

# STRUCTURE OF DNA

Topic 1

Year 10 Biology



# TOPIC 1 – STRUCTURE OF DNA

## Things to cover:

1. History
2. Location
3. Components
4. Base pairing
5. Shape

## Work to do:

1. Worksheet – Nuclear Matter (questions & mind-map)
2. Worksheet – DNA Structure (questions & colouring)
3. Textbook Qs – Ex1.6 p24 → Q1-5, 7-9, 17
4. Discussion – Ex1.6 p24 → Q20 & eBook<sup>plus</sup>

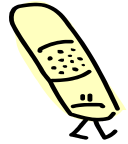
## Ideas to know:

- Friedrich Miescher
- Erwin Chargaff
- Rosalind Franklin
- Maurice Wilkins
- James Watson & Francis Crick
- DNA
- Location of DNA
- Nucleotide
- Components of a nucleotide
- Pentose sugars
- Nitrogen bases
- Base pairing rule
- Double helix
- Sugar-phosphate backbone
- Hydrogen bond
- Covalent bond

# HISTORY OF DNA

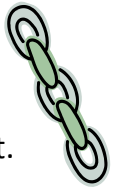
1869

- DNA was discovered by \_\_\_\_\_
- His team isolated it from pus on bandages!
- He called their discovery \_\_\_\_\_.



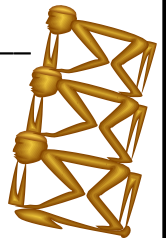
1929

- \_\_\_\_\_ determined that the compound had a \_\_\_\_\_ structure.
- He called these repeated units \_\_\_\_\_.
- He also suggested that these units link together to form \_\_\_\_\_.
- His theory was correct, but his prediction about the way the chains formed was not.



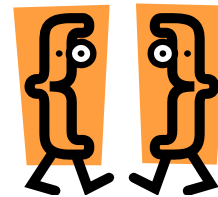
1943-1953

- \_\_\_\_\_, and **Alfred** \_\_\_\_\_ and **Martha** \_\_\_\_\_ made the suggestion that this compound was capable of \_\_\_\_\_ between generations



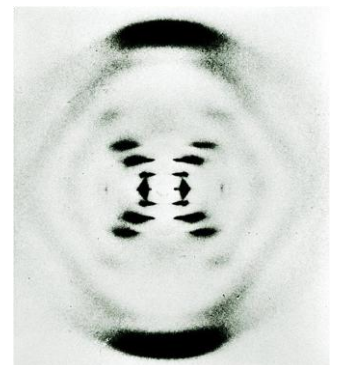
1950

- \_\_\_\_\_ determined that there were \_\_\_\_\_ types of \_\_\_\_\_ that \_\_\_\_\_ within the structure of DNA
- This is known as **Chargaff's rule** or the \_\_\_\_\_ rule.



1953

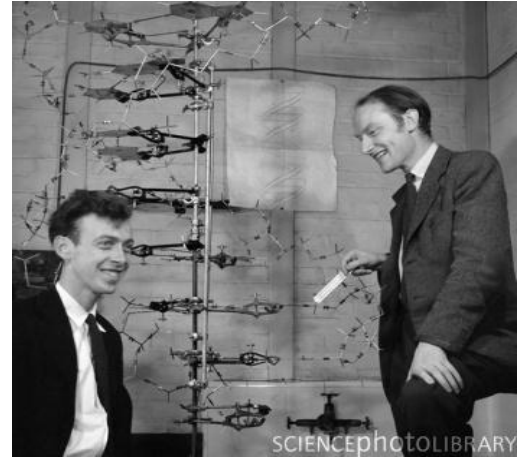
- \_\_\_\_\_ came very close to solving the DNA structure
- She made \_\_\_\_\_ portraits of DNA in order to try to determine its \_\_\_\_\_.
- Her work was given \_\_\_\_\_ *her* \_\_\_\_\_ to a group of scientists in another laboratory by her colleague, \_\_\_\_\_.



# HISTORY OF DNA

## 1953 cont

- \_\_\_\_\_ and \_\_\_\_\_  
\_\_\_\_\_ made a \_\_\_\_\_ of DNA that incorporated the findings of Chargaff, Franklin and Wilkins.
- Their model fit the experiential data so perfectly that it was almost immediately \_\_\_\_\_.



- Watson, Crick, and Wilkins won the \_\_\_\_\_  
\_\_\_\_\_ for physiology/ medicine.
- Rosalind Franklin had died of cancer in \_\_\_\_\_.
- The Nobel Prize only goes to \_\_\_\_\_  
recipients, and can only be shared among \_\_\_\_\_ winners.



- Were she alive, do you think Rosalind Franklin would have been included in the prize?



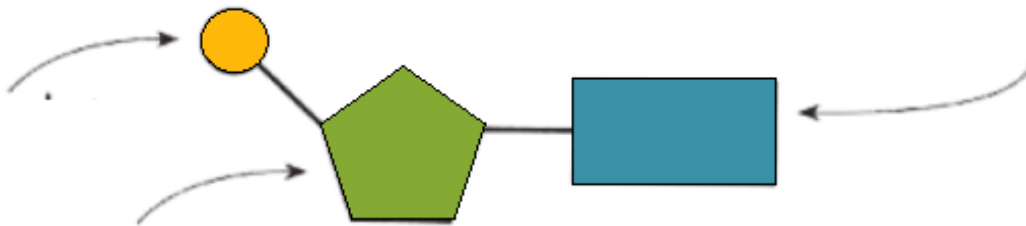
# LOCATION OF DNA

- DNA is a chemical located in the \_\_\_\_\_ of every living cell.
- It is a \_\_\_\_\_.
- Its full name is \_\_\_\_\_.
- Its role is to \_\_\_\_\_ about how to make \_\_\_\_\_.
- In this way, it \_\_\_\_\_ cell \_\_\_\_\_, \_\_\_\_\_ & \_\_\_\_\_.



# COMPONENTS OF DNA

- DNA is a large molecule made up of smaller \_\_\_\_\_ called \_\_\_\_\_
- Each nucleotide consists of:
  - a \_\_\_\_\_
  - a \_\_\_\_\_
  - a \_\_\_\_\_



- There are \_\_\_\_\_ DNA nucleotides

# COMPONENTS OF DNA

## Pentose sugars

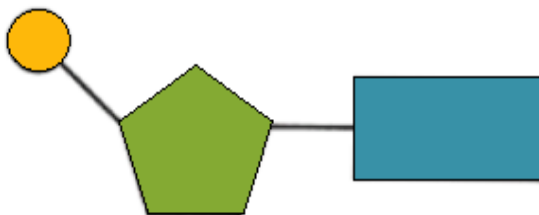
- There are \_\_\_\_\_ that are used in nucleotides:
  - \_\_\_\_\_ sugar → used in \_\_\_\_\_
  - \_\_\_\_\_ sugar → used in \_\_\_\_\_

## Nitrogen bases

- There are \_\_\_\_\_ nitrogen bases in DNA:
  - A = \_\_\_\_\_
  - T = \_\_\_\_\_
  - G = \_\_\_\_\_
  - C = \_\_\_\_\_
- There is a fifth nitrogen base found \_\_\_\_\_:
  - U = \_\_\_\_\_

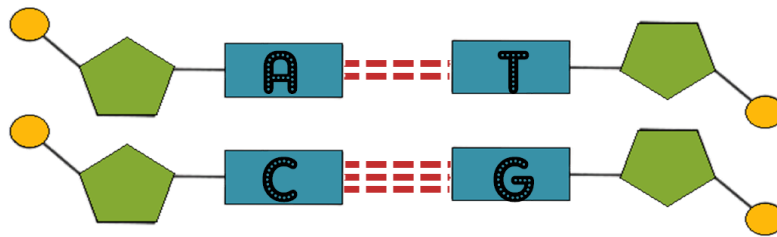
## Chemical bonds

- The three components are held together by \_\_\_\_\_.
- These bonds are \_\_\_\_\_ so that the unit holds together within the larger molecule.

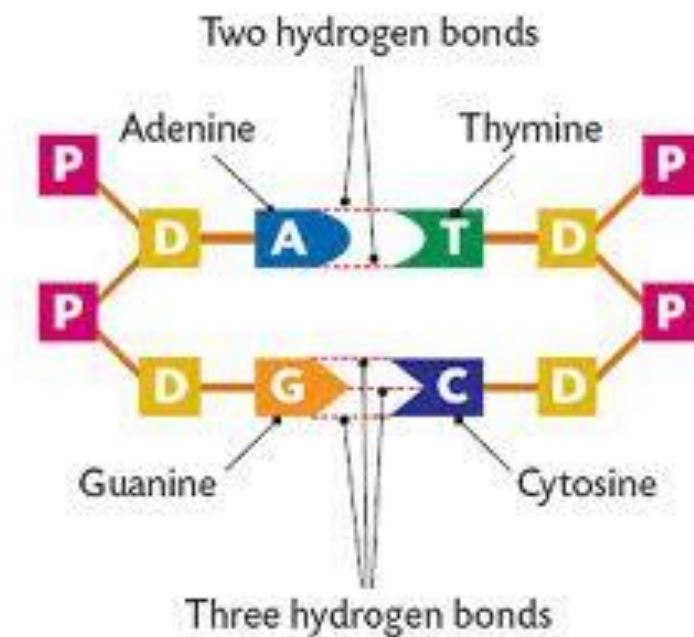


# CHARGAFF'S BASE PAIRING RULE

- They \_\_\_\_\_ exhibit \_\_\_\_\_.
- This means that **each base can only join with one other base.**
  - \_\_\_\_\_ joins with \_\_\_\_\_ (A=T)
  - \_\_\_\_\_ joins with \_\_\_\_\_ (C≡G)

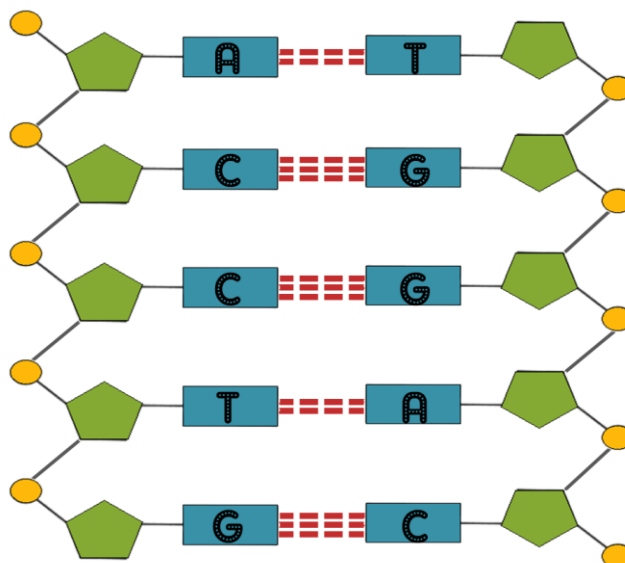


- Reasons behind the rule:
  - \_\_\_\_\_ of bases
  - \_\_\_\_\_ of \_\_\_\_\_ bonding sites



# SHAPE OF DNA

- DNA is \_\_\_\_\_.
- Each strand is made up of \_\_\_\_\_, connected through \_\_\_\_\_.
- These two strands are \_\_\_\_\_ around each other.
- This is called a \_\_\_\_\_.
- The structure is similar to a \_\_\_\_\_.
- The “rungs” of the ladder are made from the \_\_\_\_\_.
- The “sides” of the ladder are made from \_\_\_\_\_ and \_\_\_\_\_ groups.  
This is called the \_\_\_\_\_.
- The nucleotides are joined together by \_\_\_\_\_  
→ these are very \_\_\_\_\_.
- The two strands are joined together by \_\_\_\_\_  
→ these are very \_\_\_\_\_.
- This allows the strands to be \_\_\_\_\_ during \_\_\_\_\_  
and \_\_\_\_\_ without destroying the DNA completely.







Name: \_\_\_\_\_

Science Quest 10 - Ex2.1, 2.2

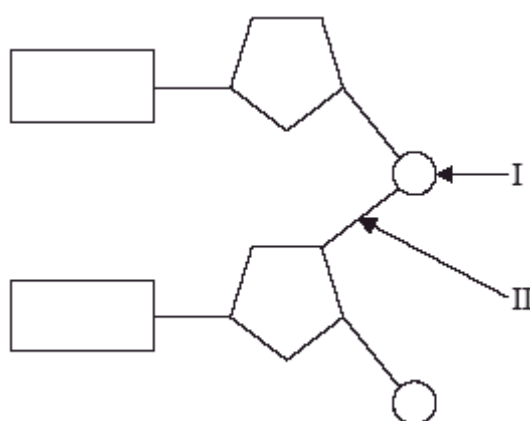
# NUCLEAR MATTER

1. Complete the following table:

| Question                                       | Response |
|--|----------|
| (a) Where is DNA located in eukaryotic cells?  |          |
| (b) Where is DNA located in prokaryotic cells? |          |
| (c) What does DNA stand for?                   |          |
| (d) What does DNA look like?                   |          |
| (e) What does DNA <u>code</u> for?             |          |
| (f) Why is the nucleus the control centre?     |          |

(6)

2. The diagram below shows two nucleotides linked together to form a dinucleotide.



(a) Identify the chemical group labelled

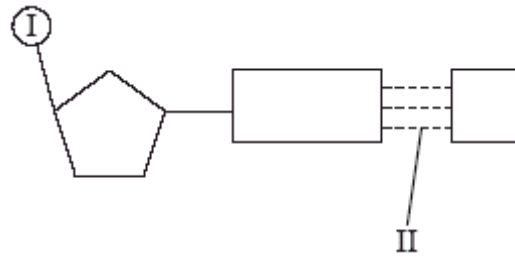
I. ....

(b) State the type of bond labelled

II. ....

(2)

3. The diagram below shows one DNA nucleotide and part of a second nucleotide.



(a) State the names of structures I and II.

I. ....

II. ....

(2)

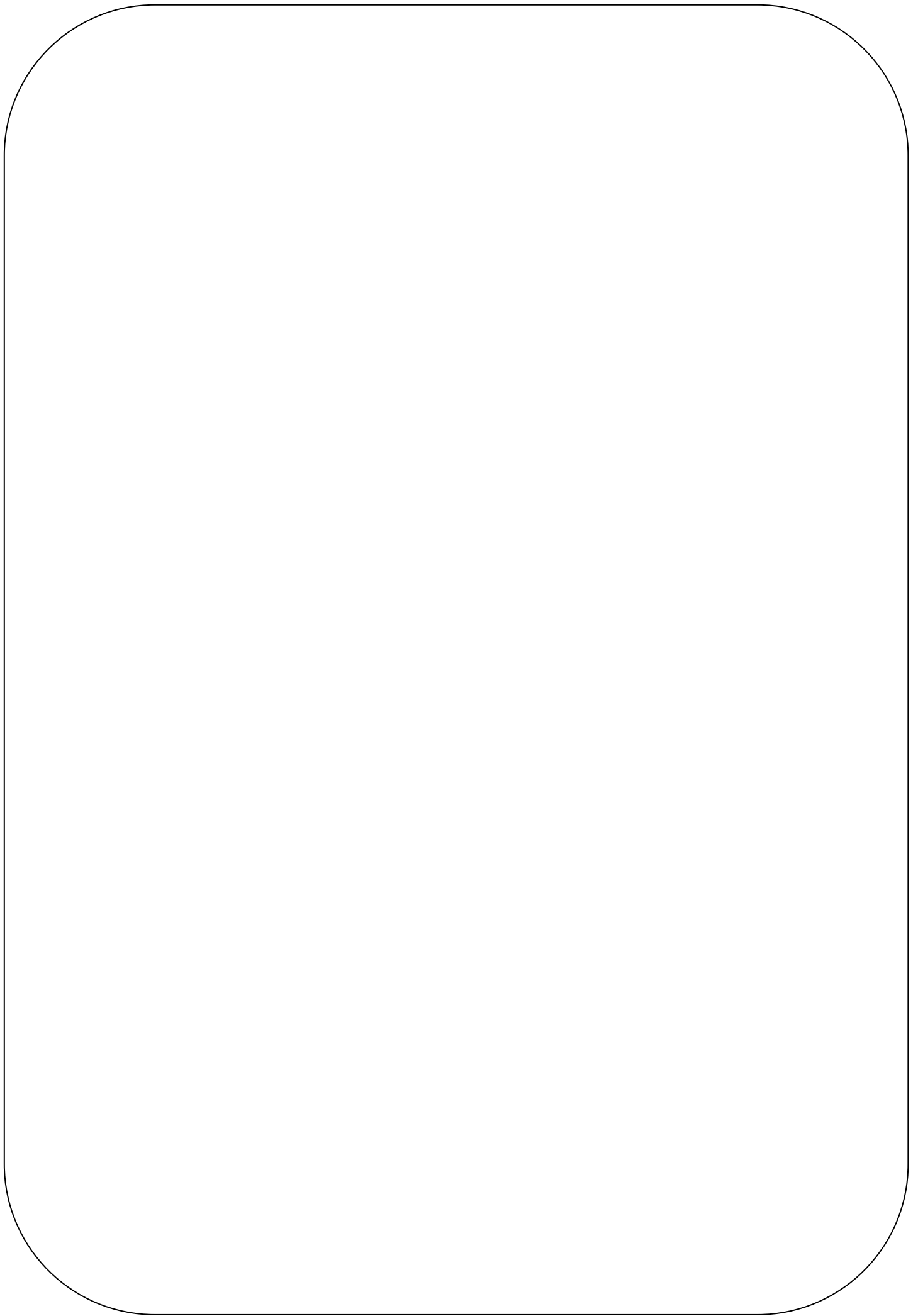
(b) On the diagram above, draw the structures that are missing from the second nucleotide.

(1)

4. Use the following words/terms to complete a mind map (See SQ10 p39 for help):

(15)

|                             |               |                             |
|-----------------------------|---------------|-----------------------------|
| ADENINE                     | DOUBLE HELIX  | NUCLEUS                     |
| COMPLEMENTARY BASE<br>PAIRS | DNA           | PENTOSE SUGAR               |
| COVALENT BOND               | GUANINE       | PHOSPHATE GROUP             |
| CYTOSINE                    | HYDROGEN BOND | SUGAR-PHOSPHATE<br>BACKBONE |
| DEOXYRIBOSE                 | NITROGEN BASE | THYMINE                     |
|                             | NUCLEOTIDE    |                             |



# DNA STRUCTURE

Recall that the nucleus is a small spherical, dense body in a cell. It is often called the "control center" because it controls all the activities of the cell including cell reproduction, and heredity. Chromosomes are microscopic, threadlike strands composed of the chemical DNA (short for deoxyribonucleic acid). In simple terms, DNA controls the production of proteins within the cell. These proteins in turn, form the structural units of cells and control all chemical processes within the cell. Think of proteins as the building blocks for an organism, proteins make up your skin, your hair, parts of individual cells. How you look is largely determined by the proteins that are made. The proteins that are made is determined by the sequence of DNA in the nucleus.

Chromosomes are composed of genes, which is a segment of DNA that codes for a particular protein which in turn codes for a trait. Hence you hear it commonly referred to as the gene for baldness or the gene for blue eyes. Meanwhile, DNA is the chemical that genes and chromosomes are made of. DNA is called a nucleic acid because it was first found in the nucleus. We now know that DNA is also found in organelles, the mitochondria and chloroplasts, though it is the DNA in the nucleus that actually controls the cell's workings.

In 1953, James Watson and Francis Crick established the structure of DNA. The shape of DNA is a double helix (**color the title black**), which is like a twisted ladder. The sides of the ladder are made of alternating sugar and phosphate molecules. The sugar is deoxyribose. **Color all the phosphates pink (one is labeled with a "p")**. **Color all the deoxyriboses blue (one is labeled with a "D")**.

The rungs of the ladder are pairs of 4 types of nitrogen bases. The bases are known by their coded letters A, G, T, C. These bases always bond in a certain way. Adenine will only bond to thymine. Guanine will only bond with cytosine. This is known as the "Base-Pair Rule". The bases can occur in any order along a strand of DNA. The order of these bases is the code that contains the instructions. For instance ATGCACATA would code for a different gene than AATTACGGA. A strand of DNA contains millions of bases. (For simplicity, the image only contains a few.)

Color the thymines orange. 

Color the adenines green. 

Color the guanines purple. 

Color the cytosines yellow. 

Note that that the bases attach to the sides of the ladder at the sugars and not the phosphate.

The DNA helix is actually made of repeating units called nucleotides. Each nucleotide consists of three molecules: a sugar (deoxyribose), a phosphate which links the sugars together, and then one of the four bases. Two of the bases are purines - adenine and guanine. The pyrimidines are thymine and cytosine. Note that the pyrimidines are single ringed and the purines are double ringed. Color the nucleotides using the same colors as you colored them in the double helix.

The two sides of the DNA ladder are held together loosely by hydrogen bonds. The DNA can actually "unzip" when it needs to replicate - or make a copy of itself. DNA needs to copy itself when a cell divides, so that the new cells each contain a copy of the DNA. Without these instructions, the new cells wouldn't have the correct information. The hydrogen bonds are represented by small circles. **Color the hydrogen bonds grey.**

## **Messenger RNA**

So, now, we know the nucleus controls the cell's activities through the chemical DNA, but how? It is the sequence of bases that determine which protein is to be made. The sequence is like a code that we can now interpret. The sequence determines which proteins are made and the proteins determine which activities will be performed. And that is how the nucleus is the control center of the cell. The only problem is that the DNA is too big to go through the nuclear pores. So a chemical is used to read the DNA in the nucleus. That chemical is messenger RNA. The messenger RNA (mRNA) is small enough to go through the nuclear pores. It takes the "message" of the DNA to the ribosomes and "tells them" what proteins are to be made. Recall that proteins are the body's building blocks. Imagine that the code taken to the ribosomes is telling the ribosome what is needed - like a recipe.

Messenger RNA is similar to DNA, except that it is a single strand, and it has no thymine. Instead of thymine, mRNA contains the base Uracil. In addition to that difference, mRNA has the sugar ribose instead of deoxyribose. RNA stands for **Ribonucleic Acid**. Color the mRNA as you did the DNA, except:

**Color the ribose a DARKER BLUE, and the uracil brown.** 

## **The Blueprint of Life**

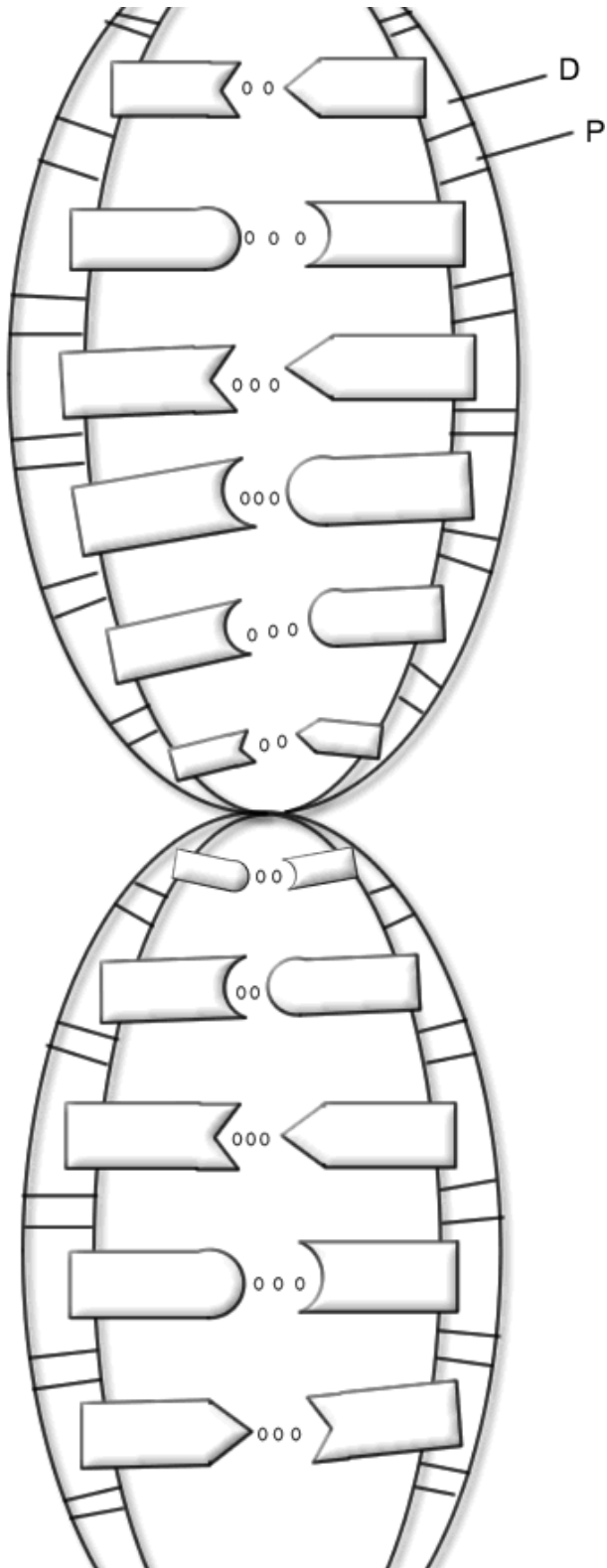
Every cell in your body has the same "blueprint" or the same DNA. Like the blueprints of a house tell the builders how to construct a house, the DNA "blueprint" tells the cell how to build the organism. Yet, how can a heart be so different from a brain if all the cells contain the same instructions? Although much work remains in genetics, it has become apparent that a cell has the ability to turn off most genes and only work with the genes necessary to do a job. We also know that a lot of DNA apparently is nonsense and codes for nothing. These regions of DNA that do not code for proteins are called "introns", or sometimes "junk DNA". The sections of DNA that do actually code for proteins are called "exons".

**USE THE TEXT PROVIDED TO ANSWER THE QUESTIONS BELOW:**

**Questions**

1. Write out the full name for DNA.  
\_\_\_\_\_
2. What is a gene? \_\_\_\_\_
3. Where in the cell are chromosomes located?  
\_\_\_\_\_
4. DNA can be found in what two organelles?  
\_\_\_\_\_
5. What two scientists established the structure of DNA?  
\_\_\_\_\_
6. What is the shape of DNA? \_\_\_\_\_
7. What are the sides of the DNA ladder made of?  
\_\_\_\_\_
8. What are the "rungs" of the DNA ladder made of?  
\_\_\_\_\_
9. What sugar is found in DNA? \_\_\_\_\_ In RNA? \_\_\_\_\_
10. How do the bases bond together? A bonds with \_\_\_\_\_ G bonds with \_\_\_\_\_
11. The two purines in DNA are  
\_\_\_\_\_.
12. DNA is made of repeating units called  
\_\_\_\_\_
13. Why is RNA necessary to act as a messenger? Why can't the code be taken directly from the DNA?
14. Proteins are made where in the cell?
15. How do some cells become brain cells and others become skin cells, when the DNA in ALL the cells is exactly the same. In other words, if the instructions are exactly the same, how does one cell become a brain cell and another a skin cell?
16. Why is DNA called the "Blueprint of Life"?
17. Complete the diagrams using the colour code provided throughout the worksheet.

## DNA - The Double Helix



## Messenger RNA

