

DNA THE CODE OF LIFE

30 JANUARY 2013

Lesson Description

In this lesson we will discuss the following:

- Location of DNA [chromosomal (genes) & mitochondrial]
- History of the discovery of the DNA molecule (Watson, Crick & Franklin story)
- DNA and RNA are nucleic acids consisting of building blocks called nucleotides
- Three components of a nucleotide as follows:
 - Nitrogenous bases linked by hydrogen bonds
 - 4 nitrogenous bases of DNA: adenine (A), thymine (T), cytosine (C), guanine (G)
 - Pairing of bases in DNA occurs as follows A : T and G : C
 - Sugar portion (deoxyribose in DNA)
 - Phosphate portion
- Functions of DNA
- DNA replication

Key Concepts

Where do we find DNA?

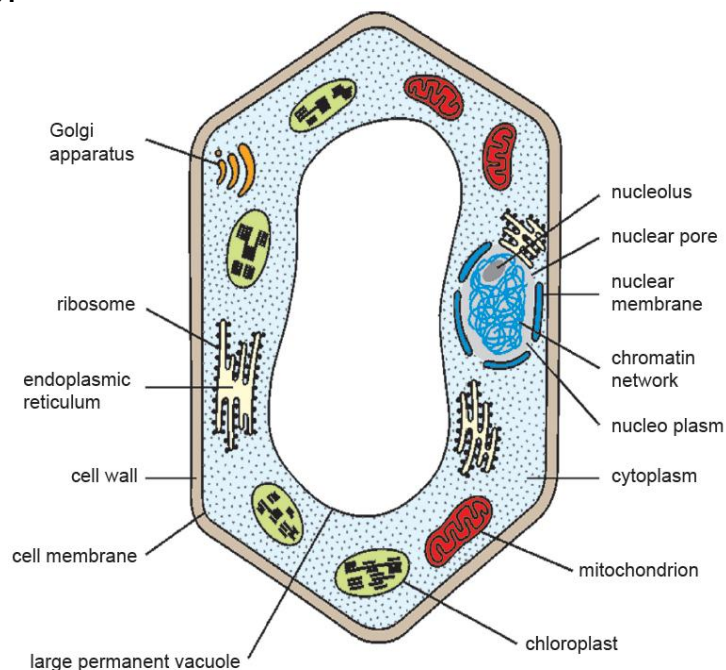
(Life Sciences for All, Chapter 4 DNA and the genetic code)

There are two kinds of nucleic acids:

deoxyribonucleic acid (**DNA**), ribonucleic acid (**RNA**).

DNA is found in the nucleus of **eukaryotic cells** where it forms part of the **chromatin**. Some also found inside the **mitochondria** and **chloroplasts** of these cells.

Figure 4.1 A typical Plant Cell



(Life Sciences for All, Chapter 4 DNA and the genetic code, pg 183)

The Structure of DNA

(Life Sciences for All, Chapter 4 DNA and the genetic code)

DNA is a polynucleotide. A polynucleotide is a very large molecule made up of a string of repeating units called **nucleotides**.

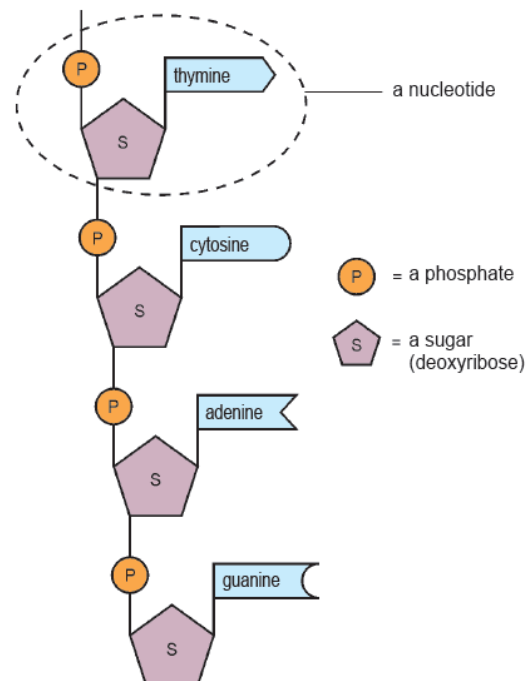
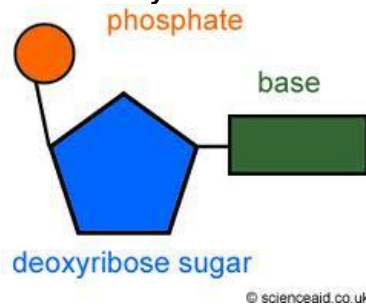
Each DNA nucleotide consists of three parts:

- one **deoxyribose** sugar molecule
- one **phosphate** group
- one **nitrogen-containing base**.

There are four possible bases that can form part of a nucleotide:

- **adenine (A)**
- **thymine (T)**
- **guanine (G)**
- **cytosine (C)**

Figure 4.2 A Polynucleotide



Adenine and guanine are **double-ringed molecules** called **purine bases**. Thymine and cytosine are **single-ringed molecules** called **pyrimidine bases**.

Table showing the percentage of each of the four bases found in the DNA from different organisms

Source of DNA	Percentage of the different bases found in the DNA			
	Adenine	Guanine	Thymine	Cytosine
Man	30,9	19,9	29,4	19,8
Chicken	28,8	20,5	29,2	21,5
Salmon	29,7	20,8	29,1	20,4
Locust	29,3	20,5	29,3	20,7
Wheat	27,3	22,7	27,1	22,8

(Life Sciences for All, Chapter 4 DNA and the genetic code, Page 184)

History - Discovery of DNA

- **Frederick Griffith** – Discovers that a factor in diseased bacteria can transform harmless bacteria into deadly bacteria **(1928)**.
- **Rosalind Franklin and Maurice Wilkins** - X-ray photo of DNA **(1952)**.
- **Watson and Crick** - described the DNA molecule from Franklin's X-ray **(1953)**.
- **Watson crick and Wilkins** – received Nobel Prize **(1962)**. Franklin passed away.

DNA is actually two polynucleotide strands lying side by side, and held together by hydrogen bonds which connect pairs of bases. As was suggested by Chargaff's research, the bases are always paired up in a particular way: a pyrimidine base with a purine base, adenine with thymine and cytosine with guanine. We call this complementary base pairing. The DNA molecule is twisted around its own central axis to give a three-dimensional shape called a double helix. There are 10 base pairs for every complete twist of the helix. The resulting structure looks rather like a ladder with the alternating sugar and phosphate groups forming the sides, and the complementary base pairs forming the rungs or steps of the ladder.

Figure 4.5 Structure of DNA

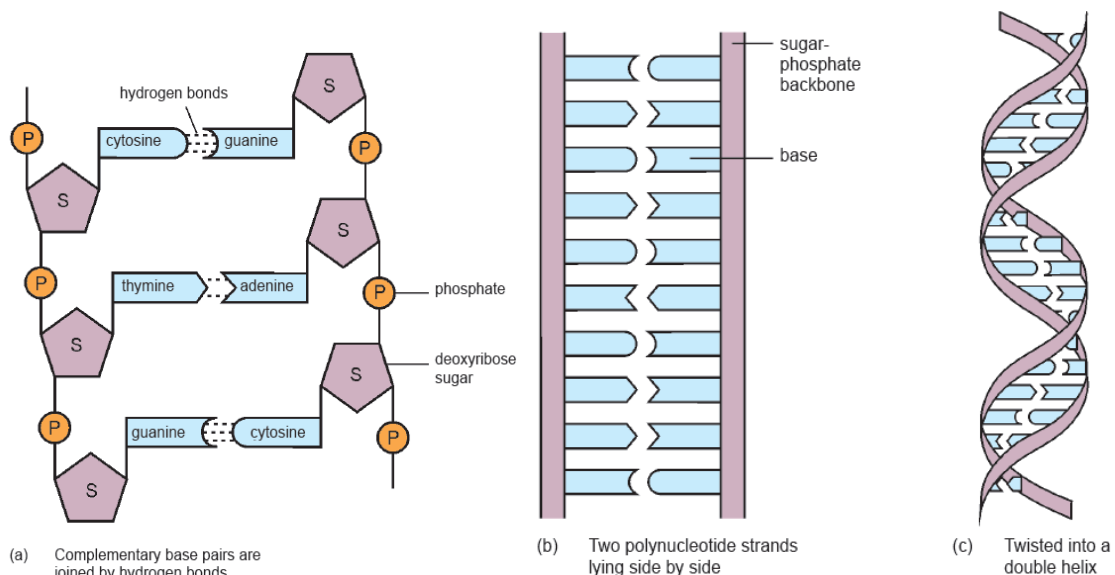


Figure 4.5 (Life Sciences for All, Chapter 4 DNA and the genetic code, Page 185)

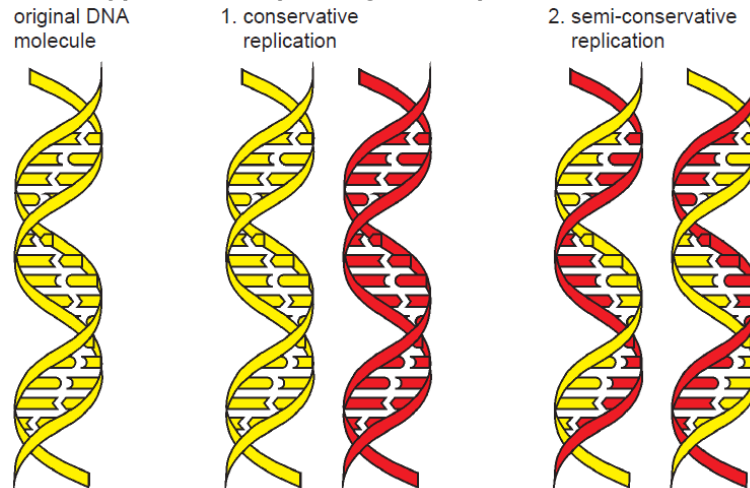
Functions of DNA

- Carry hereditary information
- Contains coded information for protein synthesis

DNA replication

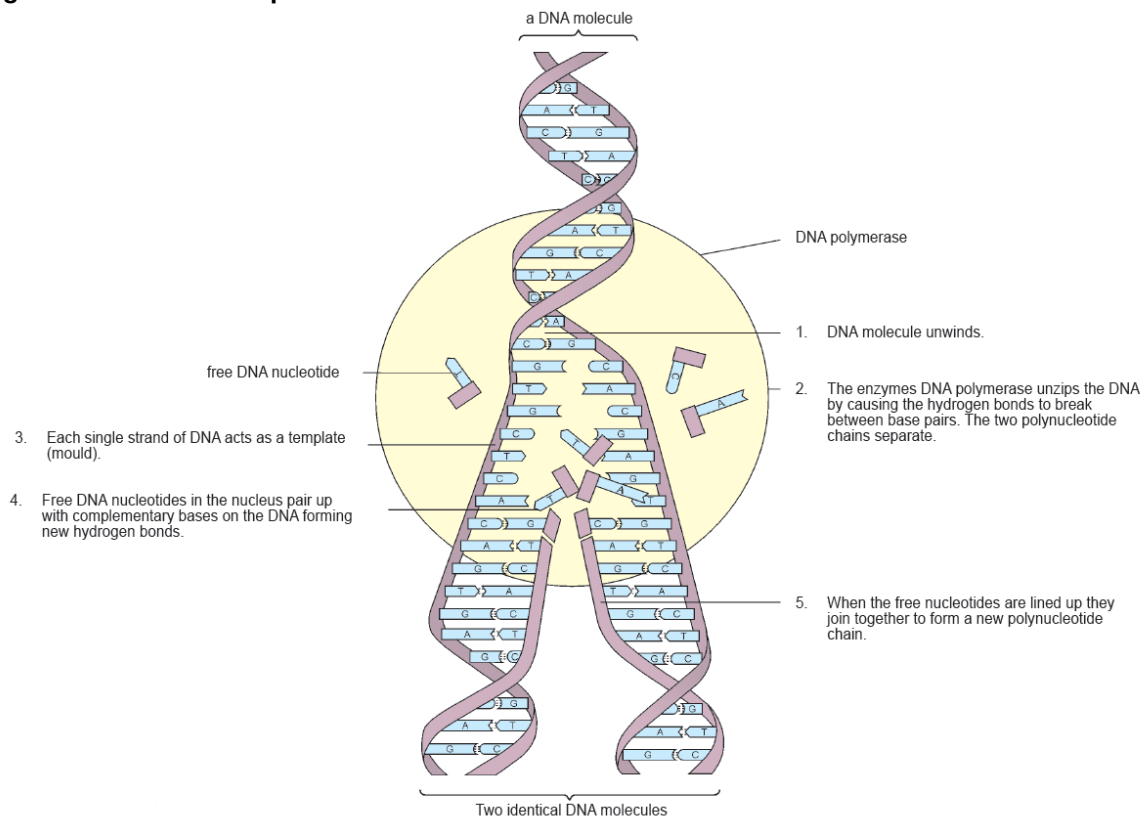
- Process whereby DNA in the original cell has to produce an exact copy of itself
- Where? Nucleus
- When? Interphase of cell division
- Why? So that genetic code is passed on to each new daughter cell formed during cell Division

Figure 4.7 Different hypotheses explaining DNA replication



(Life Sciences for All, Chapter 4 DNA and the genetic code, Page 188)

Figure 4.9 DNA Replication



(Life Sciences for All, Chapter 4 DNA and the genetic code, Page 189)

- The DNA double helix molecule **unwinds** so that it is not a double helix any more but a flat double-stranded polynucleotide chain.
- The **enzyme** DNA polymerase **unzips** the DNA molecule by causing the hydrogen bonds between the complementary base pairs to break. The two single strands of DNA separate.
- Each single strand of DNA acts as a **template** or mould as each base can only pair up with its complementary base.
- Free nucleotides in the nucleus pair up with their complementary bases on the two single strands of DNA, forming two new polynucleotide chains. Hydrogen bonds form between the complementary base pairs. – **Re-zips**
- Each single strand of DNA becomes a new double strand. The two new double strands separate from each other as DNA replication is completed.
- Each new strand of DNA rewinds to form a **double helix again** and there are now two identical DNA molecules. **Rewind**

Questions

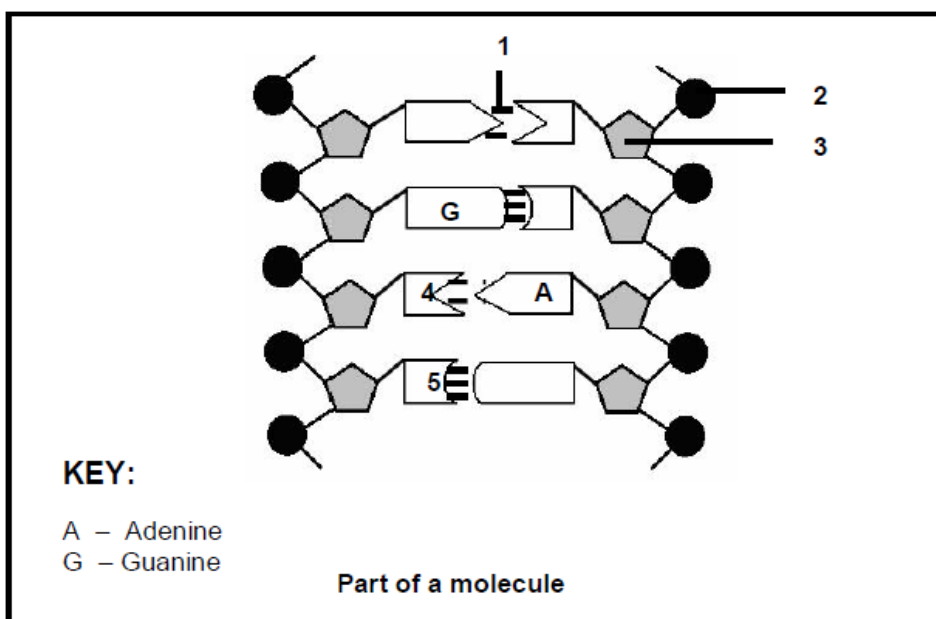
Question 1

Give the correct biological term for the following:

- The base that pairs with thymine
- The building blocks of proteins
- The bonds that hold the two polynucleotide strands of a DNA molecule together
- Repeating units (monomers) that form a nucleic acid
- Sugar that forms part of DNA
- The shape of a DNA molecule.

Question 2

The diagram below represents a part of a molecule. Study the diagram and answer the questions that follow.



- a.) Identify the molecule in the above diagram. (1)
- b.) Label the parts numbered 1 and 5 respectively. (2)
- c.) What is the collective name for the parts numbered 2, 3 and 4? (1)
- d.) What is the significance of this molecule being able to replicate itself? (2)

Question 3

When a sample of DNA was analysed, 31% of the bases were found to be cytosine.

- a.) What percentage of guanine would you expect to find in the sample?
Show how you worked out your answer. (3)
- b.) What percentage of thymine would you expect to find in the sample?
Show how you worked out your answer. (3)

Links

<http://www.youtube.com/watch?v=zdDkiRw1PdU>