

## Chapter 4 Genetics and Cellular Function

- DNA & RNA- Nucleic Acids
  - Nucleus center of hereditary and cellular control
  - DNA structure & function
    - **DNA** is a polymer of nucleotides consisting of a sugar, phosphate group, & single or double ringed nitrogenous bases
    - **Pyrimidine**: single carbon-nitrogen ring
      - Cytosine & thymine
    - **Purine**: double ringed
      - Adenine & guanine
    - Double helix
      - Backbone of **deoxyribose** alternating with a phosphate group
      - Steps are the nitrogenous bases
        - **Base pairs**
          - A&T form two hydrogen bonds with each other
          - C&G form three hydrogen bonds with each other
          - **Law of Complementary Base Pairing**: one strand governs the next
      - Function: to carry genes for the synthesis of proteins
        - 20,000 genes = 2% proteins and 98% protein is non coding
  - Chromatin & Chromosomes
    - **Chromatin**: fine, filamentous version of DNA that form chromosomes
    - Non-dividing cells: chromatin looks like beads on a string
      - Each bead is a **histone**
        - Cluster of 8 proteins
        - DNA winds around histone 1.5 times
        - **Nucleosomes**: a core particle and a short segment of DNA linker
      - **Nucleosomes** are arranged in a zigzag pattern allowing chromatin to fold
      - 30nm strand is thrown into complex irregular loops, and coils that make chromosomes 300nm thick & 1000x shorter than DNA molecules
      - Each chromosome is packed into its own spheroidal region of the nucleus called **chromosome territory**
    - Dividing cells
      - DNA is replicated
      - Each chromosome has 2 sister chromatids
        - Pinched together by a **centromere**

- o Each side of centromere is a **kinetochore**
- o RNA Structure & Function
  - (Big-small) mRNA, rRNA, tRNA
  - Only a one nucleotide chain
  - Ribose sugar
  - Uracil instead of thymine
  - Disposable molecule that works in the cytoplasm
- Genes & Their Actions
  - o What is a gene?
    - “unit of heredity”
    - Don’t always code for protein
    - Overlap sometimes
      - Short ones embedded in bigger ones
    - **Gene:** an information containing segment of DNA that codes for RNA which then usually codes for a protein
  - o The Genome
    - 46 Chromosomes; 23 pairs
    - **Genome:** all DNA in 46 chromosomes
    - **Geonomics:** study of the whole genome and how its genes & noncoding DNA interact to affect the structure & function of whole organism
      - Humans have fewer than 100,000 genes
      - Genes generate million of proteins
      - Genes average 3,000 bases long, but range up to 2.4 million
      - All humans are 99.99% identical
        - o Single nucleotide **polymorphism** account for all human variation
      - Gene rich & gene poor chromosomes
      - Geonomic Medicine
  - o Genetic Code: a system that enables these 4 nucleotides to code for the amino acid sequence of all proteins
    - A sequence of 3 DNA nucleotides stand for one amino acid: **base triplets**
      - Called a **codon** in RNA
    - 61/64 code for amino acids
      - UAG, UGA, UAA are **stop codons**
      - AUG **start codon**
  - o Protein synthesis
    - Different genes are activated in different cells
    - mRNA is made when a gene is activated
      - nucleus  $\square$  cytoplasm
      - DNA  $\square$  RNA(transcription)  $\square$  protein(translation)
    - **Transcription:** copy genetics from DNA to RNA

- DNA too large to leave nucleus
- **RNA polymerase** binds to DNA sequence & assembles mRNA
  - Opens 17 base pairs at one time
- **Pre-mRNA**
  - Exons be translated into proteins
  - Introns must be removed before translation
    - Enzymes remove and degrade them
- **Alternative Splicing**: one gene can code for more than one protein
- **Translation**: converts language of nucleotides into language of amino acids
  - **mRNA** carries code from nucleus to cytoplasm
    - Protein cap acts like passport & recognition site to tell ribosomes where to begin
  - **tRNA**: bind free amino acids in the cytosol & deliver it to the ribosome to be added to a growing protein chain
    - Turns back and coils on itself to form an "L"
    - One loop is **anticodon**-complement to mRNA
    - First tRNA to bind to a ribosome is called **initiator tRNA**
  - Ribosomes: "reading machines"
    - Large & small subunits
    - Only come together when translating mRNA
    - 3 pocket for tRNA
      - A-site □ P-site □ E-site
  - Three Steps
    - **Initiation**: mRNA through nuclear pore into cytosol to form a loop
      - Leader sequence and small subunit bind on mRNA and slide until it finds start codon
      - Anticodon binds with start codon and slides into P-site
      - Large subunit joins
    - **Elongation**: tRNA arrives with another amino acid; binds to A-site and anticodon pairs with second codon of mRNA
      - Every time tRNA leaves E-site it goes to pick up another amino acid
        - Uses 1 ATP
      - Not super precise
    - **Termination**: reaches stop codon A-site binds a protein called a **release factor**