PROBLEMS

2.1 *All Greek to me*

Now's the time to learn the Greek alphabet. Here are the letters most often used by scientists. The following list gives both lowercase and uppercase (but omits the uppercase when it looks just like a Roman letter):

$$\alpha,\ \beta,\ \gamma/\Gamma,\ \delta/\Delta,\ \epsilon,\ \zeta,\ \eta,\ \theta/\Theta,\ \kappa,\ \lambda/\Lambda,\ \mu,\ \nu,\ \xi/\Xi,\ \pi/\Pi,$$

$$\rho,\ \sigma/\Sigma,\ \tau,\ \upsilon/\Upsilon,\ \phi/\Phi,\ \chi,\ \psi/\Psi,\ \omega/\Omega$$

When reading aloud we call them alpha, beta, gamma, delta, epsilon, zeta, eta, theta, kappa, lambda, mu, nu, xi (pronounced "k'see"), pi, rho, sigma, tau, upsilon, phi, chi (pronounced "ky"), psi, omega. Don't call them all "squiggle."

Practice by examining the quote given in Chapter 1 from D'Arcy Thompson, which in its entirety reads: "Cell and tissue, shell and bone, leaf and flower, are so many portions of matter, and it is in obedience to the laws of physics that their particles have been moved, moulded, and conformed. They are no exception to the rule that $\Theta\epsilon\grave{o}\varsigma\ \alpha\epsilon\grave{\iota}\ \gamma\epsilon\omega\mu\epsilon\tau\rho\epsilon\hat{\iota}$." From the sounds made by each letter, can you guess what Thompson was trying to say? [*Hint:* ς is an alternate form of σ.]

2.2 *Do-it-yourself proteins*

This book contains some molecular structure pictures; you can easily make many more yourself. Download RasMol from `http://www.umass.edu/microbio/rasmol/index.html` (or `http://openrasmol.org`), or get some other free molecular viewing application.[9] Now go to the Protein Data Bank,[10] `http://www.rcsb.org/pdb/`. On the main page, try searching for and viewing molecules (see also the "molecule of the month" department, from which the examples below were taken). Once you get the molecule's main entry, click "explore" on the right, then "view" and download in RasMol format. Play with the many RasMol options. Alternatively, you can just click `quickpdb` for a viewer that requires no separate application. Here are some examples; several are discussed in this and later chapters:

a. thrombin, a blood-clotting protein (code `1ppb`).
b. insulin, a hormone (code `4ins`).
c. myosin, a molecular motor (code `1b7t`).
d. the actin-myosin complex (code `1alm`). This entry shows a model of one myosin motor bound to a short actin filament formed of five molecules, based on data from electron microscopy. The file contains only alpha carbon positions for the proteins, so you'll need to use backbone diagrams when you look at it.
e. rhinovirus, responsible for the common cold (code `4rhv`).

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[9]Protein Explorer, also available at `http://www.umass.edu/microbio/rasmol/index.html` requires installation of additional software. Other popular packages include PyMol (`http://pymol.sourceforge.net`) and VMD (`http://www.ks.uiuc.edu/Research/vmd/`).

[10]The PDB is operated by the Research Collaboratory for Structural Bioinformatics (RCSB). You can also find RasMol there under "software."

f. myoglobin, an oxygen-storing molecule found in muscles (code `1mbn`). Myoglobin was the first protein structure ever determined.
g. DNA polymerase (code `1tau`).
h. the nucleosome (code `1aoi`).

Use your mouse to rotate the pictures. Use the measurement feature of RasMol to find the physical size of each object. Selectively color only the hydrophobic residues. Try the "stereo" option. Print the ones you like.

2.3 *Do-it-yourself nucleic acids*

Go to the Nucleic Acid Database, `http://ndbserver.rutgers.edu/`. Download coordinates and view, using RasMol or another software:

a. the B-form of DNA (code `bd0001`). Choose the space-filling representation and rotate the molecule to see its helical structure.
b. transfer RNA (code `trna12`).
c. RNA hammerhead enzyme, a ribozyme (code `urx067`).
d. the complex of integration host factor bound to DNA (code `pdt040`). Try the `cartoon` display option.

2.4 *Do-it-yourself small molecules*

Go to `http://molbio.info.nih.gov/cgi-bin/pdb` and search for some small molecule mentioned in this chapter. You'll probably find PDB files for larger molecules binding the one you chose. Look around.

2.5 *Do-it-yourself micelles and bilayers*

Go to `http://moose.bio.ucalgary.ca/`, `http://persweb.wabash.edu/facstaff/fellers/`, `http://www.umass.edu/microbio/rasmol/bilayers.htm`, or some other database with lipid structures.

a. Go to "downloads" at the first site mentioned and look at the file `m65.pdb`, which shows a micelle containing 65 molecules of the surfactant. This picture is the output of a molecular simulation. Tell RasMol to remove the thousands of water molecules surrounding the micelle (uncheck "hydrogen" and "hetero atoms"), so you can see it.
b. At the second site mentioned, get the coordinates of the dipalmitoyl phosphatidylcholine bilayer and view it. Again remove the surrounding water. Rotate it to see the layer structure.