Exam3key

Monday, April 24, 2017 11:21 AM

Chem 106 Exam 3 Name_____

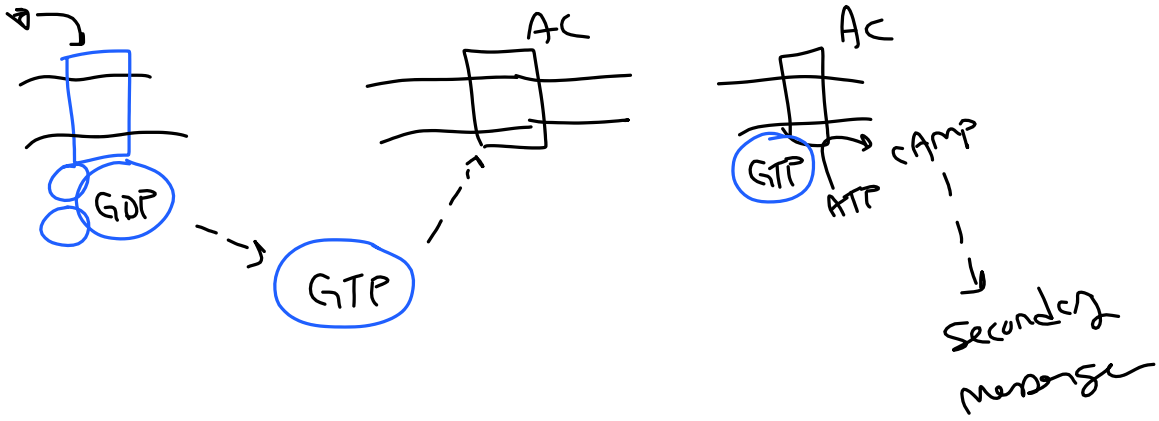
This exam is schedule for 75 minutes and I anticipate it to take the full time allotted. You are free to leave if you finish. In multiple part problems, points awarded will not be penalized for incorrect answer on previous parts, so simply **move on if you get stuck on one part**. If you need to, make up an answer for the previous part. Always neatly show work for partial credit.

1. What does GPCR stand for? G-protein coupled receptor

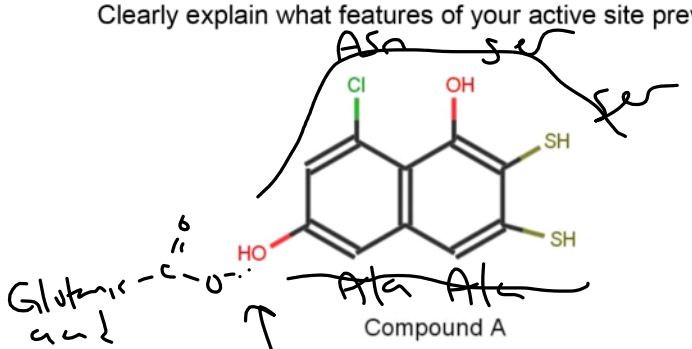
2. What is the role of a GPCR? Receive an extracellular signal and communicate that signal into the cell

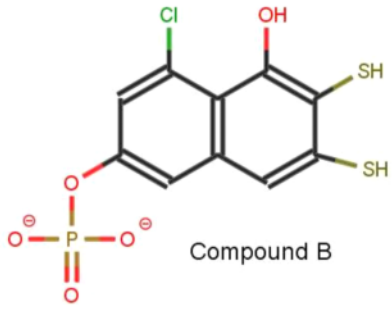
3. How do GPCRs work? Use any combination of sketches, chemical reactions, and text to completely describe their mechanism of action.

Signal binds to the receptor. This causes a conformational change that leads to the alpha subunit of the G protein to dislodge from the receptor and replace the GDP with GTP. GTP bound Alpha subunit can interact with adenylate cyclase, which activates the enzyme to convert ATP into cAMP. cAMP, in turn, acts as a secondary messenger and influences the activity of a bunch of other enzymes.



4. Sketch the active site of a protein that is able to selectively bind to Compound A but not Compound B. Clearly explain what features of your active site prevent binding to Compound B.





Asp Ser Ser

Glutamic acid

Ala Ala

not enough space for PO_4^{3-}

-(-) repel, Phosphate

5. Which of the compounds in problem 4 would bind to the active site you sketched with a lower Kd?

Compound A

Lower Kd means higher affinity. Since the active site binds Compound A, it must have a higher affinity.

6. What role does side chain modification (e.g. phosphorylation) play in biochemical signaling?

It is the chemical change that allows a protein to become active, inactive, or bind to another partner.

7. Why is $\Delta G° = 0$ for membrane transport of any neutral molecule?

$K=1$ because $K=\frac{[IN]}{[OUT]}$

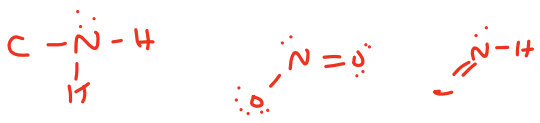
8. Determine which of these unbalanced reactions does ***NOT*** involve electron transfer to/from a ***nitrogen*** atom. Select all correct answers.

$NO_3^- \rightarrow NO$ $+5 \rightarrow +2$

$NH_4^+ \rightarrow CH_3NH_2$ $-3 \rightarrow -3$

$NO_2^- \rightarrow CH_2NH$ $+3 \rightarrow -3$

$N_2 \rightarrow NO$ $0 \rightarrow +2$



9. Balance this half reaction. Identify it as an oxidation or reduction.

$26e^- + 26H^+ + 7H_2CO_3\,(aq) \rightarrow C_7H_{12}O_7\,(aq) + 14H_2O$

reduction

10. When Cu^{2+} reacts with Mn^{2+}, solid copper and MnO_4^{-1} are produced.
    a. Write a balanced reaction that describes this process.

$(2e^- + Cu^{2+} \rightarrow Cu(s))\,5$ 0.34 V

$2(4H_2O + Mn^{2+} \rightarrow MnO_4^- + 8H^+ + 5e^-)\,2$ -1.51 V

$5Cu^{2+} + 8H_2O + 2Mn^{2+} \rightarrow 5Cu(s) + 2MnO_4^- + 16H^+$ -1.17 V

    b. What is is the oxidizing agent? Cu^{2+}
    c. Which metal gets reduced in this reaction? Cu^{2+}
    d. Is this reaction spontaneous? NO $E^\circ < 0$

$\Delta G^\circ = -10(96485)(-1.17) = 1128874.5\ J/mol$

    e. Calculate ΔG at 25 °C if 1.8 grams of copper is placed in a solution containing 26 mM Cu^{2+}, 435 mM Mn^{2+}, and 1.86 mM $KMnO_4$.

$\Delta G = 1128874.5 + 8.314(298.\pi)\ln\left(\frac{(0.00186)^2(0.435)^{16}}{(0.026)^5(0.435)^2}\right)$

$\Delta G = 932456.7\ J/mol$

11. What are three chemicals on the list of standard reduction potentials at the end of your exam that are able to oxidize liquid water to H_2O_2? Note: You can find information about this reaction at the top of the table.

$H_2O(\ell) \rightarrow H_2O_2 \quad E^\circ = -1.77\,V$

F_2, O_3, Co^{3+} ← need $E^\circ_{red} > 1.77\,V$

12. Consider a neuron with resting ion concentration listed in the table.

	$[Mg^{2+}]$	$[Cl^{-1}]$
Inside	8.6 mM	147 mM
Outside	54 mM	87 mM

a. Calculate ΔG for chloride moving into the cell if $\Delta\Psi = 0$.

$\Delta G = 8.314\,(310.15)\ln\frac{147}{87} = 1352.5\ J/mol$

b. Determine the equilibrium potential for each ion. Recall that this is the membrane potential where there is no net ion transport.

Cl^-: $\Delta G_c = -\Delta G_{MP} \qquad \Delta G_{MP} = -1352.5 - -1(96485)\Delta\Psi$

$\Delta\Psi = 0.014\,V = \boxed{14\,mV}$

Mg^{2+}: $\Delta G_c = (8.314)(310.15)\ln\frac{8.6}{54} = -4737.4\ \frac{J}{mol}$

$\Delta G_{MP} = 4737.44 = +2(96485)\Delta\Psi$

$\Delta\Psi = 0.02455\,V$ (24.55 mV)

c. Which direction will chloride flow (in or out) if $\Delta\Psi$ = -14 mV?

out

Will this make the membrane potential more positive or negative? (-) moving OUT

Will this change make Na^+ transport **into** the cell more or less spontaneous?

inside becomes more (+)

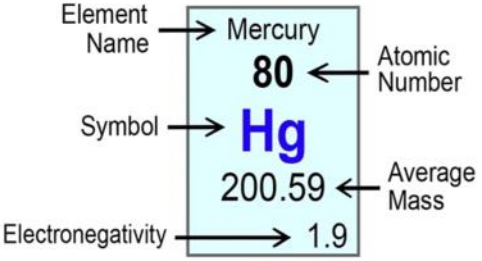
d. Determine ΔG for Na+ transport into the cell at -14 mV.

$\Delta G = \Delta G_c + \Delta G_{MP} = -4737.44 + (2)(96485)(-0.014)$

$\Delta G = -7439.02\ J/mol$

$\Delta G = \Delta G^0 + RTlnQ$ $\Delta G^0 = -nFE^o$ $\Delta G = -nFE$ $\Delta G = ZF\Delta\Psi$ $F = 96485$

Periodic Table of the Elements



Average relative masses are rounded to two decimal places.

All average masses are to be treated as measured quantities, and subject to significant figure rules.

1																	18
Hydrogen 1 H 1.01 2.1	2											13	14	15	16	17	Helium 2 He 4.00 ---
Lithium 3 Li 6.94 1.0	Beryllium 4 Be 9.01 1.5											Boron 5 B 10.81 2.0	Carbon 6 C 12.01 2.5	Nitrogen 7 N 14.01 3.0	Oxygen 8 O 16.00 3.5	Fluorine 9 F 19.00 4.0	Neon 10 Ne 20.18 ---
Sodium 11 Na 22.99 0.9	Magnesium 12 Mg 24.31 1.2	3	4	5	6	7	8	9	10	11	12	Aluminum 13 Al 26.98 1.5	Silicon 14 Si 28.09 1.8	Phosphorus 15 P 30.97 2.1	Sulfur 16 S 32.07 2.5	Chlorine 17 Cl 35.45 3.0	Argon 18 Ar 39.95 ---
Potassium 19 K 39.10 0.8	Calcium 20 Ca 40.08 1.0	Scandium 21 Sc 44.96 1.3	Titanium 22 Ti 47.88 1.5	Vanadium 23 V 50.94 1.6	Chromium 24 Cr 52.00 1.6	Manganese 25 Mn 54.94 1.5	Iron 26 Fe 55.85 1.8	Cobalt 27 Co 58.93 1.8	Nickel 28 Ni 58.69 1.8	Copper 29 Cu 63.55 1.9	Zinc 30 Zn 65.39 1.6	Gallium 31 Ga 69.72 1.6	Germanium 32 Ge 72.61 1.8	Arsenic 33 As 74.92 2.0	Selenium 34 Se 78.96 2.4	Bromine 35 Br 79.90 2.8	Krypton 36 Kr 83.80 3.0
Rubidium 37 Rb 85.47 0.8	Strontium 38 Sr 87.62 1.0	Yttrium 39 Y 88.91 1.2	Zirconium 40 Zr 91.22 1.4	Niobium 41 Nb 92.91 1.6	Molybdenum 42 Mo 95.94 1.8	Technetium 43 Tc (98) 1.9	Ruthenium 44 Ru 101.07 2.2	Rhodium 45 Rh 102.91 2.2	Palladium 46 Pd 106.42 2.2	Silver 47 Ag 107.87 1.9	Cadmium 48 Cd 112.41 1.7	Indium 49 In 114.82 1.7	Tin 50 Sn 118.71 1.8	Antimony 51 Sb 121.76 1.9	Tellurium 52 Te 127.60 2.1	Iodine 53 I 126.90 2.5	Xenon 54 Xe 131.29 2.6
Cesium 55 Cs 132.91 0.7	Barium 56 Ba 137.33 0.9	57-70 *	Lutetium 71 Lu 174.97 1.1	Hafnium 72 Hf 178.49 1.3	Tantalum 73 Ta 180.95 1.5	Tungsten 74 W 183.84 1.7	Rhenium 75 Re 186.21 1.9	Osmium 76 Os 190.23 2.2	Iridium 77 Ir 192.22 2.2	Platinum 78 Pt 195.08 2.2	Gold 79 Au 196.97 2.4	Mercury 80 Hg 200.59 1.9	Thallium 81 Tl 204.38 1.8	Lead 82 Pb 207.20 1.8	Bismuth 83 Bi 208.98 1.9	Polonium 84 Po (209) 2.0	Astatine 85 At (210) 2.2	Radon 86 Rn (222) 2.4
Francium 87 Fr (223) 0.7	Radium 88 Ra (226) 0.9	89-102 **	Lawrencium 103 Lr (262) ---	Rutherfordium 104 Rf (261) ---	Dubnium 105 Db (262) ---	Seaborgium 106 Sg (266) ---	Bohrium 107 Bh (264) ---	Hassium 108 Hs (269) ---	Meitnerium 109 Mt (268) ---	Darmstadtium 110 Ds (271) ---	Roegentium 111 Rg (272) ---	Copernicium 112 Cn (277) ---	Ununtrium 113 Uut (284) ---	Flerovium 114 Fl (289) ---	Ununpentium 115 Uup (288) ---	Livermorium 116 Lv (293) ---	Ununseptium 117 Uus (294) ---	Ununoctium 118 Uuo (294) ---

*lanthanides	Lanthanum 57 La 138.91 1.1	Cerium 58 Ce 140.12 1.1	Praseodymium 59 Pr 140.91 1.1	Neodymium 60 Nd 144.24 1.1	Promethium 61 Pm (145) 1.1	Samarium 62 Sm 150.36 1.2	Europium 63 Eu 151.97 1.1	Gadolinium 64 Gd 157.25 1.2	Terbium 65 Tb 158.93 1.1	Dysprosium 66 Dy 162.50 1.2	Holmium 67 Ho 164.93 1.2	Erbium 68 Er 167.26 1.2	Thulium 69 Tm 168.93 1.3	Ytterbium 70 Yb 173.04 1.1
**actinides	Actinium 89 Ac (227) 1.1	Thorium 90 Th 232.04 1.3	Protactinium 91 Pa 231.04 1.5	Uranium 92 U 238.03 1.4	Neptunium 93 Np (237) 1.4	Plutonium 94 Pu (244) 1.3	Americium 95 Am (243) 1.3	Curium 96 Cm (247) 1.3	Berkelium 97 Bk (247) 1.3	Californium 98 Cf (251) 1.3	Einsteinium 99 Es (252) 1.3	Fermium 100 Fm (257) 1.3	Mendelevium 101 Md (258) 1.3	Nobelium 102 No (259) 1.3