Friedrich-Schiller-
UNIVERSITÄT JENA

PRP – Ö01

PolyTarget

SCIENCE EDUCATION ON TARGET

DIDACTIC RECONSTRUCTION OF CURRENT RESEARCH AT THE INTERFACE BETWEEN NANOTECHNOLOGY AND MEDICINE

Summary

Within the project Ö01, **central findings of PolyTarget are made accessible for chemistry education through didactic reconstruction**. During the second funding phase, two teaching sequences on different PolyTarget research areas are being developed. In addition to the content reconstruction itself, model experiments are developed to introduce scientific methods and procedures in school, such as analysis and measurement methods and to improve experimental skills. **The target groups are students in grades 10 to 13, teacher students and in-service teachers** who are integrated into the project results via existing networks and can subsequently act as multipliers (see Fig. 1).

Figure 1: Areas of application of the transfer projects.

First results

Student experiments

Since the project start of Ö01, the development of a series of experiments on drug nanocarriers was focused. Until now, two experiments have been developed and tested for secondary school (see Fig. 2) in close cooperation with projects **A04** and **A06.**

Within a first experiment (I), the polymer poly(-δ-valerolactone) is prepared by means of a ring-opening polymerization starting from the monomer δ-valerolactone. TBD is used as the catalyst, ethanol acts as the initiator. The polymer from the glove box had the lowest elution time, followed by the semi-inert polymerization, while the polymerization at the lab bench had the longest elution time. This means that the ROP worked in all cases, while the inert reactions had the largest mean molar masses and the reactions at the lab bench the lowest. The turnover also behaved proportionally. It is thus possible to reproduce the ROP from the laboratory qualitatively without any problems on a laboratory bench under non-inert conditions.

The product of the reaction serves as the starting material for the second experiment (II). Before nanoprecipitation takes place due to the insolubility of the polymer in distilled water, the polymer is first dissolved in acetone. During injection using a dropper pipette, the formation of a white haze around the added drops was observed.

The nanoprecipitation produced nanoparticles in sizes between 61 and 233 nm. It becomes clear that even with a polymer that has not been purified after ROP, nanoparticles can be produced that even meet the properties of a suitable drug transporter in terms of size [1].

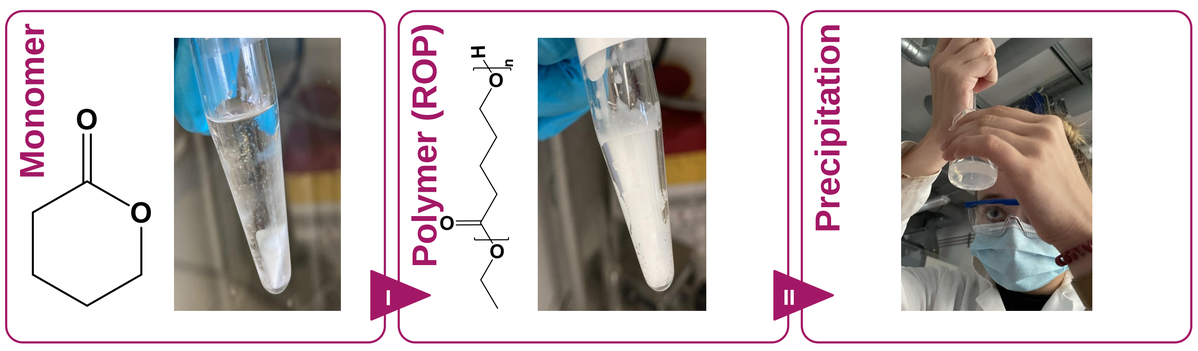


Fig. 2: Synthesis of poly(-δ-valerolactone) starting from δ-valerolactone and subsequent nanoprecipitation.

In addition, various simplifications were made and checked for their adaptation to the school context. For example, the quantities were adapted so that they appear suitable for school purposes. By increasing the amount of monomer from 500 mg to 2 g, it is easier to weigh in and measure out, and the amount of polymer produced is larger, so that visual changes are better perceived by the students. Furthermore, a stock solution is not used, and the catalyst and the initiator are weighed out directly and reacted with the monomer. In addition, the choice of chemicals was revised, and the previously used initiator benzyl alcohol was replaced by ethanol.

Piloting: Jena PolyTarget Summer School 2021

During a two-day summer school on Nanotechnology, the two experiments described were tested in practice with 24 students (grade 12). The students showed great interest in the practical implementation, and the link to their existing knowledge of polymers and the demonstration of the practical relevance to everyday life promoted motivation. In addition, the students were able to learn how to use chemical equipment that had not been used before, such as the correct handling of a micropipette (see Fig. 3).

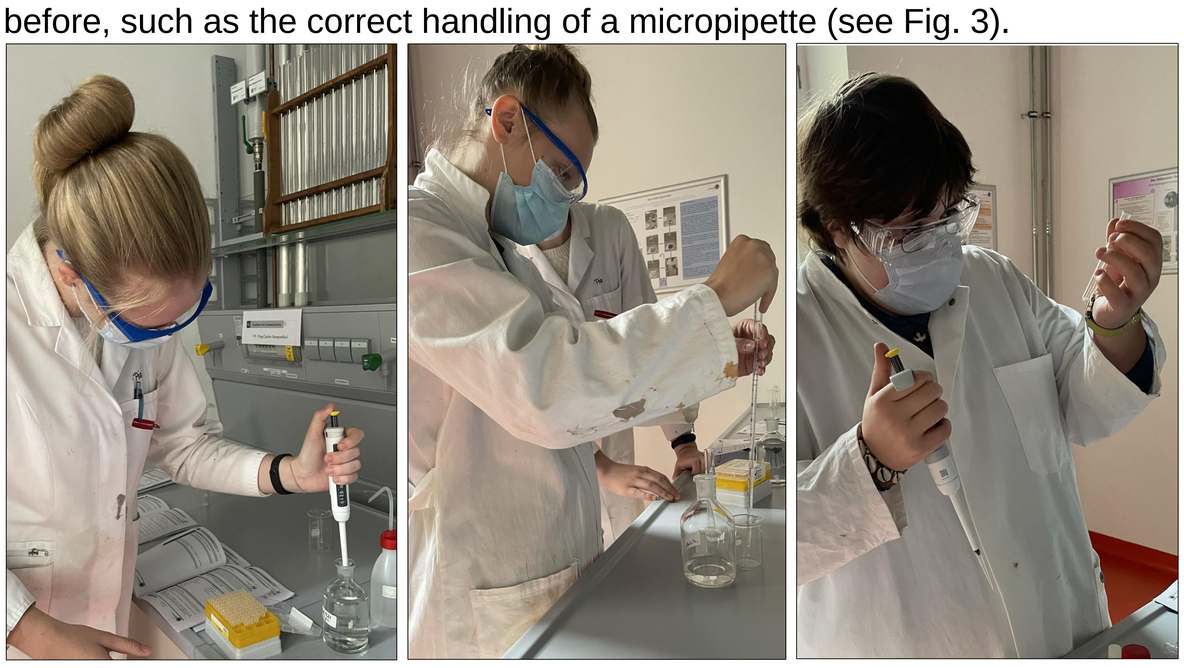


Figure 3: Students pipettes during Summer School.

Future work

Currently, the experiments described above are being further developed in collaboration with **A04** and **A06** (see Fig. 4). The aim is to dissolve the synthesized polymer together with Nile Red (model drug) in acetone and to encapsulate it in the hydrophobic interior by subsequent transfer to water (III). Discharge, *i.e.*, drug release, is to be achieved with the help of a base (IV). Due to the solvatochromic effect of Nile red, the individual steps can be followed phenomenologically by the learners and thus better understood. In addition, the drug release can be analyzed with a newly developed LabPi spectrometer so that kinetic aspects can be addressed. The students thus obtain an overall view of the synthesis from a polymer to the loading or release.

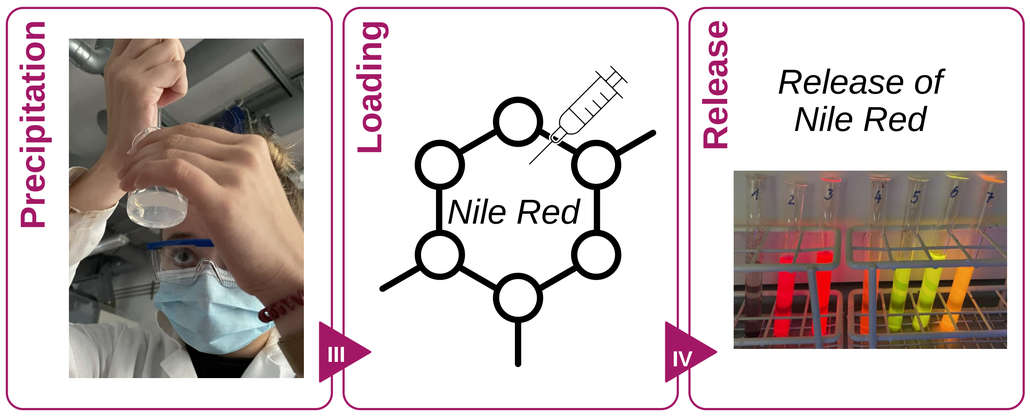
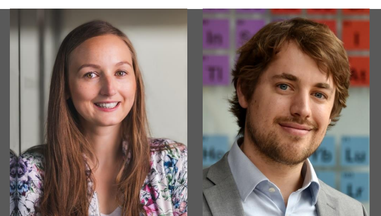


Fig. 4: Further development of the test series from nanoprecipitation to release.



Antonia Fruntke,
Prof. Dr. Timm Wilke
Chemistry Education
Friedrich Schiller University Jena

[1] J. H. Adair, M. P. Parette, E. I. Altinoglu, M. Kester, ACS Nano 2010, 4 (9), 4967-4970. | DOI: 10.1021/nn102324e

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