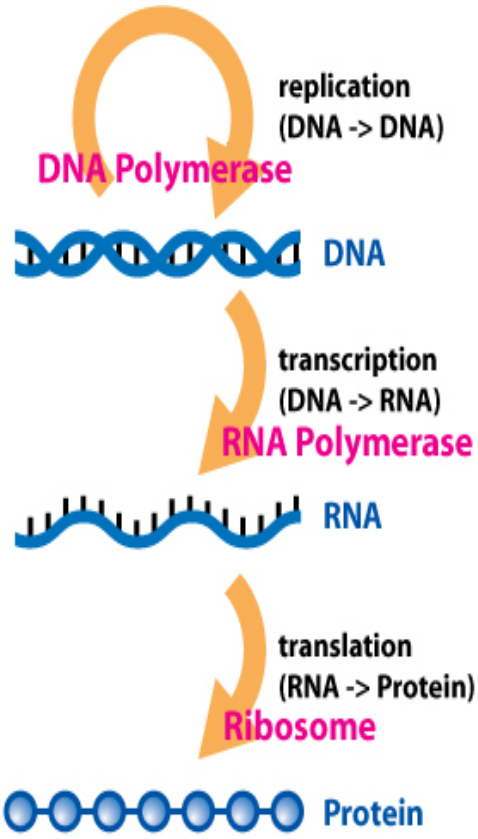
Gene Expression

Contents

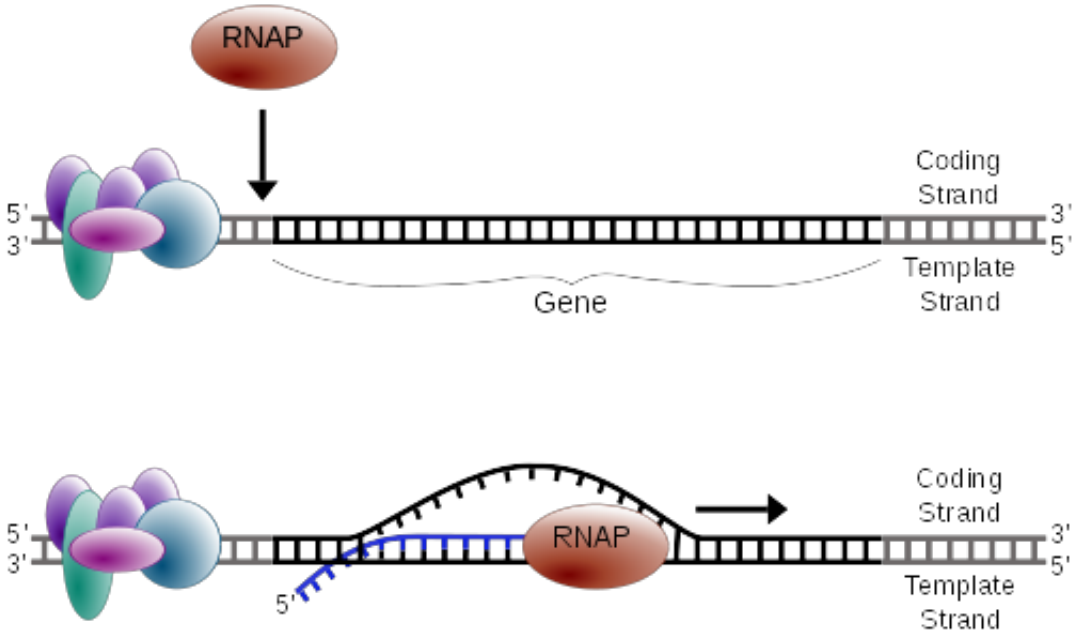
The Central Dogma



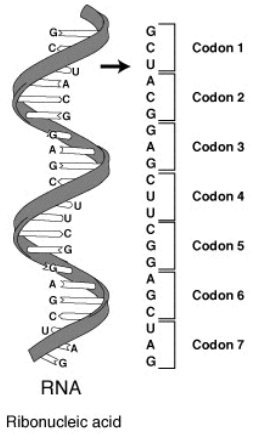
Flow of information in cells. DNA serves as a template for copying itself (**replication**). DNA can also serve as a template for RNA (**transcription**). RNA is decoded into amino acids to generate proteins (**translation**).DNA was described as a molecule consisting of 2 anti-parallel strands in a double helix by Francis Crick and James Watson. The elegant model illustrated the intrinsic redundancy that made DNA a suitable data storage vessel for genetic information. Francis Crick later posited a notion of how this information went from storage to an actual program that runs cells. Crick first posited it as a "sequence hypothesis". This idea of information flow is called the **Central Dogma of Molecular Biology**. DNA stores the information that is expressed as an intermediate message of RNA. This RNA is then translated in amino acids to yield proteins.

Transcription

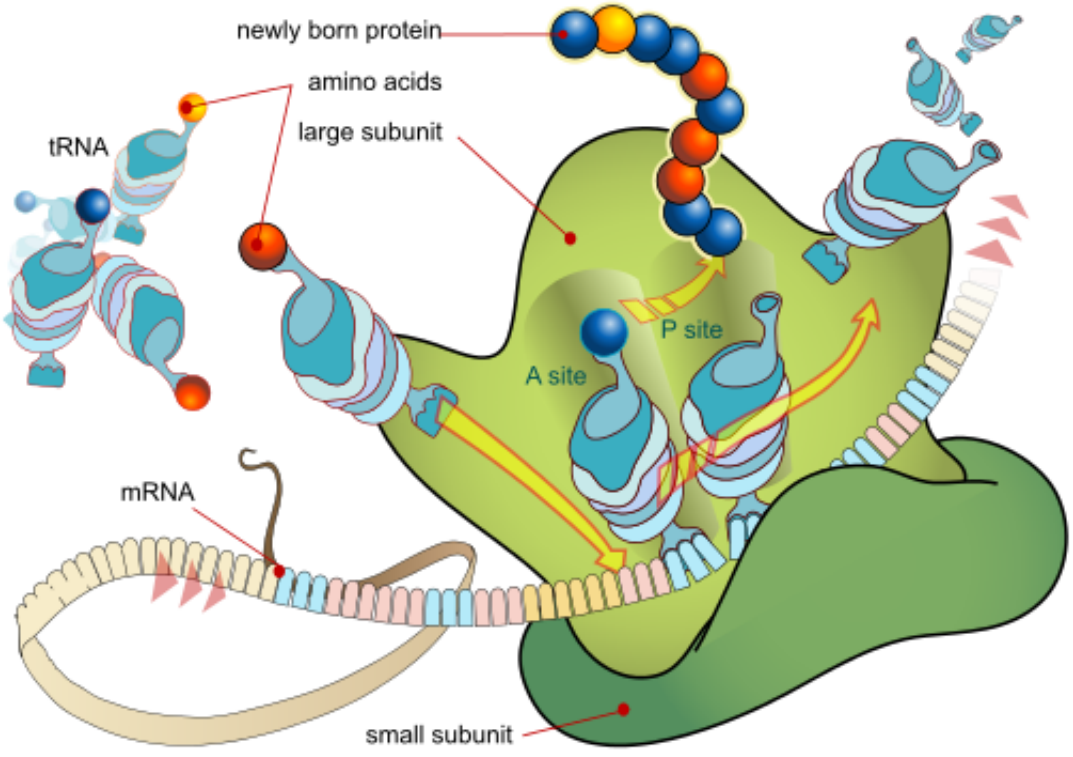
DNA is simply a storage vessel of genetic information. It sits in the nucleus and must be called upon through a process of **transcription** where an enzyme called **RNA Polymerase**"reads aloud" the stored information into a molecule called messenger RNA (**mRNA**). Since DNA is double-stranded in an **anti-parallel** fashion, we automatically know the sequence of the second strand by knowing the first. The mRNA is made through complimentary base-pairing to the **template strand**, which is the reverse complement of the coding strand. The **coding strand** is the strand that reads identical in sequence to the mRNA with the exceptions of T's being replaced by U's.



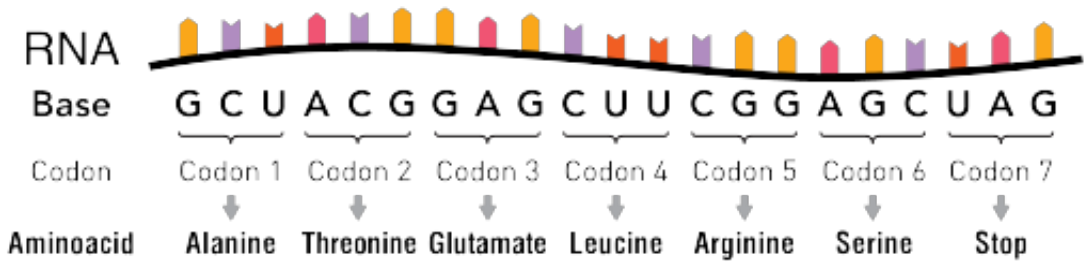
Translation

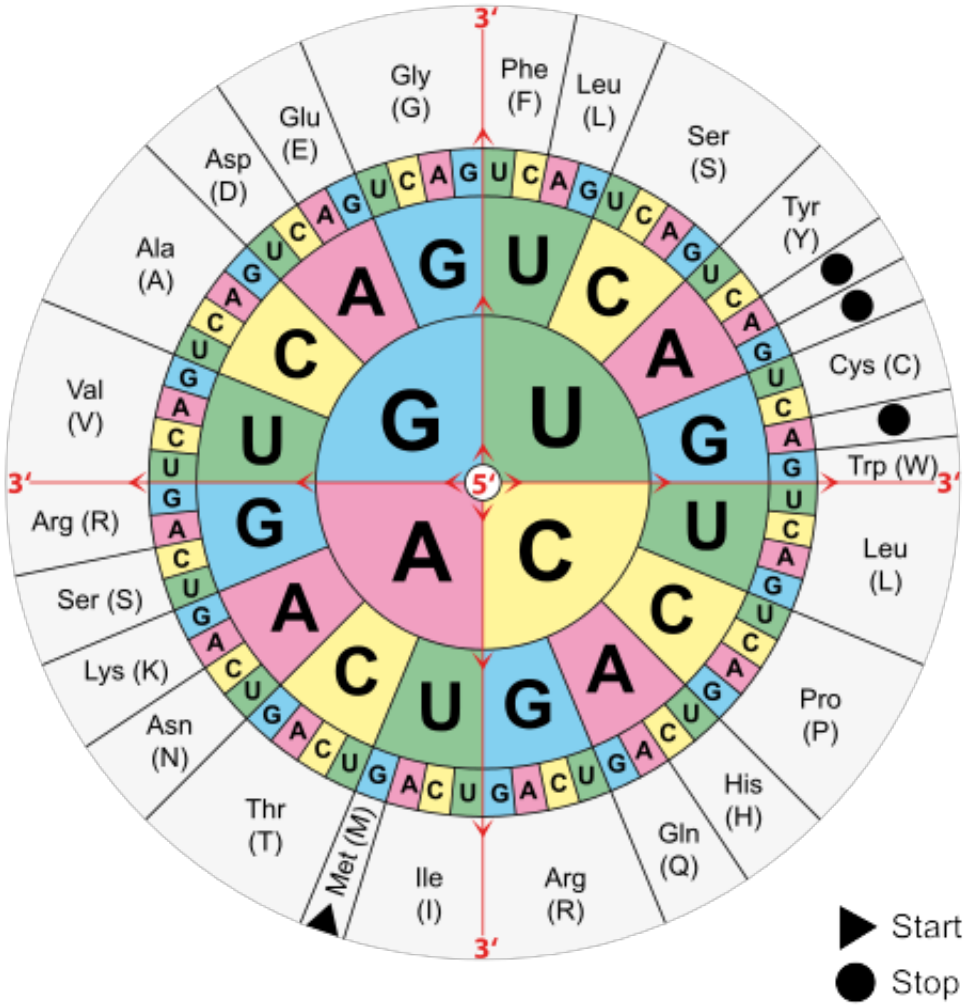


This coding strand is later decoded by the **ribosomes** with the help of transfer RNA's **tRNA**'s) that act as a decoder of the information and protein assembler in a process called **translation**. The ribosome scans along the mRNA and recognizes nucleotides in batches of 3 . These batches of 3 can be translated into an amino acid and is known as a **codon**. Since there are 4 types of bases and they are read as groups of 3, there are 4^3 (or 64) combinations of these codons. However, there are only 20 amino acids used to build proteins. This indicates that there is room for redundancy. Three of these codons tell the ribosome to stop, like a period in a sentence. These are called **stop codons**. There is one special codon that performs double duty: ATG. The codon (ATG) that encodes the amino acid Methionine also acts as a **start codon** that tells the ribosome where to start reading from. Like nucleic acids, proteins have a polarity and are synthesized in an amino to carboxyl direction. We abbreviate this by terming the beginning of the protein sequence, N-terminal, and the ending of the sequence as the C-terminal.



Ribosomes are large complexes of enzymes that coordinate the decoding of mRNA into amino acids to generate proteins.



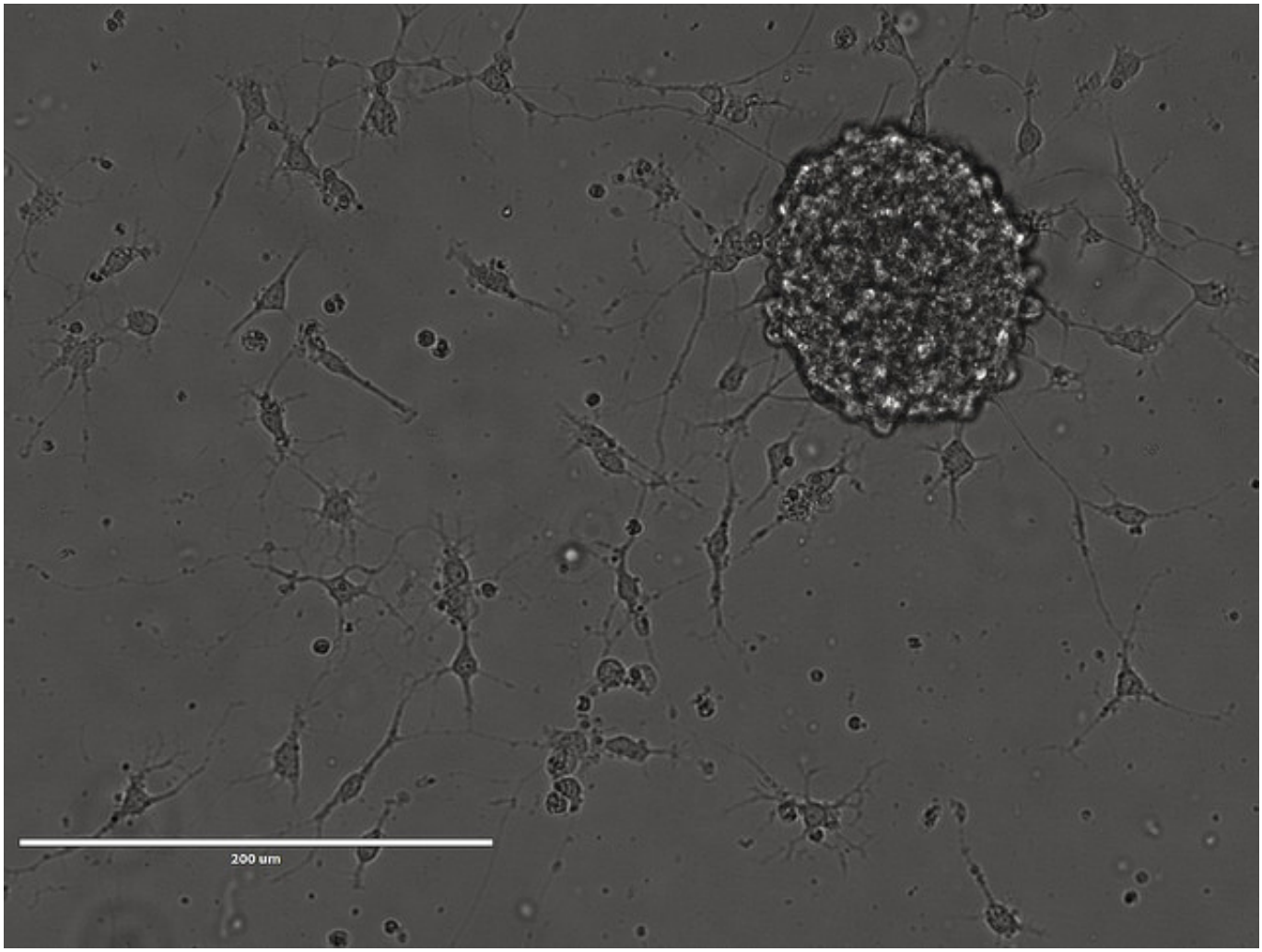


The standard genetic code.

Advanced video of Translation

Decisions… decisions…

What kinds of decisions are made for stem cells to differentiate into different cell types? What types of regulation occur during this process?



A cluster of neuronal progenitor cells (neurosphere) dissociates and differentiates into neurons.

Video Review

- Transcription Simulation (MIT License)
- **Transcription (**CC-BY-NC-ND **Cold Spring Harbor Lab –** DNA Learning Center**)** https://www.dnalc.org/content/c15/15510/transcription_basic.mp4
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Tags: integration of knowledge