Lecture 21:

Translation:

The tRNA and rRNA

Course 371

AIMS

- Understand the structure and function of tRNA.
- Understand the process in which the tRNA carries an amino acid.
- Understand the components and structures of the ribosomes of prokaryotes and eukaryotes.
- Understand the process of making the ribosome from genes to their final structure.

Translation – the process

What is translation?

Use the genetic code in the mRNA that reads 5’ ➔ 3’ to make a protein that reads N ➔ C.

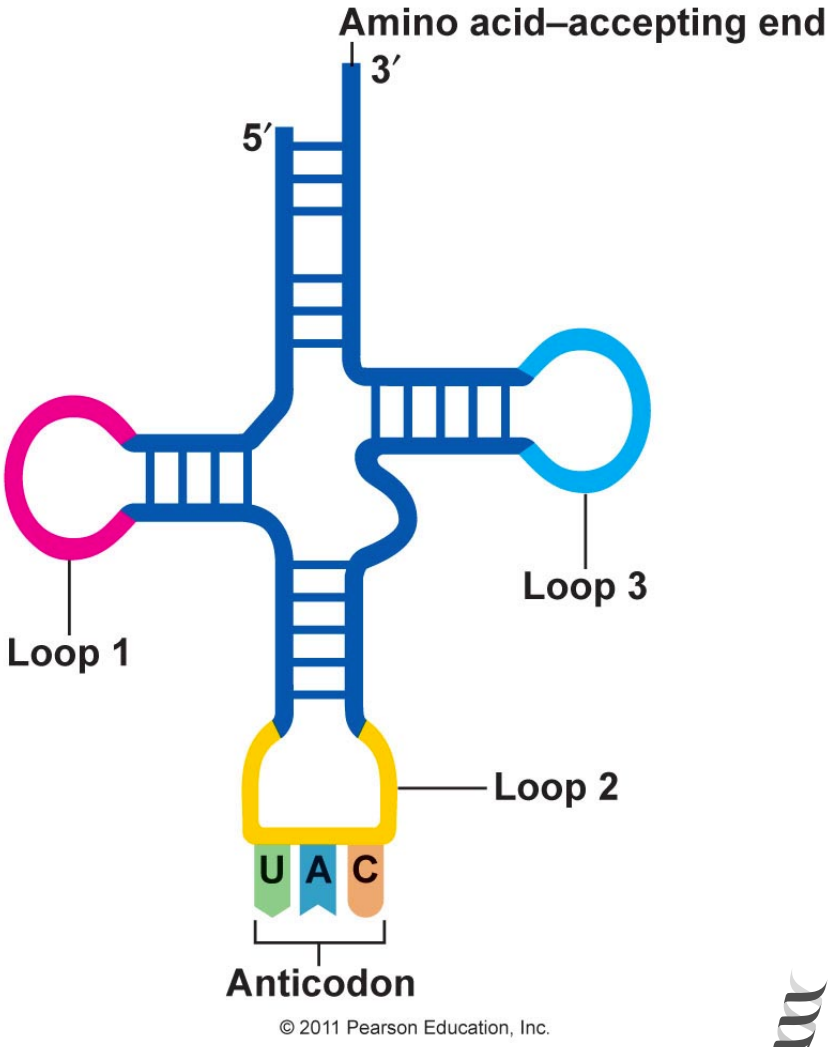
Translation – the process

What do we need to translate the genetic code?

1. mRNA
2. tRNA
3. Amino acids
4. Ribosomes

Transfer RNA (tRNA)

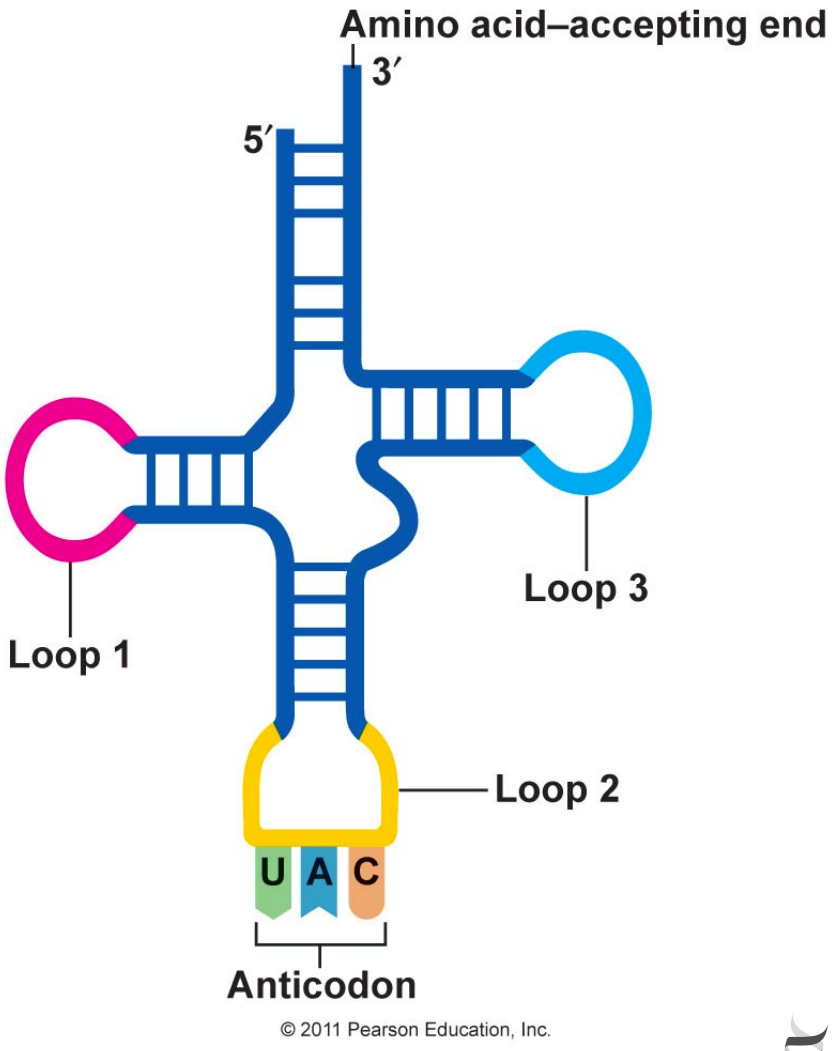
- tRNA carries the amino acid to the ribosome to make protein.
- There are specific tRNA for each codon and amino acid.



Transfer RNA (tRNA)

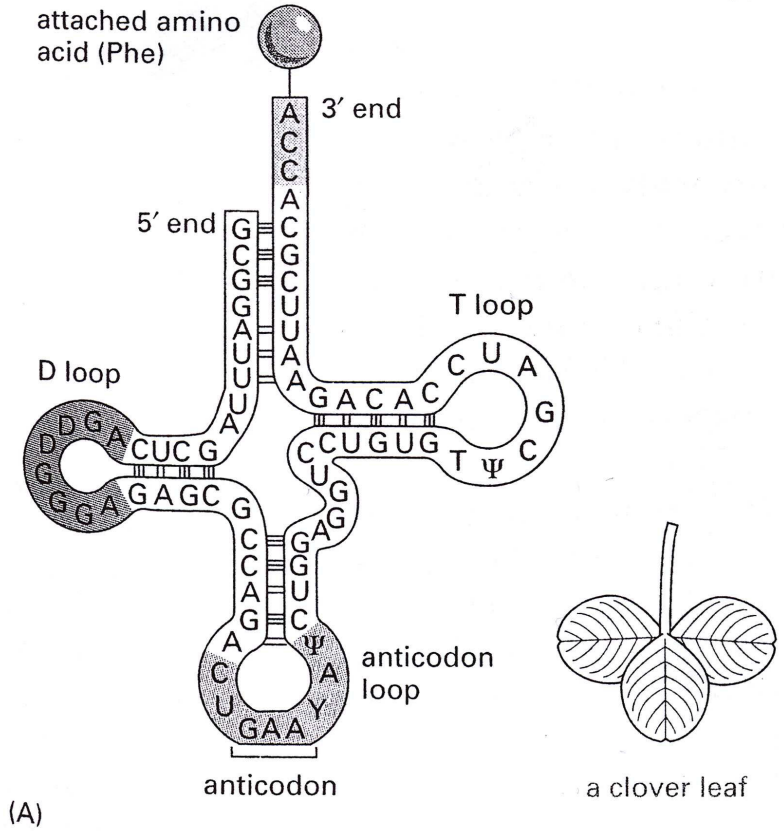
- The codon in the mRNA has a complementary sequence in the tRNA and it is called **Anti-codon.**

- **Why is it called anti-codon?**



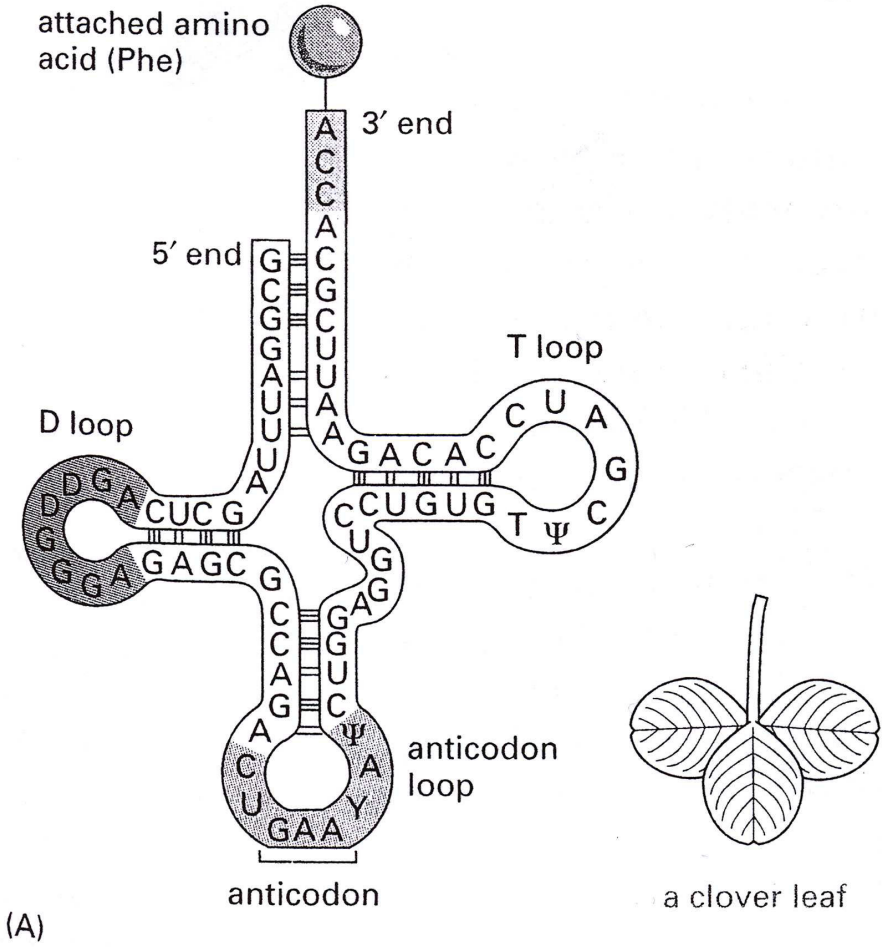
tRNA characteristics

- It is 75-90 nucleotide in sequence.
- tRNA folds to form a specific shape called **cloverleaf.**



tRNA characteristics

- **How is the shape of tRNA formed?**
- Contains three loops and the loop that contain the anticodon is called **anticodon loop.**



tRNA characteristics

- There are two ends in the tRNA:
  - 5’ end
  - 3’ end
- The 3’ end is where the amino acid is attached and it is called the **amino acid attachment site.**

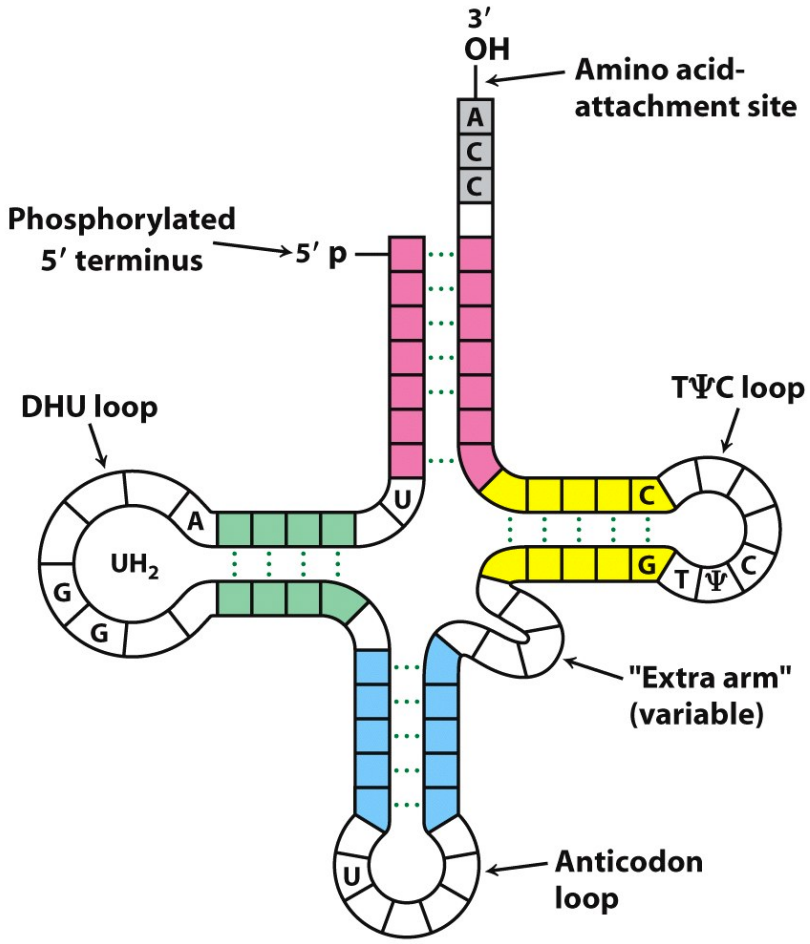


Figure 30.3
Biochemistry, Seventh Edition

tRNA characteristics

tRNA genes are found in multiple copies in the cell

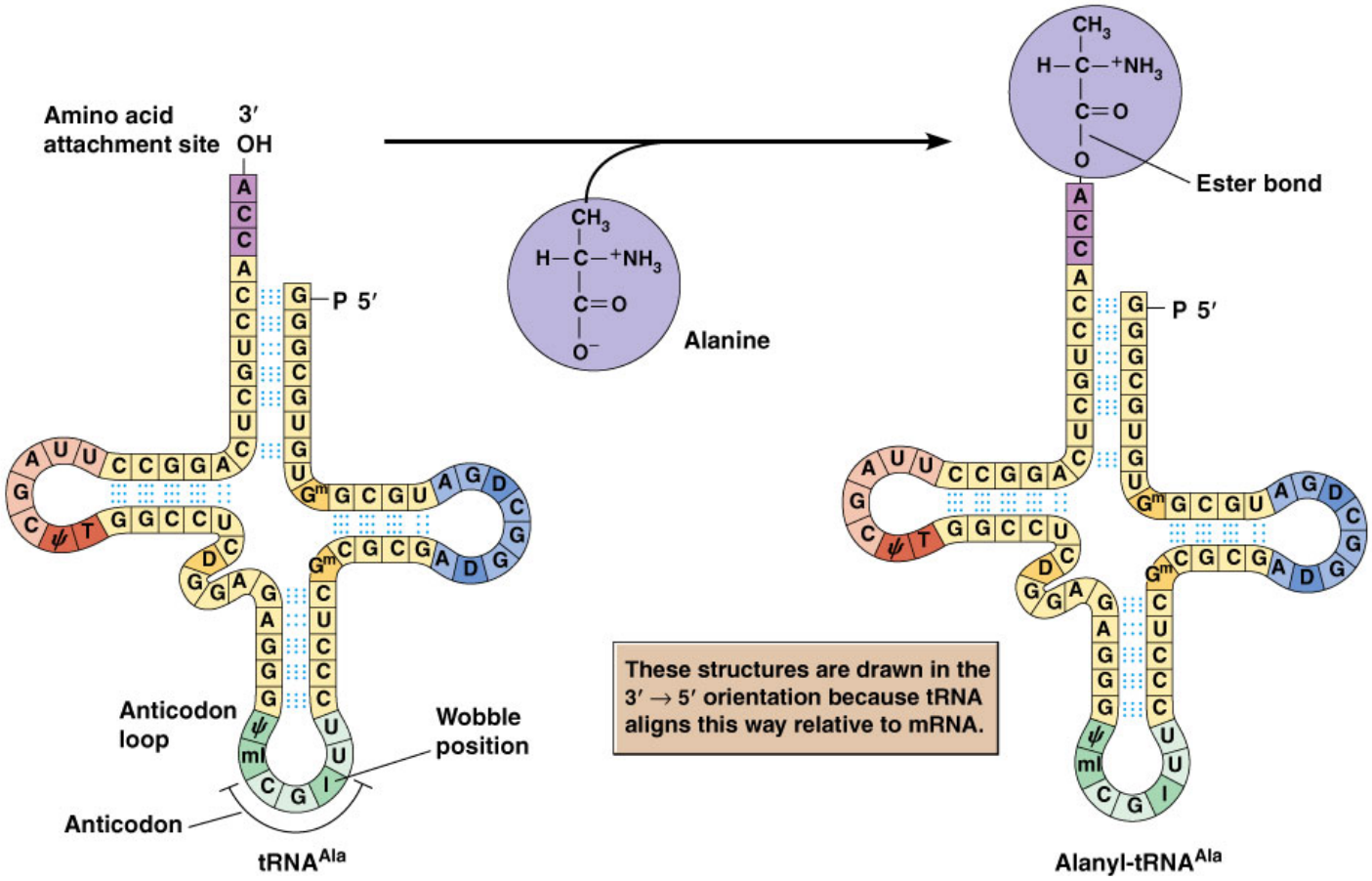
(Why?)

tRNA-amino acid

- Adding an amino acid to a tRNA is called **aminoacylation or tRNA charging.**
- An enzyme called **aminoacyl-tRNA synthetase** adds the correct amino acid to the corresponding tRNA.
- The process produces a **charged tRNA or aminoacyl tRNA.**

tRNA-amino acid

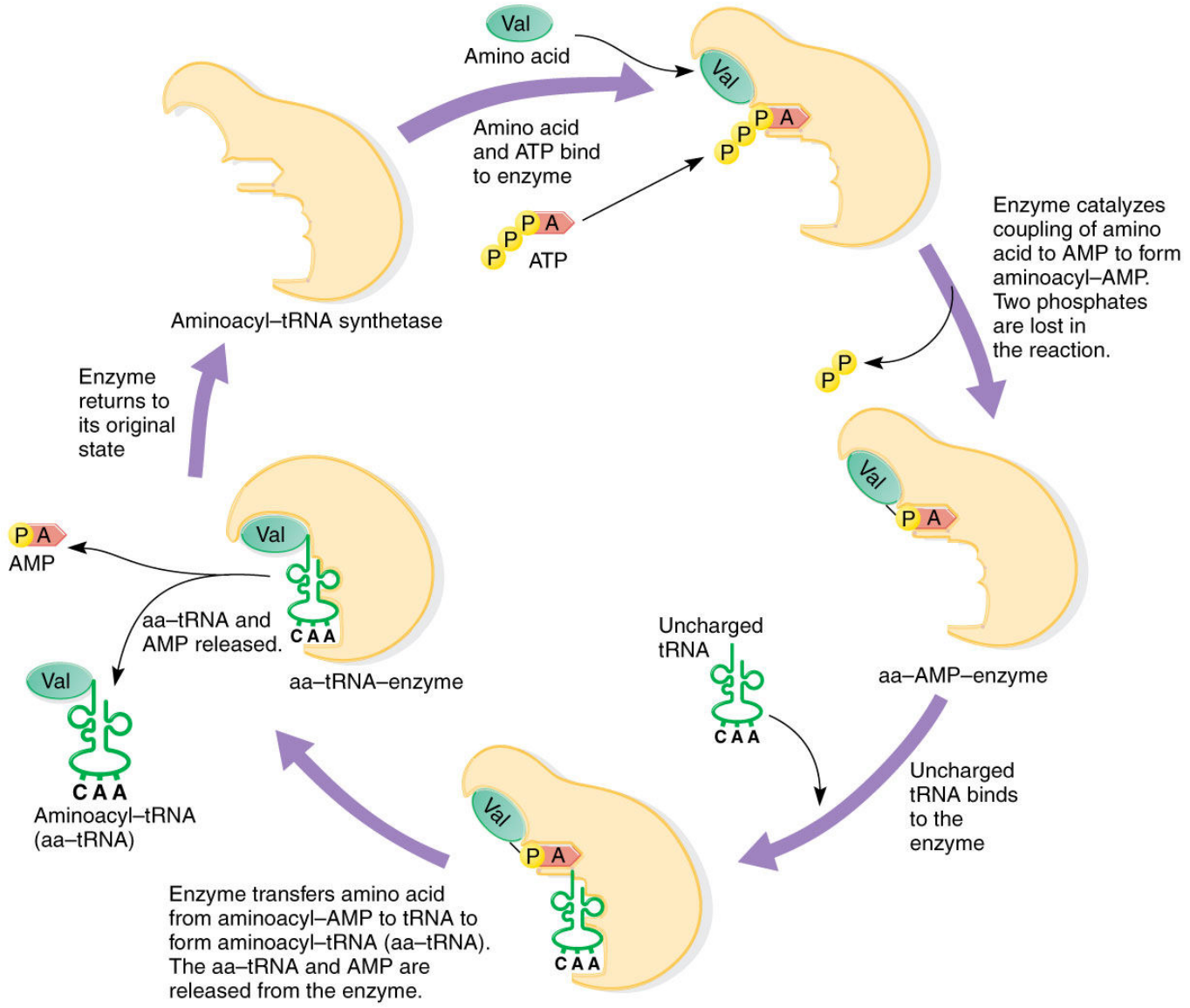
Aminoacylation or tRNA charging



tRNA-charging

- tRNA charging uses ATP as a source of energy.
- Each amino acid has a specific **aminoacyltransferase**.
- The 3’ nucleotides of tRNA is always CCA in all tRNAs.
- The amino acid binds to the 2’ or 3’ sugar of adenine (A) of the 3’ CCA.

tRNA-charging



Ribosomes

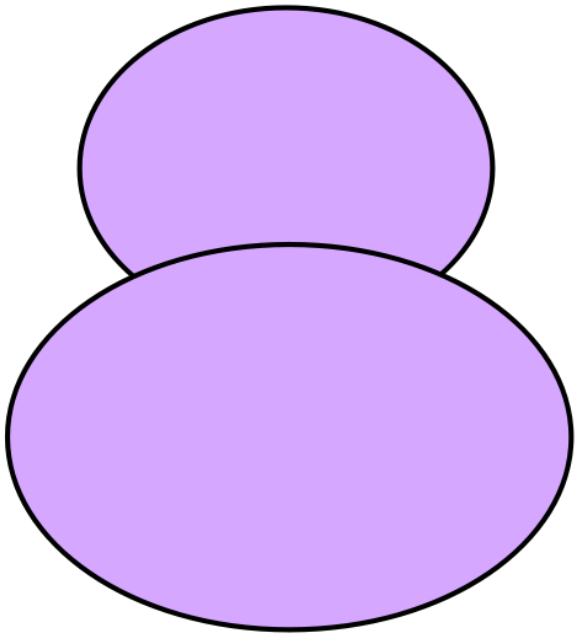
- Peptide synthesis and translation of the genetic code takes place on ribosomes.
- Ribosomes attach to mRNA and charged tRNA to make polypeptide chains.
- Both in prokaryotes and in eukaryotes the ribosome is made of:

  Large subunit
  Small subunit

- Each subunit is composed of rRNA and ribosomal proteins.

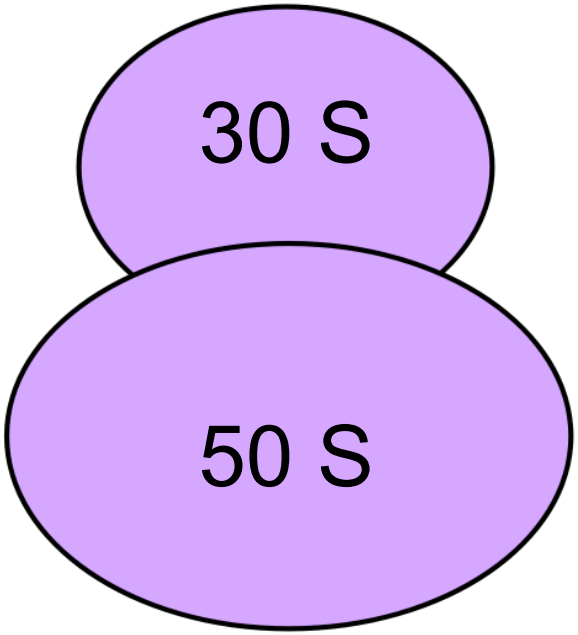
Bacterial ribosomes

- Bacterial ribosomes are called 70S ribosomes.
- The 70S ribosome is composed of two subunits:
  - Large subunit (50S):
    - 23S rRNA
    - 5S rRNA
  - Small subunit (30S):
    - 16S rRNA



Bacterial ribosomes

- The S numbers do not add up correct?
- **WHY?**



70S

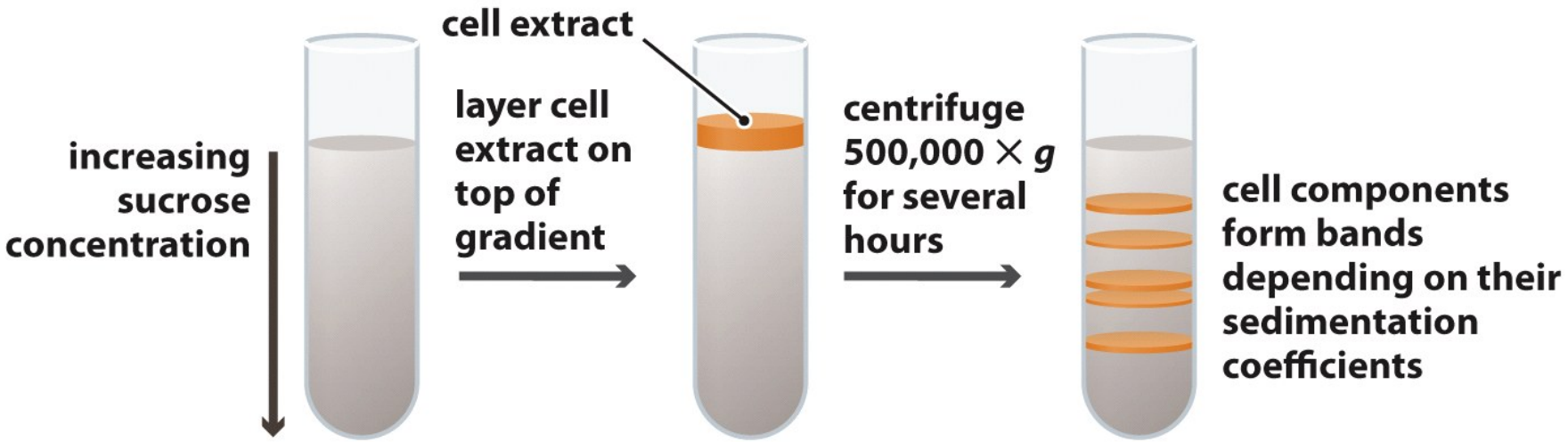
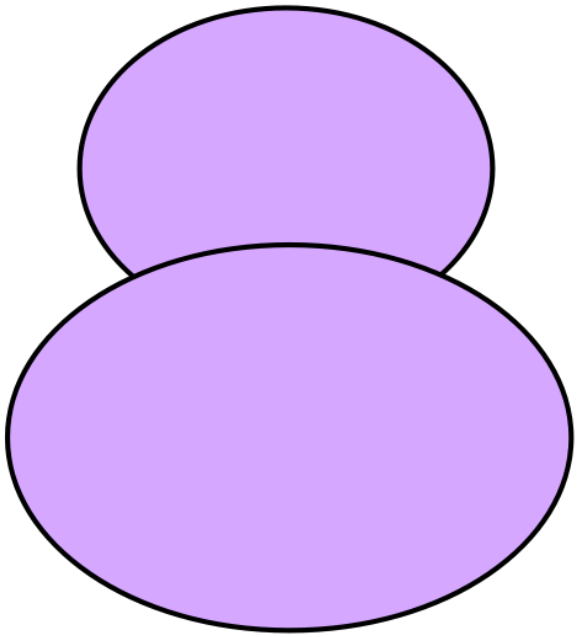


Figure 6.3 Introduction to Genetics (© Garland Science 2012)

Eukaryotic ribosomes

- Eukaryotic ribosomes are called 80S ribosomes.
- The 80S ribosome is composed of two subunits:
  - Large subunit (60S):
    - 28S rRNA
    - 5.8S rRNA
    - 5S rRNA
  - Small subunit (40S):
    - 18S rRNA



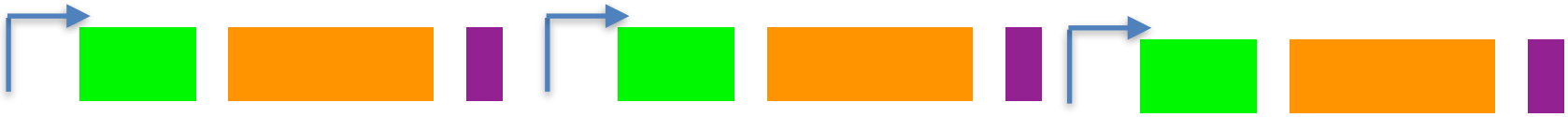
80 S

The rRNA contributes to the structure and function of the ribosomes.

Bacterial ribosomal genes

- Both prokaryotic and eukaryotic rRNA is coded in the DNA by genes called **ribosomal DNA (rDNA) or rRNA transcription units.**
- In bacteria (*E. coli*), 7 rRNA transcription units are scattered through out the chromosome.
- **Why many copies?**

Bacterial ribosomal genes



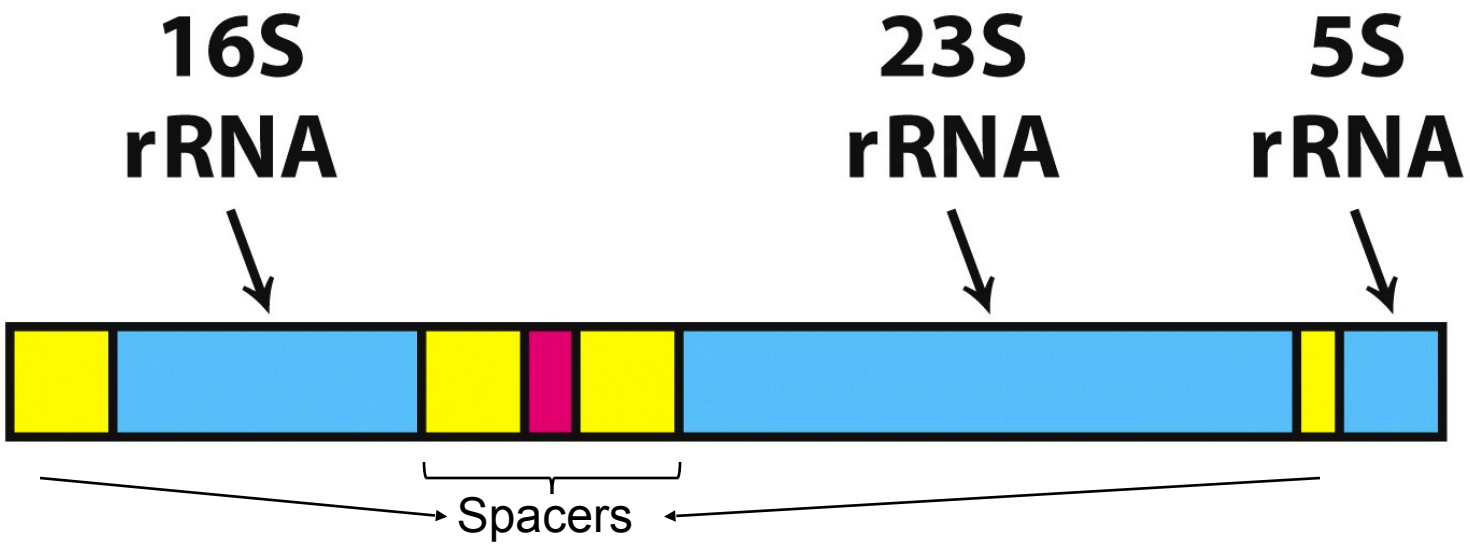
- Each rRNA transcription unit is composed of:

16S
23S
5S

- The transcription of these genes produces a **precursor rRNA (pre-rRNA).**

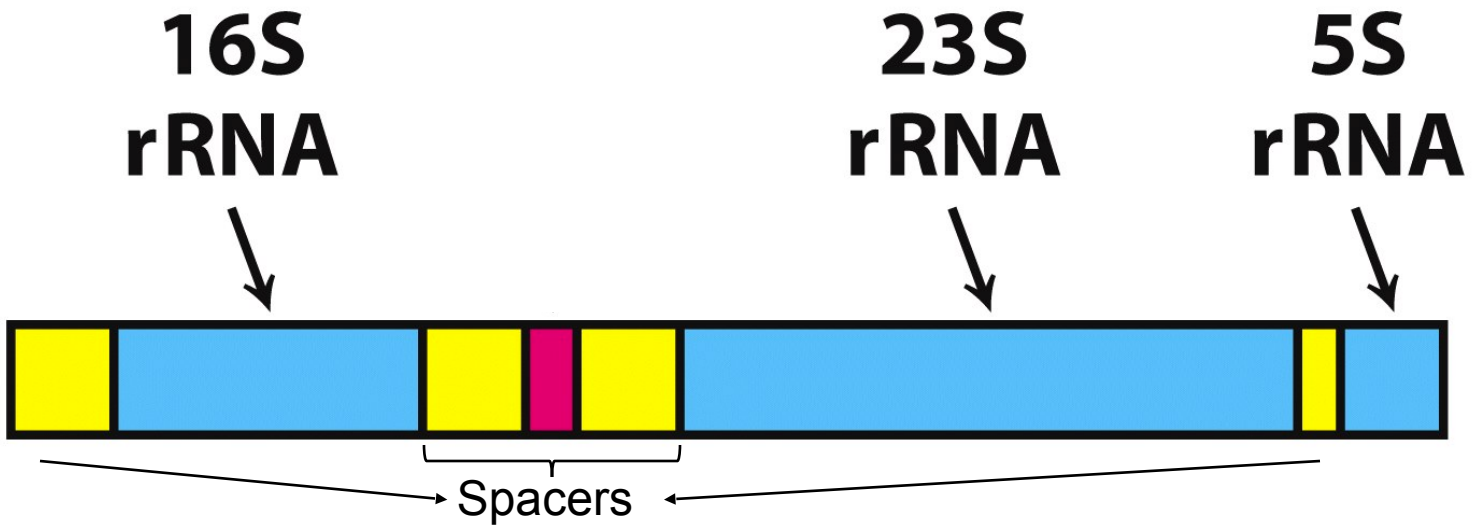
Bacterial ribosomal genes

- The pre-rRNA transcribed is 5' 16S-23S-5S 3' with non-rRNA sequences in between.
- The non-rRNA sequences are called **spacers.**



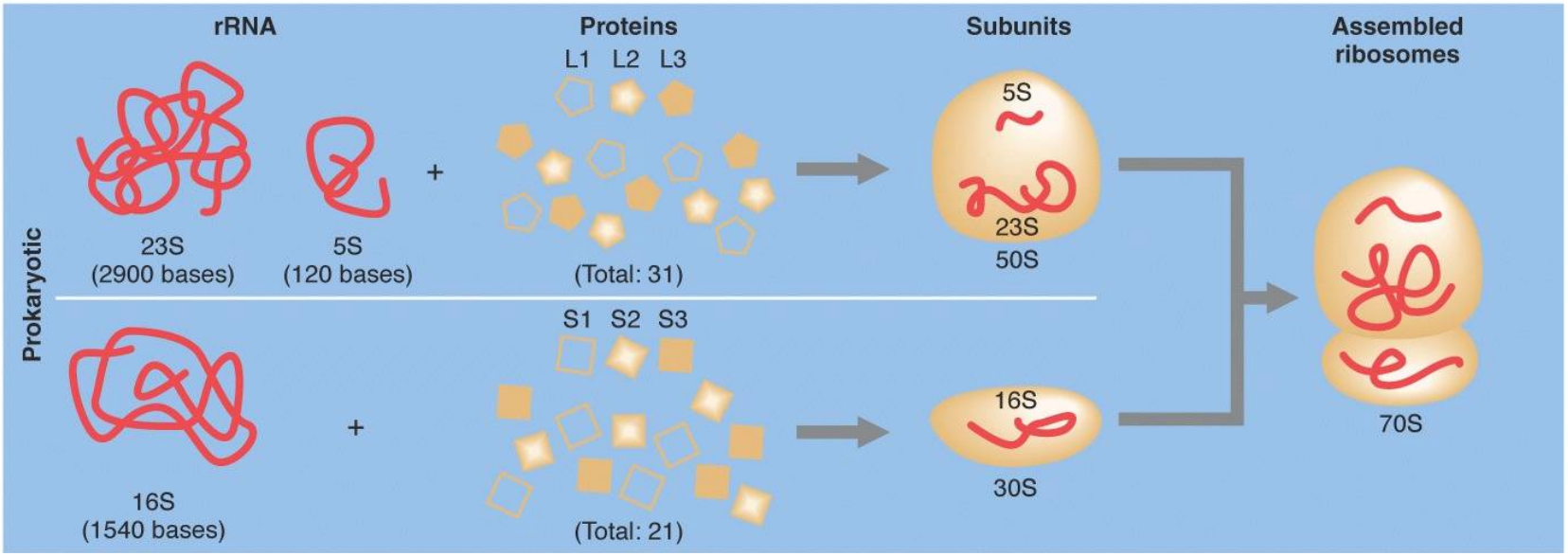
Bacterial ribosomal genes

- **Ribonucleases** remove the spacers and release three rRNA separate molecules.
- **Is this like intron splicing?**



Prokaryotic ribosome

Ribosomal proteins with the three rRNA make the ribosome two subunits.



Eukaryotic ribosomal genes

- Eukaryotic rRNA is coded by rDNA genes.
- The rDNA genes are composed of units containing:

18S-5.8s-28S

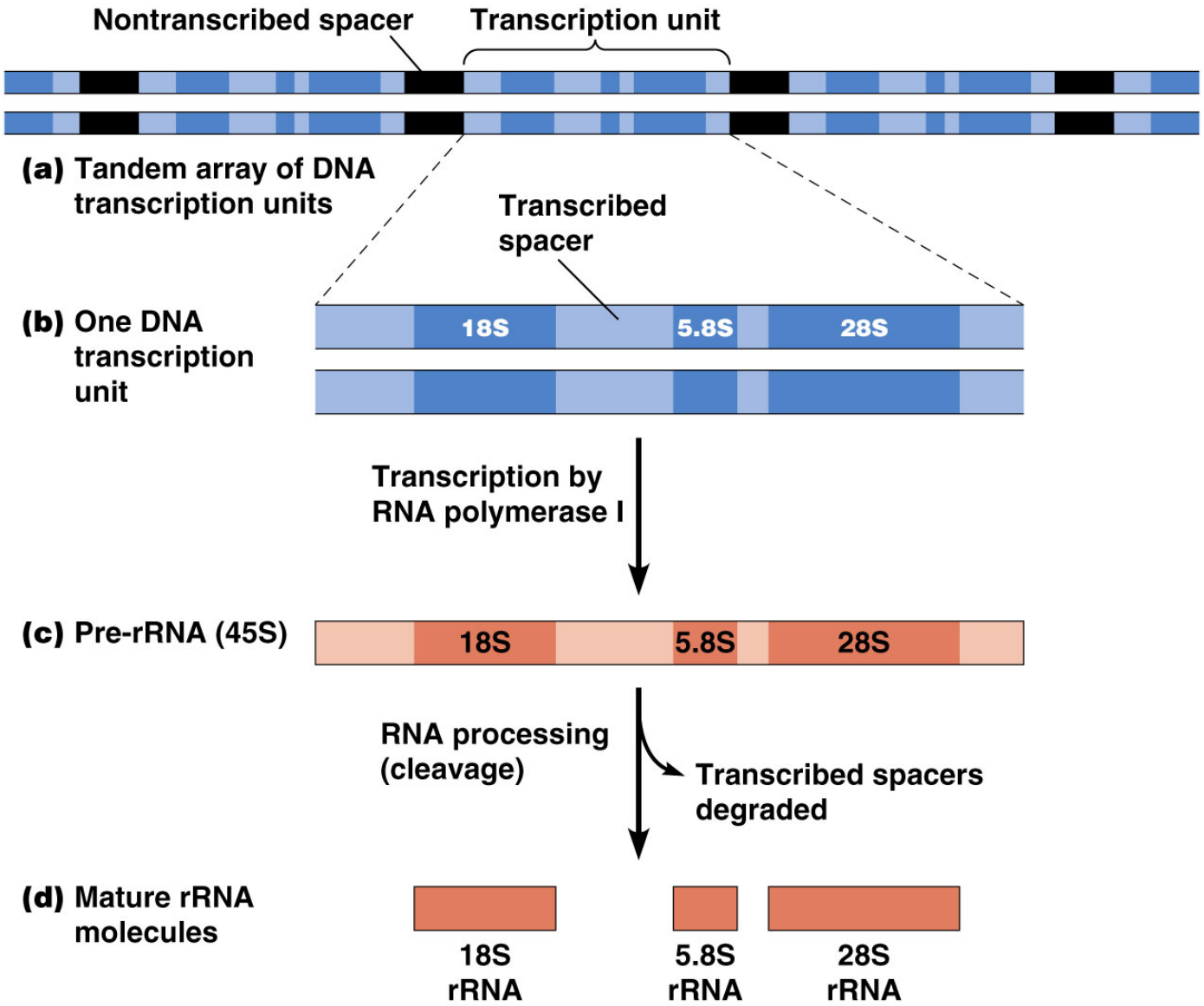
- This unit is repeated in eukaryotic genomes 100-1000 times.
- **Why?**

Eukaryotic ribosomal genes

- The rDNA repeat units get transcribed by RNA Pol I producing a pre-rRNA with spacers.
- Pre-rRNA:

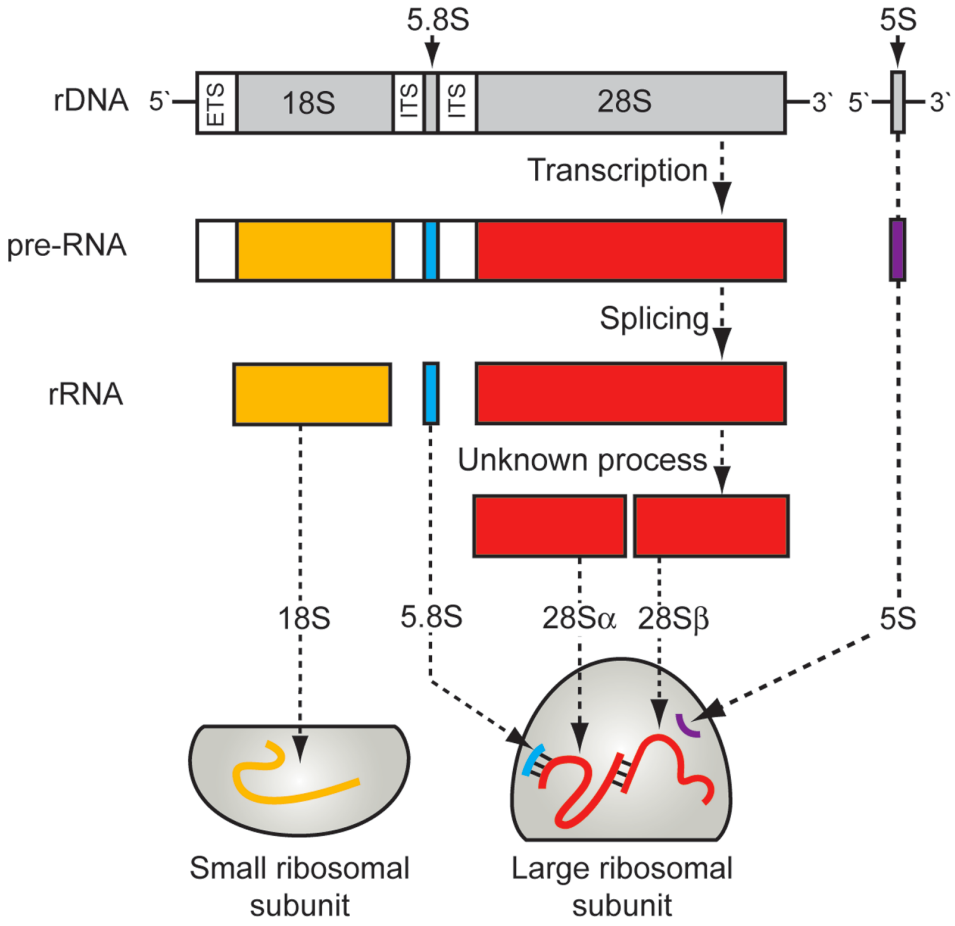
5’ 18S-5.8S-28S 3’

Eukaryotic ribosomal genes



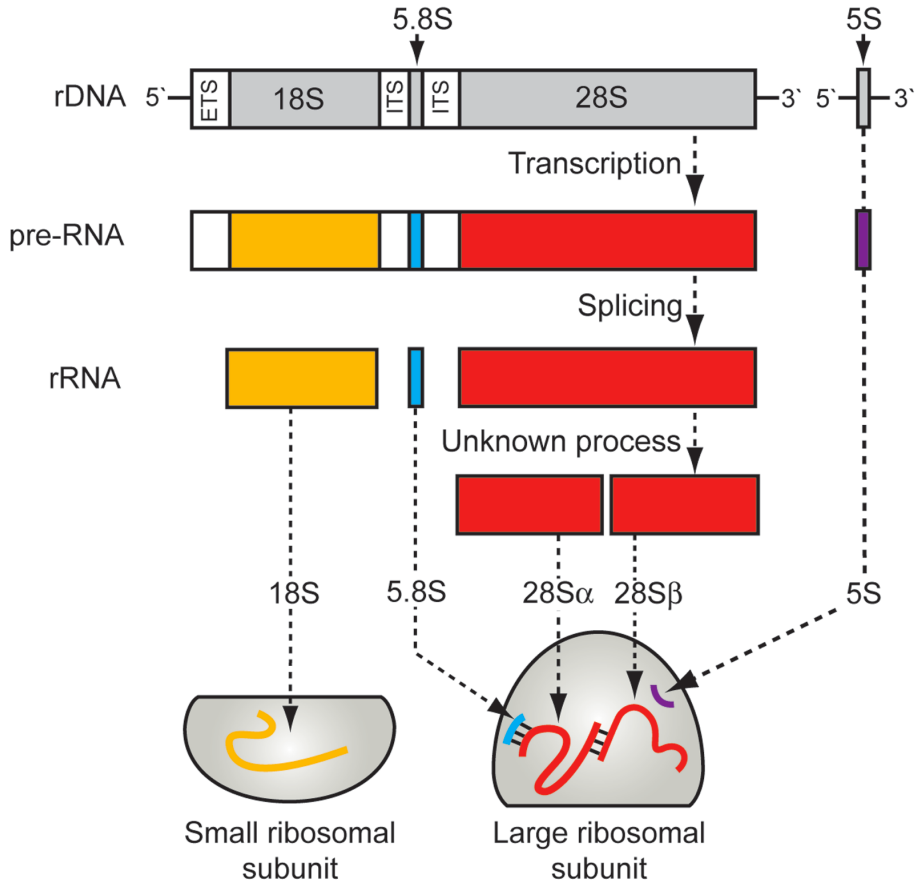
Eukaryotic ribosomal genes

- **Ribonucleases** process the rRNA unit and remove spacers.
- 5S rRNA is located in other location than the repeat unit.
- **What is the effect of the location 5S gene on its transcription?**



Eukaryotic ribosomal genes

- 5S rRNA is transcribed independently by RNA Pol III.
- The ribosomal proteins and the four rRNA molecules make the eukaryotic ribosome.



To think about

- **Where does the polymerase come from?**
- **The number of copies of rDNA genes in prokaryotic and eukaryotic genomes.**
- **The difference between intron splicing in eukaryotic genes and spacer removal in prokaryotic and eukaryotic pre-rRNA processing.**

Stuff to know

Aminoacylation

Ribosomal DNA

rDNA

CCA

80S ribosome

5S rRNA

tRNA

tRNA loops

Ribosomal small subunit

rRNA transcription unit

23S rRNA

Aminoacyl-tRNA synthetase

70S ribosome

5.8S rRNA

Anticodon loop

Ribosomal large subunit

Pre-rRNA

28S rRNA

16S rRNA

tRNA charging

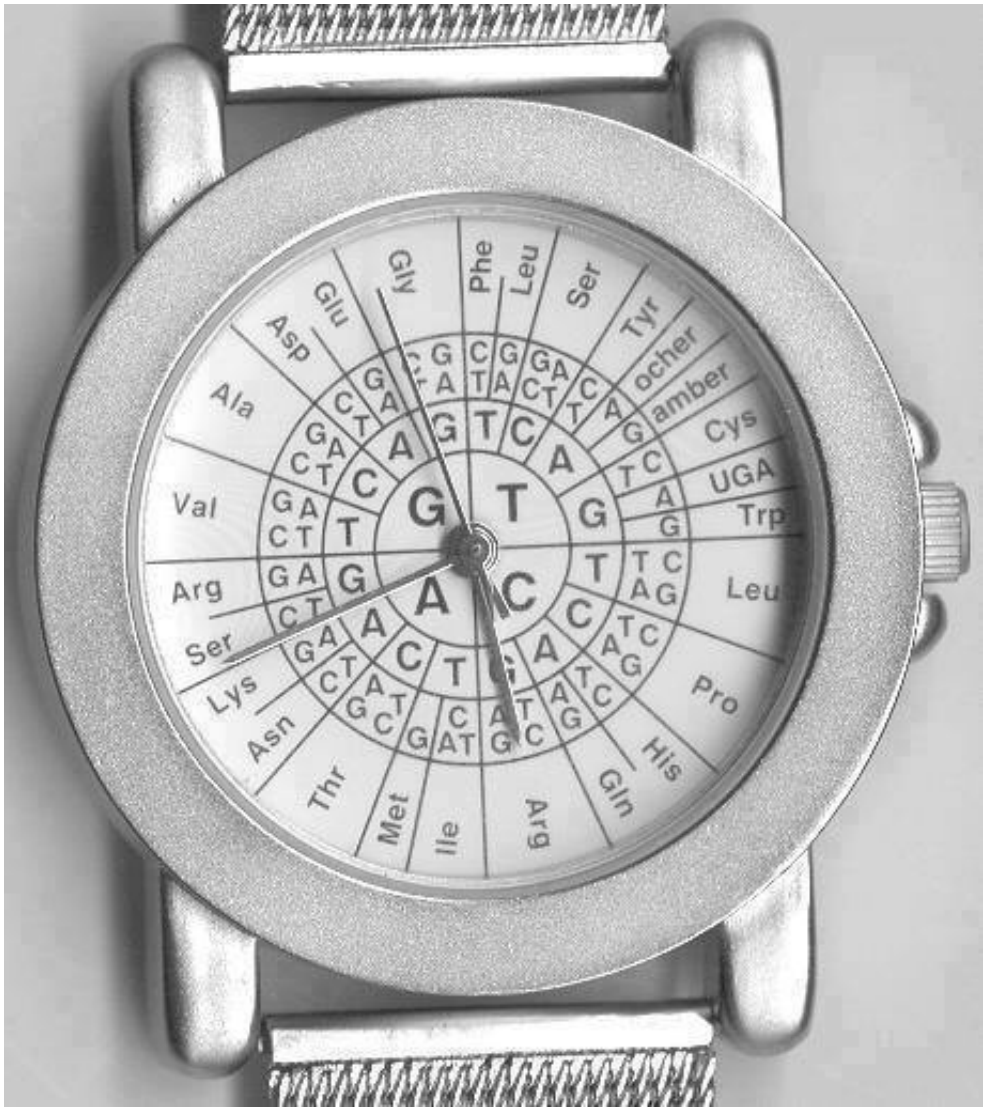
Ribosomes

Cloverleaf shape

Expectations

- You know the structure of tRNA and the process of charging the molecule with amino acids.
- You know the ribosomes of prokaryotes and eukaryotes:
  - Components
  - Genes
  - Structure

For a smile


Gly
Phe
Leu
Ser
Tyr
ocher
amber
Cys
UGA
Trp
Leu
Pro
His
Gln
Arg
Ile
Met
Thr
Asn
Lys
Ser
Arg
Val
Ala
Asp
Glu