ABOUT THE LAB:

The lab will focus on the comparison of random, scale-free, small-world graphs and a graph of the zebrafish descending neurons.

Exercises:

1. Creating a scale-free graph.
Read the documentation for the package to create scale-free graphs here: `http://www.mathworks.com/matlabcentral/fileexchange/11947`. Then, use the command SFNG with a 100 nodes, 'mlink' of 1 and a seed matrix of $\begin{bmatrix} 0 & 1 & 0 & 0 & 1 \\ 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \end{bmatrix}$ to create the adjacency matrix C_{sf}. Find the degree of C_{sf}.

2. Creating a random graph.
Use the command 'makerandCIJ_dir.m' to create a random graph with the same number of nodes and edges as the scale-free graph in problem 1. Call the adjacency matrix for this graph C_{rand}.

3. Creating a small-world graph.
Run 'makesmallworld.m' with the same number of nodes (N) and edges (K) as the previous graphs. Let $p = 0.2$. Call the adjacency matrix C_{sw}.

4. Visualization of the three graphs.
Look at the three adjacency matrices using 'spy', 'CNet' and and 'PLplot'. Carefully label and save all of your figures. Based on the figures, compare random, scale-free and small-world networks.

5. Numerical experiment: choosing a different seed for scale-free networks.
Pick a 3 different seed matrices and create scale-free networks with 200 nodes. Show the seed, a visualization (of your choice) and describe what you see.

6. Numerical experiment: changing p in the small-world network.
Choose 3 different values of p. Record your values for p and describe how the small-world networks change.

7. Adjacency matrix of the descending neurons.
Load the file 'rsMap.mat' into Matlab. You will use the adjacency matrix called 'adjacent'. How many nodes and edges does it have? Use 'spy' to look at the structure. Create a small-world and a random network with the same number of nodes and edges as the data. Describe how these graphs compare to the adjacency matrix. Comment on what the reasons

might be for these differences.

7. Exploration.
Imagine that you are studying the nervous system of an organism from a purely anatomical (rather than physiological or functional) perspective. What sort of question(s) would you ask? (It might be useful to refer back to the "Mathematics is Biology's New Microscope" paper for inspiration.) Explain your question(s) and how you would go about investigating it. Would you employ a computational approach? What would be advantages and disadvantages of it?