

S1. The first amino acid in a certain bacterial polypeptide chain is methionine. The start codon in the mRNA is GUG, which codes for valine. Why isn't the first amino acid formylmethionine or valine?

**Answer:** The first amino acid in a polypeptide chain is carried by the initiator tRNA, which always carries formylmethionine. This occurs even when the start codon is GUG (valine) or UUG (leucine). The formyl group can be later removed to yield methionine as the first amino acid.

S2. A tRNA has the anticodon sequence 3'-CAG-5'. What amino acid does it carry?

**Answer:** Since the anticodon is 3'-CAG-5', it would be complementary to a codon with the sequence 5'-GUC-3'. According to the genetic code, this codon specifies the amino acid valine. Therefore, this tRNA must carry valine at its acceptor site.

S3. In eukaryotic cells, the assembly of ribosomal subunits occurs in the nucleolus. As discussed in chapter 12, the 5.8S, 18S, and 28S rRNAs are actually synthesized as a single 45S rRNA precursor that is processed by cleavage to produce the three rRNAs. The genes that encode the 45S precursor are found in multiple copies (i.e., they are moderately repetitive). Within the nucleus, the segments of chromosomes that contain the 45S rRNA genes align themselves at the center of the nucleolus. This site is called the **nucleolar-organizing center**. In this region, active transcription of the 45S gene takes place. Briefly explain how the assembly of the ribosomal subunits occurs.

**Answer:** In the nucleolar-organizing center, the 45S rRNA is processed to the 5.8S, 18S, and 28S rRNAs. This processing was described in chapter 12. The other components, 5S rRNA and ribosomal proteins, must also be imported into the nucleolar region. Since proteins are made in the cytosol, they must enter the nucleus through the nuclear pores. When all the components are present, they assemble into 40S and 60S ribosomal subunits. Following assembly, the ribosomal subunits exit the nucleus through the nuclear pores and enter the cytosol.

S4. Throughout chapter 13, we have seen that the general mechanism for bacterial and eukaryotic translation is very similar at the molecular level. In both cases, a polypeptide with a defined amino acid sequence is made on the surface of a ribosome due to the sequential interactions between the anticodons in tRNA molecules and the codons in an mRNA. In addition, we have also seen some interesting distinctions between these processes in bacteria and eukaryotes. Summarize the differences between bacterial and eukaryotic translation.

**Answer:** See table.

#### A Comparison of Bacterial and Eukaryotic Translation

	<b>Bacterial</b>	<b>Eukaryotic</b>
Ribosome composition:	70S ribosomes: 30S subunit— 21 proteins + 1 rRNA 50S subunit— 34 proteins + 3 rRNAs	80S ribosomes: 40S subunit— 33 proteins + 1 rRNA 60S subunit— 49 proteins + 3 rRNAs
Initiator tRNA:	tRNA <sup>fmet</sup>	tRNA <sup>met</sup>
Formation of the factors compared to initiation complex:	Requires IF1, IF2, and IF3	Requires more initiation  bacterial initiation
Initial binding of mRNA methylguanosine cap to the ribosome:	Requires a Shine-Dalgarno sequence	Requires a 7-
Selection of a start codon: rules	AUG, GUG, or UUG located just downstream  from the Shine-Dalgarno sequence	According to Kozak's
Termination:	Requires RF1, RF2, and RF3	Requires eRF
Coupled to transcription:	Yes	Not usually
Coordinated with cell sorting signals such as compartmentalization:	Less complex, due to a lack of  internal organelles	Yes, via many different  the SRP signal

S5. An **antibiotic** is a drug that kills or inhibits the growth of microorganisms. The use of antibiotics has been of paramount importance in the battle against many infectious diseases that are caused by microorganisms. In the case of many antibiotics, their mode of action is to inhibit the translation process within bacterial cells. Certain antibiotics selectively bind to bacterial (70S) ribosomes but do not inhibit eukaryotic (80S) ribosomes. Their ability to inhibit translation can occur at different steps in the translation process. For example, tetracycline prevents the attachment of tRNA to the ribosome while erythromycin inhibits the translocation of the ribosome along the mRNA. Why would an antibiotic bind to a bacterial ribosome but not to a eukaryotic ribosome? How does inhibition of translation by antibiotics such as tetracycline prevent bacterial growth?

**Answer:** Because bacterial ribosomes have a different protein and rRNA composition compared to eukaryotic ribosomes, certain drugs can recognize these different components and bind specifically to bacterial ribosomes and thereby interfere with the process of translation. In other words, the surface of a bacterial ribosome must be somewhat different compared to the surface of a eukaryotic ribosome so that certain drugs will bind to the surface of only bacterial ribosomes. If a bacterial cell is exposed to tetracycline or other antibiotics, it cannot synthesize new polypeptides. Since polypeptides form functional proteins that are needed for processes such as cell division, the bacterium will be unable to grow and proliferate.