Understandings:

1. State that DNA and RNA are two types of nucleic acids, and those in turn are made of nucleotides.

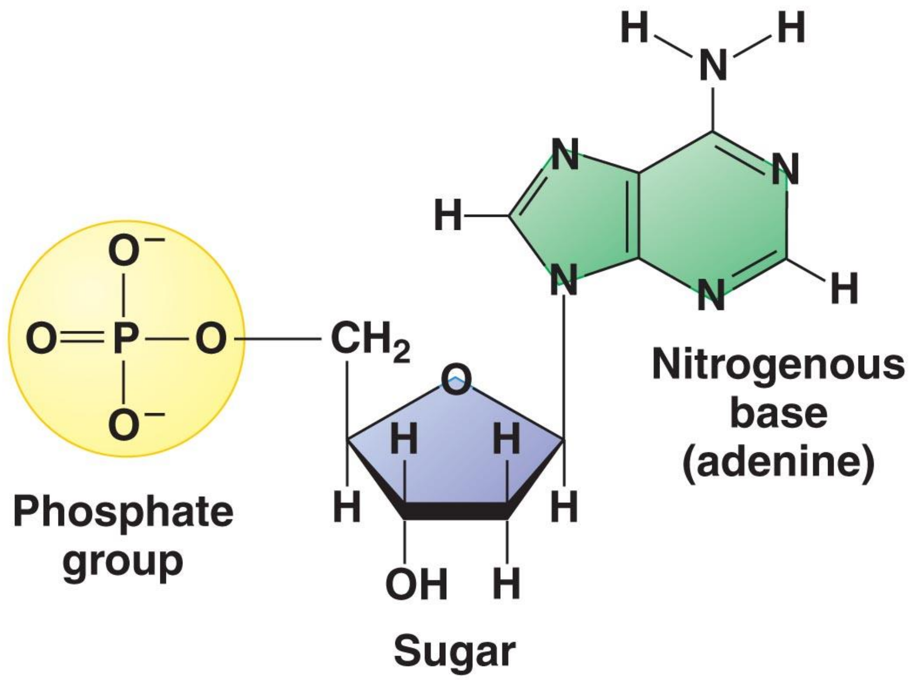
- Nucleic acids come in two forms: DNA and RNA, and the difference will be explained in next segment. Nucleic acids are basically polymer of nucleotides.

Then how does a nucleotide look like? It consists of three main parts:

1. A five carbon sugar in middle, as deoxyribose or ribose depending on whether it is DNA or RNA.
2. A phosphate group PO_4^{3-} that makes the nucleotide negatively charged and acidic**.**
3. A nitrogen base that come in 4 forms. For DNA, those are adenine, cytosine, guanine and thymine. For RNA, those are adenine, cytosine, guanine and uracil.

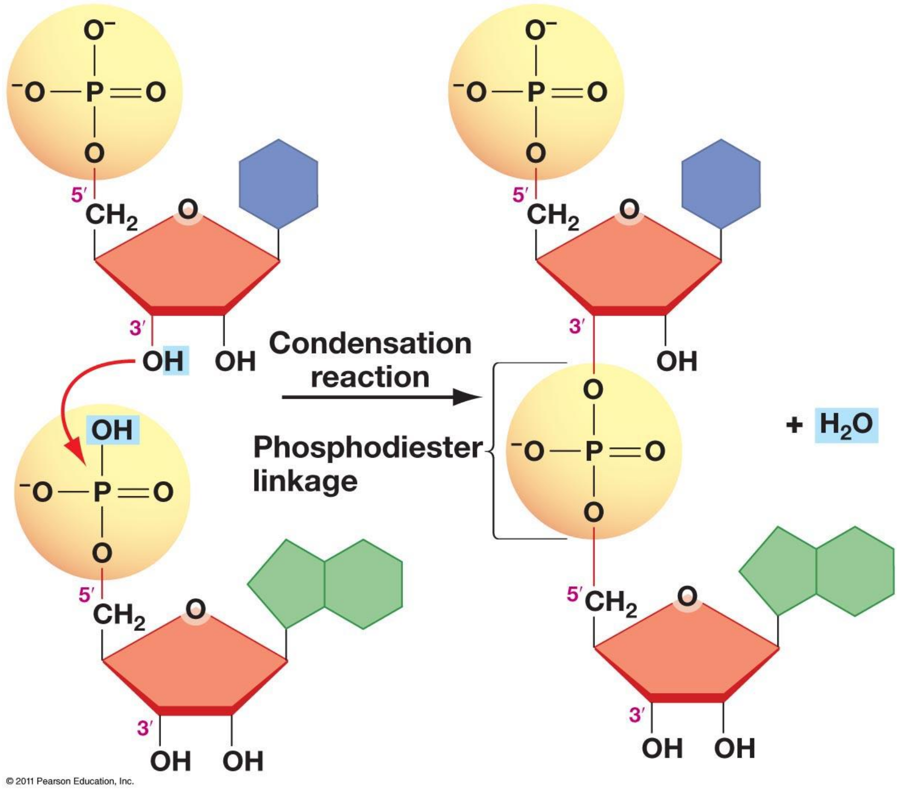
The different structures are held by covalent bonding hence strong bonds.

Together, they should look something like this (this is DNA, not RNA because we have “deoxided” in Carbon 2’.



When we want to make a polymer of the nucleotides, to form nucleic acids, we use covalent bonding again between upper O^- of phosphate group and Carbon 3' in sugar.

So our nucleic acid will look like this:



As usual, we have condensation taking place.

We can see that this is RNA since we now have oxygen in 2'.

The important thing here is that bases do not affect this bonding. What does that mean? It means that the nucleotides may bond in any order hence generate any sequence hence store any information**.** This is the remarkable key to information storing in DNA.

So they have different assigned roles in their play.
Bases store information.
Phosphate and sugar makes stable, strong bonding.

Extra notes

- Why is it even called nucleic acid when you have base pairs? The answer was indirectly answered above. When the nucleic acids eventually bind with other nucleic acids, the bases get buried into hydrogen bonding and the backbone is phosphate**.** Hence the DNA appears to have acidic properties. Also, since phosphate group makes the molecule negative, it had the ability to accept electron pair, which is acidic property**.**

Why use prime for carbon? This is to **not mix up with the carbon in the base**. Since the carbon in **base is not so significant for bonds**, we just name the carbons in sugar uniquely.

2. Outline the difference between DNA and RNA.

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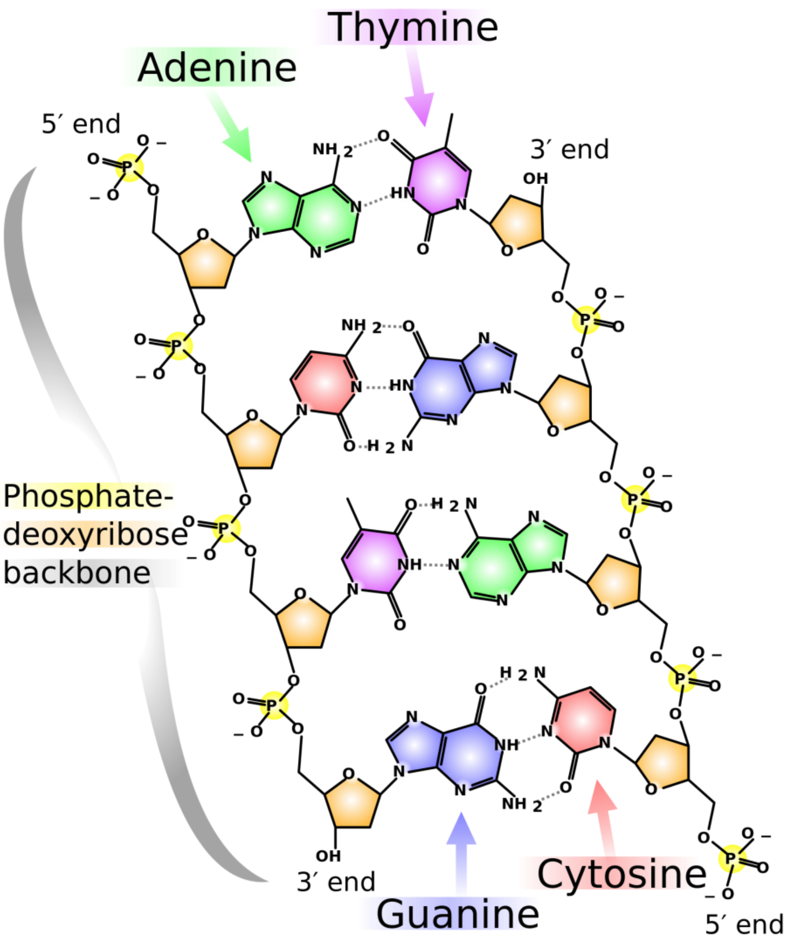
DNA	RNA
One fewer oxygen than RNA, hence the name deoxyribonucleic acid. Sugar has formula of $C_5H_{10}O_4$	Sugar has formula of $C_5H_{10}O_5$.
Double stranded (helix).	Single stranded.
The sugar type in the nucleotide is deoxyribose.	The sugar type in the nucleotide is ribose.
The nitrogen bases they have are Adenine, Cytosine, Guanine and Thymine.	The nitrogen bases they have are Adenine, Cytosine, Guanine and Uracil instead of Thymine.

3. Explain the structure of the DNA.

- So what happens when the nucleic acids of DNA bind together?

When these long polymers of nucleotides bind, they will first of all form a double helix. The direction of one of the helixes will be opposite from the other. Here is a picture.



As you can see, the direction of the left nucleic acid is upside down.

Another thing to notice is its complementary base pairing. Only A binds with T, vice versa and only G binds with C, vice versa.

This is due to the number of possible hydrogen bonds forming. If A would bind with G or C, an extra potential hydrogen bond will be left hence make the molecule instable. Thus it is like the grammar of information storing!

Applications and skills:

1. Explain how Watson and Crick discovered the double helix structure of DNA using modelling.
- Model comes from the Latin word modus, which means method. Thus models were, and still are, preliminary plans of how something might look like, such as buildings.

In molecular biology, these kinds of models are common as well. People propose models, test it and either accept or reject.

Watson and Crick did similarly in structure of DNA. I tried to make a brief timeline of their work.

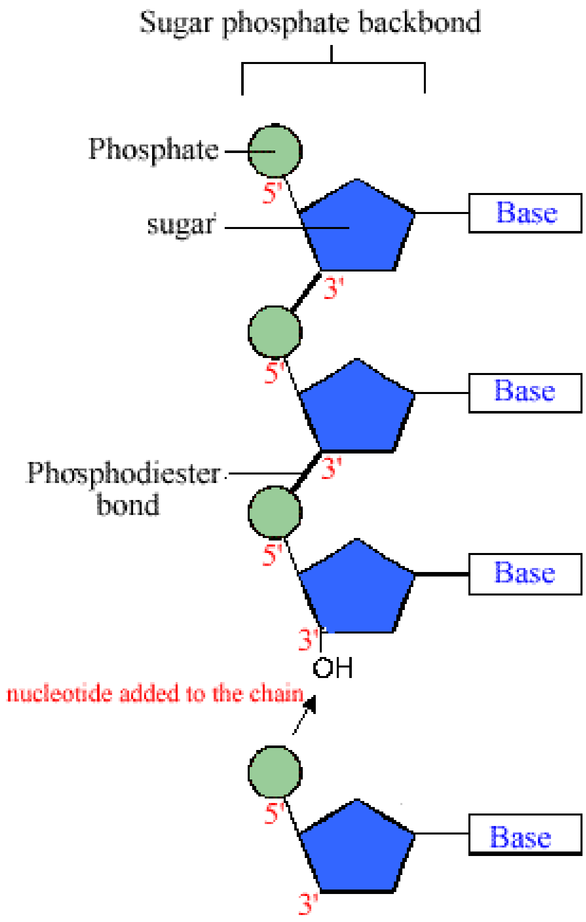
1. Initial model was a triple helix held by ionic bonds with magnesium, with the bases facing outwards with no bonding with other bases. But this was rejected when Franklin said there was not enough magnesium, and Chargaff's study showed that number of A=T and G=C.

2. Chargaff's study hinted that A binds with T and G binds with C through hydrogen bonding. All the other quantities fitted so that phosphates could bind with sugar molecules.

3. Crick and Watson noticed that the strands had to run in opposite direction in order for molecules to fit together. This is the model we know of today.

2. Draw simple diagrams of nucleotides using circles, pentagons and rectangles as phosphate, sugar and base respectively.

- Basically, do like this.



Just keep in mind of which carbons bond with the different parts.

Carbon 1' – Base

Carbon 3' – Other phosphate

Carbon 5' - Phosphate

TOK:

1. The story of the elucidation of the structure of DNA illustrates that cooperation and collaboration among scientists exists alongside competition between research groups. To what extent is research in secret 'anti-scientific'?

2. What is the relationship between shared and personal knowledge in the natural sciences?