This exam is composed of 20 questions.

As discussed in the course syllabus, honesty and integrity are absolute essentials for this class. In fairness to others, dishonest behavior will be dealt with to the full extent of University regulations.

I hereby state that all answers on this exam are my own and that I have neither gained unfairly from others nor have I assisted others in obtaining an unfair advantage on this exam.

Signature

PERIODIC TABLE OF THE ELEMENTS

<table>
<thead>
<tr>
<th>1A</th>
<th>2A</th>
<th>3B</th>
<th>4B</th>
<th>5B</th>
<th>6B</th>
<th>7B</th>
<th>8B</th>
<th>8B</th>
<th>8B</th>
<th>1B</th>
<th>2B</th>
<th>3A</th>
<th>4A</th>
<th>5A</th>
<th>6A</th>
<th>7A</th>
<th>8A</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>1</td>
<td>1.008</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Li</td>
<td>3</td>
<td>6.939</td>
<td>9.012</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Na</td>
<td>11</td>
<td>22.99</td>
<td>24.31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>19</td>
<td>39.10</td>
<td>40.08</td>
<td>44.96</td>
<td>47.90</td>
<td>50.94</td>
<td>53.00</td>
<td>55.85</td>
<td>58.93</td>
<td>63.55</td>
<td>65.39</td>
<td>69.72</td>
<td>72.61</td>
<td>74.92</td>
<td>78.96</td>
<td>79.90</td>
<td>83.80</td>
</tr>
<tr>
<td>Be</td>
<td>4</td>
<td>9.012</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mg</td>
<td>12</td>
<td>24.31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ca</td>
<td>20</td>
<td>39.10</td>
<td>40.08</td>
<td>44.96</td>
<td>47.90</td>
<td>50.94</td>
<td>53.00</td>
<td>55.85</td>
<td>58.93</td>
<td>63.55</td>
<td>65.39</td>
<td>69.72</td>
<td>72.61</td>
<td>74.92</td>
<td>78.96</td>
<td>79.90</td>
<td>83.80</td>
</tr>
<tr>
<td>Sc</td>
<td>21</td>
<td>44.96</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ti</td>
<td>22</td>
<td>47.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>23</td>
<td>50.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cr</td>
<td>24</td>
<td>53.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mn</td>
<td>25</td>
<td>55.85</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fe</td>
<td>26</td>
<td>58.93</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Co</td>
<td>27</td>
<td>63.55</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ni</td>
<td>28</td>
<td>65.39</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cu</td>
<td>29</td>
<td>69.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zn</td>
<td>30</td>
<td>72.61</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ga</td>
<td>31</td>
<td>74.92</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ge</td>
<td>32</td>
<td>78.96</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>As</td>
<td>33</td>
<td>79.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Se</td>
<td>34</td>
<td>83.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Br</td>
<td>35</td>
<td>86.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kr</td>
<td>36</td>
<td>88.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 5B | 6B | 7B | 8B | 8B | 8B | 1B | 2B | 3A | 4A | 5A | 6A | 7A | 8A |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| B  | 13 | 10.81 |
| C  | 14 | 12.01 |
| N  | 15 | 14.01 |
| O  | 16 | 16.00 |
| F  | 17 | 19.00 |
| Ne | 18 | 20.18 |
| Al | 19 | 26.98 |
| Si | 20 | 28.09 |
| P  | 21 | 30.97 |
| S  | 22 | 32.07 |
| Cl | 23 | 35.45 |
| Ar | 24 | 39.95 |
| Rb | 37 | 85.47 |
| Sr | 38 | 87.62 |
| Y  | 39 | 88.91 |
| Zr | 40 | 91.22 |
| Nb | 41 | 92.91 |
| Mo | 42 | 95.94 |
| Tc | 43 | 99.00 |
| Ru | 44 | 101.1 |
| Rh | 45 | 102.9 |
| Pd | 46 | 106.4 |
| Ag | 47 | 107.9 |
| Cd | 48 | 111.8 |
| In | 49 | 114.8 |
| Sn | 50 | 118.7 |
| Sb | 51 | 121.8 |
| Te | 52 | 127.6 |
| I  | 53 | 126.9 |
| Xe | 54 | 131.3 |
| Cs | 55 | 132.9 |
| Ba | 56 | 137.3 |
| La | 57 | 138.9 |
| Hf | 58 | 178.5 |
| Ta | 59 | 181.0 |
| W  | 60 | 183.8 |
| Re | 61 | 186.2 |
| Os | 62 | 190.2 |
| Ir | 63 | 192.2 |
| Pt | 64 | 195.1 |
| Au | 65 | 197.0 |
| Hg | 66 | 200.6 |
| Tl | 67 | 204.4 |
| Pb | 68 | 207.2 |
| Bi | 69 | 209.0 |
| Po | 70 | 210.0 |
| At | 71 | 211.0 |
| Rn | 72 | 222.0 |
| Fr | 87 | 226.0 |
| Ra | 88 | 227.0 |
|  | 89 | (261) |
|  | 90 | (262) |
|  | 91 | (263) |
|  | 92 | (264) |
|  | 93 | (265) |
|  | 94 | (266) |

D-glucose

β-D-Glucose
1. (5 points) Which listing below correctly orders the boiling points of the indicated molecules?
   1) 1-butanol > propanoic acid > diethyl ether
   2) diethyl ether > propanoic acid > 1-butanol
   3) 1-butanol > diethyl ether > propanoic acid
   4) propanoic acid > 1-butanol > diethyl ether
   5) propanoic acid > diethyl ether > 1-butanol

   **think about what H-bonding opportunities are available for each. How can that molecule interact with another of itself?**

   **(4) acid > alcohol > ether (all have about the same MW) (Chptr 18)**

2. (5 points) The products of the following reaction are:

   \[
   \text{CH}_3\text{COCH}_3 + \text{NaOH} \rightarrow
   \]

   1) methanol and sodium formate
   2) methanol and sodium acetate
   3) sodium propanoate and water
   4) sodium acetate and formaldehyde
   5) none of the above

   **(2) hydrolysis of an ester Chapter 19, p 480 / Quiz 2**
3. (5 points) Which two reactants would lead to the Fischer esterification reaction intermediate shown at right?
   1) butanal and formic acid
   2) butanoic acid and methanol
   3) propanoic acid and methanol
   4) 1-butanone and formic acid
   5) none of the above

   ![Intermediate structure]

   (3) OWL 18.5e / Quiz 2

   You might have remembered that Fischer esterifications involve an attack by an alcohol on a carboxylic acid, but if you didn’t, the other reactions won’t lead to intermediates of this sort. An alternative view of the above is:

   ![Alternative view structure]

4. (5 points) Nylon-66, shown below, is an example of what kind of polymer?

   ![Nylon-66 structure]

   1) polyester  2) polycarbonate  3) polyamide  4) polyacrylate

   (3) (Chptr 19) Amide linkage: \[
   \begin{align*}
   &\text{poly-amide} \\
   \end{align*}
   \]

5. (5 points) The reactions of gluconeogenesis are simply the reactions of glycolysis run in reverse
   1) True
   2) False

   (2) False (OWL 29.2) Perhaps the primary “key concept” we talked about in this section!
6. (5 points) The reaction of butanoic acid and LiAlH$_4$ in water yields:

1) CO$_2$ and propanal
2) CO$_2$ and propanoic acid
3) water and butanal
4) water and butanol
5) nothing. No reaction occurs.

Remember that LiAlH$_4$ is a reductant or H$^-$ donor. The only thing that can be readily reduced is the C=O double bond. You can simply add to H’s across the double bond, or you can think about attack by H$^-$. 

$$\text{CH}_3\text{CH}_2\text{OH} \rightarrow \text{CH}_3\text{CH}_2\text{OH} + 2\text{H}^+$$

OWL 18.5d / Quiz 2

7. (5 points) Which of the following is/are aldose(s)?

1) CHO  
2) CH$_2$OH  
3) Both  
4) Neither

(1) The first one is. see p 494 and OWL 20.1b

**Aldose \rightarrow Aldehyde. Look for the one with the aldehyde (Quiz 2)**

8. (5 points) Heating the molecule at right yields which products?

1) propanoic acid and carbon dioxide
2) acetic acid and propanoic acid
3) 2-butane and carbon dioxide
4) butanoic anhydride
5) no reaction occurs

(3) decarboxylation of $\beta$-ketocarboxylic acid (Chptr 18). There is a nice presentation of this on p. 468 of the text, using almost exactly this molecule.
9. (5 points) In metabolism, CoA-SH usually reacts directly with

1) alcohols  
2) esters  
3) anhydrides 
4) carboxylic acids  
5) water

(4) (Chapter 27) This is what CoA-SH does for a living – key concept!

10. (5 points) In the Citric Acid cycle, succinate reacts with FAD. In this reaction, succinate:

1) isomerizes  
2) is phosphorylated  
3) is dephosphorylated  
4) is oxidized  
5) is reduced

(4) (Chapter 27) – FAD is an oxidant – key concept!

11. (5 points) The negatively charged molecule carbonylcyanide-p-trifluoromethoxyphenylhydrazone (FCCP) binds to H⁺ ions in the mitochondrial intermembrane space and transports them across the inner membrane to the matrix. FCCP thus is toxic because it:

1) prevents electron flow to dioxygen  
2) leads to the build up of lactic acid  
3) prevents synthesis of ATP via the proton translocating ATPase  
4) leads to excess protonation of acetyl-CoA  
5) inhibits phosphorylation of glucose

(3) (OWL 27.6) – H⁺ gradient drives ATP synthesis in respiration – a key concept!

12. (5 points) Which listing below contains only hydrophobic amino acids?

1) Ile, Leu, Val, Phe  
2) Met, Asn, Pro, Leu  
3) Arg, Glu, Asp, Lys  
4) Arg, Glu, Val, Phe  
5) Met, Asn, Asp, Lys

(1) Chptr  22 – look at the side chains (front page of exam). Nonpolar groups aren’t charged and can’t hydrogen bond – key concept!
13. (5 points) Which fatty acid below is not of natural origin?

1) 

2) 

3) Neither are of natural origin
4) Both are of natural origin

(2) – 11 carbons – even number (Chptr21) – key concept.
Do you remember why?

14. (5 points) ATP is often hydrolyzed in order to drive unfavorable reactions. Another important and very common role for ATP that does not involve hydrolysis is:

1) reduction of carboxylic acids
2) oxidation of alcohols
3) phosphorylation of alcohols
4) oxidation of primary amines
5) cyclization of sugars

(3) Chptr 28 – Remember we talked about two key roles for ATP?

15. (5 points) What force is most dominant in driving a protein from an ensemble unfolded of states to a compact globular structure?

1) hydrophobic collapse
2) hydrogen bonding
3) disulfide bonding
4) formation of helices
5) electrostatic attraction between charged amino acid side chains

(1) Chptr 22– This is a key concept in protein folding. Oil/water et al.
16. (5 points) In the Citric Acid cycle, which is a product of the reaction of malate (shown at right) with NAD$^+$? (You are not expected to know this from memory)

![Reaction Diagram]

1) 2) 3)

(3) (Chptr 28)

17. (5 points) Which is a stable product of the following reaction?

![Reaction Diagram]

1) 2) 3)

(1) (Chptr 22 & 19)

18. (5 points) For the fatty acid at right, which is the structure of the product resulting from one complete round of β-oxidation?

![Fatty Acid Diagram]

1) 2) 3) 4) 5)

(1) (2 carbons shorter) (Chptr 28)
19. (5 points) Draw the Fischer projection corresponding to the linear form of the molecule shown at right.

Chapter 20

20. (5 points) What is the course number of this class?

1) 111 2) 250 3) 496 4) 728

(2)