

MCB102 Midterm I answer Key. Note that question 10 is worth 18 points and question 11 is worth 9 points.

- $pK = pK_a + \log\left[\frac{\text{uncharged His}}{\text{charged His}}\right]$
 $8.0 = 6.0 + \log\left[\frac{\text{uncharged His}}{\text{charged His}}\right]$
 $2 = \log\left[\frac{\text{uncharged His}}{\text{charged His}}\right]$
 $100 = \left[\frac{\text{uncharged His}}{\text{charged His}}\right]$

right formula, 2 points. calculation error: -2 points, since if calculation is wrong, then the interpretation is wrong also.
Interpretation error only: - 1 point.
- $\Delta G = -2.3 RT \log K'_{eq} = -2.3 \cdot 8.3 \text{ J/molK} \cdot 298\text{K} \cdot 3 = -17.1 \text{ kJ/mol}$

breakdown: formula, 2 points, procedures, 1 point, and results, 1 point.
- (a). ganglioside GM2. (1 point)
If ganglioside was missing (only put GM2), then minus 1 point.

(b). phosphatidyl choline (1 point)
either part of the full name was missing, -1 point.

(c) aspartate or Asp, D (1 point) (d) arginine or Arg, R (1 point)

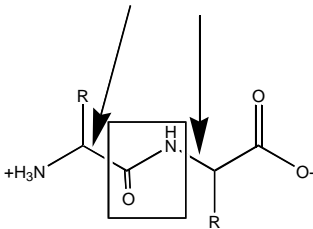
(e) Tyrosine or Tyr, Y (1 point)
for c-e missing either three letter (or full name) or 1 letter code, minus 0.5-1 point

(f) Sucrose (1 point)

(g) Tay-Sachs or mental retardation (1 point)

(h) cell membrane, or phospholipid bilayer (1 point); lipid, 0 credit, b/c it's not cellular structure.

(i) nerve cells, nervous cells, brain cells, ganglion cells (1 point), no credit for other type of cells: blood cells, fat cells, etc.
- 1 point/arrow pointing to free rotation, 2 point for box around peptide bond.



- a. Glycine repeat every third amino acid (2 points).

b. Because the glycines are small and fit very close together in a triple helix (3 points)
because of its size, full credit. something about flexibility 2 points. if they said something about h-bonding or the simple "so the helix can form" 1 point.

c. hydroxyproline or 4-hydroxyproline (1 point).
if you put proline and then explained that proline is rare in helices, 0.5 points, if just proline, 0.

d. ascorbate or vitamin C (1 point).

e. Scurvy or symptom (1 point).

6. (a) K (1 point)
 (b) YRGMDIKQMKFAMK (3 points)

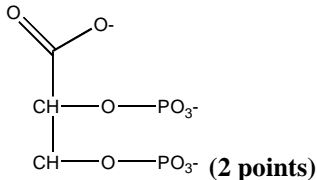
7. Proteins are denatured and bound to SDS, so that they have similar charge/mass ratios. They travel towards the positive pole. The gel matrix impedes the larger proteins more, so they migrate more slowly (4 points). many people just said the smaller ones run quicker and left it at that. that's -1. if they started talking about 2D gels or page as a purifications scheme they lost points. any other minor errors (large proteins go faster, sds breaks disulfides, etc) lost a point.

8. a-c: (1 point each plot)

Plot a is in the middle and sigmoidal, plot c is on the right and also sigmoidal, plot b is on the left, it is hyperbolic and starts at the origin. X-axis= pO₂, Y-axis = θ .

-1 point if b plot show even a little sigmoidal shape.

d. O=C=O (1 point), H⁺ (1 point)



draw means draw. if you didn't (or couldn't correctly) draw CO₂, -1. for 2,3-bpg if you drew it as an aldehyde, -0.5, if you drew it as an alcohol, -1. anything further -2.

e. The slope of the Hill plot would increase. The Hill coefficient would increase because this coefficient is a measure of cooperativity (3 points).

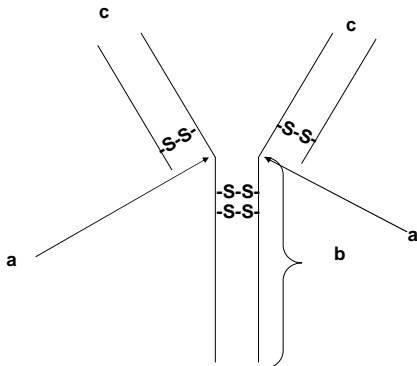
if you said they increase, full credit.

f. The R-state is favored, because a potential ionic bond that stabilizes the T state is removed (2 points). r-state= full credit, anything else = 0

g. The Bohr effect will be decreased (4 points).

h. The carbamation of hemoglobin is not affected because it occurs at the amino terminus of α and β chains. The Cowtown mutation affects only the carboxyl terminus of the β chain (2 points).

9



a. I was very strict about them pointing out exactly where the cleavage was (1 or 0)

b. (1 point)

c. (2 points) 1 point for each binding site

d. Antiparallel β -sheet. (2 points) -1 if they didn't put "antiparallel"

e. Use anion exchange. DEAE would be one example. IgG should adhere poorly. Alternatively, cation exchange. Phosphocellulose and carboxymethyl cellulose would be examples. IgG should bind strongly (2 points).

1 point if you said any of the following words and didn't say too many completely incorrect things: cation exchange, anion exchange, ion exchange, DEAE, phosphate or phosphocellulose, carboxymethyl or carboxymethyl cellulose. 1 point if you stated that IgG was positive and/or whether it would bind (cation exchange) or not bind (anion exchange)

10 a. keywords: V_{max} is lower (+1) y-intercept goes up (+1) y-intercept = $1/V_{max}$ (+1)

K_m is the same (+1) x-intercept doesn't change (+2) x-intercept = $-1/K_m$ (+2 or +1 if they don't have the negative sign)

If you had some equations or notation on the graph which indicated you weren't just guessing, you would get some points for the explanation. If you said something totally wrong, like there was inhibition, you would lose more points.

b. keywords: k_{cat} is lower (or matching answer to part a, +1) k_{cat} is proportional to V_{max} (+2 or +1 if they only say that k_{cat} is dependent on V_{max})

Instead of writing, you could just put the equation, but would lose points if the equation was wrong.

c. 1 point for K_d is the same (or matching answer to part a).

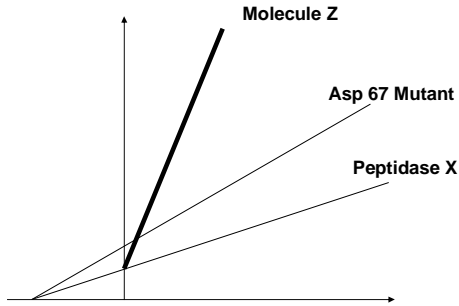
$K_m = (k_2 + k_{-1})/k_1$, $K_d = k_{-1}/k_1$, because $k_2 \ll k_{-1}$ $K_d = K_m$

1 point for saying or showing why disappearance of k_2 in K_m equation, 1 point for recognizing that K_d is related to K_m .

many people thought K_d was K_m or K_1 or K_{-1} , so they had to spell everything out for this part to get credit. If they didn't use K_d or show the equation for K_d , they wouldn't get any points. If they got all the stuff about K_d and K_m being equal, but never actually answer the question and say that K_d is the same, they would lose points.

d. Competitive inhibitor (1 point) , 0.5 point for valine side chain, 0.5 point for will not cleave because there is no peptide bond.

e. (2 points)



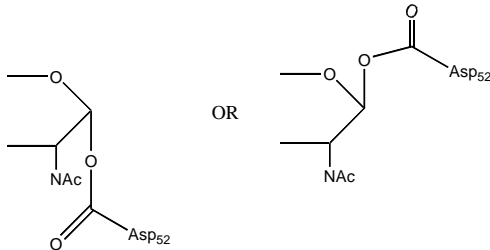
had to match answer in part d. only partial credit was if they got the right x- or y-intercept, but the slope was lower instead of higher than wild-type.

11 a. The Asp side chain is charged. The Glu side chain is not. (2 points)

no partial credit. If they didn't explicitly answer the question or if their answer was ambiguous, no credit was given.

b. 1 point for saying that nearby hydrophobic or polar side chains affected the pKa. 2nd point awarded if they went further and said that this is because of stabilization of the protonated form.

c. 1 point for drawing a carboxylate. 1 point for Asp52". 1 point for stereochemistry. 2 points for attaching the carboxylate to the right carbon.



If it didn't look exactly like the key, they didn't get full credit. If there was something very chemically wrong with the structure, they would lose points.

12 Some people gave two answers to the questions. For a through c, this meant that they got no points.

a. N-acetyl glucosamine (1 point). 1/2 point if they wrote either N-acetyl <something wrong> or <something wrong> glucosamine.

b. galactose (1 point)

c. galactose (1 point)

d. 1 point for alpha, 1 point for 1->3. For d and e if they had the right linkage but then said something like "galactosidic bond" they would lose a point.

e. 1 point for beta, 1 point for 1->4. same grading as for part d.