

CSC 314, Exam II Review

Format: This exam is open note, and requires the use of a computer

Exam II Outline

1. Bioinformatics Databases and Tools
 - a. Searching Entrez
 - b. GenBank and GenPept
 - c. UCSC Genome Browser and UCSC Table Browser
 - d. Gene Database and Orthologs
2. Python
 - a. Functions
 - b. File Input
3. Biopython
 - a. DNA/RNA sequences using Bio.Seq objects
 - i. Finding complements
 - ii. Transcribing sequences
 - iii. Translating sequences
 - iv. Using standard string methods and actions
 - b. Reading and parsing sequences in
 - i. GenBank Flatfile format
 - ii. FASTA format
4. Sequence alignments
 - a. Finding the alignment score using BLOSUM matrices and gap penalties
 - b. Finding the optimal *global* alignment using the Needleman-Wunsch dynamic programming method
 - c. Finding the optimal *semiglobal* alignment
 - d. Finding the optimal *local* alignment using the Smith-Watterman dynamic programming method
5. Using BLAST to identify similar sequences and conserved protein domains

Exam II Practice Questions

Note: This review is not comprehensive, but contains several practice problems to help prepare for Exam II. In addition to these practice problems, you should make sure to understand all labs assigned since the first exam.

1. Sequence Database questions

Look at the GenBank entry with accession number NM_001185098 to answer the questions below:

- a. What is the length of this sequence?
- b. When was the sequence last modified?
- c. How many exons does this gene have?
- d. What position marks the beginning and end of the poly-adenylation signal sequence, and what is this sequence (biological note: this sequence is recognized in the process of poly-adenylation, which is the addition of a poly-A tail to the end of a mRNA).
- e. What are the first nine nucleotides in the coding sequence (CDS), and the corresponding amino acids (you can give the 1-letter amino acid codes)?

2. UCSC Genome Browser

- a. Use the UCSC Genome Browser to display only the NCBI Genes track (under Genes and Gene Predictions) and Spike Mutations (under Variation and Repeats) for SARS-Cov2, using Pack View. What is the first mutation listed that is in red (red means bad), and why is this bad. Note that Regeneron can be used to treat COVID-19. You can view the SARS-Cov2 genome map here: <https://genome.ucsc.edu/cgi-bin/hgTracks?db=wuhCor1>
- b. Use the UCSC Table Browser to display the NCBI gene names and protein products of SARS-Cov2 (use the NCBI Genes track). How many genes are present?

3. Sequence Alignments

For (a) and (b), use a linear gap penalty of 4 points, a match score of +5 points, and a mismatch score of -1 point.

- a. Find the optimal global alignment and optimal global alignment score for the words *handy* and *say*. You must show your dynamic programming matrix to receive credit.

- b. Find the optimal local alignment and optimal local alignment score between the words *stars* and *that*. You must show your dynamic programming matrix to receive credit.
- c. Using the BLOSUM-62 matrix, a gap opening penalty of 5, and a gap extension penalty of 1, find the score of the *semiglobal* alignment given below (Recall that semiglobal alignments do not penalize gaps at the beginning or end of the alignment).

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F R I D A - - Y
- - P - A R T Y

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4. **BLAST.** The protein sequence for the *C. elegans* (worm) gene F55F8.2 can be found at accession NP_491652. BLAST this protein to find similar proteins in humans (use the default database, but limit your analysis to *Homo sapiens*). Note: the protein DDX24 is a known human ortholog of this worm gene, based on the fact that there is a high similarity.
 - a. What is the % identity and % similarity of the alignment between F55F8.2 and DDX24 (this is labeled “DDX24 protein [Homo sapiens]”)
 - b. What is the first pfam domain present in this protein? Based on these domains, what do you infer about the function of F55F8.2? Do you think it may be involved in *translation*? Why or why not?

5. **Coding questions (see *biopython_practice.ipynb* in the code folder)**