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Biotech in the classroom

Advanced training for research- and practice-oriented teaching

Biotechnology, molecular biology, and bioinformatics tend to play a minor role in curricula. The Amgen Foundation, together with the Technical University of Munich, wants to change that. They have developed a scientifically supported educational program for teachers through which teachers can introduce students to the world of biotechnology in an age-appropriate manner.

At long last, students can comprehend biotechnological procedures that they only know from detective stories and science broadcasts by trying them for themselves. The program is a boon for teachers and learners since the hands-on biotechnology curricula can now be implemented at school. Students take away subject-specific knowledge in a hands-on-oriented way that does not overwhelm them. This is how teachers describe the Amgen Biotech Experience in Germany, which brings biotechnology into the classroom.

Practice-oriented teaching

Amgen Biotech Experience (ABE) is an educational program for teachers on the topics of biotechnology, molecular biology, and bioinformatics. In addition to training courses and didactic materials, it includes the opportunity to borrow extensive biotechnology equipment for the classroom. In this way, the classroom is transformed into a biotech lab.

The students not only learn about the theory, but they are also immersed in the practice of biotechnology. ABE supports teachers in closing a gap in the science curriculum by bringing research-based and practice-oriented biology lessons to schools.

The Amgen Foundation training program is international. In Germany, it is run by the *Professur für Fachdidaktik Life Sciences* at the School of Social Sciences and Technology at the Technical University of Munich (TUM in Germany). The training program as well as the accompanying materials were developed in accordance with educational findings at the *Professur* to custom-fit German educational plans.

Positive feedback

The demand for practice-oriented biotechnology instruction is high. Since the launch of the ABE program in Germany in 2016, a total of 336 teachers from Bavaria and the Berlin-Brandenburg region have taken part in the biotechnological training series; 4,380 middle and high school students have benefited from the integrated biology lessons and have thus learned the basic techniques and methods of biotechnology themselves.

The ABE program was also in high demand during the pandemic. The free teacher training courses were held online instead of in person. And the teaching units with biotechnology

experiments could continue to be carried out in person when held in compliance with hygiene measures. The program was launched in Bavaria, and since March 2019 it has also been offered in the Berlin/Brandenburg region.

TUM's evaluation of the ABE program clearly shows the benefits for schools. (Nerdel & Schöppner, 2021). The 200 teachers surveyed who had previously participated in the ABE program indicated that they were able to apply the molecular biology topics very well in their daily teaching. In addition, according to the survey, teachers' motivation to use their newly acquired knowledge in classes is high.



With the Amgen Biotech Experience educational program, teachers can integrate biotechnology content and methods into the classroom

Biotech Methods in Practice

The advanced training series is based on the curriculum for the upper secondary schools, vocational schools, and technical and vocational high schools. Teachers from secondary schools are also part of the program. The courses offered are constantly being expanded thematically and methodically and embedded in new topics.

Due to repeated requests for new courses, the offering is becoming increasingly differentiated and is now built with basic and advanced modules both in terms of content and method (Schöppner, Großbruchhaus & Nerdel, 2022). The basic module introduces the techniques of

DNA recombination technology. The recombination of DNA, (i.e., its modification) is the basis of biotechnological research. The techniques learned in the basic module—DNA extraction, polymerase chain reaction (PCR), restriction digestion, and agarose gel electrophoresis—are among the most widely used methods used in the molecular biology laboratory. Through three experiments, participants learn not only the theory, but also the above-mentioned methods in practice. For example, they have to solve a criminal case with the help of DNA analysis.

The second experiment focuses on the phenomenon of repetitive DNA segments. More than half of human DNA consists of such repetitive sequences, including the PER3 gene. Researchers hypothesize that people who have five copies of this section of this segment are “morning people.” Those who have only four are “night owls.” Teachers and students can find out their predisposition based on their own DNA analysis.

They are also investigating how DNA influences the perception of bitter taste. To do this, teachers and students test restriction digest to determine whether they themselves have a nucleotide polymorphism (variation of a single base pair in a complementary DNA double strand) in the TAS2R38 gene, which leads to influencing their perception of bitter substances.

Advanced ABE modules

In addition to the basic module, an advanced ABE module deals with bioinformatics. Here, students learn about the use of common databases for DNA sequence information. In addition, teachers and students work with the program Py-Mol to visualize protein structures in 3D and color.

In another unit of the Bioinformatics module, they explore the influence of mutations on the spatial structure and function of the proteins. The module can be used both in extension of the Basic modules or on its own.

In the Advanced module, teachers and students look at the phenomenon of lactose intolerance. The fact that most adults in Europe are able to digest lactose is due to a recent genetic mutation that alters gene regulation and not the gene itself. In the most technically challenging module, participants apply the techniques learned in the Basic module to determine their own predisposition to lactose intolerance.

They also learn the large-scale production processes for lactose-free dairy products on a small scale. The everyday topic combines scientific research with biotechnological production and offers teachers countless possibilities for use in the classroom.

Student Research and W Seminar in the S1 laboratory

In addition, the ABE program also offers an introductory scientific seminar (W-seminar) for interested high school students. During the W seminars, students are professionally supervised and mentored for six months. Each week they learn hands-on methods of protein biochemistry in an S1 laboratory. They modify the DNA of the intestinal bacterium *E. coli*, which is used in

laboratories worldwide for biotechnological research. After genetic modification, the bacterium produces a certain protein in large quantities, which students extract, purify, and characterize by photometric and immunochemical methods. For very interested students, there is also the possibility to further deepen their research at the student research center in Berchtesgaden Land and, if applicable, prepare to compete in competitions.



Through the training, teachers not only learn the theory, but can also try out fundamental hands-on biotechnological methods

International Program of the Amgen Foundation

The Amgen Biotech Experience was launched in 1990. Today, nearly 1,500 science teachers participate in the ABE Program. Around 90,000 students are given the opportunity to try out biotechnological methods. The program is offered in the USA as well as Canada, Australia, China, Singapore, Japan and in the European countries of England, France, Germany, Ireland, Italy, the Netherlands, and Türkiye.

In addition, biotech courses are available on the online learning platform LabXchange, which was launched in 2020 with funding from the Amgen Foundation. Here, students can carry out virtual simulations and access learning materials from ABE. The virtual courses are available free of charge and are also available in German:

<https://www.labxchange.org/library/clusters/lx-cluster:abe-german>

The Amgen Biotech Experience illustrates the social commitment of Amgen and the Amgen Foundation: The biotech company wants to generate enthusiasm for the natural sciences, improve education, and to inspire and foster the scientists of today and tomorrow.

References

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Further information

<https://www.edu.sot.tum.de/fdls/lehrkraeftefortbildungen/molekularbiologie-bioinformatik/>
<https://www.amgen.de/engagement/>

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