Questions with Answers - Amino Acids & Peptides

A. Two of the common amino acids are analyzed. Amino acid X and amino acid Y both have an isoionic point in the range of 5.0-6.5 (Questions 1-4)

1._____ Which **must** be a characteristic of both amino acid X and amino acid Y?

a) Each molecule must contain two stereogenic centers.
b) ***Each molecule must have an R-group that is uncharged at pH=7.0.***
c) Each molecule must have an R-group that absorbs light at 280 nm.
d) Each molecule must react with ninhydrin to form a yellow product.

2._____ Which **could** be characteristics of these two amino acids?

a) ***Amino acid X could have two pKa values while amino acid Y could have three pKa values.***
b) Amino acid X could contain a phenyl group while amino acid Y could contain an imidazole group.
c) Amino acid X could contain a basic R-group while amino acid Y could contain an acidic R-group.
d) Amino acid X could exist in only two different forms between pH=1.0 and pH=14.0 while amino acid Y could exist in three different forms.

3._____ Which **could** happen if amino acid X is titrated with NaOH from pH=1 to pH=14?

a) X could have a pKa value greater than 7.0 for a non-polar R-group.
b) X could have a pKa value less than 7.0 for a polar R-group.
c) ***X could have a charge of +1 at low pH and a charge of -2 at high pH.***
d) X could have a charge of +2 at low pH and a charge of -1 at high pH.

4._____ Which **must** happen if amino acid Y is titrated with NaOH from pH=1 to pH=14?

a) Y must exist entirely in the fully protonated form at the lowest half-equivalence point.
b) Y must exist entirely as a zwitterion at the pKa value closest to pH=7.0.
c) Y must have equivalence points around pH=2.0 and pH=9.0.
d) ***Y must undergo deprotonation of a carboxyl group and an amino group.***

B. Two of the common amino acids are analyzed. At pH = 7.0, amino acid X is negatively charged while amino acid Y is positively charged. (Questions 5-8)

5._____ Which property will be shared by amino acid X and amino acid Y?

a) Both amino acids will contain a carboxyl group and an amide group.
b) Both amino acids will be optically active D-stereoisomers.
c) Both amino acids will have a polar aromatic R-group.
d) ***Both amino acids will react with ninhydrin to form a blue/purple color.***

6._____ Which will be a characteristic of amino acid X?

a) It will have three pKa values, two of which occur above pH = 7.0.
b) ***It will have only one isoionic point which is found below pH = 7.0.***
c) It will be fully protonated at pH = 1.0 with a net charge of +2.
d) It will be fully deprotonated at pH = 14 with a net charge of -1.

7._____ Which could happen if amino acid Y is titrated with NaOH?

a) ***It could have half-equivalence points around pH = 2, 9, and 10.***
b) It could exist in three different forms as it is titrated from pH = 1.0 to pH = 14.0.
c) It could exist entirely in its zwitterion form at one of its pKa values.
d) It could exist partially in its zwitterion form at one of its equivalence points.

8._____ Which will be a difference when comparing amino acid X and amino acid Y?

a) One of the amino acids could have only 2 pKa values while the other could have 3 pKa values.
b) One of the amino acids could have a guanidino group while the other could have an imidazole group.
c) ***One of the amino acids could contain two carboxyl groups while the other could contain two amino groups.***
d) One of the amino acids could contain an acidic R-group while the other could contain a neutral R-group.

C. The amino acid arginine contains a guanidino R-group and has pKa values of 2.2, 9.0, and 12.5. A sample of arginine is titrated from pH=1.0 to pH=14.0 with NaOH. (Questions 9-16).

9._____ Which form of arginine will exist at some point during the titration?

a) ***a form in which the carboxyl group is deprotonated while the amino group and the guanidino group are both protonated***
b) a form in which the carboxyl group is protonated while the amino group and the guanidino group are both deprotonated
c) a form in which the amino group is deprotonated while the carboxyl group and the guanidino group are both protonated
d) a form in which the amino group is protonated while the carboxyl group and the guanidino group are both deprotonated

10._____ At pH=2.2,

a) all of the amino acid molecules will be in the fully protonated form.
b) ***half of the amino acid molecules will be in the fully protonated form.***
c) all of the amino acid molecules will be in the zwitterion form.
d) half of the amino acid molecules will be in the zwitterion form.

11._____ At pH=12.5,

a) half the amino acid molecules have a -2 charge.
b) all the amino acid molecules have a -2 charge.
c) ***half the amino acid molecules have a -1 charge.***
d) all the amino acid molecules have a -1 charge.

12._____ At pH=9.0, **all** the amino acid molecules will contain

a) the amino group in its conjugate base form.
b) the carboxyl group in its conjugate acid form.
c) ***the guanidino group in its conjugate acid form.***
d) all three functional groups in their conjugate base forms.

13._____ For arginine molecules at pH=14,

a) all the ionizable groups will be charged.
b) all the guanidino groups will be charged.
c) all the amino groups will be charged.
d) ***all the carboxyl groups will be charged.***

14._____ What is the isoelectric point of arginine?

a) 5.60
b) 7.00
c) 7.90
d) ***10.75***

15._____ A solution with a pH of 2.2 contains 6.0 mmol of arginine. If 12.0 mmol of NaOH is added to the solution, what will be the pH after the NaOH has completely reacted with the arginine?

a) 14.00
b) ***12.50***
c) 10.75
d) 5.60

16._____ Which property is shared by both arginine and aspartate as each is titrated with NaOH from pH=1.0 to pH=14.0?

a) ***Both will require the same number of NaOH equivalents to complete the titration.***
b) Both will have the same number of equivalence points at the same pH values.
c) Both will have the same net charge at pH=1.0.
d) Both will have the same net charge at pH=14.0.

D. The amino acid tyrosine contains a phenolic R-group and has pKa values of 2.2, 9.0, and 10.2. A sample of tyrosine is titrated from pH = 1.0 to pH = 14.0 with NaOH. (Questions 17-24).

17._____ At which pH will all the amino acid molecules be in their fully protonated form?
a) ***1.0***
b) 2.2
c) 5.6
d) 9.0

18._____ At which pH will half the amino acid molecules be in their zwitterion form?
a) 5.6
b) ***9.0***
c) 9.6
d) 10.2

19._____ At which pH will half the amino acid molecules have a +1 charge?
a) 10.2
b) 9.0
c) ***2.2***
d) 1.0

20._____ At which pH will all the amino acid molecules have a -1 charge?
a) 12.0
b) 10.2
c) ***9.6***
d) 5.6

21._____ What is the isoelectric point of tyrosine?
a) 9.6
b) 7.1
c) 6.2
d) ***5.6***

22._____ For a solution of tyrosine molecules at pH = 10.2
a) all the α-carboxyl groups will be uncharged.
b) ***all the α-amino groups will be uncharged.***
c) all the phenolic R-groups will be uncharged.
d) all the ionizable groups will be uncharged.

23._____ A solution contains 6.0 mmoles of tyrosine. After adding 1.5 equivalents of NaOH, the pH of the solution is measured at 9.6. What was the original pH of the solution before the NaOH was added?

a) 1.0
b) ***2.2***
c) 5.6
d) 9.0

24._____ Which property is shared by both tyrosine and tryptophan?

a) Both have an R-group with a pKa value.
b) Both have the same number of equivalence points when titrated.
c) Both have the same net charge at very high pH.
d) ***Both have the same net charge at very low pH.***

E. A tetrapeptide has four pKa values and a pI of 3.5. (Questions 25-28)

25._____ Which describes the peptide bonds in this peptide?

a) The molecule contains four peptide bonds with partial double-bond character.
b) The molecule contains four peptide bonds that can become protonated.
c) ***The molecule contains three peptide bonds that have planar geometry.***
d) The molecule contains three peptide bonds that rotate between cis and trans forms.

26._____ How many amino acids in the peptide have an ionizable R-group?

a) one
b) ***two***
c) three
d) four

27._____ Which will be a property of this peptide?

a) ***The peptide will have a charge of +1 when fully protonated.***
b) The peptide will have a charge of -2 when fully deprotonated.
c) The peptide will be cleaved into two dipeptides by V8 protease.
d) The peptide will be cleaved into two dipeptides by dithiothreitol.

28._____ Which is a possible sequence for this peptide?

a) His-Lys-Asp-Glu
b) His-Val-Asp-Ala
c) Leu-Gly-Asp-Trp
d) ***Leu-Tyr-Asp-Phe***

C. A peptide has the sequence Lys-Arg-Gln-Asp-Cys (lysine-arginine-glutamine-aspartate-cysteine). (Questions 29-31)

29._____ Which describes the peptide bonds in this peptide?

a) All the peptide bonds are covalent amide bonds with tetrahedral geometry.
b) All the peptide bonds have free rotation around the carbon-nitrogen bond.
c) All the peptide bonds can be deprotonated when titrated with NaOH.
d) ***All the peptide bonds have partial double-bond character and trans configuration.***

30._____ Which reagent would be able to cleave this peptide into a tetrapeptide and a single amino acid?

a) a reagent that cleaves on the carboxyl side of sulfur-containing amino acids
b) ***a reagent that cleaves on the carboxyl side of acidic amino acids***
c) a reagent that cleaves on the carboxyl side of basic amino acids
d) a reagent that cleaves on the carboxyl side of aromatic amino acids

31._____ Which is a property of this peptide?

a) It has 5 pI values.
b) It has 5 pKa values.
c) ***It has a charge of +3 at pH = 1.0.***
d) It has a charge of -2 at pH = 14.0.