Exercises: Bioinorganic Chemistry

1. Name all elements of the periodic table relevant in biochemistry!

2. What is meant by the term “bioavailability”? Explain the biological availability of the metals of the alkaline earth and copper group!

3. Name a number of simple inorganic molecules that are of importance in biochemistry!

4. Name examples to illustrate the application potential of bioinorganic chemistry in the following fields!
   a) Biotechnology
   b) Environmental chemistry
   c) Pharmacy
   d) Biomaterials
   e) Inorganic food ingredients

5. In which bioactive materials the following ions can be found? (One example each)?
   a) Mg$^{2+}$
   b) Fe$^{2+}$
   c) Co$^{3+}$
   d) Mn$^{3+}$
   e) Ni$^{2+}$

6) Which ligands are of importance in bioinorganic chemistry?

7) Name and explain three significant properties of ascorbic acid!

8) Name a biochemical process, where molecular oxygen O$_2$ is of importance! Explain the process of the uptake and the cleavage of oxygen using simple reaction equations and draw the structure of the formed complex!

9) How does the transfer of a formal CH$_3^+$-fragment to sulphur during the formation of methionine work?

10) Before the methylation during the methionine synthesis, cobalt forms a diamagnetic, square-planar corrin-cobalt(I)-complex. What is the occupation of the d-orbitals of cobalt?

11) The reaction of NO with an haem-iron(II)-centre yields the {FeNO}$_5$-complex, similar to the pentacyanido-nitrosylferrate(II)-ion in the anti-hypertensive “sodium nitroprusside”, Na$_2$[Fe(CN)$_5$(NO)]·2H$_2$O. Also, the low-spin-configuration is the same. Why is the cyanide-complex a typical NO$^+$-complex with linear nitrosyl ligands, while the haem-complex does not exhibit these features?

12) Where do the numerous methyl substituents in molecules like tocopherol, retinol or carotin originate from?
13) Why are transition metals like Mn, Fe and Cu but not metals like Zn, Al or Ca important for photosynthesis and the respiratory chain?

14) Upon exchange of Zn$^{2+}$ by Co$^{2+}$ in carboxypeptidase A not only the enzymatic activity is preserved but the resulting enzyme is even more active. If that is the case, why does Co$^{2+}$ not occur in nature?

15) What is described by the term “dismutations”? Give an example!

16) Explain the term “model complex” on basis of a selected example!

17) Which spectroscopic methods are of significance in analytical bioinorganic?

18) Which physical processes lead to absorption bands in absorption spectra of metalloenzymes? Which order of magnitude can be expected for the extinction coefficients?

19) The redox-system $A_0^-/A_0$ ($E_0 = -1100$ mV) is a chlorophyll molecule, which acts as a first electron acceptor in the photosystem I, where the electron originates from the excited chlorophyll-cluster $P^{*}_{700}$. Estimate the energy efficiency of this process!

20) Propose a model complex for the photosynthetic cleavage of water in the OEC!

21) Explain the process of the biochemical fixation of nitrogen and compare it to the Haber-Bosch process with regard to the metal atoms involved!

22) Which metal cations are able to bind N$_2$ and why?

23) Which specific properties are characteristic for the metal cation Mg$^{2+}$? Why Mg$^{2+}$ is used as the central atom in chlorophyll?

24) Which different types of binding motifs of molecular oxygen to a metal centre do you know? Which bonding types are realized in proteins responsible for the transport of oxygen?

25) In coordination chemistry, chromium(III) is an important ion. The opposite is true for biochemistry with its redox enzymes and acid-base catalysts. What is the reason?

26) Tungsten often acts as antagonist to molybdenum-containing enzymes. Explain the reasons! Also, name organisms where tungsten is part of enzymes!