

# Homework 1

## CHM5503

Please answer all questions:

1. Please draw the chemical structures of ribose, deoxyribose, uracil, and the DNA sequence pGATC.
2. The interaction between the transition dipoles are Coulombic. As there is no net change in charge for a transition, the interaction can be approximated by dipole-dipole interactions; they are of order  $r^{-3}$  with  $r$  the distance between bases. Thus the nearest neighbor approximation can be used to estimate the extinction coefficient of a single-stranded oligonucleotide. Please estimate the extinction coefficient of the following deoxyoligonucleotide using the nearest neighbor approximation: pGGCAATGC.
3. Dr. Sankar Adhya at National Cancer Institute constructed a plasmid pBend2 to study protein-induced DNA-bending using gel electrophoresis (see pBend2's map). Assume that you have isolated a DNA-binding protein, FIU, which may cause DNA-bending. The DNA-binding sequence of FIU is 5'-ATATTGCGCATTATT-3'. Please sketch a strategy to study FIU-induced DNA-bending.
4. Please briefly discuss the structure properties of the B-form and Z-form DNA.
5. Polymerase chain reaction (PCR) is very important for molecular biology. Please describe the steps of PCR. What components are required for a PCR reaction?
6. *In vivo*, almost all DNA is supercoiled. For a supercoiled circular plasmid, the DNA supercoiling can be best described by the equation  $Lk = Tw + Wr$  where  $Lk$  is the linking number,  $Tw$  is the twist, and  $Wr$  is the writh. Please define the linking number  $Lk$ .
7. Please fill out the following blanks:
  - a. In 1953, \_\_\_\_\_ proposed the right-handed double helix DNA model, which wound around the common axis.
  - b. In 1965, \_\_\_\_\_ found DNA supercoiling of circular DNA molecules.
  - c. In 1969, \_\_\_\_\_ formulated the mathematical equations for DNA supercoiling.
  - d. In 1971, \_\_\_\_\_ discovered *E. coli* DNA topoisomerase I.