician Hans Rosling which was posthumously published by his daughter. In it, Rosling uses statistics and visualization tools to compare people's views on the world with reality, thereby identifying ten categories of biases we should watch for.

Although we hear horrible statistics all around us, and many of them are indeed horrible, here some misconceptions about how bad the state of the world is are dispelled. The most striking example is that of world poverty. While a much too large portion of the world still lives in poverty and does not have access to clean drinking water or education, Rosling shows that the living

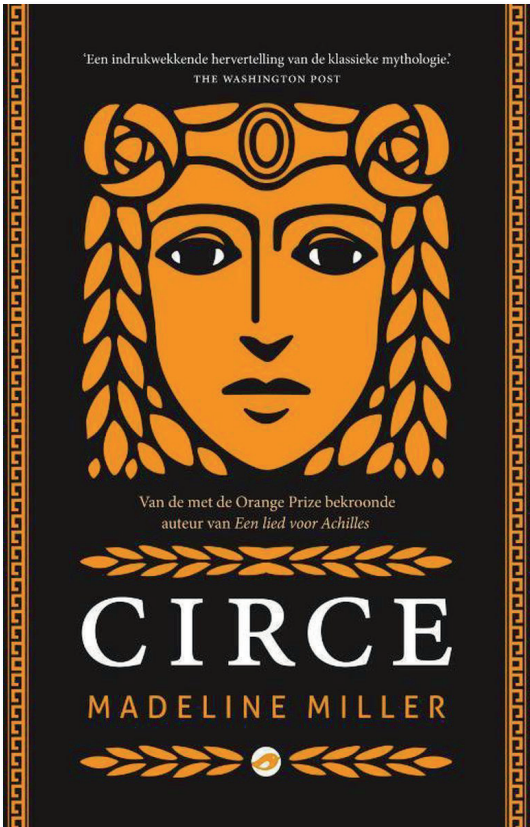
conditions of all people have in fact drastically improved over the past decades. Because a lot of people still look at the world in terms of developed vs undeveloped, we group many countries together and label them as 'poor'. Instead Rosling groups countries in one of four levels based on income. This provides a much more accurate view of things as e.g. the difference between transport by bike vs transport by foot can have a much greater impact on the well-being of a family than that of going from a motorbike to a car.

If you could also do with some positivity about the world based on rational analysis and get rid of some biases at the same time, then I would definitely recommend picking up this book.

## Circe - Madeline Miller

*"They never listened. The truth is, men make terrible pigs."*

'Circe' is a beautiful retelling of the old Greek mythology around the immortal nymph and witch Circe. She is most famous from the Odyssey, written by Homer, where she transforms his men into pigs. But who is Circe really? And why does she transform men into pigs? This book will tell you. As I am quite fond of original Greek mythology, I was at first a bit afraid that I would not enjoy this retelling. However, Madeline Miller stays close to the original stories and even mimics the poetic and melodic writing style for which old Greek stories are known. Besides, Circe's perspective shines some feministic light on the stories. Yet, the best about this book is the character development. As she is not as powerful as her family and has much more sympathy for others than most (half)-gods, she does not fit in well with them. However, she has the special power of witchcraft, feared by the others. Her personality evolves through jealousy, vengeance, loneliness, regret, desire, and love, from a 'no one' into a power-woman. *"Witches are not so delicate."*



So, if you'd like to learn more about Greek mythology (or feed your old love for it) and are interested in understanding this woman known for transforming men into pigs, I can really recommend this book.

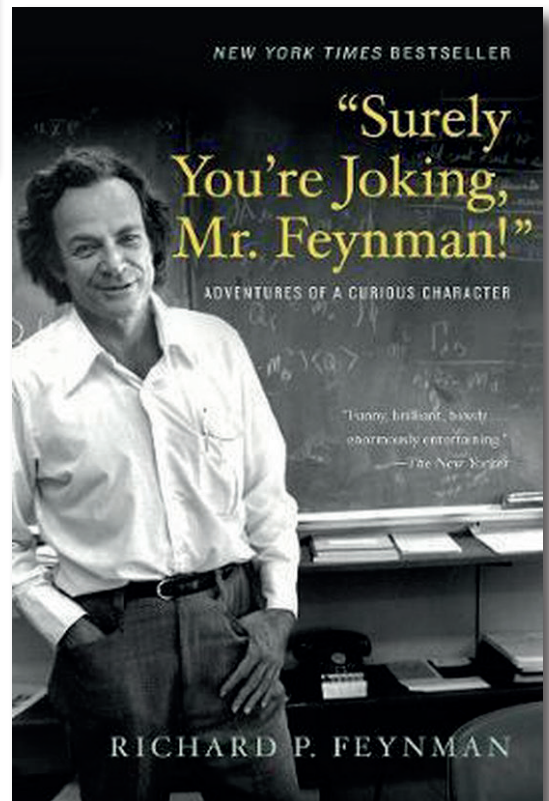
### ***Surely you're joking Mr. Feynman* - Richard Feynman**

"It doesn't matter how beautiful your theory is, it doesn't matter how smart you are. If it doesn't agree with experiment, it's wrong."

You might have heard of Richard Feynman and his contributions to quantum electrodynamics for which he was awarded the Nobel prize. However, did you know he was also very fond of playing the bongo, cracking safes during his time

at the Manhattan project, learning languages, figuring out how to lucid dream, and pranking his roommates in college? In this autobiographical book, written down from recordings of conversations with a good friend of his, you will get an insight in the mindset of the Nobel laureate, not by discussing his academic accomplishments but through a combination of small and longer anecdotes from his childhood in New York to his time as Professor at Caltech; he was for sure not the everyday dull physicist.

This book succeeds in describing discussions he had with Einstein and Bohr about the most challenging problems in physics to subsequently explain the difficulties he faced with the required etiquette for having tea when he just arrived at Princeton University.



# A Computational Chemist Meets Business

An interview with Dr. Jocelyne Vreede

*Rianne van Diest  
& Siebe Lekanne Deprez*



Students are often not aware of the collaborations between the university and industry. Sometimes it is mentioned during a lecture or while doing a project, but it is not obvious at all. In this interview, we will highlight how Jocelyne Vreede, assistant professor at the Computational Chemistry group at the UvA, came into contact with DSM and Janssen and decided to collaborate with these companies. We will also dive into her career choices and her most recent choice: becoming the programme director of the bachelor chemistry!

## Career

If one thing is for sure, then it is the fact that Jocelyne is well acquainted with the UvA. She studied Chemistry from 1996 to 2001, completed her PhD in 2007, and is now assistant professor, all at the UvA. However, when she started her study, some aspects were different from the current situation: the study was located at the Roeterseiland campus site (Science Park did not exist yet), and the BSc-MSc structure ('bama') was not yet introduced. Luckily, the ACD did exist and she became a member and soon also treasurer in the year 1998-1999. It proved to be a very beneficial decision, as Jocelyne thoroughly enjoyed her time as a student during which she got to know a

lot of people, experienced many (bizarre ACD-related) things, and learned skills such as leading an organization, collaborating with other people and bookkeeping.

During her studies, she became most interested in physical chemistry and photonics as she described herself as rather clumsy in the laboratory. During one of the 'sniffing internships' (snuffelstage) at the computational chemistry group, Jocelyne came in contact with computers and molecular simulations and became inspired to graduate within the group. She enjoyed the Amsterdam area to such an extent that she liked to continue her career as a PhD student, but now in the microbiology group at UvA. Her interest in performing molecular simulations was definitely not common; she was the first computational chemist within the group and there was a major gap to bridge in terms of knowledge between the group and her background. It turned out very well and she convinced the group that molecular simulations could aid their research.

After her PhD, Jocelyne had several options such as trying to obtain a postdoc position at the UvA or move to a different area like the industry. As became clear to her in the preceding years, she

really appreciated free-thinking at universities and did not feel like joining the industry where the focus lies more on prosecuting one, predetermined goal. Thus, Jocelyne contacted the UvA and obtained a postdoc position at the Computational Chemistry group (UvA) from 2006-2009. Jocelyne did also get offers from other universities, including ones from abroad, but since she also became a mother, she preferred more stability. While she enjoyed her time as a postdoc, she also experienced a lot of doubt and frustration from writing proposals that got rejected. The uncertainty in job security even led to her considering 'just becoming a chemistry high school teacher', but luckily some proposals were accepted eventually, and she could continue.

Currently, Jocelyne studies the dynamic properties and interactions of biological macromolecules (proteins, DNA, lipids, etc.) in biological systems using simulations. She also teaches bachelor's and master's courses and offers student projects.

### **Collaborating with DSM and Janssen**

Jocelyne has two research projects in collaboration with industry: one with Janssen Vaccines and Infectious Diseases, and one with DSM. These projects began when HIMS had received some money for public-private cooperation, which was appointed to computational chemistry. For the Janssen collaboration, Jocelyne had first approached a former office-mate from her PhD-time, who now works at Janssen. Sadly, at that time, the collaboration did not work due to struggles concerning the intellectual property from Janssen; the lawyers could not agree with each other. Later, this roommate approached Jocelyne, because he wanted to see how simulations and machine learning could help in his work. Now, they decided to make a project out of it for a Master's student. Together, they supervised this student and the research went very well - the student even works at Janssen now! In this project, they only worked with public data in

a secured digital environment from Janssen (to which Jocelyne did not always have access), to prevent legal problems with the private data from Janssen. After this project, they wanted to explore further collaborations, but this is currently on hold because the company is busy working with the Omicron variant.

DSM originally worked together with the analytical chemistry group to understand the aggregation behavior of lactase, the enzyme that breaks down lactose. Next, they found that in the presence of certain ions, the enzyme has different states of aggregation. As only a specific conformation is active, DSM wanted to know how they could specifically get that conformation. However, the analytical chemistry could not deduce what exactly the ions were doing. That is why they approached Jocelyne, who could provide insights at high detail with molecular simulation.

While setting up the collaboration, there were similar problems as with Janssen. It took three months before the legal people agreed on the project, despite the fact that they would only work with publicly accessible data.

Now, a postdoc is working on this research project, to investigate how these ions could change the aggregation of the enzyme. As lactase is a food enzyme, this research will give more knowledge about the interactions these enzymes have in complex fluids. To do this, all-atom force fields are used for Molecular Dynamics (MD) simulations. With these simulations, they can predict which amino acids are important for ion binding; by leaving them out or substituting them, it could be that the enzyme would form more of a particular conformation. DSM could next test these predictions and see if it works in an experimental setting as well. Besides these more qualitative predictions, you could also measure quantitative properties, such as binding affinity. You can calculate this by pulling away the ion from the enzyme and measuring how much work this



takes. However, in general, quantitative predictions take up way more time than qualitative ones.

A main challenge within this project was the size of the enzyme - it is one of the largest systems Jocelyne has ever simulated. One monomer is already 1000 amino acids, so a tetramer consists of 4000 amino acids, and you also have to dissolve it, for which you have to add many water molecules and ions. As DSM was not very familiar with simulations, they had to be convinced that simulating the whole system was not a good idea: it would take up too much time and computer power. Instead, you need an approximation of the system to make the predictions. Therefore, Jocelyne and her postdoc showed them tables with protein size versus computer processors needed. In contrast, with Janssen this was not an issue, because they already knew a lot about simulations and understood its limitations.

Jocelyne tells us that these projects show that these company collaborations can sometimes start very slow, because the companies can be very protective about their data. This can sometimes be difficult, as Jocelyne prefers openness about data from all people in her own research group. However, once you have earned their trust, the collaborations can be very interesting and work well, and Jocelyne has experienced that communication then goes quite easy. She talks with the research and development department, which are all scientists as well. The R&D department in turn will communicate with the managers of the companies, as they have more knowledge about the financial interests and problems. The only difficulty in communication might be due to differences in the expertise of the companies, such as the knowledge about simulations within Janssen versus DSM.

### Future/Advice

In the past five years, Jocelyne began to appreciate

administrative duties more and more. Although she had gained some experience as ACD treasurer, she preferred learning about chemistry over bookkeeping at the time. However, now she actually starts to enjoy it and wants to practice this skill further. In addition, she is convinced that education is an incredibly important aspect of being a scientist and she enjoys teaching to students which often results in new ideas and insights. For these reasons, Jocelyne decided to undertake the endeavor of becoming the director of the bachelor Chemistry as of January 2022, which she accomplished. One major goal is assisting students with the transition to the new curriculum such as introducing a group of senior students that are willing to help with difficult courses. She firmly emphasizes that students should fill in the evaluation forms because courses **cannot and will not** be improved if too few students submit the forms. Another goal is to improve the contact between high schools and the university by giving lectures at the schools for example, or letting the students experience a practicum at Science Park. She hopes that this will increase the popularity of chemistry among high school students and that it will change the dull perception of chemistry and the stereotypes that they encounter.

As for advice, Jocelyne cannot stress enough that you should not hesitate to ask questions and seek contact with people. During her career, events such as getting a PhD offer or obtaining an idea worth researching often resulted from just asking around and talking with people. Moreover, she encourages students to join a committee as you will learn skills that can be very useful later on in your career, besides it being fun of course! It does not have to be a committee within the ACD, but it can also be at your local sports club or other association. As a final note, unexpected things can come about from speaking with people and who knows if it creates opportunities!

# Chemistry vs. 'long title of a study in Wageningen'

*Michelle van Dongen*

"Long title of a study in Wageningen" or "Forest and Nature Conservation" is the way me and my friends talk about the master program a good friend of mine is doing in Wageningen at the moment. She has told us about her study multiple times, but I keep forgetting the title except that it has something to do with trees. So, when the time for the second blad edition was near again, I could not resist asking my friend Mathilde about the real name of her study, if she knows much about chemistry and if my fellow chemistry students have the same problem as I in picturing what Mathilde does all day. In this edition, we will therefore take a look at the Chemistry student vs. Forest and Nature Conservation (FNC).

## The FNC student on Chemistry

### First of all, what is your name and why do you study FNC?

My name is Mathilde and I study Forest and Nature Conservation. During my bachelor's, I studied physics, but I missed being outside and working with my hands. I mainly did calculations or programming, which is also really nice by the way. However, I rather wanted to work with my hands and do something that is more in contact with the world. Physics felt a bit further away from reality in my eyes, but with my master's now I am in contact with the real world every day.

### What do you think Chemistry entails?

\*Chuckles\*. It mainly reminds me about high school chemistry; a lot of calculations on com-

pounds, making mixtures, learning about different separation techniques, and figuring out how to make systems more efficient. You also do stuff with quantum or something, but I don't know. I do know that you also do some programming and look at differences between atoms.

### Who is 'the' Chemistry student?

You usually can pinpoint the study of people at Science Park. For me, chemistry students are a bit more the hippy types who know how to drink a lot. I mostly know Michelle but not every chemistry student is like Michelle of course. You guys are probably like the other beta students: enthusiastic about nerdy stuff of which you get way too happy.

### How do Chemistry students overestimate themselves?

I think that the higher people are on the beta ladder (mathematics, physics, chemistry), the better they think they are. I mostly see this with physics and math students, but I am not sure if chemistry students also feel that way.

### What are FNC students better at than Chemistry students?

Plant-related stuff. As an FNC student, you are further away from the beta stuff and view things less black and white, as is often the case in biology. There is no clear distinction between right or wrong; it is more about your view on things. I believe we view phenomena on a larger scale with respect to chemistry students. After all, we want to investigate a whole forest.

**What are Chemistry students better at?**

Analytical thinking. You guys think less about whether something is useful and more about how you can get on the right track in an analytical manner. I really hope you guys are better in chemistry in general.

**What do you think is the major difference and similarity between Chemistry and FNC students?**

The major difference is that FNC students are more aware of their surroundings. For example, my group chat is often filled with messages where students share a tree they found, owls that are near, or birds they heard singing. With Chemistry, you are a bit further from everyday life, I think. The major similarity is probably the passion for your subject. You guys can probably also spend a whole day doing chemistry-related stuff.

**What do Chemists do all day?**

Standing in the lab and throwing compounds together. I would like to imagine that you mainly mix the fun stuff where things explode, possibly getting into dangerous situations with plenty of colors. More seriously, you probably make long days and do simulations as well, follow lectures and do mole calculations.



The Chemistry Student  
on FNC

**First of all, what is your name and why do you study Chemistry?**

My name is Jari, and I study chemistry because I had a really good chemistry teacher in High School that made me very enthusiastic about the subject.

**What do you think Forest and Nature Conservation (FNC) entails?**

I think it is the study about how nature and in particular forests work. You probably learn about how plants and animals interact with each other

in forest areas, what different kinds of forests exist and how humans can affect forests.

**Who is 'the' FNC student?**

'The' FNC student is probably someone who really likes long walks in forests or maybe meditates in forests. I also think that he/she is worried about the cutting or burning of forests and the effect that it has on Earth's climate.

**How do FNC students overestimate themselves?**

I think they give too much credit to forests. I like forests too, but you don't get as much sun when you are in a dense forest. That's why open fields are at least as important as forests and you should not ignore them in your studies.

**What are Chemistry students better at than FNC students?**

Working in a lab all day and making all kinds of weird substances.

**What are FNC students better at?**

Becoming one with nature and finding inner peace.

**What do you think is the major difference and similarity between Chemistry and FNC students?**

I think the major difference between chemistry and FNC students is that chemistry students spend a lot more time inside, while FNC students spend more time outdoors, which is probably better. I think the major similarity is that both studies can play an important role in studying the effects and causes of climate change.

**What do FNC students do all day?**

They have a healthy breakfast in the morning; something like yogurt with fruit or something. Then they take their study books or articles about climate projections and head to the nearest park or forest to read and learn in peace. Somewhere in between they probably do yoga or pilates between the trees.

# Smaakmatrix

Inspired by the Parool

