Nucleic acids

DNA & RNA

Objectives :

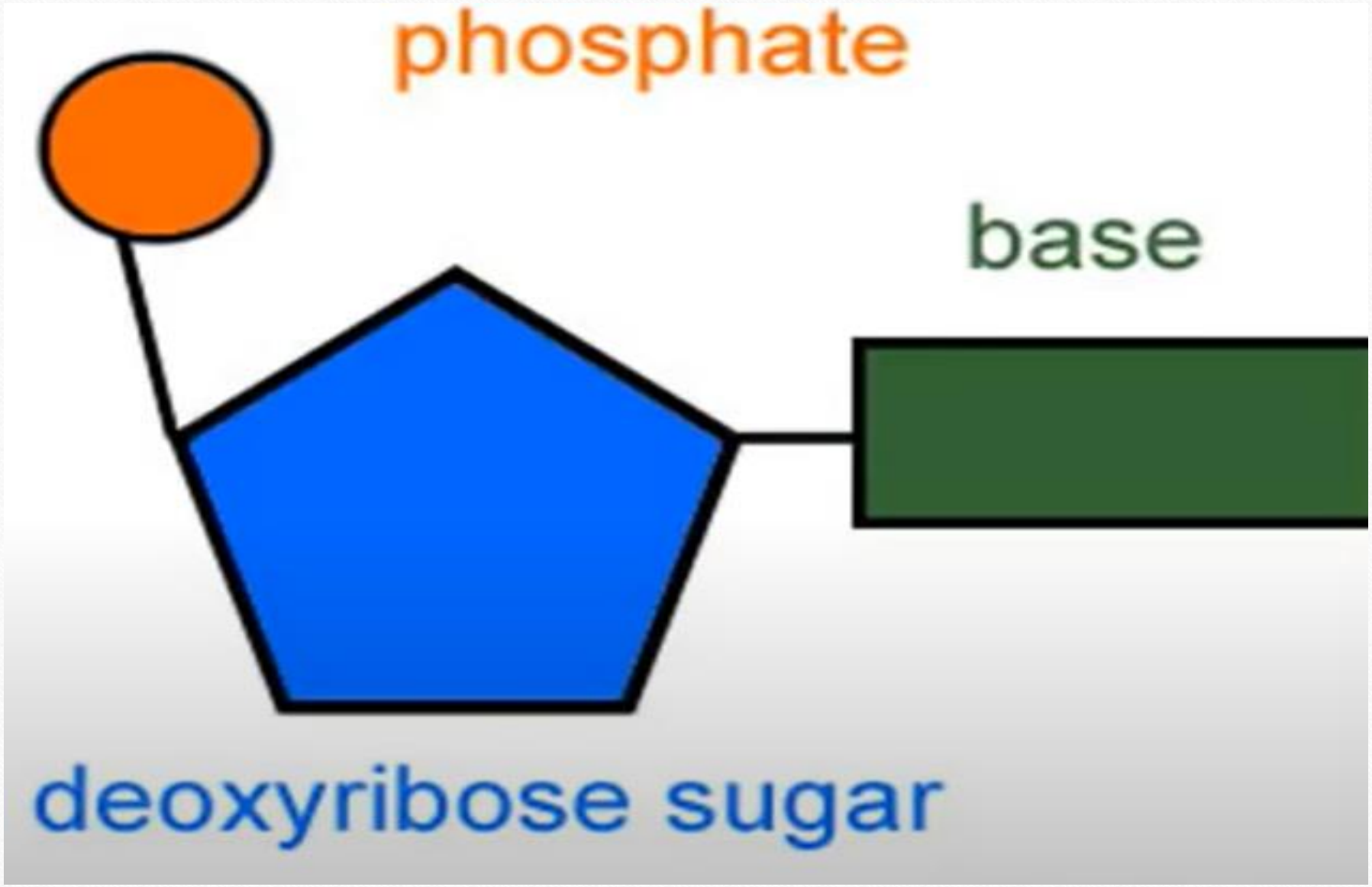
- Describe the structure of nucleotides
- Describe the structures of RNA and DNA
- Compare and contrast between the structure of DNA and RNA
- Draw simple diagrams of the structure of single nucleotides of DNA and RNA, using circles, pentagons and rectangles to represent phosphates, pentoses and bases.
- Describe the use of models as a representation of the real-world using Watson and Crick's DNA model as an example.

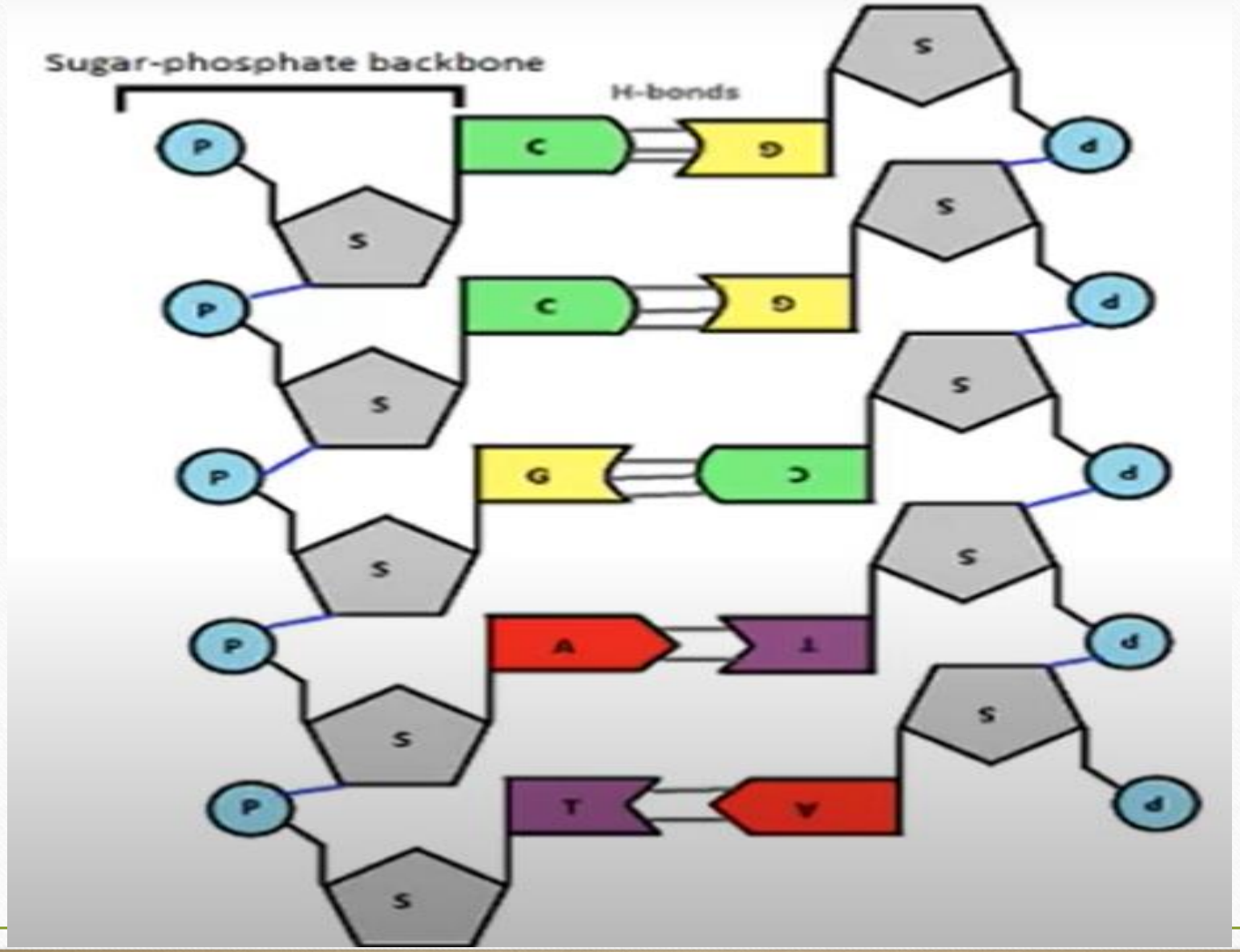
Resources :

Book pages 39,40,41

https://www.youtube.com/watch?v=5wp8gBflWtA

Genetics 101 | National Geographic – YouTube introduction


phosphate
base
deoxyribose sugar


Sugar-phosphate backbone
H-bonds
P
S
C
G
A
T

Nucleic acids

Are macromolecules that hold the genetic information which provide instructions for the formation of proteins essential for life. This information is passed from parents to offspring. There are two types of nucleic acid:

deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).

Nucleotides

Nucleic acids are composed of nucleotides that are linked together.

Each nucleotide consists of three main parts (figure 20):

1. A phosphate group
2. A pentose sugar (ribose in RNA, deoxyribose in DNA)
3. A nitrogenous base; which could be adenine, guanine, thymine, or cytosine (uracil replaces thymine in RNA).

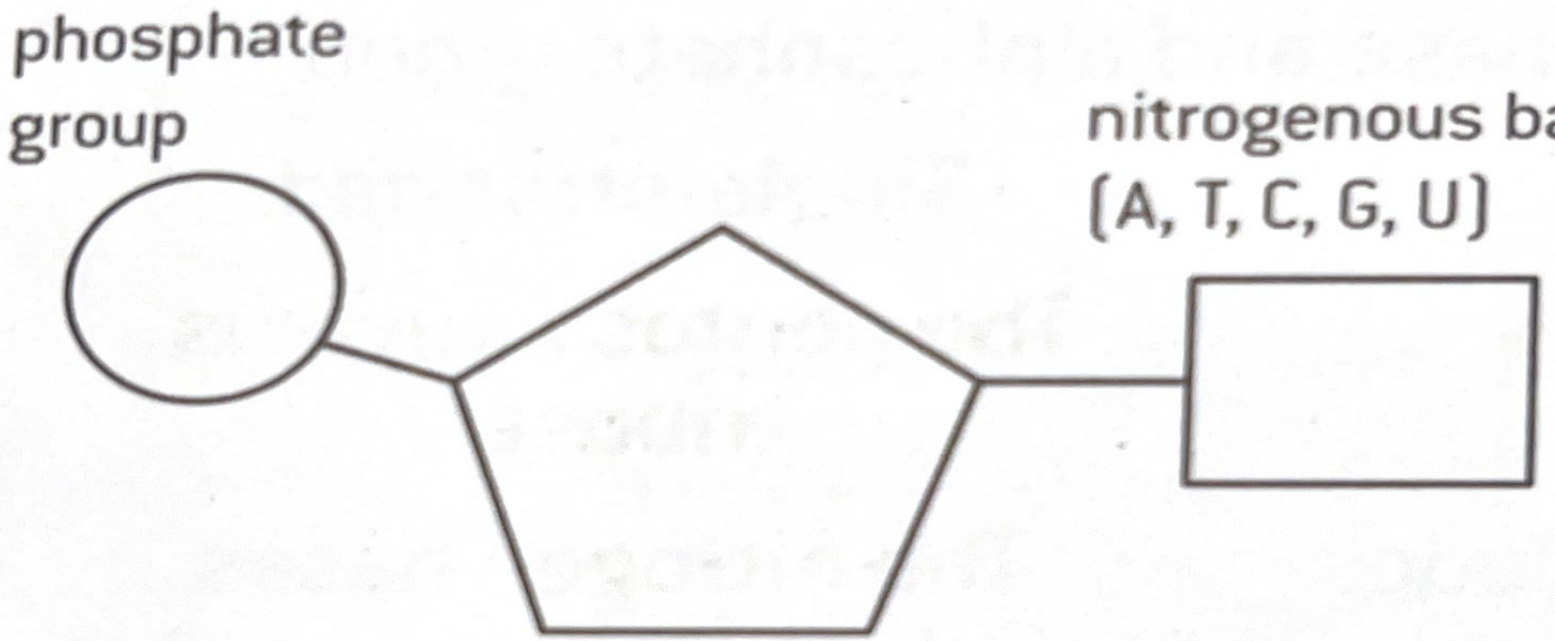


Figure 20. Nucleotide structure

RNA structure :

RNA is a single-stranded nucleic acid that consists of ribose sugar. It has the same nitrogen bases as DNA with the exception of thymine which is replaced by uracil. It **exists in several forms**, and each has a unique function in the body. For example, messenger RNA (mRNA) and transfer RNA (tRNA) play important roles in the synthesis of proteins. Ribosomal RNA (rRNA) is a component of the ribosome which is the site for protein synthesis.

DNA structure

The DNA molecule is made of two strands that wind around each other like a twisted ladder, called a double helix structure. Each strand consists of nucleotides which are linked together via covalent bonds. The sugar and phosphate groups form the backbone of the double helix, while the nitrogen bases are found in between the two strands attached to each sugar. The two strands are held together by a hydrogen bond that links the bases together, where adenine pairs with thymine and **cytosine pairs with guanine**. This is referred to as complementary base pairing. Adenine forms two hydrogen bonds with thymine whereas guanine forms three hydrogen bonds with cytosine.
Although the hydrogen bonds between the two strands are weaker than the covalent bonds, they are strong enough to keep the double helix in shape (figure 21).

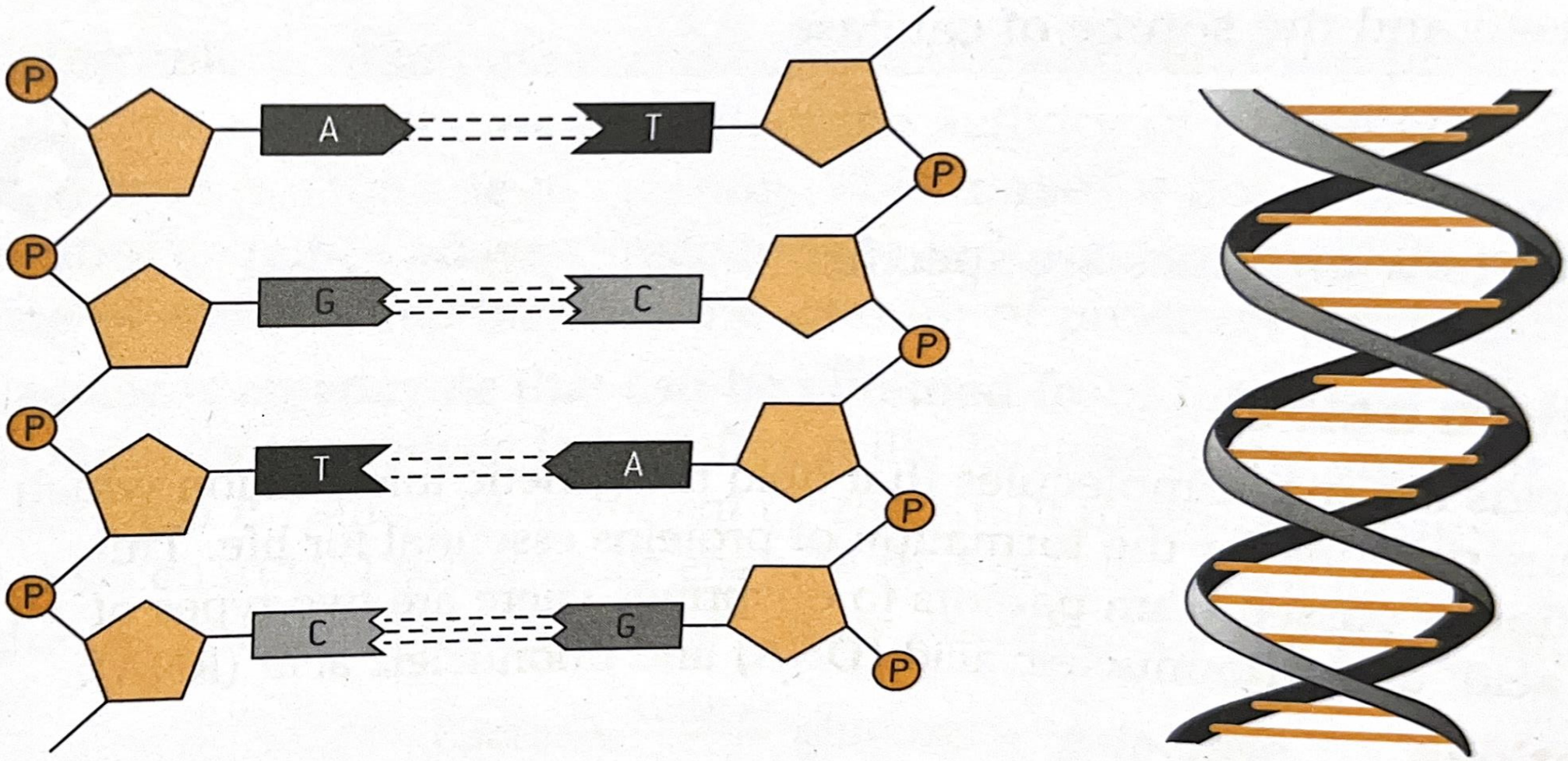
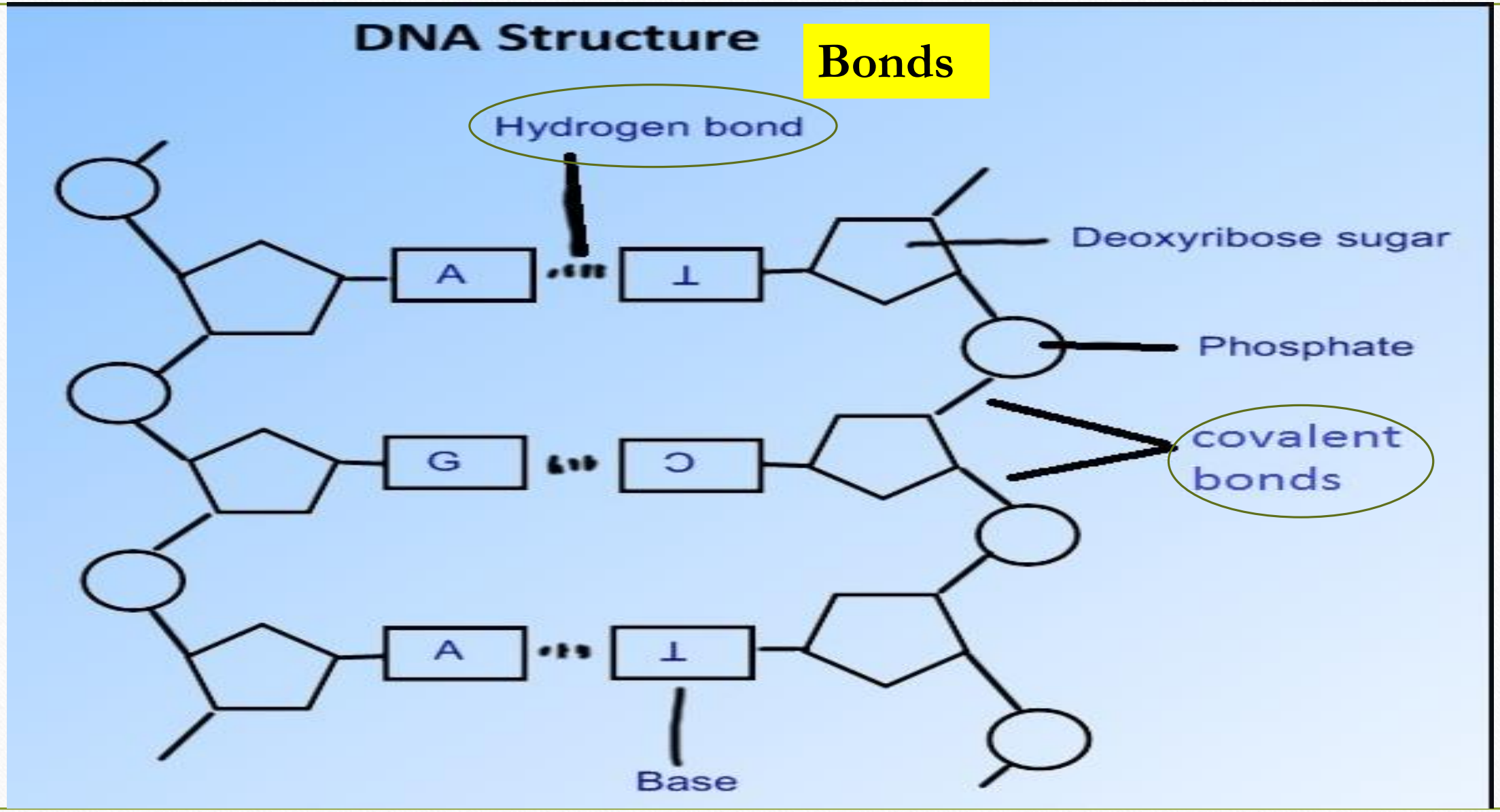
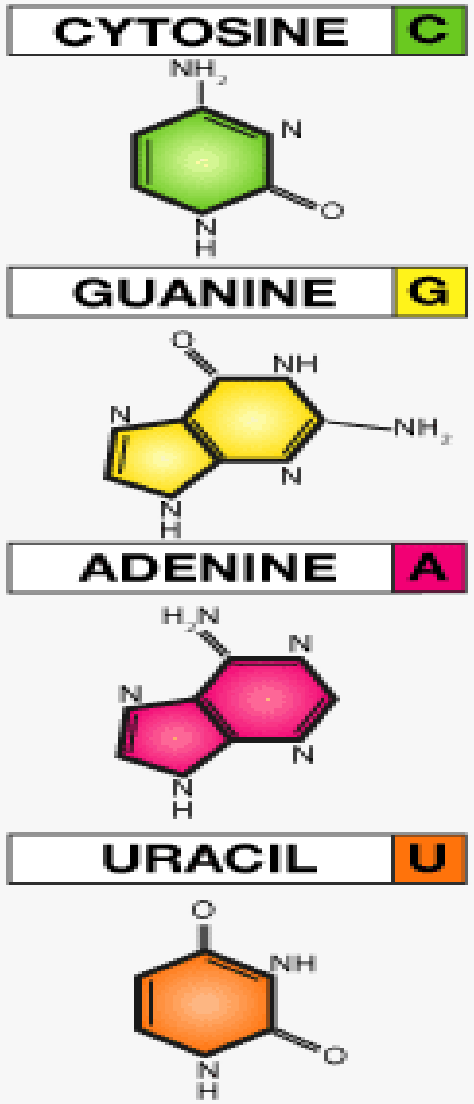
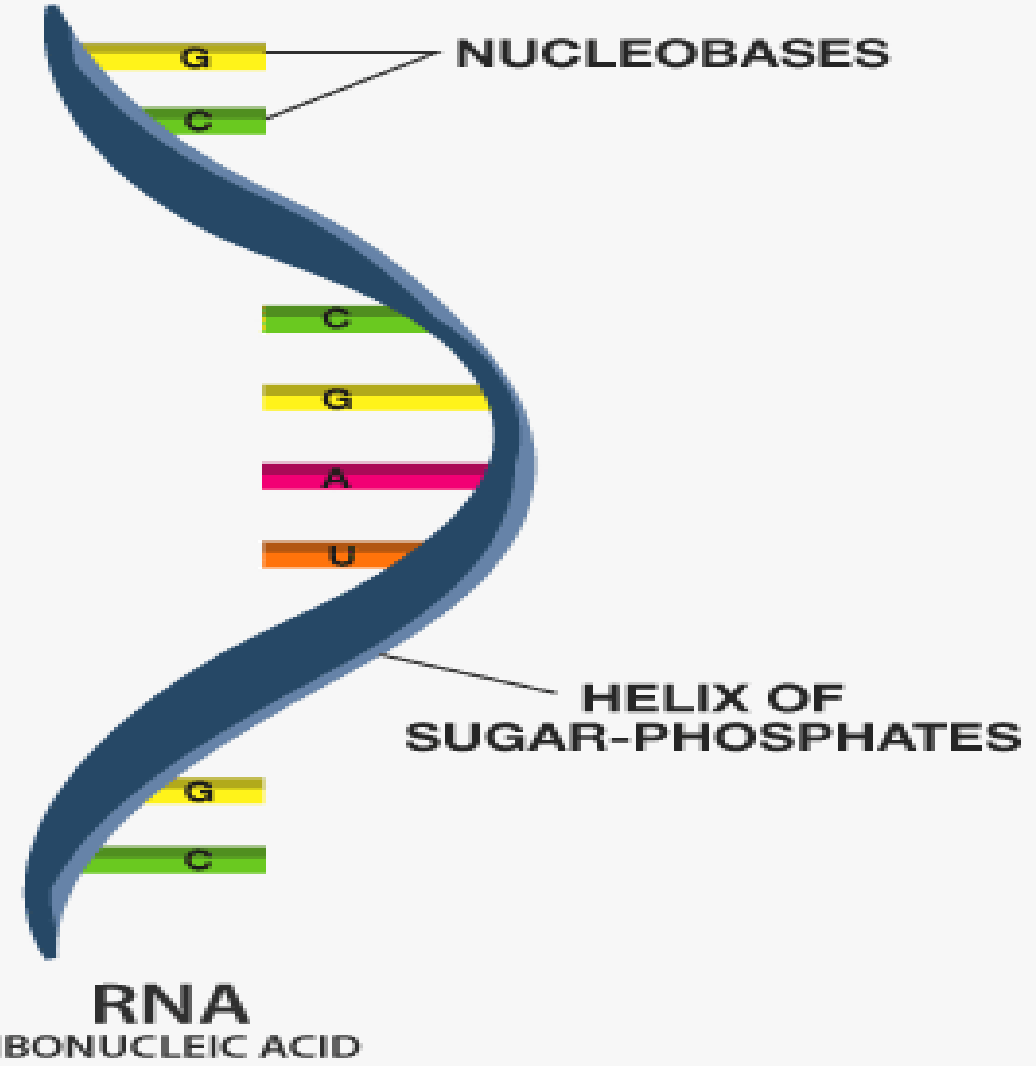


Figure 21. Left: Structure of DNA; right: DNA double helix


DNA Structure
Bonds
Hydrogen bond
Deoxyribose sugar
Phosphate
covalent bonds
A
T
G
C
A
T
Base

RNA


CYTOSINE C
GUANINE G
ADENINE A
URACIL U

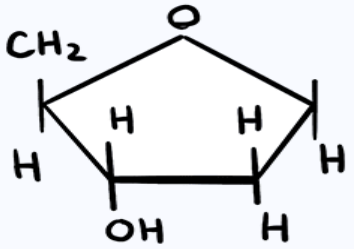

G
C
NUCLEOBASES
C
G
A
U
HELIX OF
SUGAR-PHOSPHATES
G
C
RNA
RIBONUCLEIC ACID

DNA vs. RNA

DEOXYRIBONUCLEIC ACID

DOUBLE-STRANDED SUGAR* PHOSPHATE

* DEOXYRIBOSE

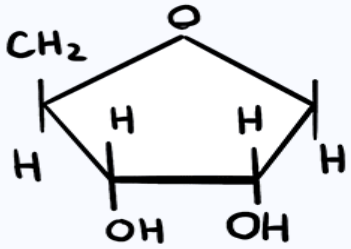


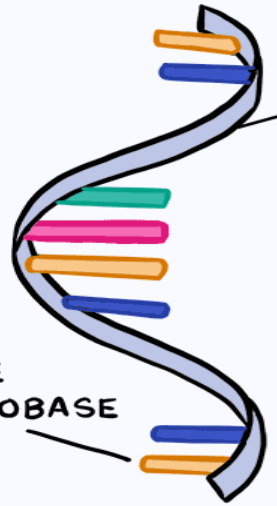
BASE PAIR

RIBONUCLEIC ACID

USUALLY SINGLE-STRANDED SUGAR* PHOSPHATE

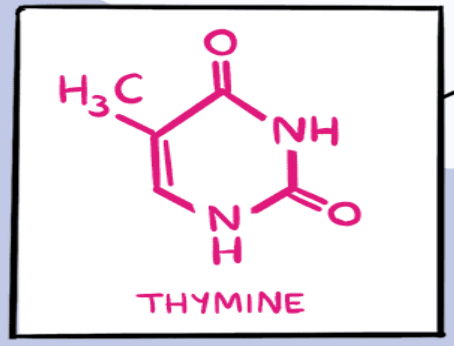
* RIBOSE



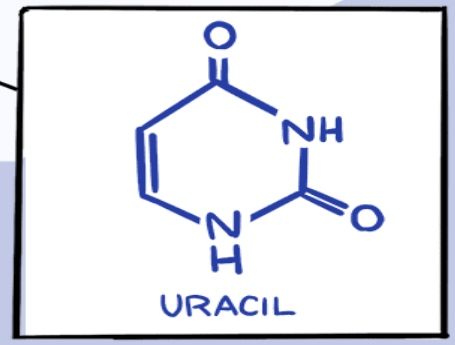


SINGLE NUCLEOBASE

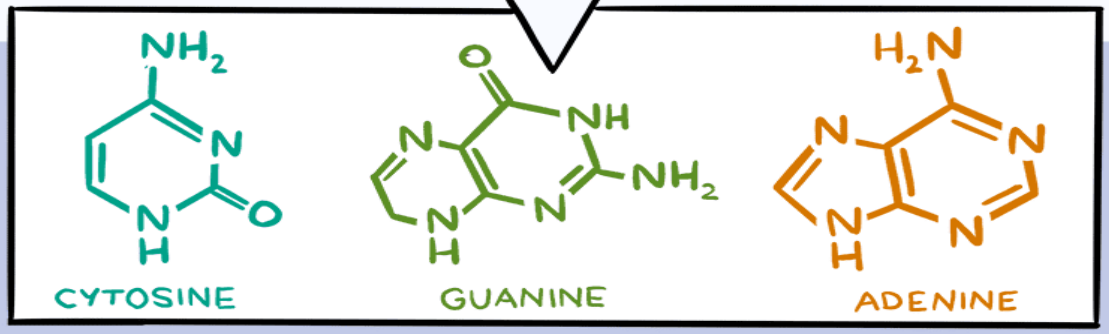
NUCLEOBASES



THYMINE



URACIL



CYTOSINE GUANINE ADENINE

ThoughtCo.

Table 7. Similarities and differences between DNA and RNA

Feature	DNA	RNA
Similarities	• both are nucleic acids • both consist of nucleotides which contain a pentose sugar, a nitrogenous base and a phosphate group	
Differences	Double-stranded	Single-stranded
	The pentose sugar is deoxyribose	The pentose sugar is ribose
	The nitrogen bases include: adenine, guanine, cytosine, thymine	The nitrogen bases include: adenine, guanine, cytosine, uracil

Describe the use of models as a representation of the real-world using Watson and Crick's DNA model as an example.

https://www.youtube.com/watch?v=V6bKn34nSbk
https://www.youtube.com/watch?v=BIP0lYrdirI

https://www.sciencebuddies.org/stem-activities/candy-DNA-model

MODEL MAKING AND THE DISCOVERY OF THE STRUCTURE OF DNA

Model making played a critical part in Crick and Watson's discovery of the structure of DNA, but it took several attempts before they were successful. They used cardboard shapes to represent the bases in DNA and found that A–T and C–G base pairs could be formed, with hydrogen bonds linking the bases. The base pairs were equal in length so would fit into a molecule between two outer sugar–phosphate backbones.

Other scientists had produced X-ray diffraction data showing the DNA molecule to be helical. A flash of insight was needed to make the parts of the molecule fit together: the two strands in the helix had to run in opposite directions. Crick and Watson were then able to build their famous model of the structure of DNA.

They used metal rods and sheeting cut to shape and held together with small clamps. Bond lengths were all to scale and bond angles correct. The model immediately convinced others that it represented the real structure of DNA. Further testing of the model confirmed this.