12.3- DNA, RNA and Protein

After the discovery of DNA's structure, scientists turned to investigating **how** DNA is used to create proteins.

Geneticists now accept that reading and expressing genes goes from **DNA to RNA to protein**.

DNA

The central dogma of biology:

DNA → RNA → protein

DNA codes for RNA, which guides the synthesis (making) of proteins.

This is the process for **all living things**- from bacteria to plants to humans.

RNA is a nucleic acid similar to DNA, but with the sugar ribose, and with uracil instead of thymine.

A-U, G-C

3 Types of RNA:

- **Messenger RNA (mRNA)**: "copied" from a strand of DNA; carries genetic information from the nucleus to the cytoplasm

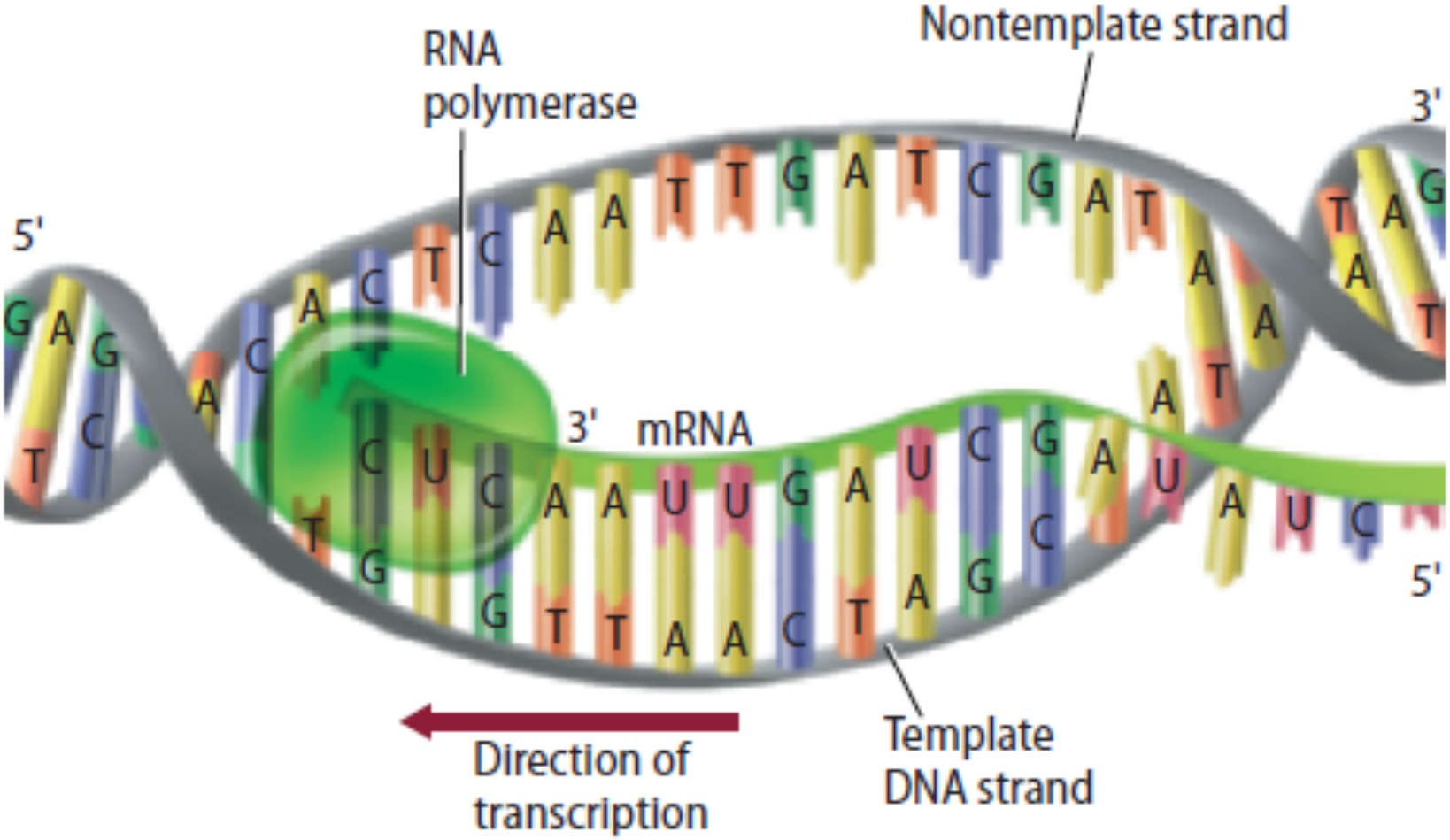
- **Ribosomal RNA (rRNA)**: forms ribosomes (protein makers)

- **Transfer RNA (tRNA)**: transport amino acids to the ribosome

Transcription and Translation

Transcription- using DNA template to create mRNA

RNA polymerase enzyme moves along the DNA strand in a 3' to 5' direction (backwards from DNA replication), synthesizing mRNA.

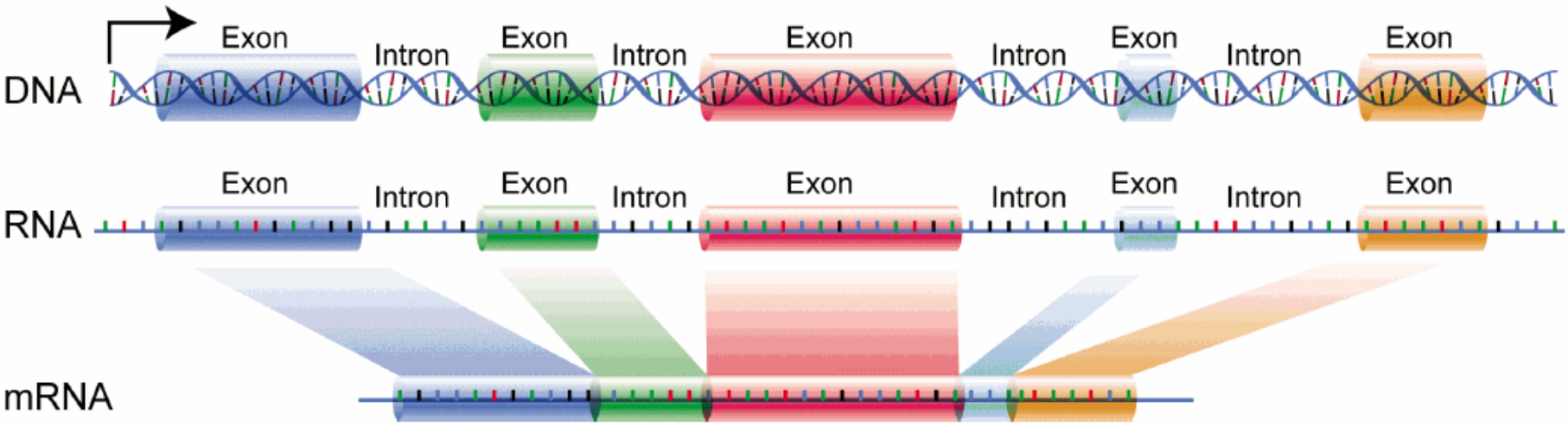

RNA
polymerase
Nontemplate strand
3'
5'
3'
mRNA
5'
Direction of
transcription
Template
DNA strand

RNA processing

In comparing DNA code with its transcribed mRNA code, scientists found that the mRNA code was much shorter than the DNA it came from.

introns- not sent to mRNA

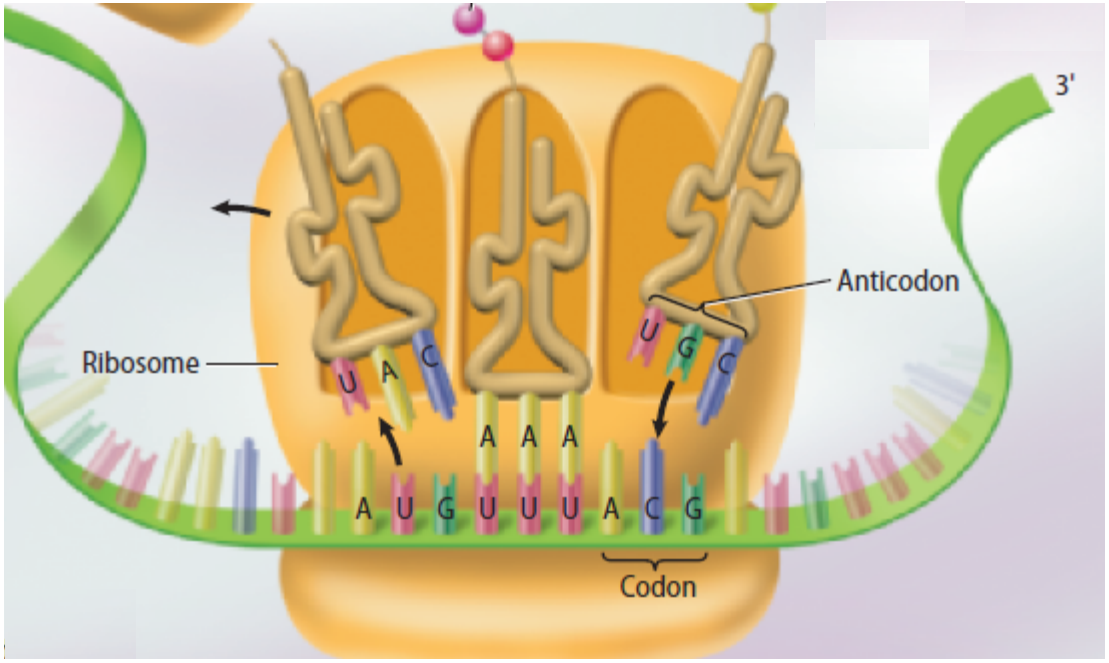
exons- show up in the mRNA



After transcription, mRNA moves from the nucleus into the cytoplasm, where it connects at the 5’ end to a ribosome.

https://youtu.be/gG7uCskUOrA 1:35

Translation- the process when mRNA code is turned into a protein



The Code

- Scientists hypothesized that the instructions from protein synthesis were encoded in DNA.
- Experiments during the 1960s demonstrated that the DNA code was a three-base code.

Codon-The three-base code in DNA or mRNA

Anticodon- the three-base code on the tRNA

There are 20 different amino acids

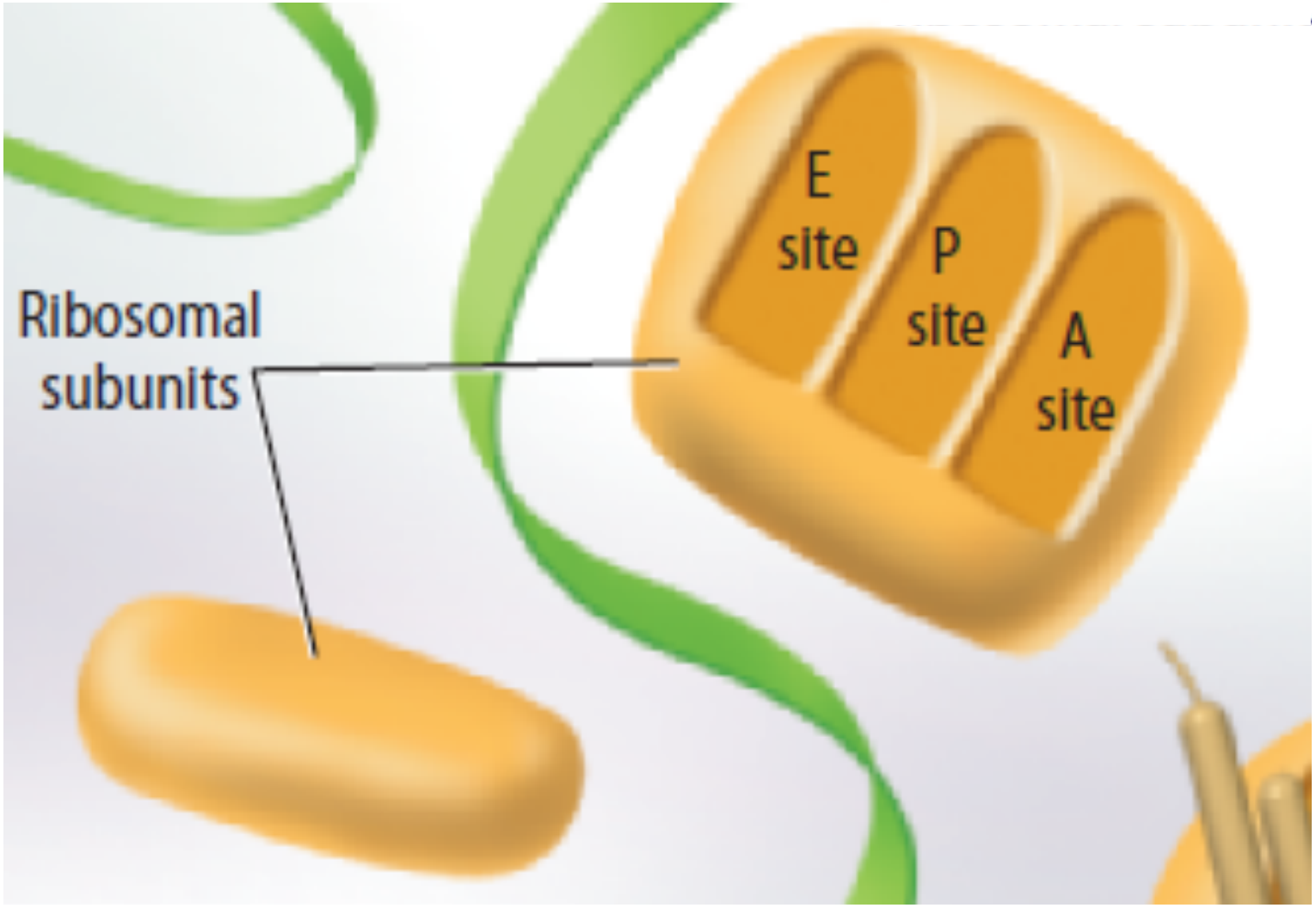
Start- **AUG** (methionine)

Stop- **UAA, UAG, UGA**

First Base	Second Base				Third Base
	U	C	A	G	
U	UUU phenylalanine	UCU serine	UAU tyrosine	UGU cysteine	U
	UUC phenylalanine	UCC serine	UAC tyrosine	UGC cysteine	C
	UUA leucine	UCA serine	UAA *stop*	UGA *stop*	A
	UUG leucine	UCG serine	UAG *stop*	UGG tryptophan	G
C	CUU leucine	CCU proline	CAU histidine	CGU arginine	U
	CUC leucine	CCC proline	CAC histidine	CGC arginine	C
	CUA leucine	CCA proline	CAA glutamine	CGA arginine	A
	CUG leucine	CCG proline	CAG glutamine	CGG arginine	G
A	AUU isoleucine	ACU threonine	AAU asparagine	AGU serine	U
	AUC isoleucine	ACC threonine	AAC asparagine	AGC serine	C
	AUA isoleucine	ACA threonine	AAA lysine	AGA arginine	A
	AUG *(start)* methionine	ACG threonine	AAG lysine	AGG arginine	G
G	GUU valine	GCU alanine	GAU aspartate	GGU glycine	U
	GUC valine	GCC alanine	GAC aspartate	GGC glycine	C
	GUA valine	GCA alanine	GAA glutamate	GGA glycine	A
	GUG valine	GCG alanine	GAG glutamate	GGG glycine	G

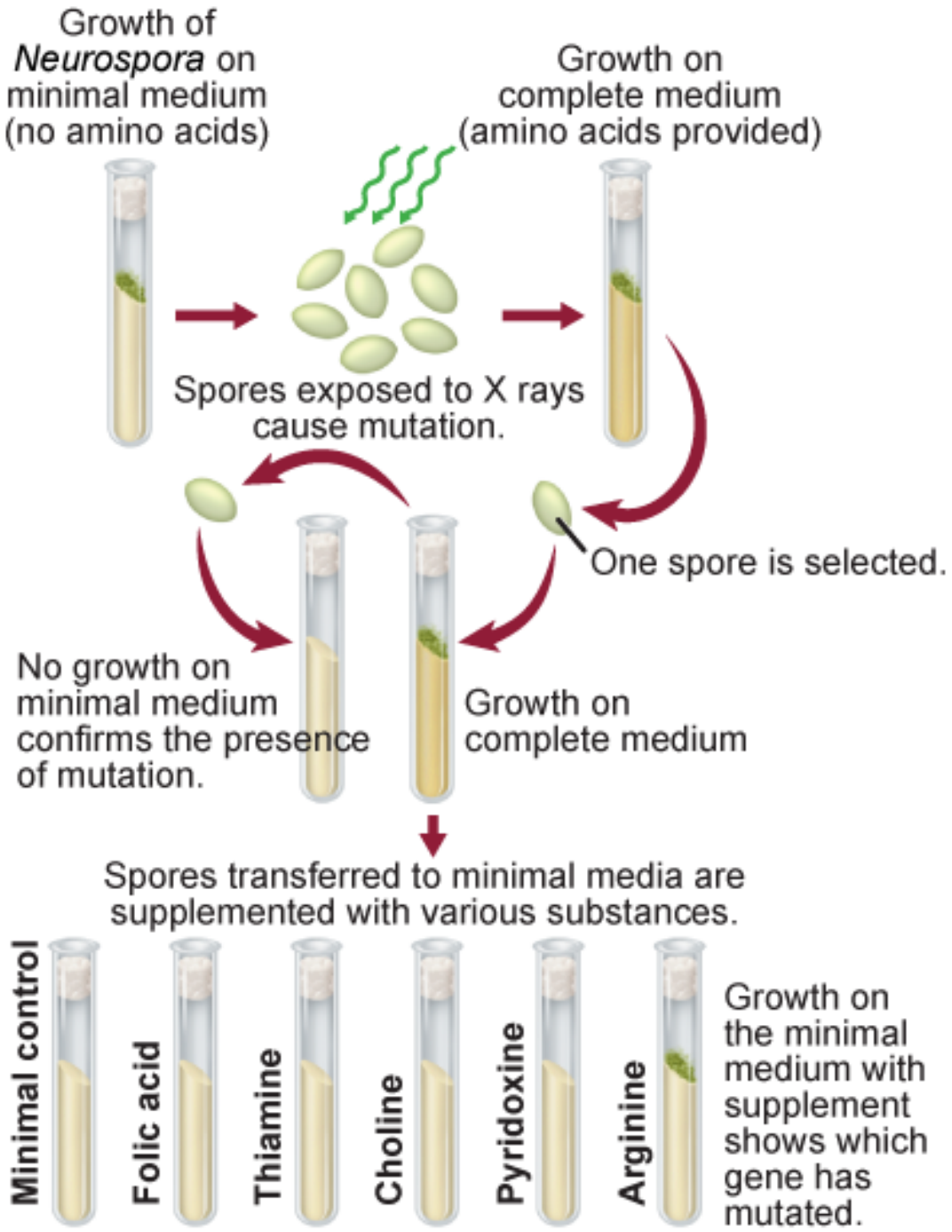
Ribosomes provide a location for protein synthesis.

- two ribosomal subunits come together to hold the mRNA in place for translation.
- The ribosome has grooves that hold tRNA for amino acid attachment.


Ribosomal subunits
E site
P site
A site

One Gene—One Enzyme hypothesis

- The Beadle and Tatum experiment showed that one gene codes for one enzyme.
- We now know that one gene codes for one **polypeptide**.


Growth of *Neurospora* on minimal medium (no amino acids)
Growth on complete medium (amino acids provided)
Spores exposed to X rays cause mutation.
One spore is selected.
No growth on minimal medium confirms the presence of mutation.
Growth on complete medium
Spores transferred to minimal media are supplemented with various substances.
Minimal control
Folic acid
Thiamine
Choline
Pyridoxine
Arginine
Growth on the minimal medium with supplement shows which gene has mutated.