4. a) Explain the origin of MEG/EEG signals; describe which neural structures generate most of the signals we can measure and discuss briefly the neurophysiological and physical factors that affect the strength of the measured signal at the MEG/EEG sensors. (3p)

b) An external sensory stimulus activates a small patch of cerebral cortex. The activation can be represented by a current dipole with peak $Q = 10$ nAm and the response comprises frequencies $1 - 17$ Hz. From the MEG forward operator, we can see that the gain at this source location to a MEG sensor is $2.0 \cdot 10^{-5}$ T/Am. That same sensor sees total noise amplitude (background brain activity, intrinsic sensor noise and environmental noise) spectral density of 40 $\mathrm{fT}/\sqrt{\mathrm{Hz}}$. The noise spectrum is assumed to be uncorrelated with stimulation and white within the above frequency interval. When optimally filtering the signal, how many responses to that sensory stimulus need to be averaged to achieve a signal-to-noise ratio (SNR) of 10? SNR is defined as the ratio of the peak signal amplitude to the RMS amplitude of the noise. (3p)

5. Which non-invasive imaging or measurement techniques can be used to obtain information about metabolic activity in the brain? Explain briefly how each method works, what kind of information on metabolism is obtained and where the resulting data can be used either in neuroscience or in clinical medicine? How do measures of metabolic activity relate to neuronal activity? (6p)