Week 12

Biological Materials and Hybrid Materials

Exercise 1

Answer these questions by true or false:

1. Biological materials are always amorphous
   True/false

2. A protein has a polydispersity index of 1
   True/false

3. Sandwich structures are only used for high-tech applications such as helicopter blades
   True/false

4. A composite material contains always amorphous and crystalline material
   True/false

Exercise 2:

Select the correct answer(s) (more than one answer can be correct)
1. DNA...
   a. is a polymer
   b. is stiff due to the double-helix structure
   c. follows the random coil model
   d. encodes proteins

2. Reinforced composites…
   a. Always contain long fibers
   b. Mechanical properties are given by the reinforcing component
   c. Can produce materials with superior mechanical properties compared to the single components
   d. In biology always contain biominerals as reinforcement
   e.

Exercise 3: Biological materials

a) What are the 3 main polymer classes found in nature?

b) What is the building block (monomer type) for each type in a)? (No need for details on the chemistry)

c) What makes spider silk to be so strong and ductile at the same time?

Exercise 4: **Self-assembly**

The volume v of a linear hydrocarbon chain with n carbon atoms is given by $v = (27.4 + 26.9n) \times 10^{-3}$ nm^3, and its critical chain length is $l_c = (0.154 + 0.1265n)$ nm

An amphiphile has an anionic head-group with an optimum head-group area in aqueous solution of $a_0 = 0.65$ nm^2.

a) What shape of micelles are formed by amphiphiles with linear hydrocarbon tails with $n = 10$?

b) What is the average size and aggregation number of each micelle?

c) What happens if n increases?

Exercise 5. For hierarchical composite materials there seems to exist an optimal number of hierarchical levels, explain why it is not just the more levels the better.

Exercise 6: Give two application examples of composite materials and describe the relevant properties given by its structure.