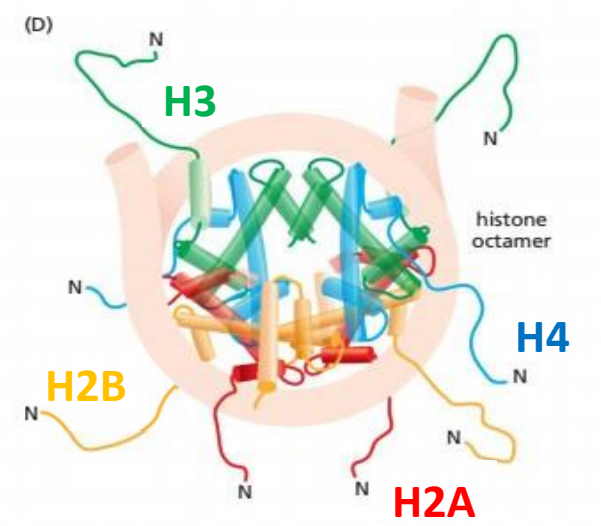
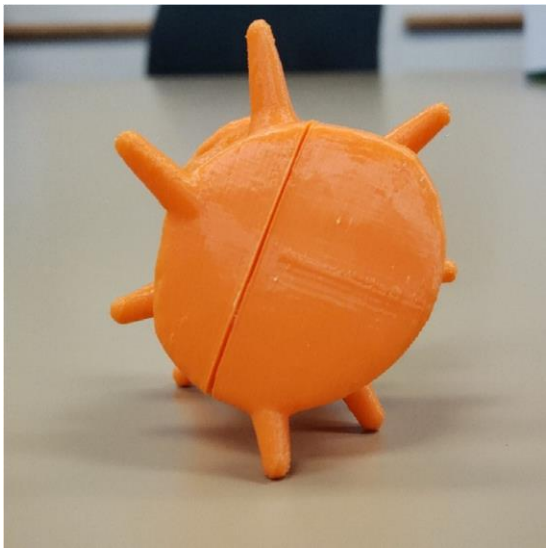
Center for BioMolecular Modeling

Let's explore chromatin structure and nucleosomes!

What is chromatin? Chromatin is the term used for the material that forms chromosomes in eukaryotes *and* archaea (but not prokaryotes). It is made up of DNA, histone proteins, and nonhistone proteins, in approximately equal mass. DNA is wound around the histone proteins to form a unit called a nucleosome (see illustration below, left). Non-histone proteins are diverse and have a number of different functions that we will revisit later in regard to epigenetics.





Histone core particle

Basic unit of chromatin = the nucleosome (histone core particle + approximately 146 bp DNA)

Histone core particle is an octamer made up of 8 proteins: [H2A + H2B + H3 + H4] x 2

Each histone protein is small (~100 aa), consisting of 3 α-helices and 2 loops which make up the globular part and an N (amino)-terminal flexible tail that protrudes from the nucleosome.

Using the 3DMD Nucleosome Kit, identify each tail on the orange histone core particle model (above,right). Notice the location of tails relative to each other.

Wrap the toober representing double stranded DNA around the histone core particle to make a nucleosome.

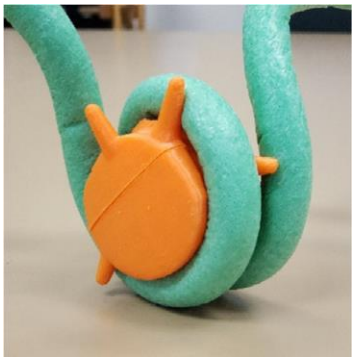
How many times does the DNA wrap around the histone core particle? 1.7

What is the location of the histone tails within the nucleosome? H2A and H2B tails are where the DNA is doubly wrapped. H2A tails are on opposite sides of the DNA helices while H2B tails are sandwiched between them. H3 tails are located where the DNA enters and exits the nucleosome so they are more exposed. H4 tails point toward other nucleosomes.

Based on their locations, hypothesize potential functions of the specific tails.

- Which tails might be important in interactions with the DNA? H2A and H2B
- Which might be important in interaction with other nucleosomes? H4
- Which might be important with interactions with other proteins? H3

With what handedness is the DNA wrapped around the histone core particle? How does that compare with what you know about the handedness of DNA? DNA is wrapped around the histone core particle in a left-handed direction while the DNA helix is right-handed.

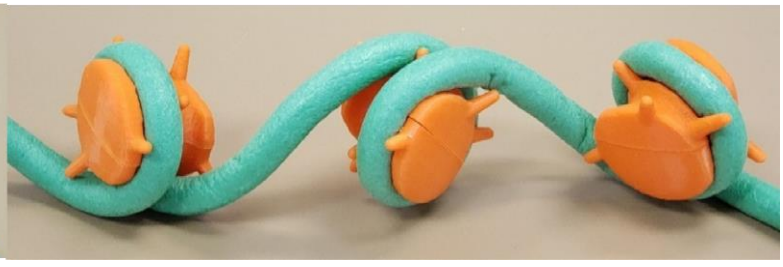


Lysine and arginine comprise over 20% of the core histones amino acid content. How might that affect interactions of histones with DNA? Positive charged histones would be attracted to negatively charged DNA backbone.

Load 5 more histone core particles on the DNA.

- Model tightly wound chromatin or *heterochromatin*. Heterochromatin is usually located near the perimeter of the nucleus and is not actively transcribed.
- Model loosely wound chromatin or *euchromatin*. Euchromatin is usually located more toward the center of the nucleus and is actively transcribed.
  - Average 200 bp spacing from the beginning of one nucleosome to the beginning of the next nucleosome.
  - Linker DNA between nucleosomes can vary from 1-2 bp (heterochromatin) up to 80 bp (euchromatin)

Heterochromatin



Euchromatin

Thought Questions:

What causes chromatin to be tightly or loosely packed?

What might the effect of tight or loose packing of chromatin be?

Do you think the packing of certain regions of chromatin might change between cell or tissue types? Why or why not?

Is the process static or dynamic? In other words, does it remain constant or change over time?

These are all good questions. Work through the Epigenetics activities in the next section to explore!