RIBOSOME

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Introduction

- The ribosome (from ribonucleic acid and the Greek soma, meaning "body") is a large and complex molecular machine, found within all living cells, that serves as the primary site of biological protein synthesis (translation).
- Ribosomes link amino acids together in the order specified by messenger RNA (mRNA) molecules.

History

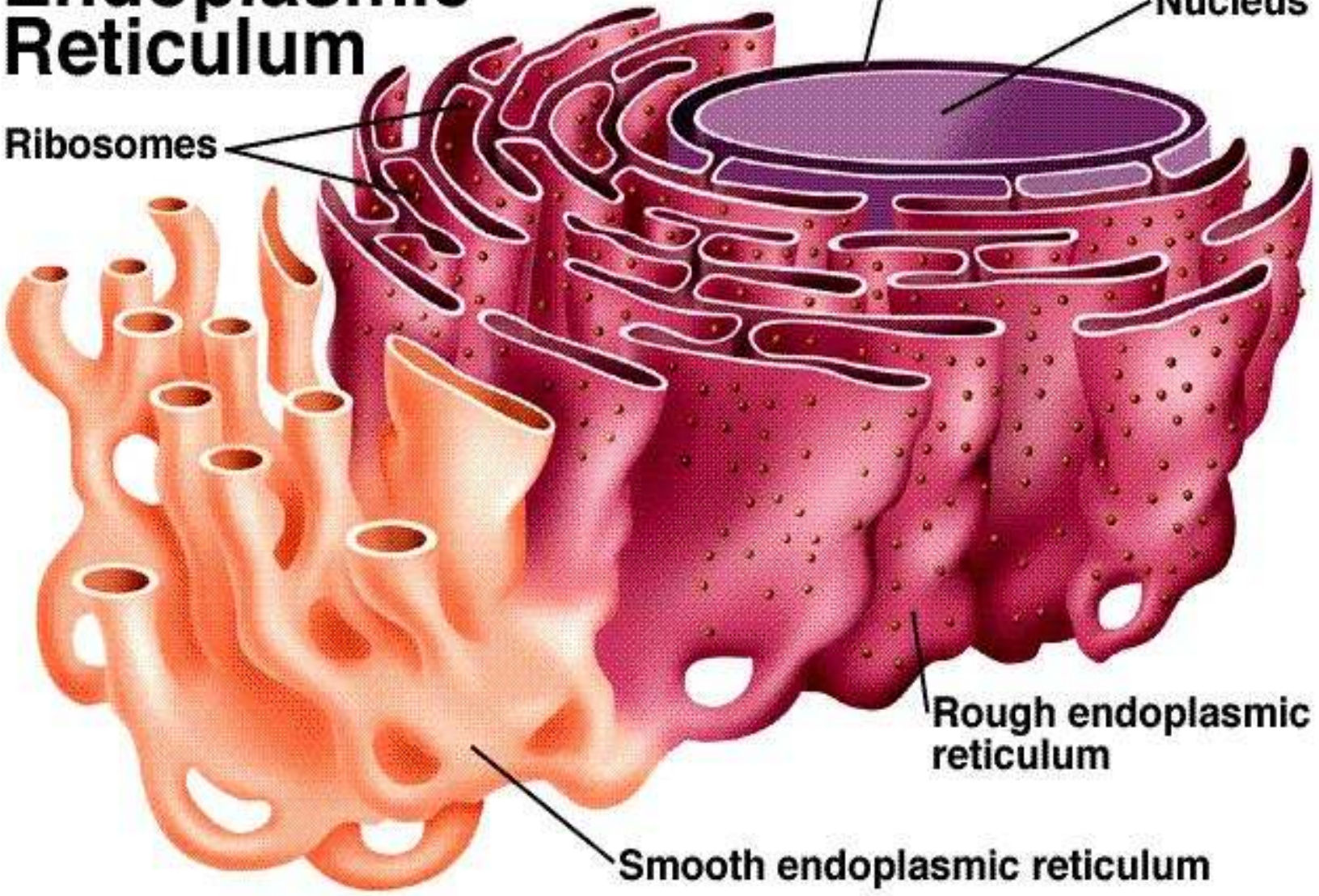
- Ribosomes were first observed in the mid-1950s by Romanian cell biologist George Emil Palade using an electron microscope as dense particles or granules for which, in 1974, he would win a Nobel Prize.
- The term "ribosome" was proposed by scientist Richard B. Roberts in 1958.

Ribosome locations

- Ribosomes are classified as being either "free" or "membrane-bound".
- Free ribosomes can move about anywhere in the cytosol.
- When a ribosome begins to synthesize proteins that are needed in some organelles, the ribosome making this protein can become "membrane-bound". In eukaryotic cells this happens in a region of the endoplasmic reticulum (ER) called the "rough ER".

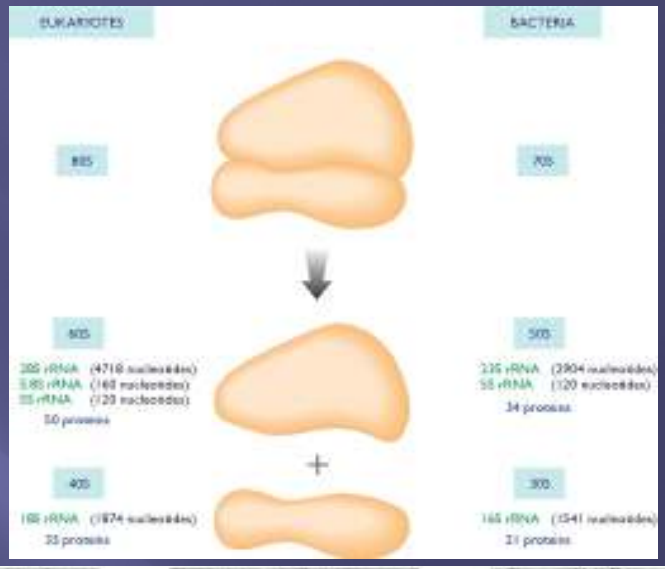
Randy Moore, Dennis Clark, and Darrell Vodopich, Botany Visual Resource Library © 1998 The McGraw-Hill Companies, Inc. All rights reserved.

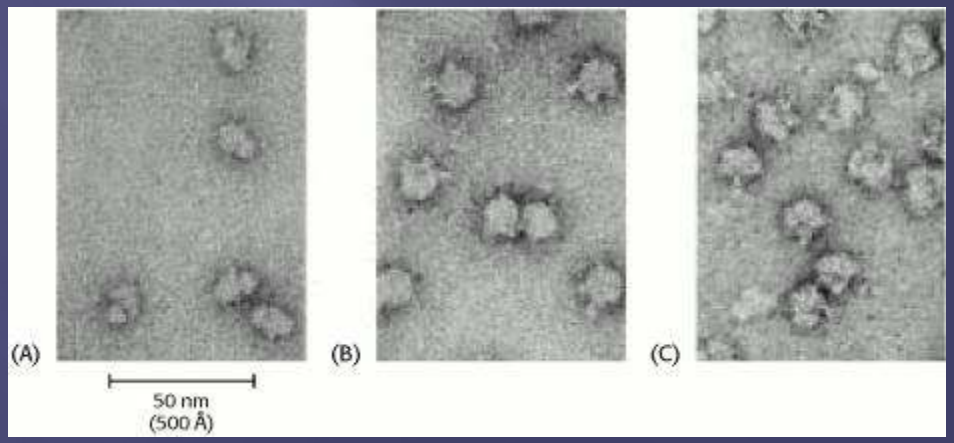
Three-Dimensional Endoplasmic Reticulum



Ribosome contain Small and Large component

- Ribosomes consist of two major components — the small ribosomal subunit which reads the mRNA, and the large subunit which joins amino acids to form a polypeptide chain.





Electron micrographs of (A) 30S subunits, (B) 50S subunits, and (C) 70S ribosomes.

Ribosome structure

- In the 1940s and 1950s, the first electron micrographs showed that bacterial **ribosomes** are oval-shaped, with dimensions of 29 nm × 21 nm, rather smaller than eukaryotic**ribosomes**, the latter varying a little in size depending on species but averaging about 32 nm × 22 nm. In the mid-1950s, the discovery that **ribosomes** are the sites of protein synthesis stimulated attempts to define the structures of these particles in greater detail.

Ultracentrifugation was used to measure the sizes of ribosomes and their components

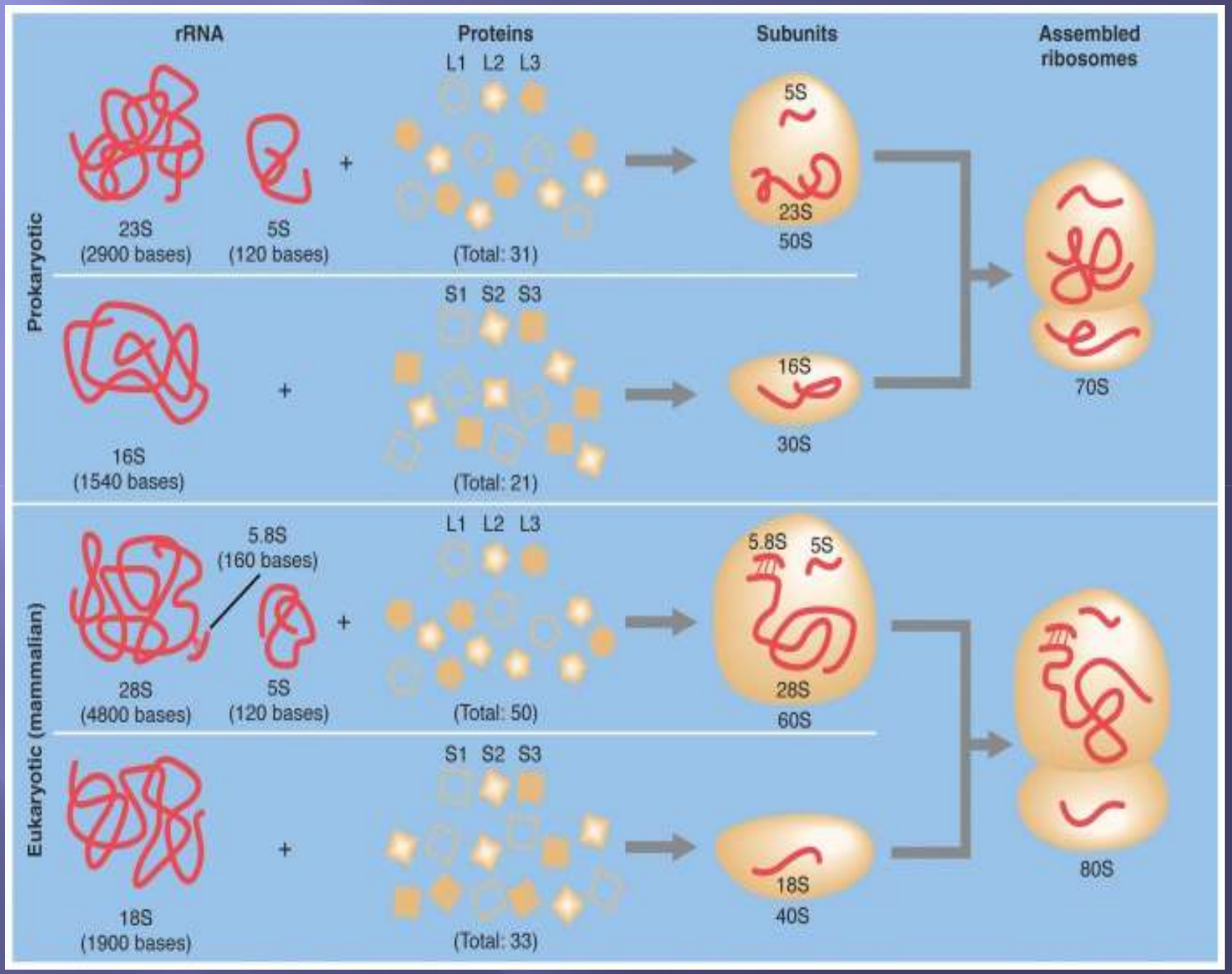
- The initial progress in understanding the detailed **structure** of the **ribosome** came not from observing them with the electron microscope but by analyzing their components by ultracentrifugation.
- Intact **ribosomes** have sedimentation coefficients of 80S for eukaryotes and 70S for bacteria, and each can be broken down into smaller components.

Ribosomal Subunits

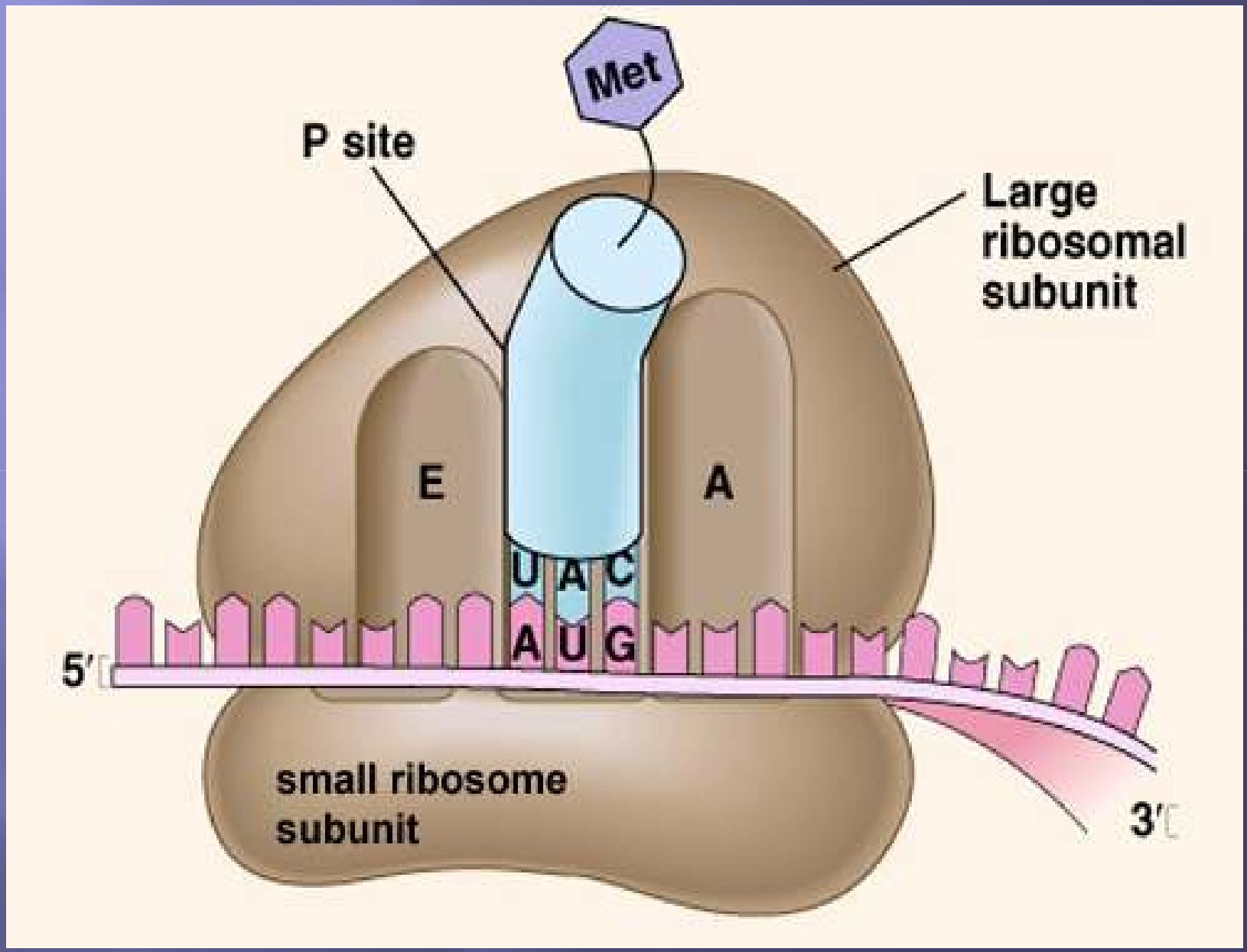
- Each **ribosome** comprises two subunits. In eukaryotes these subunits are 60S and 40S; in bacteria they are 50S and 30S.
- The large subunit contains three rRNAs in eukaryotes (the 28S, 5.8S and 5S rRNAs) but only two in bacteria (23S and 5S rRNAs). In bacteria the equivalent of the eukaryotic 5.8S rRNA is contained within the 23S rRNA.
- The small subunit contains a single rRNA in both types of organism: an 18S rRNA in eukaryotes and a 16S rRNA in bacteria.

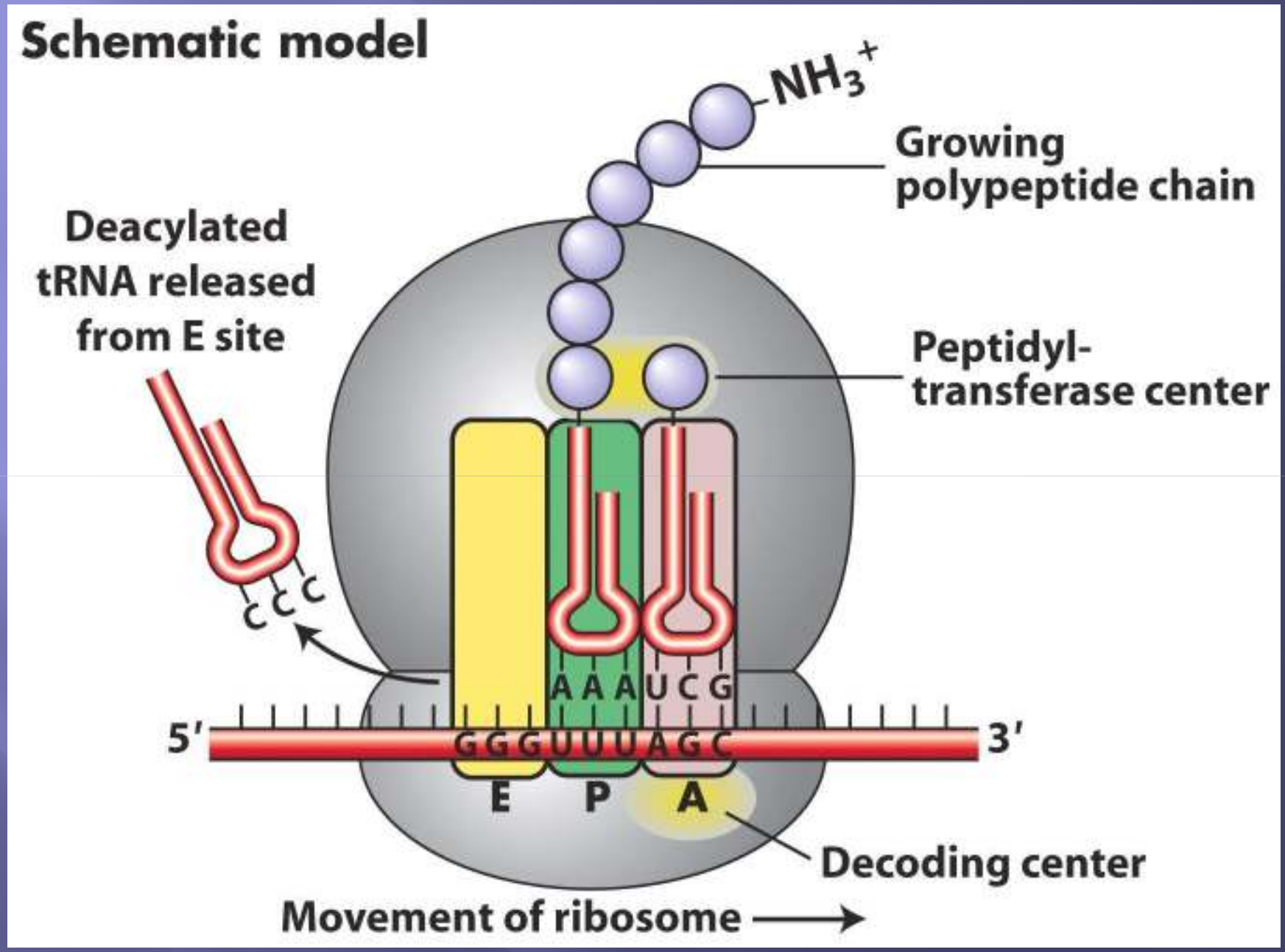
Ribosomal Proteins

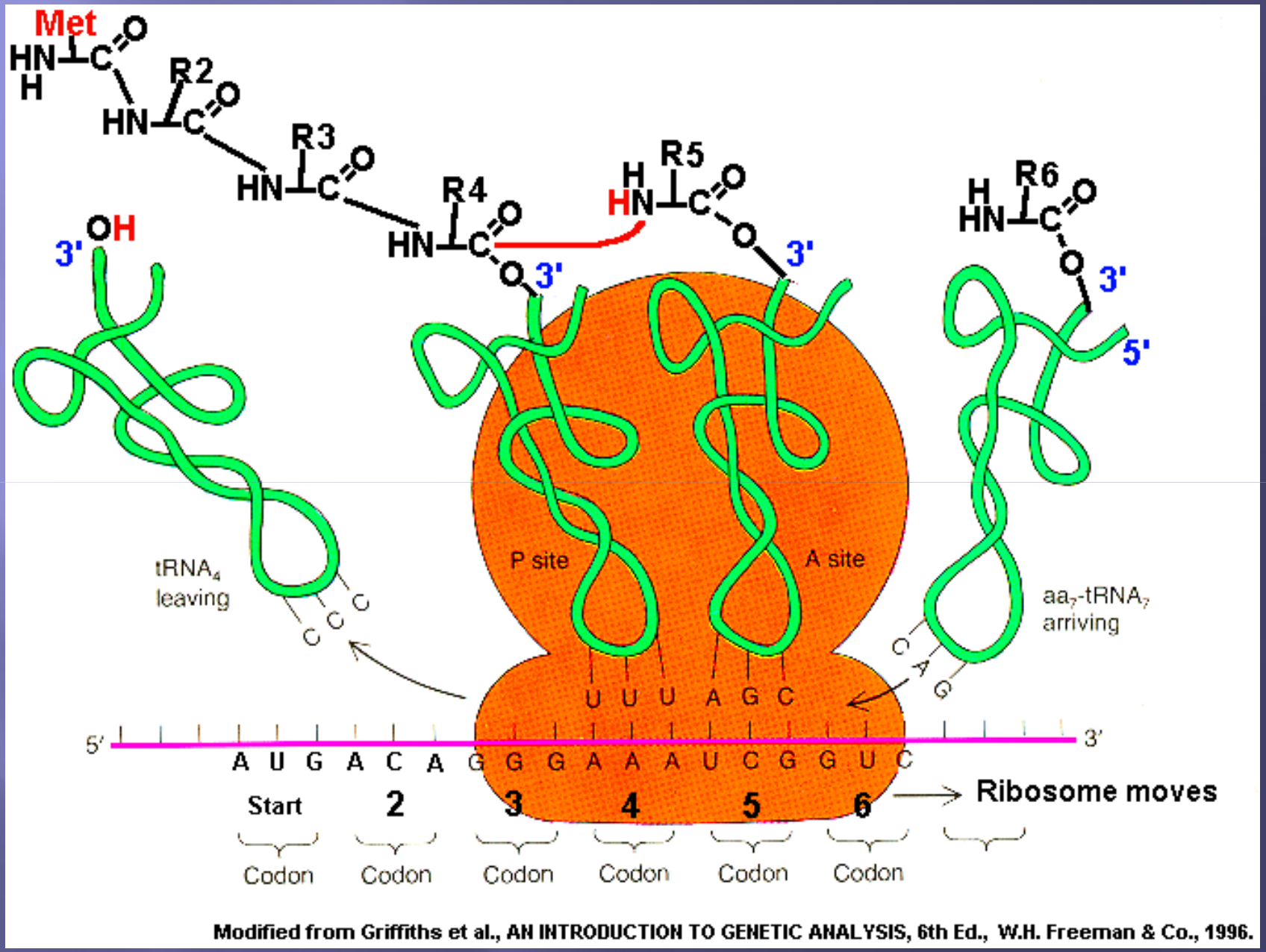
- Both subunits contain a variety of ribosomal proteins.
- The ribosomal proteins of the small subunit are called S1, S2, etc.; those of the large subunit are L1, L2, etc.
- There is just one of each protein perribosome, except for L7 and L12, which are present as dimers.


rRNA
Proteins
Subunits
Assembled ribosomes
Prokaryotic
23S
(2900 bases)
5S
(120 bases)
L1 L2 L3
(Total: 31)
5S
23S
50S
16S
(1540 bases)
S1 S2 S3
(Total: 21)
16S
30S
70S
Eukaryotic (mammalian)
5.8S
(160 bases)
28S
(4800 bases)
5S
(120 bases)
L1 L2 L3
(Total: 50)
5.8S 5S
28S
60S
18S
(1900 bases)
S1 S2 S3
(Total: 33)
18S
40S
80S

- Ribosomes are the large, ribonucleoprotein factories in which proteins are synthesized. In this process, messenger RNA (mRNA) codons are read by the anticodons of adaptor, transfer RNAs (tRNAs) that carry codon-specific amino acids.
- These amino acids are added to a growing protein chain by peptide bond formation in the heart of the ribosome.


Met
P site
Large ribosomal subunit
E
A
U A C
A U G
5′
3′
small ribosome subunit


Schematic model
NH_3^+
Growing polypeptide chain
Deacylated tRNA released from E site
Peptidyl-transferase center
C C C
A A A U C G
5′
G G G U U U A G C
3′
E
P
A
Decoding center
Movement of ribosome



Modified from Griffiths et al., AN INTRODUCTION TO GENETIC ANALYSIS, 6th Ed., W.H. Freeman & Co., 1996.

Thankyou