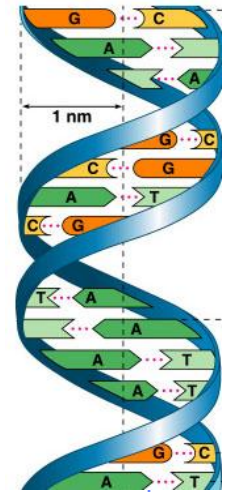
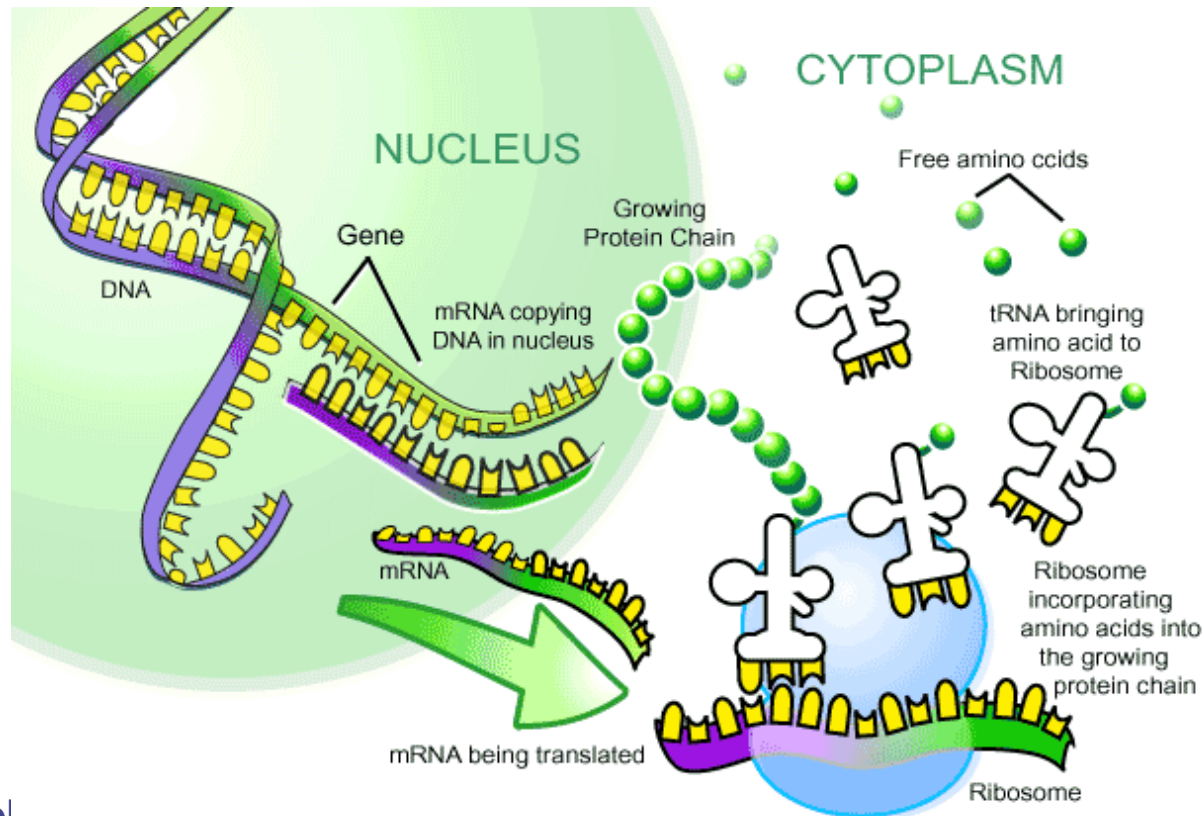


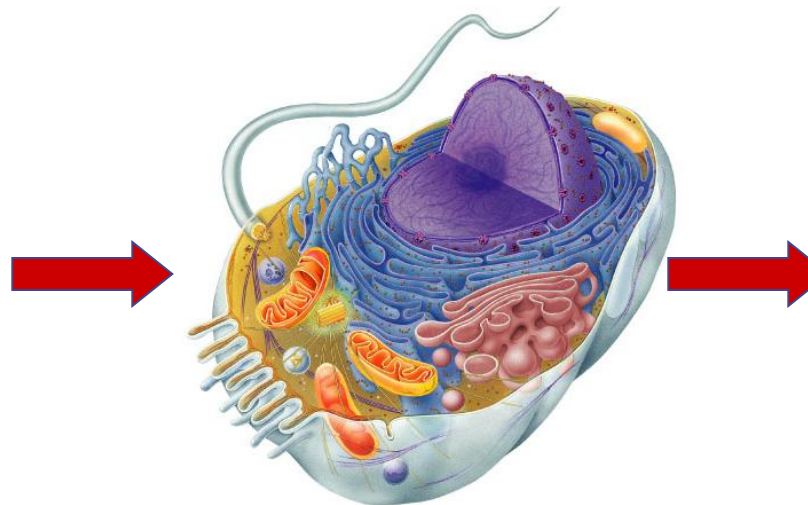
From Gene to Protein



Bodies → Cells → DNA

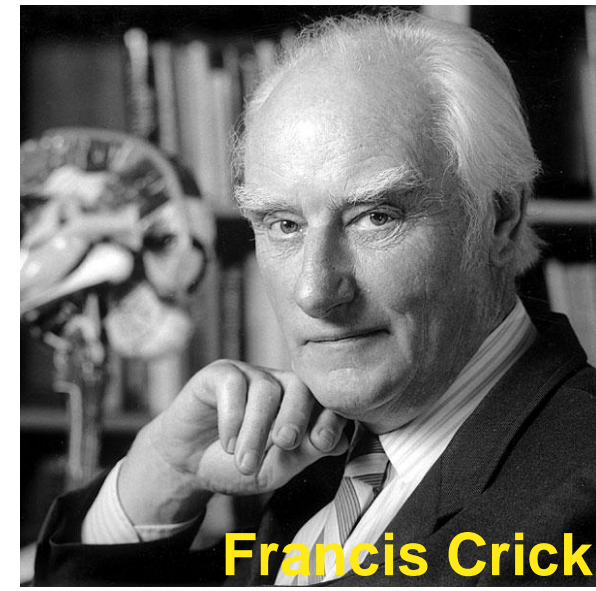
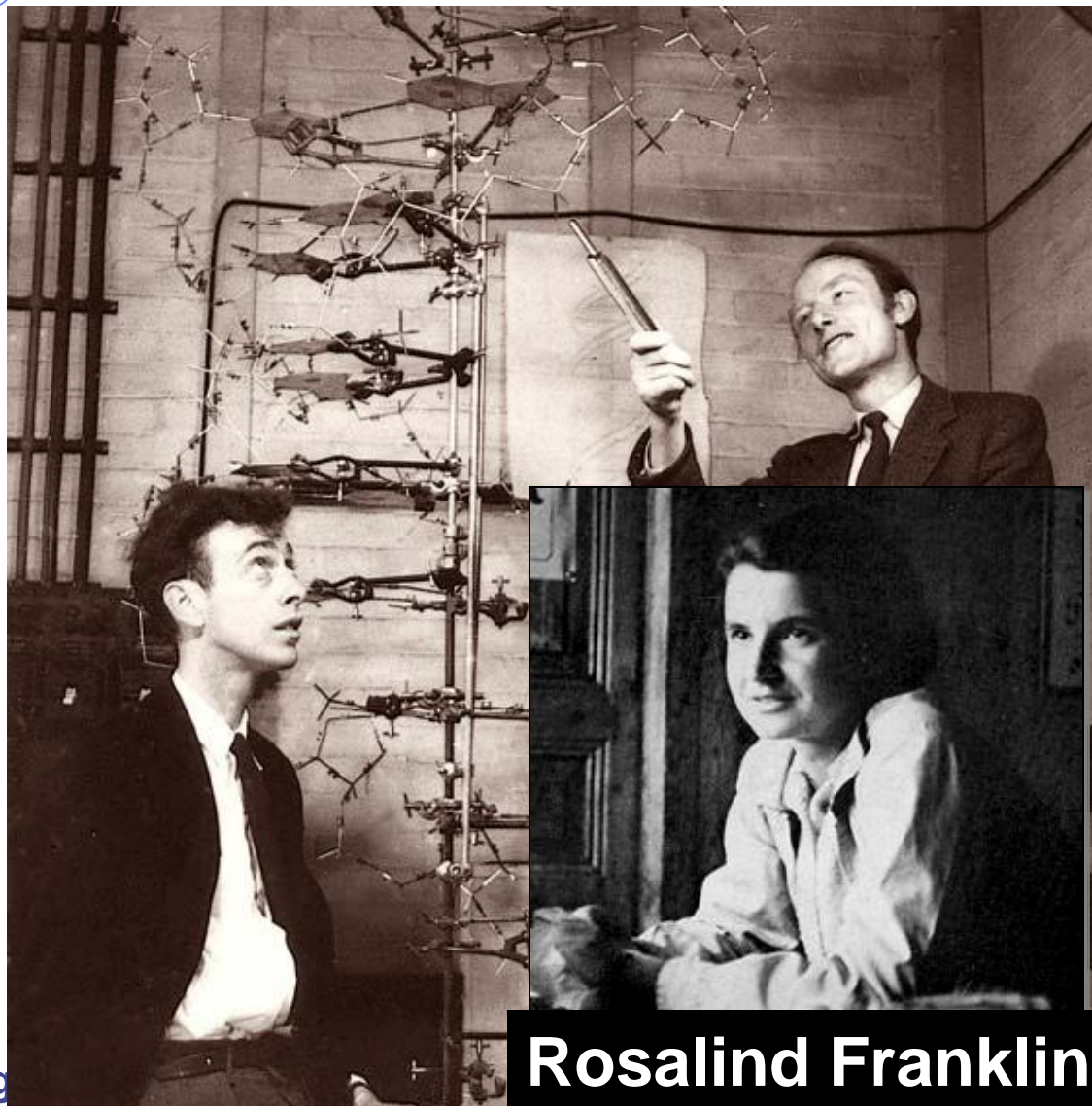
- Bodies are made up of cells
- All cells run on a set of instructions spelled out in DNA

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

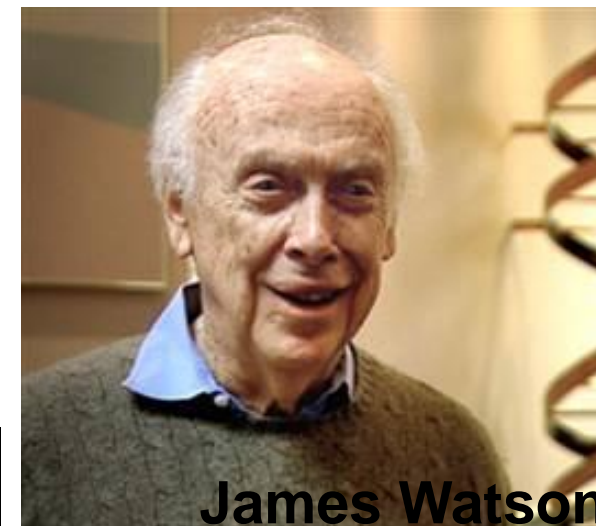


1953 | 1962

Watson & Crick: Structure of DNA



Francis Crick



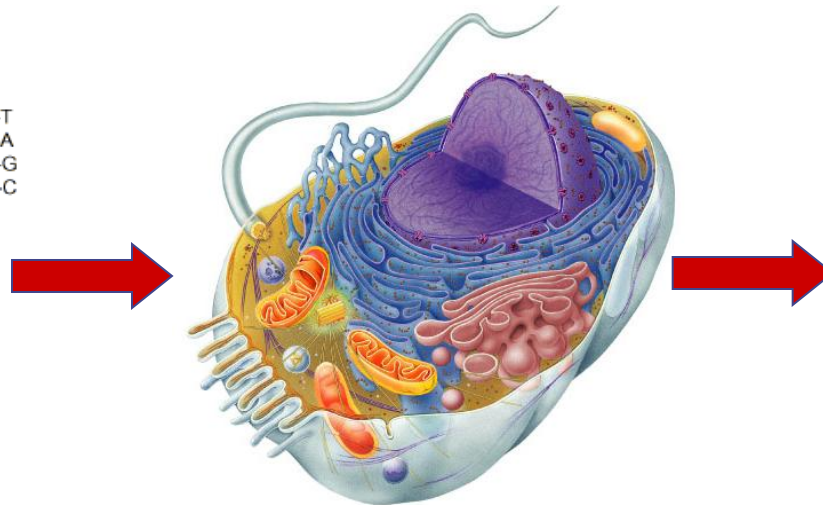
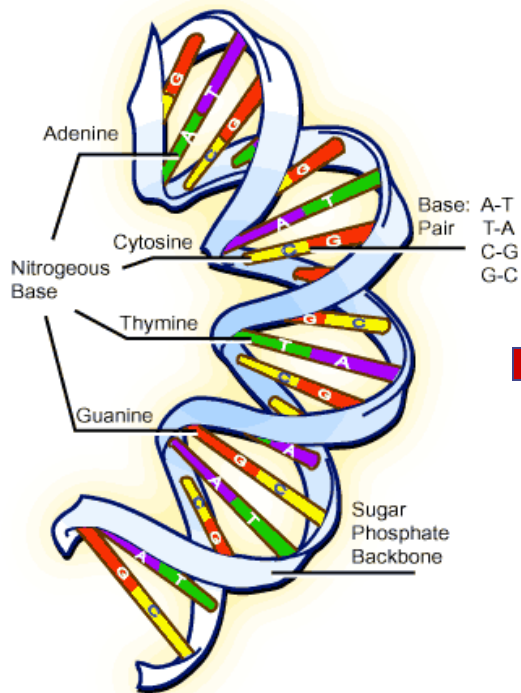
James Watson

Rosalind Franklin

Reg

DNA → Cells → Bodies

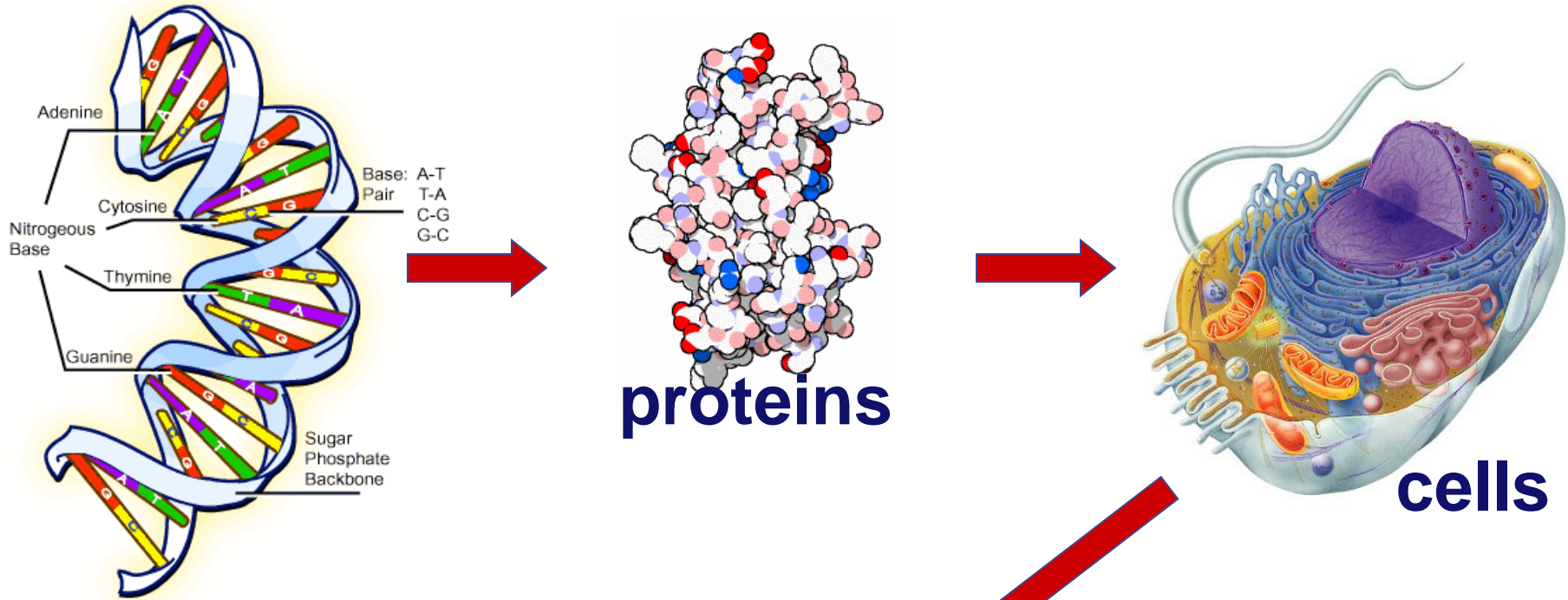
- How does DNA code for cells & bodies?
 - ◆ how are cells and bodies made from the instructions in DNA



QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

DNA → Proteins → Cells → Bodies

- DNA has the information to build proteins



QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

**DNA gets all the glory,
Proteins do all the work**

What do we know?

■ DNA

- ◆ DNA is the genetic information

■ Proteins

- ◆ proteins run living organisms

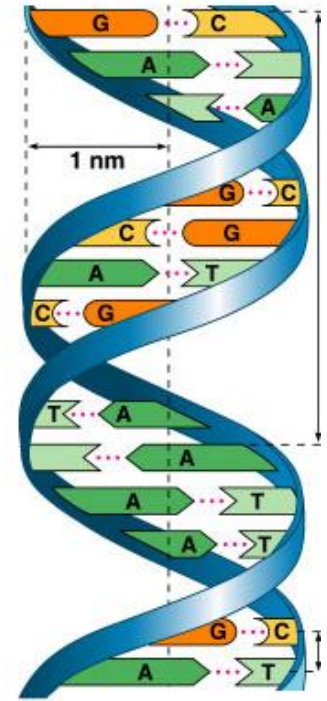
◆ enzymes

- all chemical reactions in living organisms are controlled by enzymes (proteins)

◆ structure

- all living organisms are built out of proteins

■ DNA is the instructions for making proteins



What do we know?

■ DNA

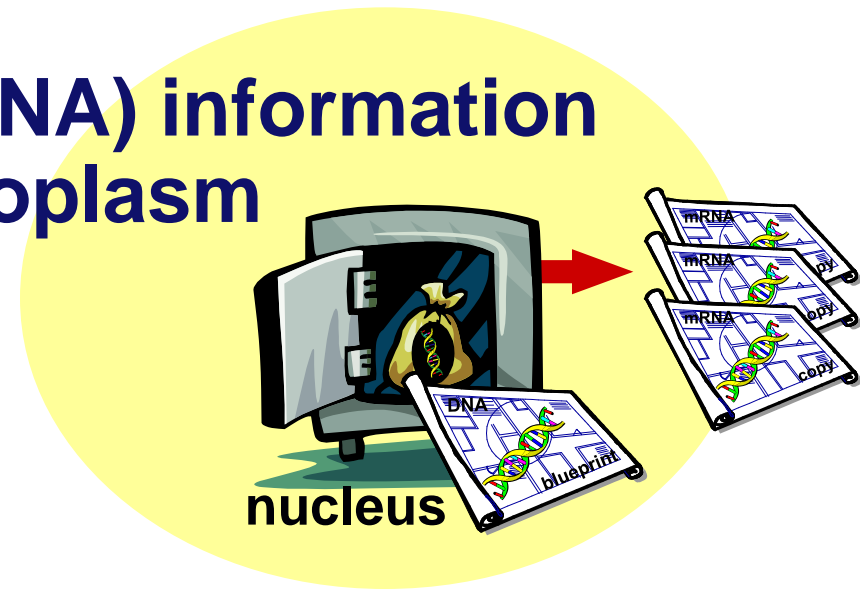
- ◆ DNA is in the nucleus
- ◆ want to keep it there = protected
 - “locked in the vault”

■ Proteins

- ◆ made by a “protein factory” in cytoplasm
- ◆ ribosomes

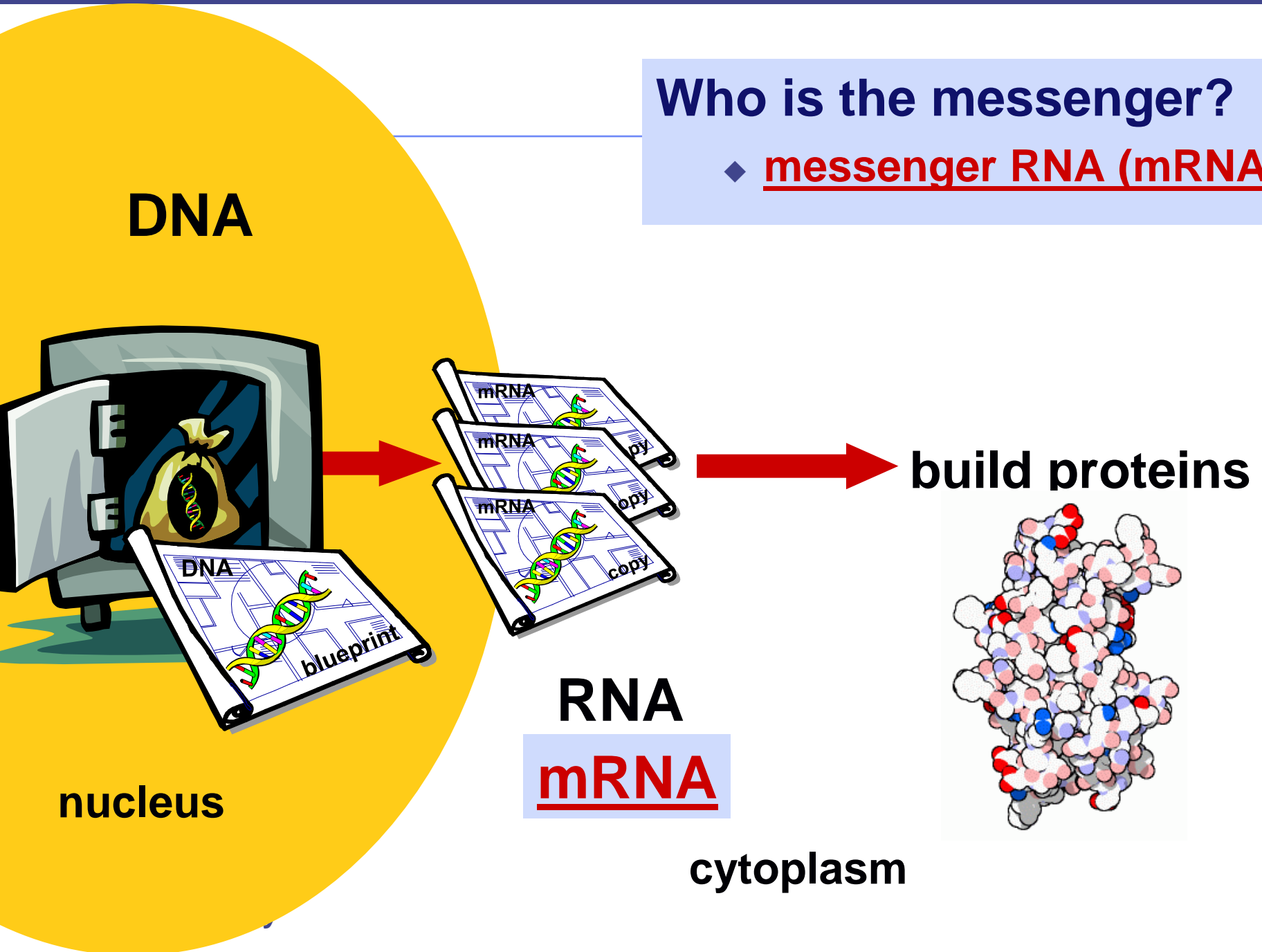
■ Need to get gene (DNA) information from nucleus to cytoplasm

- ◆ need a messenger!
- ◆ need a copy of DNA
- ◆ mRNA



Who is the messenger?

- ◆ messenger RNA (mRNA)



DNA

nucleus

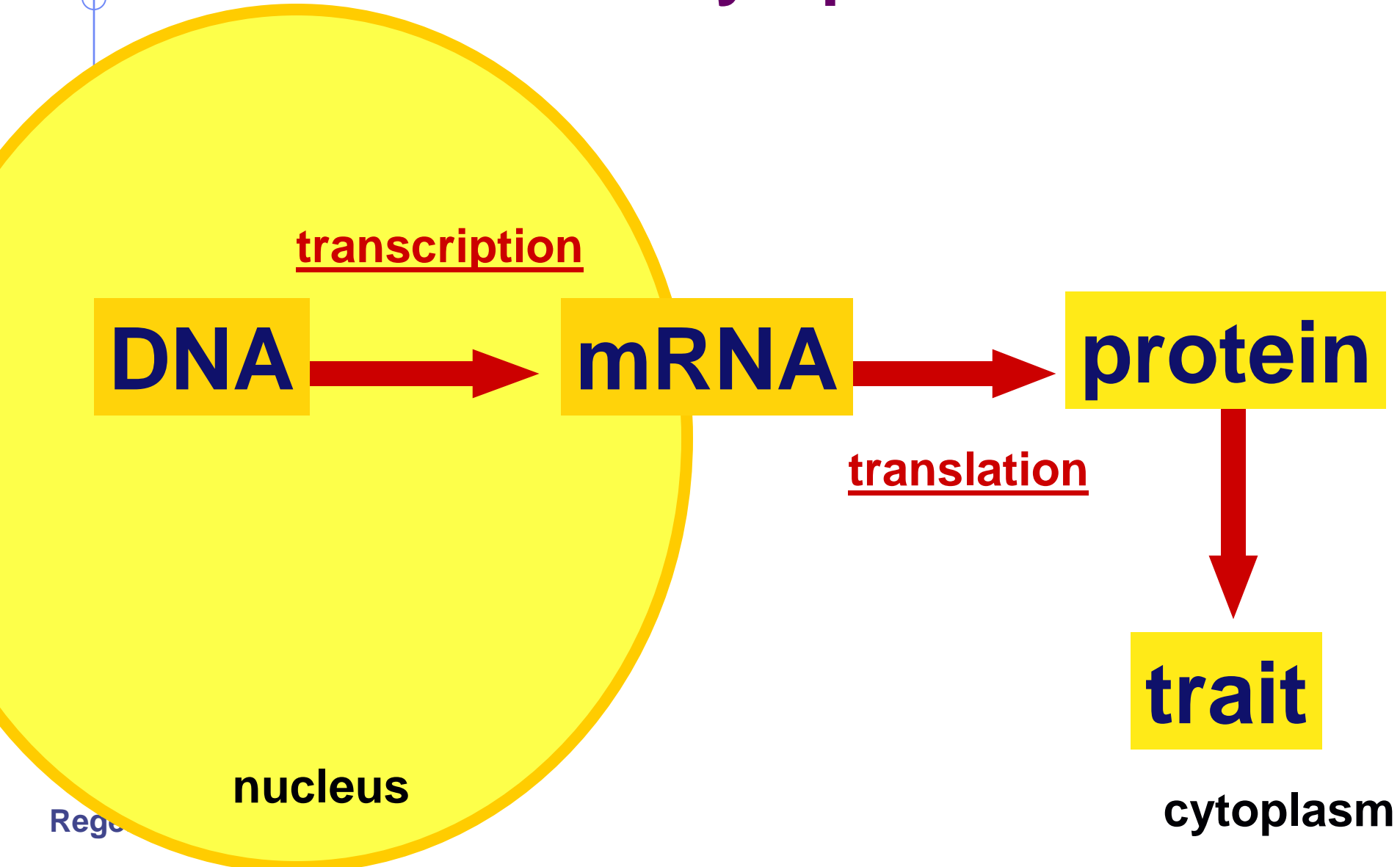
RNA

mRNA

cytoplasm

build proteins

From nucleus to cytoplasm



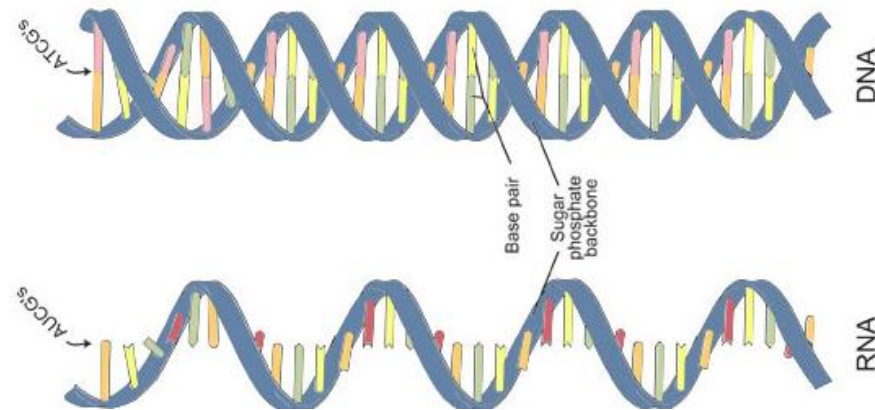
DNA vs. RNA

DNA

- deoxyribose sugar
- nitrogen bases
 - ◆ G, C, A, T
 - T = thymine
 - ◆ T : A
 - ◆ C : G
- double stranded

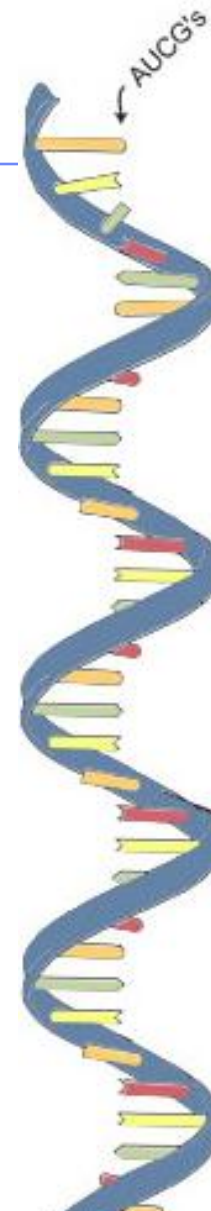
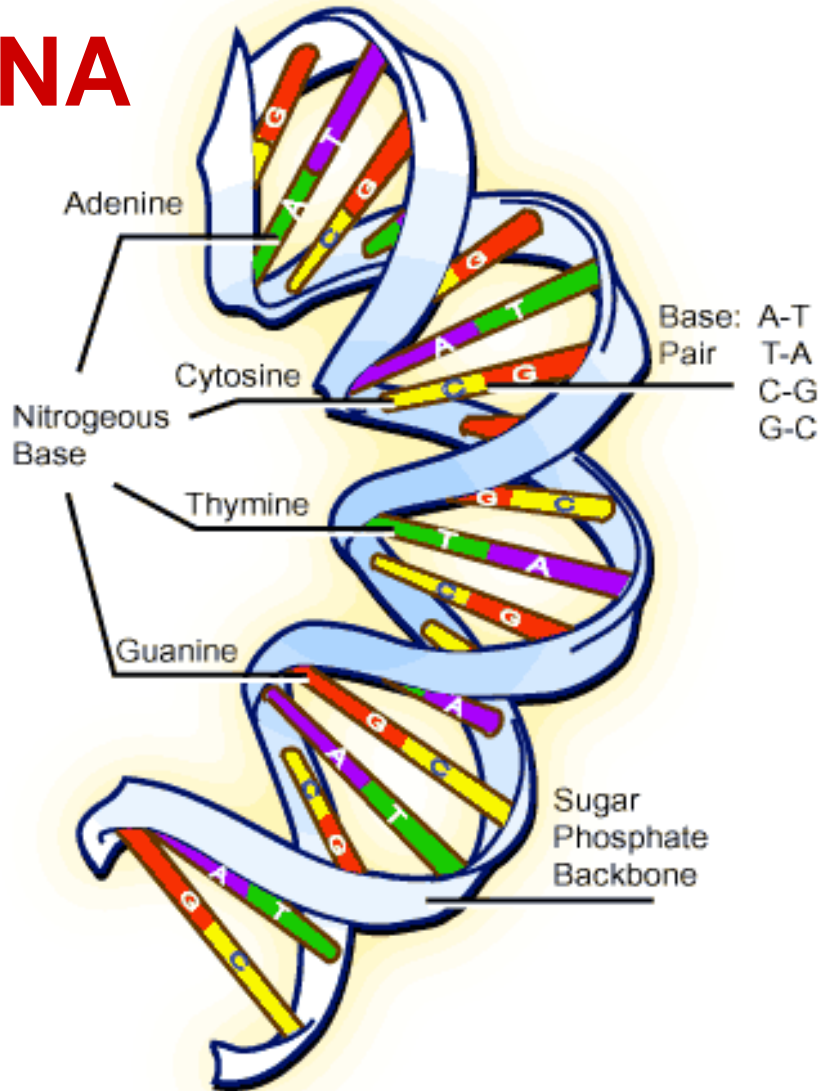
RNA

- ribose sugar
- nitrogen bases
 - ◆ G, C, A, U
 - U = uracil
 - ◆ U : A
 - ◆ C : G
- single stranded

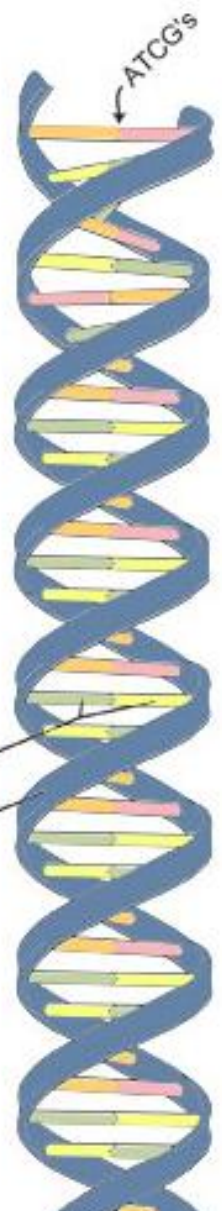


DNA vs. RNA

DNA



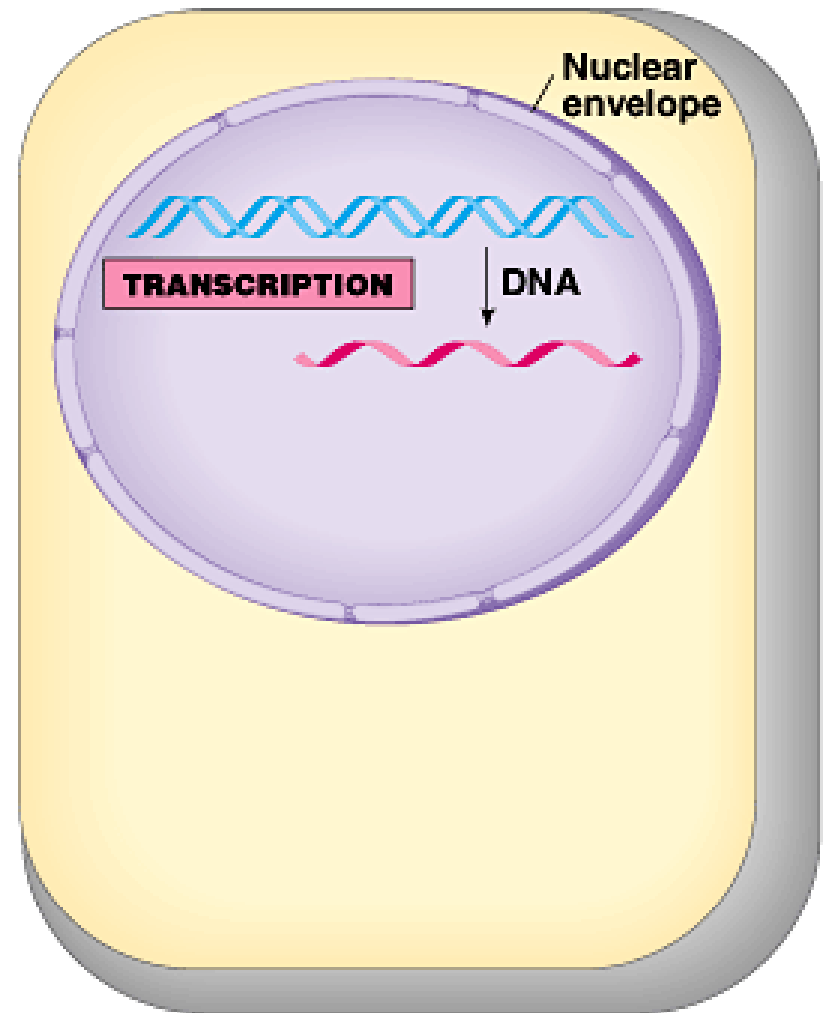
RNA



DNA

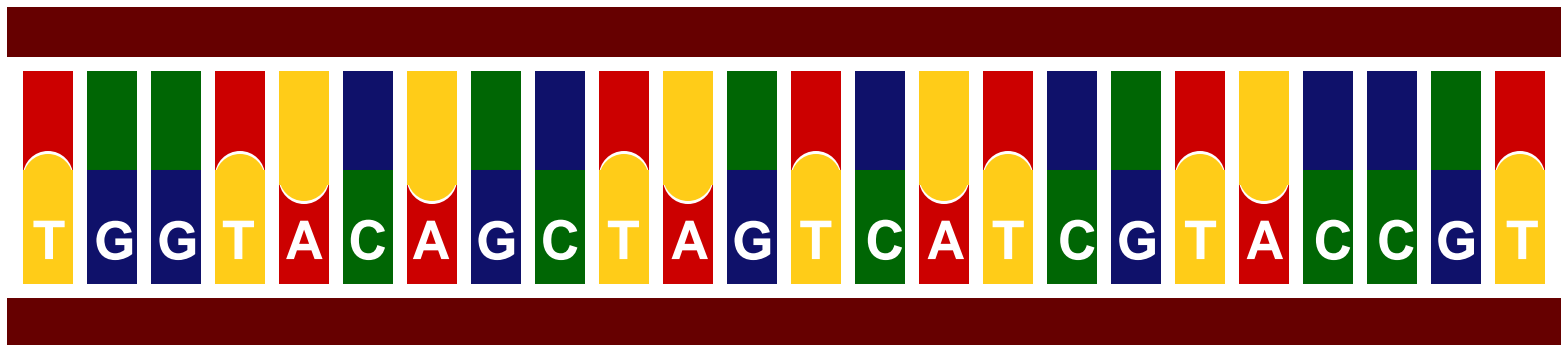
Transcription

- Making mRNA from DNA
- DNA strand is the template (pattern)
 - ◆ match bases
 - U : A
 - G : C
- Enzyme
 - ◆ RNA polymerase



Matching bases of DNA & RNA

- Double stranded DNA unzips



Matching bases of DNA & RNA

- Double stranded DNA unzips



Matching bases of DNA & RNA

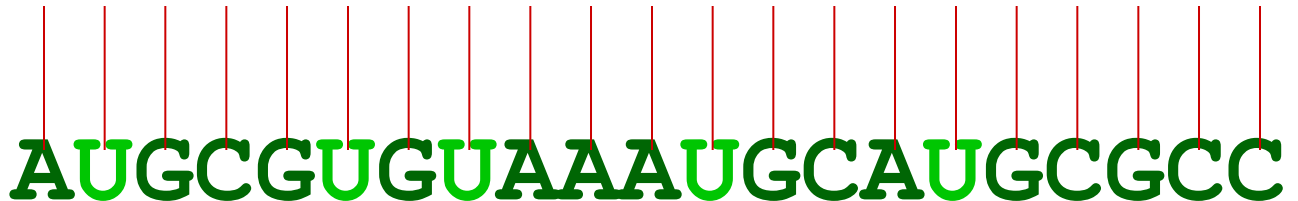
- U instead of T is matched to A

DNA

TACGCACATTTACGTACGCGG

mRNA

AUGCGUGUAAAUGCAUGCGCC



What do we know?

- **DNA**

- ◆ instructions remain in nucleus

- **mRNA**

- ◆ has the instructions for building proteins from DNA

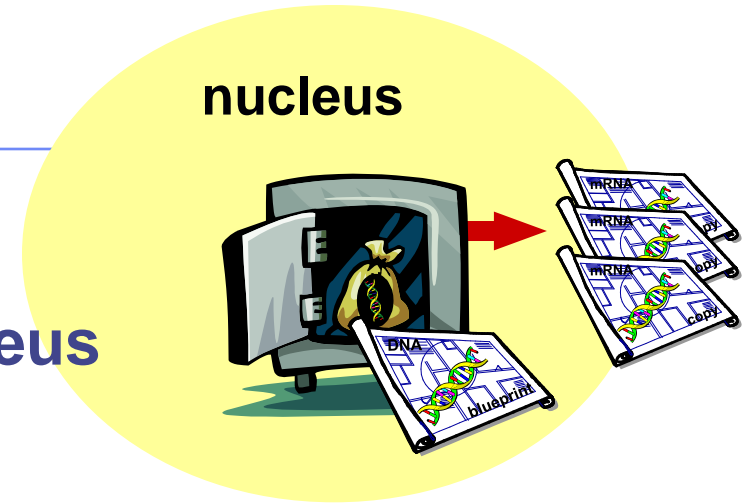
- **Proteins**

- ◆ **built as chains of amino acids**

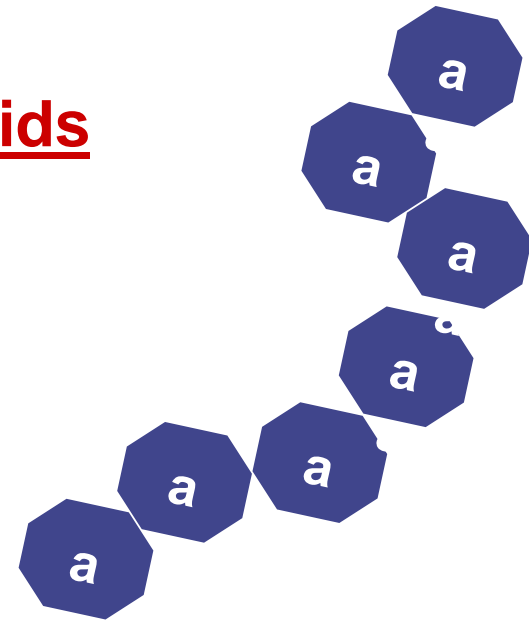
- **What reads RNA?**

- ◆ **need a mRNA reader!**

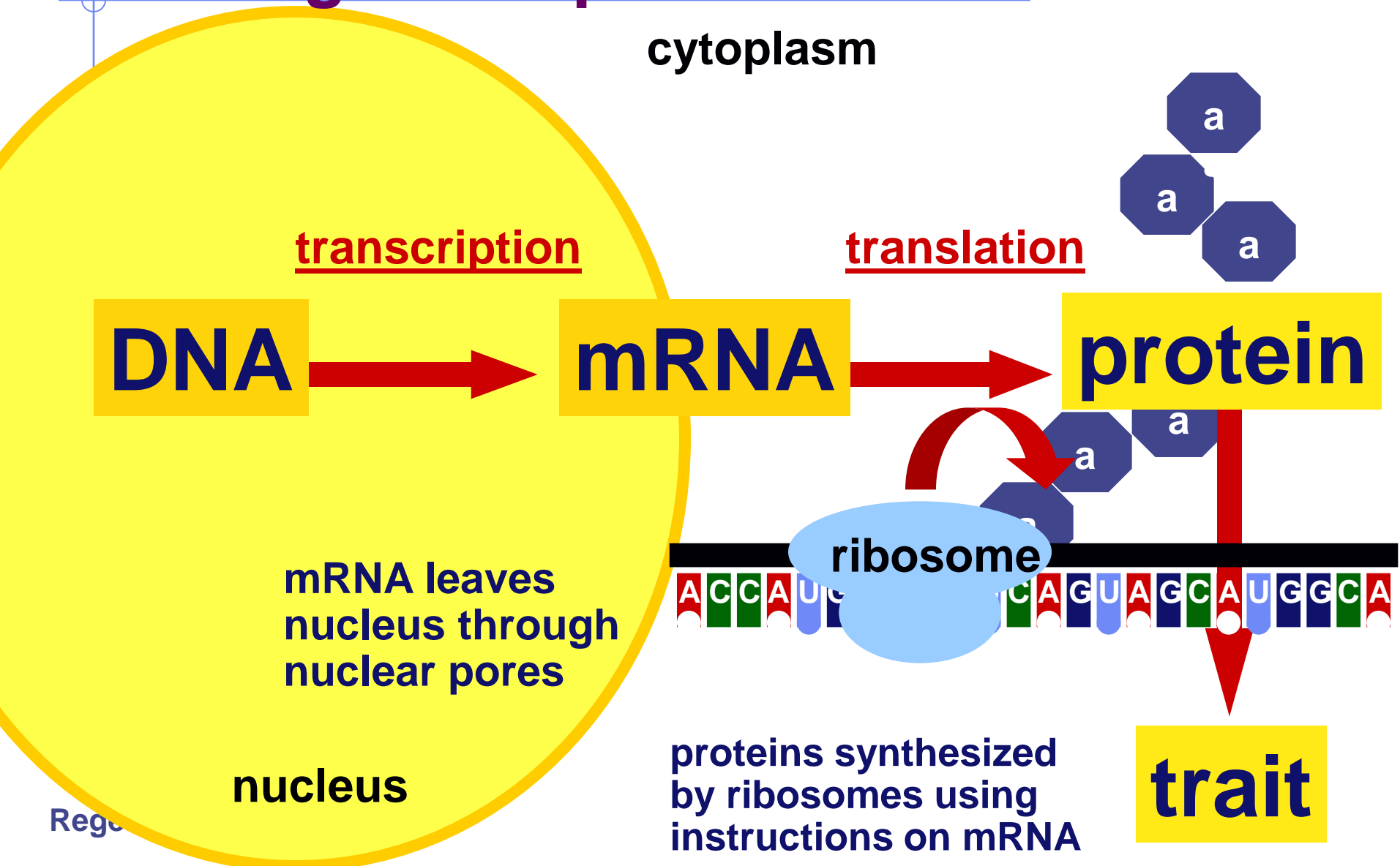
- ◆ **ribosome**



ACCAUGUCGAUCAGUAGCAUGGCA



From gene to protein



What do we know?

- mRNA

- ◆ has the instructions for building proteins from DNA

- Proteins

- ◆ built as chains of amino acids

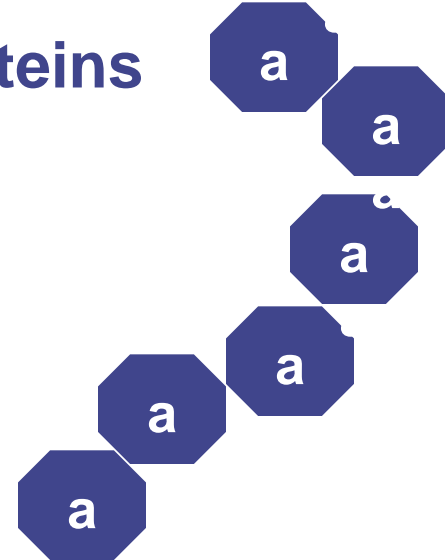
- What reads mRNA?

- ◆ ribosome

- What brings the right amino acid to attach to the protein chain?

- ◆ need an amino acid transporter!

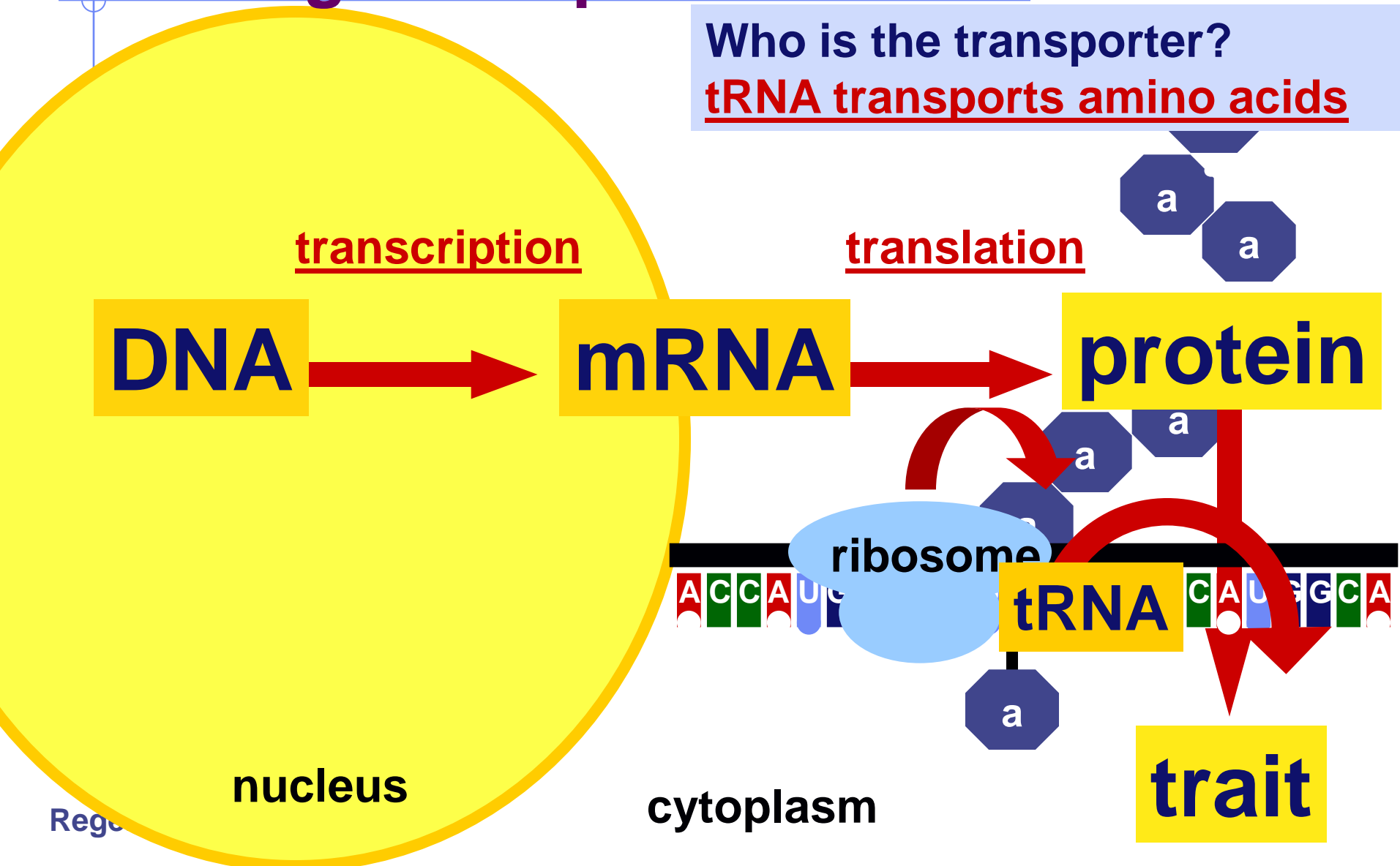
ACCAUGUCGAUCAGUAGCAUGGCA



From gene to protein

Who is the transporter?

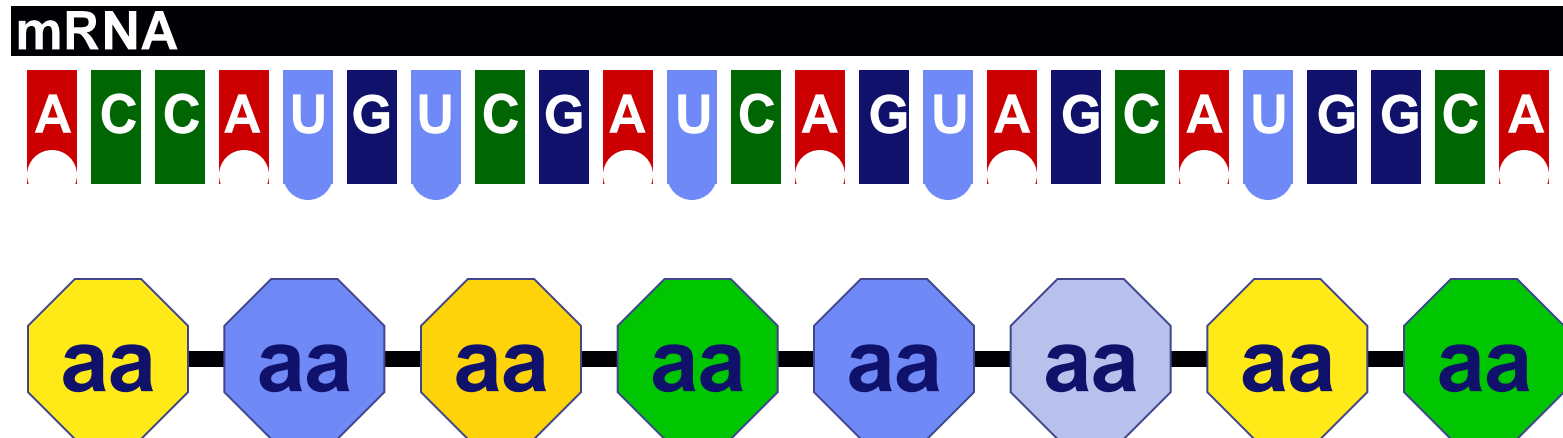
tRNA transports amino acids



RNA to protein

- mRNA leaves nucleus
- mRNA goes to ribosomes in cytoplasm
- Proteins built from instructions on mRNA

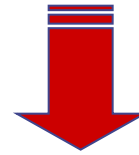
How?



How does mRNA code for proteins?

DNA

TACGCACATTTACGTACGCGG



mRNA

AUGC GUGU AAAUG CAUGC GCC



protein

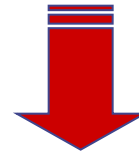
Met Arg Val Asn Ala Cys Ala

How can you code for 20 amino acids with only 4 nucleotide bases (A,U,G,C)?

mRNA codes for proteins in triplets

DNA

TACGCACATTTACGTACGCGG

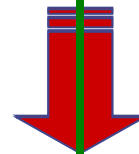


codons

AUGCGUGUAAAUGCAUGC

ribosome

ribosome



Met Arg Val Asn Ala Cys Ala

protein

■ Codon

◆ block of 3 nucleotides

The mRNA code

- For **ALL** life!
 - ◆ strongest support for a common origin for all life
- Code is redundant
 - ◆ several codons for each amino acid
 - ◆ mutation insurance!
- **Start codon**
 - ◆ AUG
 - ◆ methionine
- **Stop codons**
 - ◆ UGA, UAA, UAG

		Second base						
		U	C	A	G			
U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys
	UUC		UCC		UAC	UGC		
	UUA	Leu	UCA	UAA	Stop	UGA	Stop	
	UUG		UCG	UAG	Stop	UGG	Trp	
C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg
	CUC		CCC		CAC		CGC	
	CUA		CCA		CAA	CGA		
	CUG		CCG		CAG	CGG		
A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser
	AUC		ACC		AAC		AGC	
	AUA	ACA	AAA		AGA			
	AUG	Met or start	AAG		AGG			
G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly
	GUC		GCC		GAC		GGC	
	GUA		GCA		GAA	GGA		
	GUG		GCG		GAG	GGG		

How are the codons matched to amino acids?

DNA

TACGCACATTTACGTACGCGG

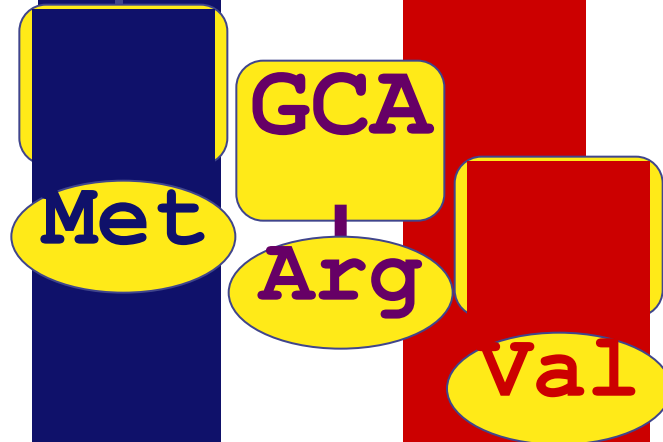
mRNA

CGU AAU UGC

codon

tRNA

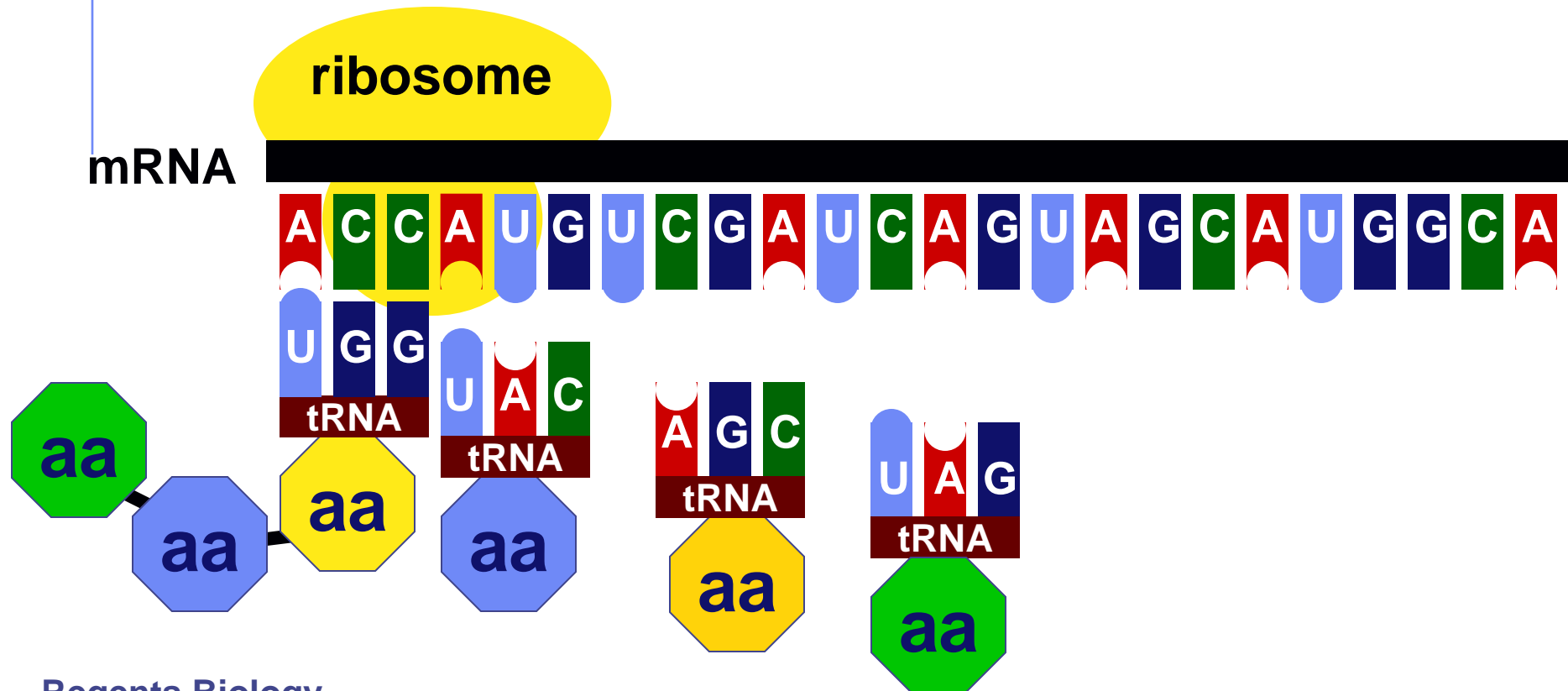
amino acid



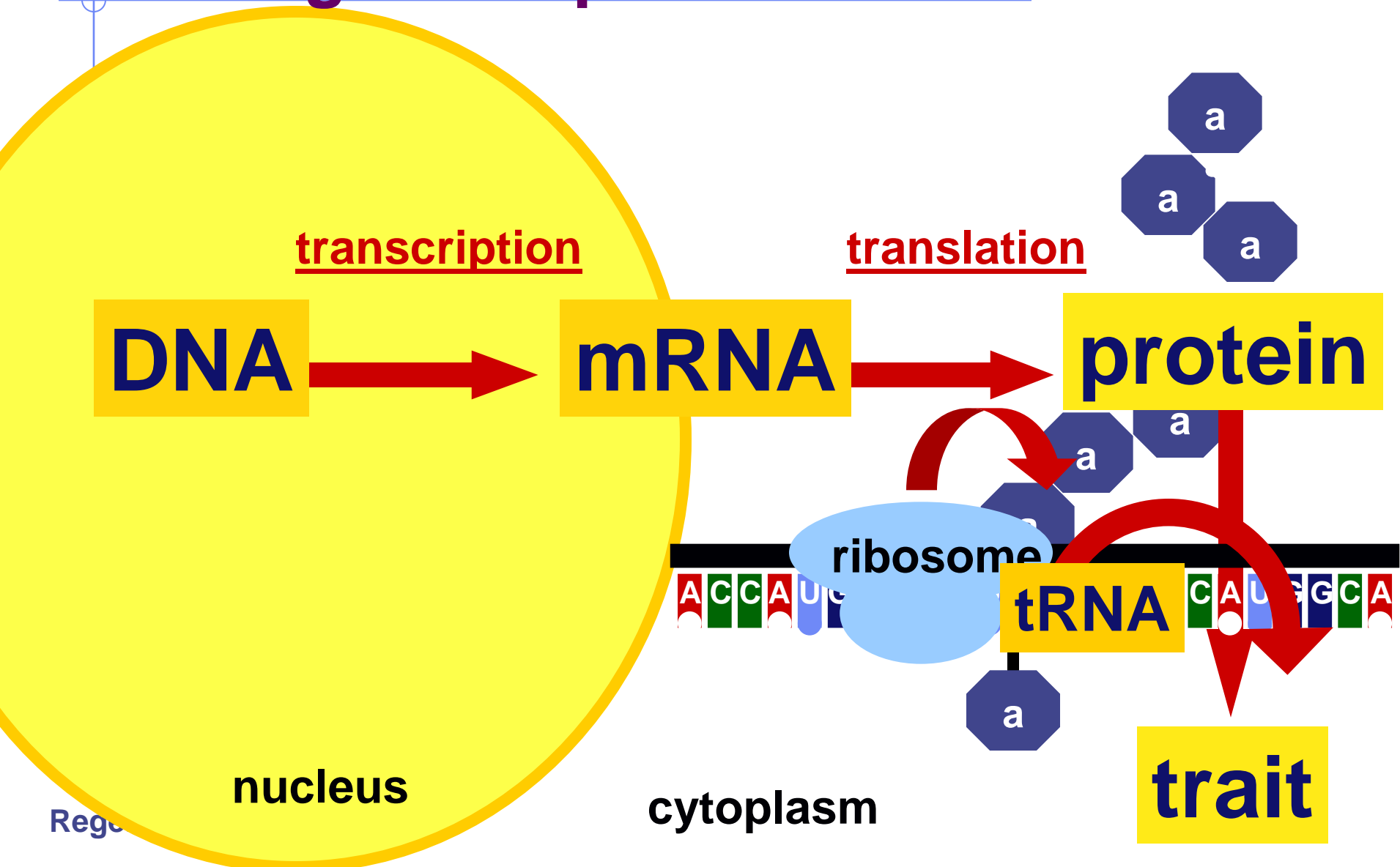
anti-codon

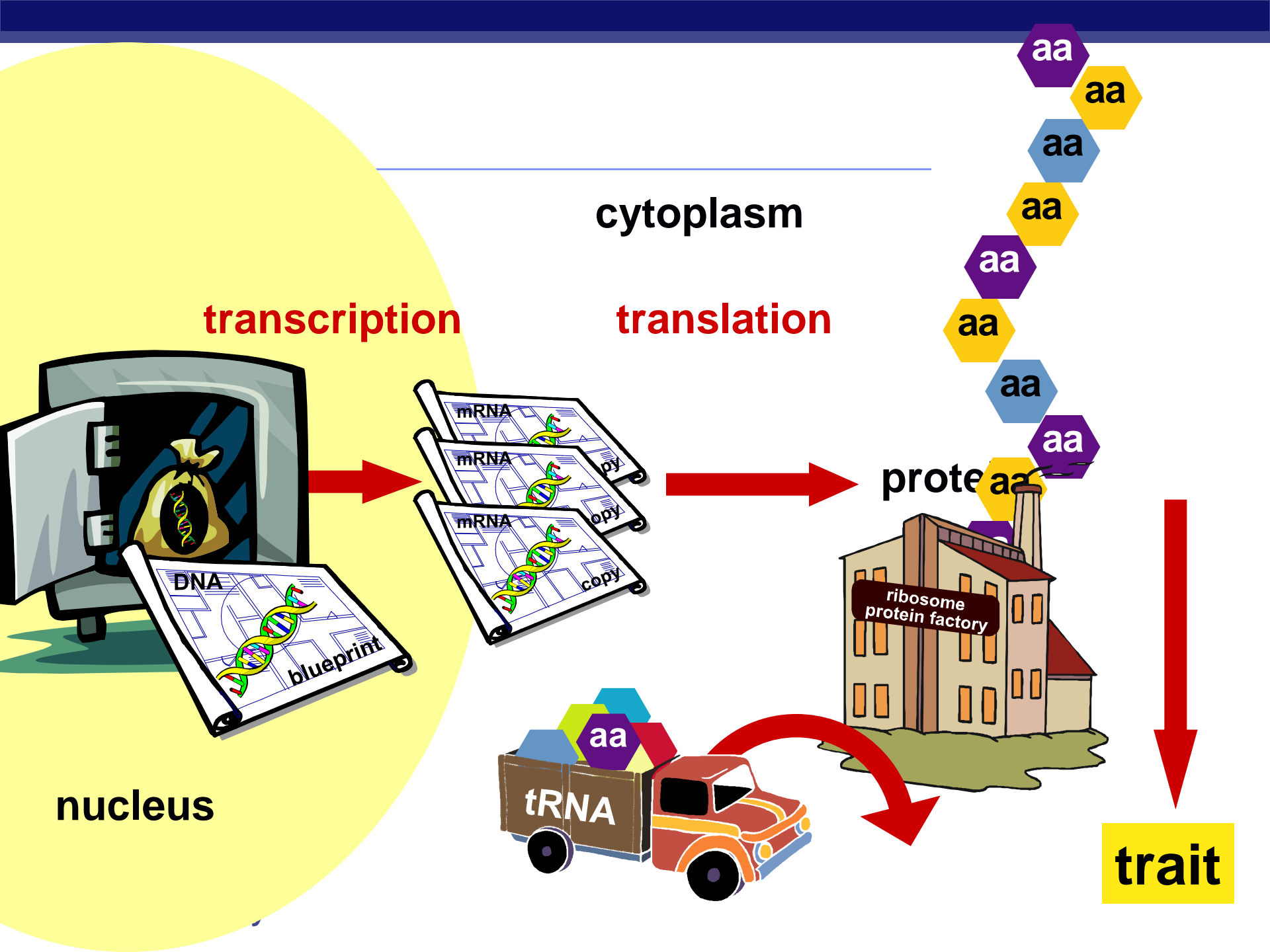
mRNA to protein = Translation

- The reader → ribosome
- The transporter → transfer RNA (tRNA)

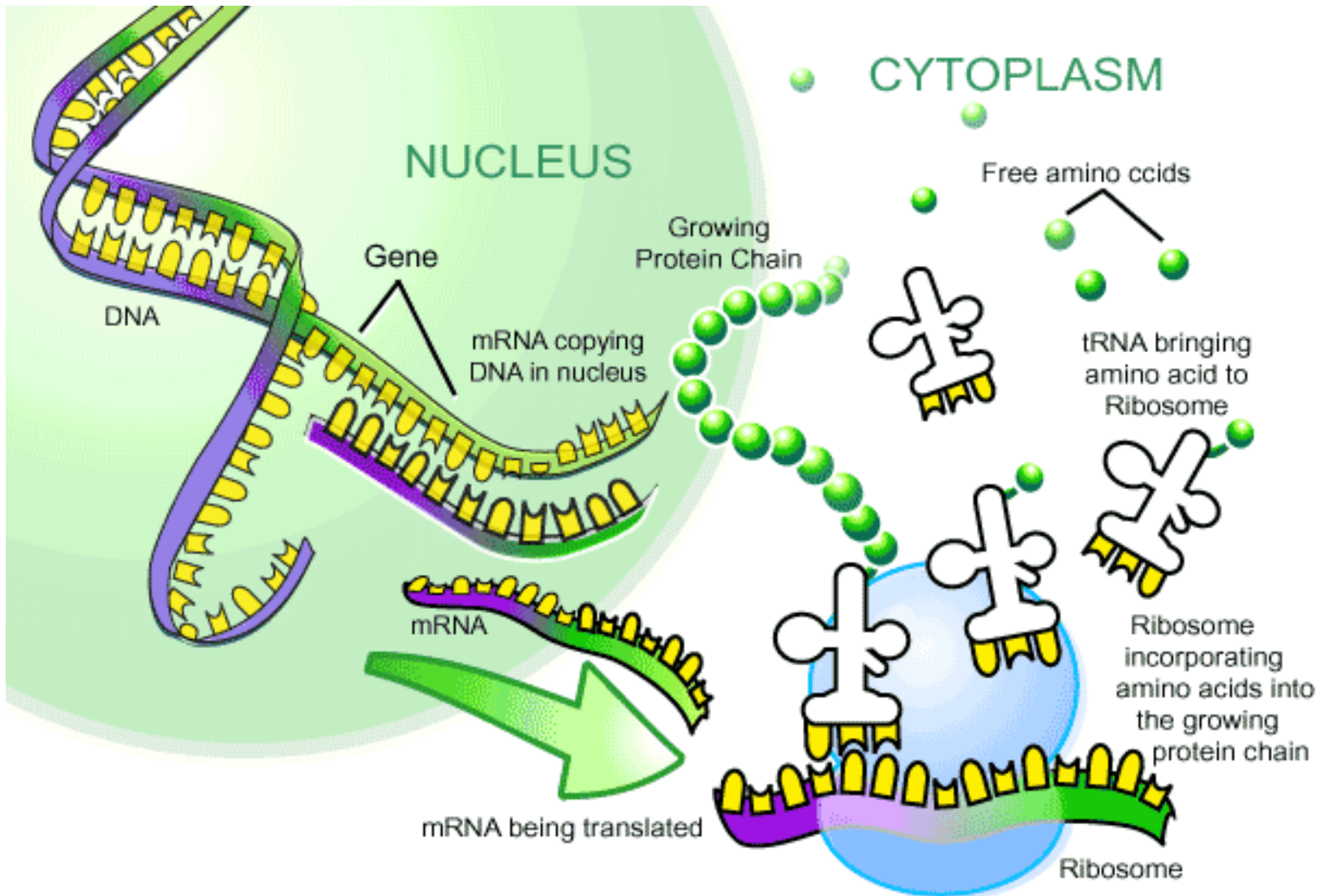


From gene to protein





From gene to protein



Can you tell the story?

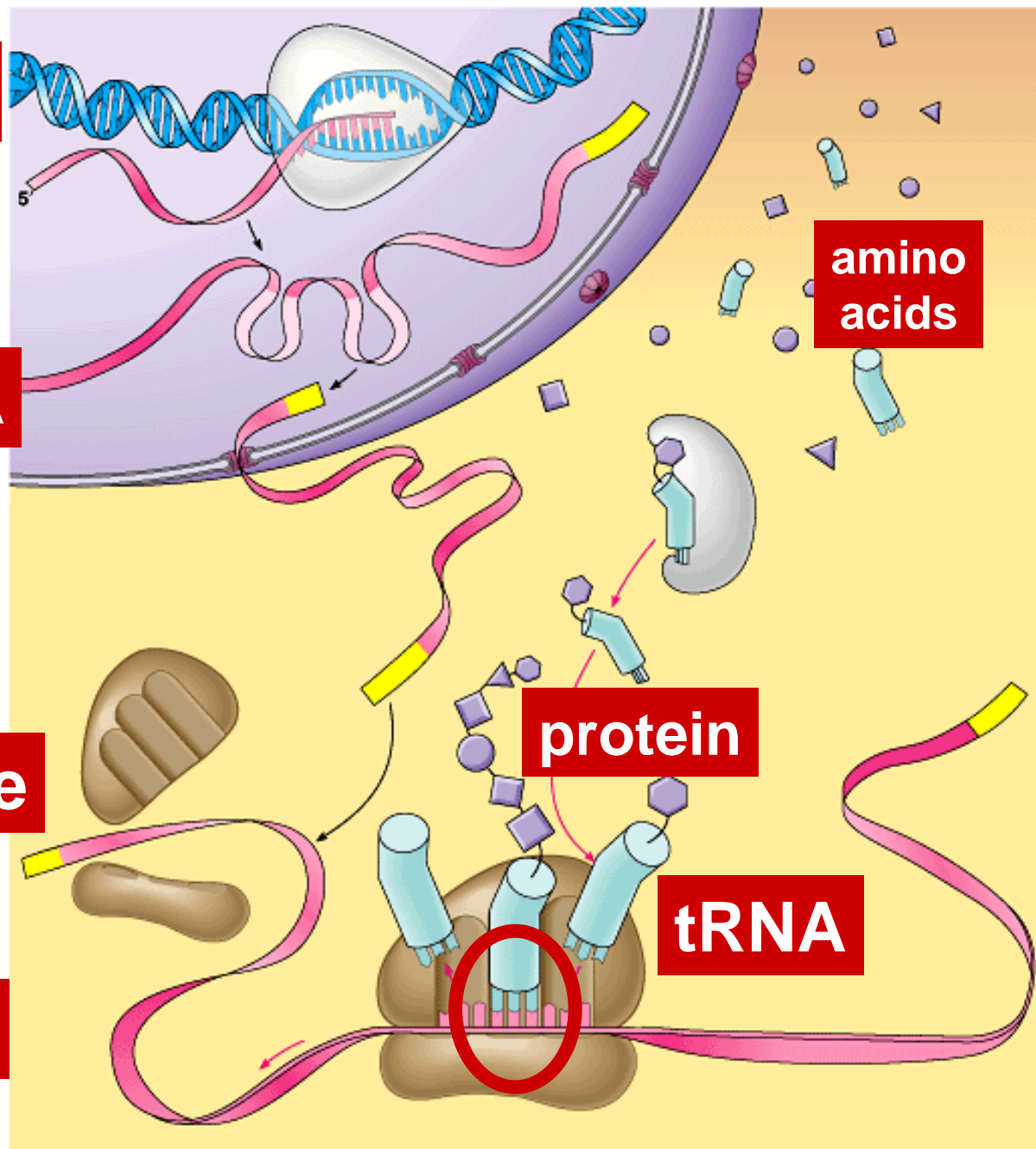
DNA

transcription

mRNA

ribosome

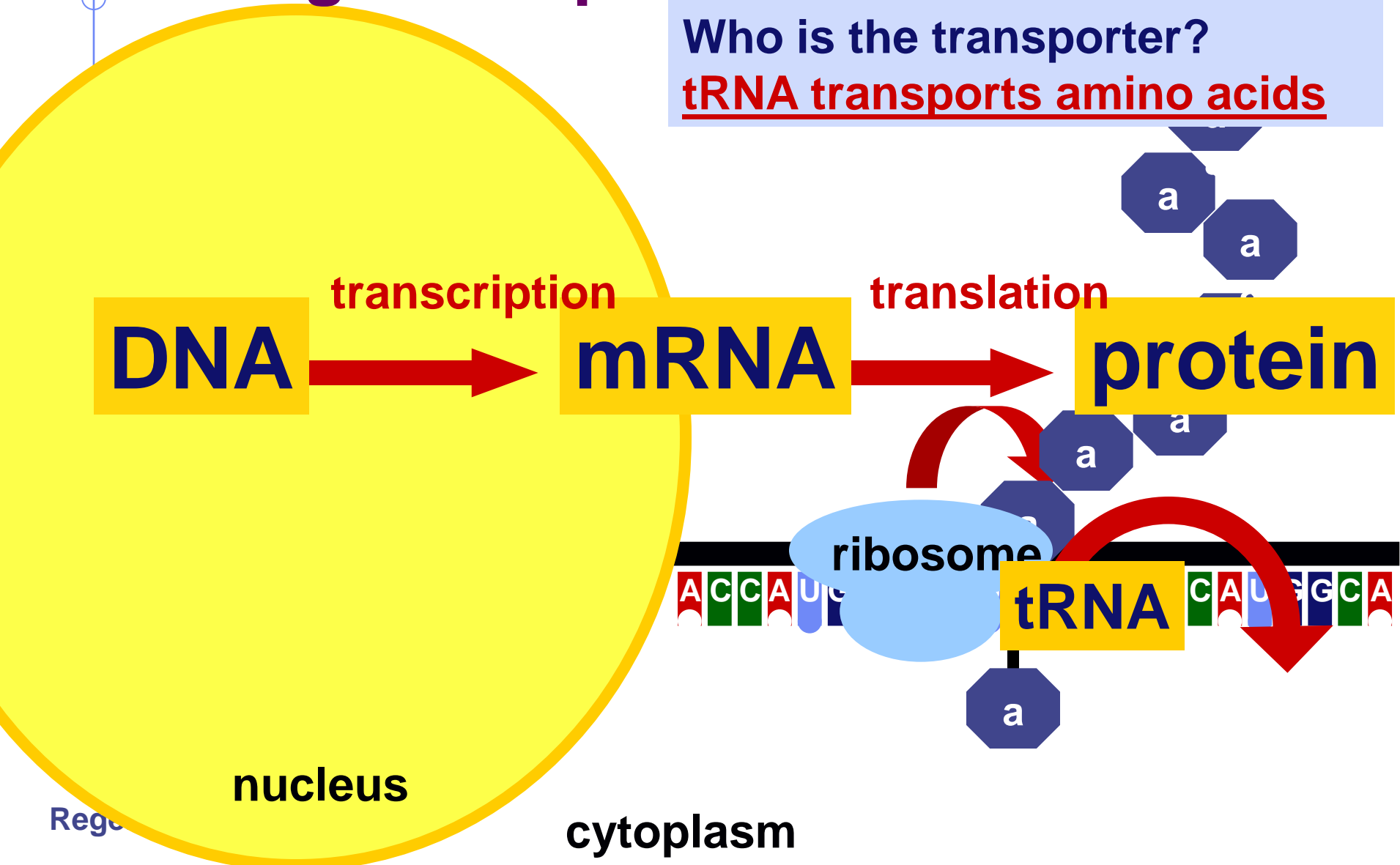
translation



From gene to protein

Who is the transporter?

tRNA transports amino acids



From gene to protein

