General Biology

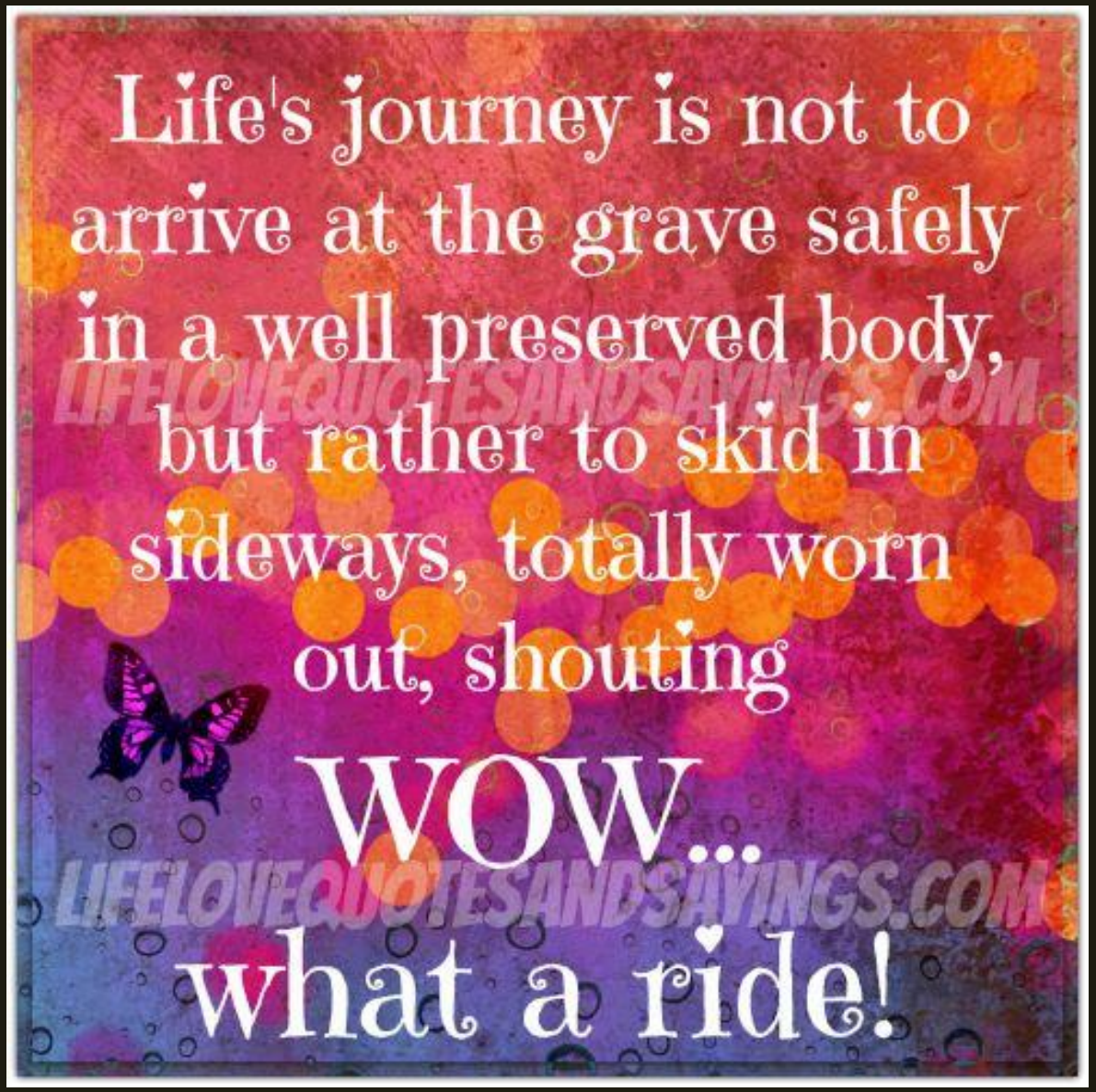
Ch 10 and 11: The Structure and Function of DNA and How Genes are controlled

“Transcription”

General Biology

Ch 10 and 11: The Structure and Function of DNA and How Genes are controlled

"Processing of RNA and Translation"

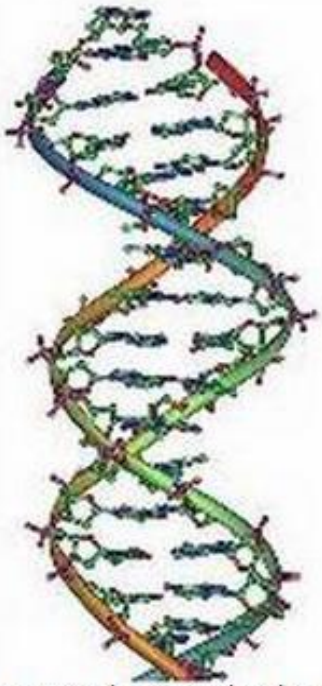

Life's journey is not to
arrive at the grave safely
in a well preserved body,
but rather to skid in
sideways, totally worn
out, shouting
WOW...
what a ride!
LIFELOVEQUOTESANDSAYINGS.COM
LIFELOVEQUOTESANDSAYINGS.COM

What is Transcription?

Have you ever had to transcribe something? Maybe someone left a message on your voicemail, and you had to write it down on paper. Or maybe you took notes in class, then rewrote them neatly to help you review.

Transcription is a process in which information is rewritten. Transcription is something we do in our everyday lives, and it's also something our cells must do, in a more specialized and narrowly defined way.

DNA: the instruction manual



One (of very many) DNA molecules which give the bongo instructions about what to do when attacked

Chapter 12

When a lioness starts chasing me with a mean look in her eyes it means that she wants to eat me. I will turn around and run as fast as I can in the opposite direction. If I do not escape I will be *toast* so I will need to run very fast. (Not literally *'toast'*- it's just an expression!)

Character traits determined genetically? Genes may hold the key to a life of success, study suggests

Date: May 16, 2012

Source: University of Edinburgh

Summary: Genes play a greater role in forming character traits -- such as self-control, decision making or sociability -- than was previously thought, new research suggests.

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FULL STORY

Identical twin boys. Genes play a greater role in forming character traits -- such as self-control, decision making or sociability -- than was previously thought, new research suggests.

Credit: © vgm6 / Fotolia

Genes play a greater role in forming character traits -- such as self-control, decision making or sociability -- than was previously thought, new research

Large study uncovers genes linked to intelligence

May 23, 2017 by Raffaele Ferrari, The Conversation

Genes controlling how our nervous system develops are linked to intelligence. Credit: Evgeny Atamanenko

Exactly what constitutes intelligence, and to what extent it is genetic, are some of the most controversial questions in science. But now a new study of nearly 80,000 people, **published in M *Genetics***, has **managed to identify a number of genes** that seem to be involved in intelligence.

According to a dictionary definition, intelligence is "the a … understand or deal with new situations" or "the

Scientists identify 40 genes that shed new light on biology of intelligence

Study significantly adds to the tally of genes connected to intellect – but researchers caution genius isn't all down to genetics

Scientists identify 40 genes that shed new light on biology of intelligence Photograph: Chung Sung-Jun/Getty Images

A major study into the genetics of human intelligence has given scientists their richest insight yet into the biology that underpins our cognitive skills.

The research on 60,000 adults and 20,000 children uncovered 40 new genes that play a role in intelligence, a haul that brings the number of genes known to have a bearing on IQ to 52.

Forming part of the blueprint for the brain, the genes provide instructions for the building of healthy neurons, the paths they take through the 3lb lump of tissue,

Scientists discover how key gene makes people fat

Marilynn Marchione, Associated Press Published 8:12 p.m. ET Aug. 19, 2015 | **Updated 8:16 p.m. ET Aug. 19, 2015**

(Photo: Rogelio V. Solis, AP)

Scientists have finally figured out how the key gene tied to obesity makes people fat, a major discovery that could open the door to an entirely new approach to the problem beyond diet and exercise.

The work solves a big mystery: Since 2007, researchers have known that a gene called FTO was related to obesity, but they didn't know how, and could not tie it to appetite or other known factors.

Now experiments reveal that a faulty version of the gene causes energy from food to be stored as fat rather than burned. Genetic tinkering in mice and on human cells in the lab suggests this can be reversed, giving hope that a drug or other treatment might be developed to do the same in people.

The work was led by scientists at MIT and Harvard University and published online Wednesday by the *New England Journal of Medicine*.

The discovery challenges the notion that "when people get obese it was basically their own choice because they choose to eat too much or not exercise," said study leader Melina Claussnitzer, a genetics specialist at Harvard-affiliated Beth Israel Deaconess Medical Center. "For the first time, genetics has revealed a mechanism in obesity that was not really suspected before" and gives a third explanation or factor that's involved.

Independent experts praised the discovery.

"It's a big deal," said Dr. Clifford Rosen, a scientist at Maine Medical Center Research Institute and an associate editor at the medical journal.

Learning Objectives

- How did I get built from the DNA structures?
- Transcription (DNA to RNA)

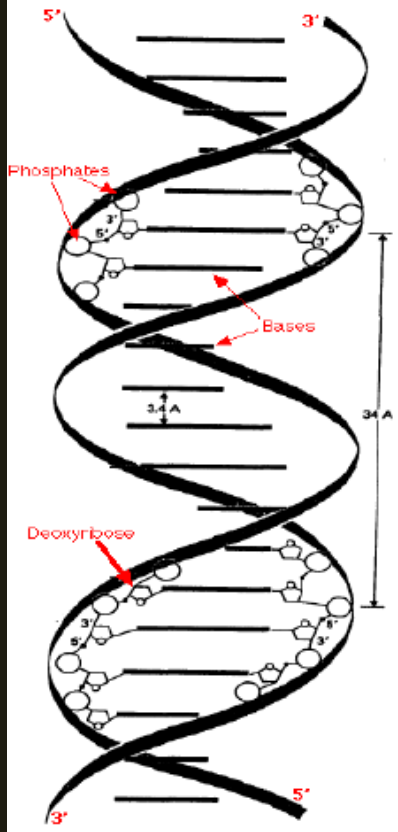
With every cell reading the programs encoded in our DNA—its like a hundred trillion computers reading a hundred trillion hard drives, every second of every day of our life

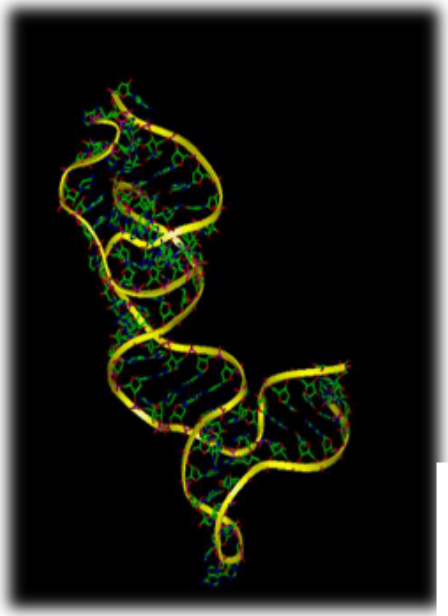
“We are fearfully and wonderfully made”

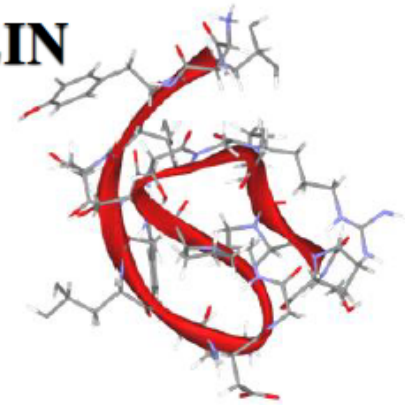
Central Dogma of Biology

replication

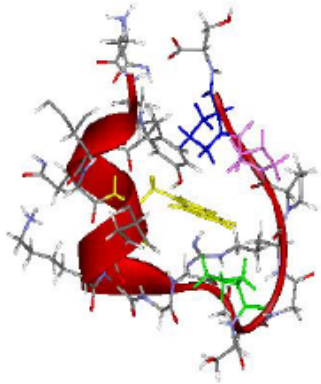
DNA → (transcription) → RNA → (translation) → PROTEIN



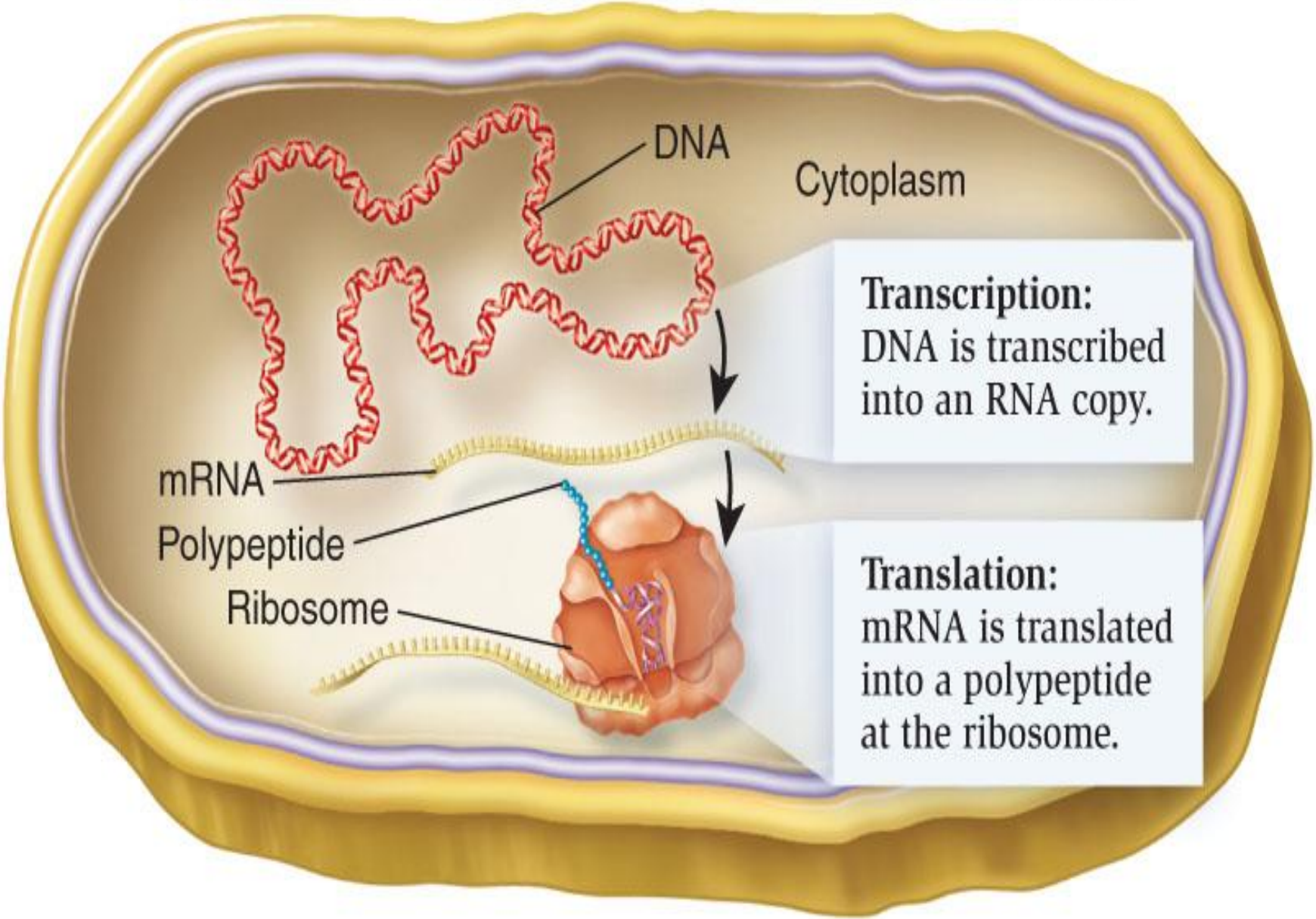


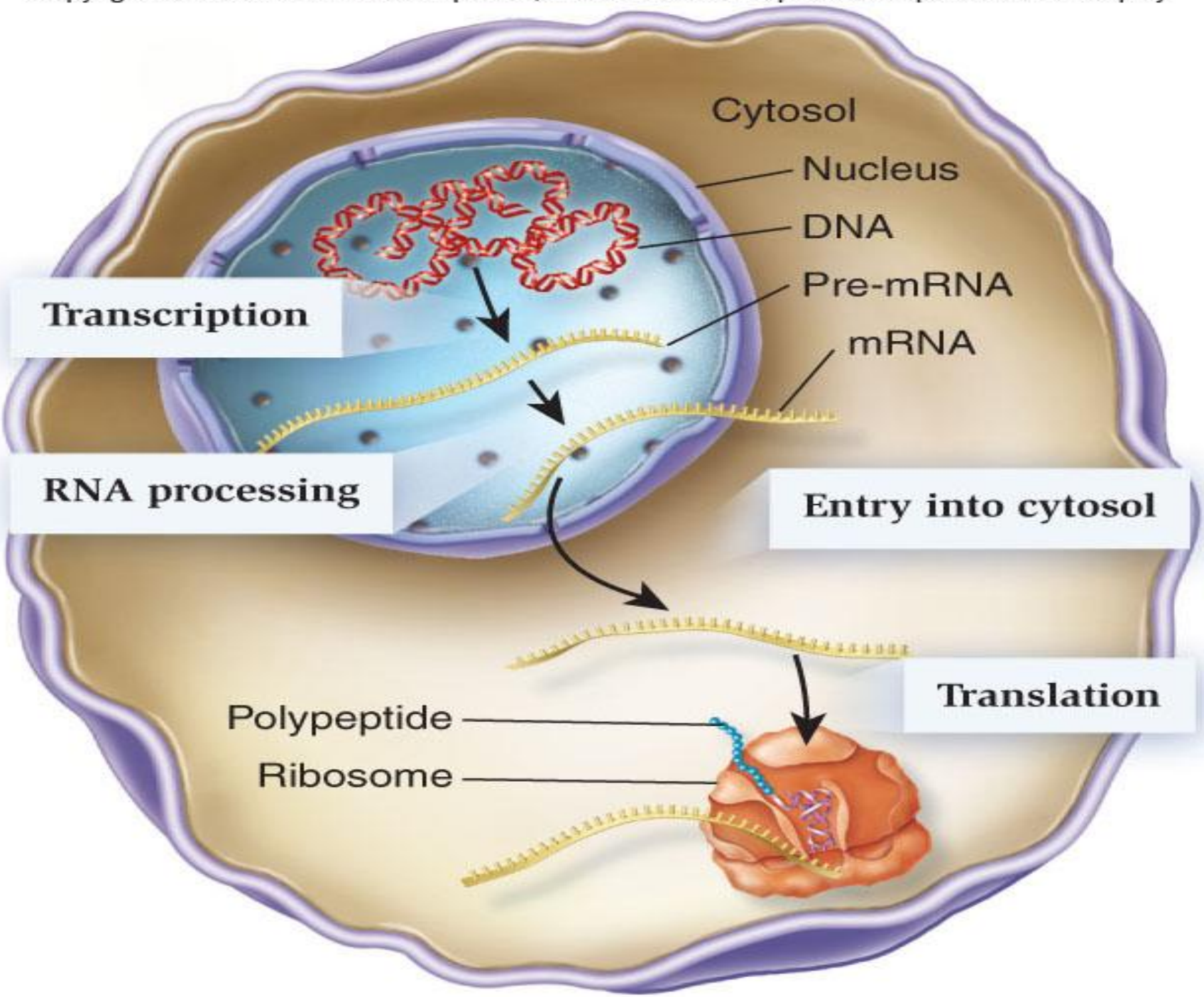


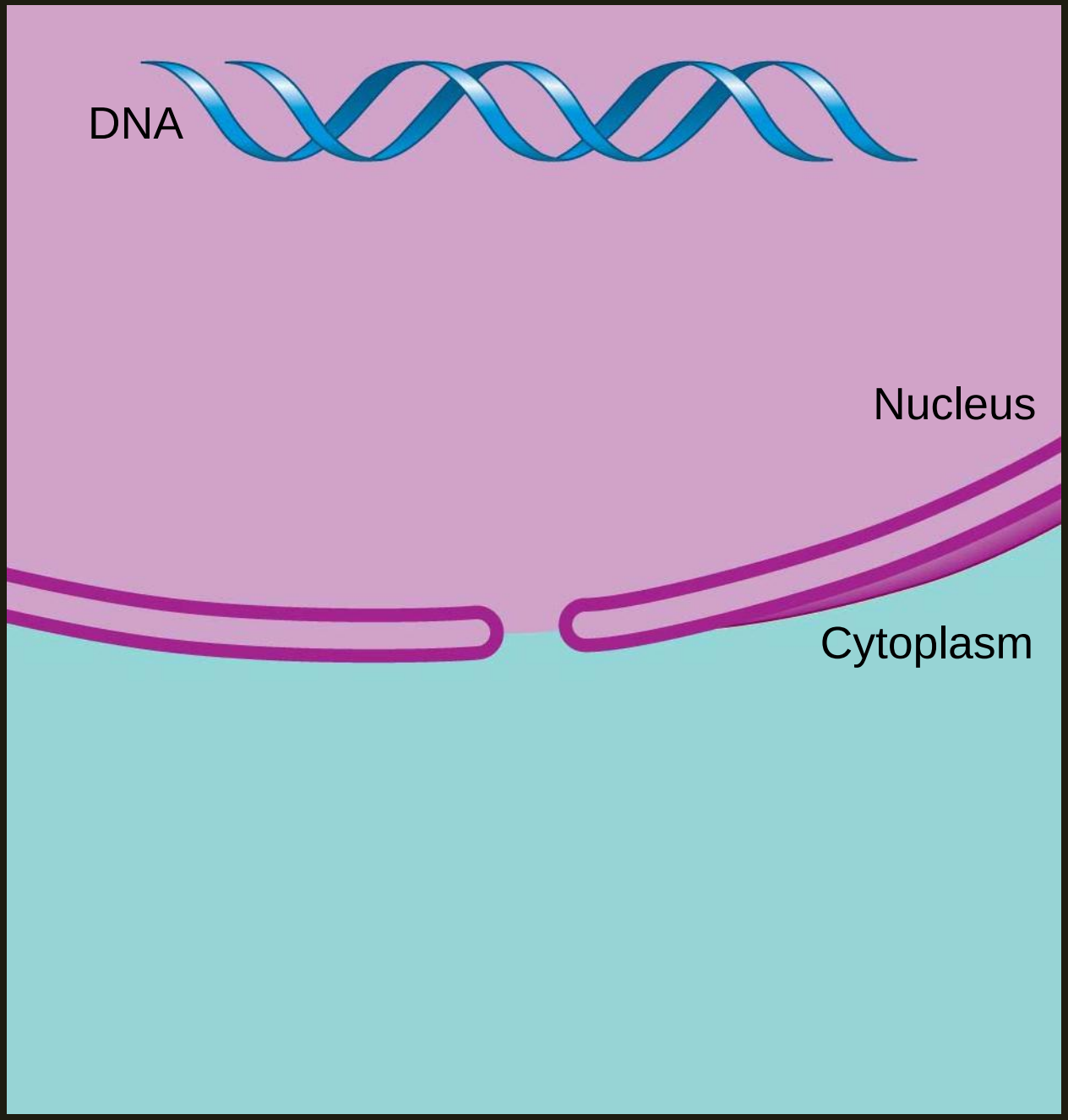
folding, assembly, targeting

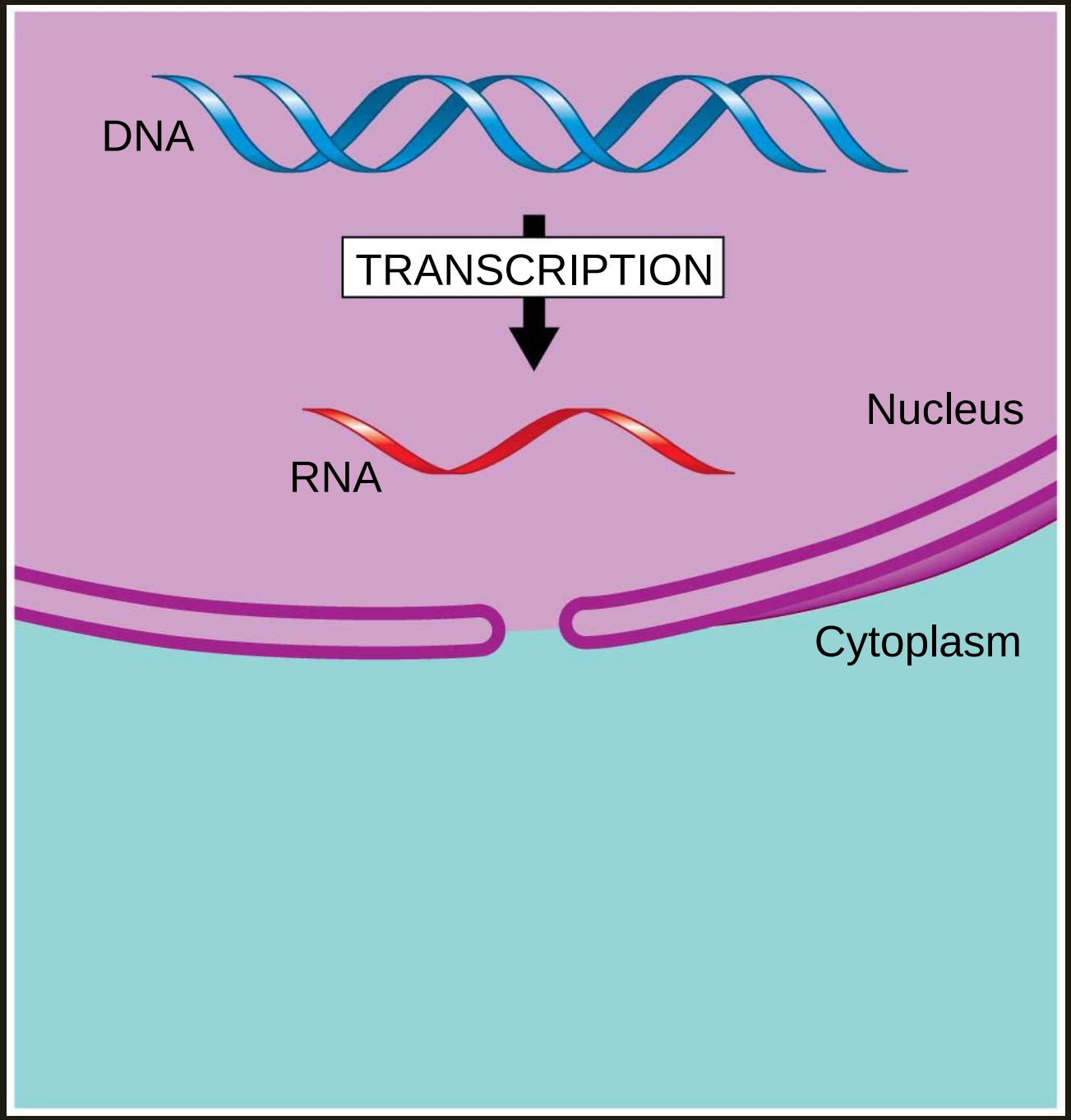


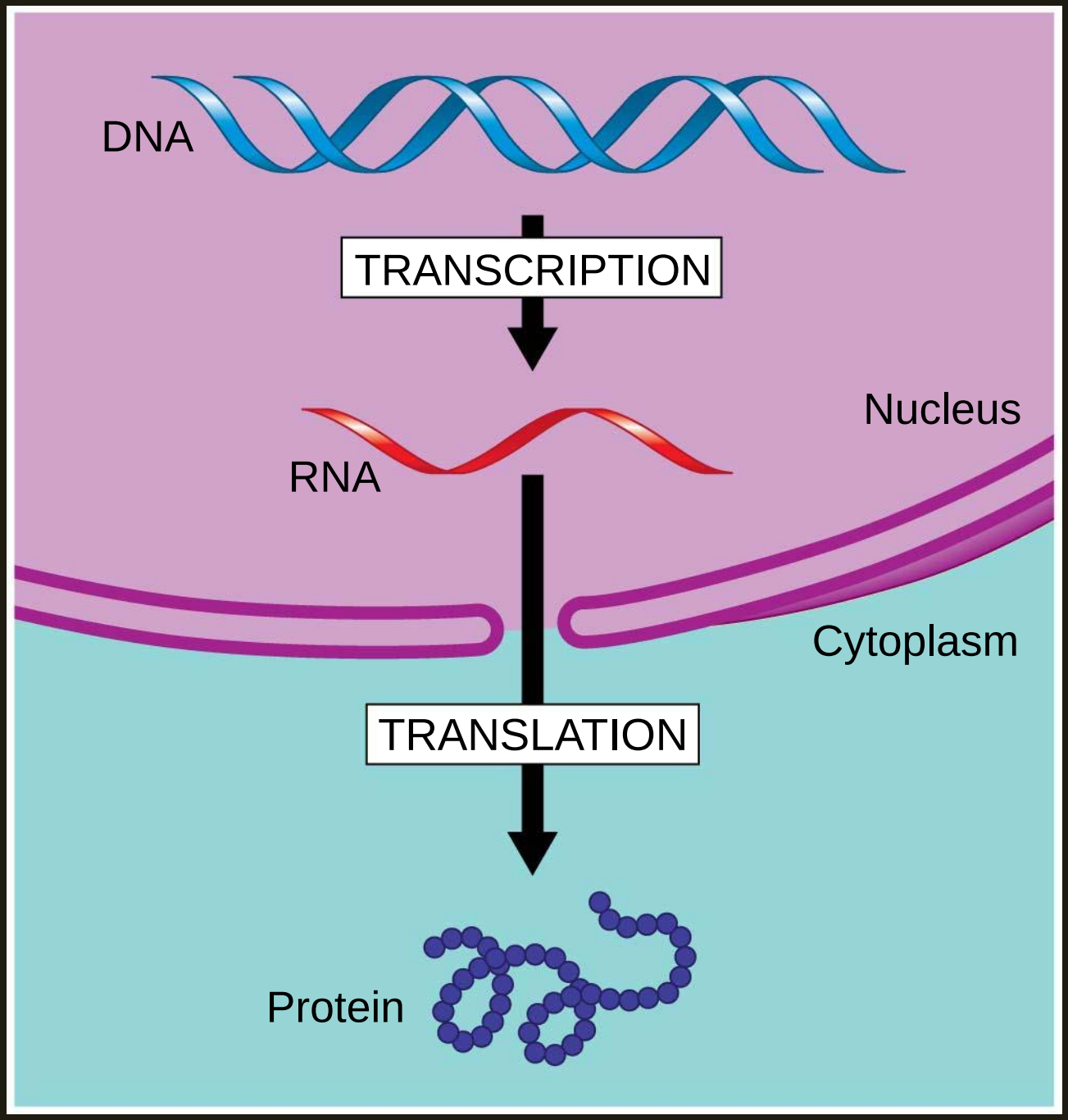
FUNCTIONAL (NATIVE) PROTEIN






DNA
Nucleus
Cytoplasm


DNA
TRANSCRIPTION
RNA
Nucleus
Cytoplasm

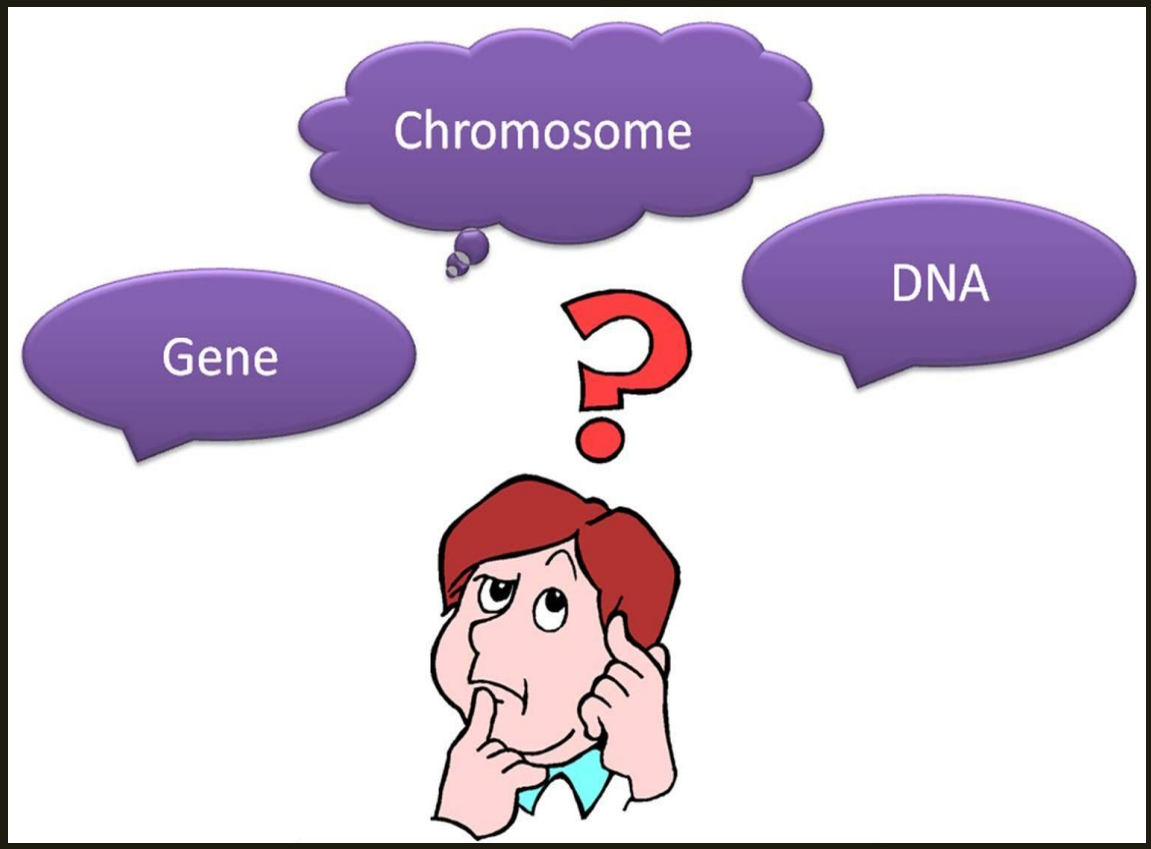

DNA
TRANSCRIPTION
Nucleus
RNA
Cytoplasm
TRANSLATION
Protein

The obvious question—
Why do we need RNA at all?

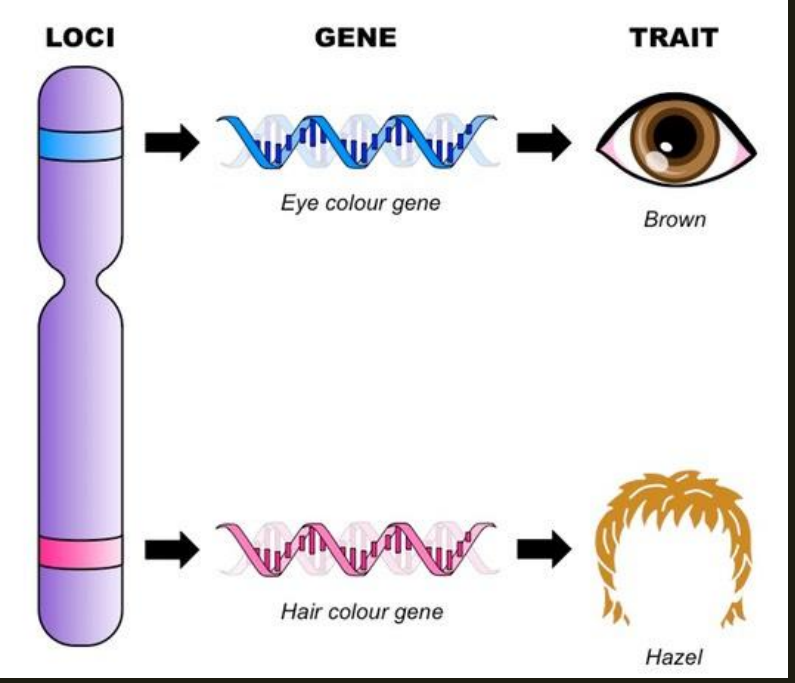
Revising Concepts

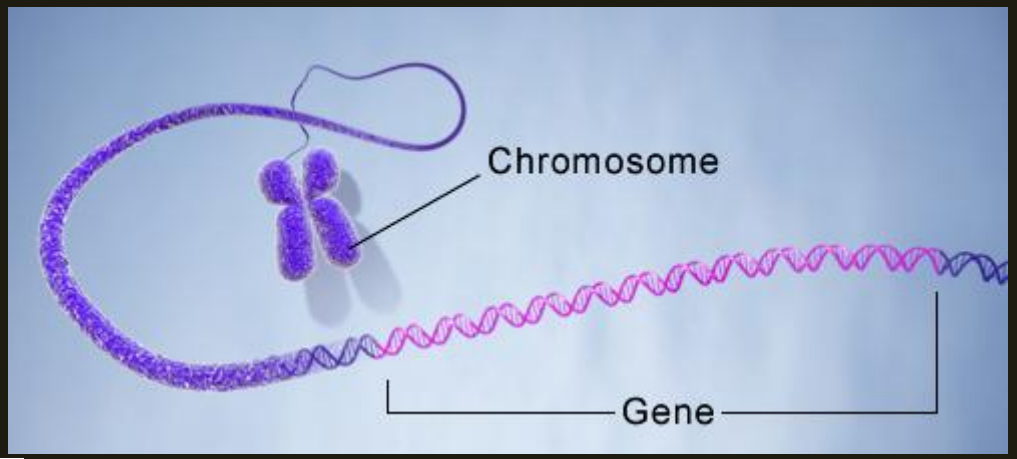
Revising Concepts

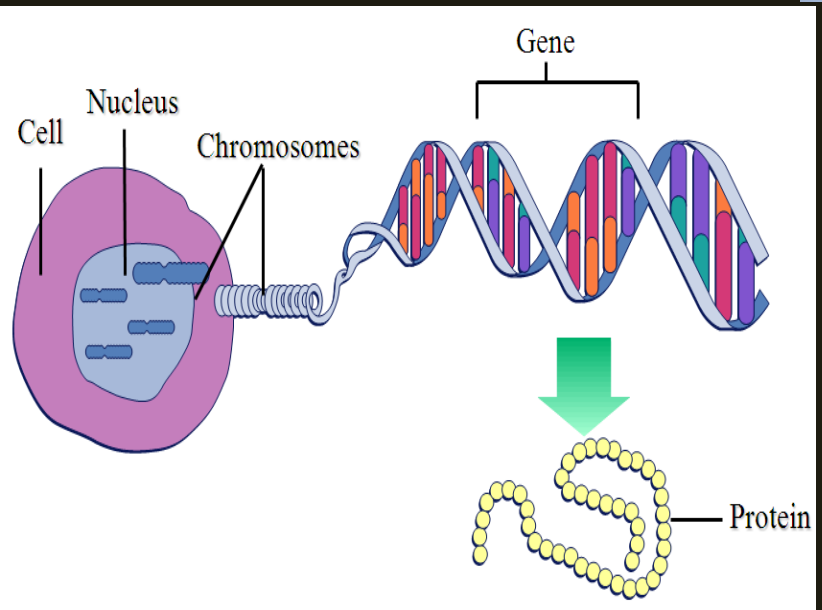
- DNA
- RNA
- Allele
- Gene

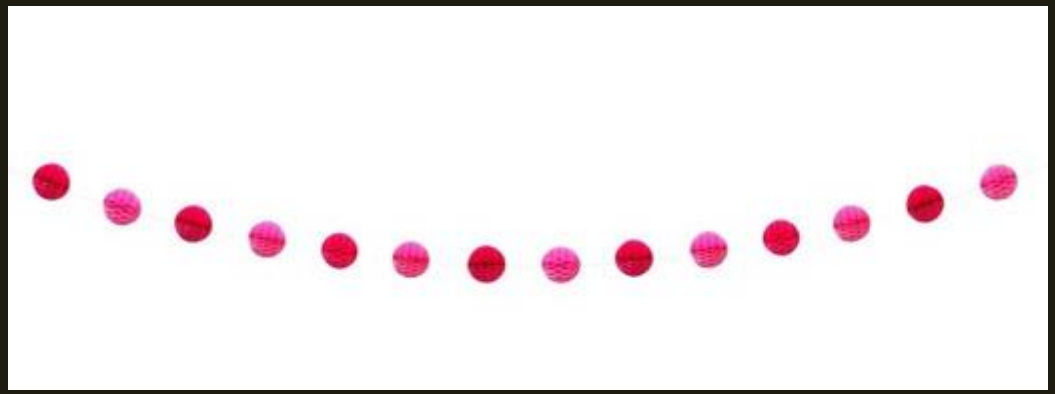


What is a Gene?



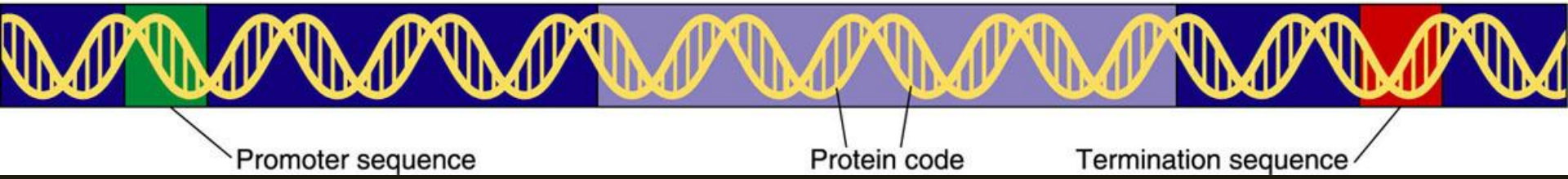




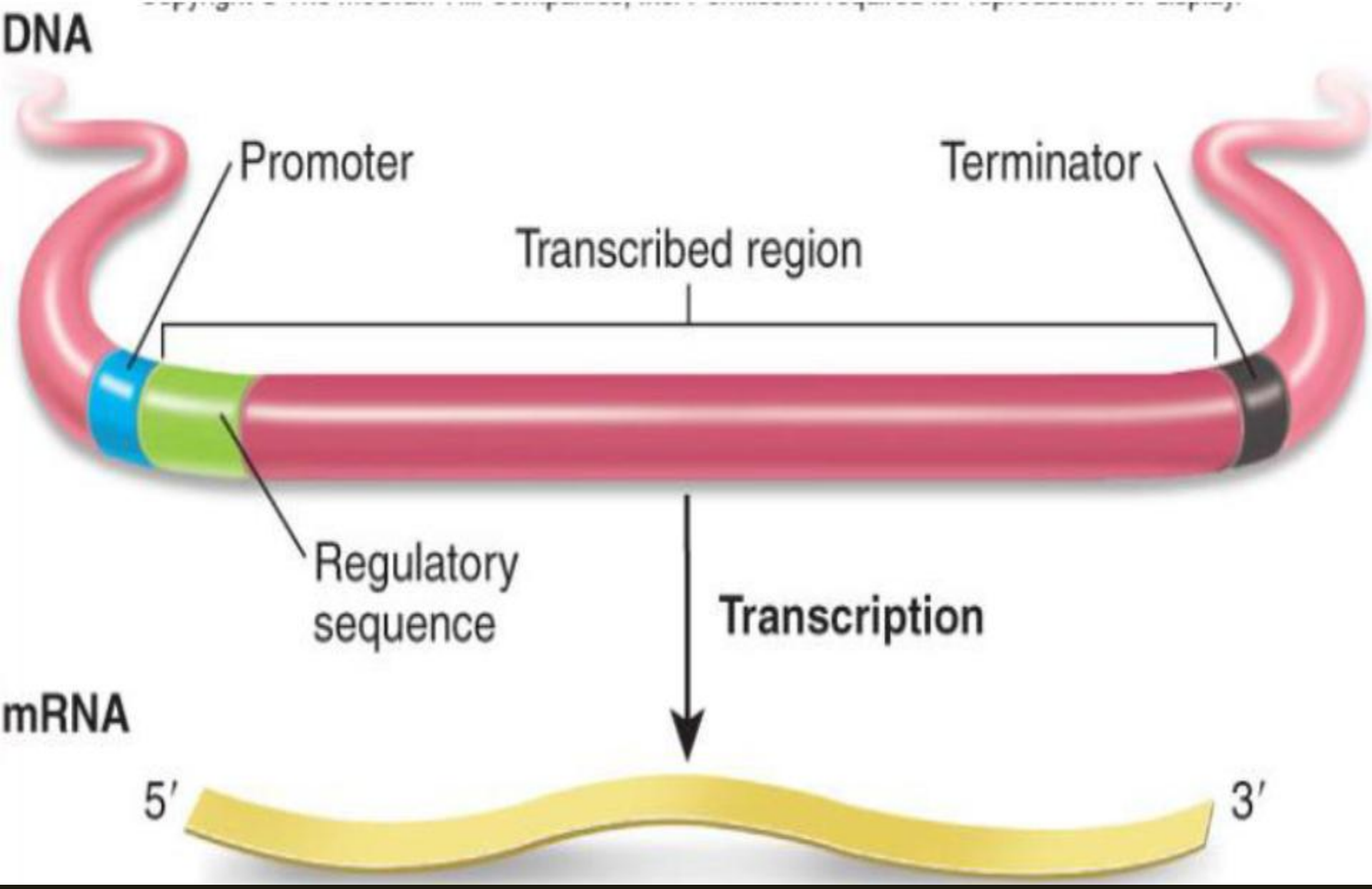


Anatomy of a Gene

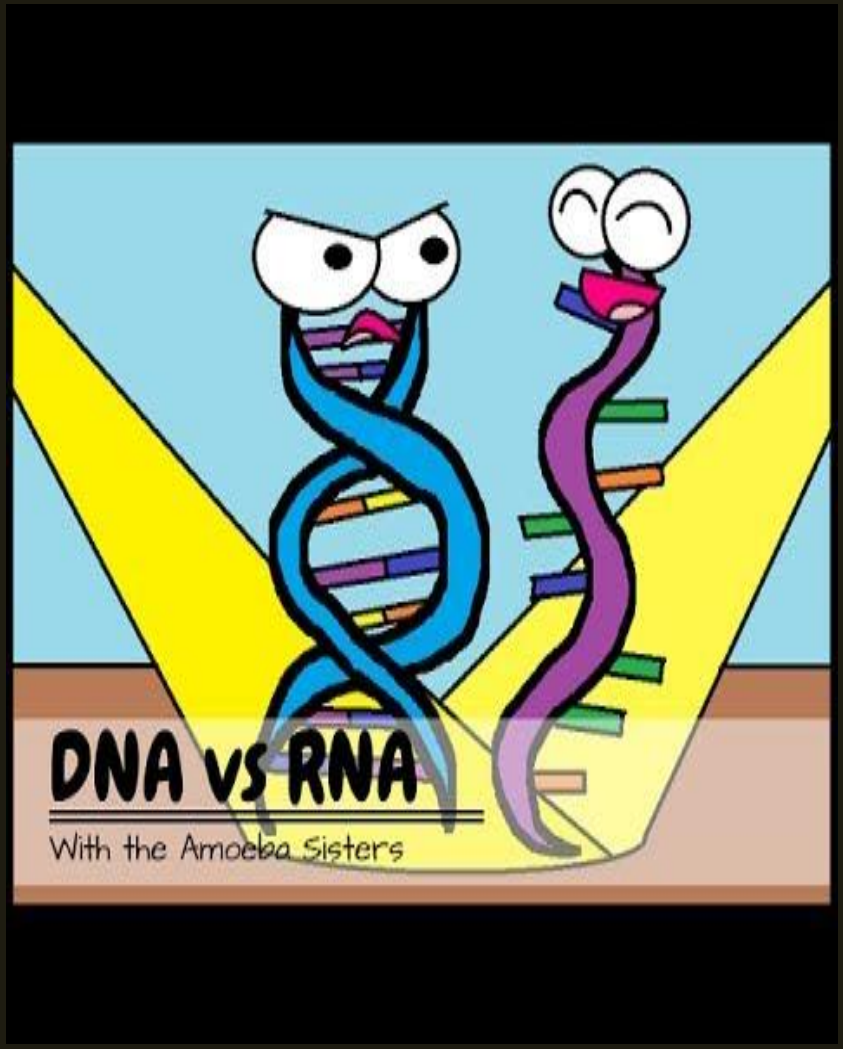
- Promoter
- Other regulatory regions
- Coding region
- Terminator



Genes are transcription units



Transcription – The Recipe…



Transcription or Expressing a Gene

Transcription: From DNA to RNA

- Broadly divided into three steps/ phases

Initiation

Elongation

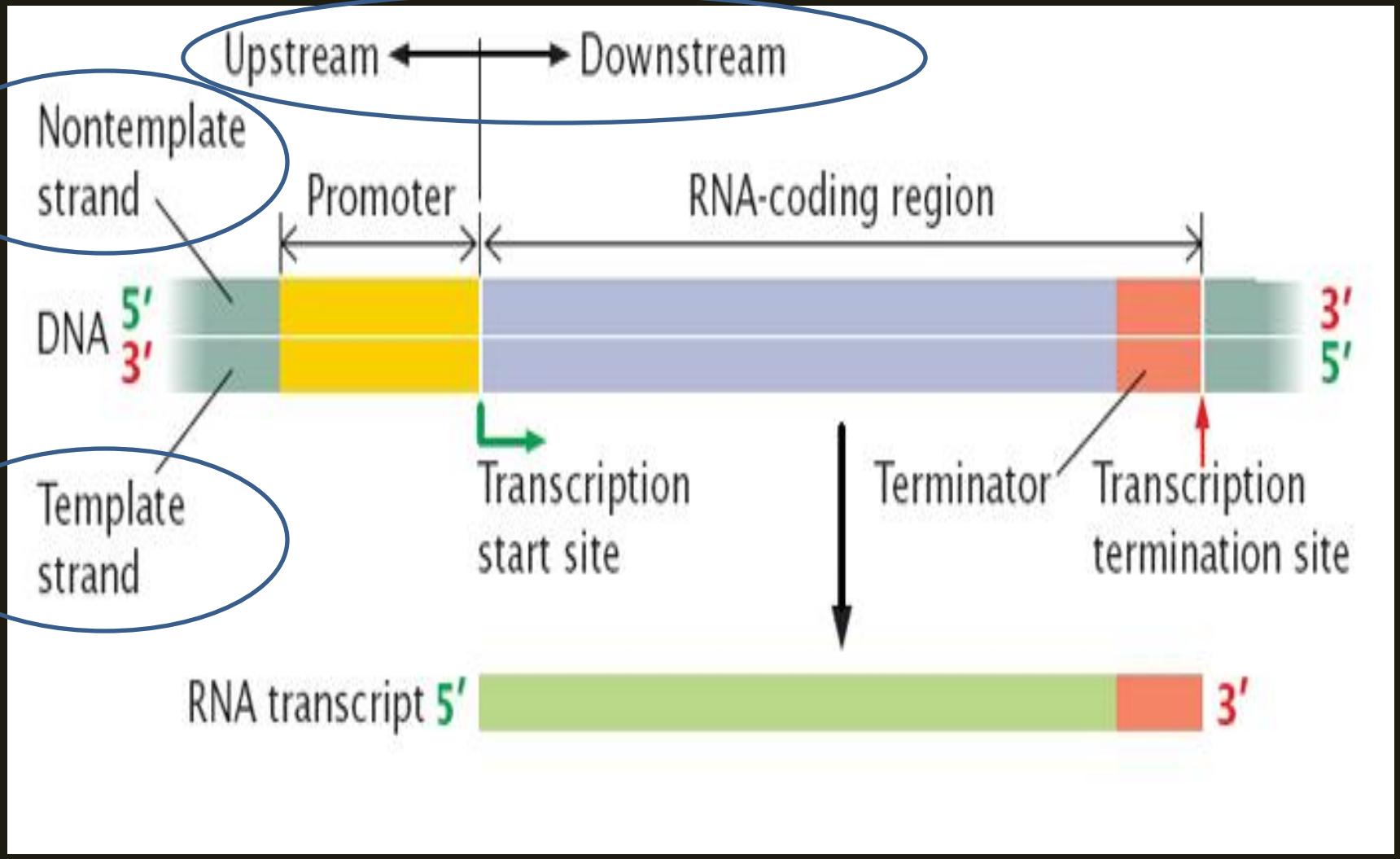
Termination

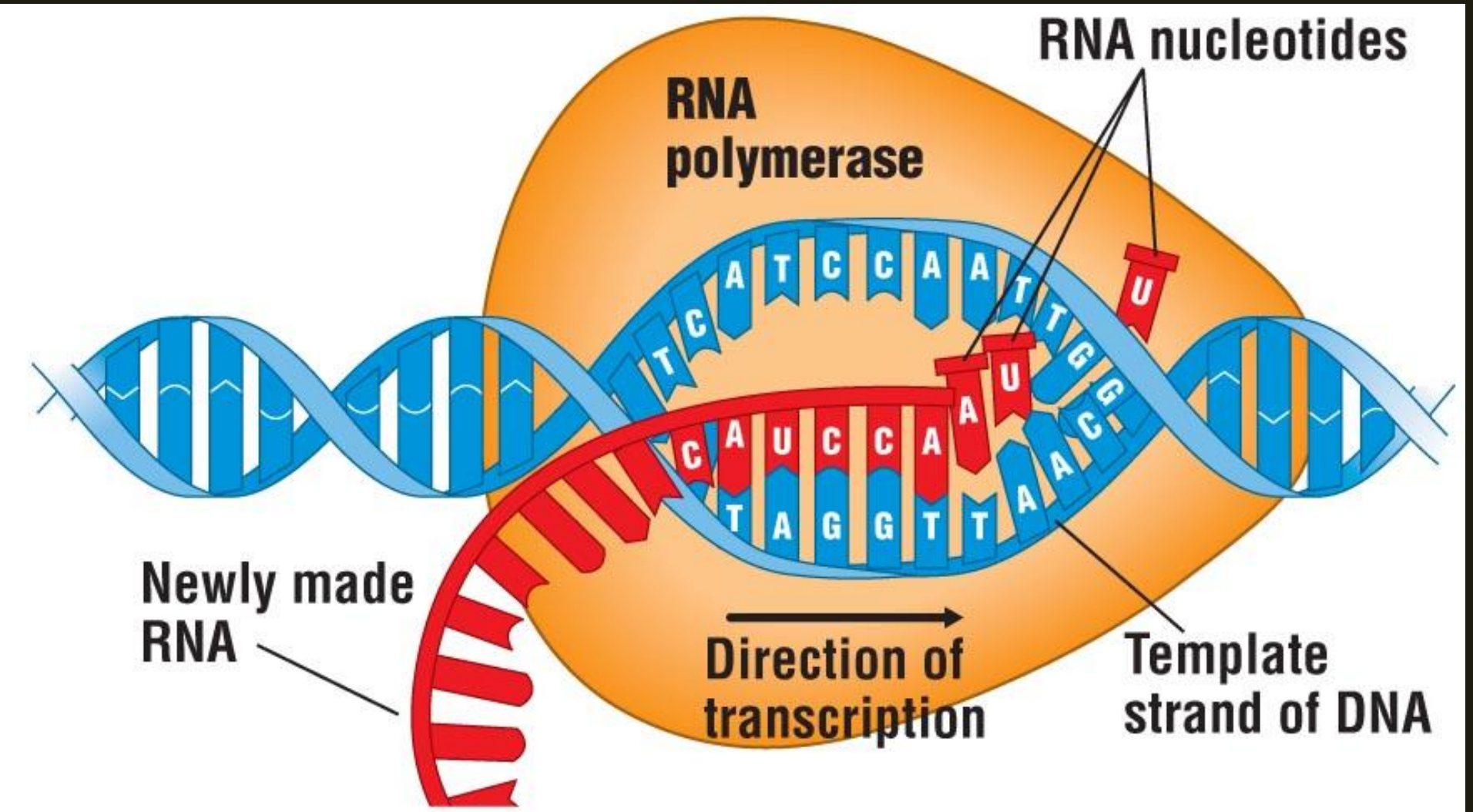
RNA Transcription

- **Basic Requirements:**
  - Gene (DNA)
  - Adenine, Guanine, Cytosine and Uracil
  - **RNA polymerase**
  - Transcription Factors (TFs)

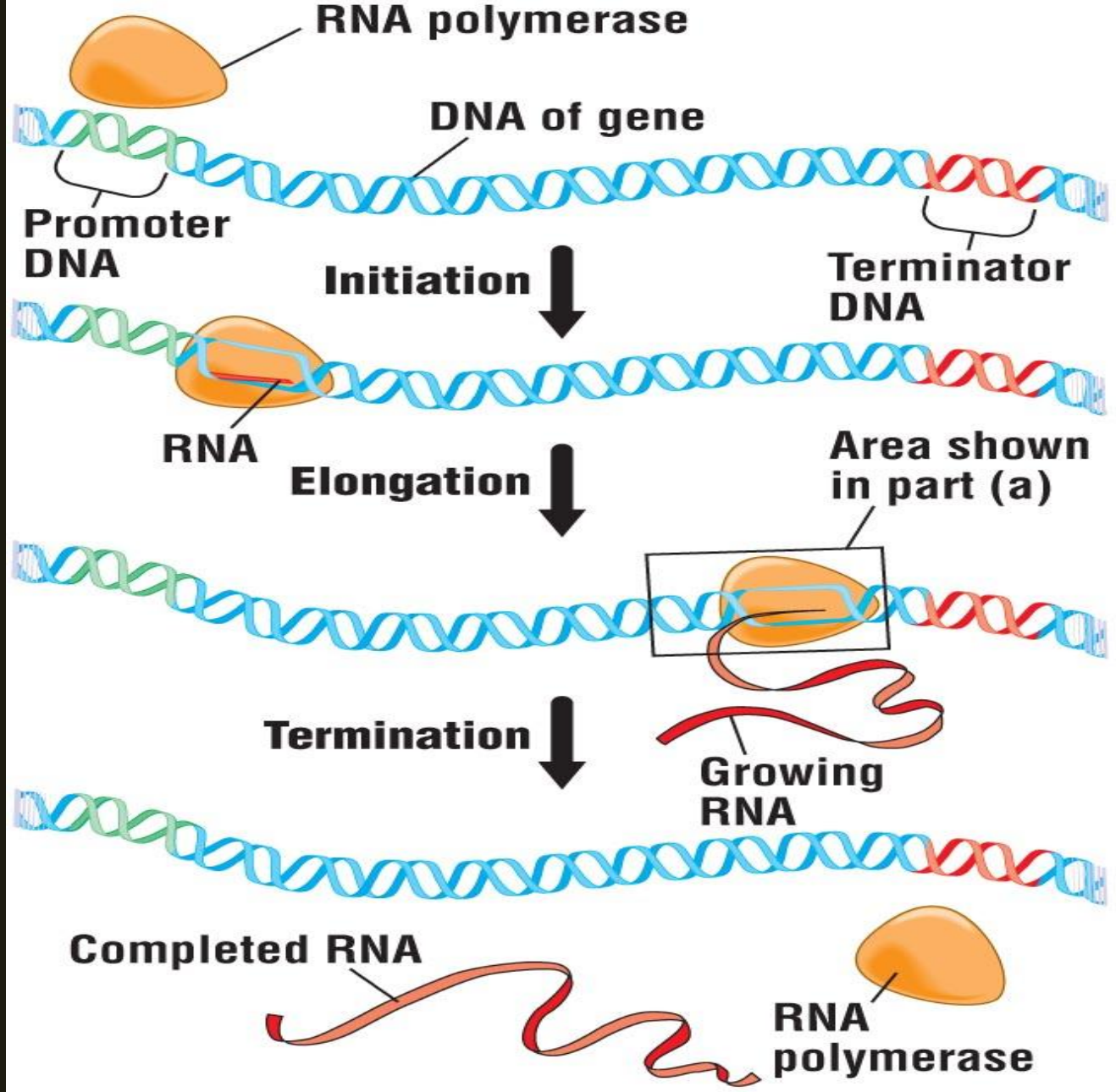
- **Output:**
  - RNA transcript - mRNA, tRNA, rRNA

The Role of Promoters

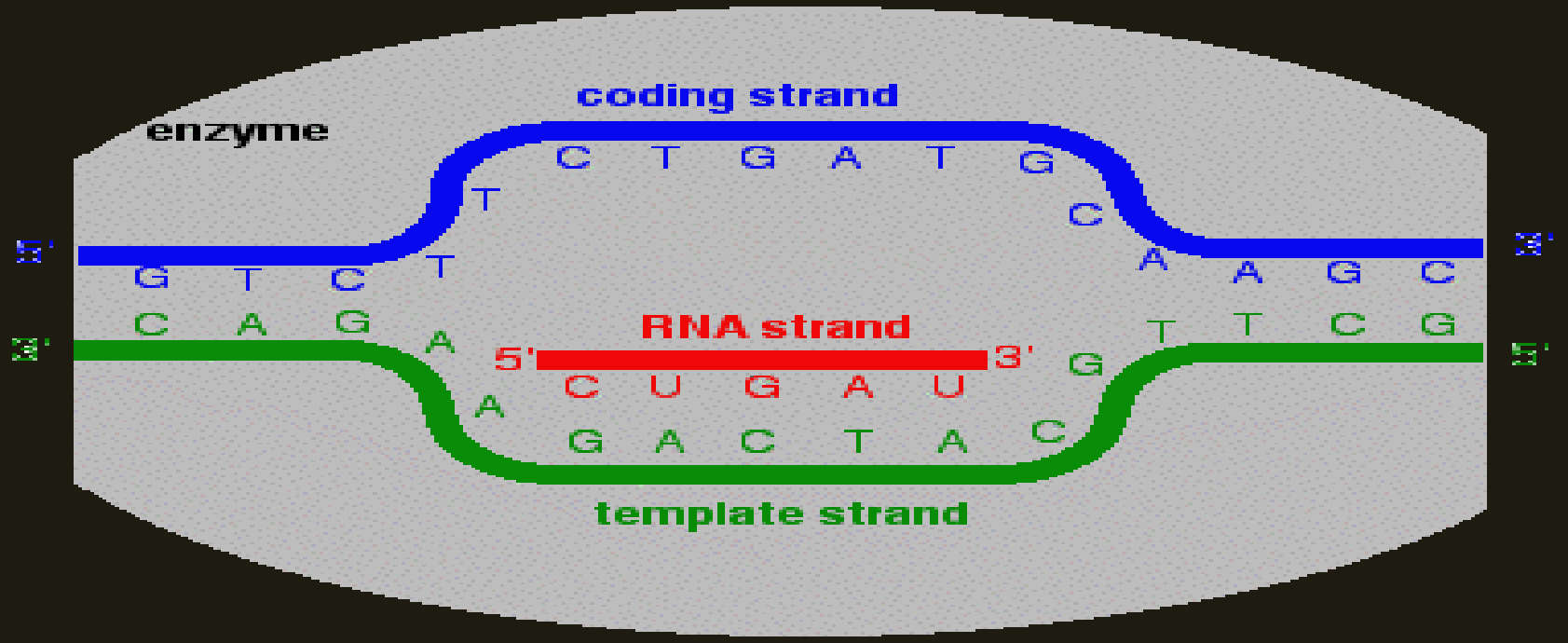


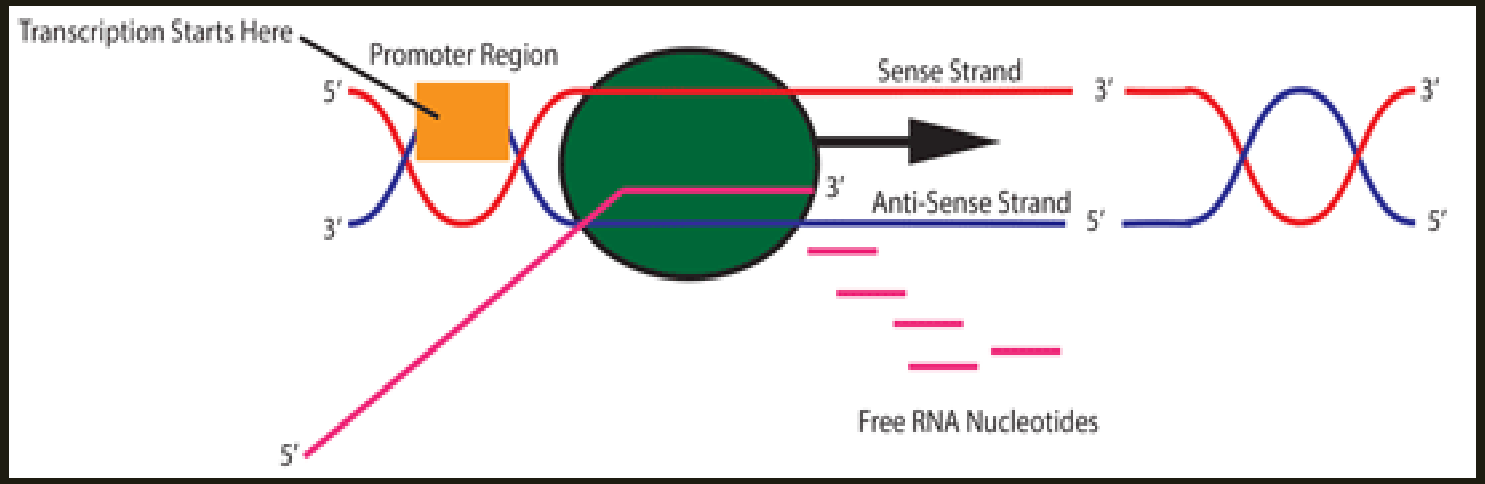


(a) A close-up view of transcription.

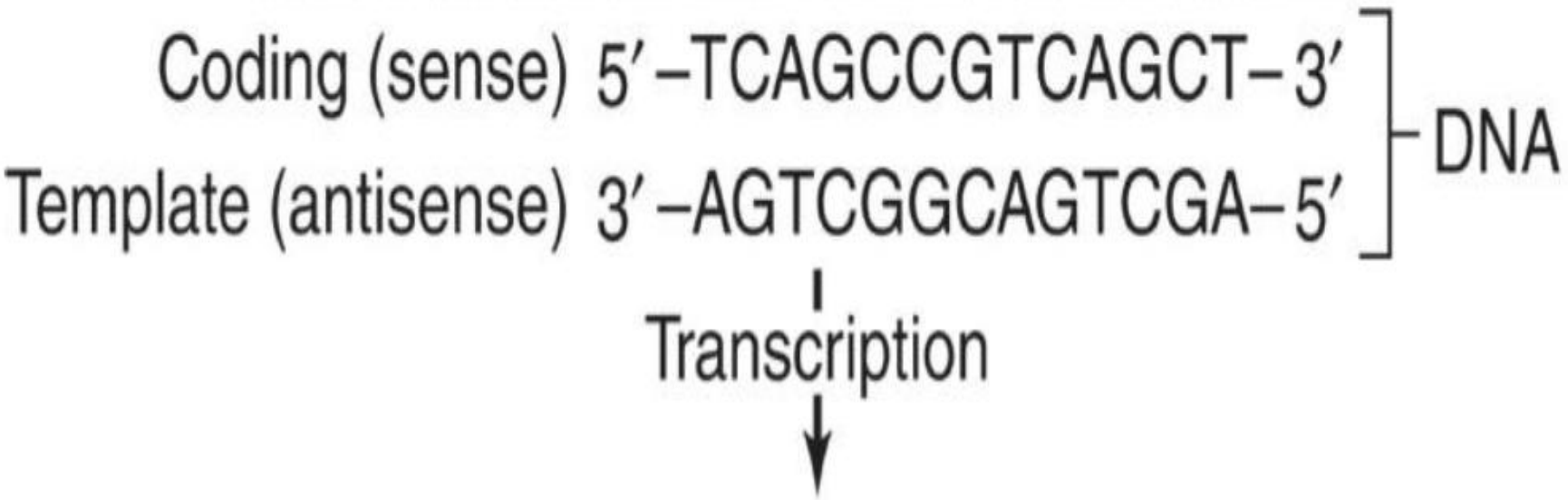


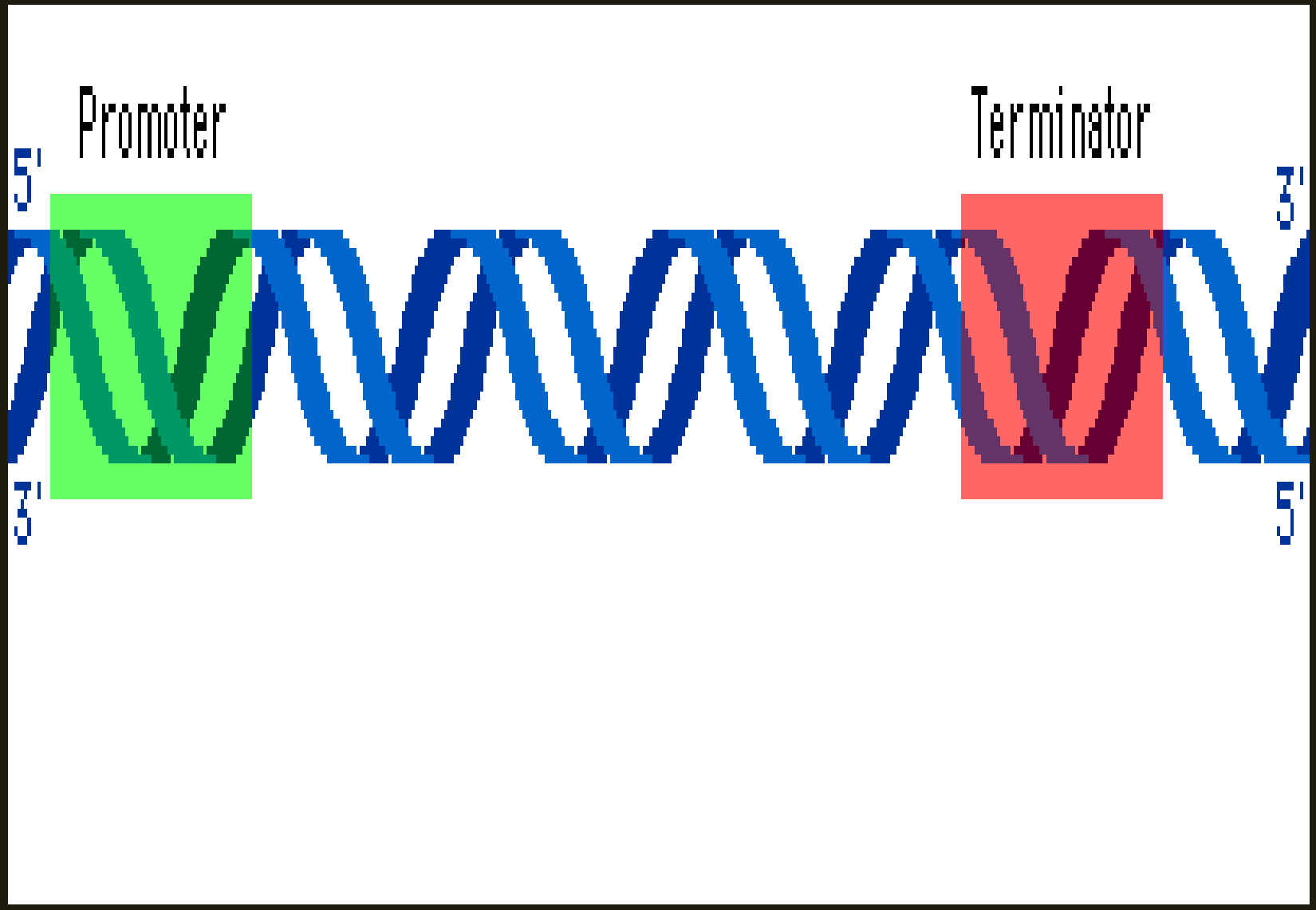
(b) Transcription of a gene.


coding strand
enzyme
C T G A T G
T
C
5'
3'
G T C
T
A A G C
C A G
A
RNA strand
5'
3'
T T C G
G
C U G A U
A
G A C T A C
template strand


Transcription Starts Here
Promoter Region
5'
3'
Sense Strand
3'
3'
3'
Anti-Sense Strand
5'
5'
5'
Free RNA Nucleotides

Only one strand of a gene is used as template for making RNA



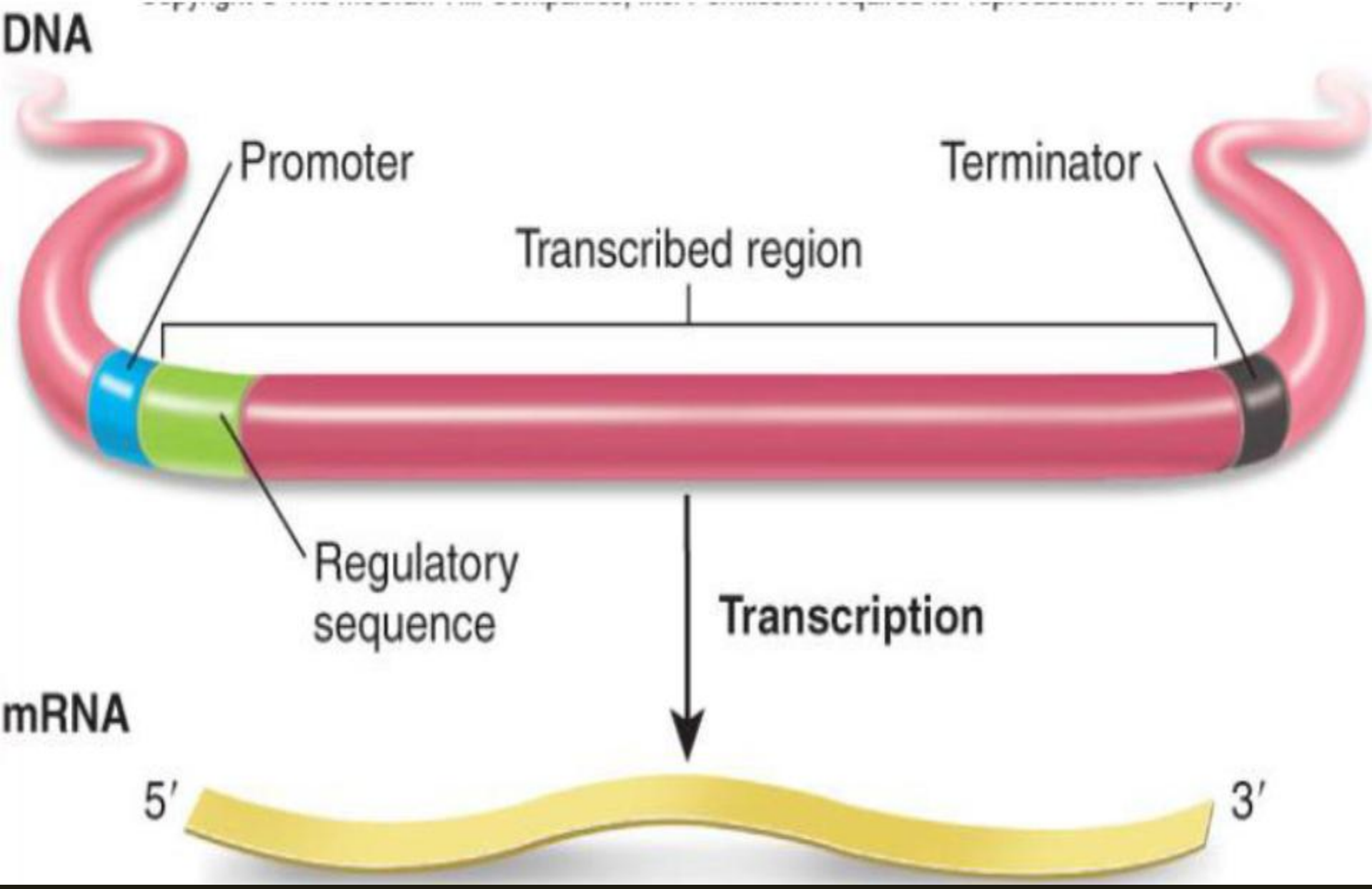

Promoter
Terminator
5'
3'
3'
5'

What makes death cap mushrooms deadly?

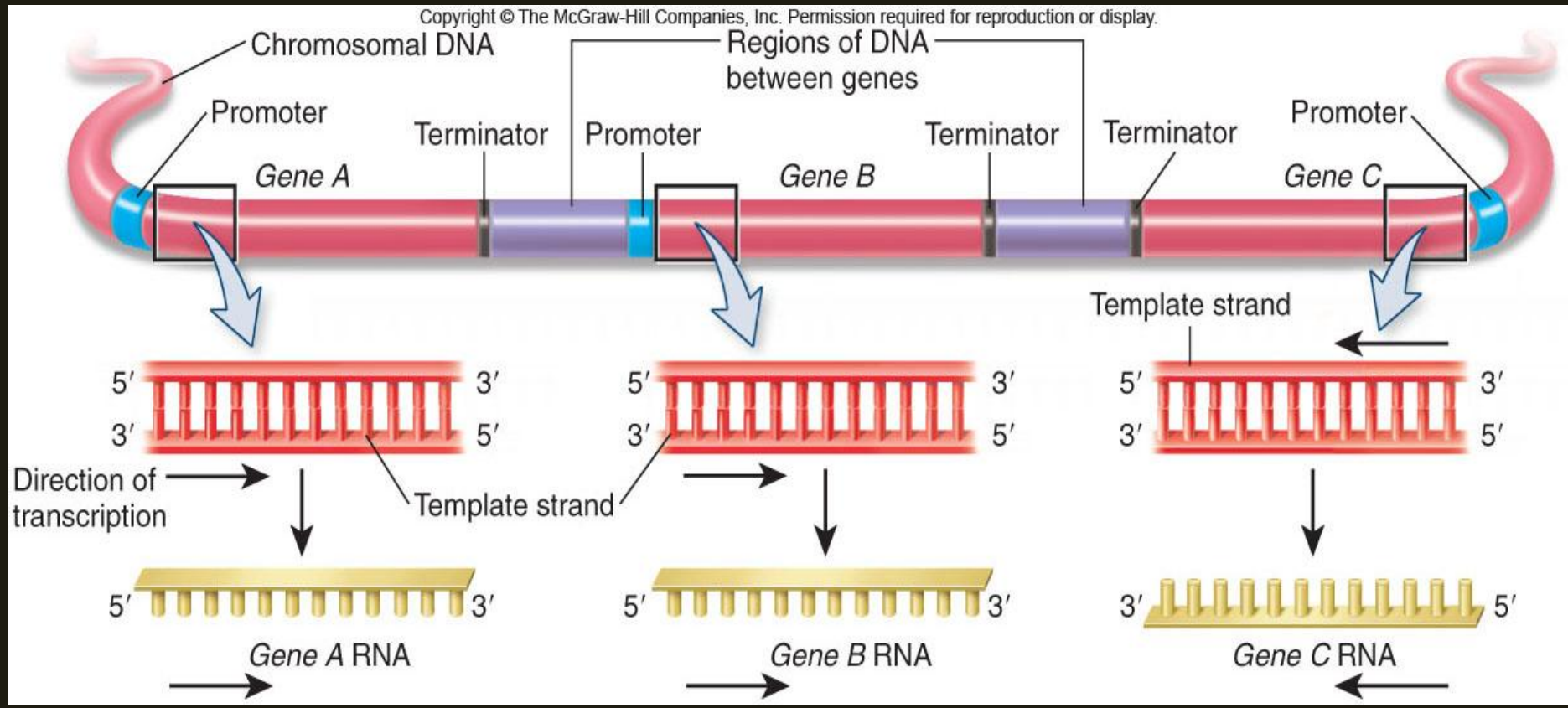
Thought Question…

Which could be more harmful to an organism - a wrong nucleotide present in a gene or a transcription mistake that leads to an incorrect mRNA? Justify briefly.

Genes are transcription units

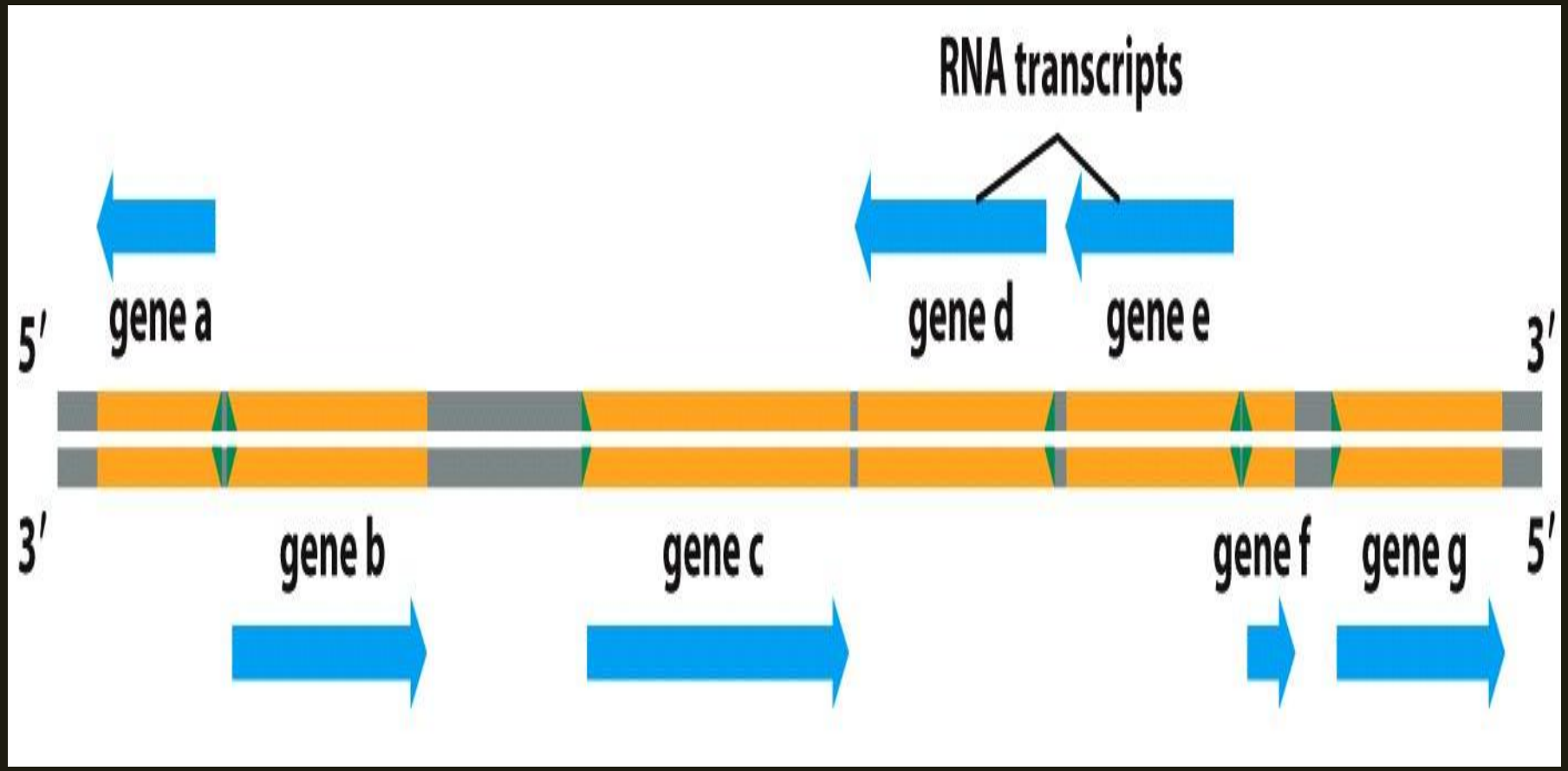


Can there be many genes located on a single chromosome?



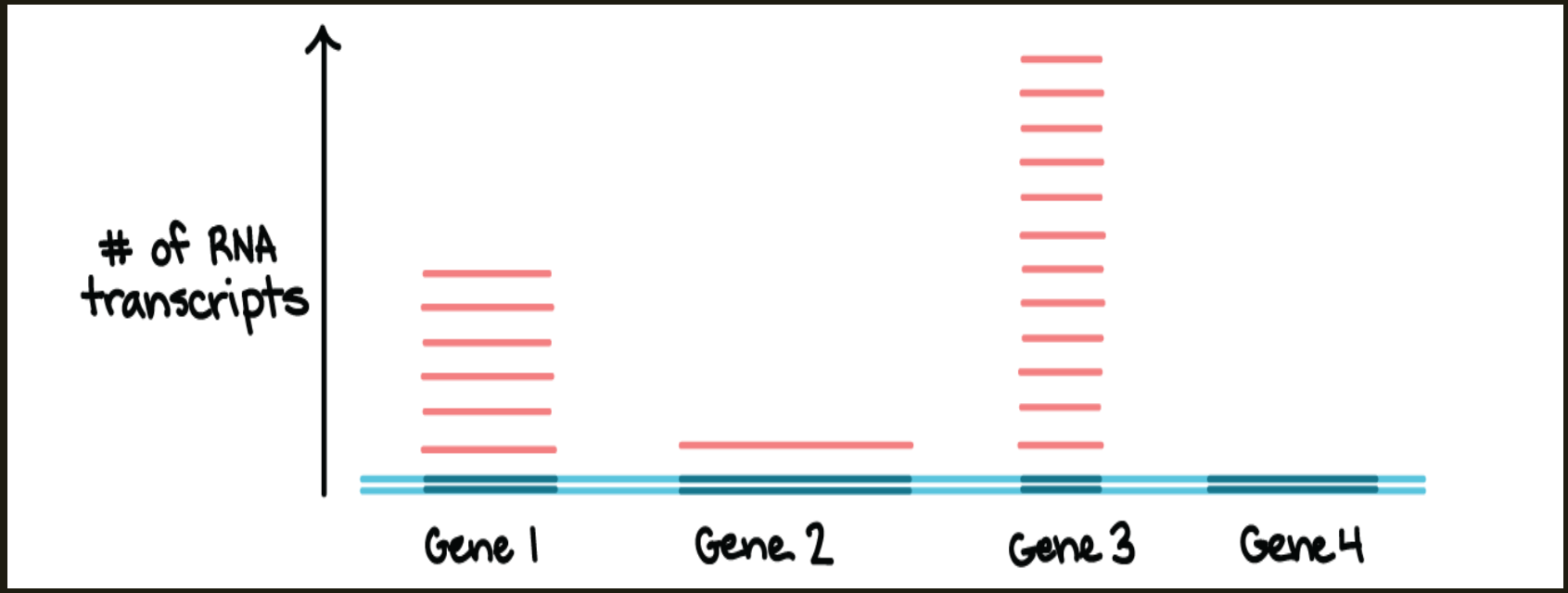
Find what is unique to this diagram?

Are all genes always located on the same strand of DNA?



Are all genes transcribed at the same time in a particular cell?

Transcription happens separately for individual genes



Not all genes are transcribed all the time. Instead, transcription is controlled individually for each gene. Cells carefully regulate transcription, transcribing just the genes whose products are needed at a particular moment.

What are the products of transcription?

- Messenger RNA (mRNA) –
  - Carries information in form of codons that is translated into amino acids to form proteins
- Transfer RNA (tRNA) –
  - Has an anti-codon and a specific amino acid
- Ribosomal RNA (rRNA) –
  - Coil around proteins to form Ribosomes
  - Ribosomes the mRNA and provide sites for tRNA activity

The following DNA strand is a template strand of a prokaryotic gene. Asterisk indicates the transcription initiation site.

a) Underline the promoter region by a dotted line.

b) Deduce the nucleotide sequence of mRNA for this gene.

d) Show 5' and 3' ends of the template strand and mRNA.

-10 * +10

GGCACCGTCGCTATTACGAAGTCGCTGACGGATC TACCCCGGATTT

4. **Nucleic acid synthesis.** The process of transcription is catalyzed by the protein enzyme RNA polymerase (RNAP), which synthesizes RNA, using DNA as a template. The start site of transcription is indicated in the sequence of the double-stranded DNA (shown below):

Promoter (**underlined** sequence) **Starting nucleotide** (big **G** in the coding strand)

coding strand: 5′-**TTGACA**TATTAGACTAAG**TATAAT**GAGCAA**G**TCC-3′

template strand: 3′-AACAGTATAATCTGATTCATATTACTCGTT**C**AGG-5′

(i) the first two substrates used by RNAP

Eukaryotic genes are interrupted

Eukaryotic genes are interrupted

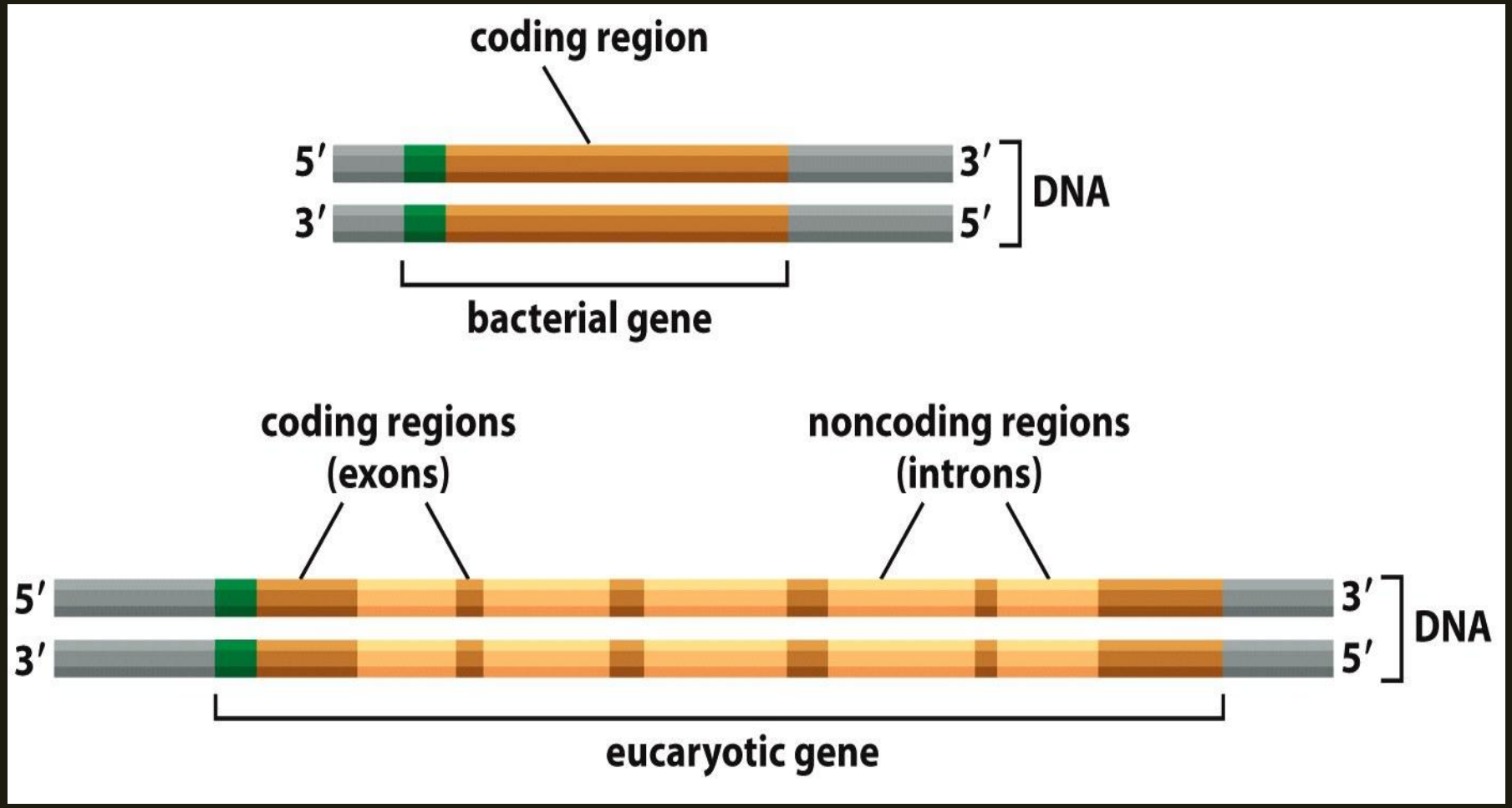
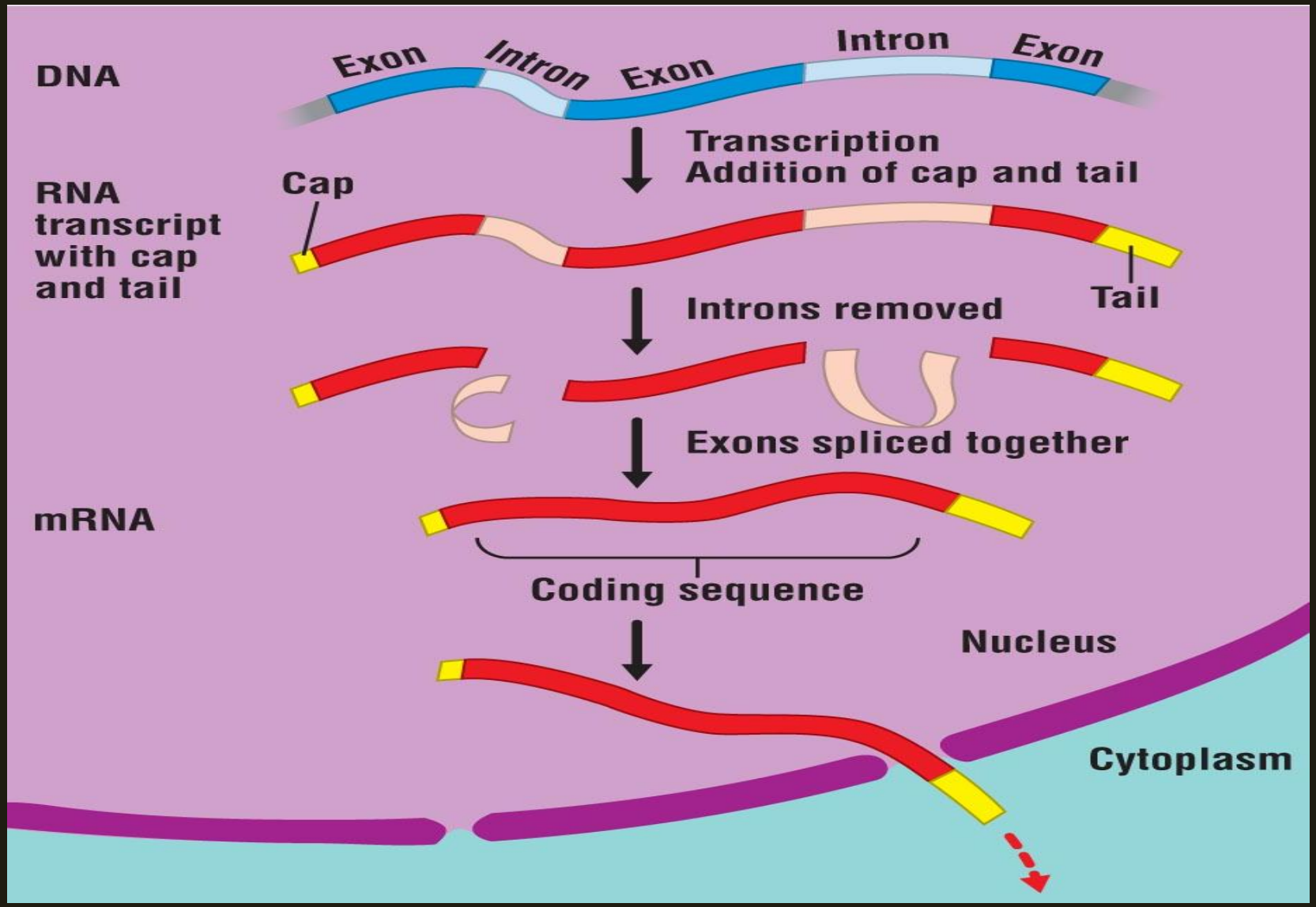
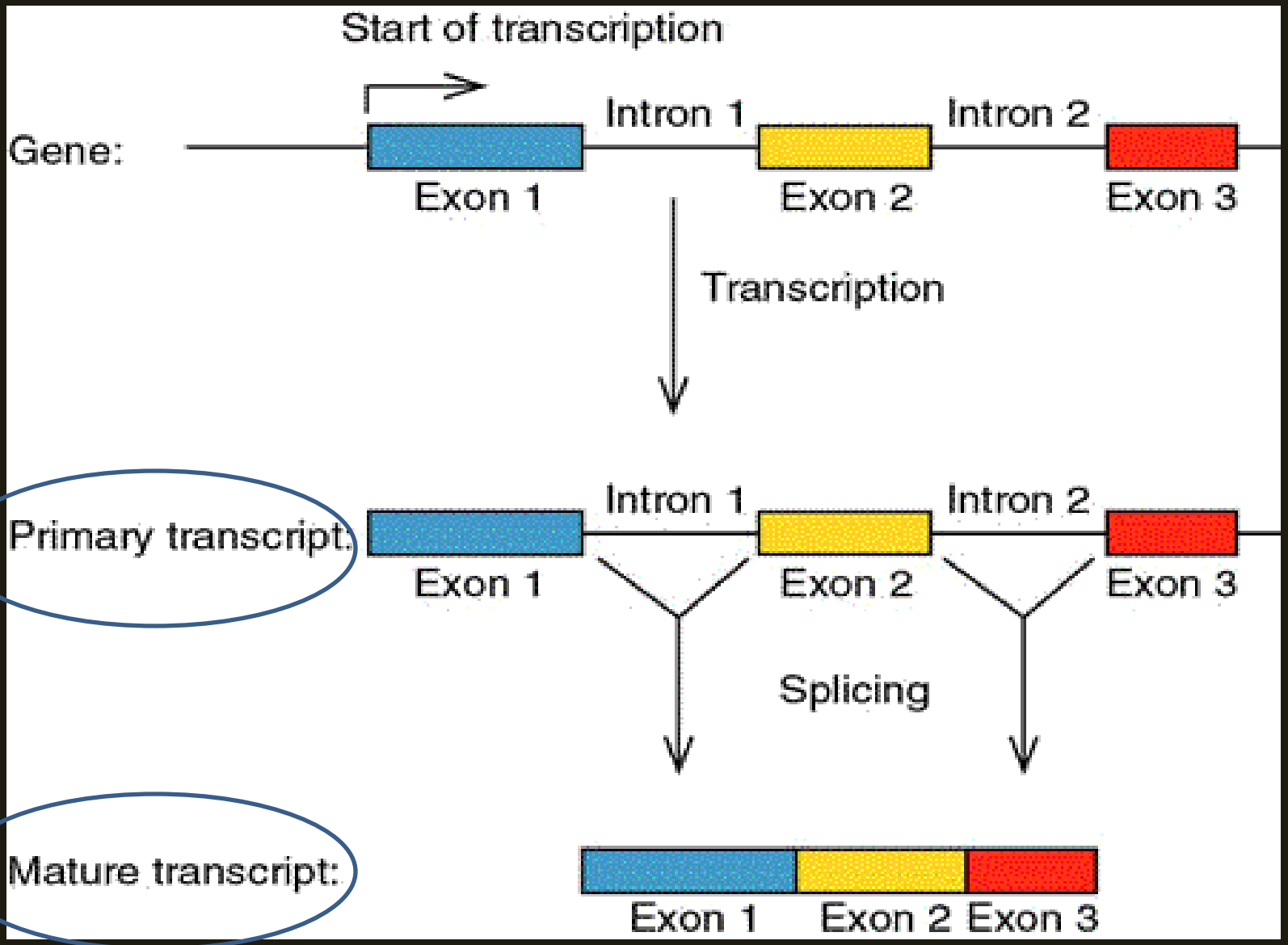


Figure 7-17 *Essential Cell Biology* (© Garland Science 2010)

Can you interpret the RNA processing before nuclear exit?



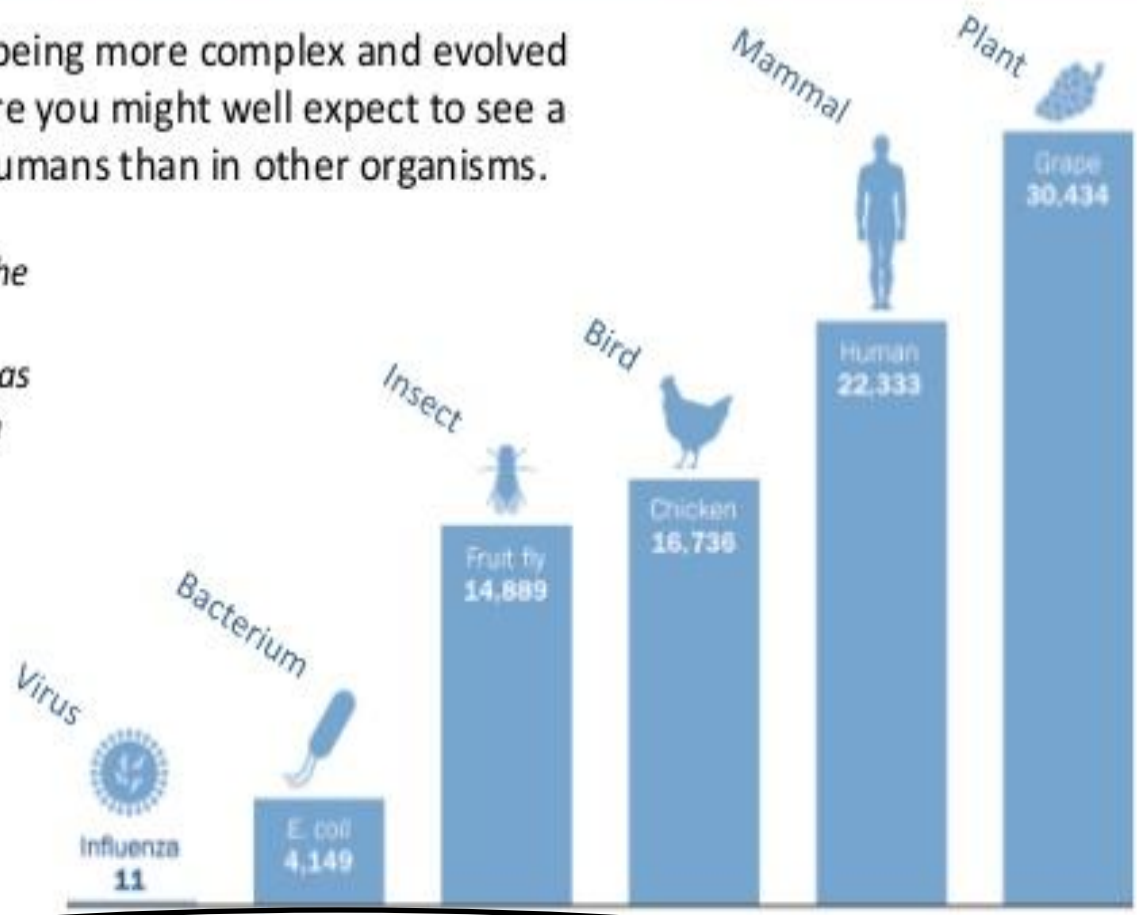
RNA Splicing



3.1.A2 Comparison of the number of genes in humans with other species.

Humans see themselves as being more complex and evolved than other species. Therefore you might well expect to see a larger number of genes in humans than in other organisms.

It is not just plants such as the grapevine that have large numbers of genes; water fleas are an animal example of an organism with more genes than humans.

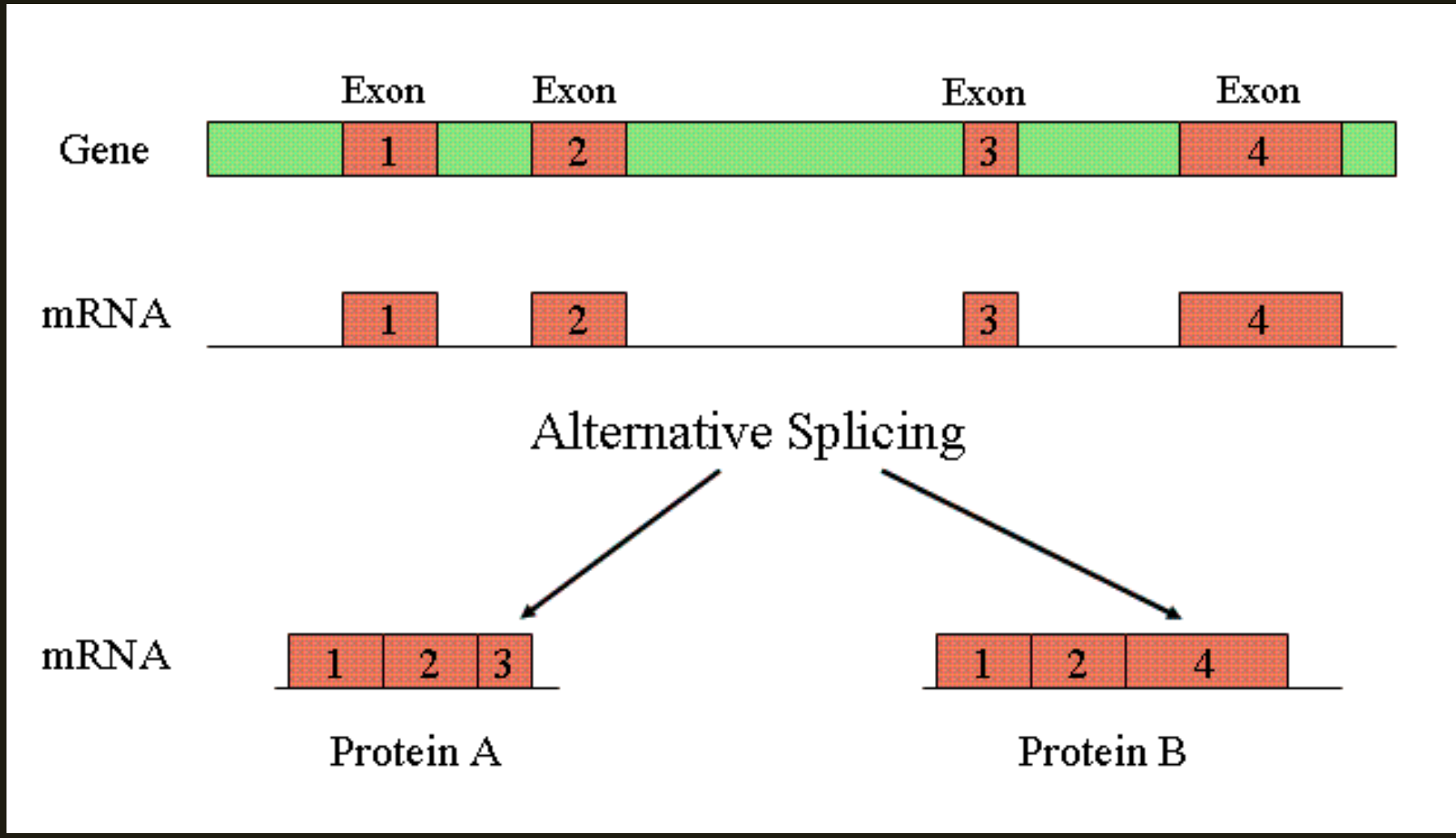


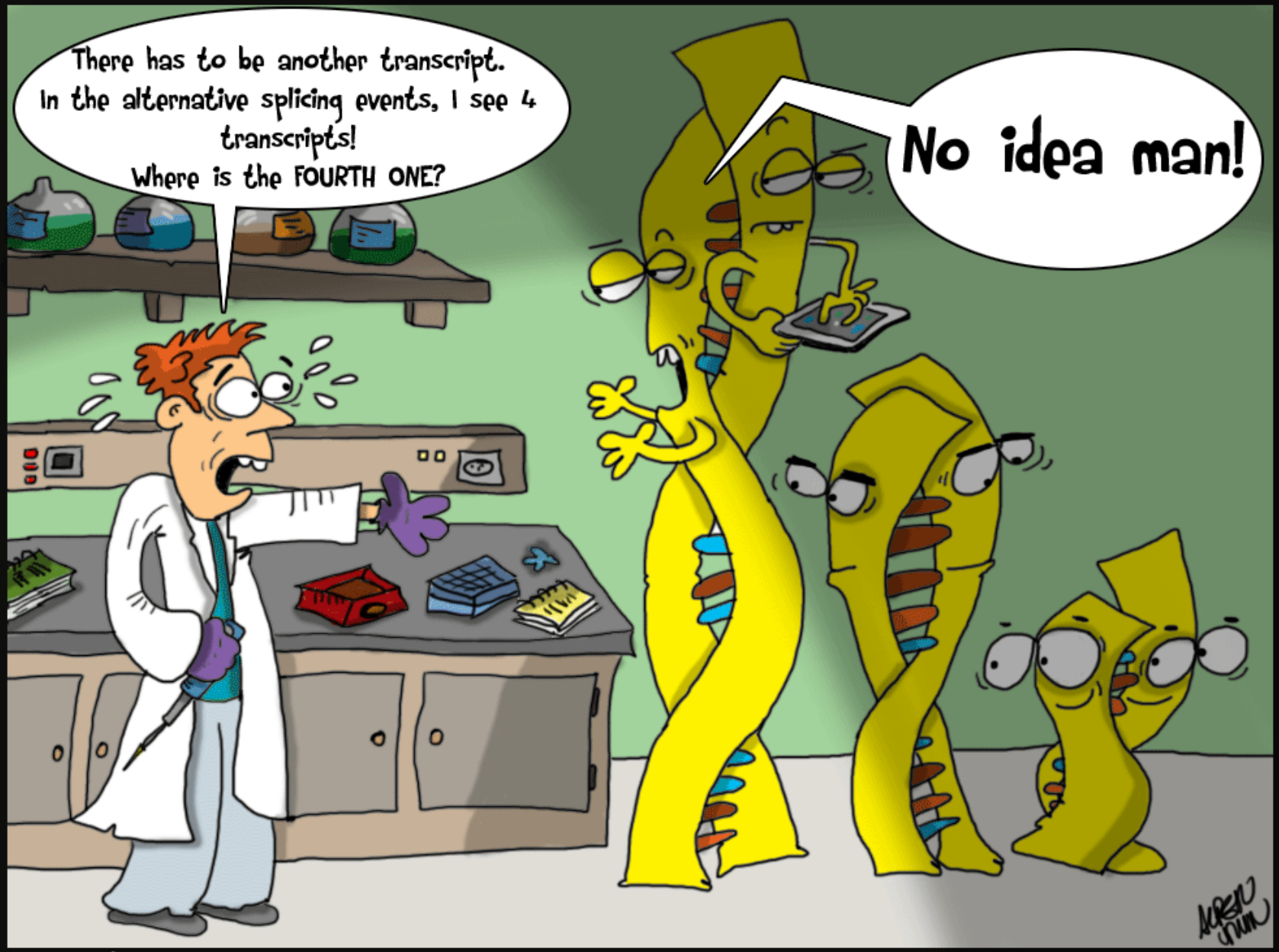
Q - When analysing an organisms' complexity, what other than the count of an organisms' genes needs to be considered?

Can more than one protein product be made from one gene?

WE are able to make 5 times as many proteins as flies or worms

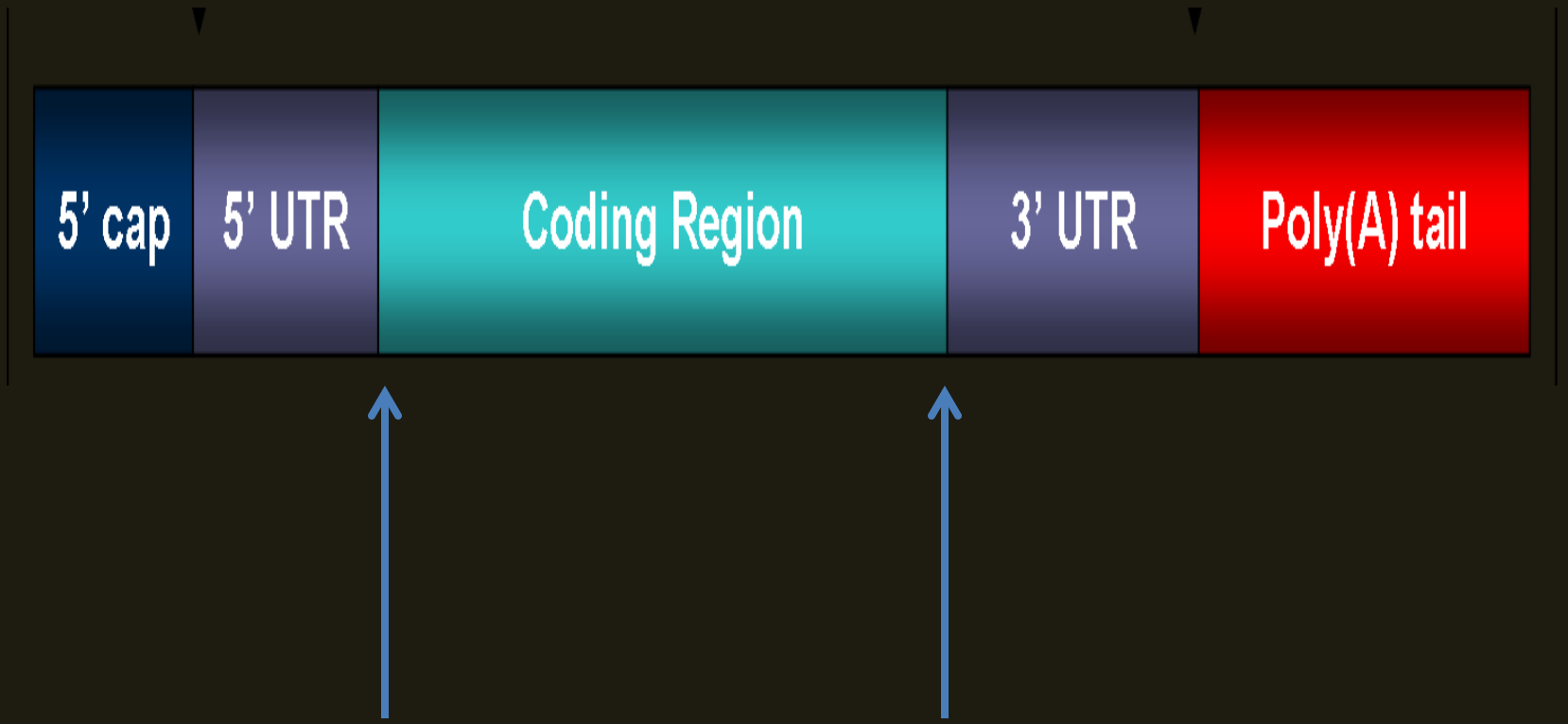
Alternative Splicing: *one gene can have more than one transcript variant*




There has to be another transcript. In the alternative splicing events, I see 4 transcripts! Where is the FOURTH ONE?
No idea man!

That’s not the END……

The Role of Capping and Poly-adenylation: concept of UTR

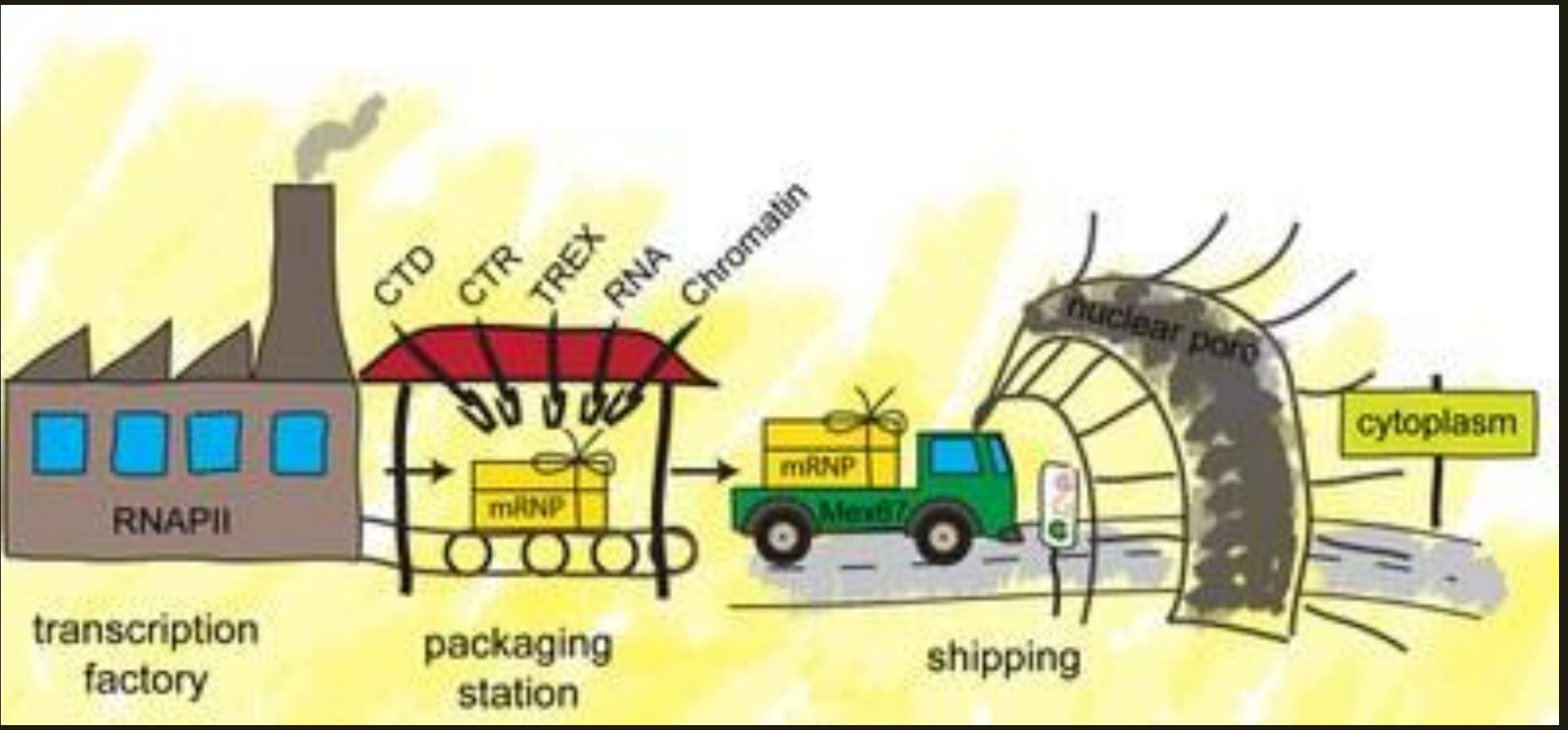


In eukaryotes, poly(A) tails and cap usually act as stabilizers of intact mRNAs. The cap plays a role in the ribosomal recognition of messenger RNA during translation into a protein.

How is prokaryotic transcription different from a eukaryotic one?

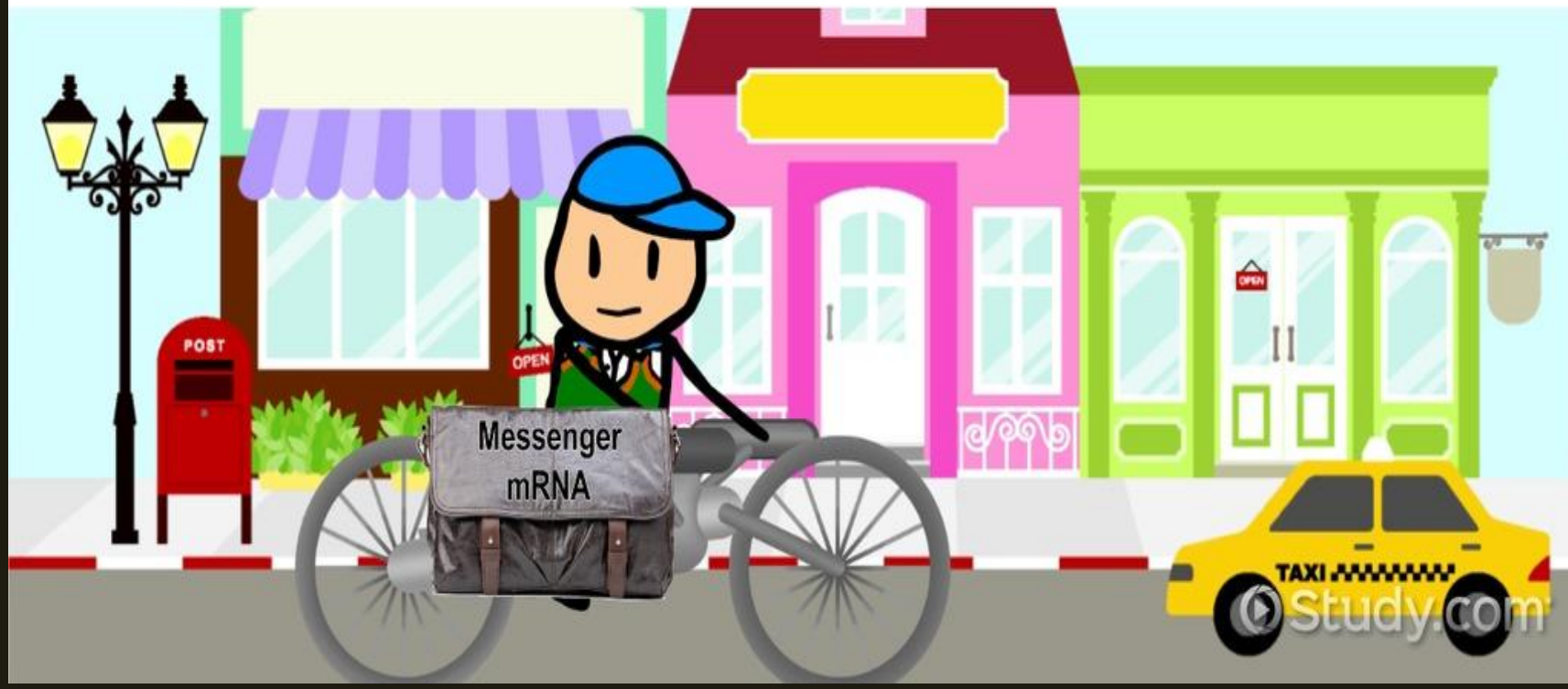
Concepts

- Genes can be on both strands of DNA
- Not all genes express together
- Eukaryotic genes have exons and introns
- Eukaryotic RNAs undergo splicing
- Alternative splicing creates transcript variants
- RNA processing also includes cap and tail
- The mature transcript contains UTRs

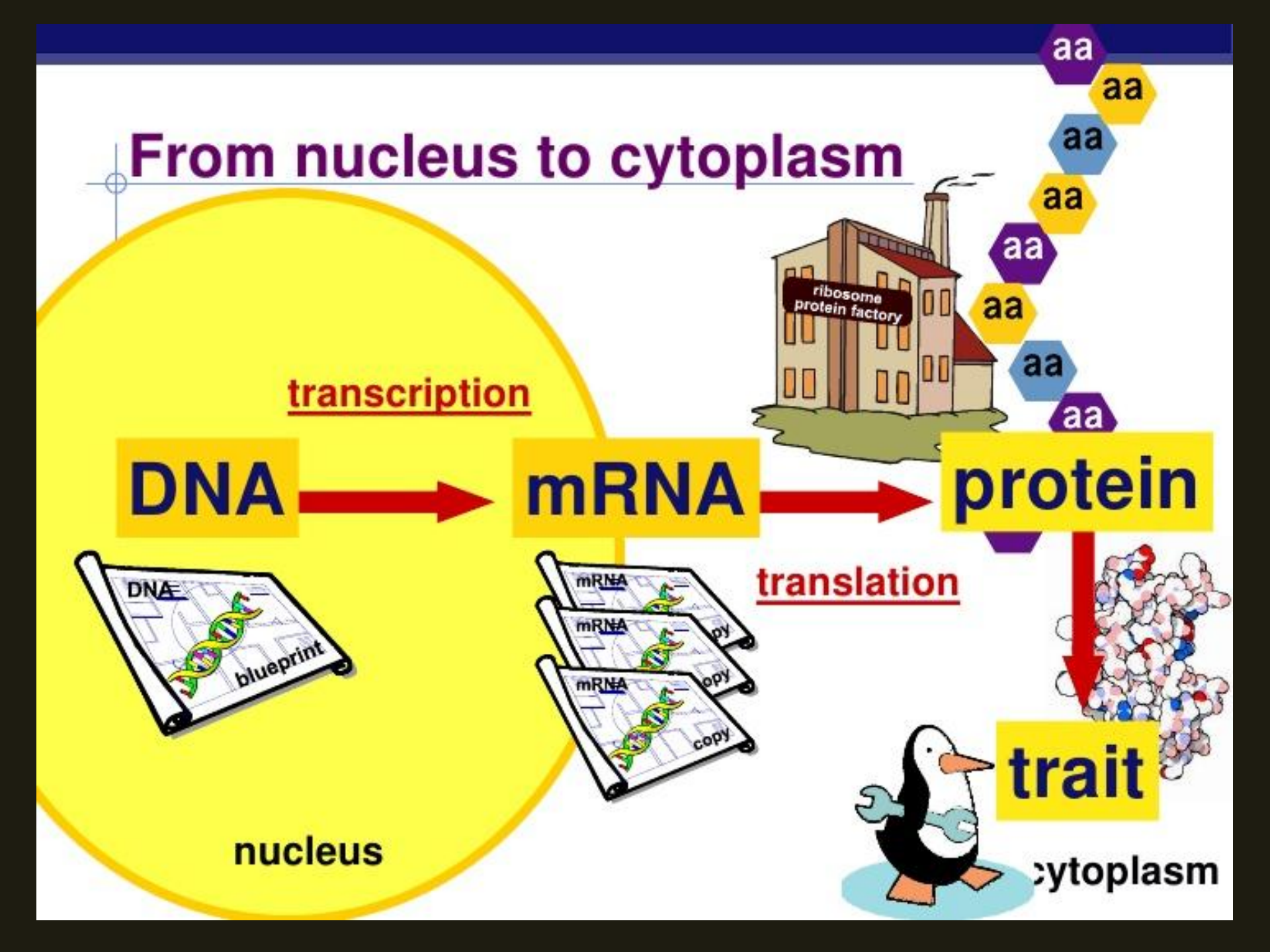

CTD
CTR
TREX
RNA
Chromatin
RNAPII
mRNP
mRNP
Mex67
nuclear pore
cytoplasm
transcription factory
packaging station
shipping

mRNA

a molecule that carries DNA's coded instructions for making a protein

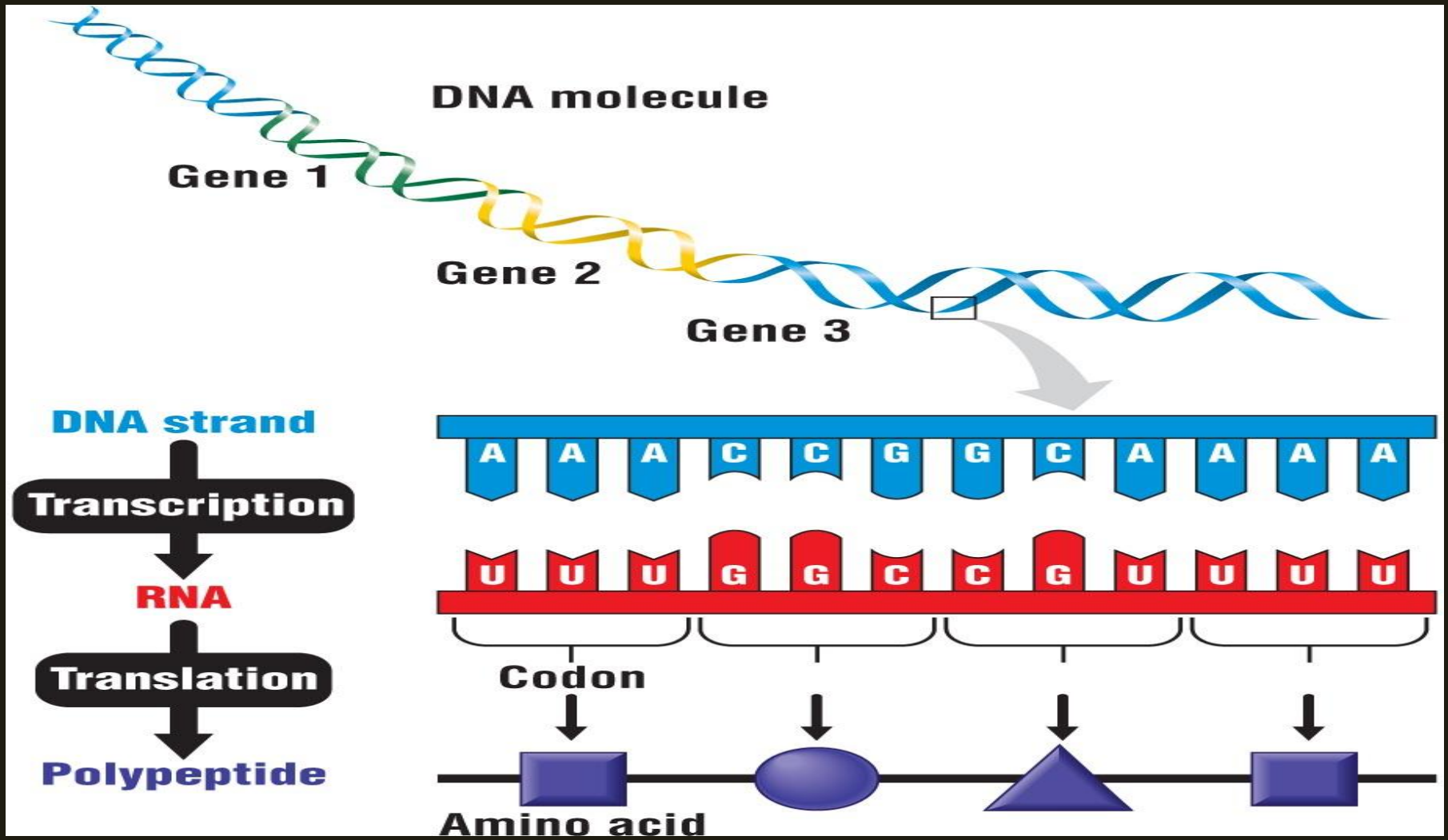


From nucleus to cytoplasm

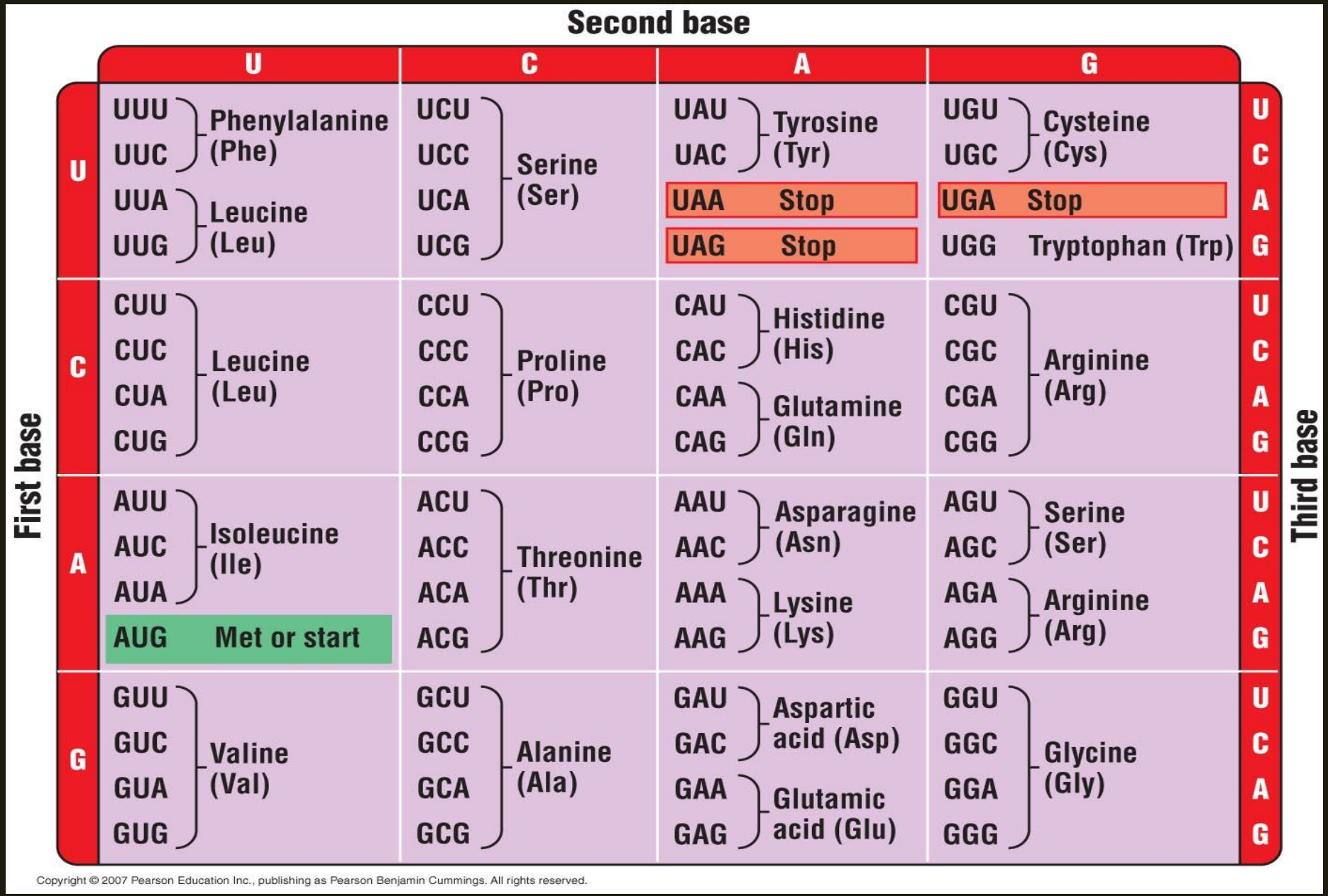



point of view.
Translation
another language;
language foreign to
written communica

Protein Translation



Codons are triplets



Note the start and stop codon