Modern Techniques in Biophysics

Topic: Nuclear magnetic resonance

Problem 1: J-coupling

A ^{13}C spin (I=1/2) is coupled to 7 protons (I=1/2) with J-coupling constant J_{CH}=100 Hz.

(a) How many peaks are expected for ^{13}C NMR spectrum?

(b) Calculated the relative intensities of each peak and draw the expected ^{13}C NMR spectrum.

Problem 2: FID and spin-echo

(a) What is an FID? Draw and explain.

(b) Draw and explain what happens to nuclear spins/magnetization when a 90^0-180^0 spin-echo pulse is applied to a sample.

Problem 3: Relaxation

(a) Draw and explain the mechanism of T_1 relaxation.

(b) Draw and explain the mechanism of T_2 relaxation.

(c) Explain the fundamental difference between T_2 and T_2^* relaxation times.

Problem 4: TR, TE and contrast

(a) Tissue A has longer T_1 than tissue B. Draw and explain why a short TR (repetition time) will enhance the contrast between these two tissues.

(b) Tissue A has longer T_2^* than tissue B. Draw and explain why a long TE (echo time) will enhance the contrast between these tissues.