Zoo-342 Molecular biology
Lecture 6

Gene expression

The central dogma

- In 1958, Francis Crick described the **central dogma:** DNA transfer information to RNA, which then directly controls protein synthesis.
- DNA also controls its own replication.

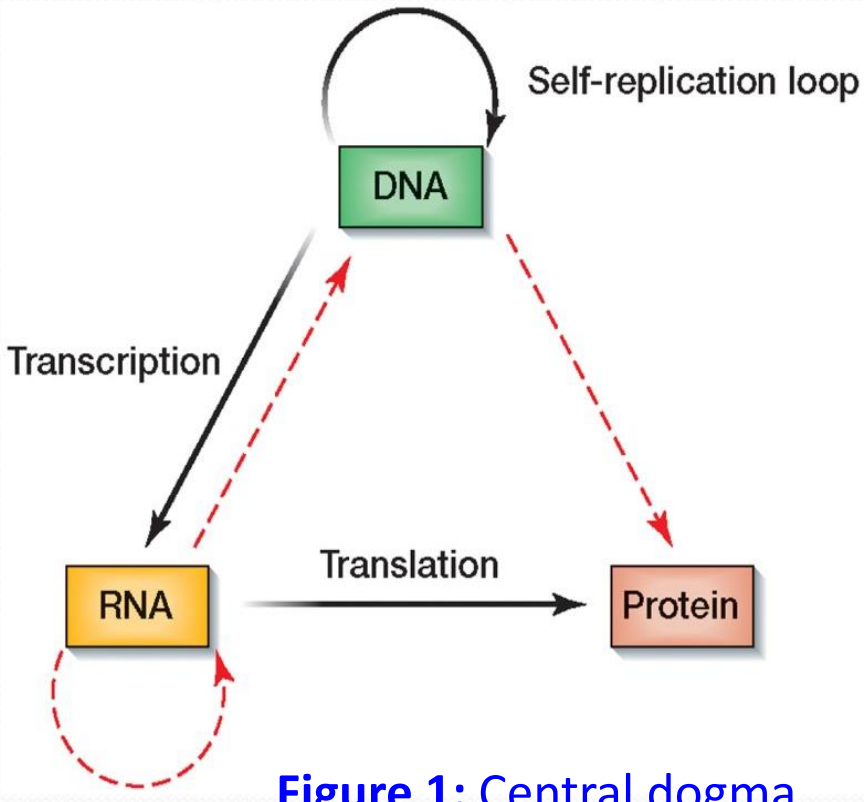

Figure 1: Central dogma

- The central dogma in molecular genetics is made up of two important process:

  1) Transcription:

  - is the first step of gene expression, which synthesizing an RNA copy from a DNA template.
  - This copy is called a messenger RNA (mRNA).

  2) Translation:

  - is the process of translating the sequence of an mRNA molecule to a sequence of amino acids during protein synthesis.

- Years later, the central dogma needed to be modified when work with RNA viruses demonstrated that RNA could be converted into DNA using the enzyme reverse transcriptase.

Types of RNA:

In the protein synthesis process, five different kinds of RNA serve critical function.

1) Messenger RNA (mRNA):

- Molecule in cells that carries the DNA sequence information from the nucleus to the sites of protein synthesis in the cytoplasm (**the ribosomes**).

2) Transfer RNA (tRNA):

- Molecule in cells that brings the amino acids and transport them to the ribosome for translation, where it base-pairs with the complementary sequence in the mRNA.

3) Ribosomal RNA (rRNA):

- The structural and functional part of the ribosome.

4) Small nuclear RNAs (snRNA):

- Essential for the proper production of mRNA by removing the **introns** (splicing) from the primary transcript to generate the **mature mRNA**.

5) microRNAs (miRNAs):

- Play an important role in regulating both transcription of RNAs and translation of proteins.

❖ **An important note:**

- mRNA, tRNA and rRNA are found in **all organisms**, while snRNA and miRNAs are found only in eukaryotic cells.
- The general relationships of the roles of mRNA, tRNA and rRNA are diagrammed in Figure 2.

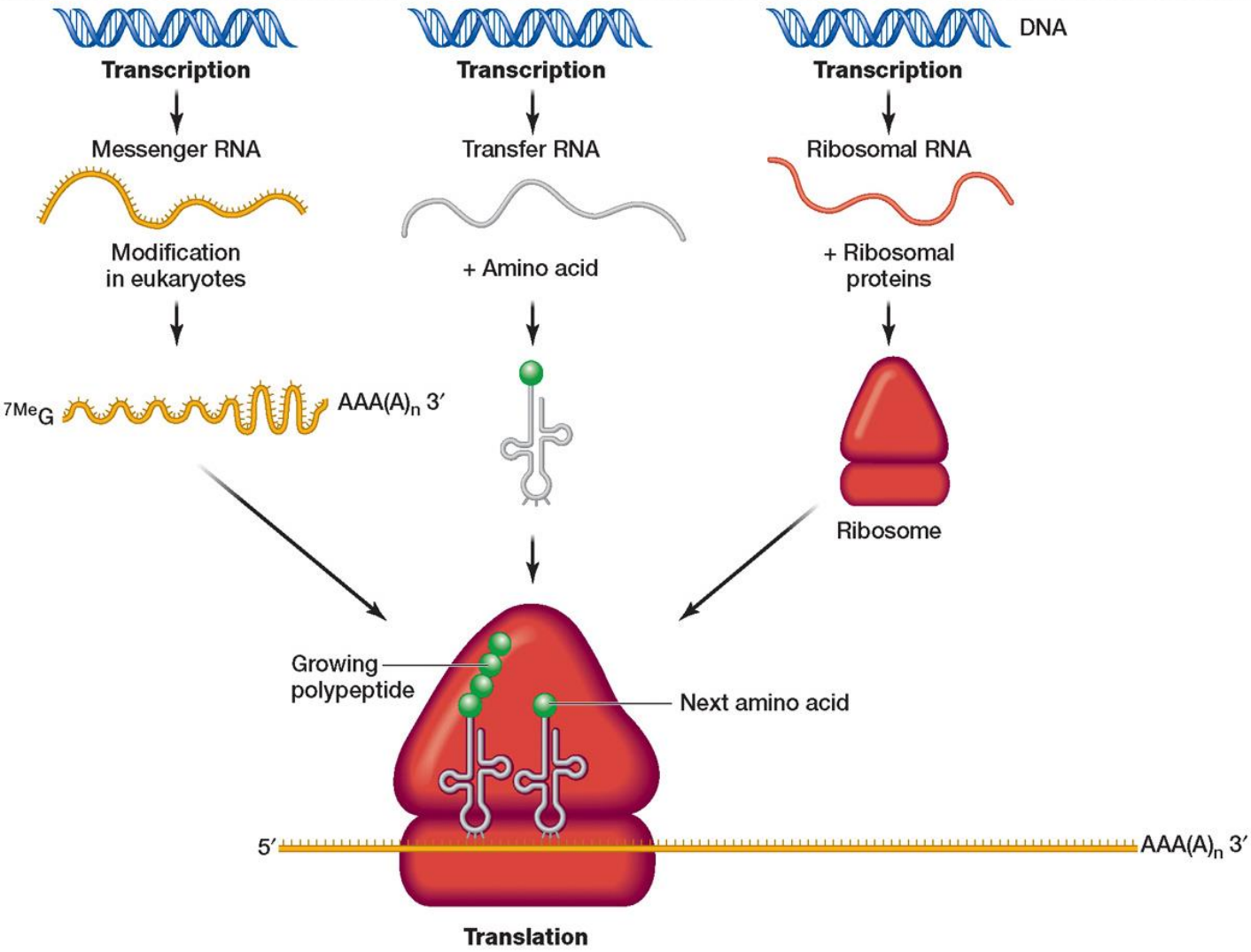

Figure 2: Relationship among three of the different RNAs, messenger, transfer, and ribosomal during protein synthesis.

How many strands does RNA have?

- For the most part, cellular RNA does not exist as a double helix.
- The evidence for this is that complementary base does not occur in corresponding equal proportion in RNA, as they do in DNA (Chargaff's ratio).
- In RNA, uracil does not usually occur in the same quantity as adenine, nor does cytosine occur in the same quantity as guanine (Table 1).

	Adenine	Uracil	Guanine	Cytosine
E. coli	24	22	32	22
Euglena	26	19	31	24

Table 1: Base composition in RNA (percentage)

Is RNA transcribed (synthesized) from one DNA strand or both?

- For any particular gene only one DNA strand is transcribed, while the complementary strand is not transcribed in that rejoin.
- The DNA strand that is complementary to the RNA sequence is called the **noncoding** or **template strand** (Figure 3).
- The **coding** or **nontemplate strand** is the DNA strand that is not complementary to the RNA sequence.
- Ribonucleotides differ from deoxyribonucleotides in two ways.

a. **First,** ribonucleotides use the sugar ribose, whereas deoxyribonucleotides use the sugar 2'-deoxyribose, which differs from ribose by the absence the hydroxyl group on the 2' carbon.

b. **Second,** ribonucleotides have the base of **uracil** instead of **thymine**, which is used in deoxyribonucleotides (Figure4).

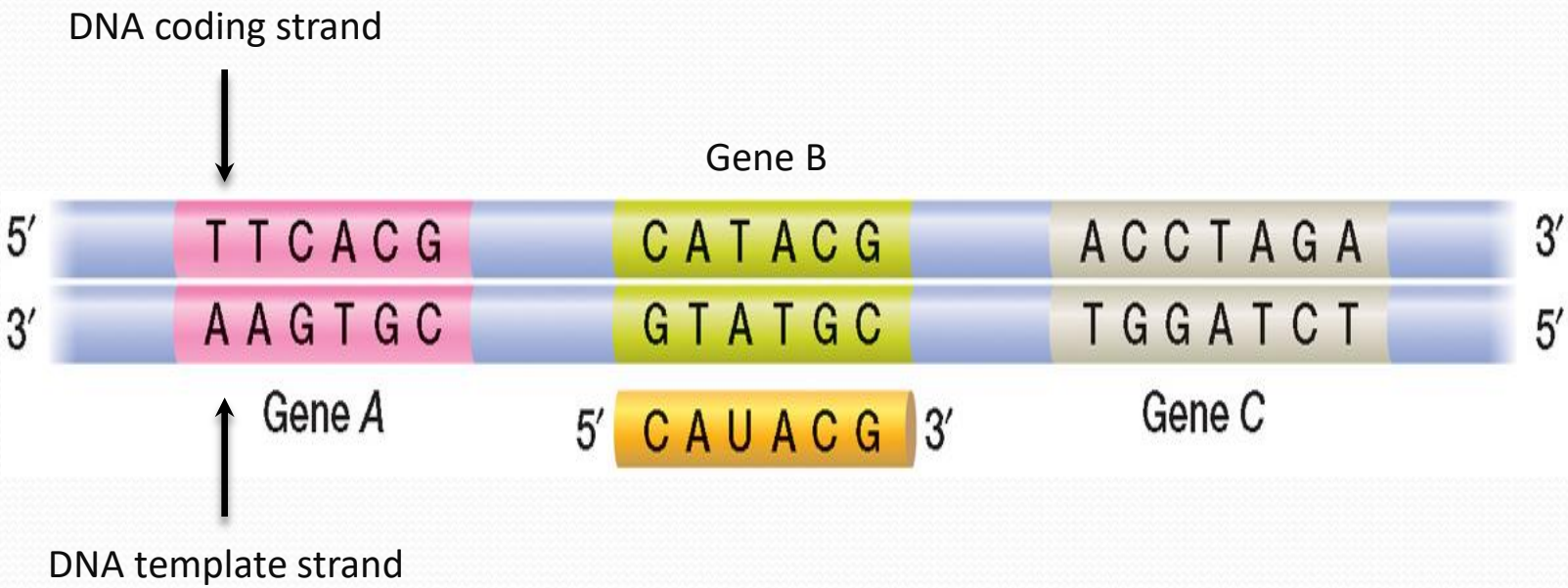

Figure 3: Relationship of gene, DNA sequence, and RNA sequence

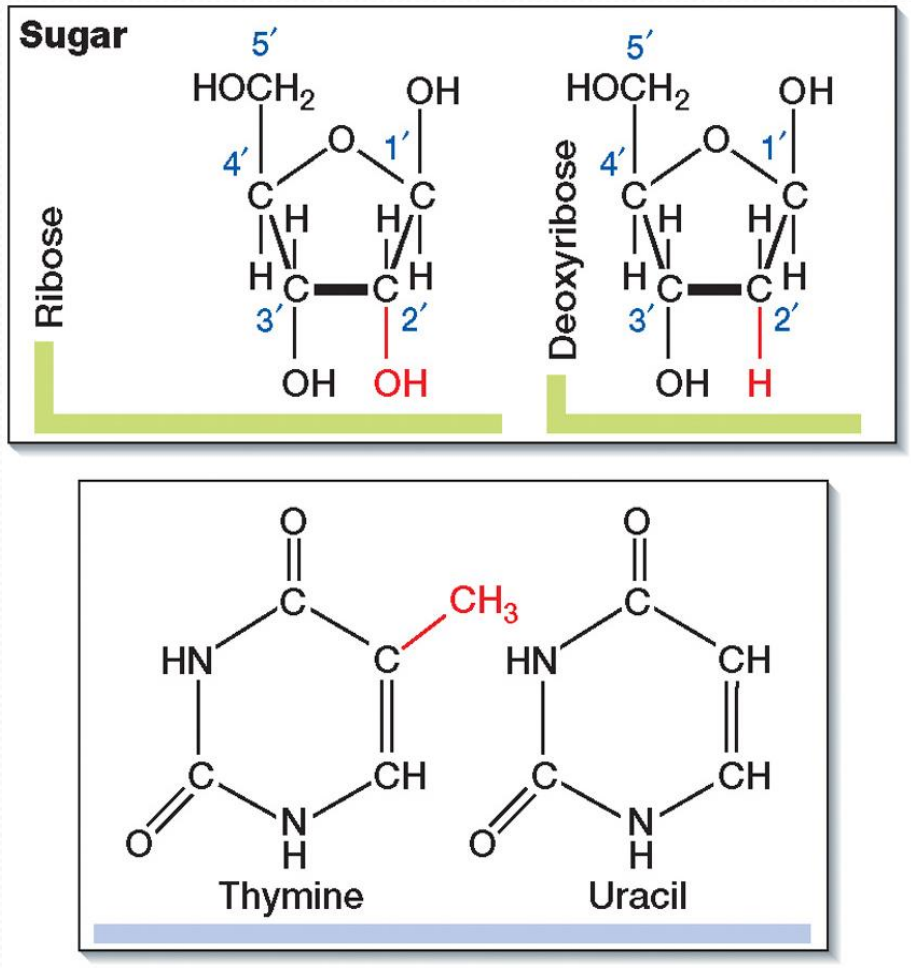

Figure 4: RNA differs from DNA in two ways