SUMMER SCHOOL OF SCIENCE

S^3/S^{3++}

12th – 22nd July 2014
Požega, Croatia

BOOKLET

WORD FROM THE ORGANIZERS

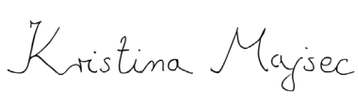
Summer School of Science is a unique place where like-minded individuals of all ages get together to share their enthusiasm for knowledge and discovery. Talented and highly motivated students, often neglected in their regular school environments, are presented with personal challenges that build self-confidence and encourage them to “think big”. In an open and informal atmosphere, students and their mentors from all over the world work in teams and exchange ideas freely. Together they find inspiration and courage to achieve more once they are back in their home environments. They form long-lasting relationships that not only help their individual careers, but also promote international and intercultural understanding. Our creative mentors, devoted to scientific and personal excellence, teach through passion. They use personalized approach to every student, making sure everyone has the best experience possible.

Beyond popularization of science, we aim to create a global network of high school students, young scientists and social entrepreneurs who are committed to building knowledge-based societies. We see Summer School of Science as a platform for future growth. In our community, every generation takes care of the younger one, ensuring survival of our volunteer-based project. Former school participants often become mentors themselves and stay involved by supporting the school in various ways. We encourage and nurture leadership skills by providing young people with challenges of project design, mentoring and organizing events. By bringing together young leaders of different nationalities, we hope to provide a model for similar projects in other countries.

Antonija Burčul

Antun Tonko Jakobović

Martina Mijušković



Kristina Majsec

FREQUENTLY ASKED QUESTIONS

What does a typical day at the Summer School of Science look like?
Depending on the project, you will either stay in the school or go to do terrain work. Project work is directed by your mentor. It usually starts at 9 AM and finishes at 6 PM. Most of the work will be done during the day, but night field trips or lab visits are not excluded. Every evening, there is at least one lecture or a workshop attended by all the participants together. One day is reserved for the excursion. There are several short breaks, as well as evening social activities.

What is it like to be on the Summer School of Science?
A lot of fun, if you like science. It can also be pretty usefull, if you plan to study science at the university. You usually learn basic concepts of science in school—about acids in chemistry, about electricity in physics or about genes in biology. This is certainly important for your education, but you are missing a critical part—the scientific method. How do we ask questions about the phenomena in nature? How do we answer them? And how can you be sure about what you've found? The Summer School of Science is the place to learn all about it. Since we believe that the best way to learn is by example and practice—we'll put you in the position of the scientist. You will work on a very specific topic with a project leader and usually two other participants.

Do I have to know a lot about the topics in advance?
At this stage you should not worry weather you know enough science to do it. Science is so specialized nowadays that often you have to start from zero. But what is important: do you know how to learn? If you can do it in the school, you can certainly do it here. In any case, project leader is there to answer all your questions.

What kind of people come to the Summer School of Science?
The Summer School of Science is a unique place because you can meet other high school students from all around world with interests in science. You will also meet lots of people who work in applied or fundamental sciences. Some of them are your project leaders, others are lecturers. Working with some of them you will learn another thing about science - it is about people. You have to be able to work in the team, present and share your ideas, but in the same time listen and respect the others. And when it comes to communication—you will have to practice that as well. You will have several chances to present your work and results.

Why is English the official language?
Because today it is practically official language of science. Most of the scientific literature is written in English, and most of the communication at conferences or summer schools happens in English. If you choose to study chemistry, biology or physics you will have to use textbooks written in English very early. So this is a good way to start. Don't worry if your English is not perfect, if you can communicate and express you ideas—it is enough!

PROJECTS

EXPLORING THE GENOME ARCHITECTURE WITH NEXT–GENERATION SEQUENCING

One of the breakthroughs in molecular biology was the discovery of the genetic code, because DNA of every organism hides important information dictating not only its future, but also revealing its ancient evolutionary past. Nowadays we are facing a rapid development of the new generation sequencing, followed by a multitude of novel applications in biology and medicine. For example, it is possible to sequence several human genomes in a matter of days. The ability to sequence the whole genome of many related organisms has allowed large-scale comparative and evolutionary studies to be performed that were unimaginable just a few years ago. In terms of evolution, the next generation sequencing enabled us to investigate depth of information beyond the capacity of traditional DNA sequencing technologies and therefore showed that variations in the genomic structure, such as variation in copy numbers and inversions of DNA sequence, are a major source of human evolution and phenotypic variation.

In this project participants will be exposed both to the "dry" and "wet" molecular biology. First, they will learn to use bioinformatics tools to assess large scale data. The starting point will be genome and transcriptome sequencing data of different primates, and the main task will be to use given information to find structural variations such as deletions, duplications and translocations in the genome of the respective species. Further on, we will move on to the lab and experimentally validate the existence of interesting candidates by PCR and gel electrophoresis Finally, in order to understand how variations in the genome architecture may lead to phenotypic variation, we will look for the connection between these structural variations and possible effects on gene expression.

Matilda Maleš
EMBL HEIDELBERG, GERMANY

Matilda obtained her bachelor's degree in molecular biology at the University of Zagreb, followed by a master's degree at University of Heidelberg in Germany. Now, she is doing a PhD in genomics at EMBL Heidelberg, being particularly interested in the role of the non-coding genome in the embryonic development. When not working, she can be found swing dancing, doing yoga or just chilling with a good book. Matilda is participating in the Summer School of Science since 2006, twice as a high-school student and later twice as a workshop leader.

Jelena Tica
EMBL HEIDELBERG, GERMANY

Jelena is currently doing a PhD in molecular biology at EMBL Heidelberg and she is particularly interested in genomic structural variations, cancer genomics and genome evolution. Before she moved to Germany, she obtained her B.Sc. and M.Sc. degree in molecular biology at University of Zagreb. In her free time, Jelena likes to read books, watch movies and play computer games. Also, she goes to the gym, learns German and writes about beauty-related inventions in her blog

SHEDDING LIGHT ON FRACTALS

We live in a three dimensional world, so we know what a three dimensional object is (for example, a ball). We can also understand two dimensional (a circle), even one dimensional objects (a line), but would it make any sense to talk about non-integer dimensions, such as 2.65 or 1.3? It turns out it would; such objects are called fractals. They can be easily found in nature if you know where to look. Many different physical processes, such as diffusion, aggregation and electrical discharge, result in fractals. Through the analysis of the incipient structure we can gain valuable information on the underlying microscopic process.
In this project we will investigate the properties of fractals arising from aggregation of colloidal particles using light scattering techniques which are used in many modern experiments. In the course of the project we will design and construct the apparatus, write the necessary software and conduct a numerical simulation of the aggregation process. Through the comparison of the experiment and the simulation we will gain information on the process governing the growth of the fractal cluster.

Marija Došlić
FACULTY OF SCIENCE,
UNIVERSITY OF ZAGREB, CROATIA

Marija is a student of physics at the Faculty of Science at the University of Zagreb, where she is currently working on her diploma thesis in the field of high Tc superconductors. She has participated in high school competitions both as a student and as a mentor. In her spare time she enjoys reading newspapers (all of them), crocheting, travelling and hiking with friends.

Veronika Sunko
FACULTY OF SCIENCE,
UNIVERSITY OF ZAGREB, CROATIA

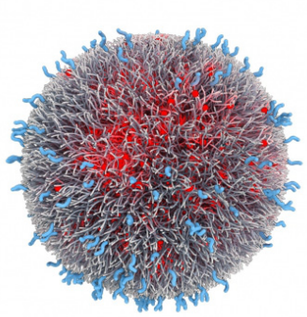
Veronika is a master student of physics at the Faculty of Science, University of Zagreb. She recently worked on the dynamics of glassy systems, and is currently working on her diploma thesis concerning complex magnetic systems at the Institute of Physics, Zagreb. She likes hiking, reading and experimental cooking.

HUMAN MICROBIOTA: FRIENDS OR FOES?

Our body hosts more than a thousand different varieties of microorganisms with a complex distribution of microbial communities within specific sites. The community of microbes colonizing the human body is referred to as microbiota. These microbiota play essential roles in energy metabolism, regulating our immune system and more importantly act as protective shield preventing pathogenic bacteria from colonizing our body. Disruption of the microenvironment and the colony architecture comprising of specific species of microorganisms can often disrupt the delicate balance of our local microbiota leading to harmful side effects or even diseases. Such imbalance in microbiota is associated with many well-studied disorders such as autoimmune disease, obesity, eczema and psoriasis.

In an effort to make the students appreciate this inter-individual and also intra-individual microbial diversity, this project will offer an opportunity to learn basic microbiology technics like bacterial cultivation, Gram staining and biochemical tests that will help them identify their own bacteria. Furthermore the students will get to know some biotechnology techniques like bacterial transformation, DNA extraction, PCR and transgenes detection. In the course of this project, the students will be challenged to ask questions and to use their critical thinking.

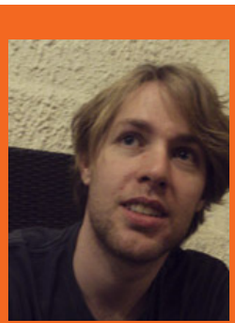
TARGETING CANCER CELLS USING FUNCTIONALIZED NANOPARTICLES



One of the major problems in cancer treatment is that cancer cells are hard to distinguish from the healthy cells. This makes it difficult to design a drug that kills only cancer cells but does not affect the healthy ones. The cancer cells do however tend to overexpress certain membrane receptors. Membrane receptors are special proteins located in the cell membrane, which allow the cell to communicate with the outside world. In the recent years a novel idea based on multivalency allows us to sharply target only cells with receptor population above a certain threshold. A multivalent particle is a particle that can form many simultaneous bonds. Therefore, we can design a drug that attaches only to cancer cells but not to healthy ones. Modern computers allow us to test and refine these ideas with simulations before experimenting with new drugs on actual patients.
In this project we will be using Monte Carlo computer simulations to design a good targeting system for drugs. Specifically, we will focus on targeting cancer cells. The nature of this problem is very interdisciplinary and we will explore relevant concepts from physics, chemistry and molecular biology. We will aim to cure our virtual patient by designing a multivalent nanoparticle that will only attach to cancer cells (thus killing them) but not to normal cells. We will design the nanoparticle properties, how many simultaneous bonds can it support and what should be the dosage (how many nanoparticles should we administer to the patient).

Marta Figueiredo
UNIVERSITY OF ZURICH, SWITZERLAND

Marta did her Master's degree in Pharmaceutical science at the University of Porto, Portugal. Working as a pharmacist, she missed the excitement of learning new things, so she went back to academia. She is currently working as a Ph.D student on the topic of kidney physiology. Besides science, she enjoys outdoor activities and meeting new people



Tine Curk
UNIVERSITY OF CAMBRIDGE, UK

Tine is a PhD student in computational chemistry at the University of Cambridge, UK. He received bachelor and master's degrees in physics from the University of Maribor. Tine is an expert on computer modeling of micro scale systems, such as polymers and nanoparticles. His main research tools are statistical mechanics and Monte Carlo simulations. In his free time Tine rows, chases rabbits, makes creative sandwiches and enjoys good music.

TEAMBUILDING WORKSHOP: CONECTABILITY

It is a part of human nature to connect and be connected. To establish a bond with another human being or a group we need to be open, honest and ready to explore. From a good connection comes understanding and the ability to create things and ideas together. That is when the whole truly becomes greater than the sum of its parts. This is why we will devote the first session to establishing connections! In an active, moving and friendly manner, having lots of fun along the way.

Ivana Štulić,
THE GENERALI GROUP, ZAGREB, CROATIA

RESEARCH SWAPSHOPS

ROBOTS! FIRING!

Ivo Sluganović
UNIVERSITY OF OXFORD, UK

General programming skills are invaluable in almost any field of today's scientific research as the amount of available data and the expected pace of progress increase exponentially. From biology to neuroscience, from social sciences to economics, being able to develop their own programs and test their ideas quickly has become a crucial skillset, one that is too often neglected outside of computer science. This workshop aims to present programming from a different view, one which is much more interactive, responsive and fun. The students will be encouraged to come up with the idea for their own artificial intelligence "battle tank", which they will then together program.

THE CHEMICAL BEAUTY OF COLORS

Aleksandar Salim
EPFL LAUSANNE, SWITZERLAND

Have you ever wondered why the autumn is so beautiful? Our perception of the world is defined by colors we see. If you start to think about it, a few question emerge in an instant. Why do we see colors? What determines the color? How does the nature utilize colorful compounds? We will try to scratch the surface and discuss a few topics regarding this matter. We will explore the chemical and electronic origins of colors. We will see how some compounds change colors in deferent environment and we will use this property to determine the pH of some household liquids. We will see that the purple colour is a combination of blue and red by separating them using chromatography. In the end we'll burn some salt to see what happens and explain how the fireworks works!

LET'S BOIL AN EGG!

Aleksandra Vančevska
EPFL LAUSANNE, SWITZERLAND

Have you ever wondered how the world looks from protein`s point of view? In this swapshop we will use Cyanobacteria proteins to explain the terms protein stability, folding and refolding. These bacteria contain an elaborate light-harvesting antenna complex in addition to chlorophyll molecules. This chromophore acts to report the integrity of the protein structure. When in its native form, the protein has a beautiful dark blue color. When it is unfolded, its blue color fades away. In simple terms we'll use this plain system to investigate the process of protein denaturation and renaturation. Basically, we are going to try to do and explain the process of "boiling an egg". By complementing this approach with the popular internet game "Fold it" students will gain insight into protein structure and how it is impacted by its surrounding.

HOW TO PREVENT EPIDEMICS USING MATHEMATICS?

Gabriela Clara Racz
UNIVERSITY OF ZAGREB, CROATIA

Mathematical modeling is the use of mathematics to describe real world phenomena, investigate important questions about observed world, test ideas and make predictions. Instead of undertaking actual experiments, modeler undertakes experiments and simulations on mathematical representation of the real world. This is a very powerful tool to test your hypothesis and predict future behaviors. Perhaps that's the reason it is used so widely, not only in natural sciences and engineering but also in social sciences and economics. Participants will learn basics of mathematical modeling in biology. They will make model of population growth, compare it with actual data, think about model deficiencies, explain deviations and try to improve it. They will also make models of spreading of infectious disease. properties of certain substances.

WHAT MAKES US THINK LIGHT IS A WAVE?

Tea Mužić
UNIVERSITY OF COPENHAGEN, DENMARK
Ivan Pribanić
UNIVERSITY OF RIJEKA, CROATIA

Light is a particle and a wave. The purpose of this workshop will be to demonstrate wave nature of light and to introduce students to methods used in investigation of natural phenomena. Light is an electromagnetic wave where its components, electric and magnetic fields, vibrate. It inherits properties of mechanical waves such as diffraction and dispersion. Diffraction refers to various phenomena which occur when a wave encounters an obstacle or a slit. Dispersion, on the other hand, is the phenomenon in which the phase velocity of a wave depends on its frequency or alternatively when the group velocity depends on the frequency. These phenomena are the cause of appearance of light and dark stripes on the background and decomposition of white light to rainbow of colors. This workshop is envisioned as combination of a lecture and hands-on experiments where students will be given an opportunity to find out more about these phenomena.

LECTURES

13th July
Lecture:
THE BORDER IS ONLY IN OURSELVES
Ivan Đikić, GOETHE UNIVERSITY, GERMANY

14th July
Lecture:
"HEARING" THE SHAPE OF A ROOM, AND OTHER TREATS WITH ECHOES
Ivan Dokmanić, EPFL LAUSANNE, SWITZERLAND

16th July
Lecture:
EFFICIENT, SELECTIVE AND ENVIRONMENTALLY–FRIENDLY SOLVENT–FREE CHEMICAL REACTIONS
Ivan Halasz, INSTITUTE RUDJER BOSKOVIC, CROATIA

17th July
LESSONS FROM A LIFE IN SCIENCE: CONROLLING CELL DIVISION
Sir Tim Hunt, LONDON RESEARCH INSTITUTE, UK

18th July
Lecture:
REGULATORY LANDSCAPE OF THE GENOME
Tibor Pakozdi, EMBL HEIDELBERG, GERMANY

19th July
Round table:
OUT–OF–FRAME EDUCATION
Ernest Meštrović, PLIVA, CROATIA and swapshop leaders
+ cake! :)

20th July
Lecture:
THE DEVELOPMENT OF GALAXIES THROUGH THE HISTORY OF UNIVERSE
Vernesa Smolčić, UNIVERSITY OF ZAGREB, CROATIA

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INFORMATION FOR FOREIGN PARTICIPANTS

Web page
http://www.drustvo-evo.hr/s3/

Currency
The official currency is Croatian kuna (kn). One hundredth part of kuna is called lipa (lp). As Croatia is not in the Euro zone, the euros are commonly not accepted. One euro is around 7,50 kunas.

Croatian basics
Pronunciation of special characters:
č as in check, change
ć as in chin (softer than č)
š as in shop, shelter
dž as in jar
đ as in ginger, jingle (softer than dž)
ž as in measure

Common phrases:

Good morning / afternoon / evening.	Dobro jutro / dan / večer.
Good night.	Laku noć.
Hello (informal).	Bok.
Goodbye.	Do viđenja.
My name is ____ .	Zovem se____ .
Nice to meet you.	Drago mi je.
Please.	Molim.
Thank you (very much).	Hvala (lijepa).
You are welcome.	Nema na čemu.
Excuse me (getting attention).	Oprostite.
Excuse me (begging pardon).	Izvinjavam se. (Pardon.)
Do you speak English?	Govorite li engleski? (formal) Govoriš li engleski? (informal)
I can't speak Croatian (well).	Ne govorim hrvatski (dobro).
Help!	Upomoć!
Look out!	Pazi!
I don't understand.	Ne razumijem.
Where is the toilet?	Gdje se nalazi WC?
Yes. / No. / Maybe.	Da. / Ne. / Možda.

Power supply
The standard power supply through all of the Croatia is AC 220V 50Hz. The power plug and socket look like this:

Adress of the school:
Gymnasium Požega
Ulica dr. Franje Tuđmana 4/A
HR-34000 Požega
Croatia

1. Gymnasium
2. Restaurant
3. Vila Dora

SCHEDULE

Day1: July 12, Saturday
14:00–16:00 Students arrival
16:00–17:00 Everybody gets settled
17:30–19:30 Teambuilding
19:30–20:30 Dinner
20:45–21:15 Organizers introductory speech
21:15–22:00 Presentations of projects
22:00–23:00 Group forming and first meeting

Day2: July 13, Sunday
08:00–09:00 Breakfast
09:00–13:00 Project work
13:00–14:00 Lunch
14:00–18:00 Project work
18:00–18:30 Short break
18:30–19:30 Dinner
19:30–20:00 Shortbreak
20:00–21:30 Lecture: The border is only in ourselves;
Ivan Đikić, GOETHE UNIVERSITY, GERMANY
21:30–23:00 Social activities

Day3: July 14, Monday
08:00–09:00 Breakfast
09:00–13:00 Project work
13:00–14:00 Lunch
14:00–18:00 Project work
18:00–18:30 Short break
18:30–19:30 Dinner
19:30–20:00 Short break
20:00–21:30 Lecture: "Hearing" the shape of a room, and other treats with echoes;
Ivan Dokmanić, EPFL LAUSANNE, SWITZERLAND
21:30–23:00 Social activities

Day 4: July 15, Tuesday
08:00–09:00 Breakfast
09:00–13:00 Project work
13:00–14:00 Lunch
14:00–18:00 Project work
18:00–18:30 Short break
18:30–19:30 Dinner
19:30–20:00 Short break
20:00–21:30 Briefing
21:30–23:00 Social activities

Day 5: July 16, Wednesday
08:00–09:00 Breakfast
09:00–13:00 Project work
13:00–14:00 Lunch
14:00–18:00 Project work
18:00–18:30 Short break
18:30–19:30 Dinner
19:30–20:00 Short break
20:00–21:30 Lecture: Efficient, selective and environmentally –friendly solvent–free chemical reactions;
Ivan Halasz, INSTITUTE RUDJER BOSKOVIC, CROATIA
21:30–23:00 Social activities

Day 6: July 17, Thursday
08:00–09:00 Breakfast
09:00–13:00 Project work
13:00–14:00 Lunch
14:00–18:00 Project work
18:00–18:30 Short break
18:30–19:30 Dinner
19:30–20:00 Short break
20:00–21:30 Lecture: Lessons from a life in science:
Conrolling cell division;
Sir Tim Hunt, LONDON RESEARCH INSTITUTE, UK
21:30–23:00 Social activities

Day 7: July 18, Friday
09:00–18:00 Field trip
18:00–18:30 Short break
18:30–19:30 Dinner
19:30–20:00 Short break
20:00–21:30 Lecture: Regulatory landscape of the genome;
Tibor Pakozdi, EMBL HEIDELBERG, GERMANY
21:30–23:00 Social activities

Day 8: July 19, Saturday
08:00–09:00 Breakfast
09:00–13:00 Project work
13:00–14:00 Lunch
14:00–18:00 Swapshop
18:00–18:30 Short break
18:30–19:30 Dinner
19:30–20:00 Short break
20:00–21:30 Round table: Out–of–frame education;
Ernest Meštrović, PLIVA, CROATIA
and swapshop leaders + cake! :)
21:30–23:00 Social activities

Day 9: July 20, Sunday
08:00–09:00 Breakfast
09:00–13:00 Project work
13:00–14:00 Lunch
14:00–18:00 Project work
18:00–18:30 Short break
18:30–19:30 Dinner
19:30–20:00 Short break
20:00–21:30 Lecture: The development of galaxies through the history of universe;
Vernesa Smolčić (UNIVERSITY OF ZAGREB, CROATIA)
21:30–23:00 Social activities

Day10: July 21, Monday
08:00–09:00 Breakfast
09:00–13:00 Project work
13:00–14:00 Lunch
14:00–18:00 Project work
18:00–18:30 Short break
18:30–19:30 Dinner
19:30–20:00 Shortbreak
20:00–21:30 Final presentations
22:30–3:00 Final party