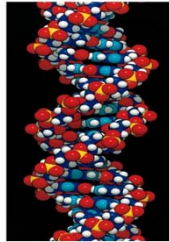


BIO 1140 Unit 1-1: DNA & RNA Structure

- Reading
 - Chapter 12.1-12.2, pp 257-264
 - Other sections referred to in the Figures
 - Material from the scientific literature
- Objective: To understand structure-function relationships
 - Structure of DNA and RNA.
 - "the static and the dynamic"
 - basic chemistry
 - basic structural forms
 - DNA and RNA modifications



1

BIO 1140 Unit 1-1: DNA & RNA Structure

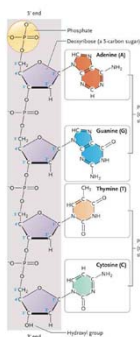
Key Questions that we will try to answer:

- What is the structure of DNA and how do we know?
- Is DNA always the genetic material?
- Is the DNA structure always the same?
- Is the DNA structure in the cell relevant?
- Is the genome what we think it is?
- Without chromatin, would it be necessary to invent it? (next section)

2

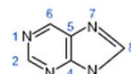
BIO 1140 Unit 1-1: DNA & RNA Structure

(Reference Slide 1)



Useful information (F37-F39)

- The bases are heterocyclic, aromatic rings
- The numbering system



Purine



Pyrimidine

If this was RNA what would change?

- Uracil replaces thymine (no -Me group)
- Ribose replaces deoxyribose (2' OH)

3

Fig. 12-4, p. 262

The Basic Building Blocks for DNA & RNA (F37-F39)

- There are 4 nitrogenous bases (4 types, A, C, G, T) (adenine, cytosine, guanine, thymine)
- A base is a purine or pyrimidine
 - (adenine, cytosine, guanine, thymine)
- A base + a pentose sugar = nucleoside.
 - if the sugar is a deoxyribose, it is a deoxyribonucleoside (deoxyadenosine, deoxycytidine, deoxyguanosine, deoxythymidine)
- A nucleoside + phosphate = deoxynucleotide
 - (deoxyadenosine 5'-monophosphate, deoxycytidine 5'-diphosphate, etc.)
- There are 5'-monophosphates, 5'-diphosphates, 5'-triphosphates (deoxyadenosine 5'-monophosphate (dAMP), deoxyadenosine 5'-diphosphate dADP), deoxyadenosine 5'-triphosphate dATP).

DNA is the genetic material (at least most times)

(a brief summary of the evidence)

- Transformation experiments
- Chargaff's rules
- Phage infection experiment
- X-ray analysis
- Role of Model Building
- The modern "synthesis"- DNA structures

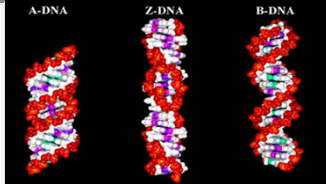
The Basic or Archetypal Structural Forms for DNA and RNA.

Type of Organism	Genetic Material	Organization
"Bacterium"	dsDNA(s) circular	Protein/DNA Nucleoid
"Eukaryote"	dsDNA linear	Protein/DNA Chromosome
Mitochondrion	dsDNA circular	Protein/DNA
Chloroplast	dsDNA circular	Protein/DNA
Virus	ss or ds DNA circular or linear ss or ds RNA circular or linear	Protein/DNA Protein/DNA
Viroid	ssRNA, circular	None ?

NOTE: except for viroids, **WHY NUCLEIC ACID AND PROTEIN?**

The DNA structure is NOT always the same. Why NOT?

- DNA changes during replication, transcription and other processes;
- With abnormal DNA composition the structure can change.
 - A-DNA is found in RNA/DNA hybrids (transcription)
 - AT-rich DNA has different groove parameters
 - Z-DNA is found in GC-rich DNA and is left-handed!



These *in vitro* results suggest that **microheterogeneity** can occur in the DNA structure!

Example 1: Models of Different DNA structures

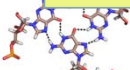
The DNA structure is NOT always the same

There are a variety of "strange structures" but do they "exist" in nature?

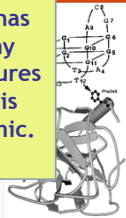
What can we conclude about DNA structures?

DNA has many structures and is dynamic.

with hairpin structures

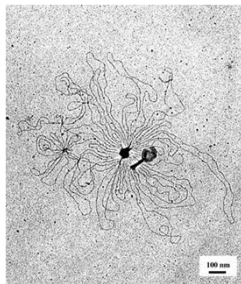


G_tetraplex



DNA aptamers**

The Basic Structural Forms for DNA and RNA.



DNA released from bacteriophage (bacterial virus). You can see individual dsDNA!

The Basic Structural Forms for DNA and RNA.

Fig. 20-4, p. 468

Fig. 9-5, p. 185

0.5 μm

16

The Basic Structural Forms for DNA and RNA.

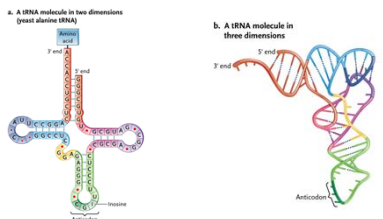
DNA released from chromosome. After you remove histones you can see individual ds DNA!**

We can conclude that there are many structures for DNA & DNA-Protein in the cell. This is not surprising because...

17

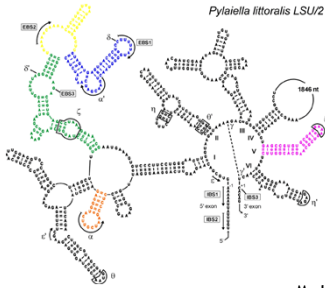
RNA structures are highly organized

- Primary (5' GGGCGUG...etc)
- Secondary (could you have predicted it?)
- Tertiary (could you have predicted it?)
- Red dots are modified bases



RNA structures are highly organized

Pyraliella littoralis LSU2



Model of a group II intron showing
Extensive pairing with itself (p295).
This is a _____ structure.

The Basic Structural Forms for DNA and RNA - Is That All There Is?*

DNA can be **extensively** modified in the cell . These modifications are normally **post replication**.

While there are many modifications we will only discuss (later) the methylation of cytosine. 5-methylcytosine (5MeC) is implicated in the regulation of eucaryotic genes.

RNA can be **extensively** modified in the cell . These modifications are normally **post transcriptional**.

While there are many modifications we will only discuss (later) the methylation of guanosine and polyadenylation of mRNA; RNA editing that changes cytosine to uridine; and some modifications in tRNA that affect structure.

More information about these can be found in Supplemental Information on the BIO1140 WEB site. I suspect more are waiting to be discovered.

What lessons can we draw from these examples?

- chemistry is important for structure and function
- tertiary structure is important for correct binding of proteins
- structures are dynamic and can be affected by
- can we predict the structure?



We can conclude that there are many structures for DNA, DNA-Protein, RNA, & RNA-Protein in the cell.
This is not surprising because...

BIO 1140 Unit 1-1: DNA & RNA Structure

- Summary
 - Structures of DNA & RNA
- What are the main remaining issues?
- What more do we need to know?

