1.

I began testing my algorithms with the sequences and scores presented in class as a start for getting toward correctness. I first implemented Needleman and tested the sequences SEND and AND and received the same results as the lecture slides. I then tested the sequences SIMILARITY and PILLAR and got the correct results. I then tested two empty sequences, one empty sequence compared to a sequence of arbitrary lengths, and sequences that were the same. I then tested arbitrary random patterns of sequences of length 50, then 100, and then up to a 1000 or more proteins in a sequence. Finally, to get an idea of how long it would take for extremely large input I used arbitrarily random sequences of 10,000 proteins in length which did take some time to compute.

2.

The two algorithms accomplish the same task but in a different manner. For the discussion let N = the length of the longer sequence being compared, and M = the length of the shorter sequence. The Needleman algorithm has a space and time complexity of O(NM) where N is the length of sequence 1 and M is the length of sequence 2. It takes of O(NM) to fill the score matrix, O(N+M) to move the length of the matrix and O(N) time to do the traceback to find the optimal alignment. Thus the time complexity would be O(NM) + O(N+M) + O(N) = O(NM). The space complexity is O(NM) because it takes N * M space to fill the matrix.

The Hirschberg algorithm has a space complexity of O(N) and a time complexity of O(NM). It only takes O(N) space because when calculating the score, only one line of the score matrix is stored for calculating and a second for the previous one, which equals O(2N)= O(N). It has a time complexity of O(NM) still because although you have to recalculate the lines of the score matrix every time the problem is being divided into smaller parts and so

lves them separately. The calculation becomes O(2M N) since it is done twice, dividing the shorter sequence in half and calculating the top half in O(M N) time and calculating the bottom half in O(NM) time.