## ON THE TEACHING OF EXPONENTIAL FUNCTIONS: AN APPLICATION-BASED INTRODUCTION FOR BIOLOGY STUDENTS

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Powers, exponential, and logarithmic functions are essential in the natural sciences. They serve as models of many phenomena, and therefore play a key role in the teaching of subjects and mathematics. However, after analyzing five mathematics textbooks written for 11th graders, we concluded that biology as a motivation hardly appears in the teaching of exponential functions. So, don't be surprised that students interested in biology don't like math. Many people ask why they need to learn math if they won't use it later anyway. As our teaching experience in both high school and university (biology, pharmacist) shows, and a survey we did also demonstrates that a lot of people are afraid to learn math, not only in college, but also during their high school years. It is interesting to note that the little ones are not yet afraid... Learning the exponential and logarithmic function is especially problematic and difficult, although they are naturally connected with several biological processes.

In our courses for biologists and pharmacy students, we show a number of practical examples, illustrate the theoretical concepts with applications immediately. Instead of abstract discussion, we often focus on interactive graphical illustration. Based on our experience, we have developed a visual introduction to exponential and logarithmic functions for students with a biological interest, including some deeper topics for advanced students. Introductory examples help the development of concepts, definitions, and applications as well, such as the tricky behavior of exponential changes (slow at first, very fast later). Although the time of logarithmic rulers is over, the importance of logarithmic plots is unquestionable; the study of exponential functions is much easier with them. Exponential equations mean particularly difficult problem the student. The mathematics curriculum is limited to their technical handling (e.g., transforming to quadratic equations), but biological processes are not aware of this. Indeed, students need to know that most of the equations cannot be solved symbolically... and the curriculum should suggest what to do in these cases (e.g. approximation methods), even if full-depth discussion is not possible.

 K. HORTI, Teaching exponential and logarithmic functions in high schools with biology motivation, master's thesis (in Hungarian), Bolyai Institute, University of Szeged (2020)