Week 11

(Preparing for) **Tuesday's lecture:**

Budgeting homework time (50 min): Chapter 2, section 2.3 is that is 1725 words in length with three data figures that require thinking and notetaking for the Trifecta. Reading at 200 words per minute would mean the section might take 10 minutes to read. Yet figures 2.20 and 2.21 are challenging and require time to think and read about them for the Trifecta. Of course, when done properly, when you pause to review figures, try Integrating Questions, and take notes, this assignment will take you more like 50 minutes.

1. _______ **For Tuesday's lecture,** carefully read section 2.3: "How do cells make proteins?" and take handwritten notes in your lecture notebook.

2. _______ **Try to answer some Integrating Questions** and **Review Questions**.

3. _______ (Trifecta): **Prepare to explain (aloud) Figures 2.20, 2.21 and 2.22 in class** (Purpose, Methods, Findings).

2.3 How do cells make proteins?

Biology Learning Objectives

- Demonstrate in writing and diagrams how proteins are made.
- Apply the genetic code to deduce the protein encoded by a mRNA.

2.3 How do cells make proteins?

- Context: Ribosomes, mRNA, amino acids, and their tRNAs are required to form proteins in the cytoplasm using a genetic code in mRNA.
- Major themes: Heritable information provides for continuity of life, information can be expressed and regulated without loss of content, and non-heritable information is transmitted within and between biological systems.
- Bottom line: Ribosomes pair tRNAs with codons in the mRNA to assemble the amino acids in the proper order to form proteins.

Biology Learning Objectives

- Demonstrate in writing and diagrams how proteins are made.
- Apply the genetic code to deduce the protein encoded by a mRNA.

By the mid-1960s, biologists were certain which cellular components were required for the production of proteins, a biochemical reaction referred to as **translation.** During translation, amino acids are connected to each other via new covalent bonds (Figure 2.20A) called **peptide bonds**. A **dipeptide** is the translation product from two amino acids. Water is the waste product with each peptide bond formed. Translation

How are Proteins Made?

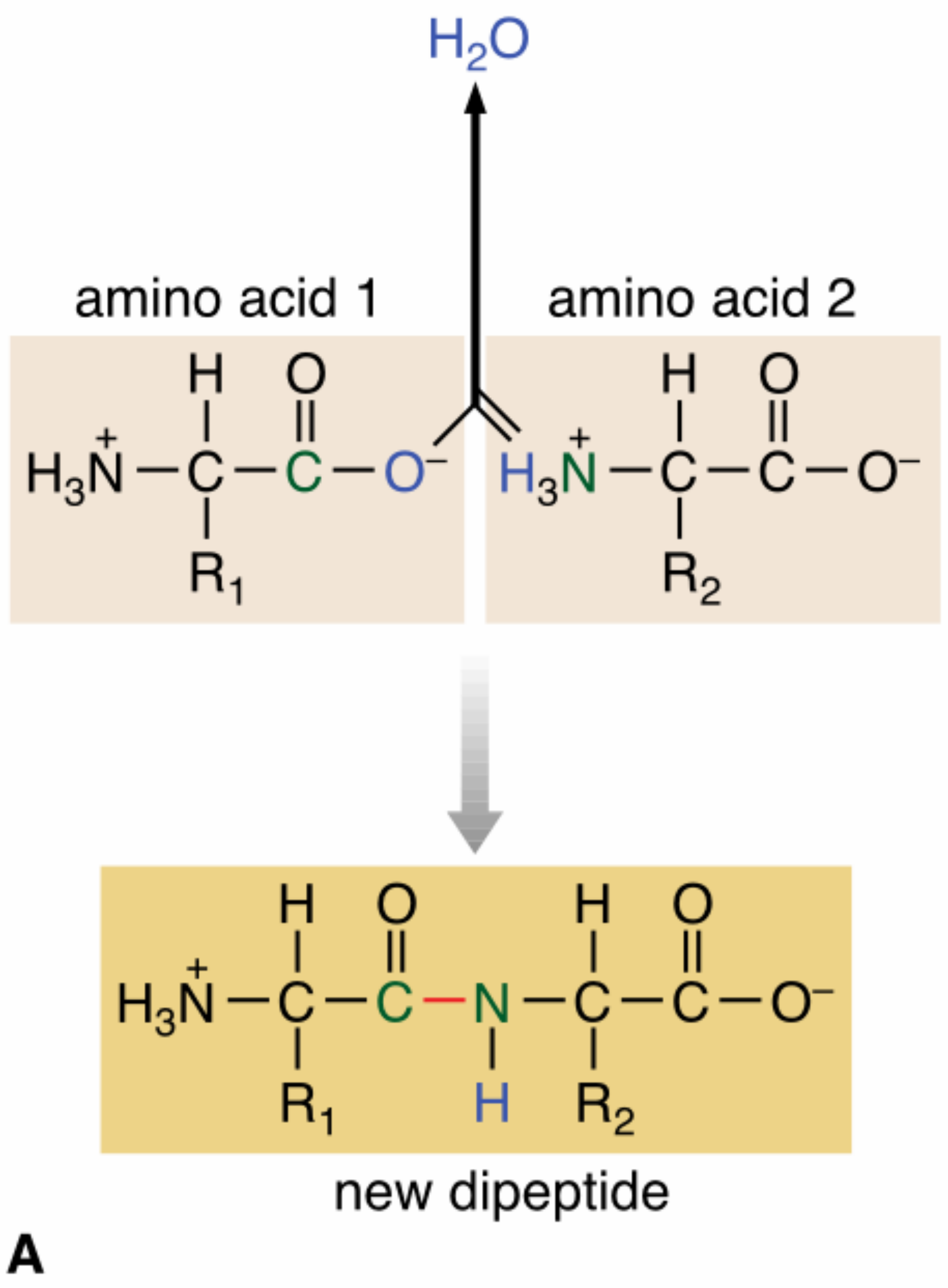
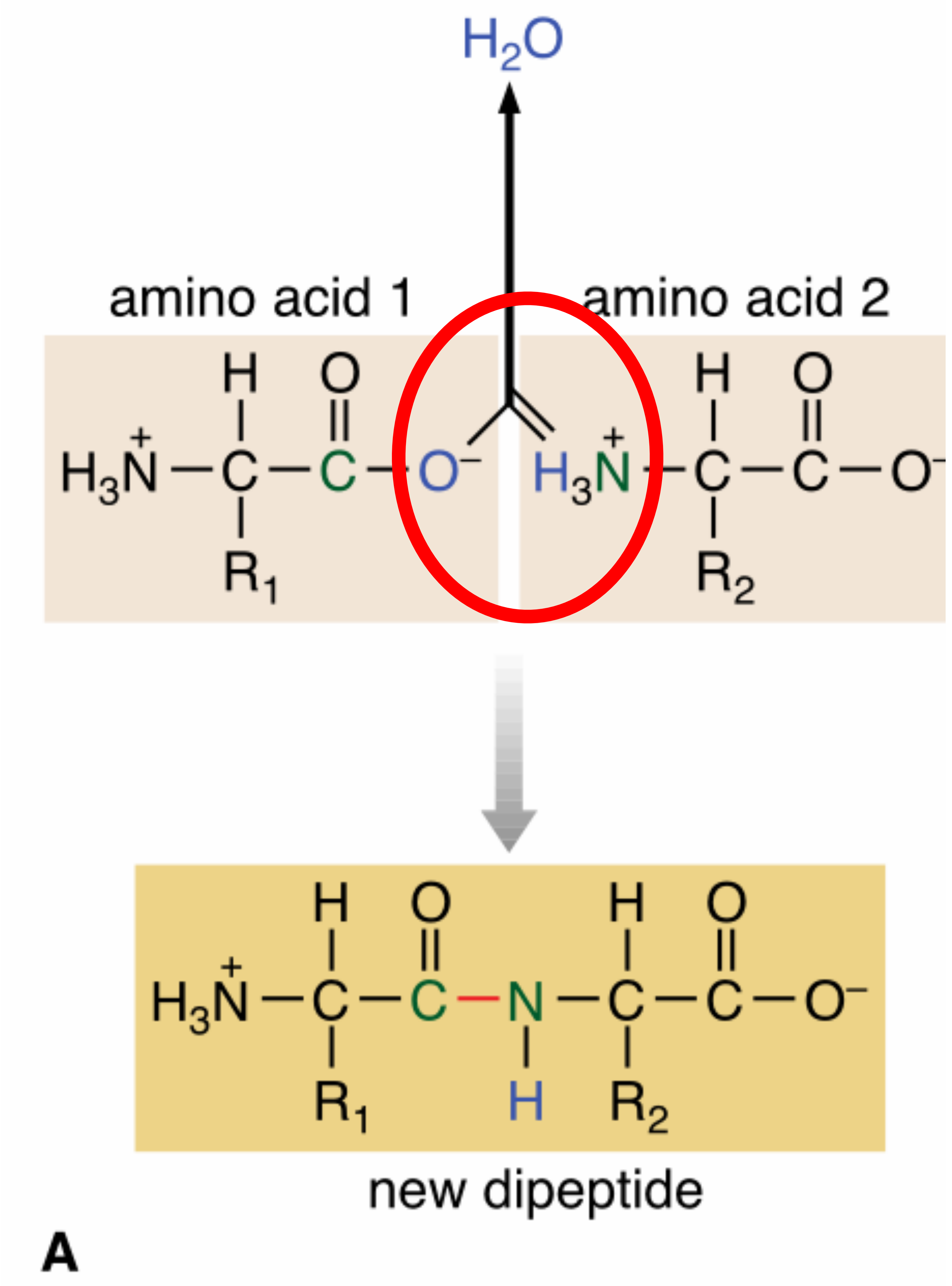


Fig. 2.20

What is required to build a protein?

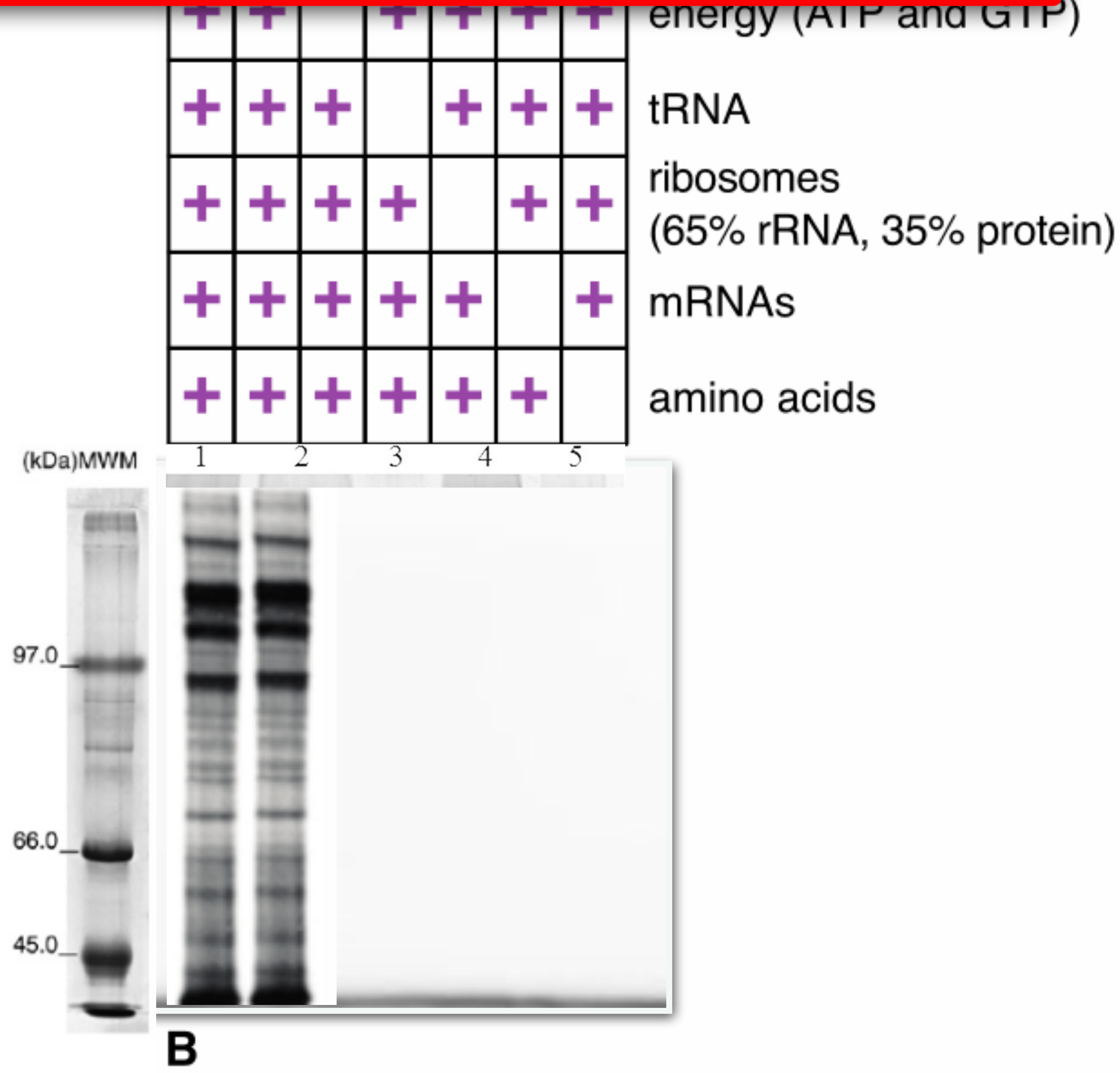
Proteins from Amino Acids



How do cells make a new (peptide) covalent bond between two amino acids?

Fig. 2.20

1. How do they visualize the molecules of interest?
2. How do they separate them in an orderly fashion?



Trifecta?

Fig. 2.20

Proteins from Amino Acids

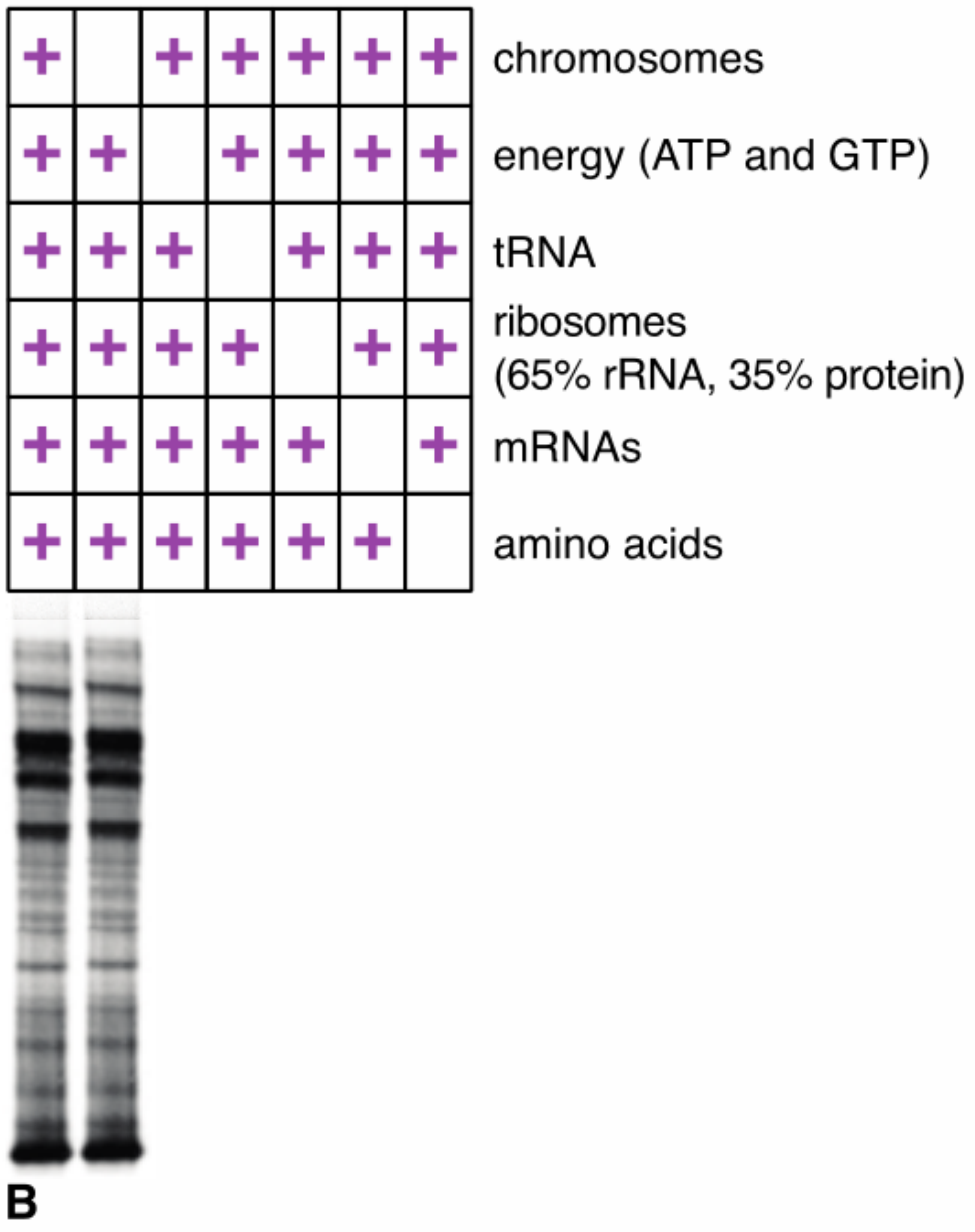


Fig. 2.20

Proteins from Amino Acids

ingredients: DNA	chromosomes
energy	energy (ATP and GTP)
tRNA	tRNA
ribosomes	ribosomes (65% rRNA, 35% protein)
mRNA	mRNAs
amino acids	amino acids

Fig. 2.20

Proteins from Amino Acids

chromosomes

energy (ATP and GTP)

tRNA

ribosomes
(65% rRNA, 35% protein)

mRNAs

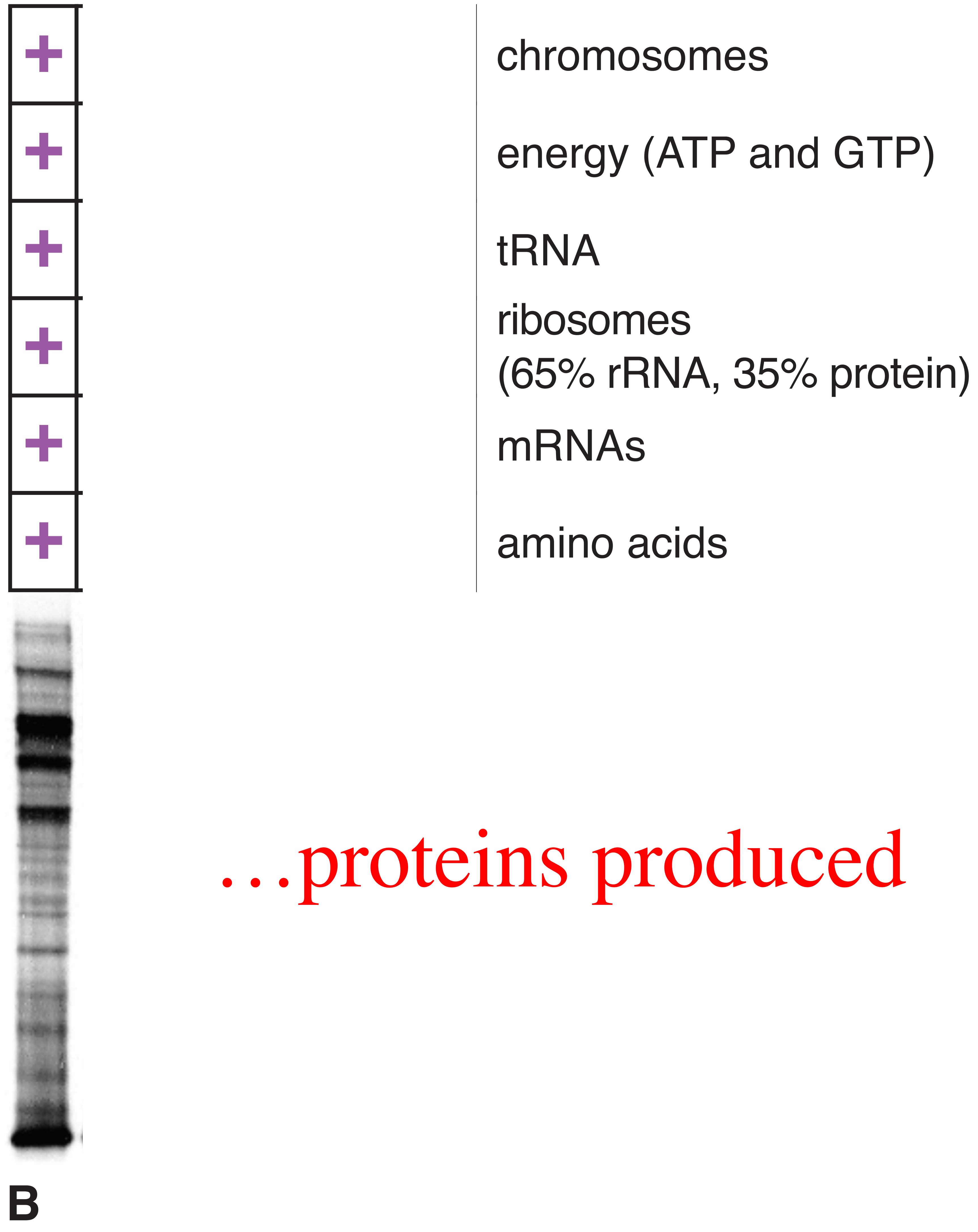
amino acids

method: gel electrophoresis (denaturing)
stain all proteins dark

Fig. 2.20

Proteins from Amino Acids

all ingredients….

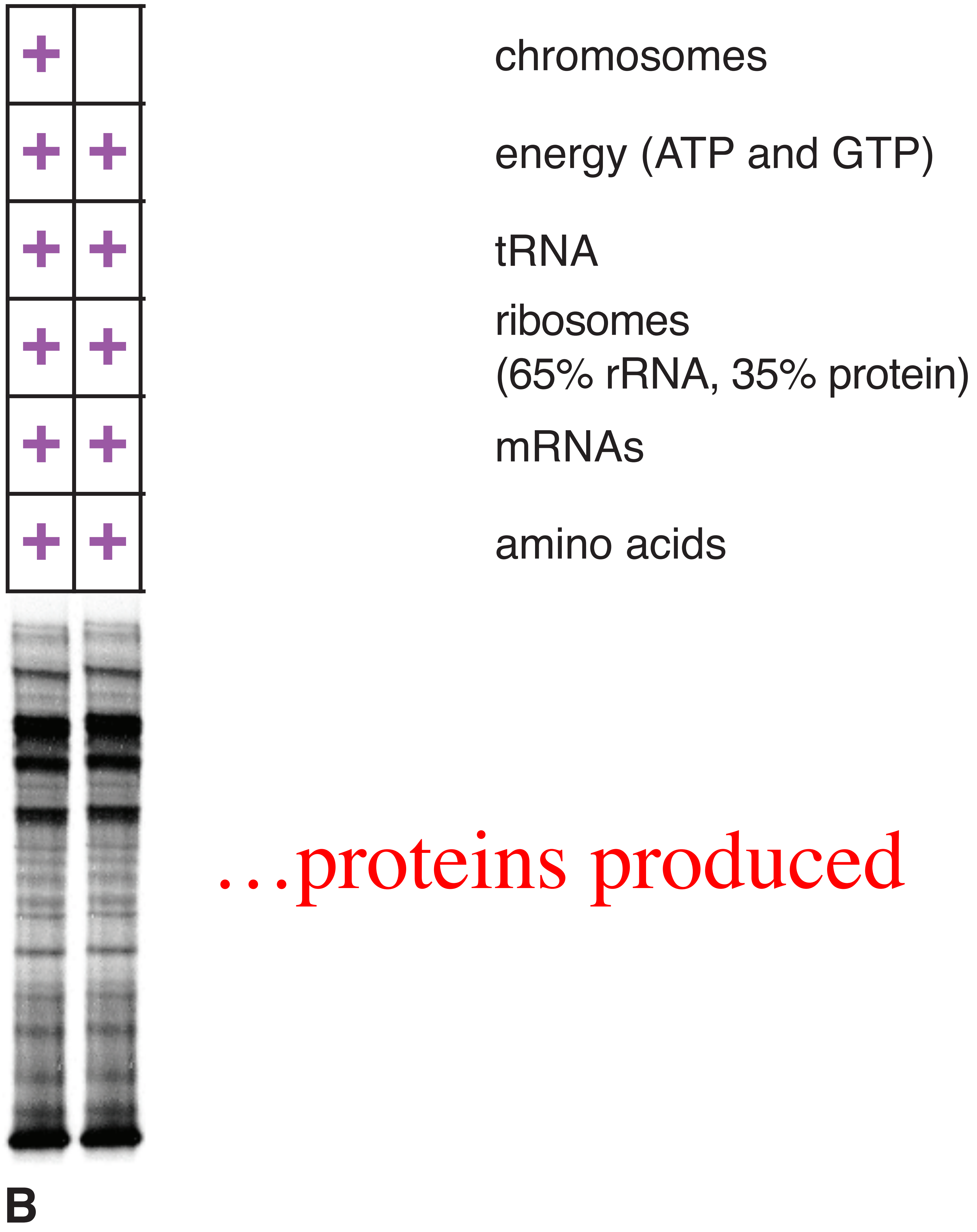


…proteins produced

Fig. 2.20

Proteins from Amino Acids

omit DNA…



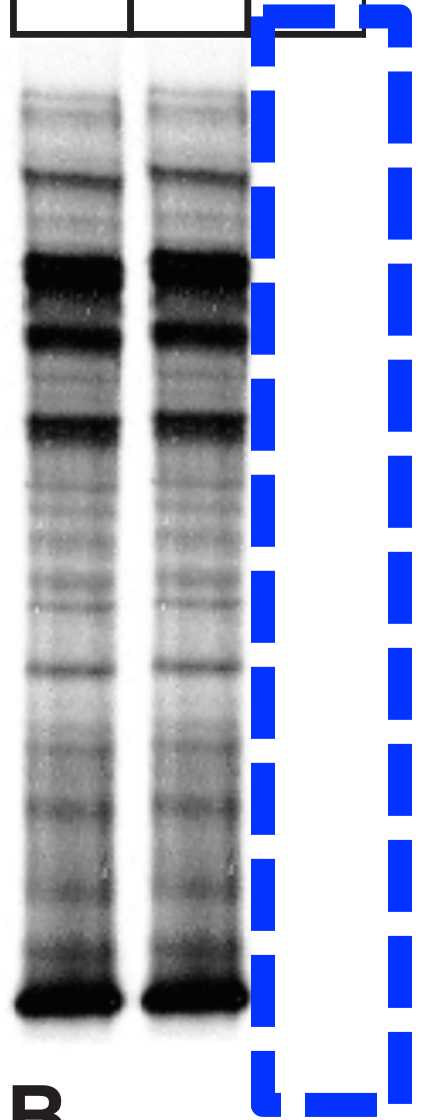
…proteins produced

Fig. 2.20

Proteins from Amino Acids

omit energy source…

+		+	chromosomes
+	+		energy (ATP and GTP)
+	+	+	tRNA
+	+	+	ribosomes (65% rRNA, 35% protein)
+	+	+	mRNAs
+	+	+	amino acids



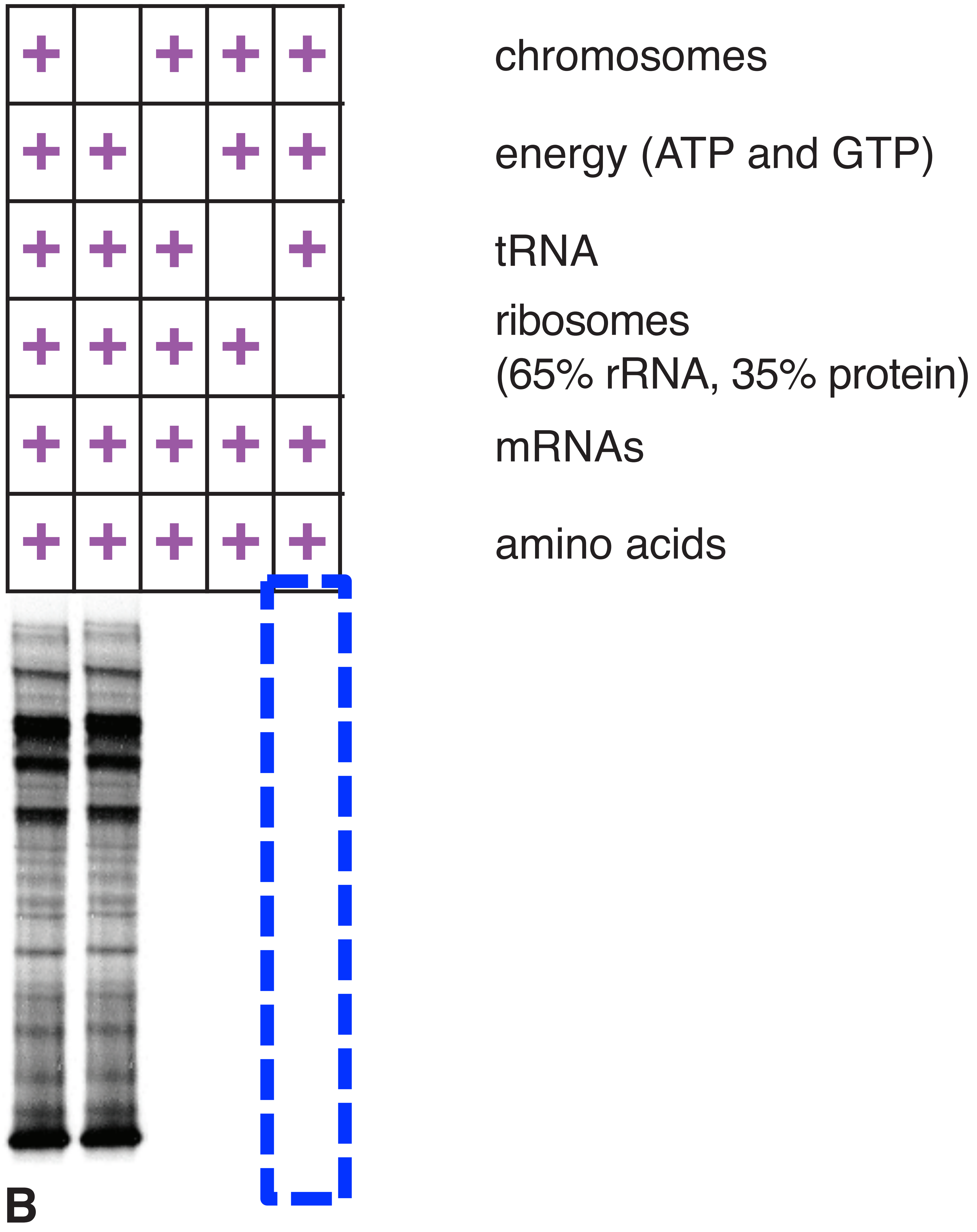
B

…no proteins produced

Fig. 2.20

Proteins from Amino Acids

omit ribosomes…



…no proteins produced

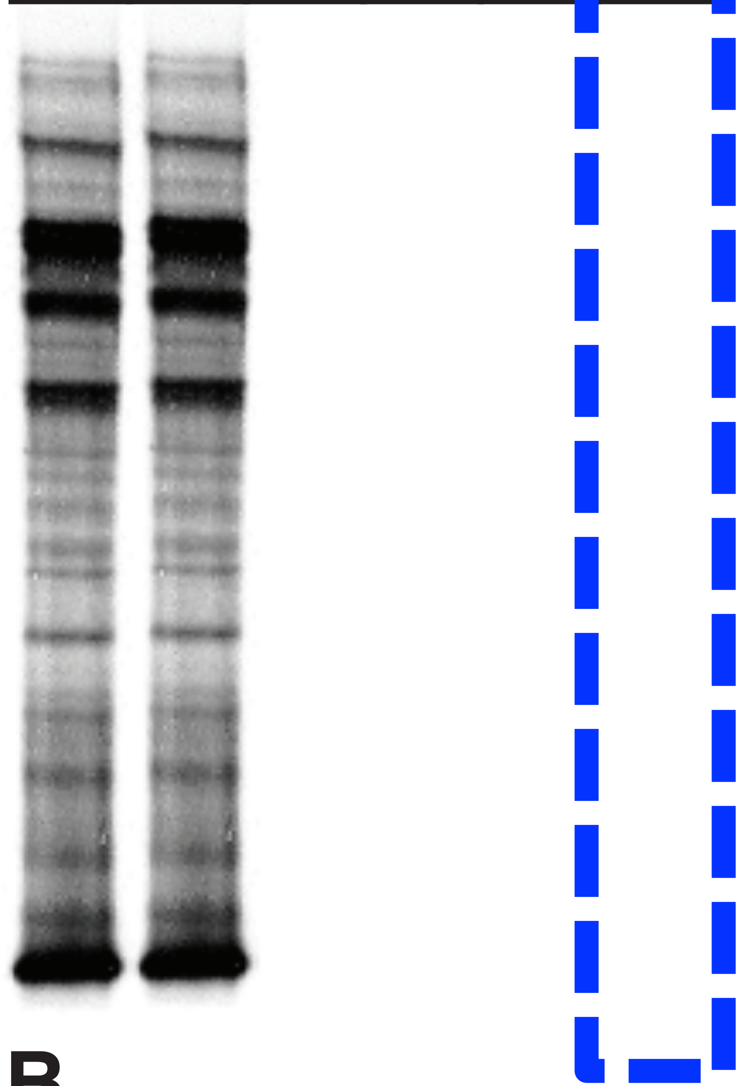
Fig. 2.20

Proteins from Amino Acids

+		+	+	+	+	chromosomes
+	+		+	+	+	energy (ATP and GTP)
+	+	+		+	+	tRNA
+	+	+	+		+	ribosomes (65% rRNA, 35% protein)
+	+	+	+	+		mRNAs
+	+	+	+	+	+	amino acids

omit mRNAs…

…no proteins produced



B

Fig. 2.20

Proteins from Amino Acids

omit amino acids…

…no proteins produced

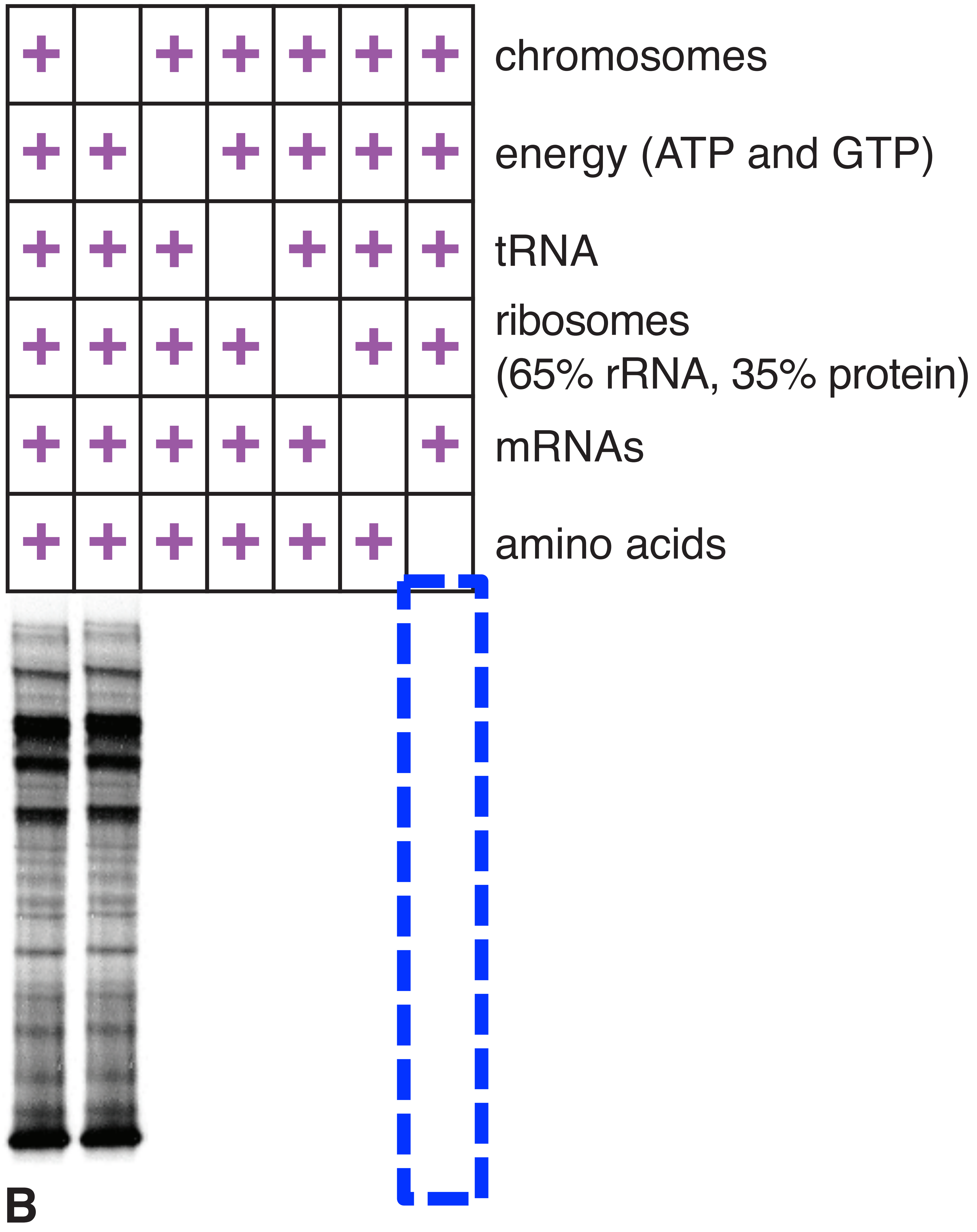
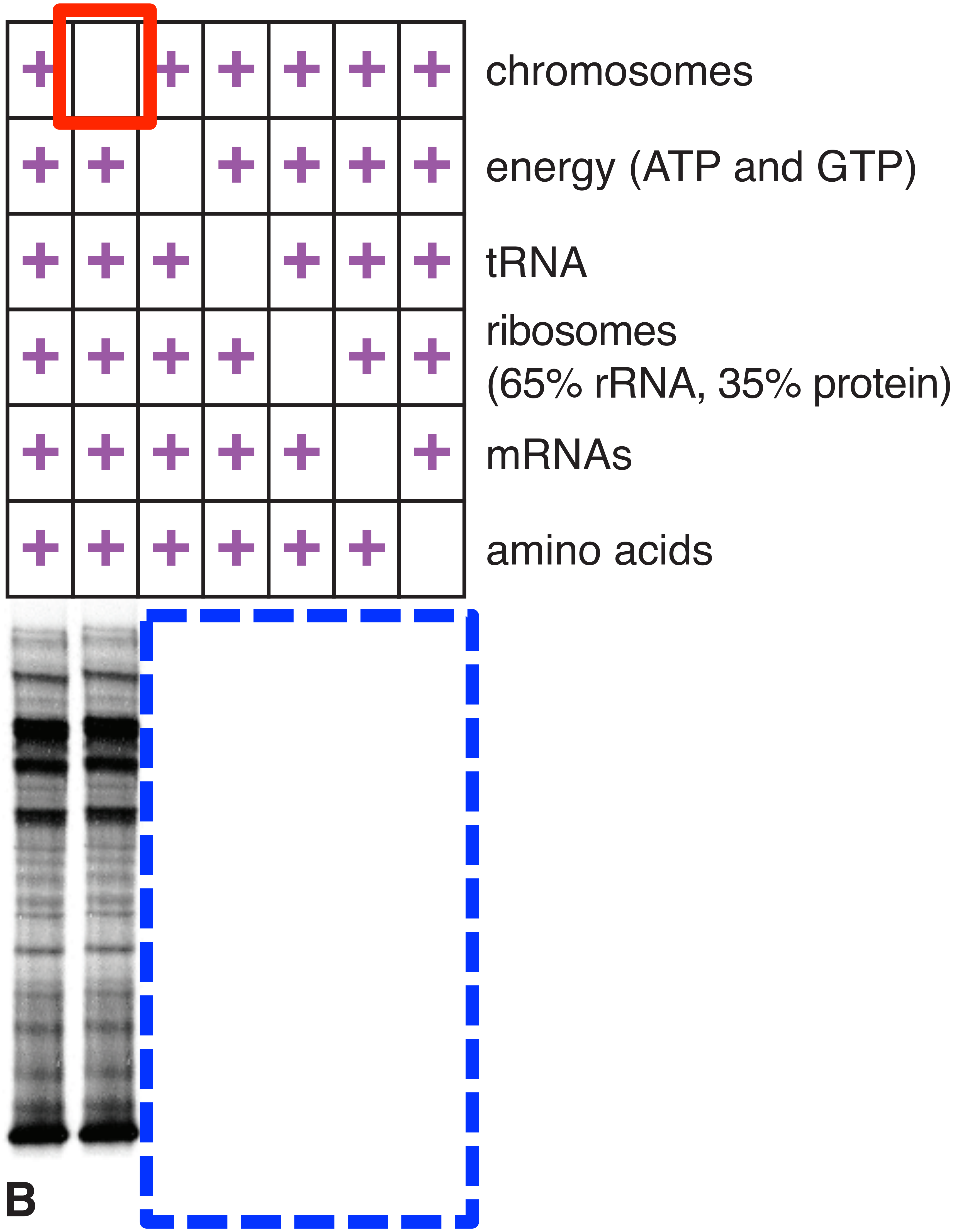


Fig. 2.20

Proteins from Amino Acids

DNA is the only ingredient not used in translation.

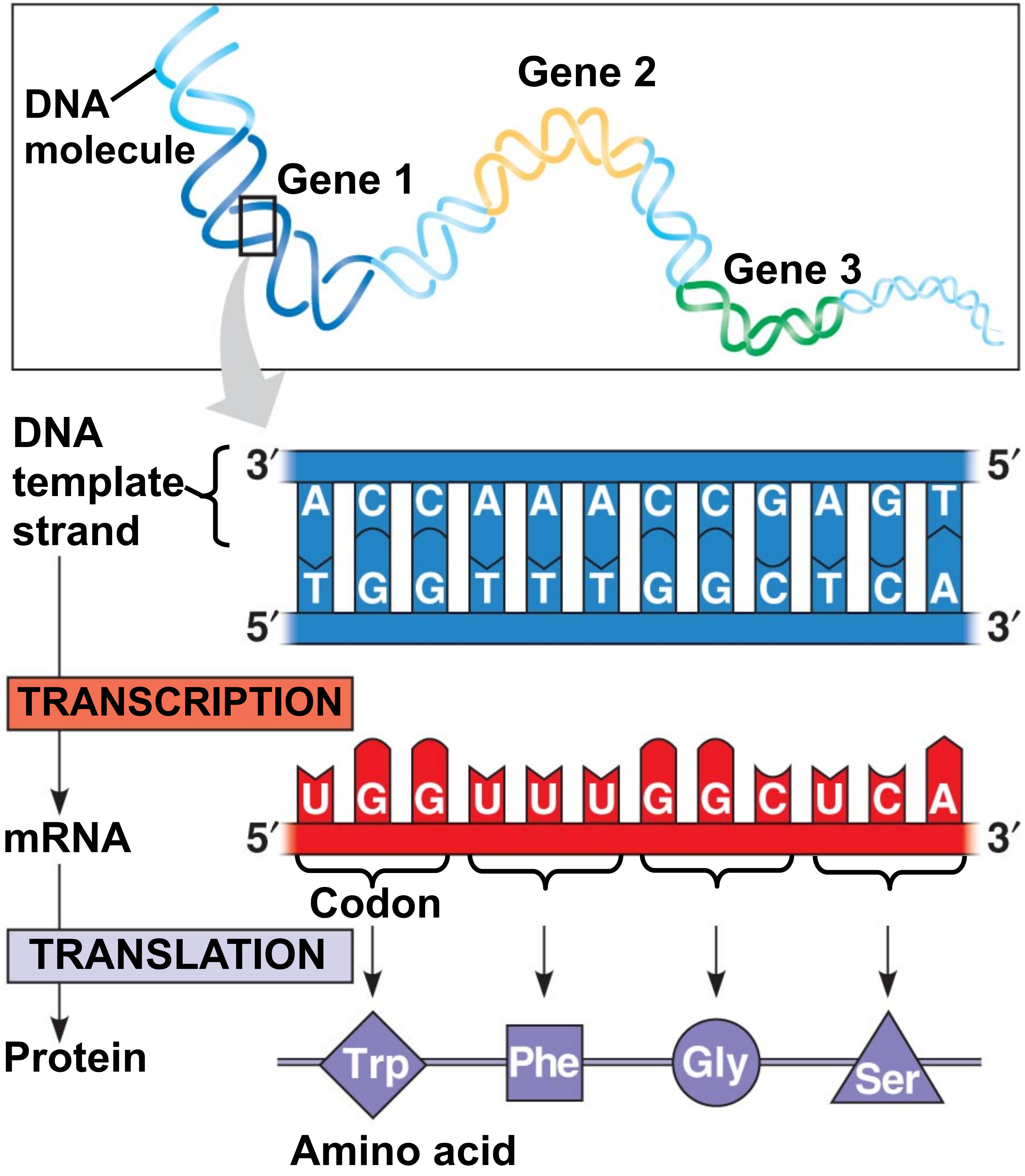


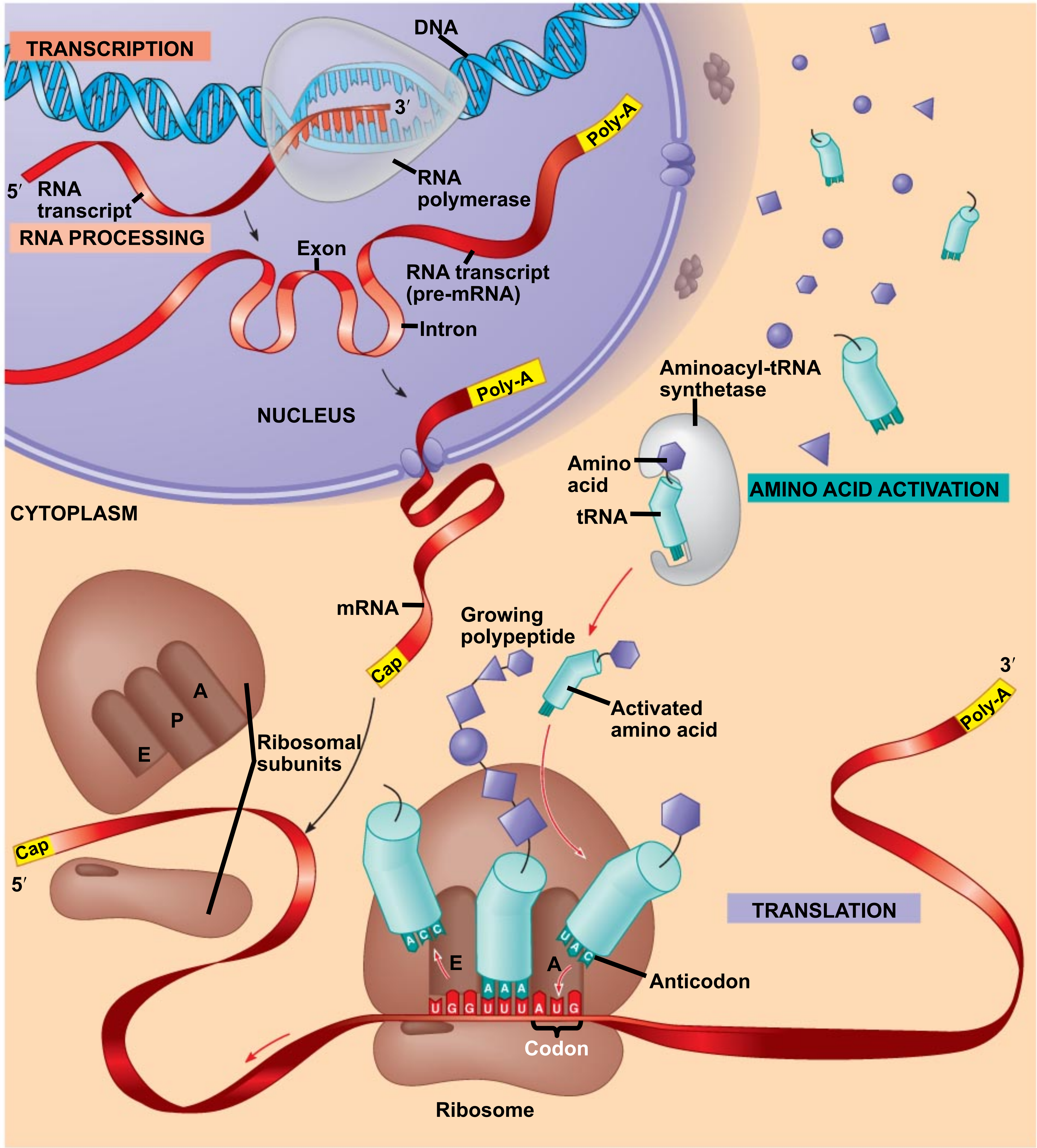
…no proteins produced

Fig. 2.20

Translation: 3 parts

- **Language** (AUG!)
- **Translators** (tRNA & synth)
- **Factory** (Ribosome subunits)

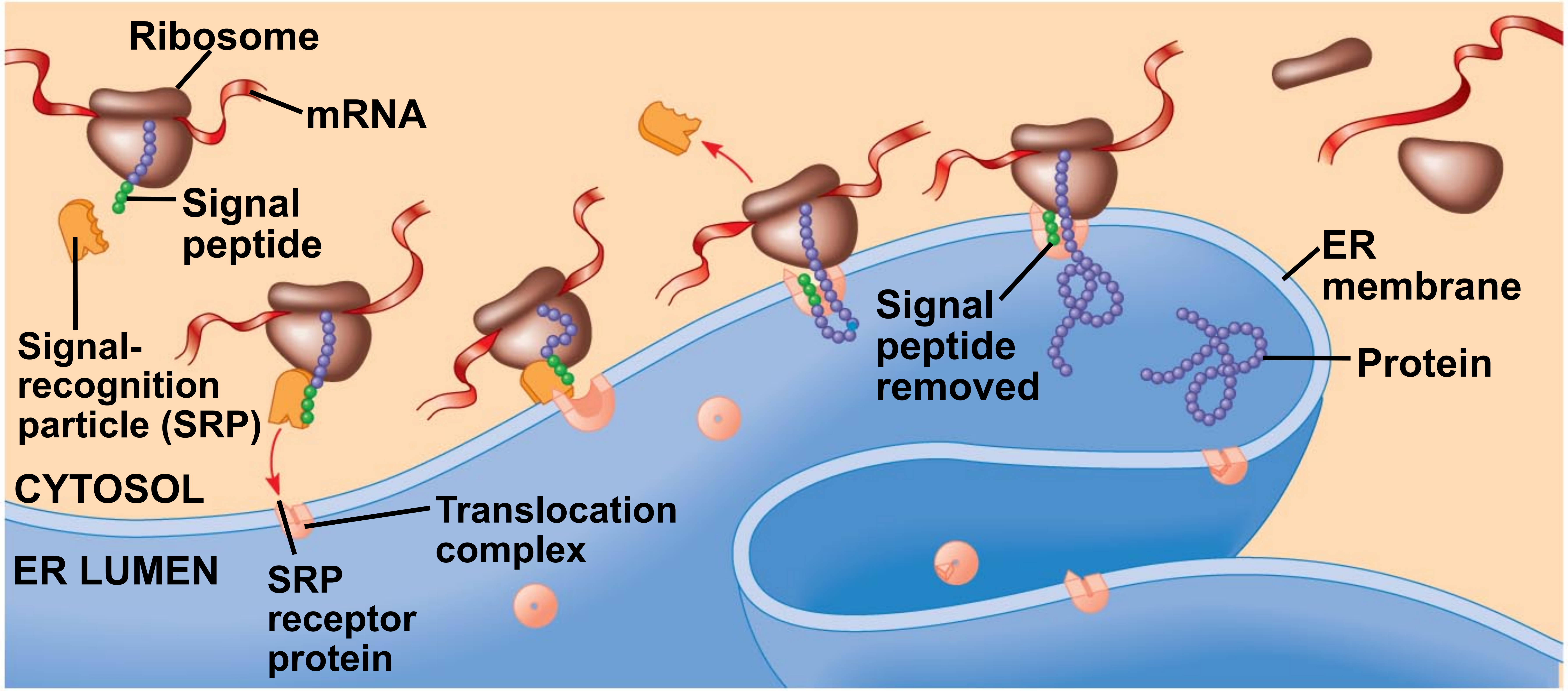

DNA molecule
Gene 1
Gene 2
Gene 3
DNA template strand
3′
5′
A C C A A A C C G A G T
T G G T T T G G C T C A
5′
3′
TRANSCRIPTION
mRNA
5′
U G G U U U G G C U C A
3′
Codon
TRANSLATION
Protein
Trp
Phe
Gly
Ser
Amino acid

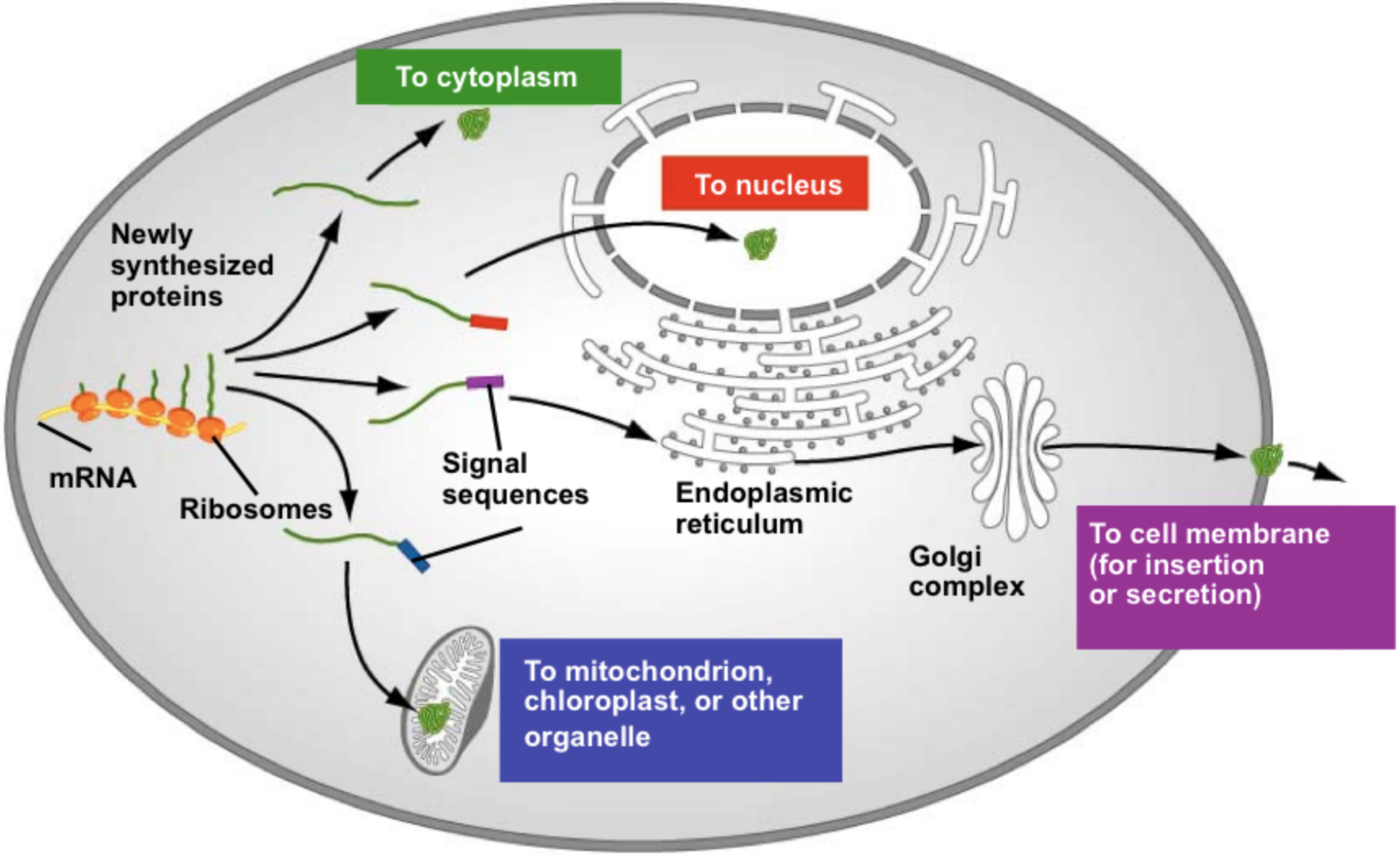

TRANSCRIPTION
DNA
3′
5′
RNA transcript
RNA polymerase
Poly-A
RNA PROCESSING
Exon
RNA transcript (pre-mRNA)
Intron
NUCLEUS
Poly-A
Aminoacyl-tRNA synthetase
Amino acid
tRNA
AMINO ACID ACTIVATION
CYTOPLASM
mRNA
Growing polypeptide
Cap
A
P
E
Ribosomal subunits
Activated amino acid
3′
Poly-A
Cap
5′
TRANSLATION
E
A
Anticodon
A C C
A A A
U A C
U G G U U U A U G
Codon
Ribosome

The RNA Tie Club was right!

Table 17.1 Types of RNA in a Eukaryotic Cell

Type of RNA	Functions
Messenger RNA (mRNA)	Carries information specifying amino acid sequences of proteins from DNA to ribosomes.
Transfer RNA (tRNA)	Plays catalytic (ribozyme) roles and structural roles in ribosomes.
Ribosomal RNA (rRNA)	Plays structural and catalytic (ribozyme) roles in ribosomes.
Primary transcript	Serves as a precursor to mRNA, rRNA, or tRNA and may be processed by splicing or cleavage . In eukaryotes, pre-mRNA commonly contains introns, noncoding segments that are spliced out as the primary transcript is processed. Some intron RNA acts as a ribozyme, catalyzing its own splicing.
Small nuclear RNA (snRNA)	Plays structural and catalytic roles in spliceosomes, the complexes of protein and RNA that splice pre-mRNA in the eukaryotic nucleus.
SRP RNA	Is a component of the signal-recognition particle (SRP), the protein-RNA complex that recognizes the signal peptides of polypeptides targeted to the ER.


Ribosome
mRNA
Signal peptide
Signal-recognition particle (SRP)
CYTOSOL
ER LUMEN
SRP receptor protein
Translocation complex
Signal peptide removed
ER membrane
Protein



To cytoplasm
To nucleus
Newly synthesized proteins
mRNA
Ribosomes
Signal sequences
Endoplasmic reticulum
Golgi complex
To cell membrane (for insertion or secretion)
To mitochondrion, chloroplast, or other organelle