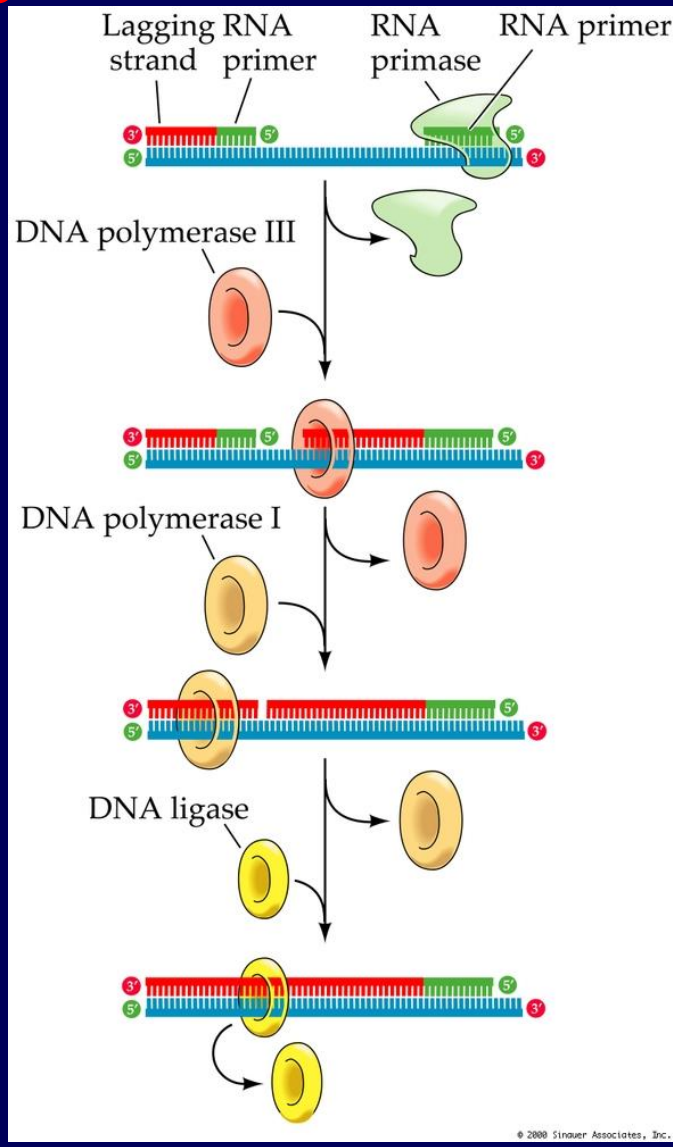
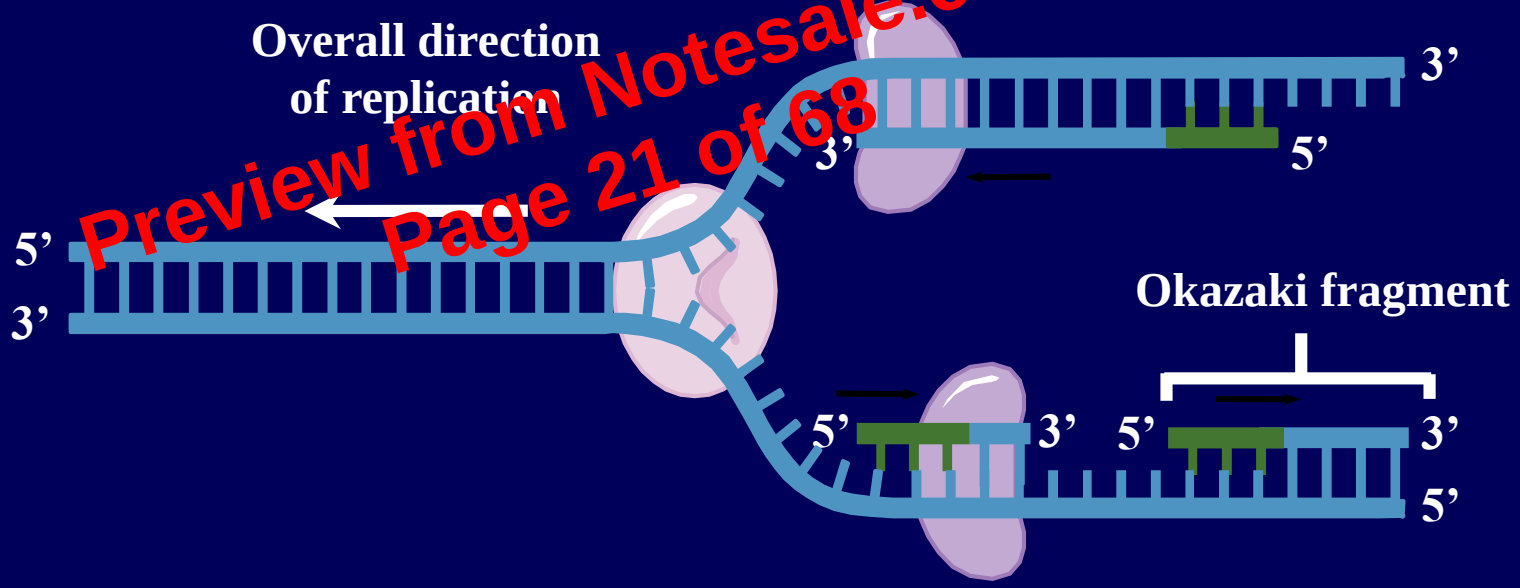
The Mechanism of DNA Replication

- Many proteins assist in DNA replication
- DNA helicases unwind the double helix, the template strands are stabilized by other proteins
- Single-stranded DNA binding proteins make the template available
- RNA primase catalyzes the synthesis of short RNA primers, to which nucleotides are added.
- DNA polymerase III extends the strand in the 5’-to-3’ direction
- DNA polymerase I degrades the RNA primer and replaces it with DNA
- DNA ligase joins the DNA fragments into a continuous daughter strand



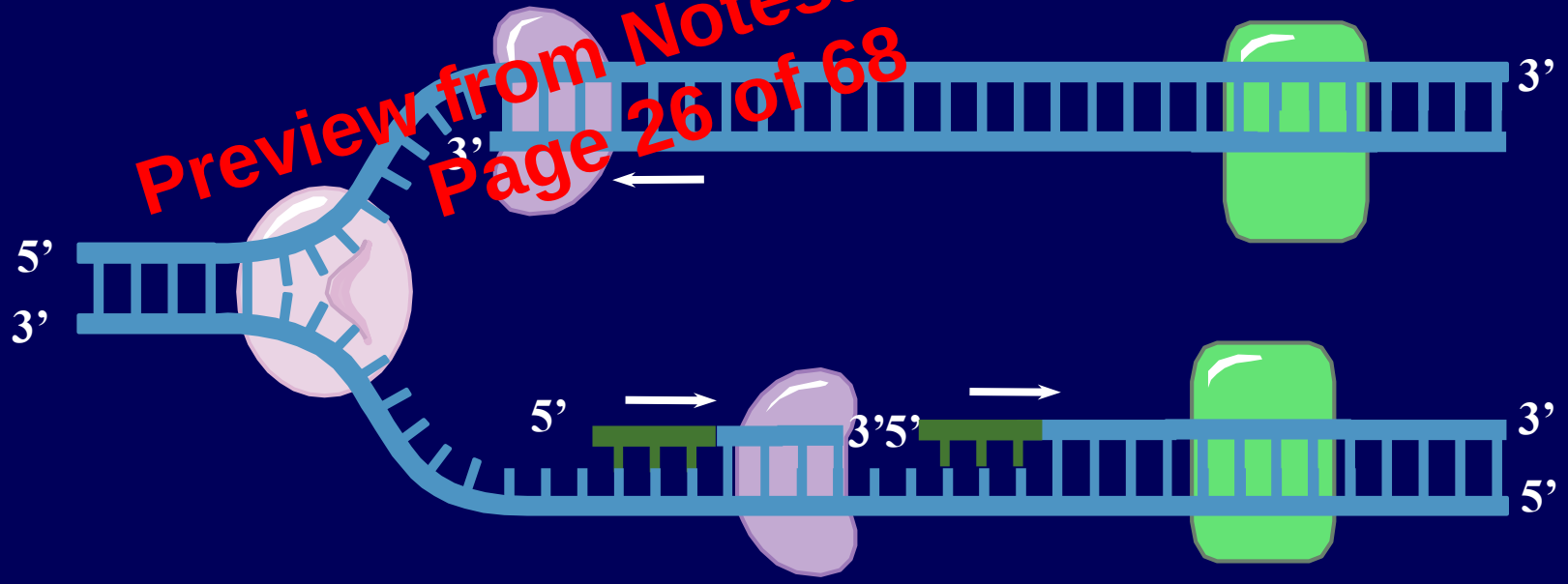
Replication



Leading strand synthesis continues in a 5’ to 3’ direction.

Discontinuous synthesis produces 5’ to 3’ DNA segments called Okazaki fragments.

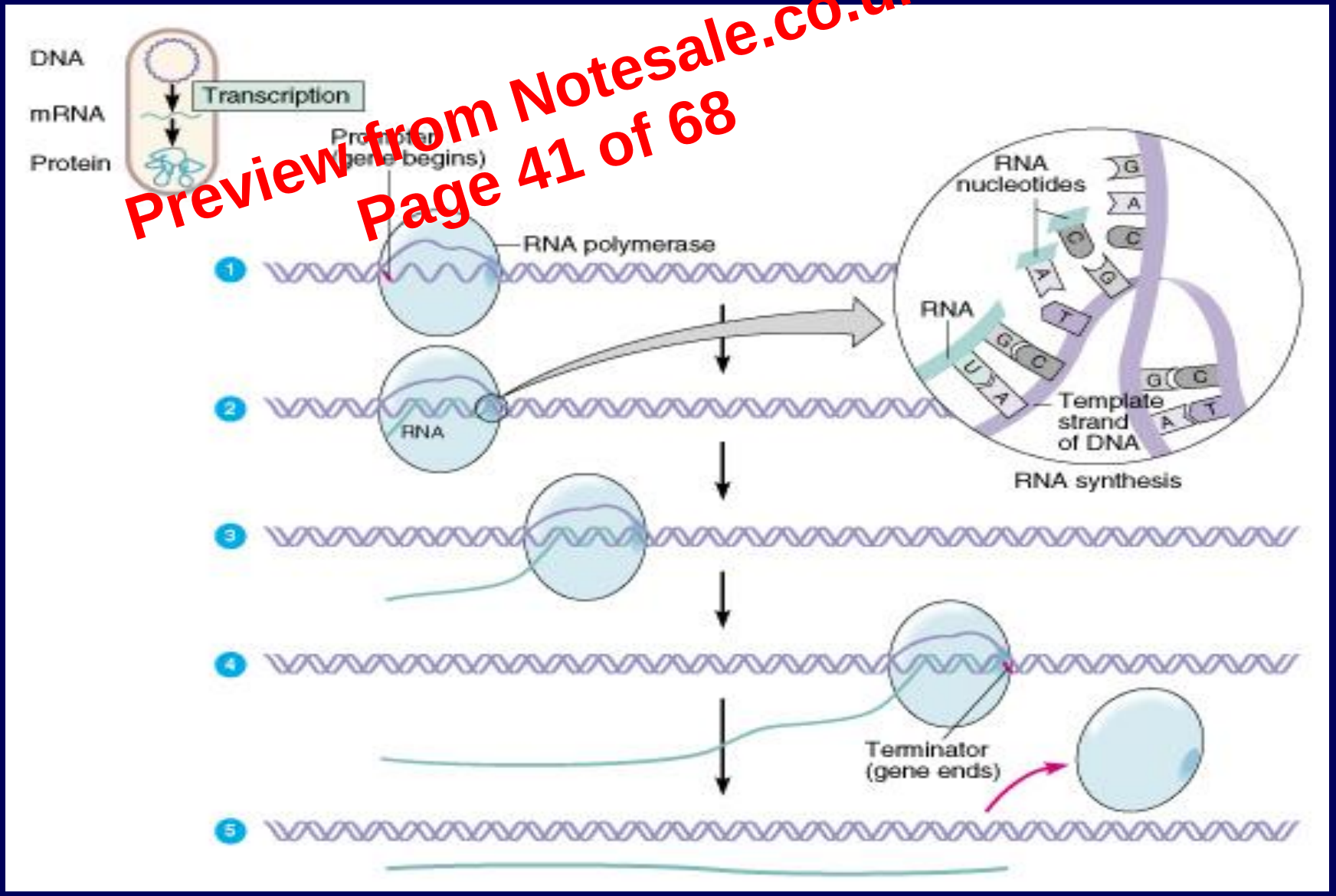
Replication



Polymerase activity of DNA polymerase I fills the gaps.

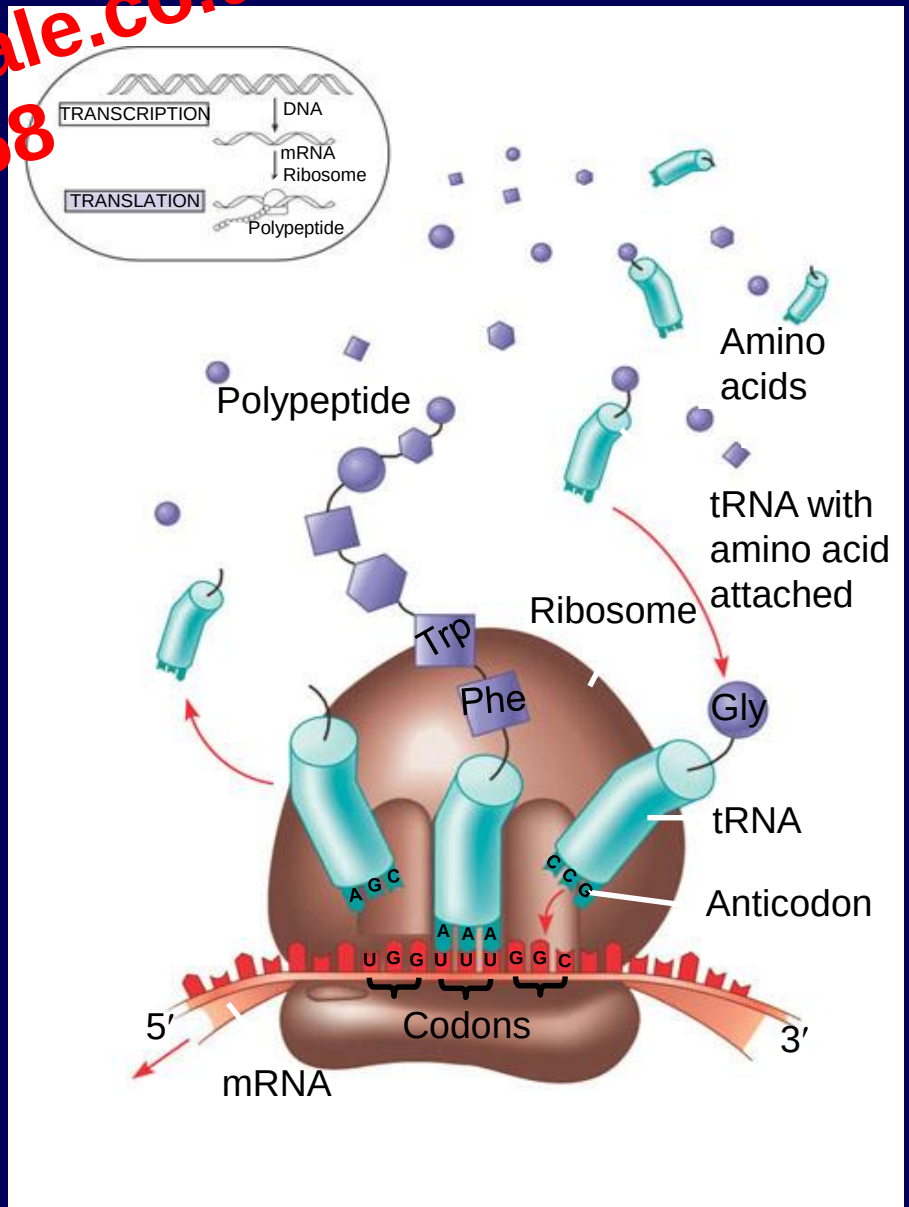
Ligase forms bonds between sugar-phosphate backbone.

Transcription Overview



Translation

- Translation is the RNA-directed synthesis of a polypeptide
- Translation involves
  - mRNA
  - Ribosomes - Ribosomal RNA
  - Transfer RNA
  - Genetic coding - codons

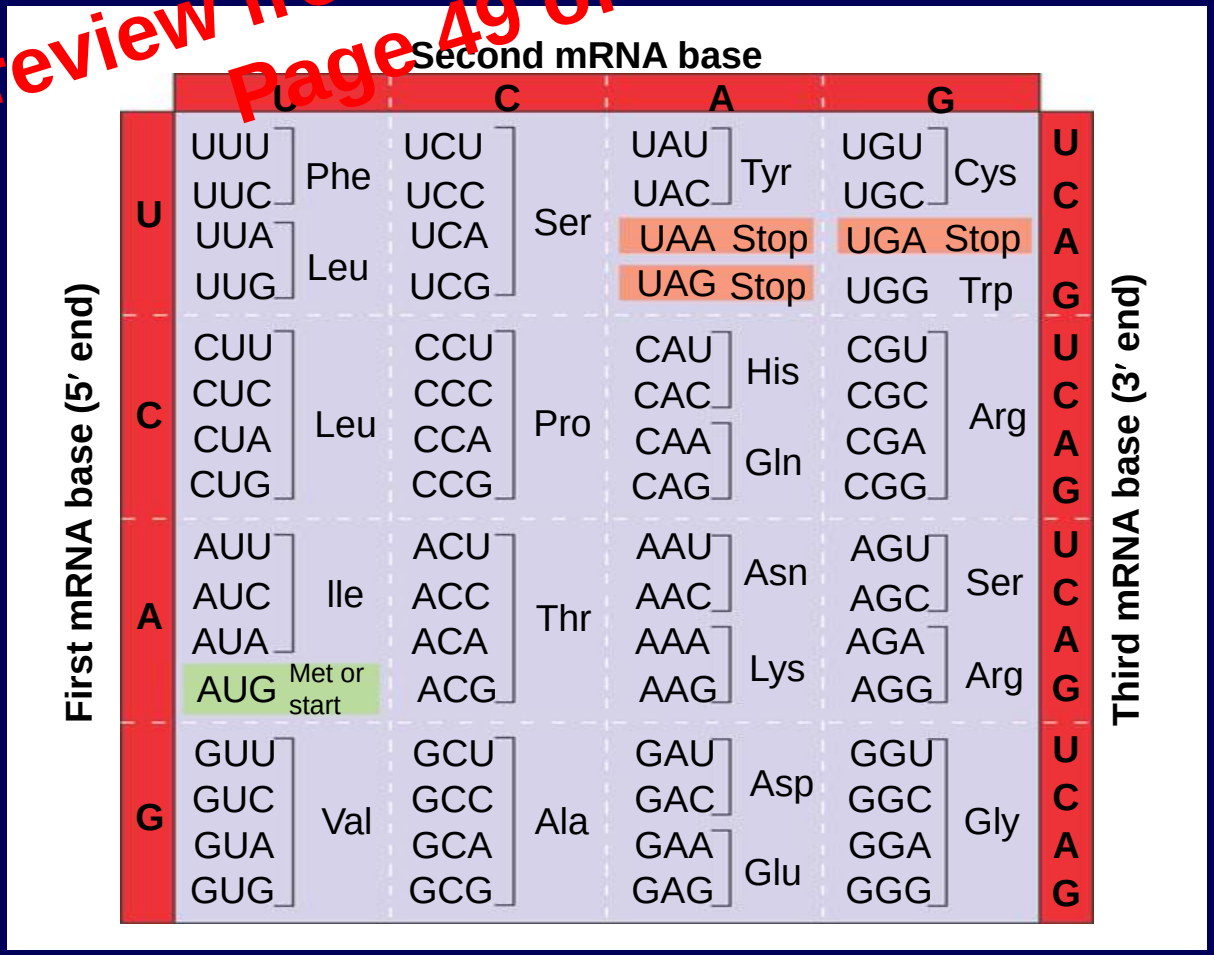


The Genetic Code

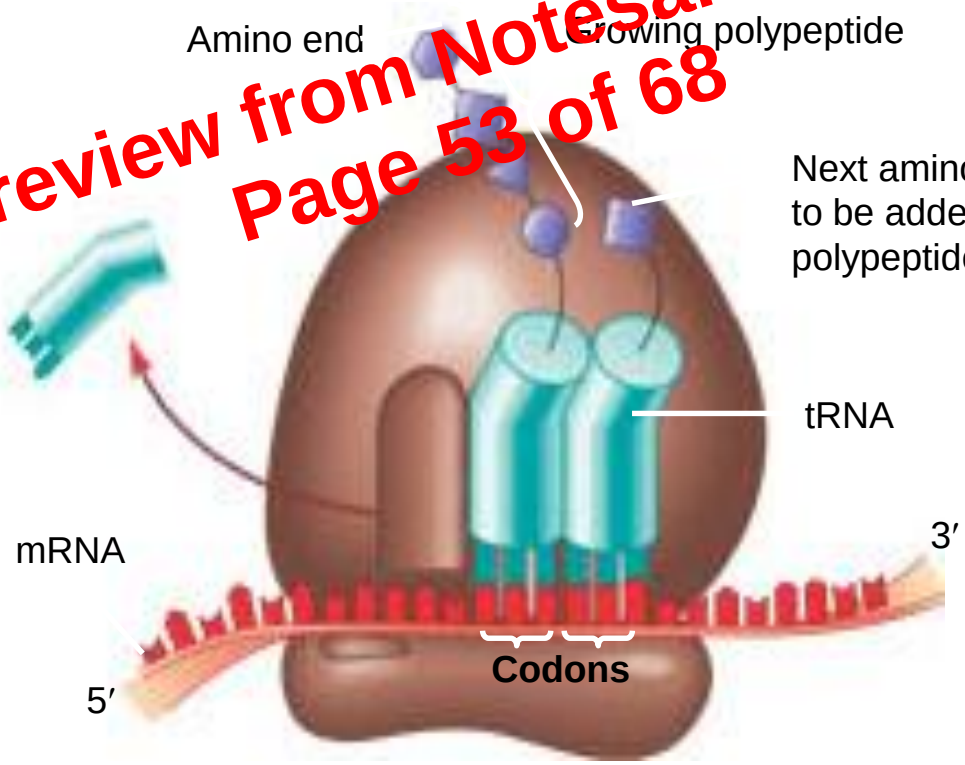
- Codons: 3 base code for the production of a specific amino acid, sequence of three of the four different nucleotides
- Since there are 4 bases and 3 positions in each codon, there are 4 x 4 x 4 = 64 possible codons
- 64 codons but only 20 amino acids, therefore most have more than 1 codon
- 3 of the 64 codons are used as STOP signals; they are found at the end of every gene and mark the end of the protein
- One codon is used as a START signal: it is at the start of every protein
- Universal: in all living organisms

The Genetic Code

- A codon in messenger RNA is either translated into an amino acid or serves as a translational start/stop signal



Building a Polypeptide



(c) **Schematic model with mRNA and tRNA.** A tRNA fits into a binding site when its anticodon base-pairs with an mRNA codon. The P site holds the tRNA attached to the growing polypeptide. The A site holds the tRNA carrying the next amino acid to be added to the polypeptide chain. Discharged tRNA leaves via the E site.

Mutagens

- **Mutagens** are chemical or physical agents that interact with DNA to cause mutations.
- Physical agents include high-energy radiation like X-rays and ultraviolet light
- Chemical mutagens fall into several categories.
  - Chemicals that are base analogues that may be substituted into DNA, but they pair incorrectly during DNA replication.
  - Interference with DNA replication by inserting into DNA and distorting the double helix.
  - Chemical changes in bases that change their pairing properties.
- Tests are often used as a preliminary screen of chemicals to identify those that may cause cancer
- Most carcinogens are mutagenic and most mutagens are carcinogenic.

Viral Mutagens

- Scientists have recognized a number of *tumor viruses* that cause cancer in various animals, including humans
- About 15% of human cancers are caused by viral infections that disrupt normal control of cell division
- All tumor viruses transform cells into cancer cells through the integration of viral nucleic acid into host cell DNA.

Substitutions

- A base-pair substitution is the replacement of one nucleotide and its partner with another pair of nucleotides
  - Silent - changes a codon but codes for the same amino acid
  - Missense - substitutions that change a codon for one amino acid into a codon for a different amino acid
  - Nonsense -substitutions that change a codon for one amino acid into a stop codon