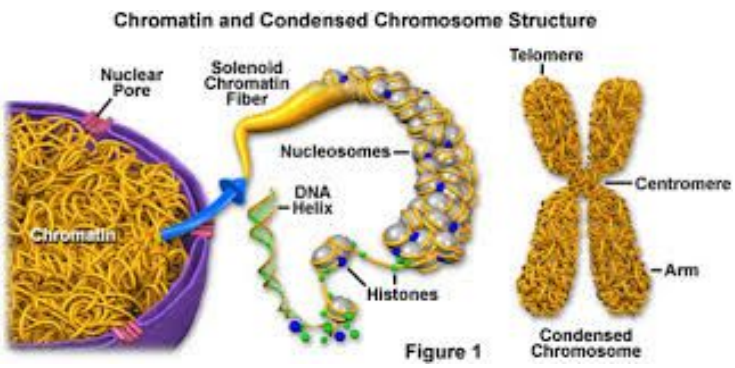
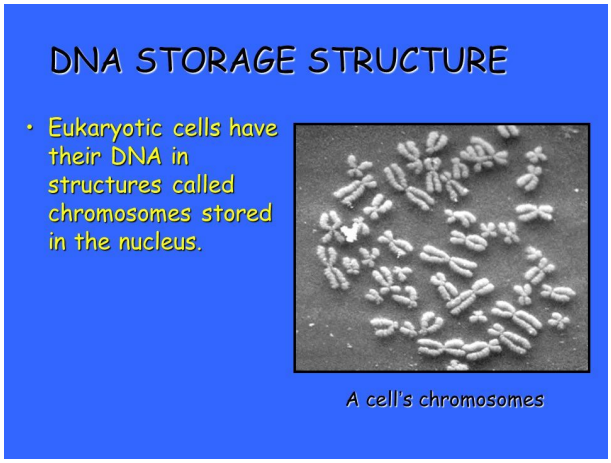
DNA

"Then I was beside Him [as] a master craftsman; and I was daily [His] delight, Rejoicing always before Him" Proverbs 8:30

- DNA controls heredity
- deoxyribonucleic acid: deoxyribose sugar + phosphate + nucleic acid
- Watson & Crick; each gene of an organism is the part of the DNA molecule that controls a particular trait
- every somatic cell contains 46 chromosomes in its nucleus; each cell contains all info necessary to manufacture all unique substances that make up the human body

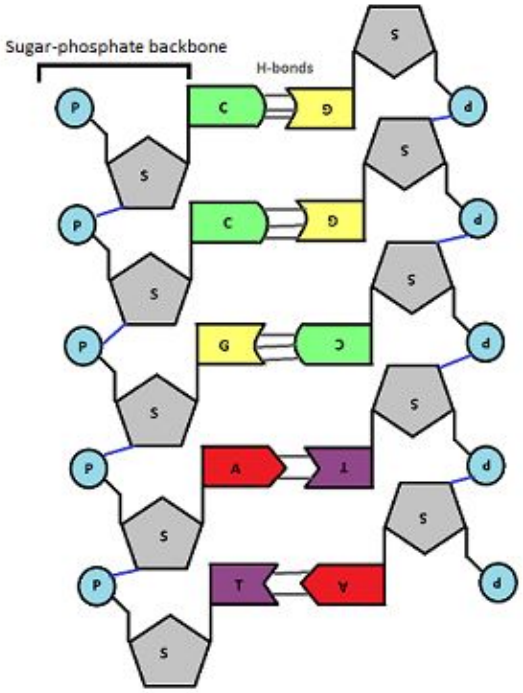
DNA Storage

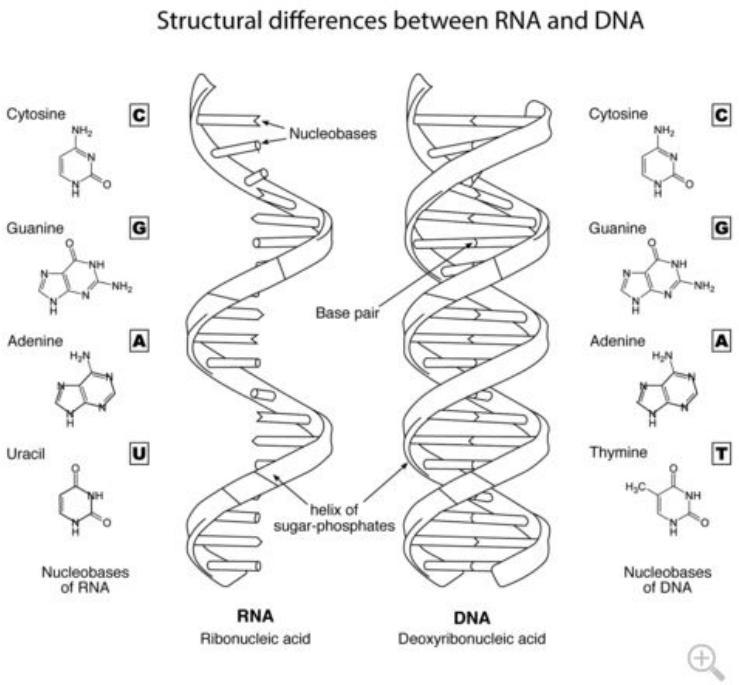




- histones: protein spools of coiled DNA
- nucleosome: groups of eight histone = nucleosome
- chromatin: DNA wrapped around histones
- when cell prepares to divide, nucleus coils the chromatin fibers into tight coils which are then bound into a large bundle --> these bundles of tightly coiled DNA are the chromosomes that are visible during mitosis and meiosis
- once a cell has divided, each daughter cell "unpacks" the DNA and stores it as chromatin

Structure of Nucleic Acids



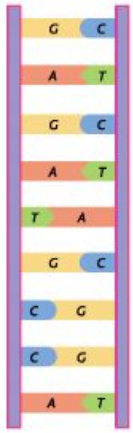


- RNA: ribonucleic acid; like DNA, composed of special molecules called nucleotides
- nucleotide: composed of three parts
  1) sugar molecule (deoxyribose in DNA, ribose in RNA)
  2) phosphate group
  3) nitrogen-containing base
- each DNA consists of two nucleotide chains that are twisted about one another like a twisted ladder: double helix
- strands forming legs of DNA ladder consist of nucleotide chains connected by bonds between sugar and phosphate molecules
- rungs consist of paired nitrogen-containing bases (base pairs)
- bases: guanine (G), cytosine (C), adenine (A), thymine (T)
  each rung composed of two bases, and only one type of base will fit another (A-T, G-C)
- RNA structure is similar to DNA except that RNA consists of only one strand instead of two; same bases (G, C, A) and uracil (U) instead of (T); U pairs with A

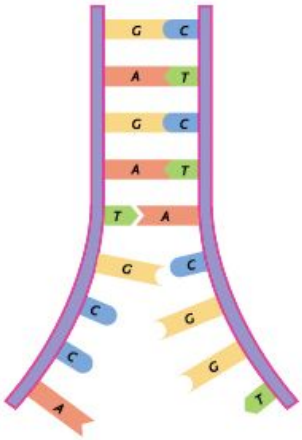
DNA Replication

- cell makes a copy of its DNA before replication
- occurs in S stage of cell life cycle (G1/S/G2/M)
- 1) unwind DNA into two separate strands
  2) polymerase attaches individual nucleotides to each separated strand of DNA, creating new complementary strands
- replication results in two identical DNA molecules identical to original molecule

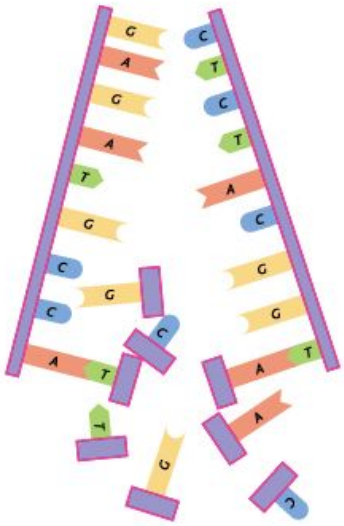
1 *A representative portion of DNA, which is about to undergo replication.*



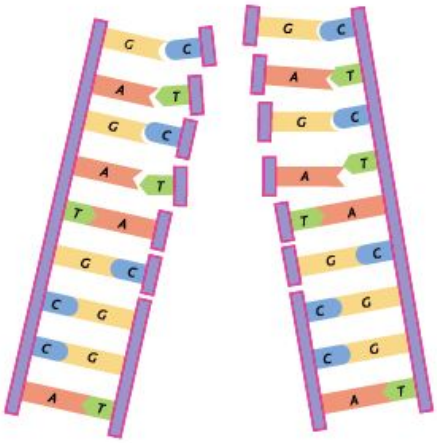
2 *The two strands of the DNA separate. The hydrogen bonds between the bases break.*



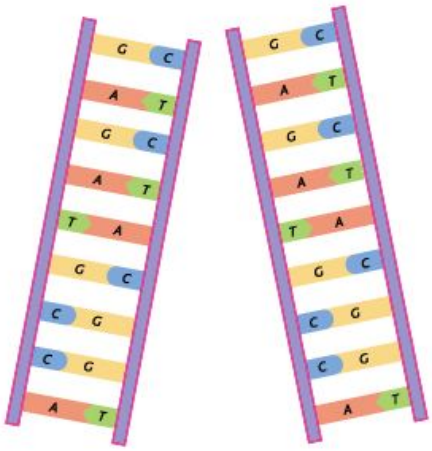
3 *Free nucleotides are attracted to their complementary bases.*



4 *Once the new nucleotides have lined up, they are joined together by the enzyme DNA polymerase.*

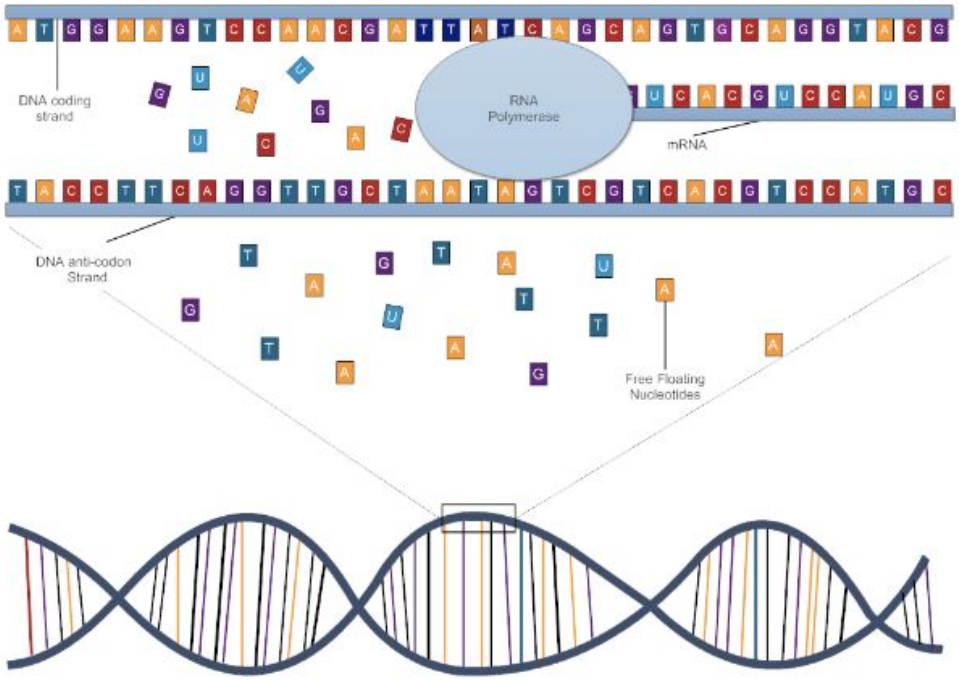


5 *Finally, all the nucleotides are joined to form a complete polynucleotide chain using DNA polymerase. In this way, two identical strands of DNA are formed. As each strand retains half of the original DNA material, this method of replication is called the semi-conservative method.*



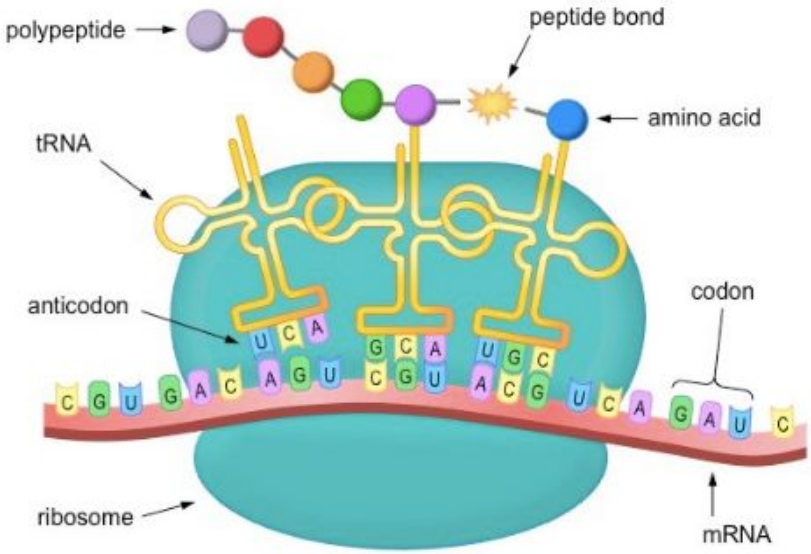
<u>RNA and Transcription</u>

- when new protein needed, DNA coding transcribed onto a messenger RNA (mRNA)
- molecule in nucleus then shipped to cytoplasm where used by ribosomes as template for new protein
- DNA segment unzipped allowing RNA copy then zipped back together
- same base pairing: A-U, G-C
- tRNA - transfer RNA collect free amino acid molecules and carry them to ribosomes to be assembled into proteins; each tRNA specific to one type of amino acid
- rRNA - ribosomal RNA serves as part of the ribosome structures



<u>Protein construction</u>

- codon: consecutive sequence of three nucleotides in mRNA that translates into one specific amino acid
- genetic code: table with all possible combinations of nucleotides and amino acids generated
- stop codons: UAA, UAG, UGA instruct ribosome to stop translation
  start codon: AUG indicates beginning of a protein and codes for methionine
- sequence translated by dividing sequence into consecutive triplets to code amino acids
- translation: process of synthesizing proteins from RNA pattern



Mutations

- error in replication resulting in random changes in DNA; base is added, deleted, or substituted
- result from improper base pairings or physical damage such as oxidation, radiation, or carcinogens
- can also involve deletions of entire genes
- mutation in gametes can be passed on to offspring
- almost always harmful to organisms

DNA Extraction

- During a DNA extraction, a detergent will cause the cell to pop open, or lyse, so that the DNA is released into solution.
- Then alcohol added to the solution causes the DNA to precipitate out.
- In this activity, strawberries will be used because each strawberry cell has eight copies of the genome, giving them a lot of DNA per cell. (Most organisms only have one genome copy per cell.)