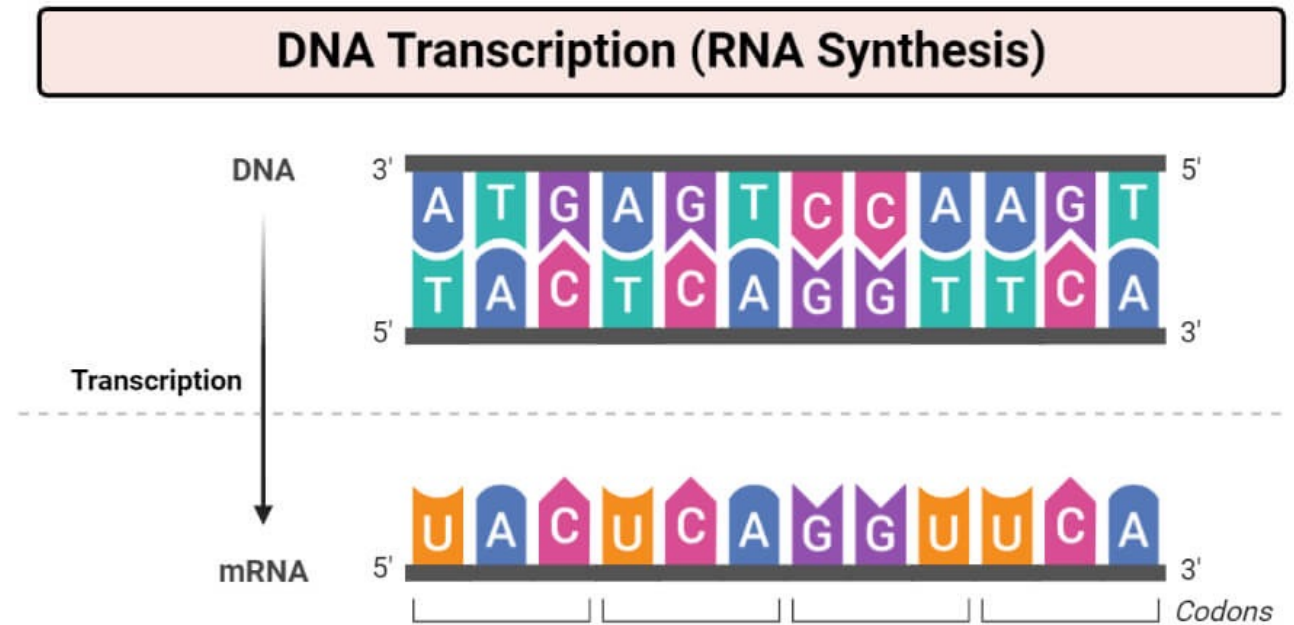


# Lesson 11

## DNA transcription



# DNA transcription

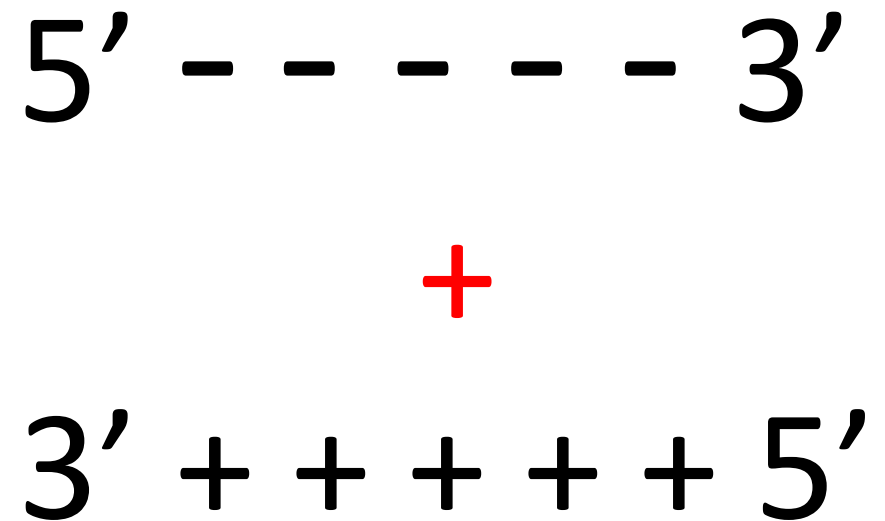
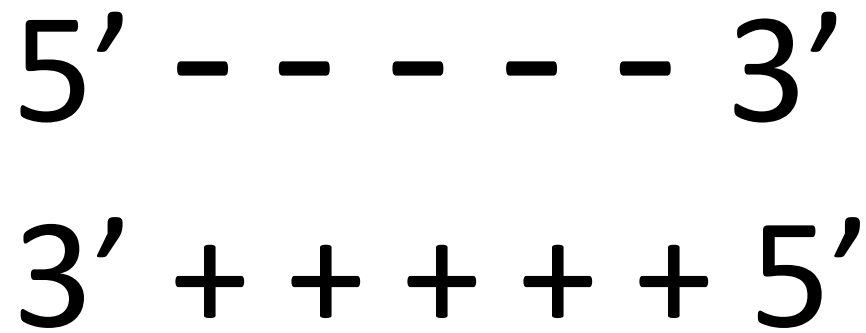
- **DNA (gene) transcription** is a process that produces an **mRNA** from a DNA template
- The process takes place in the **cell nucleus**
- Two major difference with DNA replication
  - RNA uses U instead of T
  - **Only 1 DNA template strand is used: the BOTTOM strand**

5' - - - - - 3' → non-template strand

3' + + + + + 5' → **template strand**

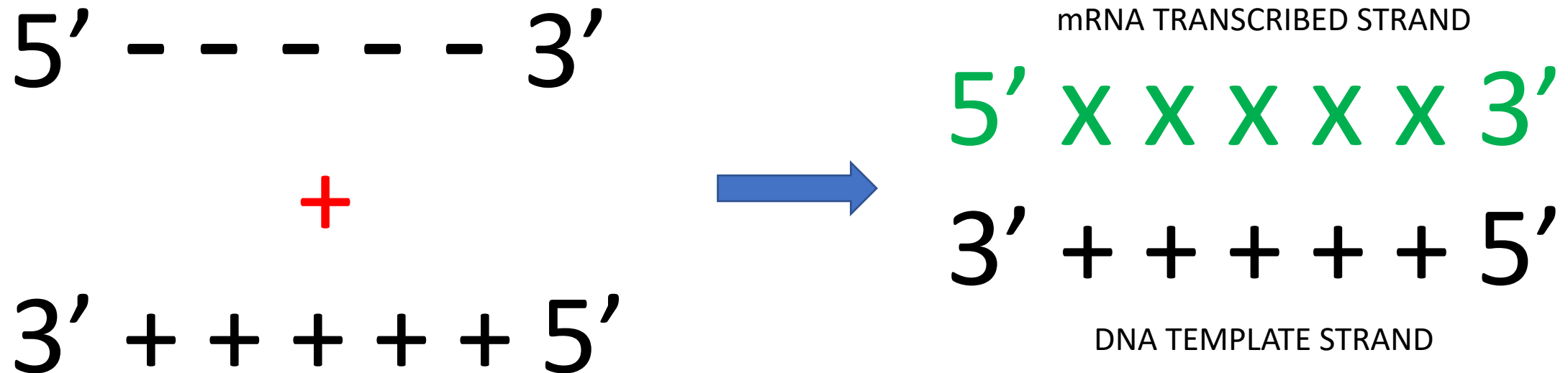
# DNA transcription

## 1. DNA strands separate



# DNA transcription

2. mRNA is transcribed (copied) from the DNA template strand



# DNA transcription

3. mRNA transcribed strand leaves the DNA template strand
4. DNA template and non-template strands base-pair again

5' X X X X X 3'

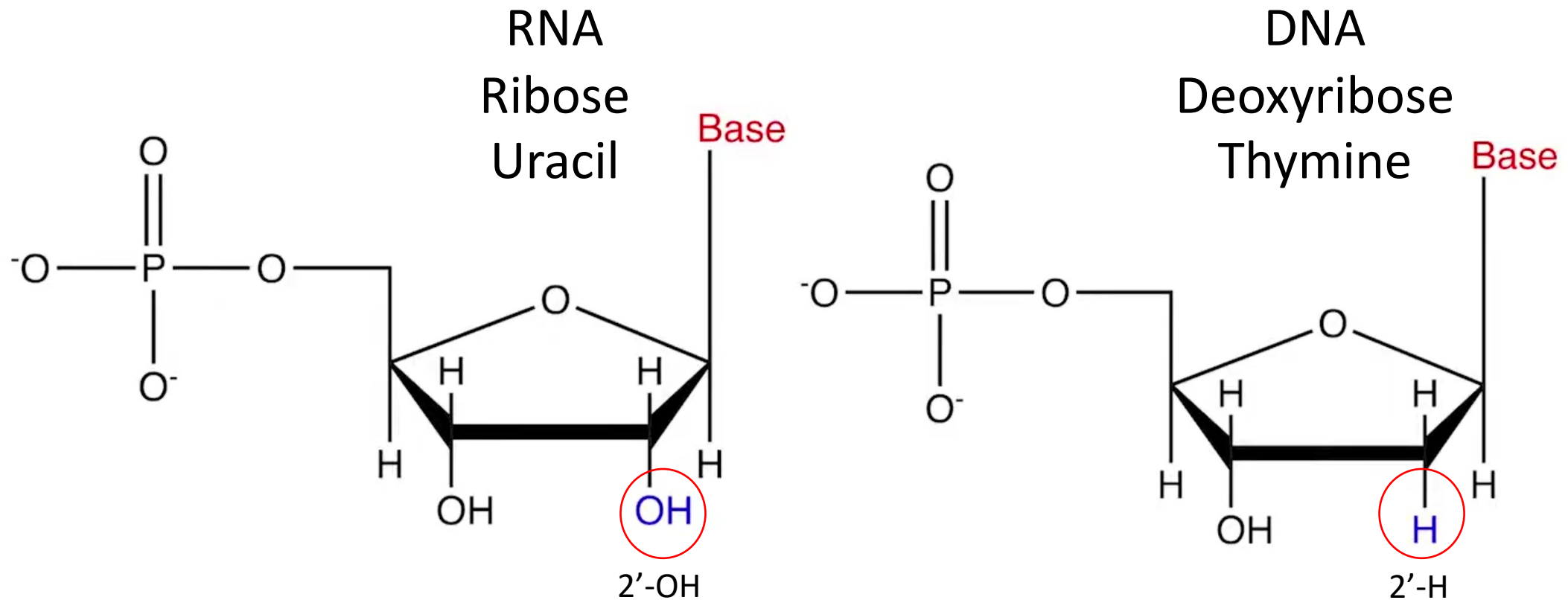
+

3' + + + + + 5'

5' - - - - - 3'

# DNA transcription

- The transcribed 5'xxxxx3' mRNA strand = same as DNA non-template strand (with U in place of T)



# DNA transcription

- The transcribed 5'xxxxx3' mRNA strand = same as DNA non-template strand (with U in place of T)
- The 2'-OH on ribose is a reactive group
  - Makes RNA substantially more reactive (hydrolysis) = less stable than DNA
- This is why DNA (a double stranded nucleic acid) is a better genetic storage material than RNA (usually a single stranded nucleic acid)

# Locating the file to be transcribed

- Only 2% of DNA contains the codes for proteins
  - We are still figuring out what are the functions of the other 98%
    - Much of it seems to be involved in regulating how the information in DNA is used
- When a cell needs to build a protein, it must recognize the gene for that protein among all other genes
- Cells recognize a specific gene by its **PROMOTER**
  - A unique sequence on DNA that is located at the beginning of the gene to be expressed

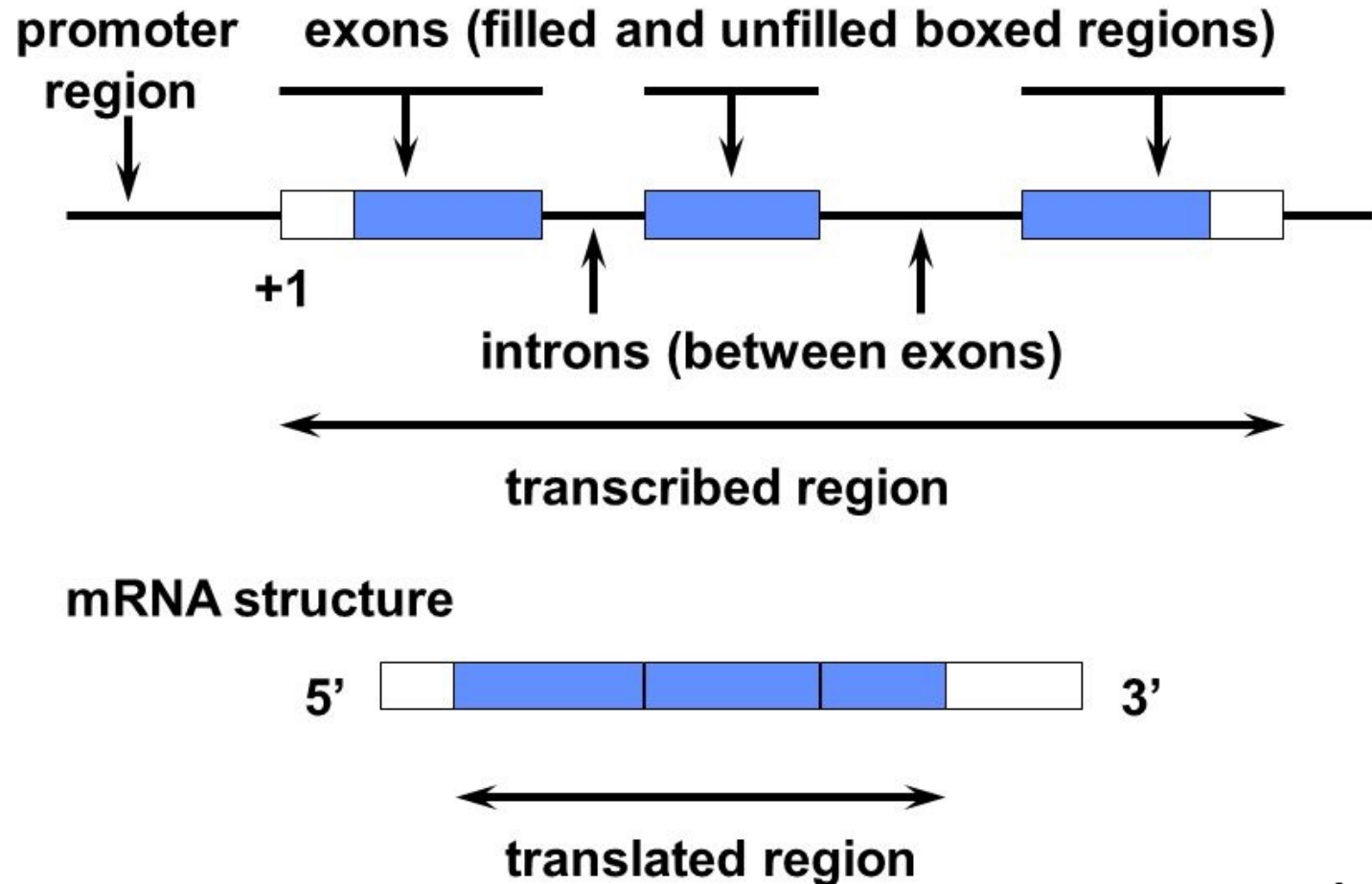


# Promoters

- In eukaryotes, promoters have variable sequences
- Yet, 20% eukaryotic promoters contain a common sequence:

**TATAAA**

- This is called a **TATA box**

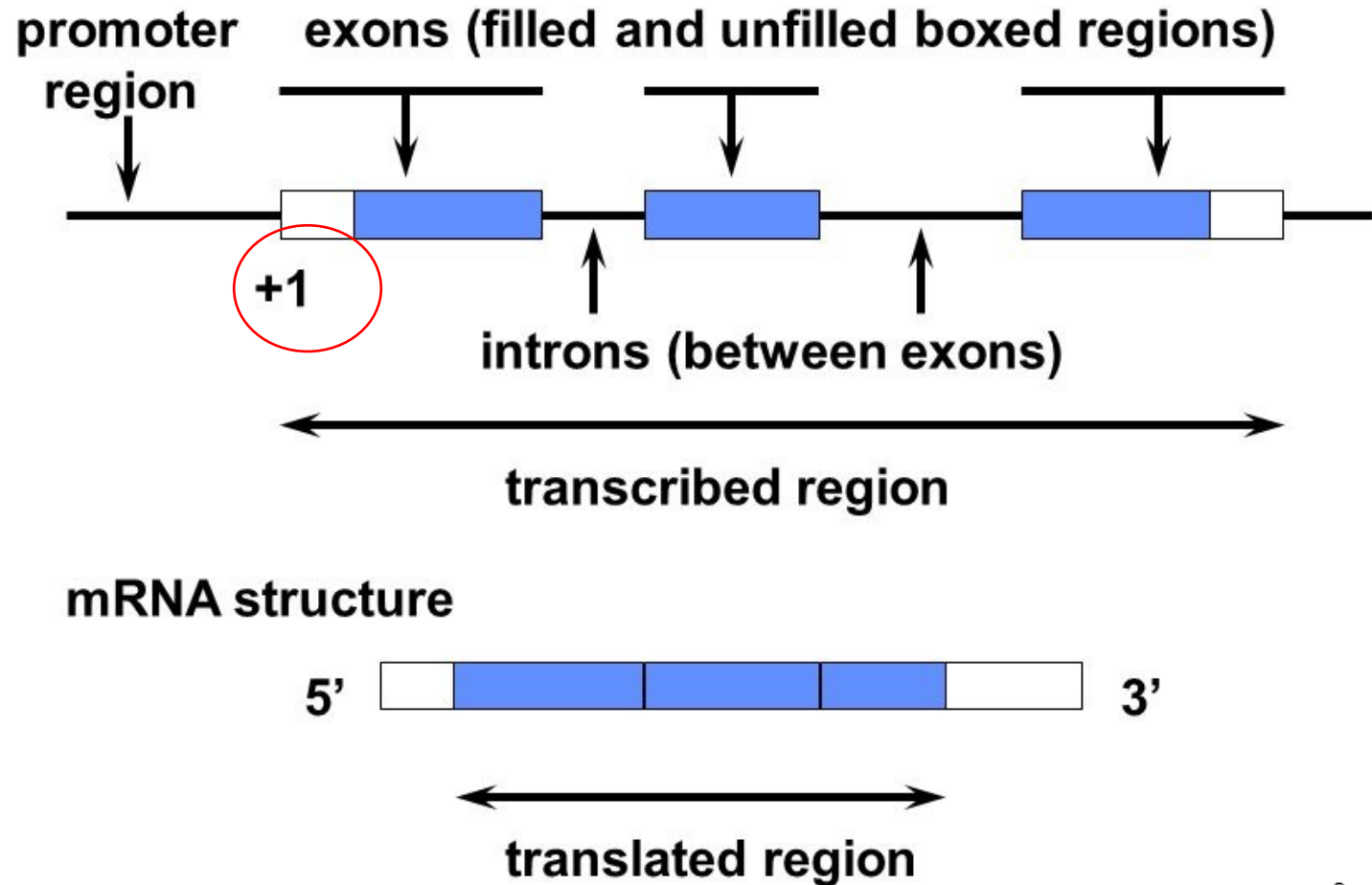


# Promoters

- In eukaryotes, promoters have variable sequences
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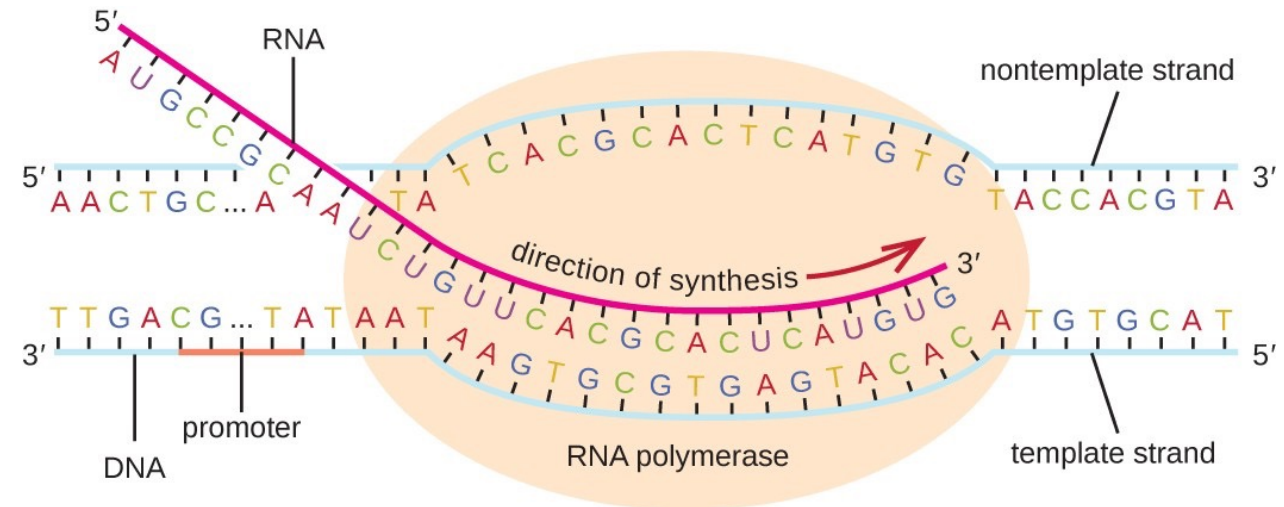
TATAAA

- This is called a **TATA box**
- The TATA box is located near the site where transcription begins
  - called **+1 site**



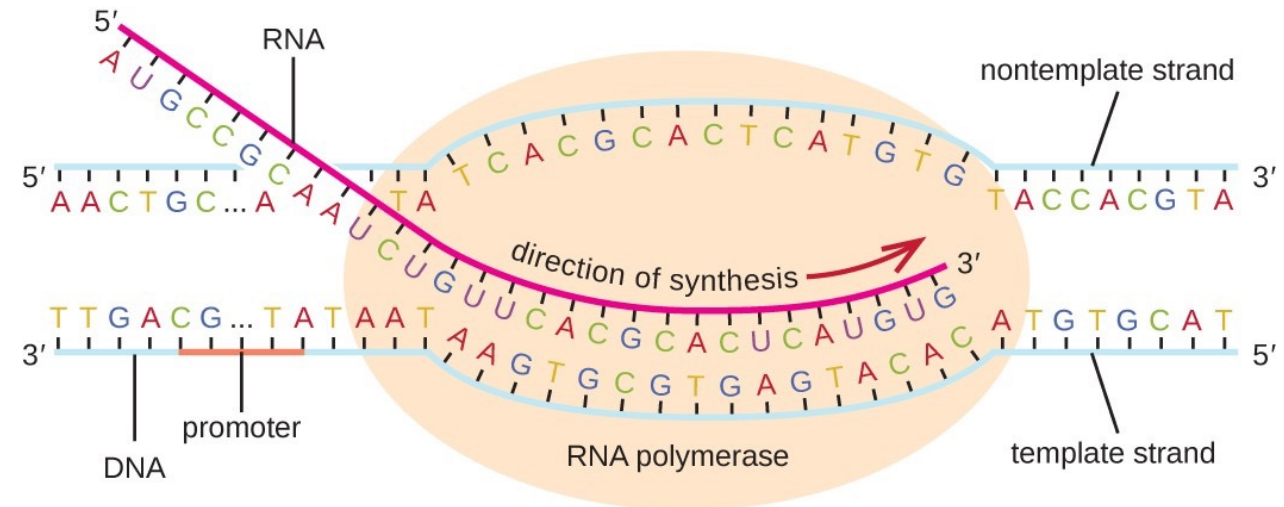
# RNA polymerase – the transcription master

- The enzymes that reads and copies the DNA info onto RNA is called **RNA polymerase**
- The RNA POL
  - Binds at the promoter
  - Unwinds the DNA DH
  - Uses the **template strand (3'-5')** to build the RNA molecules based on the complementarity principle



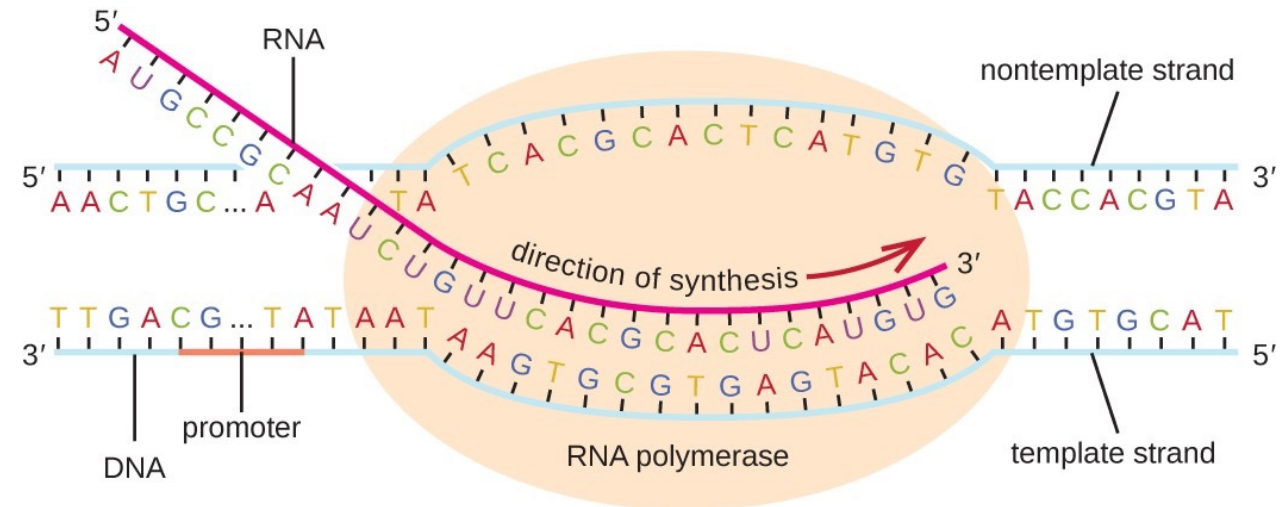
# RNA polymerase – the transcription master

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- The RNA POL
  - Binds at the promoter
  - Unwinds the DNA DH
  - Uses the template strand (3'-5') to build the RNA molecules based on the complementarity principle
- The DNA strand that is not read is called **non-template strand**
  - it is often called **coding strand**
- This might seem confusing
  - **The reason is that, ultimately, the sequence of the non-template strand is the same of the newly synthesized RNA (only with U in place of T)**



# RNA polymerase – the transcription master

- RNA POL **reads** the template strand of DNA **in the 3' to 5' direction** in order to **build** the new RNA molecule in **the 5' to 3' direction**
- *i.e.*, the 5' end of the incoming nucleotide is added to the 3' end of the growing RNA chain



# The RNA POL helpers – transcription factors

- RNA POL needs helpers to recognize promoters
  - Regulatory proteins that control the transcription process
- In eukaryotes, these proteins are called **transcription factors**
  - They help RNA POL in locating and binding to promoters





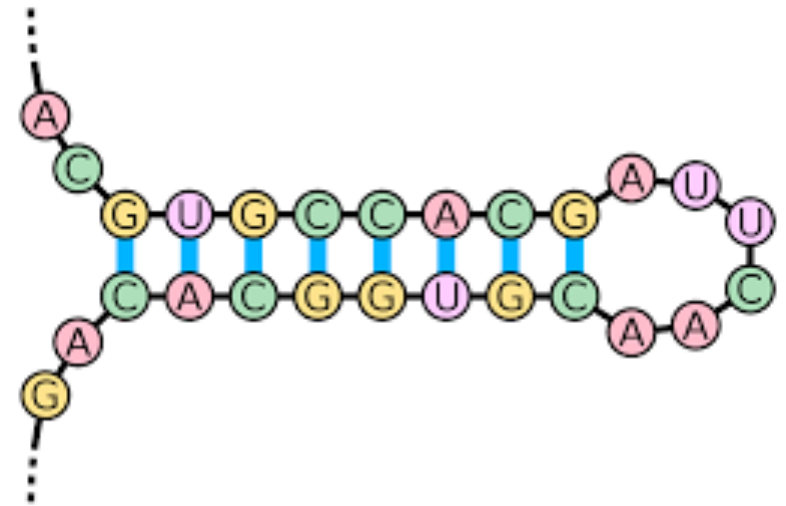
# Transcription terminators

- Just like promoter sequences mark the beginning of genes, transcription **terminators** mark the end of genes
- Once the RNA POL reads in a terminator sequence, it
  - unbinds from the DNA template strand and
  - releases the newly synthesized RNA



# Transcription terminators

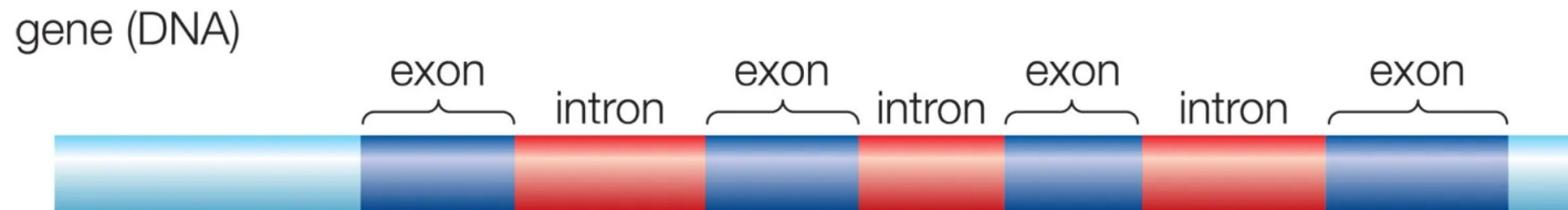
- Just like promoter sequences mark the beginning of genes, transcription **terminators** mark the end of genes
  - Once the RNA POL reads in a terminator sequence, it
    - unbinds from the DNA template strand and
    - releases the newly synthesized RNA
- A transcription terminator often contains a code that induces the corresponding synthesized RNA to fold back onto itself to form a **hairpin loop (or stem-loop)**
  - This structure knocks off the RNA POL from DNA, ending transcription





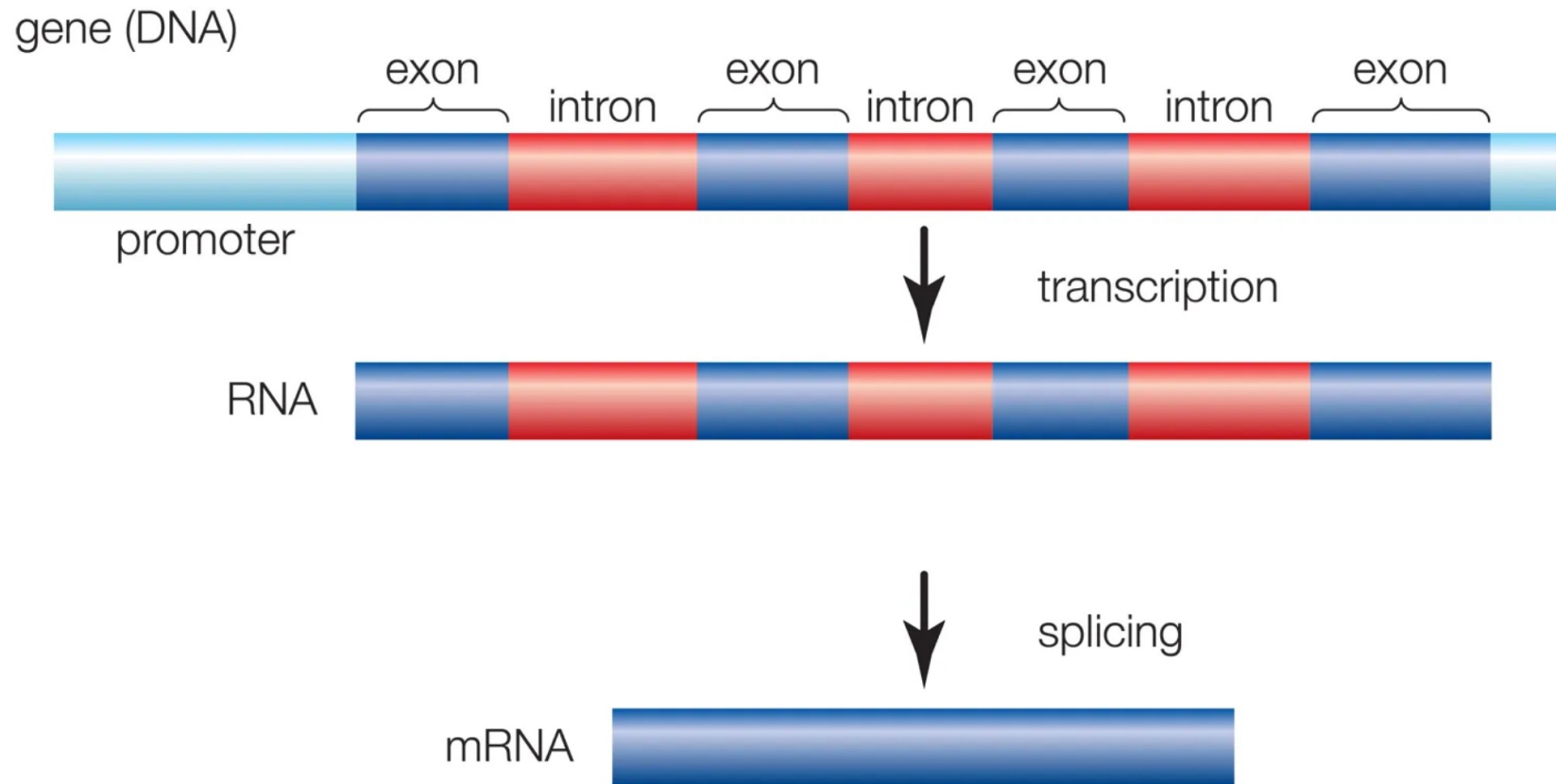
# RNA processing in eukaryotes – a finishing touch

- The RNA just transcribed is not quite ready to be translated → it is not yet a true **mRNA = messenger RNA**
  - It is called **pre-mRNA** or **primary RNA transcript**
- To become an mRNA, the pre-mRNA must get rid of all those gene sequences that do not codify for the corresponding protein = **introns**

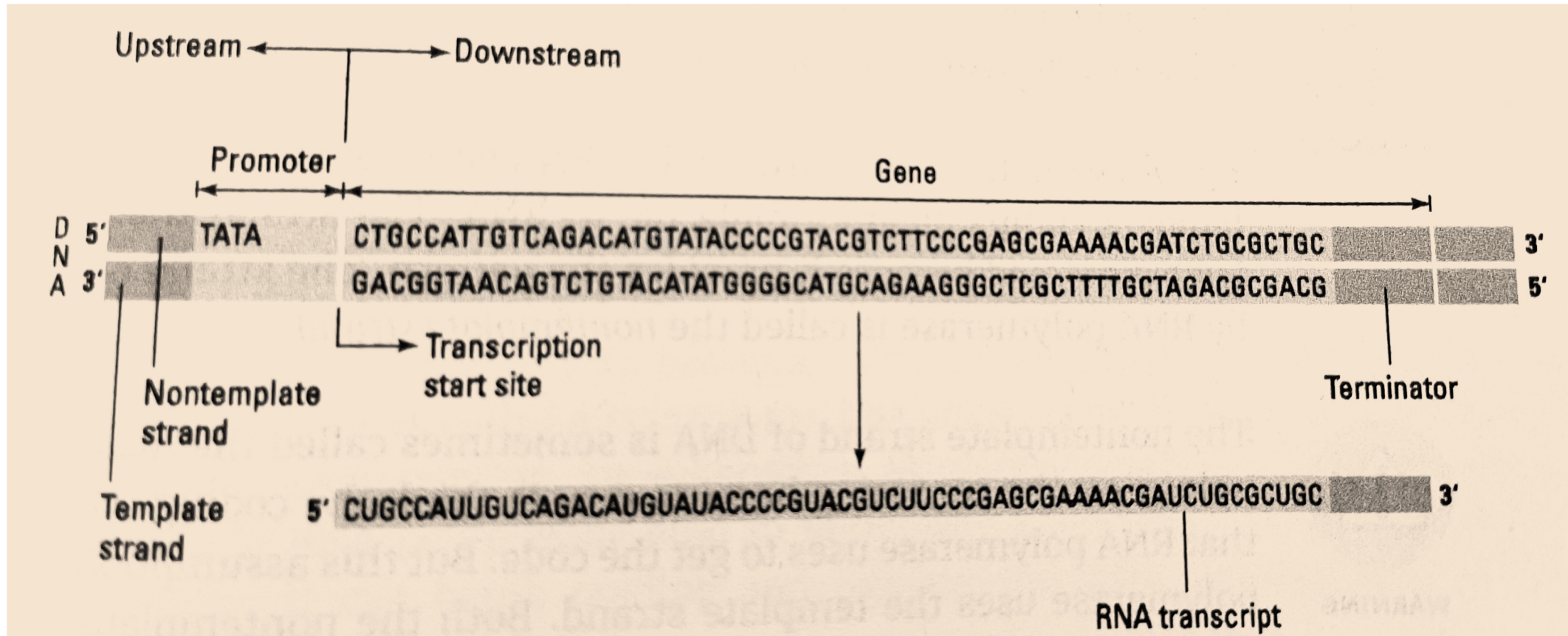


- The final mRNA must be devoid of non-coding information (introns)

# RNA splicing – from RNA to mRNA

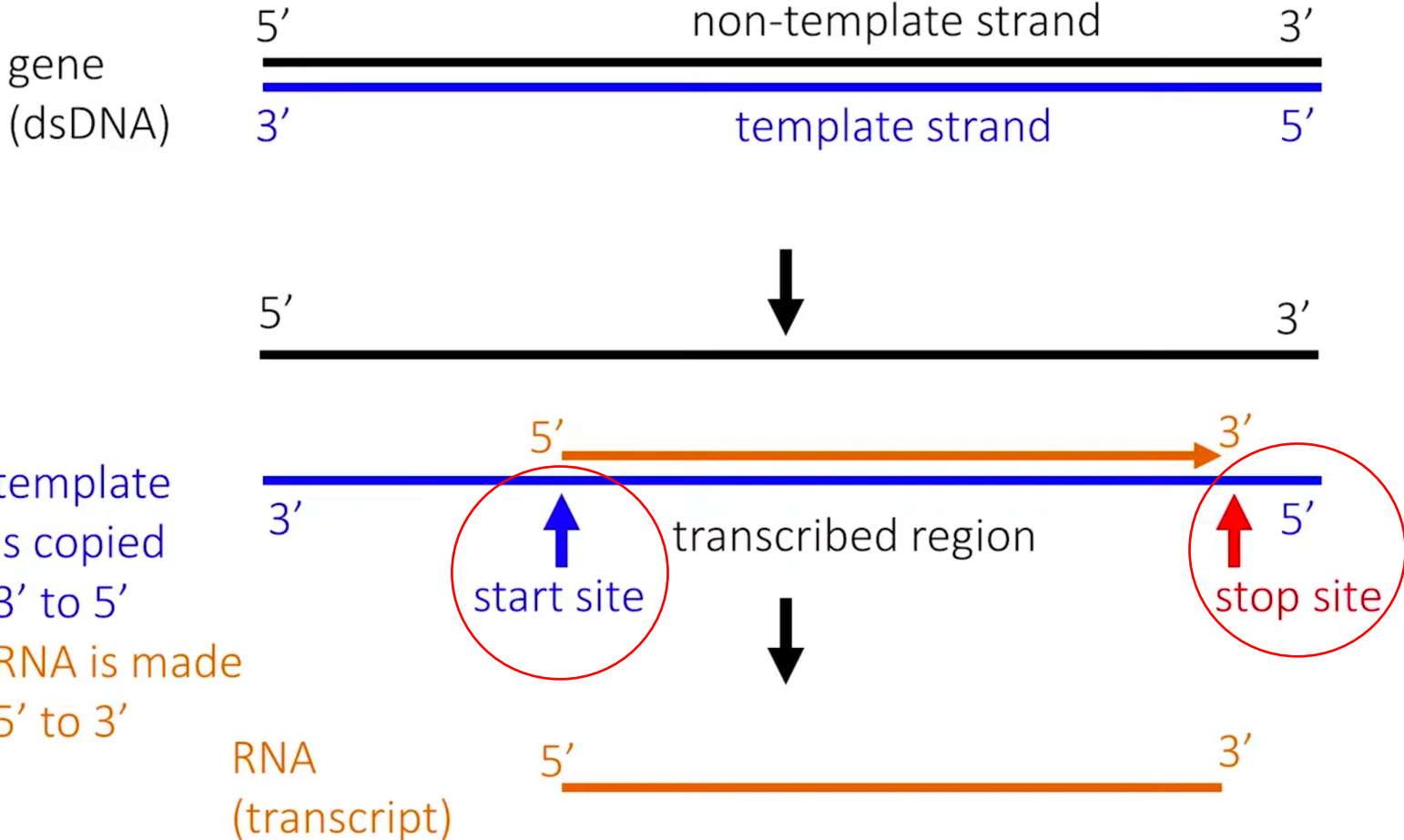


# Transcription – the basic recap



# DNA transcription

Transcription from specific strand/position



# DNA transcription – ONLY THE BOTTOM STRAND

- Complementary DNA strands are transcribed into different mRNAs

