Chemical Biology 03
Fall 2009
O'Hara

Problem Set 6: Cell Communication

Due Wed Nov 9th in class

I. STEROID HORMONES: Review the hormone tutorial on the protein data bank on anabolic steroids: http://pdbbeta.rcsb.org/pdb/static.do?p=education_discussion/molecule_of_the_month/pdb92_1.html and answer the following questions:

a. What are two main functions of anabolic steroids?

b. Trace the path of testosterone from its synthesis to one of its many target sites.

c. How does testosterone enter the cell?

d. What is testosterones action once it enters the cell?

e. Draw the chemical structure of testosterone and the more active form of testosterone that is made in some cells.

f. Why can't you just take testosterone orally to build up muscles?

g. What are designer steroids?

h. How do certain "dietary supplements" provide a way around the bans on steroid use?

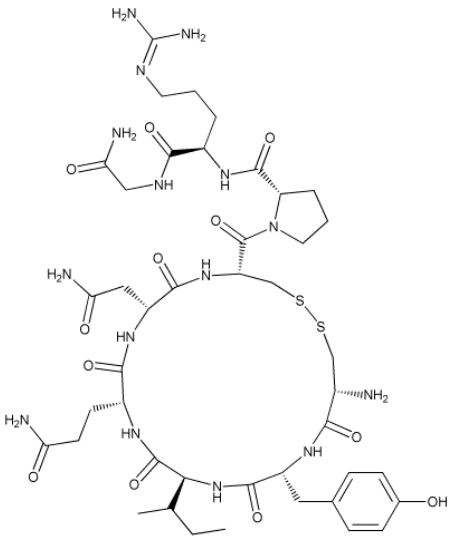
i. The hormone binding domain of the testosterone receptor protein is shown in pdb structure (PDB entry 2am9). Access this entry, and scroll down towards the bottom of the page where you will see a table of ligand chemical components. The last entry is testosterone (TES) and you will have the option of selecting a new program "ligand explorer". Select this program, and download the Java program onto your computer so that you can look at the ligand interactions. Then use the program to describe the four hydrogen bonds (include the atom on the testosterone, the amino acid number and atom, and the distances) and the two hydrophobic interactions that occur at less than 3.6 Å (you may need to change the cut-off distance for hydrophobic interactions to limit them to two.

j. A synthetic designer steroid, tetrahydrogestrinone (THG) can also bind to this receptor (PDB entry 2amb). THG is the "undetectable" anabolic steroid uncovered in the 2003 BALCO doping scandal. Does this molecule (named 17H in the pdb entry) make the same hydrogen bonds and hydrophobic interactions as TES?

k. Use your knowledge of the electronegativity of atoms to explain why you do not see H-bonds between carbons and hydrogens?

l. Use your knowledge of the structure of the atom to explain the origin of the hydrophobic interaction? (why does like dissolve like?)

II. Peptide Hormones. Shown below is a cyclic peptide.



a. Circle the N- terminus.

b. Put a square around the C-terminus.

c. What is unusual about the C-terminus?

d. How many amino acids does this peptide have?

e. A reaction between two amino acid side groups has created the ring. What are the amino acid side groups that reacted, and what is the new type of bond called?

Amino acids that reacted _____

Name of the new bond _____

f. How many amino acids are in the ring?

g. How does this peptide differ from vasopressin?

h. How would this difference affect the binding of this peptide to receptors?

i. List the amino acids from N to C terminus.

_____ _____ _____ _____ _____ _____ _____ _____ _____

j. Is has been noted in class that the concentration of this hormone in blood is pg/mL. If the average molecular mass of an amino acid is 110 g/mole, calculate the molarity of this peptide in blood.

III. Nitric Oxide and Oxidation and Reduction

Nitric Oxide and Lewis Structures

Shown below are several complexes of nitrogen and oxygen. Draw the Lewis Structures for each and calculate the total number of valence electrons and the formal charge on each atom.

Molecule – Lewis Structure	Total Number of Valence Electrons	Formal Charges
O_2		
N_2		
NO		
$[NO_3]^{-1}$		
N_2O		
NO_2		