Lecture 3, Jan 17, 2023

RNA

- Like DNA, but instead of thymine we have uracil, which is the same as thymine but the CH_3 is not there
  - Uracil still pairs with adenine
  - The extra methyl on thymine makes the molecule more stable since it blocks the molecule, so RNA is less stable
- The sugar molecule is now only a ribose, not a deoxyribose
  - At the 2 spot there is now an OH group instead of just hydrogen
  - Not having the oxygen also makes DNA more stable and gives it space to coil
- Overall RNA is much less stable than DNA and more prone to mutations
  - DNA can last a lifetime but RNA degrades in 30 minutes
  - RNA is mostly a temporary molecule; when it degrades the cell reuses its parts
- RNA comes in only one strand, unlike the double helix of DNA
  - The ribose backbones still cause it to twist
  - RNA is also shorter than DNA
- A *primary structure* is when the RNA is still in a single strand; coiling may occur
  - Messenger RNA (mRNA) is just a single strand without bonds within itself, i.e. a primary structure
  - Transfer RNA (tRNA) is a tertiary structure
  - When the RNA folds it can start hydrogen bonding within itself; in 2D it begins forming a secondary structure, then in 3D it forms a tertiary structure
  - "The collection of base pairs in the tertiary structure is the secondary structure"

The Central Dogma (DNA Transcription)

- DNA makes (messenger) RNA, which then makes proteins
- Consider a template strand of DNA; RNA nucleotides will come in and attach to the DNA nucleobases, and form an RNA strand piece by piece
  - The hydroxyl is exposed on the 3' end of the RNA, which drives the reaction
  - This process goes from the 3' end of the DNA (which matches the 5' end of the RNA) to the 5' end of the DNA (which matches the 3' end of the RNA)
  - The RNA created is the same as the coding strand of the DNA, except thymine is replaced with uracil
  - "read up, write down" mnemonic
- Cells in different parts of the body may only be able to produce certain things
  - Every cell in your body has your complete DNA, but only in certain cells can certain parts of the DNA be activated
  - e.g. only cells in the liver can produce albumin
- There may also be inducible gene expression
  - e.g. the pancreas responds to blood glucose level (glucagon) which expresses a gene that stops glucagon
- Transcription factors assemble on a certain part of the DNA (maybe in response to environmental stimulus); it contains DNA polymerase, which splits apart the DNA locally, allowing RNA nucleotides to come in and attach, producing an RNA strand
- Eukaryotic gene structure:
  - Control elements in the DNA (enhancers/silencers and the TATA box) indicate where to start transcribing (upstream regulatory sequence)
    - Transcription factors assemble at the TATA sequence
    - Positive transcription factors indicate to the DNA polymerase where to start
      - If there is a negative transcription factor attached, it prevents positive transcription factors and DNA polymerase from attaching to the gene and copying it
  - *Introns* and *exons* in the open reading frame (ORF)
    - The introns join together the exons, but the introns are not needed and are spliced away later

  - A termination sequence and other control mechanisms are at the end (downstream regulatory sequence)
- The resulting raw RNA strand is processed by a *spliceosome*, which cuts the DNA at the introns and throws those parts away
  - This leaves us with the exons only, giving us the mature mRNA