Research and Peer Instruction in First-Year Teaching

Susanne Illenberger and Sebastian Springer

Biochemistry and Cell Biology, Jacobs University Bremen, Germany

s.illenberger/s.springer@jacobs-university.de

Introduction: ***General Biochemistry and Cell Biology*** is a highly successful undergraduate course in the 'Biochemistry and Cell Biology' (BCCB) Bachelor program at Jacobs University Bremen. It provides scientific training both in the matter (experiments are discussed and evaluated) and in the method (peer instruction).

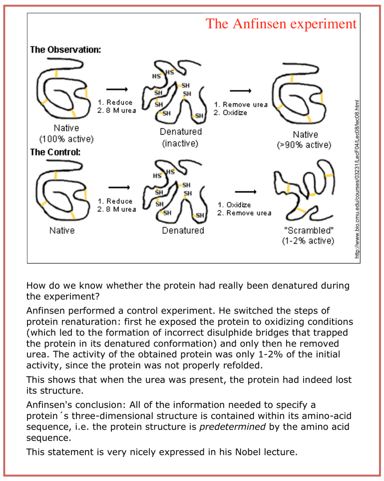
Concept and Challenges: The 'shell model' of teaching in the School of Engineering and Science demands that first-year 'General' lectures give an overview of the entire field of the program, to be built upon in subsequent courses. The subject of the BCCB major are the fields of biochemistry, cell biology, and molecular genetics. Students often bring very good prior knowledge in one of these fields and rudimentary knowledge in the others. Thus, the course always has to cater to beginners and the advanced at the same time. In addition, students come from extremely different learning cultures, some used to discursive learning in class, others to reproduction only. Most students need 2-3 months to adapt to the rigorous learning and testing environment of Jacobs.

The course consists of 56 classes that deal with increasingly complex subjects, from chemical bonds up to the biology of development. It aims to give students not only an overview of the field, but – importantly – also an insight into how scientific knowledge is generated and interpreted. An important contribution of the success of the course – not discussed here further – is the weekly quiz, which tests the material acquired in the previous week, and which ensures that students keep abreast of the curriculum.

Discussing research: About 15% of the course are set aside to discuss research techniques such as protein isolation or molecular cloning. To enable students to understand how scientific knowledge is generated, we then discuss selected historical experiments in detail, including method, experimental setup, outcome, and their paradigmatic value for the field. All the information from the lecture is available to the students in annotated slide files. An example of one slide (from a show of 30) is shown here:

slide shown in class ➔

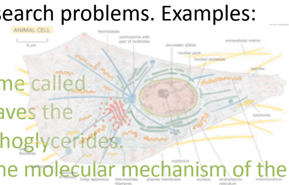
additional annotation ➔



About fifteen original experiments are discussed in the lecture.

Peer Instruction: We have realized that getting students to discuss the subject with each other is the key to the acquisition of the material, and to the equalization – as far as possible – of the different degrees of knowledge and learning skills. Discussions also lead to networking and cooperation, which is an essential component of real-life science but not at all practiced in the high schools of some countries.

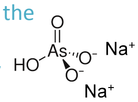
To get students to interact, one 'open question' is given every week. It must be answered in next week's quiz, and it is typically too difficult for a traditional first-year course, often derived from actual research problems. Examples:



Why are cells so small?

Bee venom contains an enzyme called phospholipase A2, which cleaves the central fatty acid from phosphoglycerides. What is the molecular mechanism of the destruction of red blood cells after a bee sting?

Arsenate (AsO_4^{3-}) has been used as a poison from ancient times. It disturbs glycolysis by interfering with the phosphoglycerate kinase reaction. Why does arsenate interfere with that reaction, and why is interference toxic to the cell?



Such questions can only be solved if students work together and/or network with peers from the upper years of the program. They quickly notice that it is not enough to refer to the slide files but that they must develop their own ways of acquiring information and to evaluate it critically. The midterm examination consists mainly of such open questions. Students have consistently reported that solving these 'real' questions, though strenuous, has been the best experience of their first year lectures.

Outcomes: The General BCCB lecture has won a number of awards and a university-wide recognition. We believe that this is due to the real-life science skills that it teaches. They lay a firm foundation for the second year 'Advanced' courses, but, more importantly, they give students insight into the nature and the working reality of the field that they are studying; this leads to excellent motivational outcomes and allows many students to commit to the area of BCCB as their career aim. We are very happy to answer any questions by email (see above).

Image sources: Essential Cell Biology 1st ed.; cosmosmagazine.com;