**Professor Mariel Vazquez**
**March 20, 2008**

**Math 414-1 / 714-1**
**Homework 5: Supercoiling**
**The homework set is due on Thursday, April 3rd**

**I. Reading Assignment:**
DNA topology by Bates and Maxwell, sections 2.1-2.5

**II. Literature search:**

- **a.** Klenin K. and Langowski J., Computation of writhe in modeling supercoiled DNA (2000); find the paper in PubMed, read it. Give a brief summary of the paper's contents. You will use this paper to complement your lecture notes (we will go into the details in class).
- **b.** Search review papers on DNA supercoiling; write a commentary of one of the papers

**III.** Using regular diagrams, illustrate the correspondence between overwinding of a short DNA molecule and changes in helical pitch and supercoiling. Repeat for unwinding.

**IV.** Consider a linear fragment of DNA. What atomic groups do you need to add to the end of the chain to form a closed DNA molecule?

**V.** Let A and B be two circular DNA molecules of different length, but with same linking number difference $\Delta Lk = +3$:

Molecule A: $\Delta Lk = Lk_A - Lk_0^A = +3$
N = 500bp
Molecule B: $\Delta Lk = Lk_B - Lk_0^B = +3$
N = 1,000,000bp

Compute the supercoiling densities $\sigma_A$ and $\sigma_B$, and interpret your results.

**VI.** In *Escherichia coli* cells the DNA chromosome and all naturally occurring plasmids have supercoiling density $\sigma = -0.06$. Consider a bacterial plasmid of length 4361bp.
a) Calculate the linking number Lk of this plasmid, as well as the linking number difference $\Delta Lk = Lk - Lk_0$.

b) Is this plasmid relaxed, positively or negatively supercoiled? Argue using results from part a. Explain your answer. Do you know the name of this plasmid?