UNDERGRADUATE SUMMER RESEARCH INTERNSHIPS

National Center of Competence in Research for Bio-Inspired Materials

Research Projects Summer 2026

The National Center of Competence in Research (NCCR) Bio-Inspired Materials offers undergraduate students (from Switzerland and abroad) the opportunity to spend the summer break (8-10 weeks) participating in cutting-edge research within one of the Center's research groups. The undergraduate students have the opportunity to work on a research project and to interact with leading experts in their fields of interest and with fellow students from around the world. The students get a glimpse of advanced research work, gain desirable hands-on work experience, develop their transferable skills, and have the unique opportunity to explore career options and network with professionals. Beyond conducting research in the hosting lab, undergraduates participate in scientific lectures, social and networking events. At the end of the summer, the students present the results of their research projects in a poster session followed by a summer party. The students have the opportunity to learn about Switzerland from an insider perspective, and to take the first steps toward learning or practicing French and/or German language skills.

Requirements

To apply to the program, you need to fulfill the following conditions:

- Be a national of Switzerland, a member state of the European Union, or a country with a Visa exemption agreement with Switzerland for a maximum period of stay of 89 days;
- Be enrolled at a University as a full-time undergraduate student in a relevant field of natural sciences, such as medicine, biology, biochemistry, chemistry, physics or materials science;
- Be an undergraduate student having concluded a minimum of 2 years of a degree program by the start of the internship;
- Certify that you are and will be registered as an undergraduate at your University/College for the upcoming academic year;
- You are not an undergraduate student at the University of Fribourg;
- Have very good (oral and written) English language skills (level B2/C1).

Terms of the research stay

Duration: 8-10 weeks; Only Period between June 15 – August 31

How to apply

Applicants must submit their applications online at www.bioinspired-materials.ch/

Applications are open from December 1, 2025, until January 20, 2026.

Project ID	Project title	Group	Field
P26-01_Clough	Mechanophore-functionalised polymeric nanoparticles for mapping nanoscale extracellular forces	Clough	Chemistry, Materials Science & Engineering
P26-02_Limbach	Demicellization of cholesterol by plant extracts	Limbach	Biology, Chemistry, Biochemistry, Physics, Materials Science & Engineering
P26-03_Limbach	From nano to macro: Multiscale rheological insights into biopolymer gel formation	Limbach	Physics, Materials Science & Engineering
P26-04_Mayer	Biological nanopores for bioanalytical protein sensing	Mayer	Biology, Chemistry, Biochemistry, Physics, Materials Science & Engineering
P26-05_Mayer	Noise reduction strategies in plasmonic optical trapping of single proteins	Mayer	Biology, Physics
P26-06_Steiner	Modeling butterfly wing nanostructures with curved surface physics	Steiner	Chemistry, Physics
P26-07_Steiner	Light meets geometry: Simulating superchiral fields in woven structures	Steiner	Physics, Materials Science & Engineering
P26-08_Steiner	Exploring natural and synthetic porous biomaterials through FIB-SEM tomography	Steiner	Materials Science & Engineering
P26-09_Vanni	Integrating molecular simulations and data-driven methods to study protein-induced membrane remodeling	Vanni	Biology, Biochemistry, Chemistry, Physics, Materials Science & Engineering
P26-10_Weder	Strong and tough adhesives inspired by the crosslinked structure of collagen	Weder	Chemistry, Materials Science & Engineering
P26-11_Weder	Development and application of novel mechanophore loops	Weder	Chemistry
P26-12_Weder	Supramolecular mechanophore for visualizing mechanical force in polymer materials	Weder	Chemistry, Materials Science & Engineering
P26-13_Weder	Combining dynamic chemistries to access complex adaptive polymer systems	Weder	Chemistry, Materials Science & Engineering

UNDERGRADUATE SUMMER RESEARCH INTERNSHIPS

National Center of Competence in Research for Bio-Inspired Materials

Research Projects Summer 2026

Project ID	**URI P26-01_Clough**
Project title	**Mechanophore-functionalised polymeric nanoparticles for mapping nanoscale extracellular forces**
Research group	Prof. Jessica Clough https://www.ami.swiss/mechanoresponsive/en/
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	8 to 10 weeks
Possible period	**Period 15 June – 31 August including 20.08.2026**

Project summary

Cells interact with their surroundings through molecular linkages such as integrins, which transmit mechanical forces between the extracellular matrix and cytoskeleton. Measuring these forces is key to understanding how cells sense and remodel their environment, for instance during cancer invasion. Most current techniques rely on 2D assays that do not capture the complexity of 3D matrices. This project, in collaboration with Dr. Grazon and Dr. Rosendale (University of Bordeaux), will develop mechanophore-functionalized polymer nanoparticles as optical probes for mapping extracellular tensile forces in 3D. Mechanophores change their spectra under mechanical stress and, when grafted onto nanoparticles, report local forces in the 10–100 pN range. The student will synthesize and functionalize nanoparticles, characterize their optical and structural properties by e.g., fluorescence spectroscopy and dynamic light scattering, and test their mechanosensitivity in cell-free hydrogels under load.

Keywords: Polymer nanoparticles, mechanophores, force sensing, organic synthesis, hydrogels, fluorescence spectroscopy and microscopy.

UNDERGRADUATE SUMMER RESEARCH INTERNSHIPS

National Center of Competence in Research for Bio-Inspired Materials

Research Projects Summer 2026

Project ID	**URI P26-02_Limbach**
Project title	**Demicellization of cholesterol by plant extracts**
Research group	Prof. Hanjo Limbach https://www.ami.swiss/en/groups/foodscience.html
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	10 weeks
Possible period	**Period 15 June – 31 August including 20.08.2026**

Project summary

Micellization is a crucial step in the intestinal absorption of cholesterol. In the small intestine, bile salts, phospholipids, and cholesterol spontaneously self-assemble into mixed micelles (typically 3–20 nm in diameter), which solubilize hydrophobic cholesterol and facilitate its uptake by enterocytes[1]. One of the pharmacological strategies to lower blood cholesterol levels is to inhibit the formation of these bile acid–cholesterol micelles, thereby reducing cholesterol absorption. Certain dietary components with known bioactivity in lowering cholesterol, such as soluble dietary fibers, bioactive peptides, and plant-derived phytochemicals also exert similar functions.

This project takes inspiration from the self-assembly micellization process and applies soft matter characterization techniques to understand how plant-derived bioactives influence micelle stability and disassembly (“demicellization”). Collectively using asymmetric flow field-flow fractionation (AF4) coupled with multi-angle light scattering (MALS), X-ray scattering techniques and advanced microscopic imaging, we will investigate structural changes in model bile-cholesterol micelles upon interaction with selected plant extracts of known composition.

Through this project, the student intern will gain hands-on experience in nanostructural characterization and separation techniques that are adapted to bio-inspired food colloidal systems. The results will contribute to a deeper understanding of the intervention from food constituents in hypercholesterolemia at a nanoscale level.

Keywords: Micellization, self-assembly, cholesterol-lowering, plant extract, dietary bioactives.

Reference:

[1] Yi et al., *Chem. Phys. Lipids*. 2016, 200.

UNDERGRADUATE SUMMER RESEARCH INTERNSHIPS

National Center of Competence in Research for Bio-Inspired Materials

Research Projects Summer 2026

Project ID	**URI P26-03_Limbach**
Project title	**From nano to macro: Multiscale rheological insights into biopolymer gel formation**
Research group	Prof. Hanjo Limbach https://www.ami.swiss/en/groups/foodscience.html
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	10 weeks
Possible period	**Period 15 June – 31 August including 20.08.2026**

Project summary

The project aims to understand the rheological (flow and deformation) properties of biopolymer gels by studying their behavior across multiple length scales[1].

Specifically, the student will be trained in: 1) Macroscopic shear rheology, measuring bulk mechanical properties like viscosity, elasticity, and yield stress. 2) Optical passive micro-rheology, using microscopy to track embedded particles and infer local viscoelastic properties. 3) Dynamic light scattering (DLS), probing nanoscale dynamics and structure via Brownian dynamics.

The goal is to correlate these measurements with different preparation protocols to understand how processing affects gel properties. No previous experience is necessary but basic physics would be helpful.

Keywords: Biopolymer, rheology, fluid gels, process-property relations.

Reference:
[1] D'Oria et al., *Food Hydrocolloids* 2024, 149.

UNDERGRADUATE SUMMER RESEARCH INTERNSHIPS
National Center of Competence in Research for Bio-Inspired Materials

Research Projects Summer 2026

Project ID	**URI P26-04_Mayer**
Project title	**Biological nanopores for bioanalytical protein sensing**
Research group	Prof. Michael Mayer https://www.ami.swiss/biophysics/en/
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	8-10 weeks
Possible period	**Period 15 June – 31 August including 20.08.2026**

Project summary

Measurement of ionic current through nanopores enables label-free, single-molecule characterization of analytes in solutions. Biological nanopores have recently emerged as powerful tools for detecting unfolded proteins, DNA, and synthetic polymers. However, the analysis of full-length proteins remains challenging because most commonly used biological nanopores possess diameters too small to accommodate large, globular molecules. Over the past two years, we have developed a new class of large-diameter biological nanopores, designed to overcome these constraints. In this project, we will explore the use of these nanopores for single-molecule sensing of proteins that are highly relevant to neurodegenerative diseases, such as Alzheimer's and Parkinson's disease, and we will extend these studies to the analysis of real patient samples. The student will contribute to ongoing efforts by assisting in the development and optimization of protocols for bioanalytical sensing. They will gain experience in single-molecule techniques, including the use of nanopores, and any prior knowledge of working with proteins (characterization, handling) will be highly appreciated.

Keywords: Proteins, single-channel measurements, biosensors.

BIO-INSPIRED MATERIALS
NATIONAL CENTER OF COMPETENCE IN RESEARCH

Swiss National Science Foundation

UNDERGRADUATE SUMMER RESEARCH INTERNSHIPS

National Center of Competence in Research for Bio-Inspired Materials

Research Projects Summer 2026

Project ID	**URI P26-05_Mayer**
Project title	**Noise reduction strategies in plasmonic optical trapping of single proteins**
Research group	Prof. Michael Mayer https://www.ami.swiss/biophysics/en/
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	10 weeks
Possible period	**Period 15 June – 31 August including 20.08.2026**

Project summary

In recent years, plasmonic optical trapping has emerged as a powerful technique to study single protein dynamics in physiologically relevant conditions. In this approach, a diluted solution of proteins is placed over a metallic surface that presents an engraved plasmonic nanostructure, a nanocavity. Upon resonant illumination with a tightly focused laser beam, an intense, confined electric field is induced in the nanocavity, creating an optical trap that attracts the nearest protein, enabling the study of single-protein dynamics through the transmitted laser signal. Double nanoholes made of gold are commonly used due to their plasmonic resonance in the near-infrared range. Their shape resembles a bow tie or a hand barbell. However, the effective size of these apertures through which the light is transmitted is, on average, between 100 and 300 nm. Such a small size makes it challenging to detect the transmitted light. It makes the detection process highly sensitive to fluctuations in laser intensity, electronic noise, and optical shot noise, which, in turn, degrade the signal-to-noise ratio, rendering the study of protein dynamics a challenging task.

The project will focus on noise reduction strategies by balancing two optical detectors available in the setup using a basic electronic circuit and Python-based data analysis routines. The applicant should have a basic knowledge of optical microscopies, electronics, and Python coding.

Keywords: Optical trapping, plasmonics, balanced photodetection.

UNDERGRADUATE SUMMER RESEARCH INTERNSHIPS
National Center of Competence in Research for Bio-Inspired Materials

Research Projects Summer 2026

Project ID	**URI P26-06 Steiner**
Project title	**Modeling butterfly wing nanostructures with curved surface physics**
Research group	Prof. Ullrich Steiner https://www.ami.swiss/physics/en/
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	10 weeks
Possible period	**Period 15 June – 31 August including 20.08.2026**

Project summary

Some butterflies and beetles have 3D nanostructures in their wing scales, so-called photonic crystals, that are able to produce coloration without pigments. These photonic crystals may form through self-assembly in dying cells, where a biopolymer called chitin grows along curved membranes shaped by lipids[1,2]. In this project, you will use a simulation tool called Surface Evolver[3] to model how these curved shapes might form. Instead of tracking every molecule, you'll apply a mathematical model that minimizes the surface bending energy[4]. This approach is much faster and can still capture the essential physics. You will explore how different conditions - like lipid concentration, pH, or sugar levels - can affect the shapes that form. The goal is to analyze structures seen in experiments and better understand how nature builds these complex patterns. This project is ideal for students interested in biophysics, geometry, and computational modeling.

Keywords: Biophysics, soft matter, 3D curvature, computational modeling.

References:
[1] Saranathan et al., *Proc. Natl. Acad. Sci. U.S.A.* 2010, 107(26).
[2] Wilts et al., *Sci. Adv.*2017, 3.
[3] Brakke, *Experimental Mathematics* 192, 1(2).
[4] Chen and Jin, *Interface Focus* 2017,7.

UNDERGRADUATE SUMMER RESEARCH INTERNSHIPS
National Center of Competence in Research for Bio-Inspired Materials

Research Projects Summer 2026

Project ID	**URI P26-07_Steiner**
Project title	**Light meets geometry: Simulating superchiral fields in woven structures**
Research group	Prof. Ullrich Steiner https://www.ami.swiss/physics/en/
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	10 weeks
Possible period	**Period 15 June – 31 August including 20.08.2026**

Project summary

Certain nanomaterials can twist light in ways that are useful for detecting molecules, improving chemical reactions, or making better sensors[1]. Periodic structures on a substrate, also known as metasurfaces, can create extremely confined and twisted light fields, known as superchiral fields[2]. The rotational twist of these fields, quantified by the chirality density[3], is much stronger than what you get from regular circularly polarized light. Our group has shown that metal-based networks can similarly confine light[4]. This project explores more complex woven shapes developed by the Evans group[5] that have special geometric and topological features. You will use optical simulations to study how strongly light can be twisted in these interwoven structures. This project is an opportunity to learn about nanophotonics, geometry, and computational physics.

Keywords: Chiral light, interwoven geometries, computational photonics.

References:

[1] Avalos-Olando et al., *ACS Photonics* 2022, 9(7).
[2] Pura et al., *ACS Photonics* 2024, 11(10).
[3] Thapa and Biswas, *Nanoscale* 2025, 17.
[4] Schumacher et al., *ACS Photonics* 2025, 12(9).
[5] Evans et al., *Topology and its Application* 2025, 368.

UNDERGRADUATE SUMMER RESEARCH INTERNSHIPS
National Center of Competence in Research for Bio-Inspired Materials

Research Projects Summer 2026

Project ID	**URI P26-08_Steiner**
Project title	**Exploring natural and synthetic porous biomaterials through FIB-SEM tomography**
Research group	Prof. Ullrich Steiner https://www.ami.swiss/physics/en/
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	10 weeks
Possible period	**Period 15 June – 31 August including 20.08.2026**

Project summary

Biomaterials are engineered or natural substances interacting with biological systems for tissue and organ repair or replacement. Their design balances biocompatibility, mechanical properties, functionality, and degradation. Current examples include polymers, ceramics, metals, and natural macromolecules, with growing focus on micro- and nanoscale architectures. In tissue-engineering scaffolds, porosity is key for nutrient transport, vascularization, and mechanical integrity.

Nature inspires designs such as gyroid-like nanostructures in beetles and butterfly wings, combining coloration and resilience. FIB-SEM tomography enables 3D analysis of porous materials like porous silicon, measuring pore size, connectivity, and surface area.

The project will involve hands-on training in preparing samples for FIB-SEM and characterizing them using this tomography technique. Prior knowledge in 3D image processing and experimental experience in a chemical wet lab is desirable. Proficiency in the use of scanning electron microscopy is required.

Keywords: Bioinspired design, FIB-SEM tomography, porous silicon.

UNDERGRADUATE SUMMER RESEARCH INTERNSHIPS
National Center of Competence in Research for Bio-Inspired Materials

Research Projects Summer 2026

Project ID	**URI P26-09_Vanni**
Project title	**Integrating molecular simulations and data-driven methods to study protein-induced membrane remodeling**
Research group	Prof. Stefano Vanni https://www.unifr.ch/bio/en/research/bioinformatics/vanni.html
Host Institution	Department of Biology, University of Fribourg
Duration	8-10 weeks
Possible period	**Period 15 June – 31 August including 20.08.2026**

Project summary

Protein-induced membrane remodeling underlies many essential cellular functions, including cell division, vesicle formation, and lipid homeostasis. These processes rely on the coordinated actions of lipids and proteins that induce or stabilize membrane curvature, promote lipid translocation, and drive membrane fusion or fission. In our lab, we use molecular dynamics simulations to obtain molecular-level insight into the diverse classes of proteins that participate in membrane remodeling.

In this project, we will combine large-scale simulation data with machine learning algorithms to extract common structural and dynamic features that underline the remodeling activity of several classes of proteins. These could be scramblases, small amphipathic peptides involved in membrane fusion/fission events, or disordered proteins. This integrative approach will allow us to identify emerging principles across distinct remodeling events.

Keywords: Cellular membranes, lipids, molecular dynamics, machine learning, computational biology, artificial intelligence, computational mechanics.

UNDERGRADUATE SUMMER RESEARCH INTERNSHIPS

National Center of Competence in Research for Bio-Inspired Materials

Research Projects Summer 2026

Project ID	**URI P26-10_Weder**
Project title	**Strong and tough adhesives inspired by the crosslinked structure of collagen**
Research group	Prof. Christoph Weder https://www.ami.swiss/en/groups/polymer-chemistry-and-materials/
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	10 weeks
Possible period	**Period 15 June – 31 August including 20.08.2026**

Project summary

Collagen, the most abundant protein in the human body, is the primary load-bearing structural component of connective tissues subjected to high mechanical loads. Collagen molecules form triple helices that self-assemble into cross-striated fibrils. These fibrils are covalently crosslinked by a trivalent crosslinker bearing one weak “arm” with a sacrificial bond. Upon rupture, the overall linkage between the two triple helices remains intact due to the two remaining arms. This mechanism dissipates energy, thereby toughening collagen. This project focuses on the synthesis and characterization of adhesives incorporating collagen-inspired trivalent crosslinkers with one sacrificial arm. We begin by synthesizing cyclobutane-based crosslinkers that can undergo a [2 + 2] cycloreversion upon mechanical activation, serving as sacrificial bonds. These crosslinkers will then be integrated into adhesive polymeric materials, which will be evaluated for their adhesive strength on various substrates. We anticipate that incorporating collagen-inspired crosslinkers into soft materials will yield strong and tough adhesion. The project begins with the synthesis of a new mechanophore—a cyclobutane crosslinker—and its incorporation into polymer adhesive formulations, followed by the mechanical characterizations and the adhesion properties for the adhesive specimens. The student will engage in an interdisciplinary project, combining organic synthesis, polymer chemistry, bioinspired design. Prior experience in organic synthesis and/or thermomechanical polymer characterizations are welcome.

Keywords: Organic and polymer synthesis, mechanical characterization, collagen-inspired adhesives.

UNDERGRADUATE SUMMER RESEARCH INTERNSHIPS
National Center of Competence in Research for Bio-Inspired Materials

Research Projects Summer 2026

Project ID	**URI P26-11_Weder**
Project title	**Development and application of novel mechanophore loops**
Research group	Prof. Christoph Weder https://www.ami.swiss/en/groups/polymer-chemistry-and-materials/
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	10 weeks
Possible period	**Period 15 June – 31 August including 20.08.2026**

Project summary

Drawing inspiration from nature's ability to sense and adapt to force, this project encompasses the synthesis and application of novel mechanochromic motifs that exhibit an optical response when subjected to mechanical stress. These targeted molecules, referred to as mechanophores, can be integrated into polymers to enable real-time stress monitoring. One design strategy that we developed to achieve this involves covalently bonded chromophore pairs (dimers) that can interact reversibly through π–π stacking, forming either an excimer state or a charge-transfer complex. These interactions affect the chromophores' optical properties and can be altered by an applied mechanical force that pulls the chromophores apart, providing a measurable signal. The project will involve the synthesis and characterization of a new mechanophore, its incorporation into a polymer, and the evaluation of mechanochromic responses. This internship offers hands-on experience at the interface of organic chemistry, bioinspired design, and materials science, contributing to the development of smart materials for advanced sensing applications.

Keywords: Molecule synthesis, mechanochemistry, polymer synthesis, mechanical testing.

UNDERGRADUATE SUMMER RESEARCH INTERNSHIPS
National Center of Competence in Research for Bio-Inspired Materials

Research Projects Summer 2026

Project ID	**URI P26-12_Weder**
Project title	**Supramolecular mechanophore for visualizing mechanical force in polymer materials**
Research group	Prof. Christoph Weder https://www.ami.swiss/en/groups/polymer-chemistry-and-materials/
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	10 weeks
Possible period	**Period 15 June – 31 August including 20.08.2026**

Project summary

Mechanical forces, such as tension and compression, are widespread in nature. Materials exposed to mechanical forces can undergo deformation that may lead to their damage. To probe force-induced deformation or damage, molecular force sensors known as mechanophores have been developed. These motifs convert mechanical input into optical signals, enabling force visualization via fluorescence, absorbance or chemiluminescence. In this project, supramolecular mechanophores, which function by rupturing weak, noncovalent interactions in response to forces, will be incorporated into polymer materials for force visualization. These mechanophores will be synthesized and characterized in solutions and in polymer materials. The instant response and inherent reversibility of mechanophores will be evaluated. Techniques to characterize their photophysical properties, including fluorescence and UV-Vis spectroscopy, and mechanical-related testing such as tensile stretch, compression, shearing, and grinding, will be performed. This project can be tailored to the applicant's interests, with a focus on mechanophore synthesis, material characterization and mechanical testing.

Keywords: Supramolecular mechanophore, mechanochromic polymer.

BIO-INSPIRED MATERIALS
NATIONAL CENTER OF COMPETENCE IN RESEARCH

Swiss National Science Foundation

UNDERGRADUATE SUMMER RESEARCH INTERNSHIPS
National Center of Competence in Research for Bio-Inspired Materials

Research Projects Summer 2026

Project ID	**URI P26-13_Weder**
Project title	**Combining dynamic chemistries to access complex adaptive polymer systems**
Research group	Prof. Christoph Weder https://www.ami.swiss/en/groups/polymer-chemistry-and-materials/
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	10 weeks
Possible period	**Period 15 June – 31 August including 20.08.2026**

Project summary

In nature, dynamic chemistry governs essential processes such as protein folding, enzymatic regulation, and molecular self-assembly, where reversible interactions allow complex and adaptable structures to form spontaneously. Inspired by these natural systems, this project aims to utilize Dynamic Covalent Chemistry (DCC) to design advanced polymeric materials with adaptive and stimuli-responsive properties. DCC enables reversible bond formation and dissociation, allowing polymers to reorganize their molecular architecture in response to external stimuli such as heat, light, pH, or catalysts. Key examples include thia-Michael exchange, Diels-Alder cycloaddition, disulfide metathesis, and transesterification. Integrating such reversible motifs imparts self-healing, stress relaxation, recyclability, and reprocessability to polymer systems. This project focuses on combining dynamic chemistries and chromogenic moieties to create color-changing polymers capable of complex adaptive behavior.

Keywords: Dynamic chemistry, dynamic covalent bonds, chromogenic polymer.