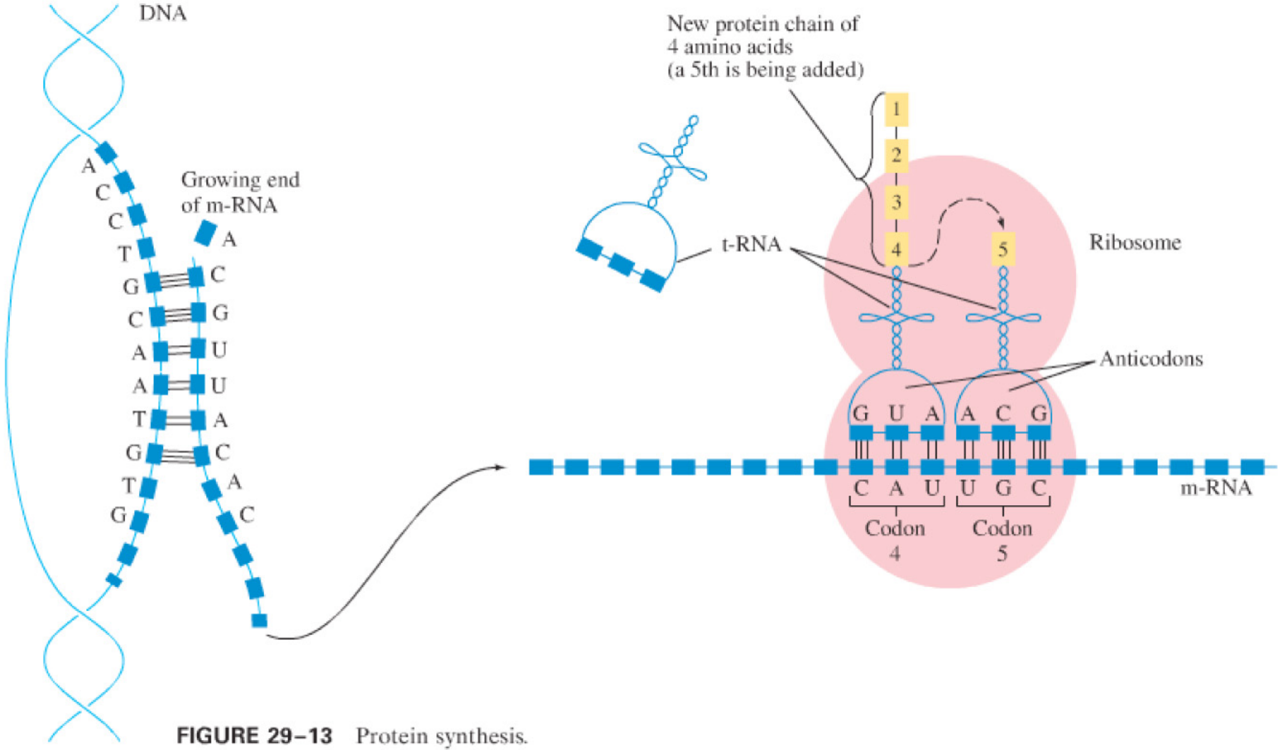

FIGURE 29–13 Protein synthesis.

PHYSICS APPLIED
Protein synthesis

The standard model for how amino acids are connected together in the correct order to form a protein molecule is shown schematically in Fig. 29–13. It begins at the DNA double helix, for each gene on a chromosome contains the information for producing one protein. The ordering of the four bases, A, C, G, and T, provides the "code," the "genetic code," for the order of amino acids in the protein. First, the DNA double helix unwinds and a new molecule called *messenger*-RNA (m-RNA) is synthesized using one strand of the DNA as a "template." m-RNA is a chain molecule containing four different bases, like those of DNA except that thymine (T) is replaced by the similar uracil molecule (U). In Fig. 29–13, a C has just been added to the growing m-RNA chain in much the same way that DNA replicates (Fig. 16–45); and an A, attracted and held close to the T on the DNA chain by the electrostatic force, will soon be attached to the C by an enzyme. The order of the bases, and thus the genetic information, is preserved in the m-RNA. The m-RNA is buffeted about in the cell (remember kinetic theory) until it gets close to a tiny organelle known as a *ribosome*, to which it can become attached by electrostatic attraction, Fig. 29–13. Also held by the electrostatic force to the ribosome are one or two *transfer*-RNA (t-RNA) molecules. These t-RNA molecules "translate" the genetic code of nucleotide bases into amino acids in the following way. There is a different t-RNA molecule for each combination of three bases. At one end of the t-RNA molecule is the "anticodon," a set of three nucleotide bases. If all three bases of the anticodon match (in the sense of G to C and A to U) the three bases of the "codon" on the m-RNA at its attachment to the ribosome, the anticodon is attracted electrostatically to the m-RNA codon and is held there briefly. On the other end of a t-RNA molecule is the appropriate amino acid. The ribosome has two particular attachment sites which hold two t-RNA molecules while enzymes link their two amino acids together to lengthen the amino acid chain (yellow in Fig. 29–13). As each amino acid is connected by an enzyme (4 are already connected in Fig. 29–13, a fifth is about to be connected), the old t-RNA molecule is removed—perhaps by a random collision with some molecule in the cellular fluid. A new one soon becomes attracted as the ribosome moves along the m-RNA.