Lecture 11:

Transcription

Course 281

Lessons for life

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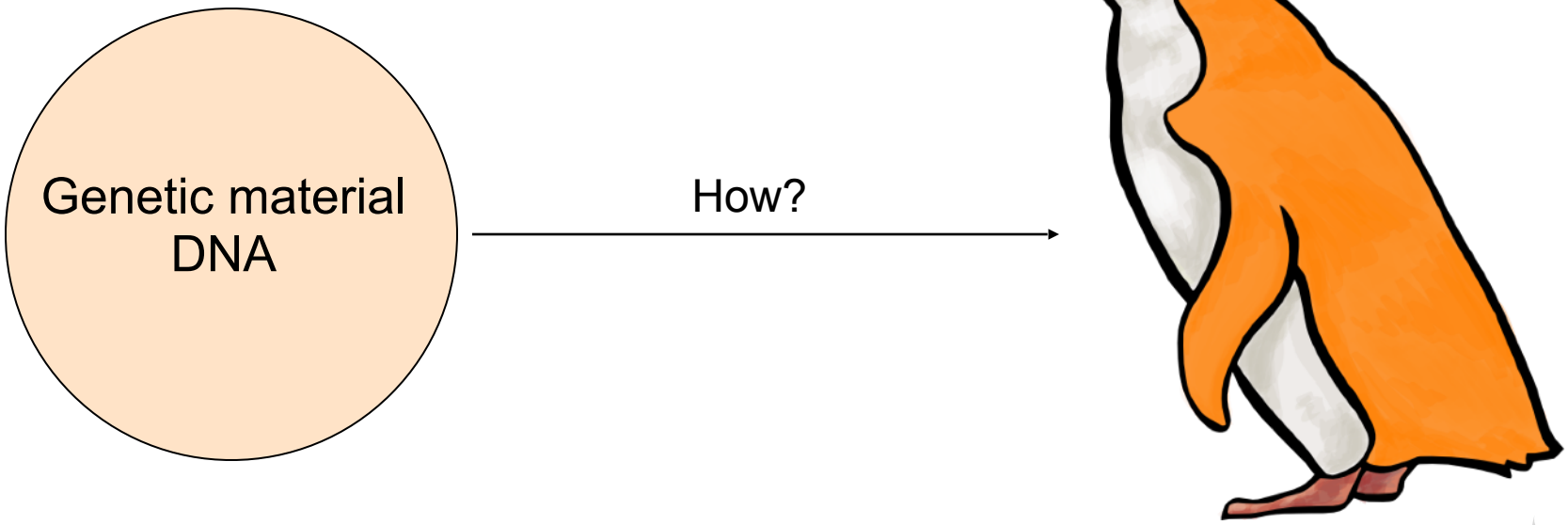
"Excuses are the nails used to build a house of failure." -- Jim Rohn

AIMS

- Understand the process of which DNA becomes a characteristic.
- Understand what parts of the DNA is read.
- Understand the first process in the path of expressing genes (transcription).
- Understand what is needed to copy DNA into an RNA molecule.
- Understand the types of RNA and their functions and characteristics.

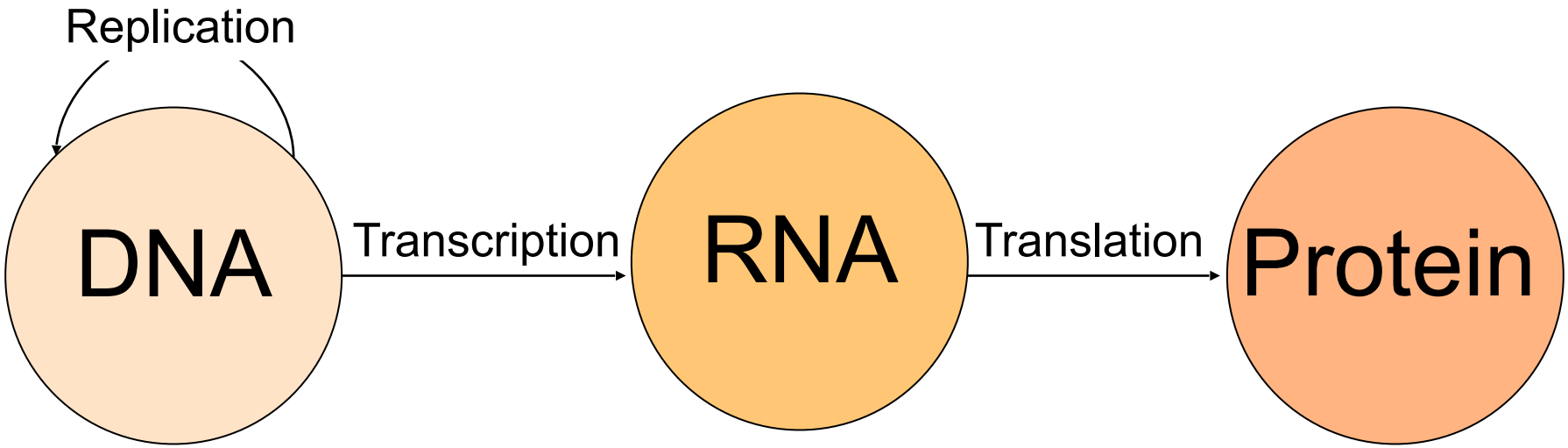
From DNA to phenotype

- DNA is the genetic material and the instructions to how living organisms are constructed.
- So how do we go from DNA to a phenotype (such as eye color).
- How is the code read?



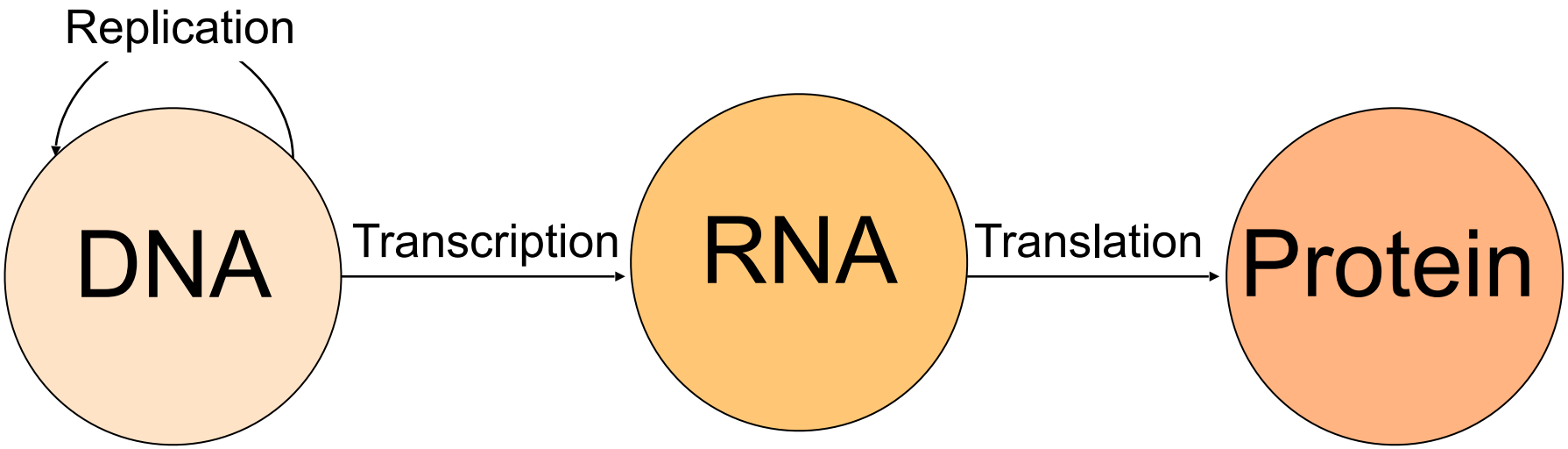
Terms and processes

- Francis Crick called these processes **the central dogma of molecular biology.**
- DNA double strands are **replicated** into DNA double strands.



Terms and processes

- DNA double strands are **transcribed** into a single stranded RNA molecule.
- Single strand RNA molecule is **translated** into amino acid sequence (protein).



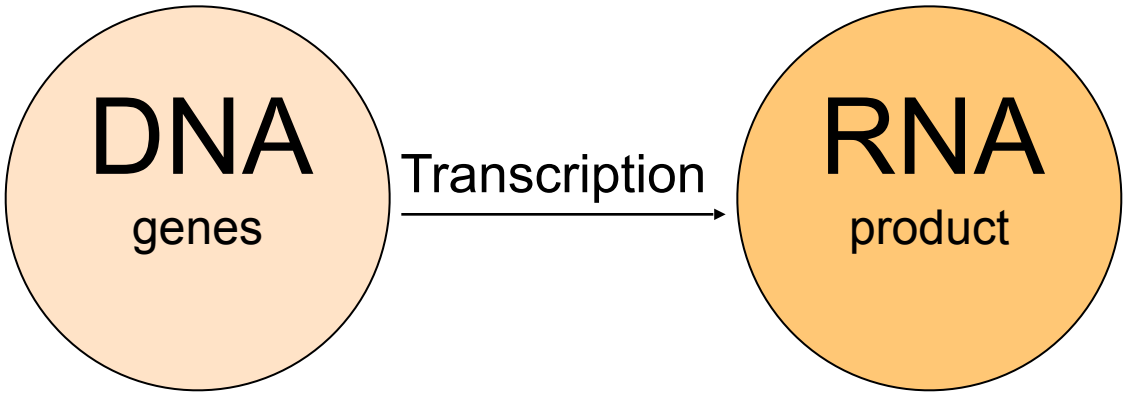
Some Terms

- The process of making DNA from DNA template is called **Replication.**
- The process of making RNA from DNA template is called **Transcription.**
- The process of making DNA from RNA template is called **Reverse Transcription.**

So what is the process in which telomerase acts?

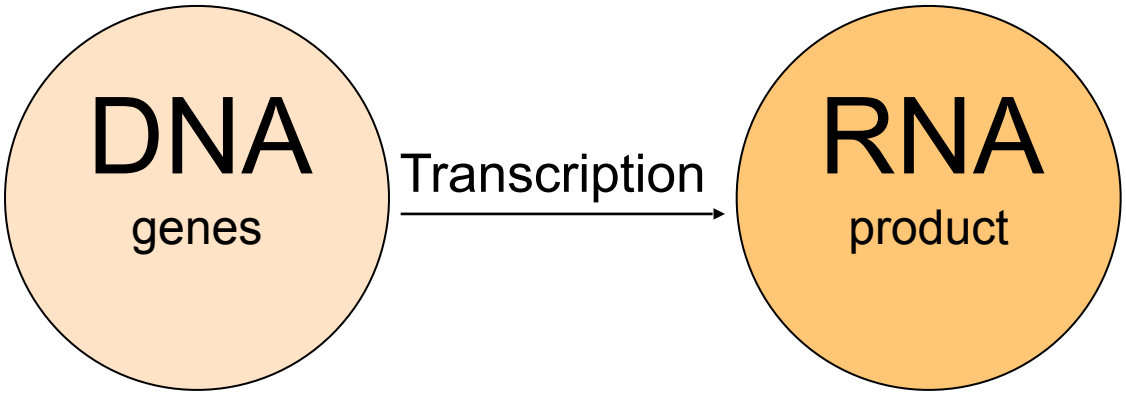
Gene expression

- DNA contain specific locations that can be read and make a product.
- These regions that give products are called **genes**.



Gene expression

- The transcription of genes is reading the genes and expressing them in the form of RNA.
- Transcription = **Gene expression** = the process of copying DNA into an RNA product.
- The RNA product of a gene is a sign of the gene expression.



Review

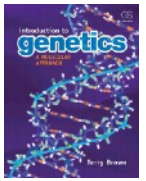
What are the differences between DNA and RNA?

	DNA	RNA
Sugar	deoxyribose	ribose
Bases	A, G, C, T	A, G, C, U
Strands	Double strands	Single strand
Genetic material	Most life	Some viruses
Enzymatic activity	None	Many with
Structure	Double helix	Linear or folded

- mRNA is usually not more than 4% of the total cell's RNA.

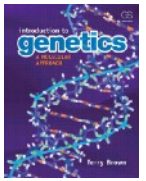
- The majority of the cell's RNA are noncoding RNA.

- RNA that are not translated into protein but instead play their roles in the cell as RNA.



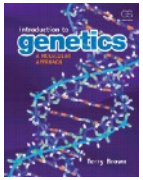
- Typical bacterium contains 0.05 to 0.10 pg of noncoding RNA (~ 6% of its total weight).

- A mammalian cell contains 20 to 30 pg noncoding RNA (~1% of the cell as a whole).



Types of noncoding RNA

- Ribosomal RNA
- Transfer RNA
- siRNA
- microRNA
- snRNA



RNA types

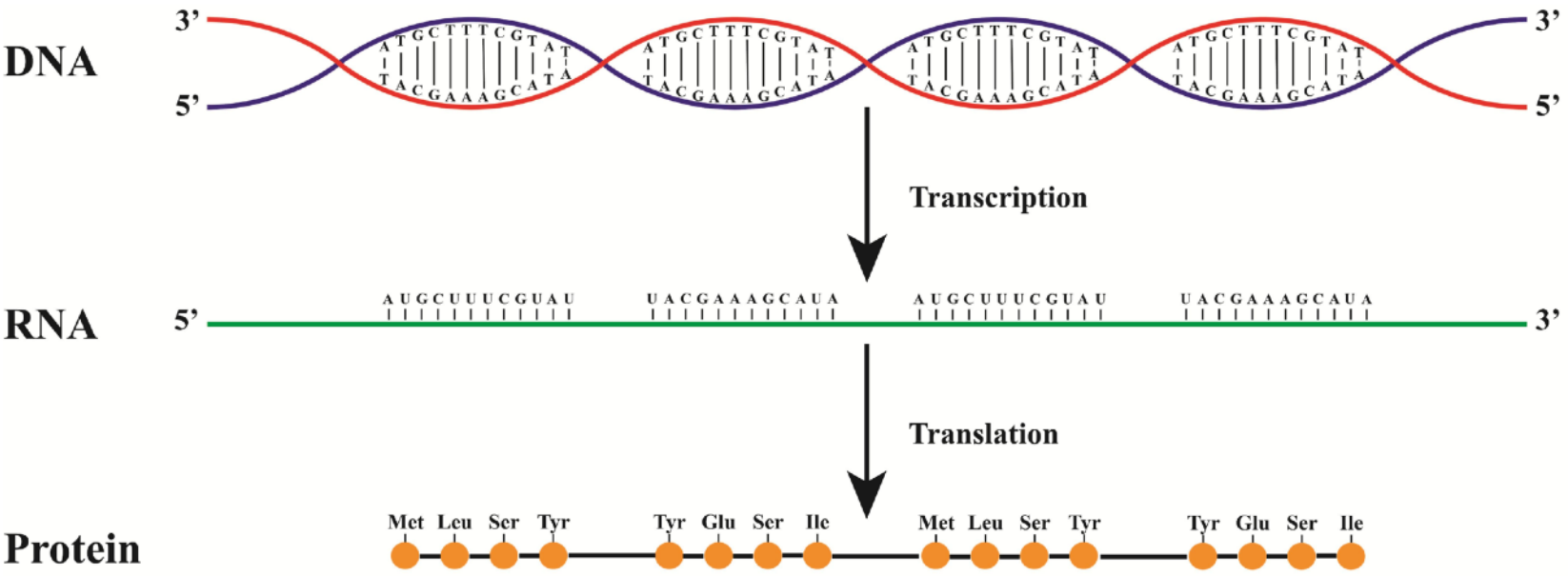
DNA is transcribed to make the following RNA products:

- Messenger RNA (mRNA)
- Ribosomal RNA (rRNA)
- Transfer RNA (tRNA)
- Small nuclear RNA (snRNA)

mRNA

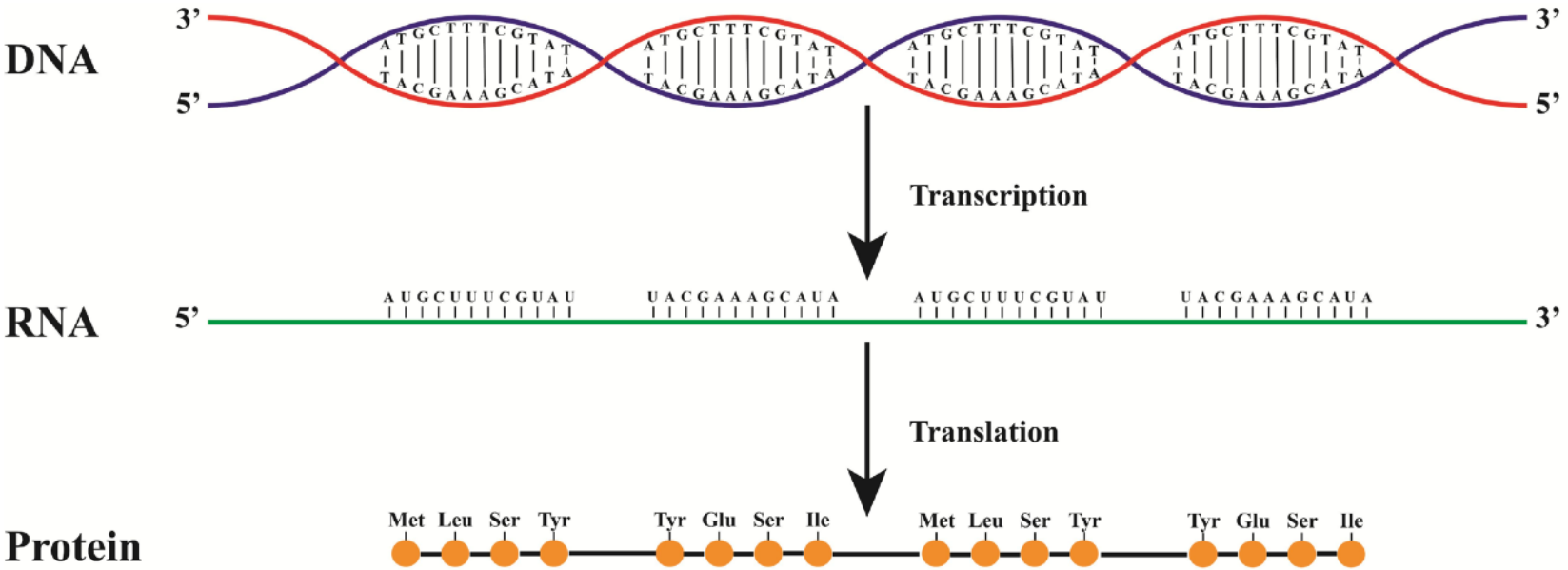
Messenger RNA (m-RNA) function and characteristics:

- carries the code to make amino acids (proteins).



mRNA

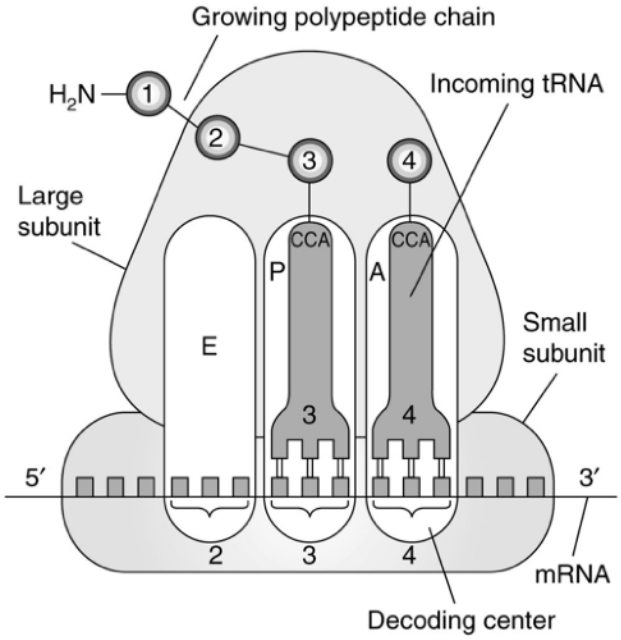
- No function other than carrying the code.
- made of linear sequence of ribonucleotides and remains linear.

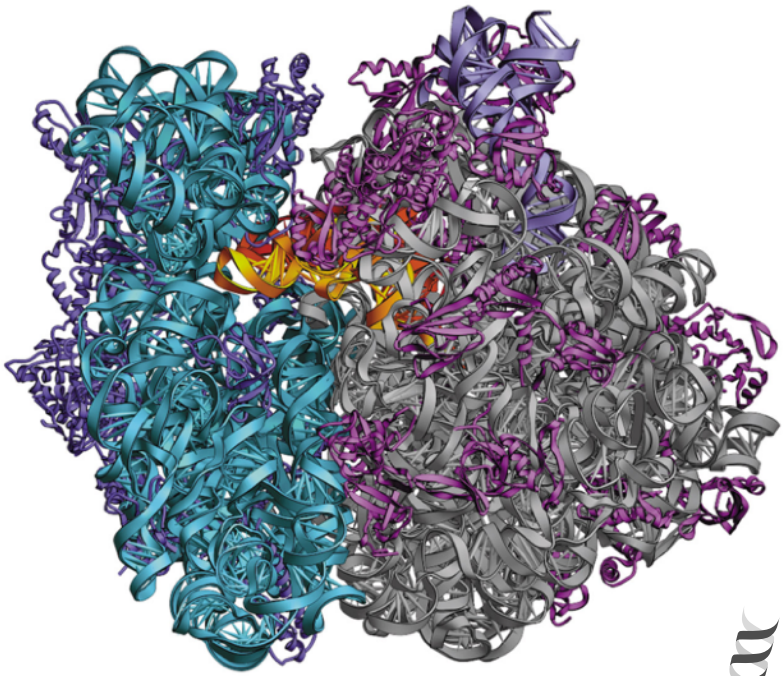


rRNA

Ribosomal RNA (r-RNA) function and characteristics:

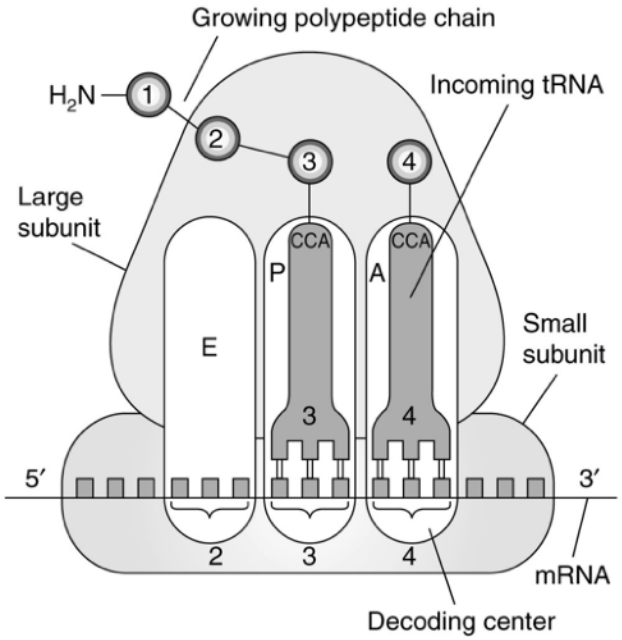
- Makes (with proteins) the ribosomal machinery to translate RNA into amino acid sequence (proteins).

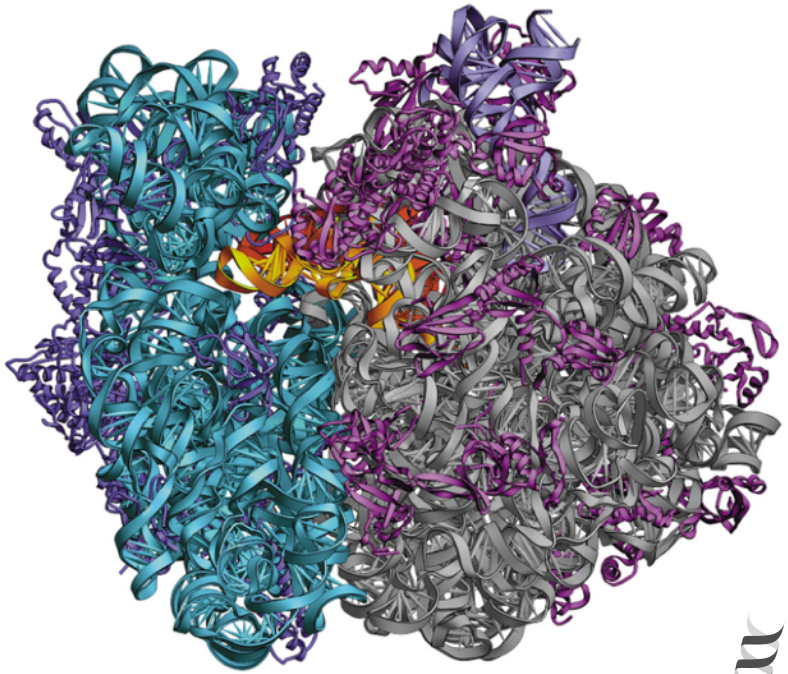




rRNA

- First made of linear sequence of ribonucleotides then folds into three dimensional structure.
- Compose a multi-unit machine.

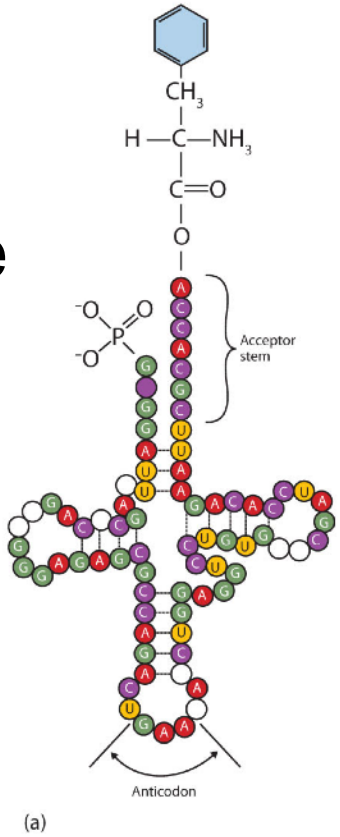


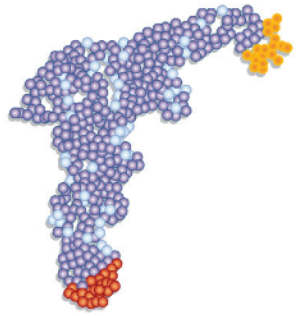


tRNA

Transfer RNA (t-RNA) function and characteristics:

- Carries the amino acids to the ribosome which are needed to make proteins.
- Like rRNA it is first made of linear sequence of ribonucleotides then folds into three dimensional structure.

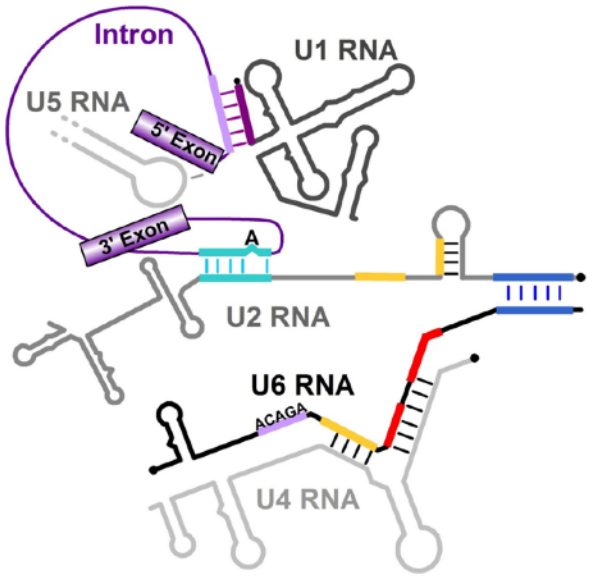




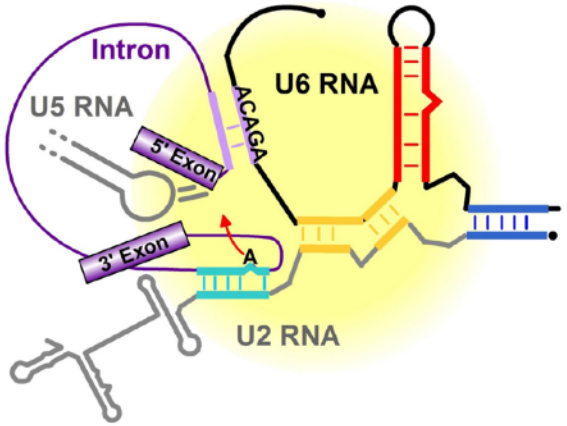
snRNA

Small nuclear RNA (sn-RNA) function and characteristics:

- Involved in the processing of mRNA in eukaryotes.



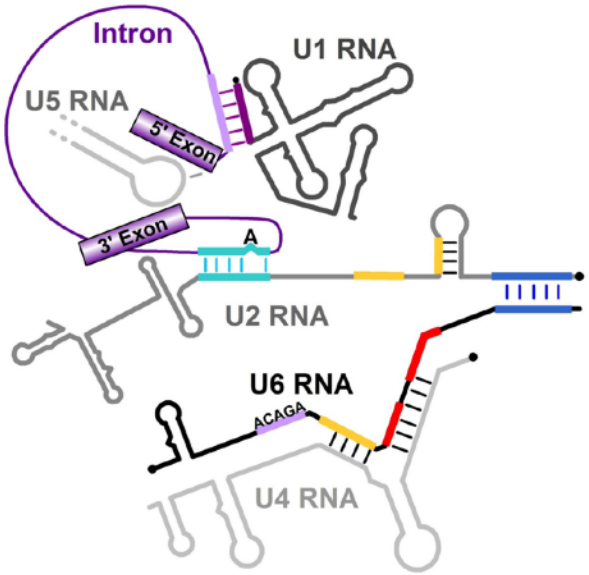
pre-catalytic spliceosome



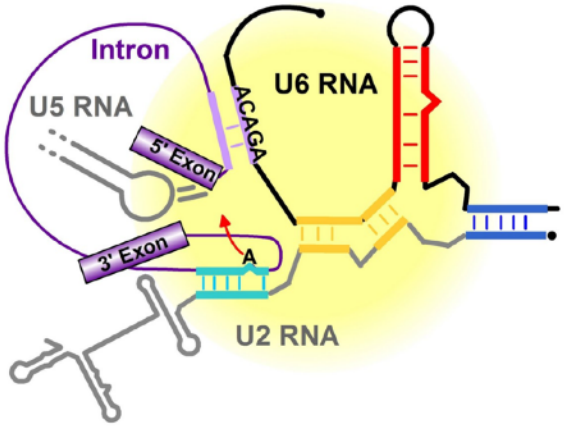
catalytically activated spliceosome

snRNA

- Part of the spliceosome machine.
- First made of linear sequence of ribonucleotides then folds into three dimensional structure.



pre-catalytic spliceosome



catalytically activated spliceosome

Making RNA

Making RNA requires:

1. DNA template (gene).
2. RNA copier (RNA polymerase).
3. RNA building blocks (ribonucleoside triphosphate NTPs)

1. DNA template

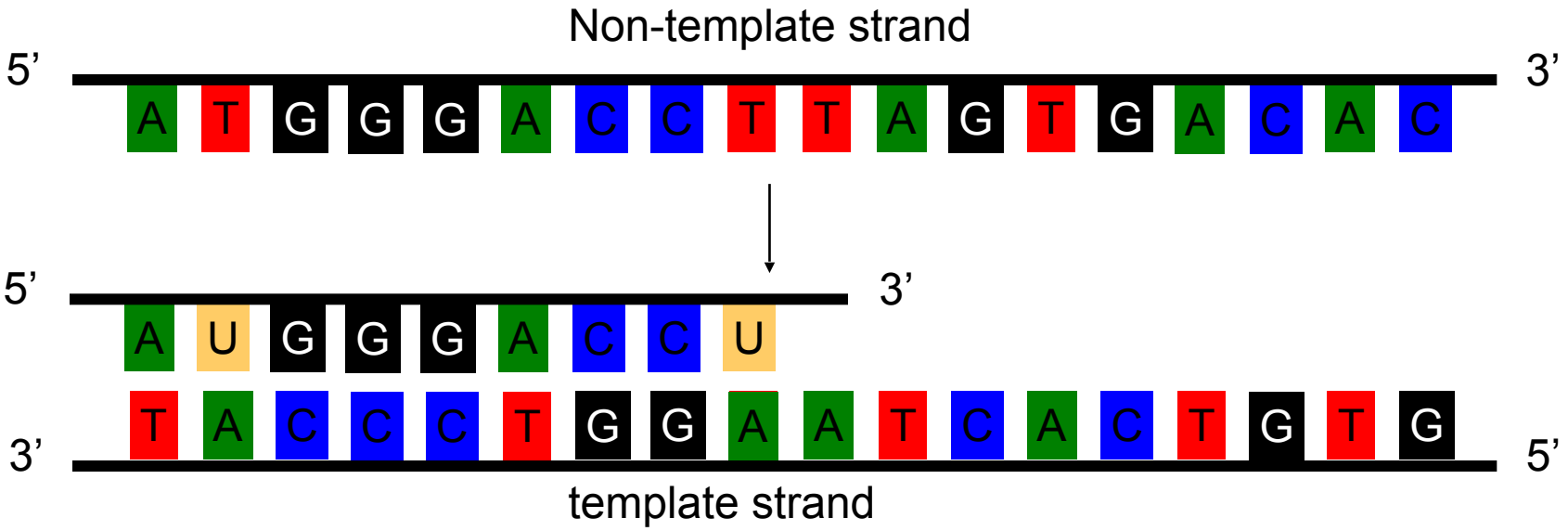
What is the direction of DNA synthesis?

What do you think is the direction of RNA synthesis?

1. DNA template

- RNA is synthesized 5' ➔ 3'.
- Only **ONE** of the DNA two strands serves as a template. Which one?

- The RNA template strand is the DNA's (3' ➔ 5'). The other strand is called the non-template strand.



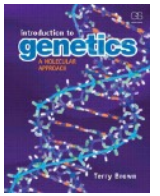
2. **RNA copier**

- DNA is transcribed and RNA is synthesized using **RNA polymerase.**
- In bacteria there is only one RNA polymerase to transcribe all kinds of genes.
- RNA polymerase is called **Holoenzyme (complete enzyme)**

4.2 ENZYMES FOR MAKING RNA

• An enzyme that transcribes DNA into RNA is called a **DNA-dependent RNA polymerase.**

• RNA polymerases are the central component of the transcription process.



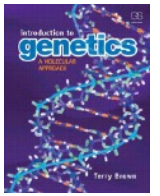
4.2 ENZYMES FOR MAKING RNA

Prokaryotes

- The RNA polymerase of *E. coli* has two versions.

- Holoenzyme comprises five subunits, 2αββ'σ where as core enzyme lacks σ and has 2αββ’ subunits.

- Both enzymes have separate roles in transcription.



2. **RNA copier**

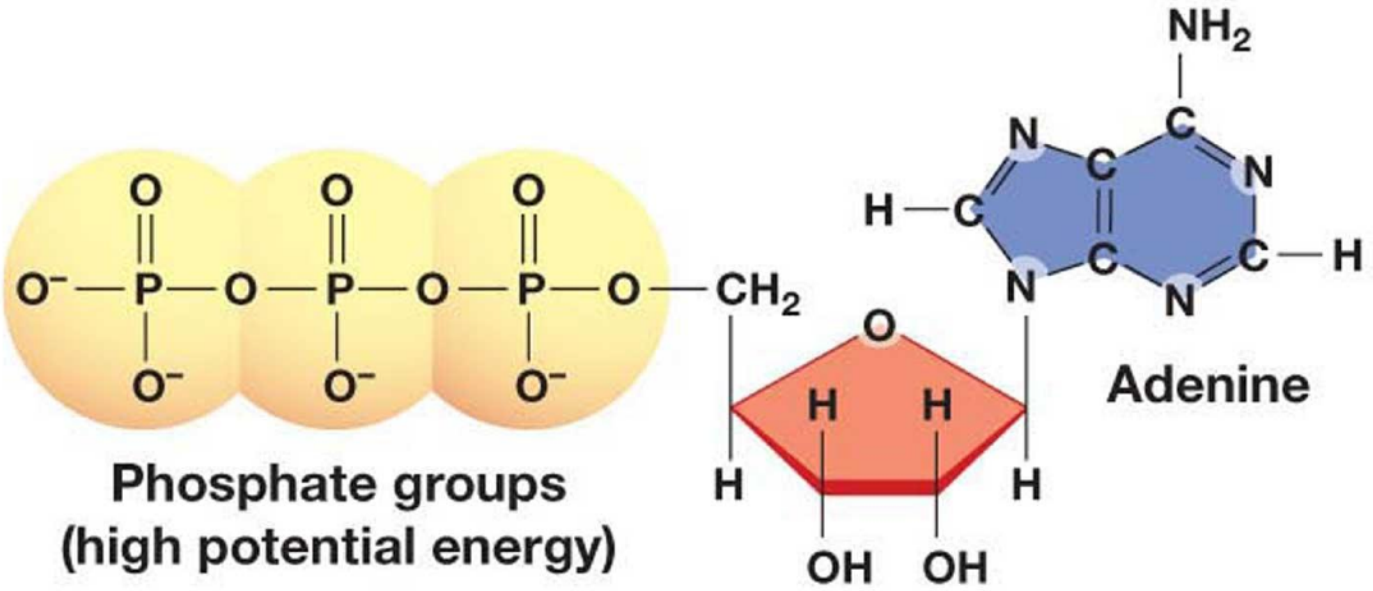
Holoenzyme

Core enzymes
Composed of multiple subunits:
Two α (alpha)
β (beta)
β’ (beta prime)

σ sigma subunit
Makes core enzyme bind to a specific sequence

3.**RNA building blocks**

Ribonucleoside triphosphate (NTP)



Four NTPs serve as the building blocks of DNA (ATP, **UTP**, GTP, CTP)

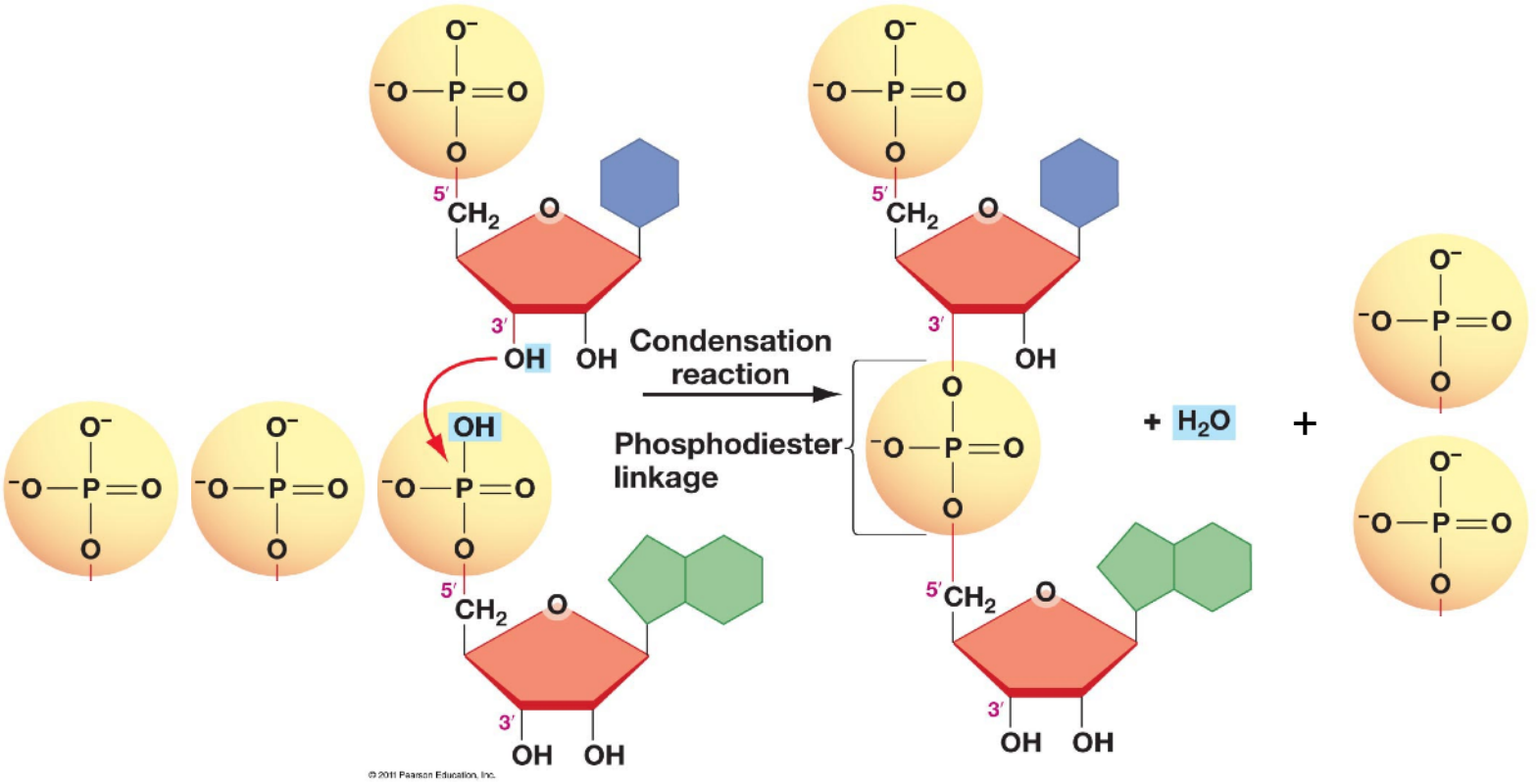
Remember **Nucleotides!**

3.RNA building blocks

Why ribonucleoside triphosphate (NTP)?

3. **RNA building blocks**

For the energy required to for the phosphodiester bond



To study

tRNA

Linear RNA

mRNA

σ

ribonucleotide

Core enzymes

α

transcription

UTP

Non-template strand

translation

Ribonucleotidetriphosphate

β

rRNA

Sigma factor

3D RNA

Holoenzyme

snRNA

Central dogma of molecular biology

Gene expression

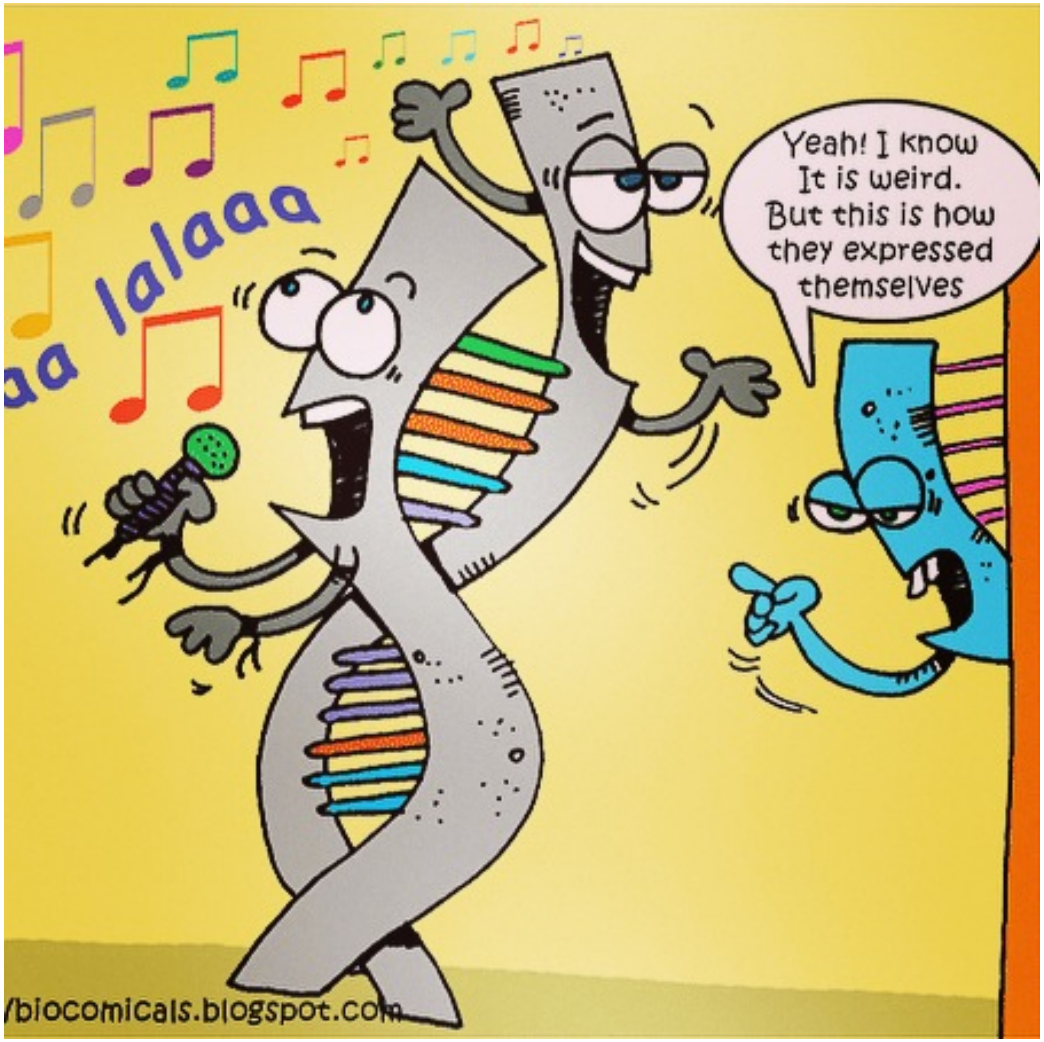
Template strand

β'

Expectations

- You know the central dogma of molecular biology.
- You know that genes are read and transcribed into RNA.
- You know the components of RNA synthesis and gene expression.
- You know that there are many types of RNA molecules that get transcribed and their functions.

For a smile


aa lalaaa
Yeah! I know
It is weird.
But this is how
they expressed
themselves
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