Water

1. Why is water so different compared to methane although they have nearly the same molecular weight?
2. What are the main differences between water and methane which has nearly the same molecular weight?
3. What happens during the dissolution of a salt in water?
4. Which properties must a compound have to dissolve in water?
5. What information do you get if you measure the conductivity of a solution?
6. Why is water and ethanol miscible whereas water and oil is not?

Isomerism

7. What is a stereoisomer?
8. What are geometric isomers and give an example?
9. What are enantiomers and give one example?
10. Which features allow an organic compund to be chiral?
11. Why is it so important that a bioactive compound has the correct stereochemistry?
12. Which descriptors are used to define an enantiomer and how do you use them?
13. Draw D-glycerinaldehyde in a Fischer-projection and explain why it is D-compound!
14. What are diastereomers and give an example?
15. What is a meso-compound and give an example?

Kinetics

16. What happens with the reaction rate if the reaction temperature is increased? Give an estimate for the relative value!
17. What happens with the reaction rate if the concentration of the reactants is increased?
18. How does a catalyst influence the reaction rate and what happens to the catalyst? Draw a simple rection coordinate diagram without and with catalyst!
19. What do you measure if you want to determine a reaction rate and explain how you obtain eventually the reaction rate?
20. What is a rate low and give an example?
21. What is the order of a reaction and describe how you determine it?
22. Give the rate law for a first order process and explain what you do to determine the rate constant!
23. Give the rate law for a second order process and explain what you do to determine the rate constant!

24. What is the half-life of a compound (reactant) and does it depend on the concentration of this compound (reactant) in a first order process?
25. What is the half-life of a compound (reactant) and does it depend on the concentration of this compound (reactant) in a second order process?
26. Under which circumstances do reactions occur? Explain all necessary features!
27. What is the activation energy? What happens with the reaction rate if the activation energy is high?
28. Draw a simple reaction coordinate diagram and explain which information is given in it in detail!
29. Why is the reaction rate higher at higher temperatures? Give an explanation based on Maxwell-Boltzmann distribution!
30. What is the Arrhenius equation? Explain the individual parts of the equation!
31. How can the activation energy be determined? Give a detailed description!
32. What is an elementary process with regard to reaction mechanisms?
33. What determines the reaction rate in a multistep mechanism?

Lipids

34. Which four groups of bioorganic compounds are lipids?
35. What are waxes?
36. What are fats?
37. How can a fat be analyzed and what information is obtained from these analyses?
38. What are saturated and unsaturated fatty acids? In which configuration do unsaturated fatty acids occur and what property is effected by that?
39. What is the difference between a fat and an oil how is it caused on a structural point of view? Can an oil be transformed into a fat and in case how?
40. Why are unsaturated fats less stable than saturated ones?
41. What is a saponification of a fat?
42. What is a soap and why does it have a cleaning effect? What general property must a detergent have?
43. What is a phosphoglyceride?
44. What are the special properties of phosphoric acid esters compared to carboxylic and sulfonic acid ester?
45. How does a cell membrane look like schematically?
46. What is a prostaglandin? From which compound are they derived?
47. What are the basic units of terpenes? How many basic units build a diterpene?
48. From which terpene is lanosterine, the precursor of steroids, formed?
49. Draw the chemical structure of natural rubber!

50. What is the core structure of steroids?
51. What information is given by the descriptors α and β in a steroid?
52. Draw the structure of testosterone!
53. Draw the structure of estradiol!
54. What are typical functions of steroids?

Carbohydrates

55. What is the general formula of a carbohydrate and what are its functions?
56. How is a monosaccharide characterized? Name all characteristics!
57. Give the structure of glyceraldehydes! What are the characteristics of this sugar?
58. Give the structure of dihydroxacetone! What are the characteristics of this sugar?
59. How can you determine whether a sugar has D- or L-configuration? Which one will be found in nature generally?
60. Give the structure of D-erythrose! What are the characteristics of this sugar?
61. Give the structure of D-threose! What are the characteristics of this sugar?
62. Give the structure of D-ribose! What are the characteristics of this sugar?
63. Give the structure of D-glucose! What are the characteristics of this sugar?
64. What happens if you reduce a monosaccharide? How is the product called?
65. Draw the chemical scheme for the reaction of glucose with henylhydrazine! How is the product of this reaction called?
66. What happens if you oxidize a monosaccharide with bromine? How is the product called?
67. What happens if you oxidize a monosaccharide with nitric acid? How is the product called?
68. What is the Tollens reagent and for what do you use it?
69. Are sugar stable in basic media?
70. How can you generate a pentose from a tetrose?
71. How can you generate a pentose from a hexose?
72. D-Glucose exists in 2 forms, α and β. Give an explanation for this and draw the structure of the α-form! What is the exact name of this compound!
73. What does the term “mutarotation” mean?
74. Why does an essential part of glucose exist in equilibrium in the α-form although the β-form should be much more stable due to steric effects?
75. What happens if you react a monosaccharide with an alcohol? Do the products still mutarotate?
76. Give the structure of β-D-maltose! What are the characteristics of this sugar?

77. Give the structure of β-D-cellobiose! What are the characteristics of this sugar?
78. Of which two sugars is lactose formed? Where does it occur in nature? What are its characteristics?
79. Of which two sugars is sucrose (table sugar) formed? Where does it occur in nature? What are its characteristics?
80. What is the difference between starch and glycogen?
81. What is cellulose? Give its structure!
82. What are glycoproteins and what is a very important function of them?
83. What are cyclodextrins, how are they characterized, and for which application are they used?

Amino Acids

84. How do naturally occurring amino acids which form proteins look like? Give a general formula in Fischer projection and describe which configuration they have!
85. Why are amino acids zwitterions?
86. What is the isoelectric point? How can you calculate this point?
87. How do side groups effect the acid-base behaviour of amino acids?
88. Explain the principles of electrophoresis!
89. Explain the principle of ion exchange chromatography!
90. How can mixtures of amino acids be separated and what is the resolution criteria?
91. Give a defined example for an amino acid with aliphatic side chain!
92. Give a defined example for an amino acid with a hydroxyl group in the side chain!
93. Give a defined example for a sulphur containing amino acid!
94. Give a defined example for an acidic amino acid!
95. Give a defined example for a basic containing amino acid!
96. Draw the chemical structure of natural phenylalanine in Fischer projection!
97. Give an example for an amino acid with an amide group in the side chain!
98. What types of abbreviations are used to name amino acids?
99. What is the primary structure of a peptide and how do you describe it without giving the chemical structure? At which end do you begin with the description?
100. How can peptides be synthesized? Give all necessary steps!
101. How can peptides be analyzed?
102. What is the Edman degradation?
103. How can you cut a peptide at defined bonds into smaller pieces?
104. By which interactions is the tertiary structure of a protein defined?

Nucleic Acids 1

105. What is a nucleotide? Give the chemical structure of one!
106. What is a nucleoside? Give the chemical structure of one!
107. Explain in terms of chemical structure how the interaction between A and T in DNA takes place!
108. Explain in terms of chemical structure how the interaction between G and C in DNA takes place!
109. How can purines and pyrimidines be synthesized?
110. Explain the principle of chemical RNA synthesis!

Nucleic Acids 2

111. Describe how the nature of DNA as the "molecule of heritage" was discovered by the Hershey-Chase experiment.
112. Explain the linkages in a DNA-single strand, and number the C-atoms of the desoxyribose which contribute to the linkage.
113. Why is G=C and A=T in DNA valid?
114. Explain the structure of DNA, and the topology of the double helix.
115. Explain the denaturation of DNA, and explain how the G/C content influences it.
116. Describe the polymerase chain reaction. What detection made the process generally applicable?
117. Explain the terms gene and genome, and coding vs. noncoding DNA. Which elements contribute to the latter?
118. What is a plasmid?
119. Explain the structure of a gene. Why are the 5' and 3' noncoding sequences important for the function of a gene?
120. Explain the structure of mRNA, rRNA and tRNA.
121. Compare DNA and RNA, and list at least three differences.
122. Explain the "dogma" of biochemistry
123. What is "transcription"? How does it occur?
124. What is translation, what does it require and where does it occur?
125. Explain the structure of a ribosome.
126. Explain the structure of the transfer-RNA, and how it confers specificity between the genetic code and the amino acid sequence of protein.
127. What is the "genetic code", and why does it "wobble"?

Proteins

128. Explain the "peptide bond". How does it influence the structure of the final protein?
129. Explain alpha-helix, beta-sheet and loops – how do these structures arise?
130. Explain the terms "motif" and "domain" in protein structures.
131. List the three most common types of protein motifs and explain their structure.
132. What is the Greek Key motif.
133. Explain the structure of alpha-domain proteins. Give examples. What stabilizes their structure?

134. Twisted-sheet vs. closed barrel – explain how these structures arise.
135. Explain antiparallel ß-sheets, and give examples. Which structures can be formed and why?
136. What is “denaturation of a protein”? Give an example.
137. Explain the process of denaturation of a protein on the basis of –S-S-groups in proteins.
138. Why are some proteins glycosylated, and which linkages to do carbohydrates occur?
139. Explain the structure of keratin.
140. Explain the structure of collagen.
141. Explain the 3D-structure of immunoglobulins.
142. Provide a brief sketch of the immune response.

Enzymes

143. What is a catalyst? What is an enzyme? Explain and compare
144. Explain the function of an enzyme and highlight the importance of the activation energy
145. Explain how an enzyme can reduce the activation energy for a reaction
146. What are cofactors? Give examples.
147. 130. What are coenzymes and how can they be grouped? Give at least 3 examples for each group.
148. What is the active center of an enzyme?
149. Explain the “transition state” of an enzymatic reaction.
150. Name the six classes of enzymes, and give examples for at least three classes
151. Describe the nomenclature of enzymes
152. Explain the Michaelis-Menten equation: which simplifications made its derivation possible, and what can be deduced/calculated from it?
153. A lipase has a Km of 0.1 mM and a Vmax of 50 U/mg for triacylglycerol. What activity will be obtained at a substrate concentration of 0.5 mM?
154. What does the Michealis-Menten constant mean to biochemistry? How can it be used?
155. Explain the estimation of Km and Vmax by the Lineweaver Burk plot
156. Explain the turn over number and specificity constant of an enzyme
157. Explain why an enzyme’s activity is temperature dependent
158. Explain why an enzyme’s activity is pH-dependent
159. List and explain different types of enzyme inhibition.
160. Compare competitive vs. non-competitive inhibition. How can the two be distinguished in an experiment?
161. Describe how irreversible enzyme inhibition works
162. 142. Explain the allosteric behaviour of an enzyme.
163. Explain the biological function of enzymes and how they can be controlled.
164. Give at least 5 examples for industrial enzymes.
165. Explain the term ‘protein engineering’.

Metabolism

166. Explain and compare the principles of catabolism and anabolism. How do coenzymes aid in these processes?

167. Explain the “steady state equilibrium” of metabolism. What generates the flow into one direction?
168. What is an “energy rich compound”, and why is it needed for metabolism. Explain on behalf of ATP.
169. Explain different types of transport across membranes.
170. Explain uniport, symport and antiport
171. Explain “active transport” – how does it work?
172. What are NAD and NADP, and how are they involved in metabolism?
173. What are vitamins, and how are they related to coenzymes?
174. What is glycolysis? (Describe in words).
175. What is the citric acid cycle? Describe its characteristics.
176. What is the respiratory chain and what is the principle of its function.
177. How can ATP be synthesized?
178. Via which pathways can glucose metabolism occur? What are the limitations and benefits of the separate pathways?
179. Compare energy metabolism in red and white muscle fibers.
180. How is metabolism regulated?
181. Explain the regulation of metabolism at the level of gene expression – how does it work?
182. What is regulation by covalent modification? Give an example.
183. What is regulation by non-covalent modification? Give an example.
184. What is a signal transduction cascade?
185. Explain how metabolism can be regulated by feedback inhibition. Why are allosteric enzymes involved as targets?