

NAME \_\_\_\_\_ **KEY** \_\_\_\_\_

Student number \_\_\_\_\_

hydrogen 1 <b>H</b> 1.0079																	helium 2 <b>He</b> 4.0026	
lithium 3 <b>Li</b> 6.941	beryllium 4 <b>Be</b> 9.0122											boron 5 <b>B</b> 10.811	carbon 6 <b>C</b> 12.011	nitrogen 7 <b>N</b> 14.007	oxygen 8 <b>O</b> 15.999	fluorine 9 <b>F</b> 18.998	neon 10 <b>Ne</b> 20.180	
sodium 11 <b>Na</b> 22.990	magnesium 12 <b>Mg</b> 24.305											aluminum 13 <b>Al</b> 26.982	silicon 14 <b>Si</b> 28.086	phosphorus 15 <b>P</b> 30.974	sulfur 16 <b>S</b> 32.065	chlorine 17 <b>Cl</b> 35.453	argon 18 <b>Ar</b> 39.948	
potassium 19 <b>K</b> 39.098	calcium 20 <b>Ca</b> 40.078	scandium 21 <b>Sc</b> 44.956	titanium 22 <b>Ti</b> 47.867	vanadium 23 <b>V</b> 50.942	chromium 24 <b>Cr</b> 51.996	manganese 25 <b>Mn</b> 54.938	iron 26 <b>Fe</b> 55.845	cobalt 27 <b>Co</b> 58.933	nickel 28 <b>Ni</b> 58.693	copper 29 <b>Cu</b> 63.546	zinc 30 <b>Zn</b> 65.39	gallium 31 <b>Ga</b> 69.723	germanium 32 <b>Ge</b> 72.61	arsenic 33 <b>As</b> 74.922	seleเนียม 34 <b>Se</b> 78.96	bromine 35 <b>Br</b> 79.904	krypton 36 <b>Kr</b> 83.80	
rubidium 37 <b>Rb</b> 85.468	strontium 38 <b>Sr</b> 87.62	yttrium 39 <b>Y</b> 88.906	zirconium 40 <b>Zr</b> 91.224	niobium 41 <b>Nb</b> 92.906	molybdenum 42 <b>Mo</b> 95.94	technetium 43 <b>Tc</b> [98]	ruthenium 44 <b>Ru</b> 101.07	rhodium 45 <b>Rh</b> 102.91	palladium 46 <b>Pd</b> 106.42	silver 47 <b>Ag</b> 107.87	cadmium 48 <b>Cd</b> 112.41	indium 49 <b>In</b> 114.82	tin 50 <b>Sn</b> 118.71	antimony 51 <b>Sb</b> 121.76	tellurium 52 <b>Te</b> 127.60	iodine 53 <b>I</b> 126.90	xenon 54 <b>Xe</b> 131.29	
caesium 55 <b>Cs</b> 132.91	barium 56 <b>Ba</b> 137.33	57-70 *	lutetium 71 <b>Lu</b> 174.97	hafnium 72 <b>Hf</b> 178.49	tantalum 73 <b>Ta</b> 180.95	tungsten 74 <b>W</b> 183.84	rhenium 75 <b>Re</b> 186.21	osmium 76 <b>Os</b> 190.23	iridium 77 <b>Ir</b> 192.22	platinum 78 <b>Pt</b> 195.08	gold 79 <b>Au</b> 196.97	mercury 80 <b>Hg</b> 200.59	thallium 81 <b>Tl</b> 204.38	lead 82 <b>Pb</b> 207.2	bismuth 83 <b>Bi</b> 208.98	polonium 84 <b>Po</b> [209]	astatine 85 <b>At</b> [210]	radon 86 <b>Rn</b> [222]
francium 87 <b>Fr</b> [223]	radium 88 <b>Ra</b> [226]	89-102 **	lawrencium 103 <b>Lr</b> [262]	rutherfordium 104 <b>Rf</b> [261]	dubnium 105 <b>Db</b> [262]	seaborgium 106 <b>Sg</b> [264]	bohrium 107 <b>Bh</b> [264]	hassium 108 <b>Hs</b> [269]	meitnerium 109 <b>Mt</b> [268]	unnilium 110 <b>Uun</b> [271]	ununium 111 <b>Uuu</b> [272]	unbibium 112 <b>Uub</b> [277]	ununquadium 114 <b>Uuq</b> [289]					

\*Lanthanide series

lanthanum 57 <b>La</b> 138.91	cerium 58 <b>Ce</b> 140.12	praseodymium 59 <b>Pr</b> 140.91	neodymium 60 <b>Nd</b> 144.24	promethium 61 <b>Pm</b> [145]	samarium 62 <b>Sm</b> 150.36	europium 63 <b>Eu</b> 151.96	gadolinium 64 <b>Gd</b> 157.25	terbium 65 <b>Tb</b> 158.93	dysprosium 66 <b>Dy</b> 162.50	holmium 67 <b>Ho</b> 164.93	erbium 68 <b>Er</b> 167.26	thulium 69 <b>Tm</b> 168.93	ytterbium 70 <b>Yb</b> 173.04
actinium 89 <b>Ac</b> [227]	thorium 90 <b>Th</b> 232.04	protactinium 91 <b>Pa</b> 231.04	uranium 92 <b>U</b> 238.03	neptunium 93 <b>Np</b> [237]	plutonium 94 <b>Pu</b> [244]	americium 95 <b>Am</b> [243]	curium 96 <b>Cm</b> [247]	berkelium 97 <b>Bk</b> [247]	californium 98 <b>Cf</b> [251]	einsteinium 99 <b>Es</b> [252]	fermium 100 <b>Fm</b> [257]	mendelevium 101 <b>Md</b> [258]	nobelium 102 <b>No</b> [259]

\*\* Actinide series

A

**Multiple choice questions. Note there may be more than 1 correct answer. Select all that are correct. 12pts**

1. A weak acid

- a. completely dissociates in water.
- b. is predominantly deprotonated at pHs above the pKa.**
- c. has a conjugate acid.
- d. behaves according to the Henderson-Hasselbalch equation.**
- e. none of the above.

2. At pH 4.5 what will the ratio of carboxylic acid to carboxylate be for acetic acid? The pKa of acetic acid is 4.8.

- a. 0.5
- b. 0.3
- c. 2.0**
- d. 3.33
- e. none of the above

3. What is the pH of an aqueous solution with  $[\text{OH}^-] = 3 \times 10^{-11} \text{ M}$ ?

- a. 0.00033
- b. -4.0
- c. 3.8
- d. 10.5
- e. none of the above**

4. What is the  $K_{\text{eq}}$  for this reaction  $\text{H}_2\text{CO}_3 + \text{Et}_3\text{N} \rightleftharpoons \text{HCO}_3^- + \text{Et}_3\text{NH}^+$  ?

$$= \frac{[\text{HCO}_3^-][\text{Et}_3\text{NH}^+]}{[\text{H}_2\text{CO}_3][\text{Et}_3\text{N}]} = \frac{[\text{H}_2\text{CO}_3][\text{Et}_3\text{N}]}{[\text{HCO}_3^-][\text{Et}_3\text{NH}^+]} = \frac{[\text{HCO}_3^-][\text{Et}_3\text{NH}^+]}{[\text{H}_2\text{CO}_3][\text{Et}_3\text{N}]} = k_1[\text{H}_2\text{CO}_3][\text{Et}_3\text{N}]$$

5. What non-covalent force can occur between the *side chains* of Met and P?

- a. electrostatic interactions
- b. London Forces**
- c. dipole-ion interactions
- d. hydrogen bonds

A

6. Which bases pair together in DNA?
- a. Adenine and Uracil
  - b. Guanine and Cysteine
  - c. Thymine and Adenine**
  - d. Guanine and Adenine

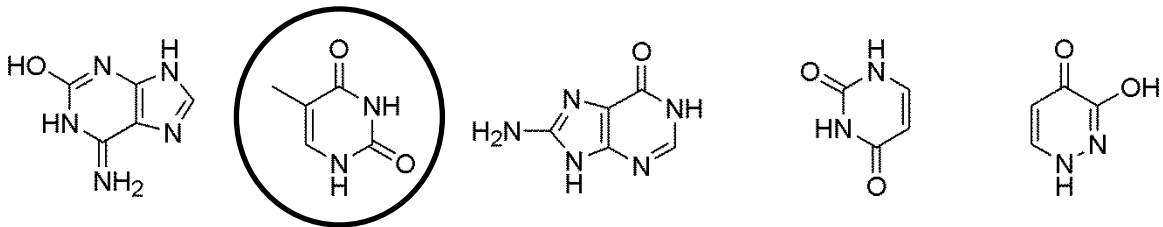
7. What is the charge on the peptide ACE at pH 9.0?

- a. +2
- b. +1
- c. 0
- d. -1
- e. -2**

8. What is the charge on the peptide CLD at pH 7.0?

- a. +2
- b. +1
- c. 0
- d. -1**
- e. -2

9. Circle the aromatic compounds below that are bases normally found in DNA?



10. In the "RNA World" hypothesis:

- a. life was thought to evolve 6 billion years ago.
- b. RNA was introduced onto the primordial earth from a meteorite.
- c. DNA later evolved due to the instability of RNA**
- d. prebiotic RNA catalyzed chemical reactions**
- e. stated that arginine, asparagine, and alanine were the first 3 amino acids.

A

**True or False questions. If false explain why. 10pts**

11. Hydrogen bonds are noncovalent bonds between two hydrogens covalently linked to carbon atoms.

True

**False** If false, explain why.

**H bonds are between X-H and :X where X = N or O.**

12. The charge of the peptide WRECK at pH 6 is 0.

True

**False** If false, explain why.

**The charge is +1**

13. The peptide Ser-Leu-Cys-Trp-Gln-Val contains 2 beta branched peptides.

True

**False** If false, explain why.

**It has only 1 beta branched amino acid, Val**

14. RNA and DNA are isomers of each other.

True

**False** If false, explain why.

**Isomers have the same formula, DNA and RNA differ by a Oxygen.**

15. Nuclear base pairing in DNA occurs via hydrogen bonds.

True

**False** If false, explain why.

A

**Short Answer**

11. 2M Sodium bicarbonate, 2M sodium carbonate, and water are provided to make 0.250 L of a 0.2 M buffer at pH 7.4. How much of each solution and water do you need to mix together to make the desired buffer. The bicarbonate-carbonate pKa is 6.1. **5pts**

$$\text{pH} = \text{pKa} + \log\left(\frac{[\text{A}^-]}{[\text{HA}]}\right) \qquad 7.4 = 6.1 + \log\left(\frac{[\text{A}^-]}{[\text{HA}]}\right)$$

$$1.3 = \log\left(\frac{[\text{A}^-]}{[\text{HA}]}\right)$$

$$19.95 = \frac{[\text{A}^-]}{[\text{HA}]}$$

$$0.2\text{M} = [\text{A}^-] + [\text{HA}]$$

$$[\text{HA}]19.95 = 0.2 - [\text{HA}]$$

$$[\text{HA}] = 0.2 / (1 + 19.95)$$

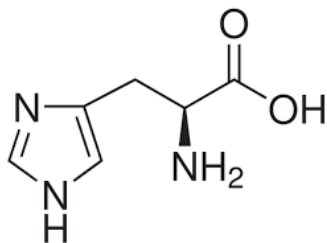
$$[\text{HA}] = 0.0095\text{M}; [\text{A}^-] = 0.1905\text{M}$$

**1.2 mL of 2M bicarbonate plus 23.8 mL of carbonate plus 225 mL water**

12. Order these interactions from strongest to weakest and give the strength of ONE of them in either KJ/mol or kcal/mol. **3pts**

	Strongest		weakest
Hydrogen bond	<b>Covalent</b>	<b>H-bond</b>	<b>London</b>
London force	<b>400 KJ/mol</b>	<b>10-40KJ/mol</b>	<b>5 KJ/mol</b>
covalent bond	<b>100 kcal/mol</b>	<b>2-10kcal/mol</b>	<b>1 kcal/mol</b>

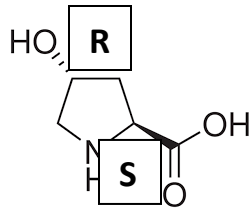
13. Draw the structure of and give the name, 3 letter code and 1 letter code for the amino acid that would be best for making a buffer at pH 6.5. **4pts**



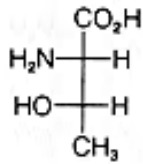
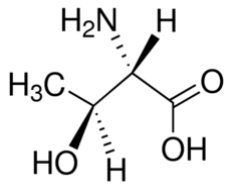
**Histidine, His, H**

A

14. Use the Cahn-Ingold-Prelog convention to determine the stereochemistry of the two stereogenic centers in hydroxyproline. **2 pts**



15. Draw this amino acid in a Fischer project and determine the configuration at the alpha and beta carbons using the Fischer-Rosanoff convention. **3 pts**



16. From this list of amino acids in 3 letter code identify which ones have ionisable side chains and place those amino acids using the 1 letters code in order from most acidic to least acidic side chains. **5 pts**

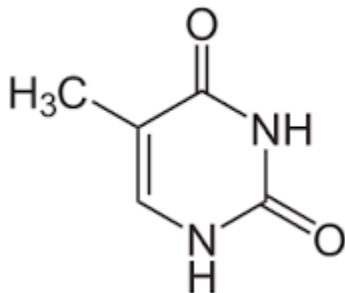
Ala, Arg, Asn, Cys, Glu, Gly, Ile, Lys, Pro, Trp

Most acidic

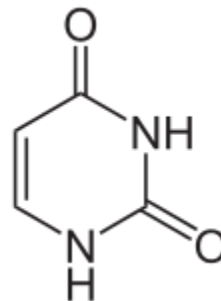
least acidic

E C K R

17. Draw the structures of uracil and thymine. Which is used in RNA and which is used in DNA? **3 pts**



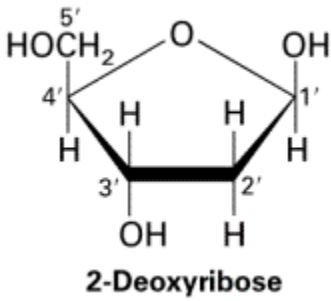
Thymine, DNA



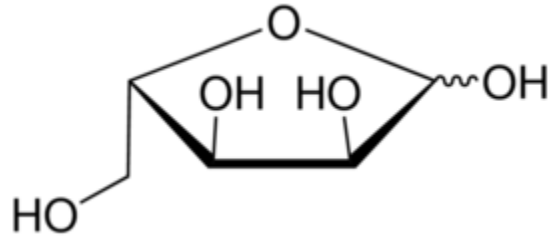
, RNA

A

18. Draw the sugar from DNA and the enantiomer of the sugar from RNA. **3 pts**



DNA

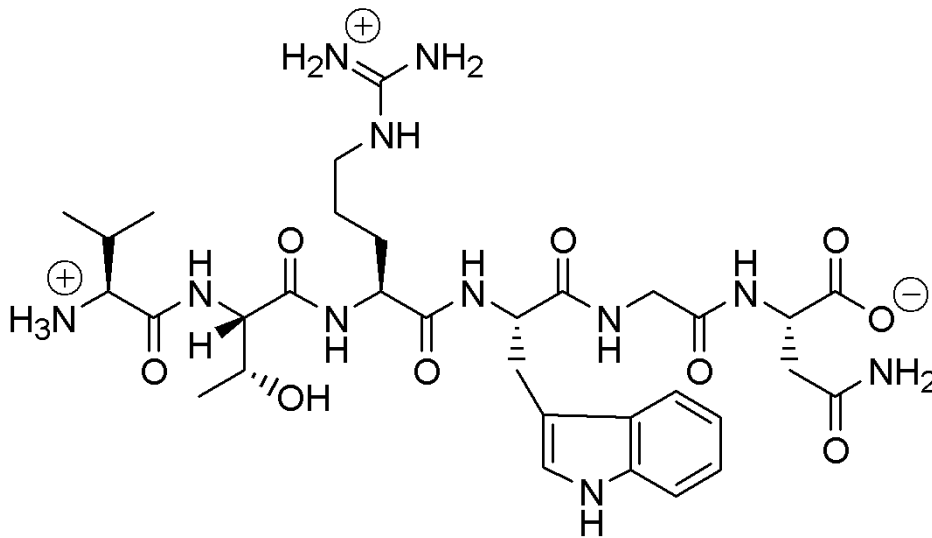


RNA

**Long answer**

19 A. Draw the structure of the hexapeptide shown below at pH 6.5. **9 pts**

Valine-Threonine-Arginine-Tryptophan-Glycine-Asparagine



B Give the peptide sequence using 3 letter codes **2 pts**

**Val-Thr-Arg-Trp-Gly-Asn**

C. Give the peptide sequence using 1 letter codes. **3 pts**

**VTRWGN**

7

A

20. Draw the structure of guanosine monophosphate hydrogen bonded to cytosine monophosphate.

6pts (don't grade the sugars and phosphates, just the bases and Hbonds)

