If you have missed the lecture, read my lecture notes and do the following exercises. Please send me your report by October 13th.

**Exercise 1:**
Calculate the Reynolds number for the flow of:

a) A glacier: density of ice: \( \rho = 900 \text{ kg m}^{-3} \); viscosity of ice: \( \eta = 10^{10} \text{ kg m}^{-1} \text{s}^{-1} \); speed of the flow: \( v = 10 \text{ m/ year} = 0.3 \text{ µm s}^{-1} \); Width of the glacier: 100 m, depth: 30 m.

b) A blood capillary: density of blood: \( \rho = 1025 \text{ kg m}^{-3} \); viscosity of blood: \( \eta = 3.5 \times 10^{-3} \text{ kg m}^{-1} \text{s}^{-1} \); speed of the blood flow in a capillary: \( v = 300 \text{ µm s}^{-1} \)
Diameter of a blood capillary: 4 µm

c) A microfluidic channel: density of water: \( \rho = 1000 \text{ kg m}^{-3} \); viscosity of water at 20 °C: \( \eta = 10^{-3} \text{ kg m}^{-1} \text{s}^{-1} \); speed of the flow: \( v = 100 \text{ µm s}^{-1} \); microchannel dimensions: width: 10 µm; height: 10 µm

d) A river of depth 10 m and width 100m, \( \rho = 1000 \text{ kg m}^{-3} \); viscosity of water at 20 °C: \( \eta = 10^{-3} \text{ kg m}^{-1} \text{s}^{-1} \); speed of the flow: \( v = 50 \text{ km/h} \)

**Exercise 2**
Consider the microfluidic channel below. The temperature is 20°C (293 K). The coloring of the water in the channel is achieved using small molecules (such as rhodamine or anthocyanin) of radius \( r \approx 1 \text{ nm} \).

a) Calculate the time it would take to have both colored mixed.
\( \eta(\text{water at 20°C}) = 10^{-3} \text{ kg m}^{-1} \text{s}^{-1} \)
\( k_B = 1.38 \times 10^{-23} \text{ m}^2 \text{ kg s}^{-2} \text{K}^{-1} \)
b) The flow speed is 400µm/s along the channel. Calculate the distance in the microfluidic channel at which both colors would be mixed.

**Exercise 3:**
Consider the microfluidic diffusive mixer below. The temperature is 20°C.

Calculate the average time it will take to diffuse across the red middle stream for:

a) a protein (r= 5 nm)
b) a Ca²⁺ ion (r= 1,1 Å)
c) Trifluoroethanol (r=2Å)

d) Assuming a flow speed of 400 µm/s, calculate the distance in the microfluidic channels these times correspond to.

e) Trifluoroethanol is often used to denature protein (unfold them into a linear chain of amino acids). Imagine a denatured protein in a trifluoroethanol solution in the middle stream. The two other streams are composed of a normal buffer (composed of ions mostly), where proteins are folded. What would this device allow you to study?