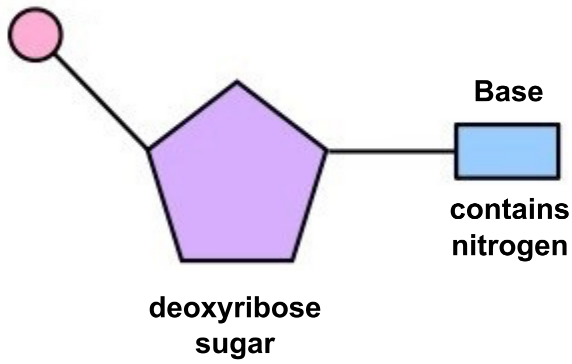
A. DNA STRUCTURE

- DNA is made up of **nucleotides**.



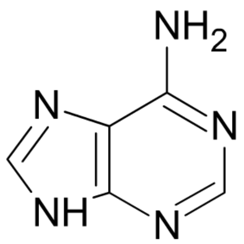
NB: nucleotides actually have three phosphates but lose two of these so that only one phosphate is incorporated into a DNA strand

- **Four** types of base: adenine (**A**), thymine (**T**), cytosine (**C**) and guanine (**G**).

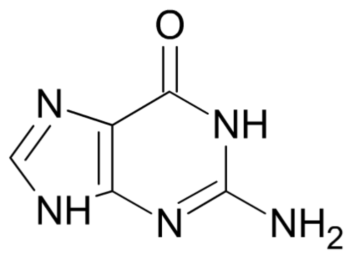
- The bases can be classed as either **purine** or **pyrimidine**.

- You are **not** expected to **memorise** the **chemical structure** of each base.

PURINE BASES
TWO RINGS
ADENINE & GUANINE

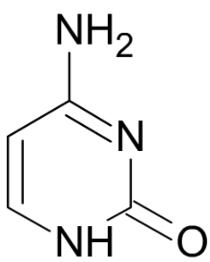


ADENINE (A)

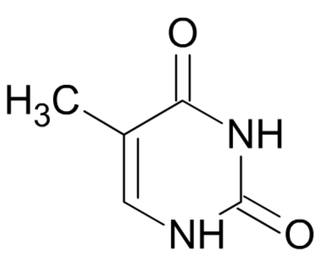


GUANINE (G)

PYRIMIDINE BASES
ONE RING
CYTOSINE & THYMINE



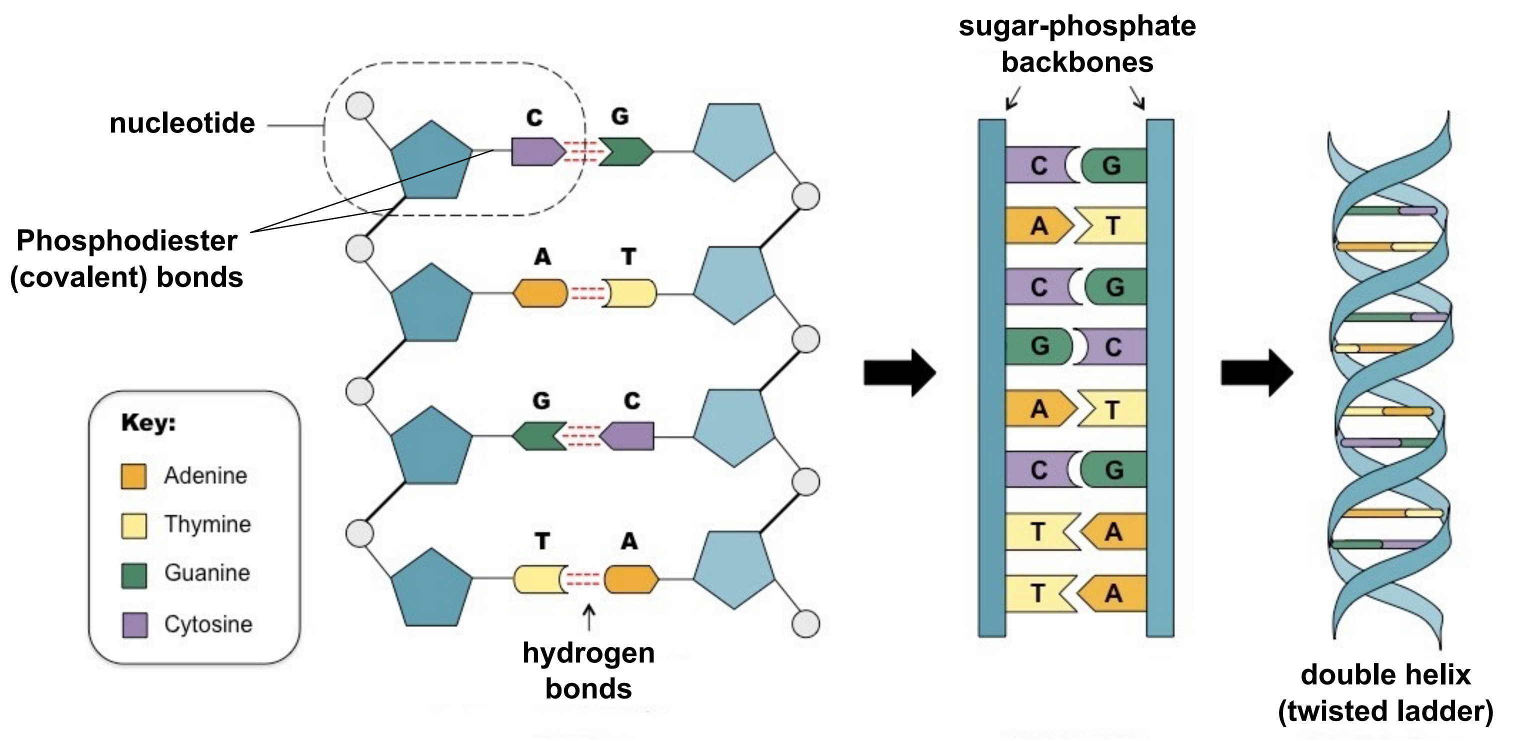
CYTOSINE (C)



THYMINE (T)

- **Pyrimidine** bases have **one ring** and the letter '**Y**' in their name – just like the word '**pYrimidine**'.

- The nucleotides connect as follows:

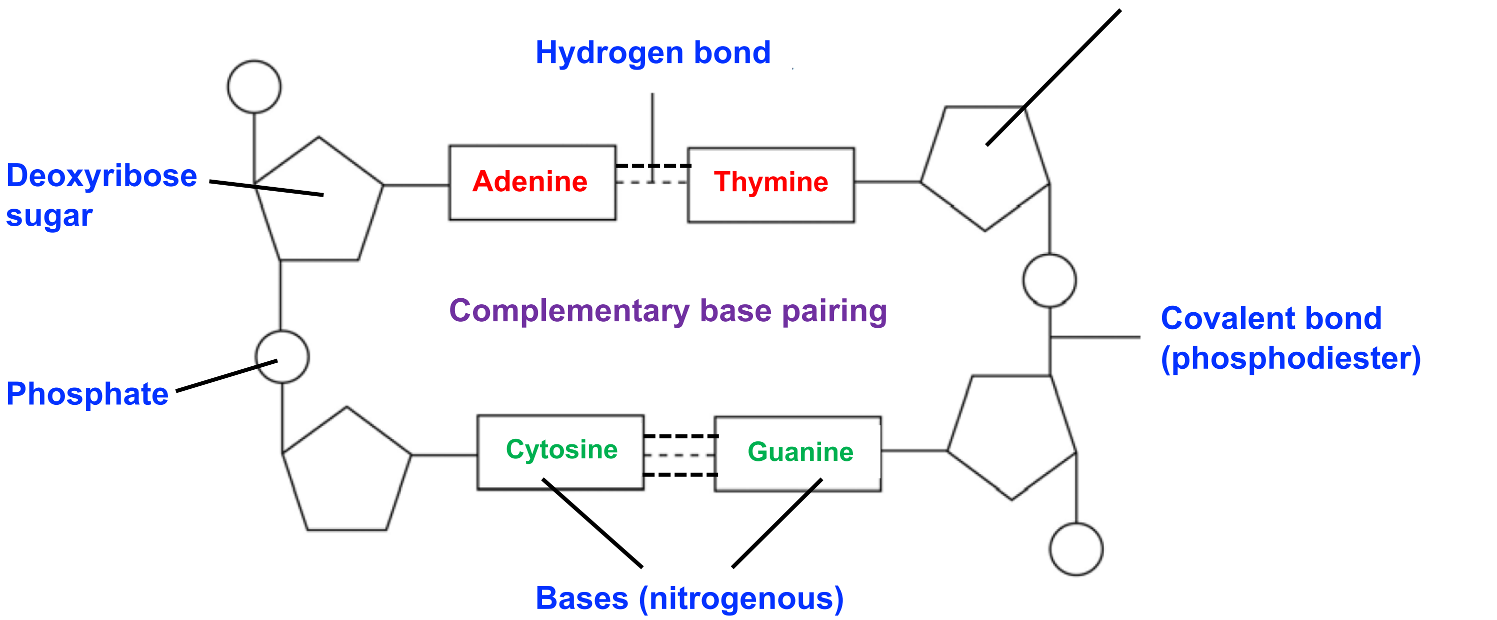


- There are **complementary base pairs** inside the molecule:
  - Adenine (**A**) pairs with thymine (**T**) with **two** hydrogen bonds
  - Guanine (**G**) pairs with cytosine (**C**) with **three** hydrogen bonds

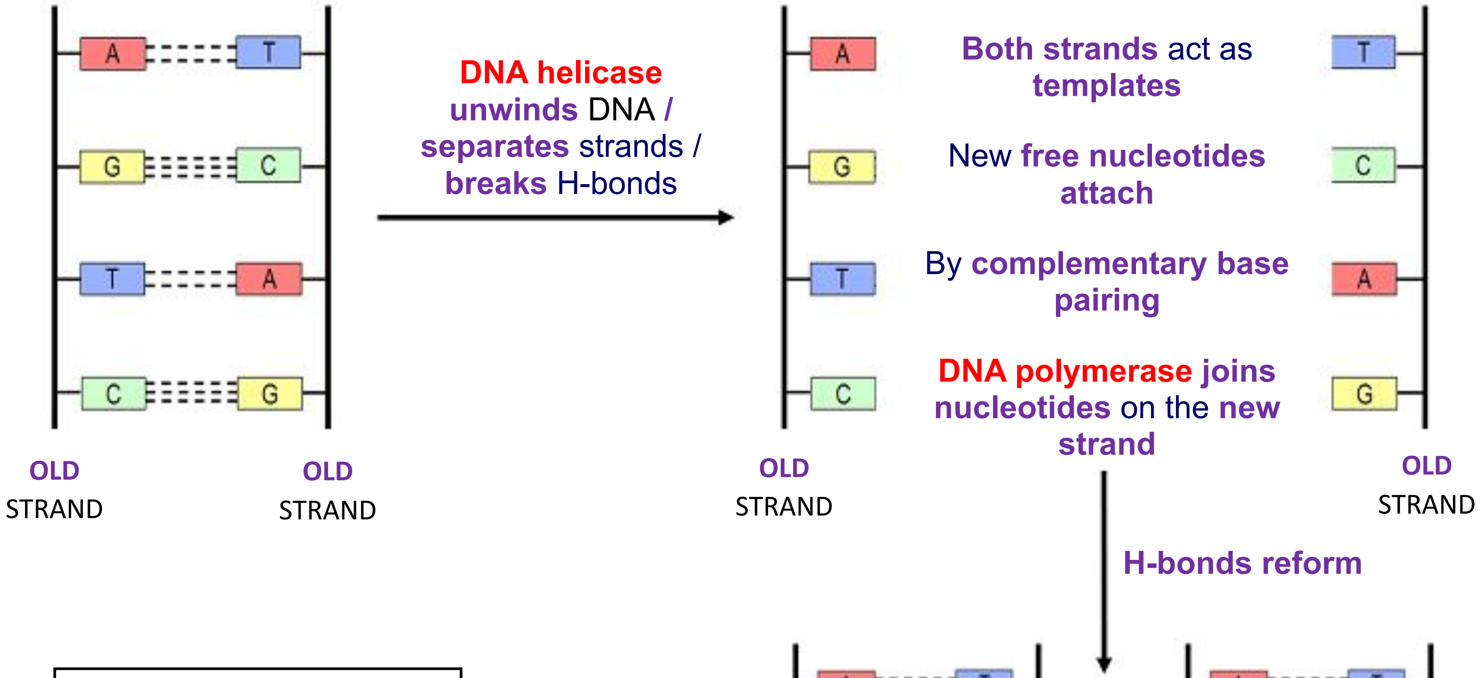
- The two DNA strands are **antiparallel** – they run in **opposite directions**.

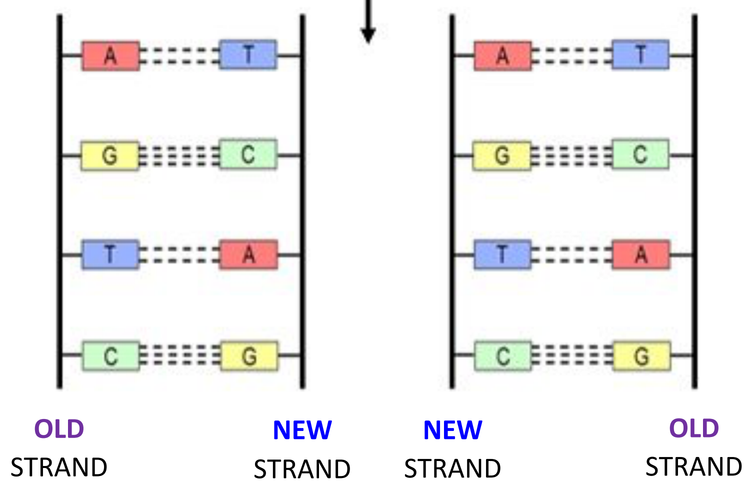
B. DRAWING DNA IN EXAMS

- Here are four nucleotides or two complementary base pairs.



C. SEMI-CONSERVATIVE DNA REPLICATION





Semi-conservative replication =

Half of the **original** DNA molecule is **kept**

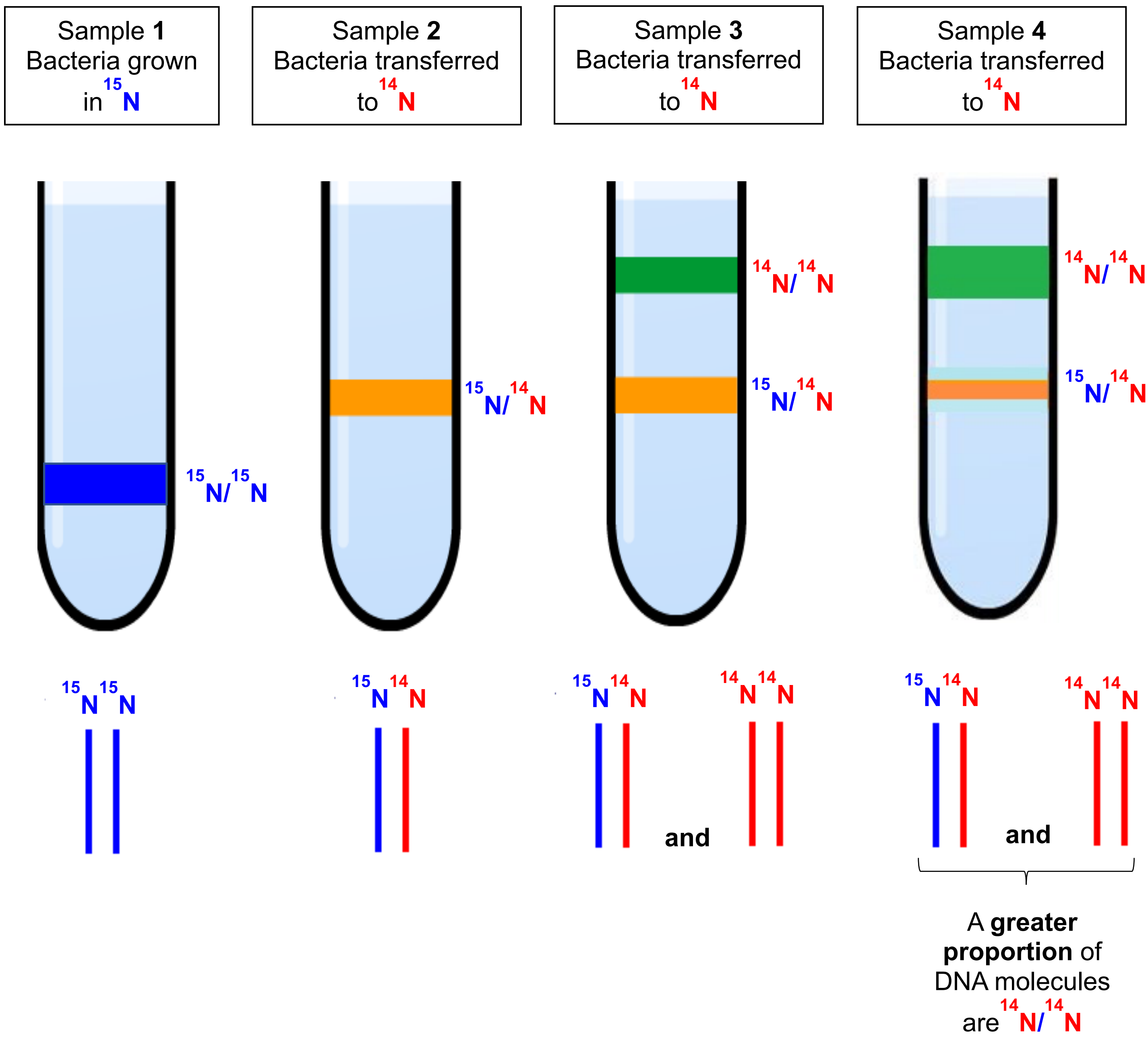
(So) **new DNA molecules** contain **one old strand** and **one new strand**

Other models proposed that were incorrect

- **Conservative** replication – **new** DNA molecules consist of **two completely new strands**; the **two old template strands go back together**
- **Dispersive** replication – **new** DNA molecules consist of **segments** of **old** and **new DNA**

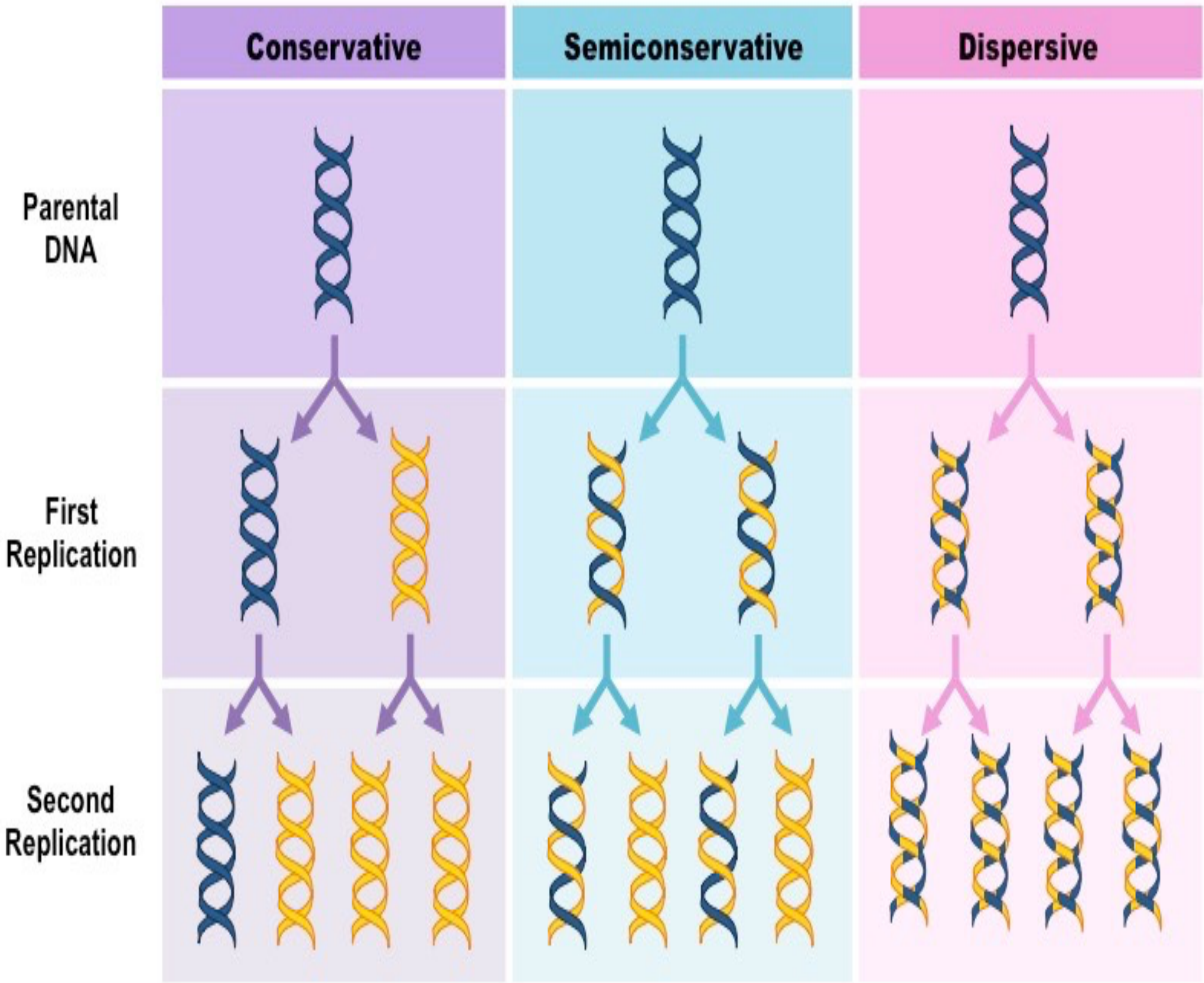
D. THE MESELSON-STAHL EXPERIMENT

- This proved that DNA replicates **semi-conservatively**.
- **Nitrogen** is needed to make DNA **bases**.
- They **grew** bacteria on medium containing **^{15}N** (heavy nitrogen isotope) for **one generation**.
- They then **transferred** these bacteria to medium containing **^{14}N** (light nitrogen isotope).
- They then **centrifuged** the **DNA** after **each** generation and viewed the **bands** produced.
- The **heavier** the DNA, the **lower** it will be in the tube.



The **position** of the **band(s)** at **each generation** is only possible if DNA replicates **semi-conservatively**

E. OTHER POSSIBLE MODELS FOR DNA REPLICATION

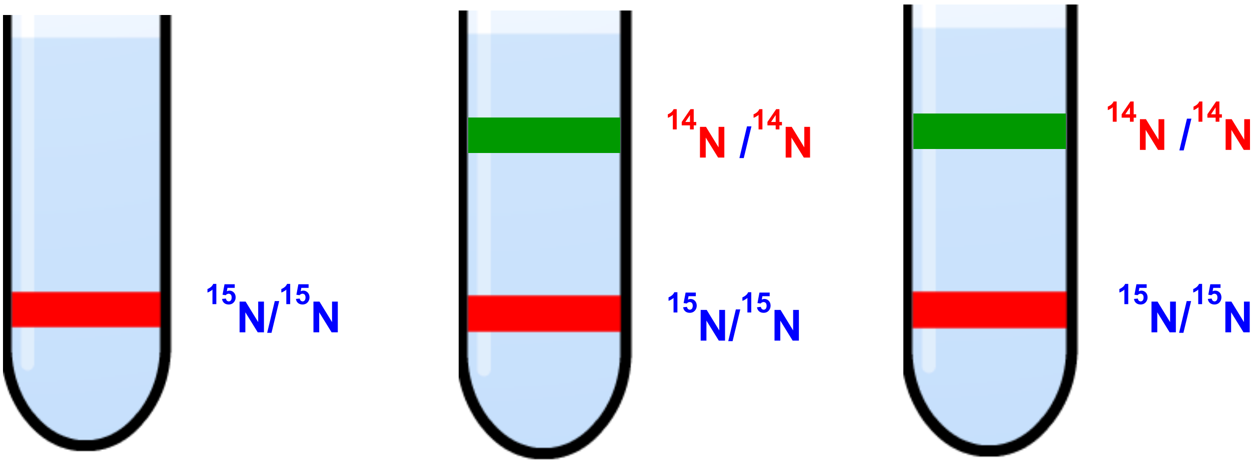


Conservative	Semiconservative	Dispersive
Completely new molecules are synthesised from a DNA template (which remains **unaltered**)	Each new molecule consists of **one newly made** strand and **one old template strand**	Each new molecule consists of **segments** of **old** and **new** DNA

If DNA Replication Was Conservative

- The following bands would have been seen (and they were **not**!):

Sample 1	Sample 2	Sample 3
Bacteria grown in ^{15}N	Same bacteria then grown in ^{14}N	Same bacteria then grown in ^{14}N

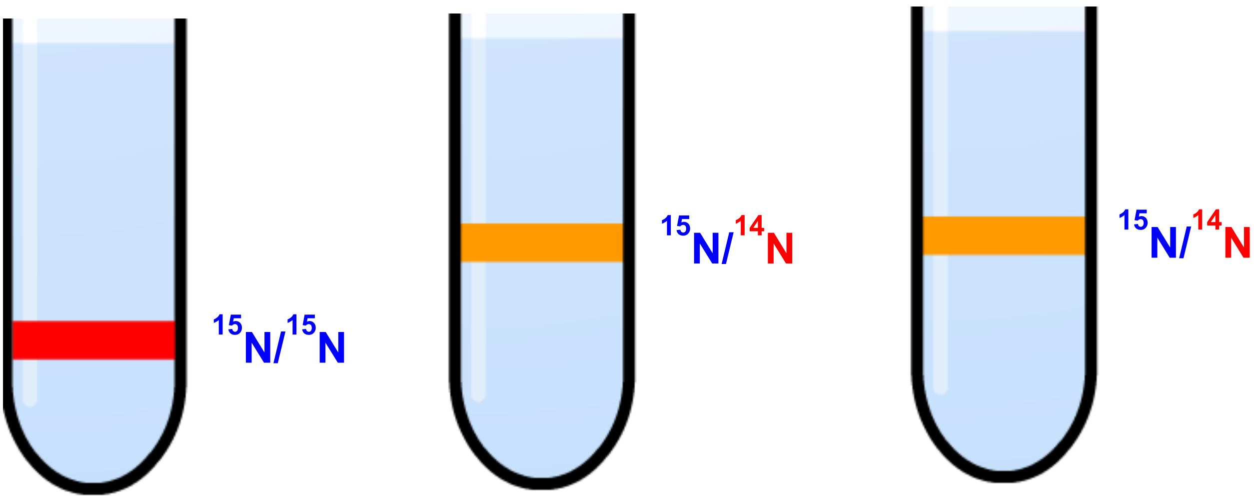


- Note that the **15/15** DNA band would get **thinner** and the **14/14** DNA band would get **thicker** with each sample, as the **proportion** of **14/14 DNA** would **increase**.

If DNA Replication Was Dispersive

- The following bands would have been seen (and they were **not**!):

Sample 1	Sample 2	Sample 3
Bacteria grown in ^{15}N	Same bacteria then grown in ^{14}N	Same bacteria then grown in ^{14}N



F. HOW THE STRUCTURE OF DNA IS ADPAPTED TO ITS FUNCTION

Structure	Function
LARGE MOLECULE	• Can **store lots** of **information** (bases/genes)
HELICAL/COILED	• **Compact** so can **store lots** of **DNA** in a **small space** within a cell
COMPLEMENTARY BASE PAIRS (A-T AND G-C)	• Ensures **DNA replication** is **accurate**
SUGAR-PHOSPHATE BACKBONE	• Provides **strength** and **stability** • **Protects** the **bases inside** from **damage**
THREE BASES CODE FOR ONE SPECIFIC AMINO ACID	• Ensures that **translation** is **accurate** • Ensures each **protein** has the **correct sequence** of **amino acids**
H-BONDS CONNECT THE BASES TOGETHER	• **H-bonds** are **weak** so DNA can be **easily broken** for **replication** and **transcription** • **Collectively**, **many** H-bonds provide **strength** and **stability**

G. CONTRASTING PROKARYOTIC DNA AND EUKARYOTIC DNA

Prokaryotic DNA	Eukaryotic DNA
Circular	**Linear**
One chromosome	**Many** chromosomes
Found in a **nucleoid**	Found in a **nucleus**
Not associated with **histone** proteins	**Associated** with **histone** proteins
Plasmids **present**	Plasmids **absent**
No introns, **only** exons	Introns **and** exons
One replication/initiation **point**	**Many replication**/initiation **points**

• **Eukaryotic** DNA is associated with **proteins** called **histones**, to make it **more compact**.

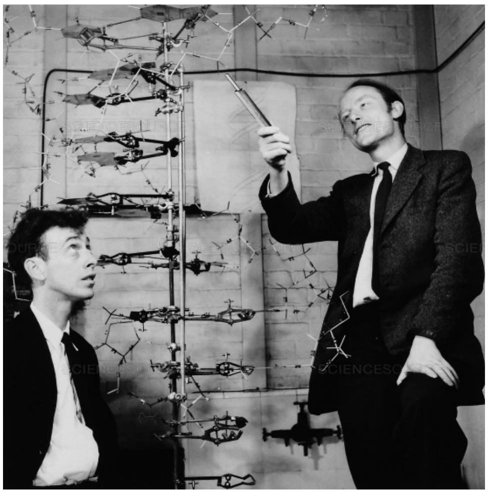
• Together, these form **chromatin** – the substance from which **chromosomes** are **made**.

H. COMPARING AND CONTRASTING DNA AND RNA

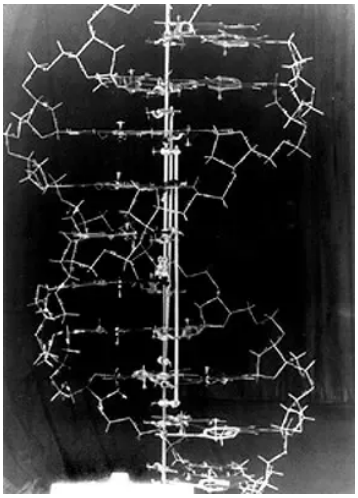
DNA	RNA
Contains **deoxyribose**	Contains **ribose**
Contains **thymine (T)**	Contains **uracil (U)**
Double stranded	**Single** stranded
Both are **polymers** of **nucleotides**	
Both contain adenine (**A**), cytosine (**C**) and guanine (**G**) bases	

I. MODEL MAKING BY WATSON & CRICK

- They used **cardboard shapes** to represent the **DNA bases** and **metal rods** to represent **bonds**. **Bond lengths** were all **to scale** and **bond angles** were **correct**.



Why was this useful?



Other scientists had **previously found** that:

- DNA is **helical** (by X-ray diffraction) = **Rosalind Franklin**.
- The **amounts** of **A** and **T** are **equal**, and the **amounts** of **C** and **G** are **equal** = **Erwin Chargaff**.

Watson & Crick found that:

- DNA is a **<u>double</u> helix.**
- The **two DNA strands** must run **antiparallel** to each other, in **opposite directions**.
- **A-T** and **G-C** complementary base pairs **could** be **formed** with **hydrogen bonds** between them.
- The **base pairs** were the **same length**, so they **could fit** into a **molecule** between the two sugar-phosphate backbones.

Watson & Crick's approach:

- They **combined** what had been discovered about the **chemical content** of DNA and **X-ray diffraction** studies.
- They **built scale models** of the **components** of **DNA**
- They attempted to **fit** the **components** of **DNA** together in a way that **agreed** with **all** of the **data**