

Question Set 1

Scales in biology and physics

Deadline to hand in the answers is 24 hours before the symposium if you would like to have any feedback. Send your answers as a pdf to jonas.tegenfeldt@ftf.lth.se

It is necessary to read and understand the papers. The lecture handouts are also helpful to understand what is important in the course.

Also standard biology and biochemistry textbooks can be helpful[1-3].

<https://bionumbers.hms.harvard.edu/>

Reminder:

- Copy and highlight (*e.g.* boldface or italics) the questions to your answer sheet.
- Give the sources of your answers. For example, if you find something on the web, give the link to the website. Give full reference to articles and books.
- Write your name and code of the course, your name, the question set, the name of the week's topic and date on each page!
- In calculations write out all units. This functions as a check that the calculations make sense.
- Write your answers using a suitable unit and with an appropriate number of significant digits. Not 0.00035mm/s ! Better to write 350nm/s !
- For liter write L rather than l since l and 1 (one) looks the same in most fonts.

- please send your answers as a ***pdf file***
- please specify references, i.e. specify where you found your answers
- please write your name in the file name

Questions Biophysics

1. How are DNA, RNA and proteins related to each other in an organism?
2. What are the relevant length scales in terms of DNA?
3. Give examples of relevant time scales in molecular biology? Steps per second for a motor protein? Replication speed? Cell division rate?
4. What size ranges do proteins span?
5. How large are bacteria? Human cells? Viruses?
6. What techniques from physics and engineering can be used to probe biology at the relevant scales? Think for example about optics, microtechnology, acoustics, electrostatics, magnetism, particle beams.
7. (*) Assume a $1\mu\text{m}$ sized spherical bacterial spore suspended in water at room temperature. What time would it take for this spore on average to diffuse distances of $1\mu\text{m}$ and 1m , respectively? Same question for a typical protein. Same question for a typical virus.
8. (**) A dolphin swims in the sea at a leisurely speed of two meters per second. For this problem, assume *laminar flow conditions* (no turbulence). Once it stops moving it fins how far does it coast? How long does it have to wait until its speed has fallen to 10% of the initial speed? Repeat the calculations for a bacterium like *E. coli*, which typically swims with a speed of $20\mu\text{m s}^{-1}$ while rotating its flagella.

Critical thinking & The web

9. How many papers has JO Tegenfeldt authored? How many of these were cited by Tegenfeldt's former postdoc W Reisner? [Use ISI Web of Science]
10. Select the five most important papers of Tegenfeldt's!
11. Tegenfeldt is the coauthor of a fair number of papers, but how many of them has he actually made a significant contribution to?
12. Seeking information on the web may appear to be easy, but how reliable are the answers you get from the web? Can you trust the web? ... your eyes? What warning signs of "bad" web sites can you think of?

13. There is still hope, though. It is possible to gain knowledge on the web, but you need to be vigilant! Give a few rules of thumb as to how to behave.
14. Once you find the information on the web, explain how you can use it in your own work in order to comply without being considered to plagiarize?
15. Assume you are given an assignment to write a report. You realize that you already have written a similar report previously. May you simply copy sections from your original report?

References

- [1] Lubert Stryer, *Biochemistry*, 7 ed. (W. H. Freeman and Co., New York, 2010).
- [2] Neil A. Campbell, *Biology*, 8 ed. (The Benjamin/Cummings Publishing Company, Inc., Menlo Park, 2009).
- [3] Carl Brändén and John Tooze, *Introduction to protein structure*. (Garland Publishing, Inc., New York, 1991).
- [4] Marc J. Madou, *Fundamentals of Microfabrication: the science of miniaturization*, (CRC Press LLC).