Exploring Watson-Crick Base Pairing and DNA Structure

Learning Goals – Content Knowledge

1) Explore how hydrogen bond donors and acceptors of the nucleosides(tides) influences the overall double helical structure of DNA including isosteric nature of the W-C basepairs and groove structure.

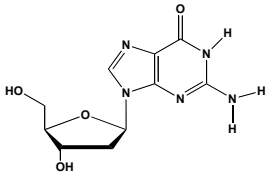
2) Predict the impact of a non-W-C pairing on a DNA double helix? Find evidence to support or refute your initial prediction by using the models provided.

3) Explore how the groove structure of a double helix might allow a protein to "read" a DNA sequence without having to unwind the DNA duplex.

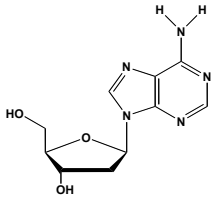
Learning Goals – Skills Development

- Use models to visualize biomolecular structures
- Transition between structural scales (atomic/macromolecular)
- Recognize links between atomic functionality and macromolecular properties/behavior

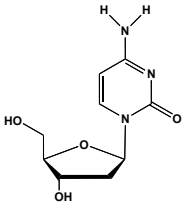
The common nucleosides



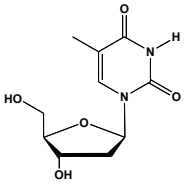
deoxyguanosine



deoxyadenosine



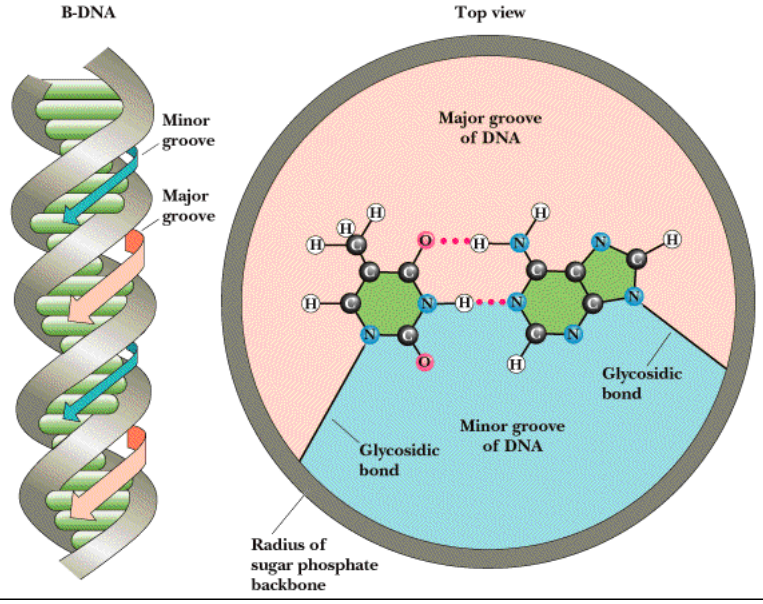
deoxycytidine



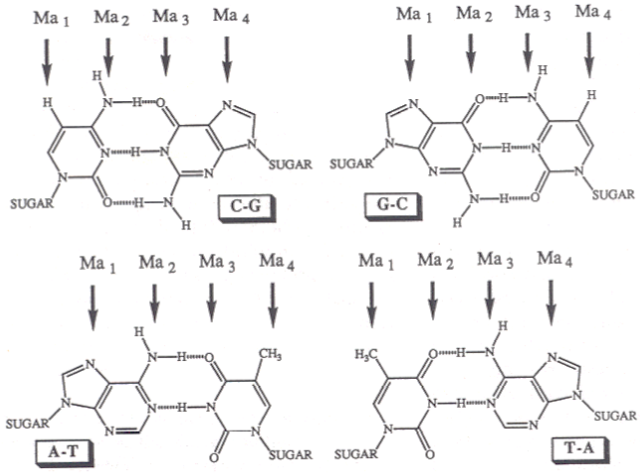
deoxythymidine

Use the nucleotides to explore the Watson-Crick base pairing patterns. - Compare the distance between pairs of carbon atoms (C1'-C1' or C4'-C4')? Are they equidistant for A•U and G•C base pairs?

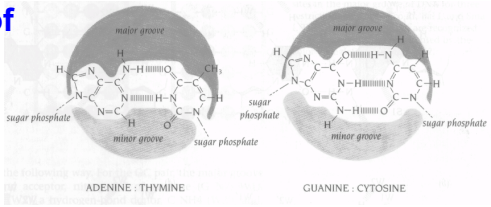
What properties of the nucleotides give rise to the structure of B-form DNA?



Sequence specific read out occurs in the grooves of duplex DNA



Reading the sequence of DNA without unfolding the duplex



Use the models of the AT and GC base-pairs above to consider the potential interaction surface in the major and minor grooves of the following DNA sequences: (↑ = donor; ↓ = H-bond acceptor; ∅ - CH_3 steric interaction; O - H atom)

EcoRI binding site

Major Groove

5'		3'
	G	C
	A	T
	A	T
	T	A
	T	A
3'	C	G 5'

Minor Groove

5'		3'
	G	C
	A	T
	A	T
	T	A
	T	A
3'	C	G 5'

BamHI binding site

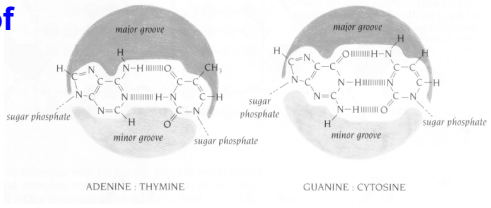
Major Groove

5'		3'
	G	C
	G	C
	A	T
	T	A
	C	G
3'	C	G 5'

Minor Groove

5'		3'
	G	C
	G	C
	A	T
	T	A
	C	G
3'	C	G 5'

Reading the sequence of DNA without unfolding the duplex



Use the models of the AT and GC base-pairs above to consider the potential interaction surface in the major and minor grooves of the following DNA sequences: (↑ = donor; ↓ = H-bond acceptor; ∅ - CH_3 steric interaction; O - H atom)

EcoRI binding site

Major Groove

5'		3'
	G ↓	↓ ↑ O C
	A ↓	↑ ↓ ∅ T
	A ↓	↑ ↓ ∅ T
	T ∅	↓ ↑ ↓ A
	T ∅	↓ ↑ ↓ A
3'	C O	↑ ↓ ↓ G 5'

Minor Groove

5'		3'
	G ↓	↓ ↑ ↓ C
	A ↓	O ↓ T
	A ↓	O ↓ T
	T ↓	O ↓ A
	T ↓	O ↓ A
3'	C ↓	↑ ↓ G 5'

BamHI binding site

Major Groove

5'		3'
	G ↓	↓ ↑ O C
	G ↓	↓ ↑ O C
	A ↓	↑ ↓ ∅ T
	T ∅	↓ ↑ ↓ A
	C O	↑ ↓ ↓ G
3'	C O	↑ ↓ ↓ G 5'

Minor Groove

5'		3'
	G ↓	↑ ↓ C
	G ↓	↑ ↓ C
	A ↓	O ↓ T
	T ↓	O ↓ A
	C ↓	↑ ↓ G
3'	C ↓	↑ ↓ G 5'