Prof. Julia Herzen
Prof. Andreas Bausch
Prof. Ulrich Gerland

Introduction to Biophysics
Winter Semester 2025/26, Exercise Sheet 1

Problem 1: Clinical imaging

a) Please assign the correct imaging method according to their spatial resolution and sensitivity to the different boxes in the figure 2 and explain what this means for the diagnosis.

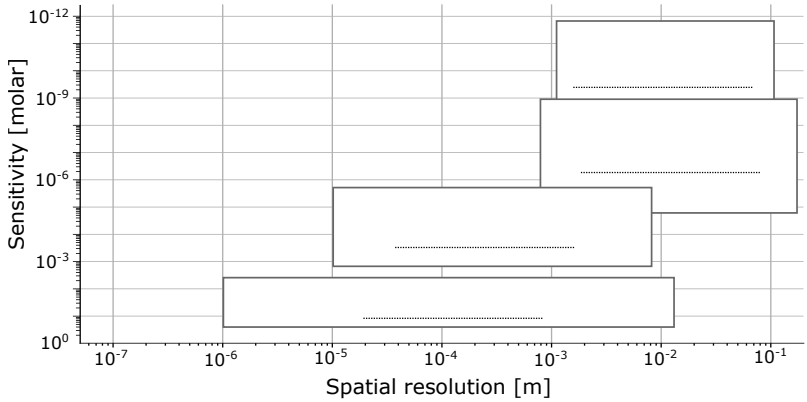

Figure 1

Solution:

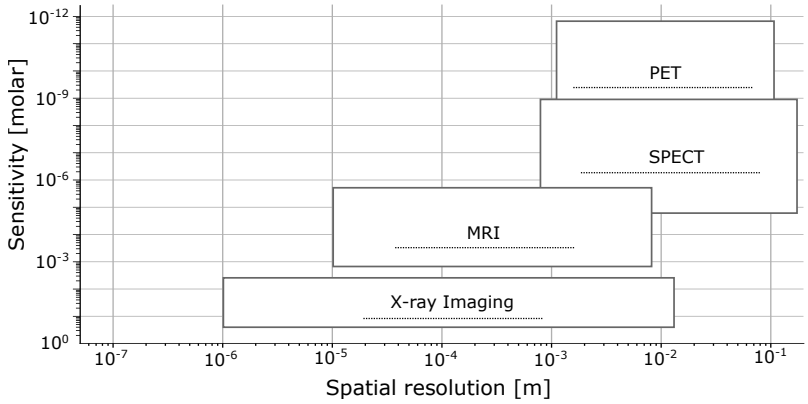

Figure 2

While X-ray imaging achieves the highest spatial resolution, it has the lowest sensitivity for small concentrations. It can visualize localized small (¡1mm) features like tumors, but not the uptake of a tracer by tumors or lymph nodes (i.e., functional imaging). The MRI has a higher sensitivity than X-ray imaging, but does not achieve the high spatial resolution. The higher sensitivity leads to a much higher contrast for soft tissue than X-rays can achieve. SPECT and PET have the lowest spatial resolution but can detect down to ng of an FTG-bonded tracer inside the human body. With that the activity (i.e. high consumption of FTG) in an organ can be visualized with very low spatial resolution. Given all that the different

imaging methods can only complement but not replace each other.
b) What defines the sensitivity and the spatial resolution in SPECT?
Solution: The collimator is the most important part an SPECT - especially, the aspect ratio defines how well one can localize the gamma quanta coming from the organ of interest.

c) How do you choose the right tracer in SPECT and in PET?
Solution: For SPECT only γ emitter can be used. The energy should be high enough to be measured outside of the body (anything below 60-70 keV will be too strongly absorbed on the way out from the inner body. The half-life time should be as short as possible, but allow for longer scans (up to 1h), as in SPECT images have to be collected from many directions. For PET only β^+ emitter can be used, which emit two γ quantas. As the detector builds a ring around the patient, no scanning is required and the half-life times can be much shorter than in SPECT (in the range of min.).