

Nucleic Acids & Protein Synthesis

A-Level Biology ■ Topic 6

A-Level Biology



Nucleic Acids & Protein Synthesis

What we will cover

- 1 Nucleotides & bases
- 2 DNA structure
- 3 DNA replication
- 4 The genetic code
- 5 Transcription & translation
- 6 Mutations



the DNA double helix

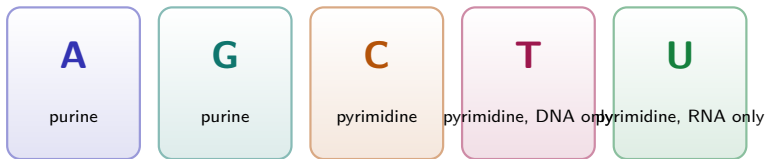
1 Nucleotides and DNA

Nucleotides

A **nucleotide** 核苷酸 has three parts: a pentose sugar, a phosphate, and a nitrogenous base. DNA uses deoxyribose; RNA uses ribose. Nucleotides join by

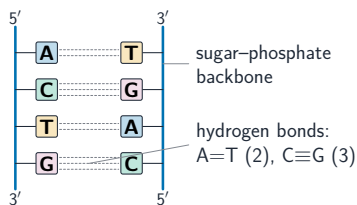
phosphodiester 磷酸二酯 bonds between the 5' phosphate of one and the 3' OH of the next.

The five bases



A pairs with T (or U in RNA); G pairs with C. Two H-bonds vs three.

DNA structure



the two strands run in opposite directions (antiparallel)

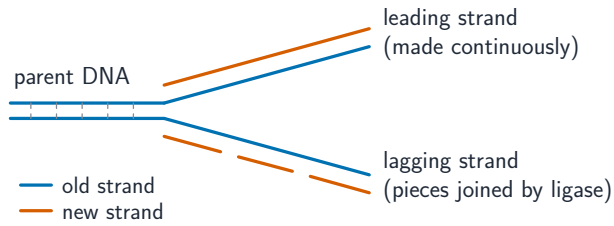
Two **antiparallel** 反平行 strands twist into a **double helix** 双螺旋.

Complementary base pairing 碱基互补配对: A—T by 2 hydrogen bonds, C—G by 3 — joined along a **phosphodiester** 磷酸二酯键 backbone.

DNA replication

Replication is **semi-conservative** 半保留复制 – each new molecule keeps one old strand.

- **DNA polymerase** 聚合酶 adds nucleotides $5' \rightarrow 3'$
- **leading strand** 前导链 continuous; **lagging strand** 后随链 in pieces, joined by **ligase** 连接酶



2 The genetic code

The genetic code

gene 基因 → polypeptide

triplet 三联体 = 3 bases

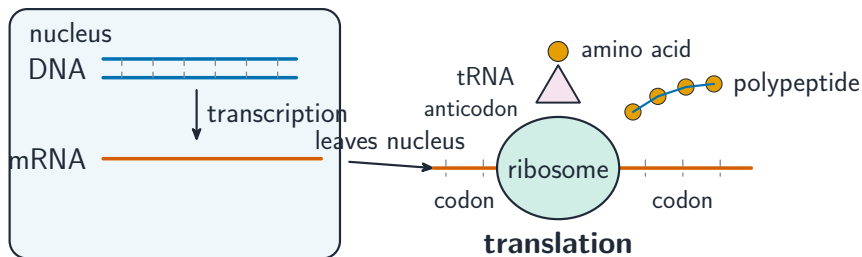
universal 通用

64 triplets, 20 amino acids ⇒ most amino acids have more than one triplet

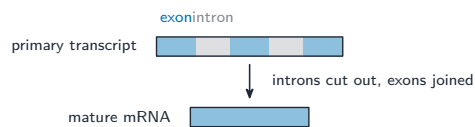
RNA 核糖核酸 is a single strand with the sugar **ribose** 核糖, and uses **uracil** 尿嘧啶 in place of thymine.

Transcription and translation

- **transcription** 转录 – DNA → mRNA 信使 RNA in the nucleus
- **translation** 翻译 – the ribosome reads **codons** 密码子; **tRNA** 转运 RNA **anticodons** 反密码子 bring amino acids



Splicing



In eukaryotes the first transcript has coding **exons** 外显子 and non-coding **introns** 内含子.

Splicing 剪接 cuts out the introns and joins the exons to make the finished mRNA.

3 Mutations

Gene mutations

original **ATG CAT TAC**
 substitution **AAG CAT TAC**
 deletion **ATG ATT AC**
 insertion **ATG GCA TTA C**

red = changed base; shaded = shifted by a frameshift (deletion or insertion)

A **mutation** 突变 changes the base sequence:

- **substitution** 替换 – swaps one base (small effect)
- **deletion** 缺失 / **insertion** 插入 – shift every later triplet (a **frameshift** 移码)

4

Recap

Worked example – transcribe and translate

A DNA template strand reads TAC GGA TTT. Give the mRNA and say how many amino acids result.

- mRNA is built **complementary** to the template, with **U** in place of **T**.
- TAC → AUG; GGA → CCU; TTT → AAA.
- mRNA: AUG CCU AAA – and **AUG is always the start codon**.
- 3 codons ⇒ **3 amino acids**; each tRNA anticodon pairs with one codon.

A → U (never T) when transcribing. **Codon** is on the mRNA, **anticodon** on the tRNA, and the **triplet** on the DNA – do not mix the three names.

Topic 6 – key takeaways

1 Base pairing

A–T (2 bonds), C–G (3);
antiparallel

2 Replication

semi-conservative; leading &
lagging strands

3 Code

triplets; transcription then
translation

4 Mutations

substitution vs frameshift (indel)

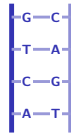
Check yourself

1 How many hydrogen bonds join C and G?

2 What does “semi-conservative” mean?

3 Where does translation take place?

4 Which mutation causes a frameshift?



Answers 1. three 2. each new molecule keeps one old strand 3. at the ribosome
4. deletion or insertion