Biochemistry and Molecular Biology

BMB Symposium 2020

Synthetic Biology
A Canvas for Curiosity

13 & 14.10.2020 | 9 am onwards

University of Bremen
Research
200
SymBo
13-14. 10. 1994

Night of Light

Prologue

Synthetic Biology
A Canvas for Curiosity

You may have asked yourself, what a canvas has to do with science...

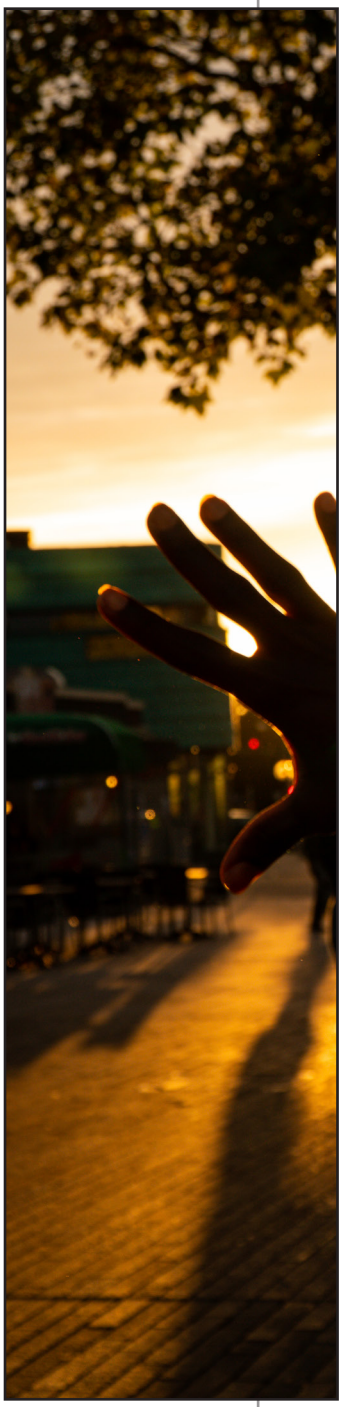
Well, we are constantly driven by one of the most powerful feelings we all know from early childhood on - curiosity. Ever since, this sensation has moved women and men to address questions about the very nature of life. We, the BMB students, were challenged to intertwine the expertise of molecular biology and non-biology disciplines, in our case: Physics, material sciences, chemistry and engineering. They seem unrelated, yet, by combining them we create new ways to seek for answers to questions in life sciences. Hence, this symposium is the canvas on which we are going to illustrate our ideas, draw our interdisciplinary projects, and bring researchers together.

We are looking forward to spending two exciting days exploring and discussing these questions. How did life originate? Are we able to create life *de novo*? How can we use evolved mechanisms to solve society's problems?

Our guest speakers investigate these fields in their everyday life and will give us an insight into their research.

We would like to encourage you to join our discussions and to be curious about where this journey might bring us.

Your organizing committee



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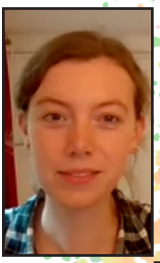
Meet "The Easels"

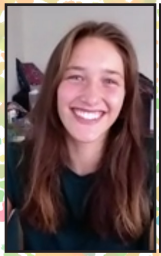


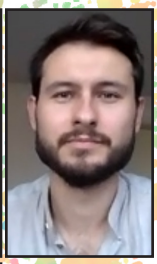
Team lead

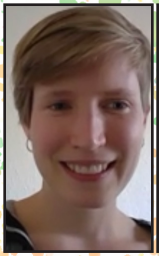
Antonia Otte

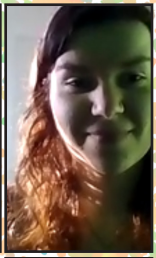
Commu team

Yara Ehlert
Joel Ananda Bose







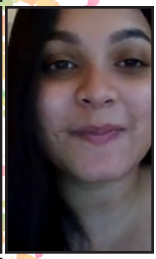


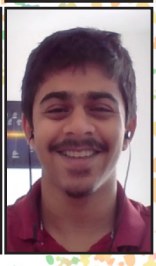
Finance team

Judith Giel
Fenja Lappenberg

Logistics team

Gabriele Karger
Saheri Sikdar





Creative team

Titinun Nuntapramote
Drishan Dahal
Chinmay Joshi

Schedule

DAY 1

09:00 Welcoming Session

Drishan Dahal.....09:20
Yara Ehlert.....09:40

Dr. Kerstin Göpfrich.....10:00
Biology revisited: A creative shortcut towards synthetic cells

10:45 Coffee Break

Paul Meyer.....11:30
Judith Giel.....11:50
Marina Ruhlandt.....12:10

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12:30 Lunch Break

Antonia Otte.....14:00
Govinda Adhikari.....14:20

Dr. Alberto Sánchez-Pascuala 14:40
Understanding to build and… to bio-automatize! Is it possible to fix CO2 better than nature?

15:25 Coffee Break

Amal John Mathew.....16:10
Chinmay Joshi.....16:30
Hirut Bedilu Habte.....16:50

DAY 2

Lina Schulz.....09:00
Joel Ananda Bose.....09:20
Saheri Sikdar.....09:40

10:00 Coffee Break

Prof. Dr. Nick Lane.....10:45
Energy Flow, Evolution, Sex and Society

Francis Nkansah Forbi.....11:30
Sonja Titze.....11:50

Corona-Regulations:

1. Always wear your mask! Except you are…
    a. sitting on your assigned seat.
    b. keeping the minimum distance of 1.5 m to the next person.
    c. eating and drinking while keeping the regulations above.
2. Sign in at the entrance with your contact details.
3. Follow the paths, which are marked on the floor.
4. Keep the minimum distance of 1.5 m at all times. Pay extra attention when using the wash rooms and entering/ leaving a room.
5. Wash and disinfect your hands as often as needed, but especially after touching commonly used tools.
6. Avoid unnecessary movement in the room.
7. Spend as much time as possible outside.
8. Do not share your disposable cup, pen, paper, headphones, ruler, unicorn, dragon, etc.
9. People with any sickness symptoms stay at home.

Guest Speaker

Dr. Kerstin Göpfrich

Max Planck Research Group Leader,
Biophysical Engineering of Life,
Max Planck Institute for Medical Research,
Heidelberg

Biology revisited: A creative shortcut towards synthetic cells

What is life and could it be different? Is it possible to build a living cell from scratch? While questions like these have fascinated mankind for centuries, it is exciting that science begins to develop tools to approach them. Bottom-up synthetic biology conventionally isolates and subsequently recombines biomolecules from cells. Instead of relying on biological building blocks, we believe that the integration of new tools and new materials can be a creative shortcut towards the assembly of active and eventually fully functional synthetic cells. DNA nanotechnology, in particular, is an interesting tool to arrange and manipulate biological components or to even build new components from scratch. We further demonstrate the division of lipid vesicles based on physical principles rather than the biological building blocks of a cell's division machinery. Systems like this may hint towards mechanisms that governed the division of protocells and lead to interesting functionality of synthetic cells. All in all, we believe that an engineering approach to synthetic biology does not only provide creative freedom but can also help to accelerate synthetic biology research.

Guest Speaker

Dr. Alberto Sánchez-Pascuala

Department of Biochemistry and Synthetic Metabolism, Max Planck Institute for Terrestrial Microbiology, Marburg

Understanding to build and... to bio-automatize! Is it possible to fix CO_2 better than nature?

Synthetic biology has come to stay. In the past, the limitation of exploiting the biological functions relied mostly on technical constraints. Nowadays, thanks to the establishment of a feasible DNA synthesis technology, our limitation lies in the lack of knowledge. The natural diversity has served as a crucial source of inspiration in different biotechnological processes. The deep characterization of biological parts (i.e. enzymes) facilitates their strongly optimization or even the founding of new scaffolds to host novel functions. Our laboratory, considering the global threat of the atmospheric carbon dioxide (CO_2) accumulation, embraces the synthetic biology approaches with the objective of developing novel and super-efficient CO_2 fixation pathways. To begin with, the enoyl-CoA carboxylases/reductases (ECRs) family was considered as a perfect candidate to compete in terms of efficiency with the well-known ribulose-1,5-bisphosphate carboxylase/oxygenase (RuBisCO). One of the most important members of the ECRs family, crotonyl-CoA carboxylase/reductase (Ccr), has been extensively studied by our laboratory. As a result, we have employed these promising carboxylases as a key stone in the development of high performance synthetic CO_2 fixation pathways, such as the crotonyl-coenzyme A (CoA)/ethylmalonyl-CoA/hydroxybutyryl-CoA (CETCH) cycle. However, all these realizations were achieved in an in vitro landscape, staying away from an in vivo implementation and its consequent bio-automation. In order to fill this gap, our efforts are now focused in the functional mobilization of these synthetic CO_2 fixation pathways into more complex systems. This has been recently well-illustrated in the fruitful integration of the CETCH cycle into chloroplast-mimicking droplets, setting the basis for its future implementation in different microorganisms.

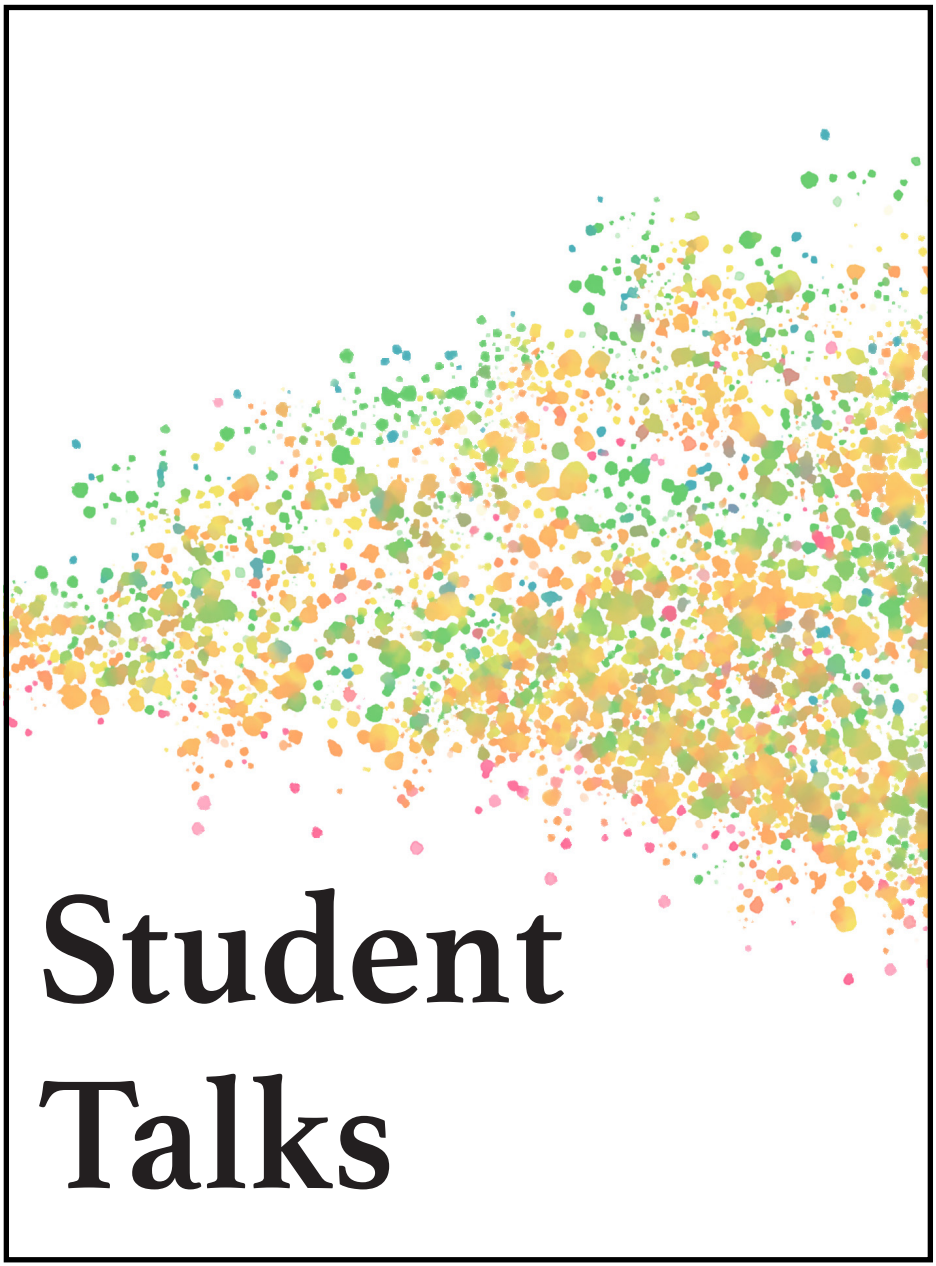
Guest Speaker

Prof. Dr. Nick Lane

Professor of Evolutionary Biochemistry,
University College London,
London

Energy Flow, Evolution, Sex and Society

Biology as a discipline, and synthetic biology as an approach, are both grounded in genes and information. Energy flow is taken for granted. I will argue that in fact energy flow structured the whole evolution of life, explaining the singular origin of eukaryotic cells and why complex aliens might be rare. I will discuss show that a perspective grounded in energy flow also explains why all eukaryotes share the same cell structures and behaviours, from the nucleus to sex, very different from anything seen in prokaryotes. Finally, for fun, I will draw a few morals from biology to apply to society.



Student Talks

Dual molecules to potentiate pharmacological efficacy

Drishan Dahal
AG Maedler
AG Radmacher

PAR2 is a pervasive cell surface receptor whose stimulation may lead into insulin secreting β-cells transdifferentiation. GLP-1R is a β-cells specific receptor whose activation potentiates the insulin secretion pathway. I hypothesise that the simultaneous activation of both receptors by the respective agonists may have a synergistic effect on β-cell maturation, survival and secretion pathways. Atomic Force Microscopy will be deployed to study the changes in the binding strength of such dual interactions. Additionally, RT-PCR for differentiation and functional genes from dual/single and un-treated α- and β-cells will be performed to assess the possible effects of receptor activation in cell cultures.

Size Separation of Mitochondria by Dielectrophoresis

Yara Ehlert
AG Groß-Hardt
AG Thöming

Energy generation, the existence of complex life, programmed cell death and the phenomenon of aging and age-associated diseases are directly linked to mitochondria – the tiny powerhouses of our cells. But not all mitochondria we harbor are identical. They differ in morphology and size, coexisting in subgroups, some of which may be involved aging and diseases. To study mitochondrial heterogeneity, it is crucial to develop methods that allow to discriminate between subgroups and separate them from each other according to specific parameters such as size. Making use of dielectrophoresis, the motion of neutral bodies induced by nonuniform electric fields, it is possible to achieve the goal of size separation of mitochondria. Research on mitochondrial heterogeneity would profit from the establishment of this powerful method.

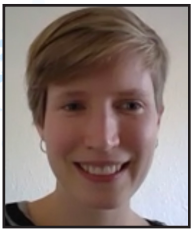
Polarizability of trypanosomal surface proteins and microparticle separation by dielectrophoresis

Paul Meyer
AG Kelm
AG Thöming

Trypanosomes are parasitic protozoa infecting a variety of hosts and can cause the fatal disease sleeping sickness in human. The endemic regions of African *Trypanosoma sp*. are often remote and have weak health systems, which makes a sufficient diagnosis difficult. This project aims to investigate the possibility of using dielectrophoresis as a method for separation or verification of presence of Trypanosoma sp. by coating microparticles with characteristic surface proteins. Insights into the polarizability of these proteins could help the development of further studies in this field.

Biologically assisted struvite precipitation under marine culture conditions

Judith Giel
AG Reinhold
AG Thöming



Phosphate is an essential nutrient. Some researchers predict its depletion within the following century, bringing about the collapse of the agricultural food production. Many attempts are currently made to recover phosphate from agricultural wastewater plants as struvite, a mineral and high-quality fertilizer which can be directly applied to the field.

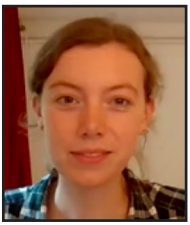
Oligotrophic microorganisms have evolved mechanisms to incorporate nutrients available at low concentrations. It is hypothesized that this capability can be used to precipitate struvite under marine conditions. Struvite production will be assessed by particle sorting with dielectrophoresis.

Purification of Archaeal Viruses for Metagenomic Analysis using functionalized porous Microbeads

Marina Ruhlandt
AG Dotzauer
AG Rezwan

Infecting every domain of life, viruses are the most abundant biological entities on the planet. Despite new highly efficient technologies, most species are still unidentified because current purification methods fail to extract enough viral particles. Here we propose the use of functionalized porous microbeads for the purification of viruses

Characterization of the interaction between mutant Huntingtin and DNAJB1 through Single Molecule Force Spectroscopy



Antonia Otte
AG Kirstein
AG Radmacher

Huntington´s disease is caused by a mutation in Huntingtin (Htt), which leads to its misfolding and aggregation. A trimeric chaperone complex has been identified that suppresses and disaggregates Htt fibrils. Although the exact mechanism is not known yet, it was shown that the chaperone DNAJB1 interacts with Htt in vitro and in vivo.

Single Molecule Force Spectroscopy (SMFS) is a tool, which allows to study the molecular forces between molecules by functionalizing them and exhibiting minor forces. Hence, force extension experiments of Htt will reveal a characteristic unfolding pattern. It is hypothesized that it will change in the presence of DNAJB1.

Decrypting the communication: Outer membrane vesicles in plant-microbe interactions

Govinda Adhikari
AG Reinhold
AG Vellekoop
AG Ciacchi
AG Rezwan

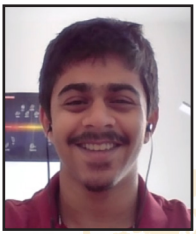
The role of bacterial outer-membrane vesicles (OMVs) in plant-microbe interactions is largely under shadow. Here, I propose to isolate them from rhizosphere of rice species, inoculated with the endosymbiont Azoarcus olearius BH72, using microfluidic chips, and determine their protein composition by mass spectrometry. At the same time the size estimation of OMVs will be carried out using dynamic light scattering and atomic force microscopy.

Investigation of mitochondrial age using Atomic Force Microscopy

Amal John Mathew
AG Groß-Hardt
AG Radmacher

Impairment of mitochondrial quality control and function with age has been implicated in a multitude of pathologies. It is important to address the question whether the age of mitochondria influences the mechanical properties of mitochondria. Here we propose the use of a fluorescent timer protein with a mitochondrial targeting sequence (‘Mitotimer’) simultaneously with Atomic Force Microscopy (AFM) to investigate and track the temporal differences in the mechanical properties of mitochondrial membrane.

Alternative method to screen and segregate triparental seeds in *Arabidopsis thaliana.*



Chinmay Joshi
AG Groß-Hardt
AG Thöming

As a general rule in biology, off springs are formed from just two parents which provide two sets of chromosomes. In plants however, progeny with three parents can be observed sporadically. Triparental progeny are of great agricultural importance as they have three sets of chromosomes, by which we can introduce new traits or characteristics. Currently, these triparental progeny are screened using an herbicide resistance assay introduced in the plant using genetic modifications. The method introduced in this talk will provide a basis for a new way of screening method to sort triparental seeds from ordinary biparental seed using magnetic nanoparticles coupled with dielectrophoresis and magnetic separation.

Hirut Bedilu Habte

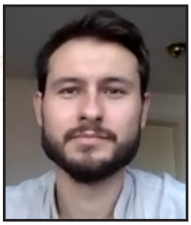
TBA

Interaction of human β-cells with self-assembled polymer scaffolds

Lina Schultz
AG Brüggemann
AG Maedler

Research efforts have focused on replenishing insulin-producing cells by producing or expanding β-cells in vitro for their use in therapies to cure diabetes. Extracellular protein scaffolds were already used to maintain the proliferation and function of β-cells in vitro and improved islet health but only on the short-term. The downside of commercially available scaffolds is that they either lack complexity or that their composition is not well defined. Here, the interaction of human β-cells with self-assembled polymer scaffolds is analysed at the attempt to pave the way for complex but still chemically defined and tuneable protein scaffolds.

Back to the roots...?!

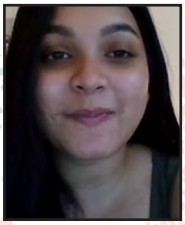


Joel Ananda Bose
AG Küstermann
AG Reinhold

About 4400 years ago, ancient peoples from Mesoamerica made use, albeit unconsciously, of plant growth-promoting bacteria (PGPB), which enriched soil of mays fields with Nitrogen. Several thousand years later, at the dawn of the 1980s, modern researchers began to focus on the use of PGPB as a sustainable alternative to conventional agricultural methods to protect plants from pathogens or competitors and increase crop yields. I invite you onto a journey “back to the roots” into the plant-associated microbiome. I will argue that current approaches to track PGPB offer many obstacles, and will point out a new, interdisciplinary way based on magnetic resonance imaging (MRI) and synthetic biology, instead. Finally, the suggested method can be a small contribution to a society that does not exceed planetary boundaries.

ZnO nanoparticles for intervention in Type1 diabetes

Saheri Sikdar
AG Maedler
AG Rezwan



Chronic inflammation plays a key role leading to beta cell failure which results in Type 1 diabetes (T1D). The target autoantigens in several organ-specific autoimmune diseases, including T1D are intracellular membrane proteins, whose initial encounter with immune system is poorly understood. Here, we propose a model of a comparative study to distinguish the secretory factors released between migration of monocytes towards EndoC betaH1 cell line and Gad65 expressed beta cell line in presence/absence of stimuli. And using ZnO nanoparticles in beta cell line as possible intervention for reduction of secretory factors which leads to inflammation resulting in beta cell death.

A study into the mechanism of antiviral activity of Mx proteins using High-speed atomic force microscopy

Francis Nkansah Forbi
AG Dotzauer
AG Radmacher

Mx proteins are evolutionarily conserved dynamin-like GTPases, expressed by type I and III interferons as effectors of the antiviral state. In different species they are localized in distinct subcellular compartments which direct their antiviral activities, human MxA is localized in the cytoplasm but surprisingly inhibits viruses irrespective of intracellular replication site. Putative association of MxA with membranes such as the endoplasmic reticulum enhances recognition of viral components, this triggers MxA oligomerization which sorts viral components to cellular locations inaccessible to new generation of viruses. Understanding the antiviral mechanism of MxA could unlock cutting-edge possibilities in molecular virology.

Using microfluidic chips as a system to monitor the T6 secretion system of *Azoarcus sp.*

Sonja Titze

AG Reinhold
AG Vellekoop

The process of nitrogen fixation and supply for plants by microorganisms is a process which could support the reduction of fertilizers in worldwide agriculture. *Azoarcus sp.* is an organism fixing nitrogen and supplying for example rice roots with this nitrogen. However, the fixation mechanism is better understand than the sharing of the nitrogen with the plant roots. One possible secretion system is the T6 Secretion System, which will be investigated on its activity under nitrogen fixing conditions. This shall be performed on a microfluidic chip to enable the control about all parameters and save resources.

Thank you

Acknowledgements

Organizing the symposium, to be more precise, organizing an art fest that showcases beautiful interdisciplinary ideas was only possible with the help of our professors, administration and alumni. The organizing committee is indebted to Prof. Nehls, Prof. Groß-Hardt and Prof. Reinhold for their mentorship. Prof. Nehls helped us both draw the starting line of our journey and also accompanied us throughout as a bridge between the University administration and the organizing committee.

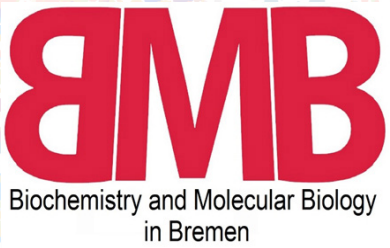
In addition, we acknowledge the effort of the research groups who supervised the research ideas of the BMB students. We are also extremely thankful to Ute Meyer, Studienbüro for her assistance and counseling in financing and organizing the event. The symposium team is also thankful to the Alumni society for their funding of lunch and coffee.

Moreover, we are also grateful to our professors who donated money to help us organize food for this event. We also thank the University administration for providing us the lecture hall where we are organizing our event.

"Thought by brain, presented by heart"


Universität Bremen


Alumni
der Universität Bremen e.V.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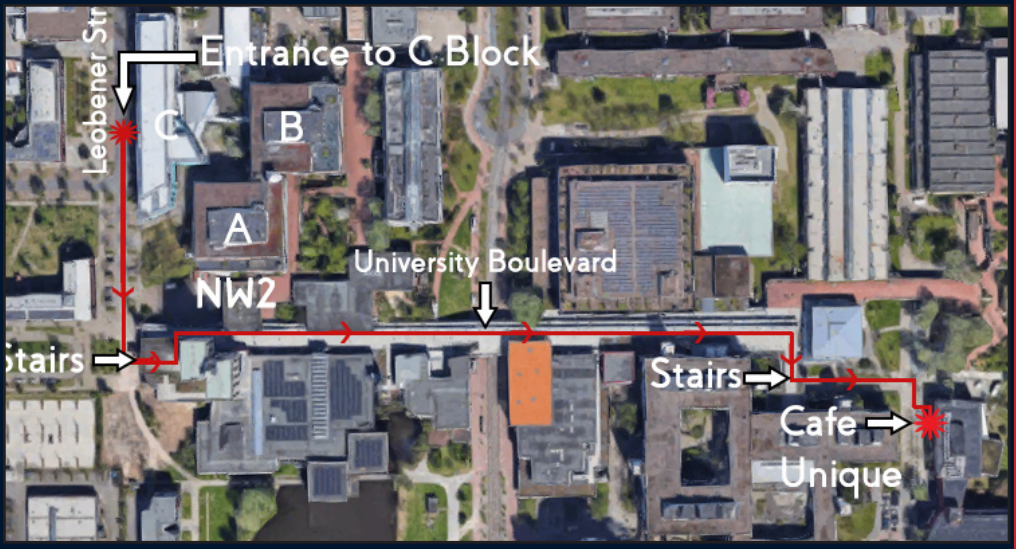
Map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