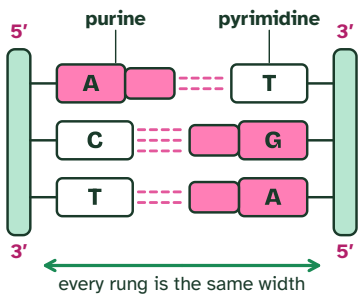
AP BIOLOGY | UNIT 6 | TOPICS 6.1 AND 6.2 | REVISION ON TWO PAGES

DNA: built to be *copied*

What to know, what to draw and what to say. Nothing else.

THE ONE IDEA

DNA holds information in the order of its bases. Each strand fixes its partner, so each is the template for a new one.



Draw it like this. Two rings for a purine, one for a pyrimidine, dashes for hydrogen bonds, and the strands antiparallel.

6.1.B START HERE

A purine always pairs with a *pyrimidine*

- **Purines**, adenine (A) and guanine (G), have a **double ring**. **Pyrimidines**, cytosine (C), thymine (T) and uracil (U), have a **single ring**.
- Two purines are too wide for the helix and two pyrimidines too narrow. One of each fits, and only **A with T** and **G with C** line up their hydrogen bonds: two for A and T, three for G and C. In RNA, U replaces T and pairs with A.
- The pairing rule is the same in all living things: it has been **conserved through evolution**.
- Know one strand and you know the other, so **each strand can rebuild its partner**. That is why DNA can be hereditary material.

WHICH BASES ARE THE PURINES — *Pure As Gold*

P	**Purines** the big ones: a double ring
A	**Adenine** pairs with T, or U in RNA
G	**Guanine** pairs with C

6.1.A DNA, AND SOMETIMES RNA

What is *passed on*

- Hereditary information is stored in DNA, as the **order of its bases**.
- It passes from a cell to the cells it divides into, and from parents to offspring, because DNA is **copied and handed on**.
- Cells always use DNA. In **some viruses** the hereditary material is **RNA**: influenza and the coronaviruses.

Gene a stretch of DNA
It holds the information for one product, at one place on a chromosome.

Allele one version of a gene
Alleles of a gene differ in their base sequence.

6.1.B DATA TO REASON FROM

Counting *bases*

- In **double-stranded** DNA every A faces a T and every G faces a C, so the amounts match.
- **Worked example:** DNA is 31% A. Then T is 31%, together 62%. The other 38% is shared equally: **G = C = 19%**.
- A + T need not equal G + C: that share differs between species.
- A **single-stranded** molecule has no partner strand, so its A need not equal its T or U.

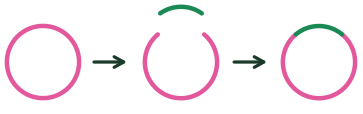
A = T in double-stranded DNA

G = C so purines are half the bases

6.1.A SMALL, CIRCULAR AND EXTRA

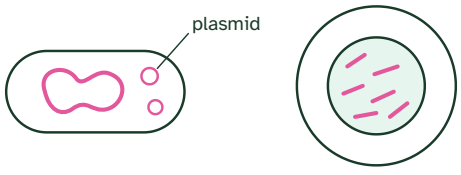
Plasmids

- A **plasmid** is a small, circular DNA molecule separate from the chromosome: **extra-chromosomal**.
- It carries only a few genes and is **copied apart from the chromosome**, so each new cell normally gets a copy.
- Prokaryotes and eukaryotes can both contain plasmids.
- A gene from another organism can be added to a plasmid, and the plasmid taken up by a bacterium.



6.1.A TWO WAYS TO ORGANIZE DNA

One circle, or several *lines*



prokaryote: circular chromosome — **eukaryote: linear chromosomes in a nucleus**

Not to scale. A bacterium is far smaller than an animal cell.

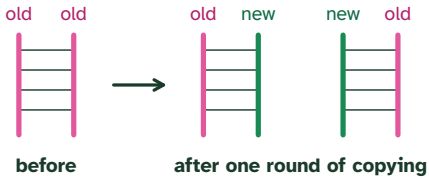
	PROKARYOTE	EUKARYOTE
Shape	**Typically circular** A closed loop. *E. coli*: about 4.6 million base pairs.	**Typically linear** Several, each with two ends. A human body cell has 46.
Where	In the **cytoplasm**: there is no nucleus.	Inside the **nucleus**.
Packing	No histones of the eukaryotic kind. Other proteins fold it.	Condensed with **histones** and associated proteins, so about 2 m of DNA fits in one human nucleus.

Replication: *semiconservative*, and always 5′ to 3′

6.2.A SEMICONSERVATIVE REPLICATION

Half old, *half new*

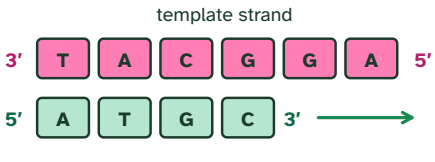
- Replication copies the DNA before a cell divides, keeping hereditary information **continuous between generations**.
- The two strands separate. Each is a **template**: new nucleotides pair with its bases and are joined into a **complementary strand**.
- **Semiconservative**: each new molecule has one old strand and one new strand. Both have the same base sequence as the original.



6.2.A DIRECTION

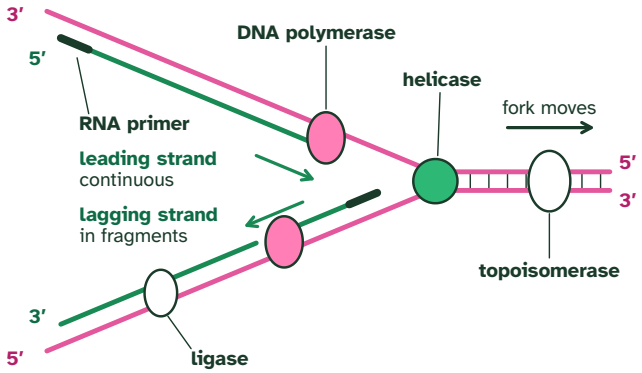
New DNA grows only *5′ to 3′*

- A strand has a free phosphate at its **5′ end** and a free hydroxyl group at its **3′ end**.
- **DNA polymerase** adds nucleotides **only to a 3′ end**, so every new strand is built 5′ to 3′.
- The template is **read 3′ to 5′**. The two templates of a helix are antiparallel, so the two new strands **grow in opposite directions**.



6.2.A FIVE PARTS, FIVE JOJS

At the *replication fork*



- Replication happens at a **replication fork**: the Y-shaped place where the helix is being opened.
- DNA polymerase **cannot start a strand**. Each one begins with a short **RNA primer**, which is later replaced with DNA.

Leading strand continuous
Its 3′ end points **toward the fork**, so DNA polymerase keeps adding as helicase opens the helix. One primer.

Lagging strand discontinuous
Here 5′ to 3′ points **away from the fork**, so it is built in fragments, each from its own primer. Ligase joins them.

UNWINDS
Helicase
separates the two strands of the helix.

RELAXES
Topoisomerase
relaxes supercoiling ahead of the fork.

STARTS
RNA primer
gives DNA polymerase a 3′ end to add to.

BUILDS
DNA polymerase
adds DNA nucleotides, always 5′ to 3′.

JOINS
Ligase
bonds the lagging fragments into one strand.

WATCH OUT

Five mistakes that *cost points*

- ✕ **A = T and G = C does not mean A + T = G + C.** In human DNA, A and T together are about 60% of the bases.
- ✕ **Semiconservative is not one old molecule and one new.** Both are half old, half new.
- ✕ **DNA polymerase builds 5′ to 3′.** To do that it moves along the template 3′ to 5′. Say which strand you mean.
- ✕ **The lagging strand is not made 3′ to 5′.** Each fragment is built 5′ to 3′, away from the fork.
- ✕ **Helicase only separates the strands.** It breaks hydrogen bonds, not the backbone, and copies nothing.

COVER THE SHEET

Can you *answer these?*

1. Describe how DNA stores hereditary information.
2. Explain why a purine never pairs with a purine.
3. Calculate the percent G in double-stranded DNA that is 22% A.
4. Describe two features of a prokaryote's chromosome.
5. Describe a plasmid.
6. Explain why replication is called semiconservative.
7. Explain why one new strand is made in fragments.
8. Predict the new DNA at a fork if ligase does not work.

IN THE EXAM

Name the strand and the direction: "the new strand is built 5′ to 3′", not just "5′ to 3′".
Give each enzyme its own job: helicase unwinds, DNA polymerase builds, ligase joins.

GO FURTHER

Animated figures, a dry lab and a marked Check are in the full guide online.