DIS STUDY ABROAD IN SCANDINAVIA

Research Assistant: Synthesis of Bioactive Molecules

Summer 2020
Credits: 6
Location: Stockholm
Prerequisites: Dependent on the 6-credit Research Opportunity - listed on the DIS Course Website

Research Area
Oscar Verho's laboratory focuses on the development of novel strategies for synthesizing and screening diverse collections of small molecules for therapeutic purposes. The research of the Verho group is deeply rooted in organic chemistry, but also interfaces with the fields of medicinal chemistry and chemical biology. As a research assistant in the Verho group, you would be offered with an opportunity to take part in different synthetic chemistry projects and be able carry out experimental work in an organic chemistry laboratory setting. This includes:

Synthesis of bioactive peptides: In this project, modern C-H functionalization chemistry will be used to assemble unnatural amino acid derivatives that will serve as building blocks for de novo synthesized peptides. Research assistants would be involved in the design of peptide structures that could become future drugs for currently intractable diseases. Moreover, research assistants would be offered an opportunity to deepen themselves in topics such as transition metal catalysis, peptide chemistry and DNA-encoded libraries.

Synthesis of a structurally diverse cyclobutane library. The goal of this project is to assemble a classical small molecule screening library consisting of different cyclobutane derivatives. As a part of this project, research assistants will be able to learn and perform a wide range of organic reactions, including for example different directed C-H functionalization reactions. Aside from providing the research assistants with a deep understanding of key concepts in organic chemistry, they would also greatly contribute to the creation of a new small molecule library that could provide promising starting points for drug discovery.

References
M. Oschmann, L. Johansson Holm, O. Verho.
Synthesis of Elaborate Benzofuran-2-Carboxamide Derivatives Through a Combination of 8-Aminoquinoline Directed C-H Arylations and Transamidations.
ChemRxiv 2019, DOI: 10.26434/chemrxiv.7925489.v1

A. J. Schmitz, A. Ricke, M. Oschmann, O. Verho.
Convenient access to chiral cyclobutanes with three contiguous stereocenters from verbenone enabled by directed C(sp3)–H arylation
Chem. Eur. J. 2019, 25, 5154-5157.

O. Verho, M. Pourghasemi Lati, M. Oschmann
A Two-step Procedure for the Overall Transamidation of 8-Aminoquinoline Amides Proceeding via the Intermediate N-Acyl-Boc-Carbamates
J. Org. Chem. 2018, 83, 4464-4476.

B. Melillo, J. Zoller, B. K. Hua, O. Verho, J. C. Borghs, S. D. Nelson Jr., M. Maetani, M. J. Wawer, P. A. Clemons, S. L. Schreiber
Synergistic Effects of Stereochemistry and Appendages on the Performance Diversity of a Collection of Synthetic Compounds
J. Am. Chem. Soc. 2018, 140, 11784-11790.

O. Verho, M. Maetani, B. Melillo, J. Zoller, S. L. Schreiber
Stereospecific Palladium-Catalyzed C–H Arylation of Pyroglutamic Acid Derivatives at the C3 Position Enabled by 8-Aminoquinoline as a Directing Group
Org. Lett. 2017, 19, 4424-4427.

M. Maetani, J. Zoller, B. Melillo, O. Verho, N. Kato, J. Pu, E. Comer, S. L. Schreiber
Synthesis of a Bicyclic Azetidine with In Vivo Antimalarial Activity Enabled by Stereospecific, Directed C(sp3)−H Arylation

J. Am. Chem. Soc. 2017, 139, 11300-11306.

What is the 6-Credit Research Assistant course?
The 6-Credit Research Assistant summer course is an experiential learning opportunity that allows students to develop research skills in a professional research setting. As a research assistant, you perform research under the supervision of a mentor (a lead scientist in the external research group). The mentor is able to offer both academic and professional advice. In addition to acquiring research experience, the goal is to develop a student/mentor relationship that benefits both the DIS student and Stockholm-based research institutions.

Learning Objectives
Through this course, DIS students will learn techniques and skills in their field of interest and as applicable to the research focus. Students will be part of an active research team and experience the dynamics of a European research institution. Throughout the summer, students will keep a research journal recording their daily involvement in the research project.

Expected Learning Outcomes

- Obtain hands-on research experience in cutting-edge laboratories
- Learn the ability to plan, conduct and critically evaluate experimental laboratory data
- Obtain the ability to perform self-directed and self-motivated experimental research
- Learn how to review scientific research papers, evaluate and criticize the experimental data and present it in a clear and logical way at journal clubs
- Be able to actively participate in scientific discussions with professionals of the research area with a critical approach to the research
- Learn how to write a scientific research paper with your experimental data and present them in a professional way

Structure of Project Work
The student's research project will be a part of a larger, ongoing research project at the research institution. The student must be able to enhance the research being performed and investigate phenomena of interest to them, their mentor, and the research team. The project should be self-directed and self-motivated under the mentor's guidance and supervision. A gradual transition toward independence is encouraged as a student gains confidence and is able to self-direct their work.

It is not expected that the student pursues a project where s/he is able to obtain definitive publishable results. The project chosen and agreed upon between the student and mentor should be focused and designed to produce results within the DIS summer calendar. While it is not necessary for the results to be significant (in that the results find a solution to the problem or hypothesis proposed), arguably any results to the proposed question are significant to the next phase of a research project.

Approach to teaching
The course requires an average of 35 hours a week of laboratory and/or clinical-based research in external research groups at local hospitals, universities, or other research institutions. The students will experience a very hands-on class, where approximately 2/3 of the contact hours will be in a laboratory setting and 1/3 of the hours will be theoretical hours, where students read, write and prepare their research. Students will be provided with the basic scientific knowledge of the field and be introduced to the methods needed to conduct the experiments. Regarding teaching style, especially in the laboratory setting, the approach is "learn by doing". For the theoretical parts, students are expected to immerse themselves in the topic and take responsibility so they achieve the highest learning outcome by actively participating in our discussions and in their presentations.

Expectations of the students
The 6-credit Research Assistant summer course is designed for highly motivated students with a strong interest in developing their research skills. During the theoretical part students are expected to actively participate in discussions and critically evaluate the research and ethical components within the field. During the practical part students are expected to actively engage by planning and performing their own experiments and carefully monitor the conducted experiments and analyzing the collected data. Moreover, students are encouraged to critically evaluate possible issues if experiments do not go the way they should, and suggest modifications to experiments or reflect on potential mistakes. Overall the most important part is being enthusiastic about the science and active participation in the form of questions, discussions and critical thinking.

DIS Contact
Tina Mangieri, PhD, DIS Associate Academic Director and Director of Research: tma@disstockholm.se
Jeanette Erbo Wern, PhD, DIS Copenhagen faculty and Copenhagen Coordinator: jwe@dis.dk

Course Location
This DIS course will be located at an external institution. Students will need to arrange a schedule with their mentor which will allow them to complete an average of **35 hours work per week** (total hours may vary according to research opportunity and expectation of mentor).

Assignments
To be eligible for a passing grade in this course all of the assigned work must be completed.
The factors influencing the final grade and their weights are reported in the following table:

Participation		30%
Literature Summary Review		5%
Outline of the Research Project	Written Project	10%
	Oral Presentation of the Project	5%
Oral Presentations at Journal Clubs		10%
Research Paper	Written Project	30%
	Oral Presentation	10%
Total		100%

Participation covers the following areas:

1. Attendance and the level of preparation, planning, and conduction of the experimental research work and the level of self-directed and self-motivated work
2. The contribution to research discussions with your research group, at journal clubs, and at project presentations

Participation is an important part of this course and to receive full credit students should be present at all the scheduled research sessions in and outside of the lab and actively participate and engage in the experimental work.

Throughout the semester, students are expected to complete various assignments to verify their involvement and learning; these will be of benefit to both the student and mentor. The students will be expected to compose the following:

A ***literature summary review*** will give the student the opportunity to seek out existing peer-reviewed articles and, therefore, enhance their scientific knowledge regarding the specific research field. In addition, it is essential that the student has knowledge of previously produced research by the research institution with which they are working.

An ***outline of the research project*** will provide the student with a foundational structure to help guide the project's completion. By creating an outline, the student will be able to better comprehend the objective of her/his efforts. The mentor will also be able to use the outline to assess areas in which the student's current knowledge and understanding may be lacking.

Journal clubs are presentations followed by discussions that will be organized by the research group to analyze certain thematic areas in depth. Journal clubs are occasions for research discussions within the

research area of the research group and development of presentation skills; They serve as an exercise for critical thinking and reading of scientific research papers and experimental data.

The research paper that the students present during the Journal Club should be related to the students' research area. The other DIS students in the same research lab should read the paper as well and prepare one or two questions for the journal club discussion.

The presentation should have a logical and clear structure and provide relevant information on the background, methods, conclusions, and future perspectives of the presented work. The original data reported in the paper should be presented and discussed in a clear way.

The ***research paper*** is the final product of the 6-credit research assistantship. The paper will explain the student's work throughout the semester and will include the overall process, the project's significance, and the contribution to the field of research in which the student engaged. Please note: this research paper is not produced with the intent of publishing. The final research paper will include the following:

- Abstract
- Introduction
- Background
- Method(s)
- Results
- Discussion
- Conclusions

Required Readings
Relevant scientific papers will be send out before the start of the course.

Research Mentor:

Oscar Vernho

Ph.D. in Organic Chemistry (Stockholm University, 2014). Group Leader, Department of Organic Chemistry, Stockholm University. With DIS since 2019.

Academic Regulations
Please make sure to read the Academic Regulations on the DIS website. There you will find regulations on:

- Course Enrollment and Grading
- Attendance
- Coursework, Exams, and Final Grade Reports

DIS - Study Abroad in Scandinavia - www.DISabroad.org