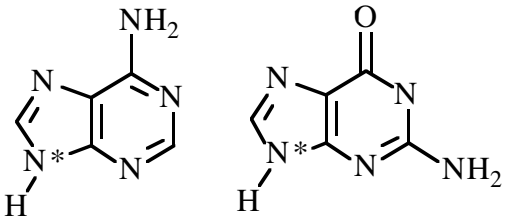
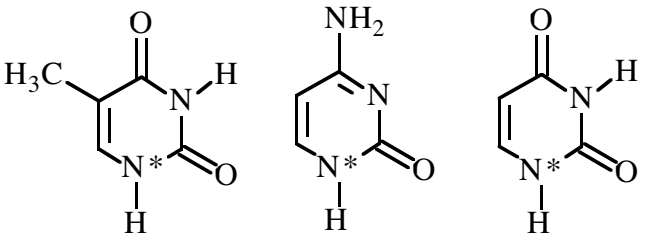
Nucleic Acids: Before we can talk about protein synthesis, we need to introduce the notions of **genetics**, **DNA**, and **RNA**. In order to do this, however, we must first introduce the "players". The building blocks of genes, DNA, and RNA are called **nucleo-tides**, and are made of a pentose (either ribose or deoxyribose), a phosphate, and a **nitrogenous base**. There are five "bases":



Adenine (A) Guanine (G)

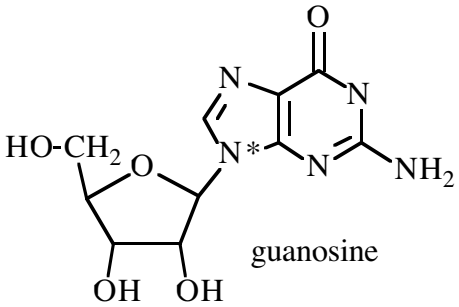


Thymine (T) Cytosine (C) Uracil (U)

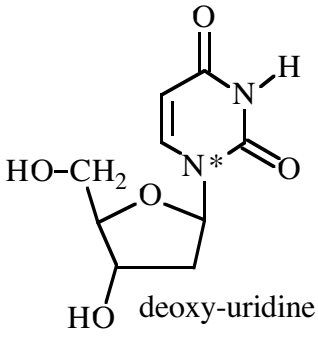
Once the sugar is bound (at the *ed nitrogen), the names change as follows:

base	ribose	deoxyribose
adenine	adenosine	deoxy-adenosine
guanine	guanosine	deoxy-guanosine
thymine	thymidine	deoxy-thymidine
cytosine	cytidine	deoxy-cytidine
uracil	uridine	deoxy-uridine

For example:



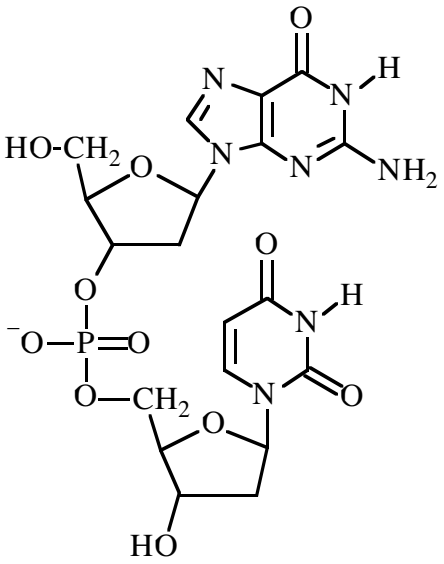
guanosine



deoxy-uridine

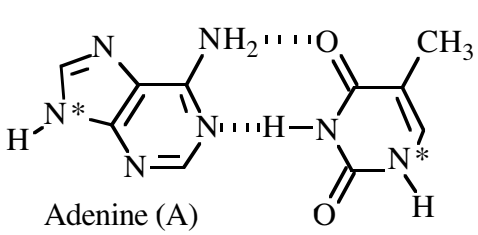
The deoxy variety of the nucleotides are the ones present in DNA (deoxyribose nucleic acids) and the regular ones are in RNA (ribose nucleic acids). The phosphate group binds to the hydroxide on carbon 5 of the sugar.

Both RNA and DNA are chains of nucleotides connected to each other via phosphate esters at the 3 carbon hydroxide:



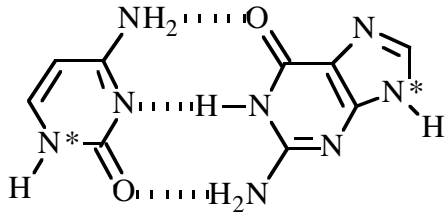
In DNA, two long strands of nucletides bound bound by **3-5 phosphodiester linkages** are held together at the nitrogenous bases in what is called **Watson and Crick base paring**. The base pairs are two different bases that "complement" each other. In DNA, these are adenine-thymine (**A-T**) and guanine-cytosine (**G-C**). The uracil base only occurs in RNA, and the thymine base only appears in DNA. This will make more sense later.

The base pairing is carried out by several (2 or 3) hydrogen bonds between the nitrogens, the amine hydrogens, and the oxygens of the bases. The two mentioned above are:



Adenine (A)

Thymine (T)



Cytosine (C)

Guanine (G)

The broken lines correspond to the hydrogen bonds. These interactions are surprisingly strong, especially since they are non-covalent, and the DNA "super molecules" are the single largest molecules in our bodies.

Genetic Code: The DNA molecules are store-houses of information. The order of the base pairs (the so-called **sequence**) is non-random, but reads linearly to describe how to make proteins. In fact, the base pairs on each DNA strand are grouped into groups of three bases that correspond to different amino acids. This sequence of three bases is called the **genetic code**. The DNA holds the information until needed. When the body needs to synthesize a protein, the part of the DNA corresponding to that protein (called a

gene) unpairs, and an RNA molecule is synthesized. This type of RNA is called **messenger** RNA (**mRNA**), since it sends the message to the "protein making machines" (known as the **ribo-somes**) to make the protein.

The mRNA is made by making base-pairs to the DNA with ribose nucleotides (instead of deoxyribose), where uridine forms a base pair with adenosine (instead of thymidine). The groups of three base pairs on the mRNA are called **codon**s. The following table lists the amino acids that correspond to the various codons:

UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys
UUC	"	UCC	"	UAC	"	UGC	"
UUA	Leu	UCA	"	UAA	STOP	UGA	STOP
UUG	"	UCG	"	UAG	"	UGG	Trp
CUU	Leu	CCU	Pro	CAU	His	CGU	Arg
CUC	"	CCC	"	CAC	"	CGC	"
CUA	"	CCA	"	CAA	Gln	CGA	"
CUG	"	CCG	"	CAG	"	CGG	"
AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser
AUC	"	ACC	"	AAC	"	AGC	"
AUA	"	ACA	"	AAA	Lys	AGA	Arg
AUG	Met	ACG	"	AAG	"	AGG	"
GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly
GUC	"	GCC	"	GAC	"	GGC	"
GUA	"	GCA	"	GAA	Glu	GGA	"
GUG	"	GCG	"	GAG	"	GGG	"